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BALLISTIC MISSILE DEFENSE 4:[1]
TERMINAL-PHASE INTERCEPTS

Compiled by Bob Aldridge

Terminal-phase intercepts take place during the last 30 seconds of a target warhead's flight, while it is reentering the earth's atmosphere. Except for the Navy Theater Wide defense, now known as the Sea-Based Midcourse Missile Defense which has been transferred to the Midcourse-Intercepts segment, the systems in the Terminal Defense segments are the same as those that were in the old Theater Missile Defense. They are the Patriot Advanced Capability Level 3 (PAC-3) system, the Medium Extended Air Defense System (MEADS), and the Theater High Altitude Area Defense (THAAD) system. Another system, the Navy Area Defense (NAD), was once part of the terminal defense segment but was canceled in December 2001 for excessive and unsatisfactory performance. All are endoatmospheric interceptors except THAAD, which is exoatmospheric.[2] The fiscal year 2002 Missile Defense Agency (MDA -- formerly Ballistic Missile Defense Organization) budget request contains $968 million for terminal defense. This funding does not include PAC-3 or MEADS, which have been turned over to the Army for funding and management. Most of the MDA request will go to the THAAD program.

PATRIOT ADVANCED CAPABILITY LEVEL 3 (PAC-3) SYSTEM

MDA has turned the PAC-3 program over to the Army to administer, and funding for the program will be through the Army.. The PAC-3 interceptor, using the Lockheed Martin Extended-Range Interceptor (ERINT), is guided by aerodynamic fins and carries a hit-to-kill warhead. Operational PAC-3s are to be 17 feet long and weigh 640 pounds. They will have a 35-kilometer (22-mile) range. Hit-to-kill warheads use sensors to locate and home on the target while small rocket thrusters maneuver onto a collision course. Destruction is accomplished by the energy of impact.

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[1]This is the fourth in a set of four papers. The set includes:

PLRC-010821 -- Ballistic Missile Defense 1: BMD Structure, Battle Management, and Sensors.
PLRC-010822 -- Ballistic Missile Defense 2: Boost-Phase Intercepts.
PLRC-010823 -- Ballistic Missile Defense 3: Midcourse-Phase Intercepts.
PLRC-010824 -- Ballistic Missile Defense 4: Terminal-Phase Intercepts.

[2]Endoatmospheric interceptors engage their targets within the earth's atmosphere. Exoatmospheric interceptors engage them above the atmosphere, or outside the atmosphere.

Sixteen PAC-3 interceptor missiles can be loaded on a Patriot launcher vehicle, compared to only four of the earlier Raytheon-built PAC-1 or PAC-2 missiles which used an explosive warhead. A Patriot battery consists of a fire-control radar set, an antenna mast group, an engagement control station, an electrical power plant, and eight launcher vehicles.

Lockheed Martin Missiles and Fire Control (Orlando, FL and Dallas, TX) is the contractor for the Patriot PAC-3 interceptor. Raytheon Company (Lexington, Massachusetts) manufactures the Patriot launchers, the fire control vehicle with its small phased-array radar, and the engagement control vehicle with computers and displays. All of these are refurbished existing equipment except for the interceptors. Boeing Electronic Systems and Missile Defense is responsible for the seeker (sensor) which guides the warhead to the target. Subcontractors for the PAC-3 system include:

ARC (unit of Sequa Corp.) -- Attitude control motors.

Lucas Aerospace Power Systems (Aurora, Ohio) -- Azimuth and Elevation actuators and motor controllers for the PAC-3 launcher. ($1.9-million contract awarded in April 1995)

R-Cubed Composites (Salt Lake City, Utah) -- Composite launch tubes. ($2 million for engineering and manufacturing development)

On 26 October 1994 Loral Vought Systems (now Lockheed Martin) received a $515 million contract for engineering, manufacture and development of the PAC-3 interceptor, also known as the Extended-Range Interceptor (ERINT). A $31.4-million, 47-month contract modification was awarded in February 1996 for continued engineering and development. The US Army received the Pentagon's approval on 12 October 1999 to move into low rate initial production of 20 missiles. Initial operation is expected in fiscal year 2002 with procurement extending through 2010.

The Army originally estimated a need for 2,200 PAC-3 to meet the two-war criteria, but only planned for 1,200. That would lower the price to $2 million for each interceptor, as opposed to $5 million during the development stage. The quantity of PAC-3s was later cut to 1,012. Pentagon budget plans for 2002 only support 966 interceptors to be purchased between 2003 and 2010. That means the unit price will be higher.

Total cost estimate for the PAC-3 system has risen from $3.6 billion in 1994 to $6.9 billion in March 2000, and is now estimated at $7.4 billion. According to the US General Accounting Office (GAO), costs will continue to rise because contractors costs could exceed current estimates, as many as 12-15 additional flight tests are being considered, and the risks and schedule delays associated with missile development.[3]

Congress appropriated $555 million ($349 million for procurement) for PAC3 in fiscal year 1998 and $570.5 million ($248.2 million for procurement) in fiscal year 1999. However, $60 million of the procurement funds for that year had to be used to pay for contractor overruns in research and development. The fiscal year 2000 request was $330 million with $300.9 million of that for procurement of missiles. The fiscal year 2001 appropriation was $446.5 million. In addition, a fiscal year 2000 supplemental of $125 million was also passed by Congress for "unfunded requirements."

40 PAC-3 interceptor missiles were procured in fiscal year 2001 and the fiscal year 2002 budget has $858 million earmarked to buy 72 interceptors, for both the PAC-3 program and MEADS (see below). From there on, the quantities to be procured are 43 in 2003, 72 in 2004, 131 in 2005, and 144 per year for 2006 through 2010. The Pentagon now wants 1.090 PAC-3 interceptors to be

[3]GAO/NSIAD-00-153, p. 3.

delivered by 2012. Full rate production was scheduled for the end of 2001 but "problems with systems reliability and difficulties in flight intercept tests have delayed that schedule."[4] Full scale production is now planned for the fall of 2002.

The first development flight test took place at White Sands, New Mexico, in October 1997. The first two tests were to verify missile performance with the remaining 16 flights as intercept tests against various targets. It is reported that successful intercepts of a Hera target ballistic missile took place at White Sands Missile Range, NM on 15 March 1999, 16 September 1999, 5 February 2000, 14 October 2000, and 31 March 2001. Two reported successful intercepts of MQ-170 drone cruise missiles took place on 22 and 28 July 2000. On 9 July 2001 a PAC-3 interceptor downed a remote-controlled F-4 aircraft but a second interceptor missed a target missile. On 19 October 2001, the PAC-3 intercepted a BMQ-74 cruise missile target drone. The program now moves into the operational test phase. Low rate initial production is already underway.

In September 2001, he PAC-3 was declared initially operational with 16 missiles deployed. Operational tests then began.

Nothing has been promulgated about the first three operational tests but, presumable, they were not intercept attempts. The fourth operational test of the PAC-3 system took place on 30 May 2002 over the Pacific. The plan was to launch two PAC-3s in rapid succession at a modified Minuteman missile. One intercepted the target but the second (the 5th operational test) failed to launch.

In his 25 June 2001 briefing, Lt. General Ronald Kadish touted the PAC-3 as having 9 successes out of 10 intercept attempts. He didn't say that 4 of the successes were against drone aircraft that are nowhere near the complexity to intercept as ballistic missiles. And he conveniently didn't even mention the 11th test (5th operational test) which failed to launch. Depending on what the MDA considers a success, the PAC-3 record is still pretty impressive, but this illustrates how programs can and will be hyped.

MEDIUM EXTENDED AIR DEFENSE SYSTEM (MEADS)

MDA has turned MEADS over to the Army for management and funding. MEADS is to be a rapidly deployable and highly mobile TMD system for use against tactical missiles or aircraft. It is to protect troops at the Corps level and was intended as a replacement for the old Hawk Air defense system. MEADS is being designed to traverse rough terrain with maneuvering troops and provide 360^0 protection. Because of its logistics versatility, it will have a smaller coverage than the Patriot PAC-3 system, although it will use the PAC-3 missile. (At the US Army's insistence, the Pentagon has mandated that the MEADS interceptor will be the Patriot PAC-3 but with a smaller and lighter launcher that is more mobile. Germany and Italy were forced to agree or the US would withhold funding.) There will be up to 16 missiles per launcher and well over 100 in a battery.

MEADS International (Orlando, FL) is a three-nation joint venture. The prime contractors are Lockheed Martin Missiles & Fire Control (Orlando, FL and Dallas, TX), Alenia Marconi Systems (Rome, Italy) -- a joint venture between BAE SYSTEMS, (Farnborough, England) and Finmeccanica SpA (Rome, Italy) -- and LFK-Lenkflugkorpersysteme GmbH (Munich, Germany).[5] The US will

[4]Coyle.

[5]The European contractor for MEADS is called EuroMEADS GmbH (Munich, Germany). It is composed of Alenia Marconi Systems and Lenkflugkorpersysteme GmbH, a subsidiary of EADS (European Aeronautic

fund 55 percent of the program, Germany 28 percent, and 17 percent by Italy. Development cost is estimated at $5 billion with the design phase consuming half of that. The 1996 estimate for developing and producing 100 complete MEADS systems, 60 for the US and 40 for Europe, was estimated at US$40 billion over 15 years. This was based on the PAC-3 missiles costing $2 million each. The rise to $3 million per copy is causing an uproar in the MEADS program. Almost 50 % of the work will be done in the US.

A three-year, $217 million contract for the risk reduction phase, focused on highly maneuverable technologies to protect an Army Corps, was to be signed in July 2000. However, internal disagreement within the German government over how many missiles it can afford, if any, has caused a series of postponements to this contract. The latest date for signing, 20 June 2001, has again been postponed for at least 3 months. Then on 27 June 2001 the German parliament approved participation in MEADS and the program went ahead.

The design and development phase is scheduled to start in 2004. The partners will determine how many units will be built and who will build what. So far no one has firmly committed to buying a certain number. They will also determine the technology each partner will own.

Following the design and development phase will be the production phase with deployment around 2011.

NATO and the European MEADS partners are looking into a cheaper interceptor to supplement PAC-3. It could be fired from the same launcher or from a different launcher, but would in either case use the MEADS radar and control systems. The cheaper interceptor would be used against lower speed targets such as airplanes.

THEATER HIGH ALTITUDE AREA DEFENSE (THAAD)

Although still administered and funded by MDA, THAAD is an Army system. It is a ground-based, exoatmospheric interceptor which will defend a larger area than PAC-3 – over distances of 193 kilometers (120 miles) and at altitudes in excess of 145 kilometers (90 miles). THAAD will use the hit-to-kill technique to destroy Scud-type missiles, with ranges up to 1,050 kilometers (650 miles), with collision energy. THAAD cannot be deployed independently -- it has to be deployed with Patriot or some other lower-tier defense system because it needs that defense to protect it against aircraft and cruise missiles. Each THAAD launcher will hold 10 interceptors. There will be nine to thirteen launchers in a battery, plus a tactical operations center and an X-band Theater Missile Defense-Ground Based Radar (TMD-GBR).

Lockheed Martin Space Systems Company (Sunnyvale, California) is the prime contractor for THAAD. It has built a new "Courtland Plant" 40 Miles west of Huntsville, Alabama to handle THAAD work. While THAAD sales to the Pentagon will be substantial, Lockheed Martin believes that sales to other countries will amount to several billion dollars and could exceed Pentagon purchases. Supporting subcontractors for THAAD are:

Aerojet Division of GenCorp (Sacramento, California) -- Gel propellant for attitude control system
Dornier GmbH. (Germany)
Honeywell Space Systems Group (Clearwater, Florida) -- Missile avionics
Sanders (Nashua, New Hampshire) -- Kill vehicle's infrared seeker.

Defence and Space Company) (Munich, Germany).

Training and special test equipment. (A subsidiary of Lockheed Martin purchased by BAE Systems North America (Rockville, Maryland).)

Northrop Grumman's Electronic Systems Integration Division (Bethpage, New York) -- Infrared focal planes w/signal process capability. Major portions of battle control station

Oshkosh Truck Company -- Army 10-wheel drive palletized load system truck modified as a transporter/launcher for THAAD.

Boeing Co, (Canoga Park, California) -- Kill vehicle's maneuvering and attitude control system

United Technologies Chemical Systems Division (San Jose, California) -- Thrust-vectoring rocket booster. Conducts rocket motor tests.

Westinghouse Marine Division (Sunnyvale, California) -- Missile's protective launch canister

Raytheon Company (Lexington, Massachusetts) -- TMD/GBR (X-band radars).

The first part of the prime contract was to built 20 missiles to be test flown at White Sands, New Mexico, and delivery of a prototype battery. The Pentagon hopes to eventually buy 1,422 THAAD missiles, 99 launchers, and 18 radars. That is enough to support testing, a "deployable prototype" unit called the User Operational Evaluation System (UOES), plus two operational THAAD battalions. The UOES will consist of 40 missiles on four launcher vehicles, two TMD-GBRs, and two Battle Management/Command, Control and Communications Units (BM/C3 -- all refurbished development equipment except the 40 missiles).

The first two tests of these 19-foot interceptors with a maximum speed of 3 kilometers per second, took place on 21 April 1995 and 31 July 1995 at White Sands Missile Range in New Mexico. They merely demonstrated that THAAD can fly, maneuver, and separate the kill vehicle. The first was reported successful but the second failed. On 13 October 1995 a retest of the failed flight took place and was reported successful.

The remaining development flight tests were to use the missiles' infrared sensors to engage targets. The first 6 of these (13 December 1995, 22 March 1996, 15 July 1996, 6 March 1997, 12 May 1998, and 29 March 1999 -- all at White Sands Missile Range) failed to intercept the target. The score: **six attempts, six consecutive failures.**

During this parade of follies the Army kept postponing which test would qualify moving into production of UOES interceptors -- all the time cutting corners and justifying more tests in order to compete with the Navy for the upper-tier interceptor. The US General Accounting Office faulted this activity:

> DOD will commit funds for producing 40 UOES interceptors well before testing provides assurance of the UOES system's capabilities. Our work has repeatedly shown that when production of weapons systems began on the basis of schedule or other considerations rather than on the basis of technical maturity, major design changes were often needed to correct problems. The design changes frequently led to additional testing and costly retrofits to units already produced.[6]

Again in 1997 the GAO gave a warning about early production of THAAD hardware. It pointed out that: “The last approved THAAD acquisition plan calls for significant production of deployment

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[6]GAO/NSIAD-97-137R, pp. 1-2. Also see GAO/NSIAD-95-18, 21 November 1994.

hardware almost 2 years before beginning independent operational testing to assess the system's operational effectiveness."[7] That same GAO report pointed to another critical test parameter which has been glossed over and eliminated:

> A suitable target for testing the THAAD system against longer range missiles does not exist, and funds have not been requested for target development and production. Without a longer range test target to represent the more formidable higher velocity missiles that THAAD could face, the system's operational effectiveness will remain in doubt and DOD will not have reasonable assurance that it could rely on THAAD in an actual conflict.[8]

After some modifications to the interceptor, THAAD finally intercepted a target missile on 10 June 1999. Another intercept was reported on 2 August 1999. After these two amazing successes (after six failures spanning almost four years) the Army decided the program was so spectacular that the final flight tests would not be necessary. Instead, after a program review in May 2000, THAAD would move into the Engineering Manufacturing and Development phase with limited production of the UOES, the deployable prototype. THAAD has not been tested since 1999.

Criticism of this profit motivated and politically oriented decision came even from inside the Pentagon. Phillip E. Coyle III, then Director of Operational Test and Evaluation for the Pentagon, called the tests "highly scripted" and nowhere near the real situation that would be encountered with actual hostile missiles.[9] He recommended more realistic tests against longer range and faster missiles -- possible in the Pacific Missile Range -- before starting even limited production. He also pointed out that the THAAD missiles used at the White Sands Range were prototypes which are not of the configuration that will be deployed. Luke Warren of the Council for a Livable World said in a more direct manner that if the tests "aren't exactly rigged, they are set up not to fail."[10] It is probable that the target vehicle and interceptor were rigged, as described for the Ground Based Interceptor used in the Midcourse phase.[11]

The Pentagon has spent $4 billion on THAAD so far with only a (arguably) 25 percent success rate to show for it. The estimate for THAAD acquisition and 20 years of operation is now set at $23 billion ($4 billion already spent, $4 billion for Configuration-1 development, $2 billion for Configuration-2 development, $6 billion production of missiles, and $7 billion for 20 years of operation). The Configuration-1 interceptor missiles are expected to cost $5 million - $7 million each. That is expected to go down to $1.8 million each for Configuration-2 interceptors.

A revised acquisition strategy for THAAD is now in place. "Configuration-1" is to be in place by 2008 to meet basic threats. It will include a launcher, interceptors, a TMD/GBR, and a BM/C3 unit. "Configuration-2" is to be in place by 2011 to meet more advanced threats with sophisticated countermeasures. However, "no flight intercept test is scheduled until 2004 and it is therefore unlikely that the first THAAD system will be deployed before 2010."[12] In addition, THAAD's requirements have been relaxed to only intercepting warheads above the earth's atmosphere

[7] GAO/NSIAD-97-188, p. 3.

[8] GAO/NSIAD-97-188, p. 3.

[9] Cited in *Mercury News*, 24 August 1999, p. 6A.

[10] Cited in *Mercury News*, 24 August 1999, p. 6A.

[11] See PLRC-000622 on National Missile Defense.

[12] Coyle.

(exoatmospheric) -- it no longer is a requirement to make interceptions after the target has reentered the atmosphere.

On 28 June 2000, Lockheed Martin signed a $4-billion. 8-year contract with the US Army for full-scale Engineering Manufacturing and Development for Configuration-1. This will include 27 flight tests with the first in 2004. The first intercept attempt is planned to take place at White Sands Missile Range, New Mexico in 2006. The next two will take place from Kwajalein Atoll in 2007.[13] Under the Bush administration, THAAD is expected to be operational in 2011.

THAAD is estimated to cost $23 billion over its 20-year lifetime ($4 billion already spent on the risk reduction phase, $4 billion for the current Engineering Manufacturing and Development phase, $2 billion for follow-on development for Configuration 2, $6 billion for all production costs, and $7 billion to operate the complete system for 20 years).

THAAD seems to be more of a corporate golden goose than anything designed to protect against an enemy attack. A senior democratic senator's aide said anonymously: "The taxpayers have paid for something we still don't have."[14] The report from an expert study group chaired by Air Force Lt. Gen. Larry Welch (ret) described the push to deploy THAAD and other hit-to-kill vehicles as a "Rush to failure."[15] In His 14 February 2000 report to Congress entitled *The Annual Report of the Director, Test and Evaluation*, Philip Coyle called for a comprehensive ground test program for THAAD, followed by as many as 27 flight tests before the missile is approved.[16]

The fiscal year 2001 appropriation for THAAD was $549.9 million. For fiscal year 2002 it was boosted to $923 million to accelerate testing and deployment by one or two years.

FUNDING ISRAEL'S BMD PROGRAMS

Two Israeli BMD programs have had huge support from the US. They are the US-Israeli Arrow interceptor program and the Tactical High Energy Laser (THEL).

1. US-Israeli Arrow Program.

Arrow is a joint US-Israel ATM interceptor program started in 1988. Arrow is designed to intercept tactical missiles at altitudes of about 48 kilometers (30 miles) with a speed of Mach-9. This allows time for a second Arrow interceptor to be fired if the first one fails to destroy the incoming warhead. Arrow is to protect against such weapons as Iraq's El-Hussein and Scud-3 missiles as well as Iran's 1,300-kilometer (810-mile) range Shihab-3 missiles. A dual-mode seeker (radar and infrared) acquires the target and a proximity-fused explosive warhead destroys it with fragmentation. Arrow warheads use the THAAD focal plane array. Arrow as presently deployed is not a mobile missile but will defend Israel from fixed sites. Further improvements to the design are necessary to meet future threats of longer range and more advanced missile systems, such as Iran's COSAR and Shihab-4 or possible exports of North Korea's Taepo-Dong.

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[13]This was the schedule under the Clinton administration. The Bush administration has not announced any change.

[14]Cited in *Mercury News*, 9 July 1998, p. 3C.

[15]Cited in *Defense News*, 21 February 2000, p. 26.

[16]*Defense News*, 28 February 2000, p. 3.

The US has no plans to deploy Arrow but supports it. It is also important to the US that the Israeli system interoperate with US anti-missile systems. Israel Aircraft Industries of Lod is prime contractor for the Arrow missile. The missile's Green Pine early-warning and fire-control radar is manufactured by Elta Electronics Industries Ltd. of Ashdod, a subsidiary of Israel Aircraft Industries. The Citron battle management system is made by Tadiran Electronics Systems Ltd in Holon. US participation is directed and funded by the MDA and managed by the US Army.

Israel's updated estimate of the cost of the Arrow system through 2010 is US$2 billion, of which about 45% is funded directly by the US and more through multi-billion dollar military aid packages to Israel from the US each year. Congress appropriated $82.7 million for Arrow in fiscal year 2000, and $53 million in fiscal year 2001. The fiscal year 2000 US budget for Arrow is $131.7 million -- $97.7 million for Arrow system improvements and $34 million as the final payment for Israel's third Arrow missile battery. That is in addition to approximately $2 billion in Foreign Military Financing aid Israel is expected to receive from the US in 2002. Israel is also negotiating to test the Arrow against an actual Scud missile at some US test range -- possibly the Pacific Missile Range Facility near Hawaii.

The Arrow system -- known as Homa, for Great Wall -- presently includes Arrow-2 missiles, the Green Pine radar, and the Citron Tree command & control system. Israel has developed the latter two but wants to buy a larger missile early warning radar from the US. Raytheon's two-faced PAVE PAWS phased array radar is a possible choice.

In March 2000 the first of three Arrow batteries -- each composed of launchers, missiles, two ground-based radars, and a command center -- was handed over to the Israeli Air Force. Israel has not announced how many missiles will be built or where they will be stationed, but at least 50 missiles will be in each battery.

Arrow is touted as one layer of a multi-layer defense system. During the handover ceremonies, Israeli Air Force Commander , Major General Eitan Ben-Eliahu said there is a long and expensive road ahead -- although Israel now has the Arrow-2, it will need and Arrow-3 and Arrow-4.

Israel wants to sell the Arrow system to other countries and the US has approved providing at least 51% of the missiles are produced in the US. Potential buyers are Turkey, India, Japan, South Korea, and Taiwan. Later, however, the US government showed concerns over potential transfer of sensitive technology to Israel. Regardless of intended use, the Arrow missile could deliver a 500-kilogram (1,100-pound) payload over 300 kilometers (186 miles), and that puts it under the Missile Technology Control Regime (MTCR).

In January 2002 it was announced that Boeing had reached agreement with Israel Aircraft Industries Ltd. (IAI) to produce Arrow missiles without violating the MTCR. Boeing would manufacture 51 percent of the missile and ship it to Israel where IAI would produce the other 49 percent and assemble the missile. By only exporting parts, rather than the entire missile, the letter of the MTCR was skirted. Israel hopes that the US will contribute $100 million annually toward Arrow production for the next four years. This agreement still does not satisfy MTCR requirements that would allow Arrow sales to third parties such as India or Turkey. Such sales have still not been approved by the US government.

In July 2002 Raytheon Co. sent Congress a paper objecting to Israel selling the Arrow missile to third parties. What was obviously a competitive battle with Boeing (the Arrow contractor) over the business market, Raytheon stated that exporting Arrow parts could undermine market opportunities for other US products, thereby jeopardizing American jobs and resulting in higher cost for the US military to obtain these products. Raytheon was referring to missile interceptors such as PAC-3 and THAAD, which it manufactures.

The Israeli navy is also trying to get into the act with initial studies for a sea-based ABM system. The Arrow is a possible candidate for a sea-based interceptor. Israel's DOD are not encouraging, however. Arrow was previously studied for sea operations and was determined to not be cost effective. The threat is coming from the wrong direction for a sea-based ABM to do much good.

2. US-Israeli Tactical High Energy Laser (THEL).

The Tactical High Energy Laser (THEL) is a follow-on to the joint US-Israel Nautilus program. Knowledge from the US Army's Mid-Infrared Advanced Chemical Laser (MIRACL) -- a ground-based laser which was developed and tested by TRW Space & Electronics Group (Redondo Beach, CA) during the 1980s Star Wars era -- was applied to the Nautilus Program which on 9 February 1996 reportedly destroyed a stationary Katyusha rocket by heating the target warhead until it exploded. TRW Space & Electronics was the US contractor. The test was conducted at the US Army's Space and Strategic Defense Command's High-Energy Laser Systems Test Facility at White Sands Missile Range, New Mexico. THEL is now being developed by TRW Space & Electronics to defend Israel's northern border against the small, 120-mm (4.7-inch) diameter Katyusha rockets fired by Hezbollah guerrillas from Lebanon. Israel's recent withdrawal from southern Lebanon has added a perceived urgency to deploy THEL as an anti-rocket defense.

THEL is a ground-based laser which includes command, control, communications and intelligence systems as well as the fire-control and target acquisition radar Israel developed for the Arrow program, and a laser pointer/tracker. The laser can fire 60 shots without reloading, at approximately $3,000 per shot. Although it's elements can be transported from place to place by cargo planes, ships, and tractor-trailer rigs, it is not a mobile system.

THEL is funded jointly by the US and Israel, and is managed by the US Army, although not for US use. $201.8 million has been spent on the program since its inception in July 1996. Israel has provided $67.5 million of that amount. There is no funding requested for THEL in the Pentagon's 2002 budget.

THEL's first successful laser test took place at TRW's Capistrano Test Facility on 26 June 1999. A prototype system was reported successful against a stationary Katyusha rocket at White Sands Missile Range in late April of 2000. The first live-fire test against a Katyusha artillery rocket on 22 May 2000 was a failure but was not reported to the media until a successful test took place at White Sands Missile Range in New Mexico on 6 June 2000. On 28 August 2000, THEL shot down two Katyusha rockets that were in the air at the same time. In September 2000 two tests were conducted. In the first, THEL shot down one rocket and shot at the second but did not destroy it. In the second test one rocket was destroyed but THEL failed to track the second. Testing was then suspended to investigate these failures. Now it is reported that on 22 September 2000 THEL again shot down two targets. Tentatively, THEL will be dismantled and sent to Israel by the end of February 2001. However, if the US reaches agreement with Israel, THEL might be kept her a year or so longer to develop a mobile system.

In June 1998 it was revealed that a highly secret study was under way to convert THEL to handle medium-range SCUD missiles and longer-range missiles such as Iran's Shahib, and to make it a truck-mobile system designated MTHEL. A prototype system that will satisfy both US and Israeli requirements is estimated to cost $200 million. On 12 June 2001 the US Army awarded a $5.6 million modification to a previous contract to TRW for a system engineering trade study of MTHEL. The work is to be completed by 1 December 2001.

Yiftah Shapir of the Jaffee center for Strategic Studies (Tel Aviv) reported on 26 May 2000 that THEL is neither practical nor cost effective. It is not practical because each truck mounted system can launch 40 of these 120-mm (4.7-inch) diameter rockets without reloading, and that a typical Katyusha battery comprises six trucks which can ripple fire 240 rockets. Shapir points out: "It takes between 2 to 3 seconds to melt down a Katyusha in midcourse, while the whole trajectory is something like 30 to 40 seconds. When you have 240 rockets flying at you, how many of those can you shoot down?"[17] He then answers his own question, estimating that only 10 of the 40 from one truck could be intercepted. Jaffee Center estimates are that the Hezbollah have 20 such trucks and Syria could immediately supply them with more from its inventory of 250.

Major General Gaby Ashkenazi, commander of the Israeli Defense Force's Northern Command. expressed similar reservations on 4 September 2000. He said THEL batteries would have about 30 seconds to react to a Katyusha attack which is usually a barrage of dozens of rockets simultaneously. He said: "It's like trying to protect the entire northern part of Israel from rain with a single umbrella."[18]

THEL is not cost effective because each shot costs $3,000. A Katyusha rocket is much cheaper than that. All the Hezbollah have to do is deploy more rockets to overcome THEL.

NATO BMD PLANS

NATO plans to award two contracts for feasibility studies in 2001 for a BMD system to protect NATO forces. The final program could run between $6 billion and $8 billion.

One team vying for the contract is led by Lockheed Martin Corp. and includes TRW, Britain's BAE Systems, and some members of the pan-European consortium European Aeronautic Defense and Space Company (EADS).

The other competing team is made up of Boeing, Raytheon, Northrop Grumman, France's Thales SA, and other members of EADS.

A HOPEFUL CONCLUSION

By the time missiles are launched at us our security will have already been lost. Other aspects of human security will have degenerated to the breaking point. We can see this happening on the domestic front -- crime, gangs, militias, poverty, unemployment, malnutrition, health deficiencies, homelessness. These same maladies are taking place on the international plane. This is the culture of violence that currently infests our country.

TMD programs continue because the manufacturers are making a lot of money and the rest of us are too bewildered to object. We might ask why TMD continues when the technologies are so wobbly and lawmakers know that testing results have been rigged and covered up. The answer is that most lawmakers are under the influence of the corporate lobby, and big business doesn't want to cut programs that enhance profits. It has already been demonstrated (note gun sales domestically and arms sales globally) that human suffering doesn't influence unconscionable business decisions.

On the other hand, with so much public pressure to balance the national budget, it is much more "enriching" for those presently in control to cut social programs which provide no return for corporate taxes. Social programs actually diminish the riches of the rich and that is why they are the

[17] *Defense News*, 19 June 2000, p. 26.

[18] *Defense News*, 18 September 2000, p. 60.

first target of the budget cutter's axe. So, although TMD is too expensive for a nation on the verge of bankruptcy, in corporate-influenced government circles profits still take precedence over social well being and truth-in-government.

TMD programs move along on a legislated schedule despite technical problems, and in the face of numerous warnings from the Pentagon's own study groups and official panels. At bests the advice is taken out of context and at worst it is completely ignored (such as Phillip Coyle's recommendations on THAAD). The solution to technical problems seems to be to rig the tests so they will not fail. Insufficient, unrealistic, and unsuccessful testing, along with immature technology, have no effect on the political decisions being made.

In spite of many warnings the American public is abrogating its own responsibilities in a democracy and tacitly accepting vested-interest decisions that put all the billion-dollar tax eggs into one political basket. It is imperative that every facet of our society -- from the media to the teaching community, from local to state governments, from religious institutions to the individual -- become aware of these diverse threats and the priority in which they should be addressed. Then the uninhibited spirit of collective insight will be unleashed to guide us toward a solution that will enhance Americans as well as other people in the world.

In the final analysis, nothing will improve until enough people feel that acting to help others is more important than seeking self gratification. It is that simple. When we think more about what turns people into criminals than places to lock them up; more about the causes of unemployment than how to get a better-paying job; more about why certain imported products are cheaper rather than spending less money -- in short, more about the well-being of everyone over our personal luxury -- then, and only then, will such exploitative programs as BMD be trashed. Then, and only then, will we see progress in promoting human rights. Then and only then will we make democracy work in its ultimate sense.

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GLOSSARY

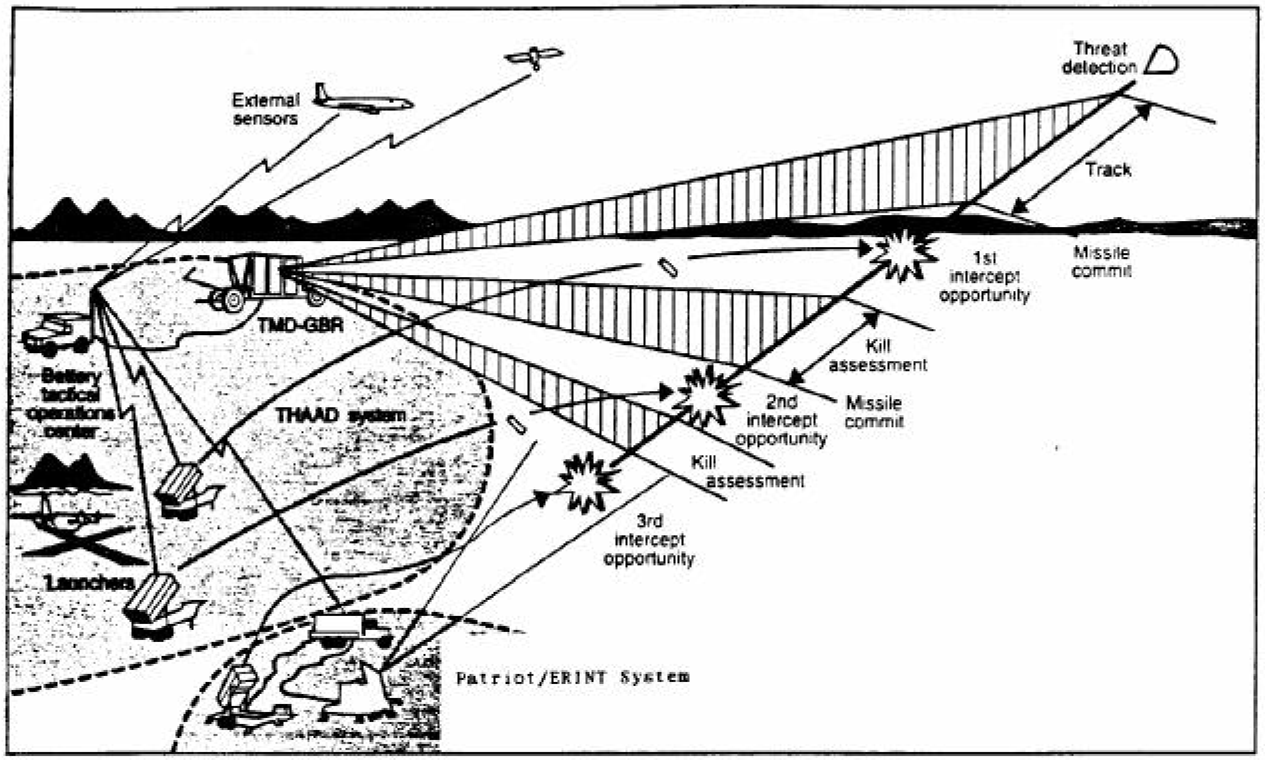
ABM	Anti-Ballistic Missile. An interceptor of ballistic missiles.
AFB	Air Force Base.
AFS	Air Force Station.
Arrow	An Israeli theater BMD interceptor which has been 80 percent funded by the US.
ATBM	Anti-Tactical Ballistic Missile. Also called ATM.
ATM	Anti-Tactical Missile. Also called ATBM.
BM/C3	Battle Management/Command, Control and Communication.
BMD	Ballistic Missile Defense.
BMDO	Ballistic Missile Defense Organization
C-5A	A US military transport aircraft.
DOD	Department of Defense (US).
DOE	Department of Energy (US).
EADS	European Aeronautic Defense and Space Company.
Endoatmospheric	Within the atmosphere.
ERINT	Extended-Range Interceptor Technology.

Exoatmospheric	Outside the atmosphere.
GAO	General Accounting Office (US Congress).
GBI	Ground-Based Interceptor for BMD.
GBR	Ground-Based Radar for BMD.
ICBM	Inter-Continental Ballistic Missile.
IRBM	Intermediate-Range Ballistic Missile.
MDA	Missile Defense Agency.
MEADS	Medium Extended Air Defense System.
MIRACL	Mid-Infrared Advanced Chemical Laser
MRBM	Medium Range Ballistic Missile.
MTCR	Missile Technology Control Regime.
MTHEL	Mobile Tactical High Energy Laser.
NAD	Navy Area Defense.
NATO	North Atlantic Treaty Organization.
Nodong-1	A North Korean SRBM. Sometimes called Scud-C.
NTW	Navy Theater Wide upper-tier missile defense system.
PAC-1	Patriot Anti-tactical-missile Capability Level 1.
PAC-2	Patriot Anti-tactical-missile Capability Level 2.
PAC-3	Patriot Advanced Capability Level 3.
Patriot	A US air defense surface-to-air missile using a conventional fragmentation warhead.
Scud	An older Soviet SRBM which has been sold to other countries.
SDI	Strategic Defense Initiative, also dubbed "Star Wars."
SLBM	Submarine-Launched Ballistic Missile.
SM-2	The US Navy Standard-2 missile.
SRBM	Short-Range Ballistic Missile.
Strategic	Pertaining to nuclear weapons: ICBMs, SLBMs and intercontinental bombers designed for a thermonuclear war between the superpowers.
Tactical	Pertaining to nuclear weapons: those designed to be used in battlefield or theater operations.
THAAD	Theater High Altitude Area Defense.
THEL	Tactical High Energy Laser.
TMD-GBR	Theater Missile Defense -- Ground-Based Radar.
UOES	User Operational Evaluation System, a THAAD "deployable prototype" system.
US	United States.

APPENDIX-A

TERMINAL MISSILE DEFENSE OPERATING CONCEPT (Land Based)

Source: GAO/NSIAD-94-107BR modified



The first alert would likely come from a space-based sensor which detects the target and cues the THAAD system for an interceptor launch. The Theater Missile Defense-Ground Based Radar (TMD-GBR) would eventually acquire and track the target. After receiving target identification and guidance information, the THAAD interceptor would engage the target, and then the tactical operations center and TMD-GBR would make a kill assessment. If necessary, a second THAAD interceptor would be fired. If the subsequent kill assessment again shows the target is not destroyed, the TMD-GBR would cue the PAC-3 system to engage the warheads.