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8 Images

Defensive weapons, United States

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Jane's Strategic Weapon Systems

Terminal High-Altitude Area Defence

Type TOP

Medium-range, ground-based, solid-propellant, theatre defence missile.

Development TOP

Studies began in 1990 for a Theatre (now Terminal) High-Altitude Area Defence (THAAD) missile system, to intercept tactical/theatre ballistic missiles or RVs, providing an area defence coverage. It is planned that THAAD will provide the upper layer of defence above existing Patriot, PAC-3 and other surface-to-air missile defence systems, intercepting ballistic missiles in the high endoatmosphere and exoatmosphere (over 120 km altitude). In 1992 Lockheed Martin was awarded a demonstration/validation contract for the THAAD missile, and Raytheon for the associated THAAD Ground-Based Radar. Discussions between the US Army and US Navy in 1994 considered the merits of developing a common ground-mobile and shipborne system, using a modified THAAD missile with a RIM-67 Standard Mk 72 boost motor assembly launched from the Mk 41 vertical launch system. The US Navy preferred the RIM-156 Standard SM-2 block 4 missile modified with an additional third-stage motor and a Lightweight Exo-Atmospheric Projectile (LEAP) kill warhead added, known as RIM-161 SM-3.

The THAAD system will comprise wheeled transporter-erector-launcher vehicles, a mobile surveillance, acquisition and tracking radar (THAAD-GBR, with the designator AN/TPY-2) and a battle management and communications system. It is planned that the THAAD system will interface with the existing Patriot and Standard/Aegis systems and share common target data with them. Early warning of ballistic missile launches could be provided for the THAAD system from DSP satellites or airborne early warning aircraft or UAVs, with target co-ordinates being passed to the THAAD radar.

The project definition and risk reduction phase was terminated early after two successful intercepts in June and August 1999, and the programme moved into the first phase of engineering and manufacturing development in June 2000. A new IIR seeker was included in the last four flight tests, but major design changes were made before the second flight test programme began. The programme was re-named in 2004, as the Terminal High-Altitude Area Defence (THAAD). A new mission computer, a reduced number of parts, increased divert thrust and fuel, improved TVC and a new cylindrical canister were developed, together with a significant reduction in the unit production cost. The minimum intercept altitude was also improved, believed to be down to around 20 km. The improvements will be divided into block 04 (configuration 1), block 08 (configuration 2) and block 10 (configuration 3) increments, with block 10 providing an increased range (perhaps with an additional stage or with a larger boost motor), and improved performance against decoys and debris. A larger diameter motor, 0.53 m, was ground tested in 2006 by Aerojet. The second phase of EMD started in 2003 and the first flight test was made in November 2005. All major components of the THAAD system are to be C-141 aircraft transportable.

Description TOP

The improved THAAD missile is a two-stage system, with the second stage a separating kinetic kill vehicle, with a total launch weight of 630 kg. In some short-range or low-altitude engagements, it is believed that the kill vehicle remains

attached to the boost motor assembly. The HTPB solid-propellant boost motor assembly has a thrust vector control system and a deployable flare skirt at the rear end to provide additional missile stability in flight at lower altitudes. A small interstage motor ensures that the first stage separates cleanly from the kinetic kill vehicle. THAAD is hot launched from its canister, which has been adapted from the ship Mk 41 VLS. The missile is believed to have a maximum velocity of 2.8 km/s, followed by a kinetic energy kill by direct impact on the target. The missile has no wings or fins and has a total length of 6.17 m, with a body diameter of 0.34 m. The kill vehicle has a length of 2.32 m and a maximum body diameter of 0.37 m. Guidance in mid-course is believed to include inertial, GPS and command updates. Terminal-guidance in the earlier kinetic kill vehicles used a Lockheed Martin gimbal-mounted platinum silicide focal plane multicolour IIR seeker, but the later kill vehicles used an indium antimonide 256 × 256 element focal plane array also used in the Israeli Arrow and US Standard SM-2 block 3B missiles. The seeker is inertially stabilised, gas cooled and has a filter switch that sets the gain for either endoatmospheric or exoatmospheric intercepts. The kill vehicle will be provided with a predicted intercept point and target object map prior to launch. The intercept point and target object map are then updated twice during the missile flight by commands from the THAAD radar, until the terminal guidance phase starts. The kinetic kill vehicle is protected by a conical shroud that opens in two halves during flight, allowing protection of the uncooled sapphire IR seeker window from aerodynamic heating at low altitudes. The kill vehicle has a Boeing Rocketdyne divert and attitude control system using liquid bi-propellants, with six thrusters for roll, pitch and yaw control and four divert thrusters. THAAD is expected to have a maximum range of 300 km, with the ability to intercept at altitudes from around 20 km up to 200 km. It is believed that salvo launches will be made, with an interval of 10 to 15 seconds between launches.

The block 10 missile is planned to include a larger motor, with a diameter of between 0.5 and 0.6 m, plus a third (kick) stage motor, to give a maximum range increased to 1,000 km. This version will have a new seeker window, upgraded software, an improved DACS and may be able to receive target updates from satellites. The maximum engagement altitude will be increased to 500 km.

The mobile THAAD transporter-erector-launcher vehicle will use the Oshkosh Heavy Expanded Mobility Tactical Truck with Load Handing System (HEMTT-LHS) M1075, to increase reload flexibility in the field. This TEL is a wheeled 4 × 4 vehicle, with two crew, the capability to carry eight missile canisters, and is C-130 and C-141 transportable. The missile canisters are raised to 80° elevation for launch. The pallet loading system will enable a complete reload to be accomplished in 30 minutes. The TEL is fitted with GPS and has a length of 12.0 m, a height of 3.25 m and a loaded weight of 40,000 kg. Eight missile canisters are loaded together onto a pallet for carriage in a C-141 aircraft. The TEL can be located up to 160 km from the radar and BMC2 vehicles, and up to nine TEL can be controlled within one fire unit or battery if required, but it is believed that the initial US Army batteries will have six TELs.

A companion programme to develop a combined surveillance/engagement radar, known as the AN/TPY-2 or THAAD Ground-Based Radar (GBR), uses an 8 to 12 GHz (X-band) single-face phased-array radar about 12.5 m long, mounted on a Heavy Expanded Mobile Tactical Truck and capable of being transported in a C-130 Hercules aircraft. The radar is non-rotating, with a 120° field of view and a crew of two. The roles include establishing a fence for early warning, tracking, discrimination, engagement, uplinks to the missiles, and kill assessment. The radar complex has five vehicles: the operator control centre, antenna, electronics unit, power supply and cooling trailers. The THAAD radar will provide uplink commands for the THAAD missiles to indicate the expected impact point and send target object maps to these missiles before the IR seeker starts to search for the designated target. The radar has an aperture of 9.2 m^2, a range of about 1,000 km and has 25,344 solid-state transceiver modules each with a power of 6 to 8 W. The radar is powered by a 1.3 MW advanced tactical generator powered by a diesel engine. The battle management and communications system (THAAD Fire Control and Communications) is distributed between two vehicle-mounted shelters with a crew of three, comprising a tactical operations centre, a communications relay and a sensor system interface. These standardised interface command post system shelters are mounted on HMMWV vehicles comprising the Tactical Operations Station (TOS) and Launch Control Station (LCS). Various software configurations are then used to perform the different THAAD systems functions within the vehicles. The THAAD system will be integrated with the US Navy Aegis weapon system so that the Cooperative Engagement Capability (CEC) can be used to cue the THAAD radar from AN/SPY-1 radar tracks, increasing the area defended by THAAD.

Specifications TOP

Length:	6.17 m
Body diameter:	0.34 m, motor assembly; 0.37 m, kill vehicle
Launch weight:	630 kg
Warhead:	Direct impact kill vehicle

Guidance:	Inertial, GPS, command with IR
Propulsion:	Solid propellant with liquid propellant kill vehicle
Range:	300 km
Surveillance/Engagement radar:	AN/TPY-2
Frequency:	8-12 GHz (X-band)
Peak power:	n/k
Range:	1,000 km

Status TOP

Contractor studies for THAAD started in 1990, with concept definition in 1991. A four-year demonstration/validation programme started in 1992 on the THAAD system, with up to 14 flight tests originally scheduled for 1995-97, but later extended into 1999. The first flight test was successfully completed in April 1995. The first launch from the Palletized Loading System TEL was made in March 1996 and the first using the THAAD radar directly in the engagement made in March 1997. By April 1999 nine test flights had been made, three tests without intercepts being attempted and with the last six attempted intercepts all failing to complete a successful interception. The ninth flight test, made in March 1999, used the new InSb seeker for the first time, although the same seeker was used on the eighth flight which was destroyed shortly after launch. The tenth and eleventh flight tests were made in June and August 1999, and both were successful and the flight test programme was terminated early to move forward into engineering and manufacturing development with a new build standard missile incorporating many improvements. Two development THAAD radars were delivered by Raytheon in 1996, and have been tested at the Kwajalain Pacific Test Range and at White Sands against closely spaced re-entry objects and during subsequent THAAD flight tests.

Phase 1 of the engineering and manufacturing development programme for the redesigned missile started in June 2000 and phase 2 continued in 2003, with the first flight test (FTT-01) made at WSMR, California in November 2005, but this was without a target. A second flight test (FTT-02), also without a target, was made at WSMR in May 2006. The third test (FTT-03) was made at WSMR in July 2006 and hit a unitary HERA target at around 90 km altitude. A planned test, FTT-04, was not launched as the target missile failed. The fourth test was in January 2007, numbered FTT-06, and was a high endoatmospheric intercept (around 80 km altitude) against a TT-1A Scud B type target launched from a barge on the Pacific Test Range at Kauai. The fifth test was in April 2007, FTT-07, and was a mid-endoatmospheric intercept at around 40 km altitude, also against a TT-1A target launched from a barge on the Pacific Test Range. The sixth test was in June 2007, FTT-05, and was a simulated low altitude intercept without a target, flown from WSMR. The seventh test was in October 2007, FTT-08, a low exoatmospheric intercept (around 120 km) against a TT-1B type target launched from a barge on the Pacific Test Range. An eighth test, FTT-09, was made in June 2008, and was a mid-endo intercept of a separated RV following a MRBM launch from a C-17 aircraft. FTT-10 was planned for September 2008, with two missiles to be fired in salvo, but the target failed and the test was not made. In March 2009 FTT-10 was re-flown, with a mid-endoatmospheric intercept at near maximum range, with two missiles fired in salvo. The first THAAD hit the target and the second hit a large piece of debris. FTT-11 was attempted in December 2009, but the target motor did not ignite after release from a C-17 aircraft. Two THAAD radars and six C2BMC groups were tested in 2005. A total of 14 development and operational evaluation tests were planned up to 2010. The initial short-range flight tests were held at the White Sands Missile Range, and the longer range flight tests will all be made from the Kauai Range in Hawaii, and initial equipment moves were made to Hawaii in October 2006, using a C-17 aircraft. The flight tests will be divided into three phases, with the first phase examining exoatmospheric and high endoatmospheric engagements, the second phase endoatmospheric engagements and the third phase more stressing targets including MRBM and countermeasures.

In August 2000, orders were placed for 30 missiles, with an option for 14 more, seven launch vehicles, three THAAD radars and six BMC3 shelter groups. Ten further missiles were ordered in January 2002. A total service inventory of 76 launchers, 10 radars, 38 TOS/LCS, 68 systems support groups and 1,250 missiles was planned, but will probably be adjusted. The US Army initially plans to field two THAAD battalions each with four batteries. Each battery will have one radar and six launchers, with a total of 135 personnel. Initial production was contracted in January 2007, with final assembly and test of the missiles at Lockheed Martin's plant at Troy, Alabama. This order included 48 missiles, six TEL and two FCC, with a planned initial in-service date for the first fire unit of 2009, and for the second fire unit of 2011. The first battery was established at Fort Bliss, Texas, in May 2008, and is part of the 4th Air Defense Artillery Regiment. The second battery was formed in October 2009. It was planned that some 25 missiles would be operational by December 2010, and 95 missiles operational by 2013. Two AN/TPY-2 radars were delivered in 2007, and these have been located at Vandenberg AFB, California, and in Japan. The block 10 capability is expected to enter service between 2012 and 2015. In September 2008, the UAE requested the purchase of 147 missiles, three fire units with nine TEL, four radars and three BMC2 sets plus support vehicles, test equipment and training. An unconfirmed report in 2009 stated that

Japan was interested in ordering THAAD systems.

Contractor TOP

Lockheed Martin Electronic Systems, Missile and Fire Control

Dallas, Texas.

(THAAD missile and system)

Raytheon Systems Company

Bedford, Massachusetts.

(AN/TPY-2)

A trials THAAD radar vehicle complex; front left is the antenna, mid-left the electronics unit, upper left the operator control centre vehicle, mid-right the cooling unit and far right the power supply unit (Raytheon)

0022201

Two standardised interface command post system shelters on HMMWV comprising the THAAD tactical operations station and launch control station

0517680

The original THAAD missile during the third test flight, October 1995 (Lockheed Martin)

0517886

Diagram of the THAAD missile (Peter Humphris)

0517887

A THAAD radar antenna unit, a single face phased-array assembly (Raytheon)

0022200

A THAAD TEL vehicle, with eight launch canisters (Lockheed Martin)

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The FTT-06 THAAD missile during final assembly and test (Lockheed Martin)

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Launch of a THAAD interceptor in March 2009 (US Missile Defense Agency)

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