

Terminal High-Altitude Area Defense (THAAD) and AN/TPY-2 Radar (Forward-Based Mode)

Executive Summary

- The Terminal High-Altitude Area Defense (THAAD) Project Office conducted one operational flight test in October 2015, in accordance with the DOT&E-approved Integrated Master Test Plan, intercepting two ballistic missile targets.
- The Army Test and Evaluation Command (ATEC) conducted a THAAD Reliability Growth Test (RGT) January 2015 through March 2015, which collected 922 hours of reliability data over 9 operational periods. This testing demonstrated some increases in reliability, with the notable exception of the launcher generators. The testing also revealed problems with the radar-to-operator interface.
- During FY15, THAAD participated in several Ballistic Missile Defense System (BMDS)-level ground tests, providing information on THAAD functionality and interoperability in various theater scenarios.
- The THAAD Program Manager continued to address the 18 material release conditions that need to be resolved before the Army will grant a Full Materiel Release for the first two fire units.

System

- THAAD is intended to complement the lower-tier Patriot system and the upper-tier Aegis BMDS; it can 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, other regional sensors, and through command and control systems.
- The AN/TPY-2 (Terminal Mode) radar is used by THAAD. This section also discusses the AN/TPY-2 Forward-Based Mode (FBM) variant of the THAAD radar. Operated by the Army, this mobile/transportable phased array X-band radar provides regional and strategic ballistic missile threat data to the entire BMDS through the Command and Control, Battle Management, and Communications (C2BMC) system. The AN/TPY-2 FBM variant of the THAAD radar is currently deployed in Japan, Israel, Turkey, and the U.S. Central Command area of responsibility.



Mission

- U.S. Strategic Command deploys THAAD to protect critical assets worldwide. U.S. Northern Command, U.S. Pacific Command, U.S. European Command, and U.S. Central Command will use THAAD to intercept short- to intermediate-range ballistic missile threats in their areas of responsibility.
- All Combatant Commanders will use the AN/TPY-2 (FBM) radar to detect, track, classify, and engage ballistic missile threats that target the United States and its allies, and to provide data for situational awareness and battle management through the C2BMC.

Major Contractors

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

Activity

- The Missile Defense Agency (MDA) conducted all testing in accordance with the DOT&E-approved Integrated Master Test Plan.
- ATEC conducted a THAAD RGT, which collected 922 hours of reliability data over 9 operational periods. This was the first test conducted with the new Configuration 2 hardware and software, which addresses a large number of obsolescence issues. ATEC conducted this testing January 2015 through March 2015 at McGregor Range, New Mexico.
- THAAD provided hardware-in-the-loop representations for two BMDS-level ground tests: Ground Test Distributed-04e (GTD-04e) Part 2 in January 2015, using version 2.2 software and Ground Test Integrated-06 (GTI-06) Part 1 in May 2015, using version 2.2 software. These tests provided information on THAAD functionality and interoperability in various theater scenarios.
- AN/TPY-2 (FBM) participated in several BMDS-level ground tests. Two U.S. Pacific Command AN/TPY-2 (FBM) CX-1.2.3 radars participated in GTD-04e Part 2 in January 2015, HWIL representations of the AN/TPY-2 (FBM) CX-2.1.0 radars were used in the GTI-06 Part 1 in May 2015, and a HWIL representation of an AN/TPY-2 (FBM) CX-1.2.3 radar was used in the GTI-06 Part 3 developmental test. In these tests, C2BMC tasked and managed the Kyoga-Misaki, Japan AN/TPY-2 (FBM) radar, two AN/TPY-2 (FBM) radars exercised boost phase cueing, and C2BMC managed radar data in a cross-area of responsibility data sharing environment.
- The THAAD program also conducted several smaller test events including missile round pallet transportation testing in February 2015, and environmental testing of the radar prime power unit in June 2015.
- AN/TPY-2 (FBM) CX-2.1.0 participated in Flight Test Operational-02 (FTO-02) Event 1 in June 2015 at the Pacific Missile Range Facility in Kauai, Hawaii. The MDA intended to demonstrate the operational capability of the regional/theater European Phased Adaptive Approach Phase 2 BMDS, anchored by the Aegis Ashore combat system, to defend Europe against medium-range ballistic missiles. The radar would have cued Aegis Ashore in a medium-range ballistic missile engagement. Due to a target malfunction, MDA did not complete this test but has rescheduled it for early FY16.
- The MDA conducted BMDS-level FTO-2 Event 2 and Event 2a in September and October 2015 at Wake Island and the broad-ocean area surrounding it. This test used THAAD version 2.7 software and Lot 4 interceptors. THAAD completed near-simultaneous engagements of two targets: a complex short-range ballistic missile target and a medium-range ballistic missile target. The engagement of the medium-range target followed the failure of an Aegis BMD Standard Missile-3 Block IB guided missile to intercept the target. An AN/TPY-2 (FBM) radar also tracked the targets.
- The MDA continues to accumulate contractor-collected reliability data and score the data for the deployed AN/TPY-2 (FBM) radars. The THAAD Program Office and BMDS

Operational Test Agency are also preparing for a 90-day reliability assessment period in FY16 to collect and compare reliability across the fleet of deployed AN/TPY-2 (FBM) radars.

Assessment

- FTO-02 Event 2 and Event 2a demonstrated that THAAD, AN/TPY-2 (FBM), and BMDS capabilities against theater/regional threats increased during FY15 and early FY16. THAAD Lot 4 interceptors, for the first time, hit one short-range and one medium-range threat-representative ballistic missile target while Aegis BMD simultaneously engaged an air-breathing threat with Standard Missile-2 (SM-2) Block IIIA guided missiles. An SM-3 Block IB with Threat Upgrade guided missile, which MDA intended to hit the medium-range ballistic missile target, failed early in flight. Full assessment of the FTO-02 Event 2 and Event 2a test mission data with respect to operational effectiveness, operational suitability, and interoperability is ongoing.
- ATEC collected RGT reliability data in a full battery configuration in an operational status and a desert environment with the new THAAD Configuration 2 hardware and software. In general, the system showed signs of reliability growth, although there were a few notable exceptions. There were an inordinate number of failures of the launcher generators. These failures do not necessarily cause system aborts, but the maintenance burden if these problems were to continue would be extremely high. ATEC also found that the radar does not properly alert the operators of the operating state of the radar.
- During GTD-04e Part 2 and GTI-06 Part 1, the BMDS Operational Test Agency reported several findings affecting both THAAD and AN/TPY-2 (FBM) that require further investigation. These findings affect volume of message traffic, radar resources, operator workload, deficient debris mitigation implementation, and deficiencies in cybersecurity scanning.
- The THAAD program continued work on achieving a Full Materiel Release of the first two THAAD batteries, which achieved a Conditional Materiel Release in February 2012. The THAAD Project Office continues to address the 18 open conditions that need to be resolved before the Army will grant a Full Materiel Release. Fixes and testing of the open conditions are scheduled through FY17. Of the original 39 conditions, 16 conditions were closed in FY12 – FY14 and 4 were closed in FY15:
 - Testing of the optical block in the missile Flight Sequencing Assembly
 - Establishing an institutional training base
 - Conducting a system supportability demonstration and modifying procedures based on the demonstration, as necessary
 - Providing and validating documented procedures for the Contractor Logistics Support personnel
 - Work also continues on additional materiel release conditions for follow-on THAAD software versions 1.3.1 and 1.4.0.

- The Army and MDA are also working on achieving Full Materiel Release of various versions of the AN/TPY-2 (FBM) software, and have made progress this year, although several of the conditions will take years to close. The materiel release conditions for version CX1.2.3_18 also includes the training and documentation required for Soldier operation of the radars. Soldiers began taking over some operations from contractors on some of the radars in July.

Recommendations

- Status of Previous Recommendations. DOT&E's classified February 2012 THAAD and AN/TPY-2 Radar OT&E and LFT&E report contained 7 recommendations in addition to the 39 Conditional Materiel Release conditions. In FY15, the MDA addressed one classified recommendation (Survivability #4) of the five remaining recommendations. The MDA should continue to address the two remaining classified recommendations (Effectiveness #2 and Effectiveness #5) and the two remaining unclassified recommendations. 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). Some, but not all, of these deficiencies have been addressed by hardware modifications included in THAAD Configuration 2. Conducting 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 additional testing is required.
 - The program addressed the FY13 recommendation to reassess their reliability and maintainability growth planning curves.
 - The program partially addressed the FY14 recommendation to conduct thorough end-to-end testing of the THAAD Configuration 2 that incorporates considerable obsolescence redesigns of hardware and software. The MDA should continue to plan to rigorously ground-test the THAAD system to verify that these changes can withstand the range of environments and conditions required.
- FY15 Recommendation.
 1. The MDA should prioritize flight and ground testing that involves THAAD and Patriot engagement coordination to ensure that information passed between THAAD and Patriot does not disrupt organic intercept capabilities or contribute to increased interceptor wastage and threat missile leakage. The Integrated Master Test Plan 17.1 includes Patriot and THAAD participation during the FTO-03 operational flight test.

FY15 BALLISTIC MISSILE DEFENSE SYSTEMS