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BALLISTIC MISSILE DEFENSE 3:[1]
MIDCOURSE-PHASE INTERCEPTS

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Midcourse is the long coast range through space after the rocket motors burn out and before the warheads start reentering the earth's atmosphere. It is the time when the warhead separates from the missile structure or, in the case of multiple warheads and chemical-biological weapons, when the warheads or canisters separate from the deployment platform. This is also the time when penetration aids such as chaff and decoys are deployed.

The midcourse phase of a ballistic missile's flight lasts about 20 minutes for an ICBM -- less time for shorter-range missiles. It is the longest time of any of the three phases of a missile's flight. The systems being pursued to shoot down missiles during this phase are the Ground-based Midcourse Segment and the Sea-based Midcourse Segment.

GROUND-BASED MIDCOURSE SEGMENT

The Ground-Based Midcourse Segment is nothing more than what used to be called National Missile Defense. The name has been changed and buried in this segment in an effort to defuse criticism about defending the entire US. This segment still pursues only the ability to shoot down long-range strategic missiles.

1. Some Recent History.

Let us first review some of the history during the last decade on this capability. Since the name of the program at the time of this history was National Missile Defense (NMD), where that name appears it should be remembered that NMD is now called the Ground-Based Midcourse Segment.

a) The Rumsfeld Report. Congress, which has pushed NMD heavily since 1996, did not like the 1995 National Intelligence Estimate conclusion that "no country, other than the major declared nuclear powers, will develop or otherwise acquire a ballistic missile in the next 15 years that

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[1]This is the third 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.

could threaten the [US]." So in January 1998 it set up the "Commission to Assess the Ballistic Missile Threat to the United States" -- known as the Rumsfeld Commission because it was chaired by former defense secretary Donald Rumsfeld (now metamorphosed as defense secretary again under the George W administration). But the Rumsfeld Commission was told to only assess real or potential threats from ballistic missiles carrying nuclear, chemical or biological weapons. It was not to decide if these threats were probable or feasible, or if other means of delivering weapons of mass destruction were more likely. Nor was it to seek solutions to these threats. The commission was limited to finding specific threats so Congress could use them to promote its Star Wars ambitions.

Some hostile countries are building short-range and medium-range missiles. But, contrary to much information that has been promulgated, the Rumsfeld Report points out that none have started on a missile that could reach the US. If they did decide to do so it would take about five years from the time of that decision to acquire such a capability (10 years in the case of Iraq). The Rumsfeld report identified only North Korea, Iran, and Iraq as potential threats -- a far different perspective than the more commonly mentioned 25-30 countries with ballistic missile programs. General Henry Shelton, then chairman of the Joint Chiefs of Staff, summed up this threat in a 24 August 1998 letter to Senator James Inhofe: "The [Rumsfeld] commission points out that through unconventional, high-risk development programs and foreign assistance, terrorist nations could acquire an ICBM capability in a short time, and that the intelligence community may not detect it. We view this as an unlikely development."[2]

Lest the Rumsfeld Report be forgotten, the US National Intelligence Council beat the war drums again on 9 September 1999, warning that proliferation of medium-range ballistic missiles, driven primarily by sales from North Korea, present an "immediate, serious and growing threat ..." It's report promulgated such alarmist hypotheses as that Iran, with Russia's help, *could* test a missile before 2010 that *could* deliver a several-hundred-kilogram warhead against the US. The report also said that short-range missiles launched from offshore ships *could* reach the US. (Emphasis added.) One true prediction the report made is that "likelihood is increasing" of a terrorist attack on the US with chemical weapons. That attack would not "likely" be made with missiles, however.[3]

b) The Welch Panel. It soon became clear that the US National Intelligence Council was beating the war drums to counteract a stinging 40-page report by an Independent Review Team commissioned by the Defense Department. The report was quietly slipped to Congress in early November of 1999 but the Pentagon had been studying it since it was released over two months earlier. Headed by a former Air Force Chief of Staff, retired General Larry Welch, the panel was composed of 12 experts -- many from the Rumsfeld Commission. It is touted as "the most experienced collection of civilian and retired military officers to have studied the antimissile effort."[4] But this panel stated that the missile defense program is plagued by inadequate testing, spare parts shortages, and management lapses. It criticized the government and contractors for exhibiting a legacy of overoptimism about their ability to develop a reliable missile interceptor.

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[2]Cited in Gronlund, p. 47.

[3]All citations from *Mercury News*, 10 September 1999.

[4]Cited in Graham.

Regarding testing, the panel pointed out that the actual kill vehicle has not been tested on the actual booster (as opposed to prototype warheads and surrogate boosters) and there is "major concern" by the panel that the kill vehicle will not be able to withstand the actual shock loads. The actual booster is much faster and the loads predicted are "more than an order of magnitude greater than those of the surrogate booster now being used."[5] The panel recommended that President Clinton delay his decision to build NMD. Much of the data for a 2000 deployment decision would have been based on ground tests and computer simulations, and the panel found that even these are behind schedule and have inadequate resources, and warned against a "rush to failure." This bought the Pentagon more time for initial deployment of NMD -- from 2003 to 2005. CIA estimates then said that America would be vulnerable to a missile attack from North Korea by 2005, and later in the decade from Iran. This was later denied.[6]

c) The American Physical Society Assessment. In April 2000, the American Physical Society, representing 42,000 physicists, stated that the US should not deploy NMD until it "is shown -- through analysis and through intercept tests -- to be effective against the types of offensive countermeasures that an attacker could reasonably be expected to deploy with its long-range missiles."[7]

Finding the target warhead masked by countermeasures is a major problem. In space the cone shaped warhead tumbles and turns, giving off a flickering or twinkling infrared signature that the kill vehicle's sensor is supposed to recognize. Decoys can be designed to emit similar signatures. Or the warhead can be shielded inside a metalized mylar balloon so it would look like one of many balloons. Or it can be enclosed in a liquid-nitrogen-cooled shroud so no infrared signature is emitted. Decoys and other countermeasures to protect the warhead are numerous and cheap, and virtually impossible to overcome.

d) Welch Panel II. The Welch Panel was again convened by the Pentagon for another independent study with extensive access to secret documents. The panel's 13 June 2000 secret report was not the most optimistic from the Pentagon's viewpoint. The unclassified Executive Summary of the Welch Panel's report concluded that the technical knowledge was available to meet the type of countermeasures to be expected from a threat in 2005. However, to achieve the technical performance expected by 2005 is a high risk, and the panel expressed concern about meeting the challenge of countermeasures that may evolve later. The Welch Panel is currently investigating future countermeasures.

From what has been released to the public, it appears that expert studies are only addressing a single warhead on a missile. If a terrorist nation made a biological attack there would be scores of

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[5]Cited in Graham.

[6]After the Clinton administration delayed construction of an X-band radar on Shemya Island in Alaska, thus making it impossible to meet a 2005 deployment date, the Pentagon denied it claimed North Korea would be a threat by 2005. Calling attention to a "version" of the 1999 National Intelligence Estimate which was placed on the CIA website, Assistant Defense Secretary Kenneth Bacon pointed out that it doesn't mention a 2005 date (we don't know what the actual classified version stated, or if that date originated in some secret CIA report). It appears that the Pentagon is padding public opinion to save face.

[7]Cited in Bagger.

small canisters on each missile. Countermeasures would not be necessary. The sheer numbers would overwhelm a missile defense.

The Welch Panel also said that testing wasn't realistic. Target warheads in the test fly from east to west. In an actual scenario those warheads would be going in the opposite direction. All of the panel's concerns were also raised by the General Accounting Office a month earlier.[8]

e) From Clinton to Bush. With the takeover of the George W. Bush administration, negotiations with North Korea were halted and the ABM Treaty was dubbed a "cold war relic." Donald Rumsfeld was resurrected as Secretary of Defense. After about six weeks in office Rumsfeld announced that he was no longer going to differentiate between "national" and "tactical" missile defense. He would henceforth refer only to ballistic missile defense. This re-muddying of the BMD waters seems aimed at mitigating opposition to NMD from America's allies because Rumsfeld said: "What's 'national' depends on where you live, and what's 'theater' depends on where you live."[9] But it is also means agitating the ABM Treaty by confusing NMD elements with TMD operations.

Congress appropriated $1.87 billion for NMD in fiscal year 2001, $135 million more than the administration requested. $847 million was requested for fiscal year 2002. The Congressional Budget Office (CBO) estimates that deploying BMD according to plans at that time would cost $59.4 billion (including $10.6 billion for SBIRS-Low). Then it will cost another $1.1 billion annually (in year 2000 dollars) to operate the system after 2015.[10] The Ground-Based Midcourse Segment (NMD) operating concept is illustrated in Appendix-A.

2. The Ground-Based Midcourse Segment Contractors.

The Ground-Based Midcourse Segment consists of Ground-based Interceptors (GBIs) carrying Exoatmospheric Kill Vehicles (EKVs). These will be alerted and aimed by upgraded Ballistic Missile Early Warning System radars, X-band tracking radars, and the Space-Based Infrared System. All of these elements are to be coordinated by a Battle Management/Command, Control and Communications System. (The radars, space sensors, and battle management aspects are discussed in a companion paper.) On 30 April 1998 the Pentagon awarded a three-year, $1.6 billion development contract to the Boeing Defense and Space Group's Systems Development Center (Seal Beach, CA). This contract expired in April 2001. However, a follow-on contract was awarded in December 2000 to Boeing Company's Space and Communications Group (Anaheim, California) which will be in force from 1 January 2001 through 30 September 2007. The Boeing team includes TRW and Raytheon. Boeing, as lead systems integrator (prime contractor), will oversee the design and testing of the NMD system. Most of the work will be performed at Huntsville, Alabama; Tucson, Arizona; Sudbury and Bedford, Massachusetts; and Colorado Springs, Colorado. The first site for a ground-based midcourse intercept system will probably be at Fort Greely, Alaska.

3. The Ground-based Interceptor (GBI).

The GBI will consist of a three-stage booster stack and the Exoatmospheric Kill Vehicle (EKV). It is the weapon part of NMD. The GBI will travel at speeds up to 25,000 miles per hour

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[8]See GAO/NSIAD-00-131,

[9]Rumsfeld-3/2001.

[10]CBO-4/2000, p. 10.

to engage hostile missiles, and fire the EKV to destroy the threatening warhead above the atmosphere by impact energy.

a) The Booster Stack. On 27 July 1998 the Department of Defense (DOD) selected the GBI booster stack design that uses three commercial off-the-shelf motor stages. These motor stages will be assembled by Boeing Corp. Subcontractors for the booster stages and motors are Alliant Tech Systems (Magna, UT) and United Technologies Chemical Systems Division (San Jose, CA). The initial contract will order five booster stacks for test flights, plus hardware for ground and static testing. The first GBI booster stack was originally scheduled to fly in March 2000. Problems in putting together these off-the-shelf boosters have caused that date to slip at least 1-3/4 years. It is estimated that each booster stack will cost $3 million.

The actual booster stack will probably not fly until IFT-12 to IFT-15. Until then the Payload Launch Vehicle (PLV) will serve as a surrogate booster. The PLV is a 2-stager Minuteman-2 missile which doesn't give the interceptor the speed and range necessary to intercept real-life warheads.

On 2 August 2001 it was announced that Orbital Sciences Corporation was awarded a seven-month, $11-million contract from Boeing to develop a concept for an Alternative Boost Vehicle.

The test of a $10-million, three-stage prototype booster stack was destroyed 30 seconds after launch from Vandenberg Air Force Base in California on 13 December 2001, because it veered off course. There was apparently one successful flight test of the booster stack previously but it is not known how many flight tests preceded the December 13th attempt -- test firings were scheduled for August and October of 2001.

b) Exoatmospheric Kill Vehicle (EKV). In December 1998 Raytheon was selected as sole producer of the Exoatmospheric Kill Vehicle (EKV). A subcontractor to Raytheon is Axsys Technologies Inc. (Englewood Cliffs, NJ) which will supply the high-precision mirrors and other parts. Raytheon describes its design: "It has its own [long wavelength infrared] seeker, [liquid bi-propellant] propulsion, communications, guidance, and computers to support intercept targeting decisions and maneuvers."[11] Cold gas thrusters are used to control the attitude (position) of the 55-inch-long, 24-inch-wide, 120-pound EKV and aim its seeker as it approaches the target at 4,500 miles per hour. The EKV then has about 5 minutes (450 miles) to home on the target and destroy it with a combined impact velocity (closing velocity) of 12,000-16,500 miles per hour. This collision takes place at about 140 miles altitude.

In January 1998, Raytheon had two successful seeker flight test -- Integrated Flight Tests 1A and 2 (IFT-1A and IFT-2), launched from Kwajalein Missile Range in the Marshall Islands, to analyze its sensor's ability to identify and track objects in space. Raytheon's EKV then moved to a series of three intercept flight tests (IFT-3 through IFT-5) each using a surrogate booster known as the Payload Launch Vehicle (PLV) made by Lockheed Martin Space Systems Company (Sunnyvale, CA), and carrying a prototype kill vehicle (not the final EKV design). The criteria was that two of the three tests must be successful in order to proceed with limited deployment of the system. IFT-5 was reported successful but the other two did not intercept their targets. Then President Clinton deferred a deployment decision to his successor.

President George W. Bush took office in January 2001 and shortly thereafter changed the BMD program to one of research, development, and testing. IFT-6 did not fly until the following July.

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[11]"Exoatmospheric Kill Vehicle (EKV)."

The prototype EKV will continue to be used for several more tests. The production EKV is not expected to be tested until IFT-13 which will probably fly in 2003.

As a backup, $100 million has been budgeted for fiscal year 2002 to investigate Boeing's alternate design for an exoatmospheric kill vehicle (EKV).

c) GBI/EKV Intercept Flight Tests. The first three qualification flights during the Clinton administration took place over the Pacific Missile Range with the target warhead launched from Vandenberg Air Force Base in California and the interceptor launched from Meck Island of the Kwajalein Atoll in the Marshall Islands. A prototype X-band GBR in Kwajalein was used which was about one-third the size of the production model. A shorter-range, lower-powered surrogate GBR in Hawaii, known as the FPQ-14, was also used but it needed a signal from the target warhead in order to see it. Other sensors used were the DSP satellite along with airborne and shipboard sensors. Each of these Integrated Flight Tests cost $100 million.

Officials reported that IFT-3 on 2 October 1999 successfully intercepted its target -- which was one warhead coming from a known direction on a preset trajectory, at a scheduled time. Evidence later showed that the test was further rigged to score a hit as were some early predecessors -- the Homing Overlay Experiment in 1984 and the first Exoatmospheric Reentry-vehicle Intercept System (ERIS) test in 1991.[12,13] Let us examine this test a little closer.

The IFT-3 test plan called for one large balloon to be deployed from the hostile missile along with the target warhead. In space there is no air friction so the balloon traveled along with the target warhead at the same speed, but its larger infrared signature is constant rather than the smaller signature which flickers due to the tumbling reentry vehicle. Decoys are supposed to look like the actual warhead to lure interceptors astray. This balloon was proffered as a decoy but was actually a marker buoy to attract the kill vehicle's attention and draw it close enough to see the target. When the EKV was launched it failed to orient itself correctly with the star field and drifted a little off course. Nevertheless, it saw the balloon in the corner of its vision field. After homing on the balloon the EKV was eventually able to see the target warhead's flickering but weaker signal and make a kill.[14] Here is how Under Secretary of Defense Dr. Jacques Gansler describes it:[15]

> In this early test what we were trying to do was to pull it off and so used something that was even larger and much more obvious, and we figured that might pull the interceptor off to the target, and in fact, it did, in the flight. It found this decoy

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[12]After three failures, a fourth test of the Homing Overlay Experiment on 10 June 1984 finally hit the target which was coming from a known direction on a given trajectory at a prescribed time and velocity. This dubious success was touted by Pentagon officials as proof of the kinetic kill technology. In August 1993 the New York Times quoted four unnamed former Reagan administration officials who said the June 1984 test was rigged to succeed. Three means of cheating were described: 1) putting a radio signal on the target to guide the interceptor, 2) heating the target to make it more obvious to infrared sensors, and 3) using explosives to simulate a collision in case of a near miss. The Army denied these allegations and gave excuses for each action.

[13]The ERIS-1 test in January 1991 was reported by the Army as having achieved its planned goals and that it demonstrated successful discrimination of its target. The US General Accounting Office reported that target discrimination was not achieved. (GAO/NSIAD-92-282, p. 3)

[14]NMD Briefing 1/2000. Also see Glanz

[15]NMD Briefing 6/2000, p. 19.

> first because it was larger, did have more radiation, and it found it first, and it said, "Oh, there's the target," and started to go for it ... and its software said "That's the wrong target," And then it shifted to the target that had the characteristics it was supposed to have had ...

In addition, the *Washington Post* reported that both the interceptor and the target missile used NAVSTAR Global Positioning System (GPS) to maneuver onto a collision course.[16] A hostile missile would not be so accommodating as to broadcast its position and trajectory, signal its position to the GBR, and send up a marker balloon for its warhead.

The Ballistic Missile Defense Organization (BMDO -- now renamed Missile Defense Agency, MDA) says that a beacon on the target warhead broadcasts its location and trajectory information, derived from the GPS satellites, to the FPQ-14 radar on Hawaii so it can act like a surrogate X-band radar to track the warhead's path. BMDO (now MDA) states there is no direct communication between the Target and the interceptor. Given the Pentagon's poor track record for truthful reporting, it seems likely that the target warhead did, indeed, tell the interceptor how to find it -- especially with all the political pressure for a successful test.

The IFT-4 flight -- the second attempt to intercept a target -- took place on 19 January 2000 and failed to intercept the target warhead because of a plumbing leak of liquid-nitrogen used to cryogenically cool the infrared sensors. Additions from previous tests included space-based sensors, use of the actual BM/C3 system, and the field of view for the EKV was increased by 210%. Like the previous test, one large balloon was deployed to mark the target warhead and NAVSTAR GPS was used on both EKV and target. In spite of all this rigging, the test failed.

IFT-5 also failed on 8 July 2000. The main addition was communication with the EKV using the In-Flight Interceptor Communications System. This gives the EKV a couple of in-flight fixes from tracking sensors, and is part of the operational system. There was also a fix to the sensor cooling system.

The IFT-5 target also used a beacon to signal its position and trajectory to the surrogate X-band GBR in Hawaii. Both EKV and target carried NAVSTAR GPS receivers which, according to BMDO (now MDA) Director General Ronald Kadish "does not enter this situation at all, unless we have an anomaly where something breaks down, and we don't expect that to happen."[17] An anomaly? Like if the kill vehicle can't find its target? It looks like the deck was stacked for a success. The Pentagon is quite adept at justifying something for one purpose and using it for another. Furthermore, the GPS units used on both target and kill vehicles was newer and more accurate than what was used on previous flights.[18] Nevertheless, IFT-5 failed in three ways. First, the decoy balloon failed to inflate. Second, the interceptor missile was veering off course. Third, the kill vehicle failed to separate from the surrogate booster.

Since the failure of IFT-5, there have been two Risk Reduction Flights designated RRF-9 and RRF-10. Both took place on 28 September 2000 and involved using Minuteman-3 missiles routinely operationally tested from Vandenberg Air Force Base in California. These were not intercept tests and neither used an interceptor missile nor a kill vehicle. The first, RRF-9, used the early-warning satellites, a ground-based Early Warning Radar for tracking, the BM/C3 elements in Colorado

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[16]Published in *Mercury News*, 4 October 1999, pp. 1A & 12A.

[17]NMD Briefing 6/2000, p. 16.

[18]Bates.

Springs and Kwajalein, the Ground Based Radar prototype on Kwajalein, and the In-Flight Interceptor Communications System to discriminate among 20 objects dispensed by the Minuteman-3 payload. RRF-10 used a modified Mark-12A reentry vehicle released from the Minuteman-3 missile as the threat object to exercise all the NMD elements that will be used in the next intercept test. Both of these tests were, of course, reported successful.

Integrated Flight Test-6 (IFT-6) took place on 14 July 2001 -- a year after the previous intercept attempt failed. It was essentially a repeat of the ill-fated IFT-5. The interceptor used the surrogate booster stack and the EKV was a prototype. It also used a prototype X-band radar at Kwajalein Atoll. Other system elements were the early warning satellites, the upgraded early warning radar in California, the BM/C3 system at Colorado Springs, Colorado as well as the one at Kwajalein, and other sensors on surface ships and aircraft.

The target vehicle was also the same as IFT-5. It had one large balloon to guide the EKV toward the target and the GPS beacon to advertise its location and trajectory. Also, as pointed out by Tom Collins of the Union of Concerned Scientists, the EKV was pre-programmed with the infrared signatures of both the balloon and the target warhead.[19] These are attributes that would not be known in advance in real life. Neither would the EKV know from what direction, on what trajectory, at what time the hostile missile would be traveling.

First reports released from the Pentagon were that the test was successful. This was soon hyped in the media as a "spectacular" success. Later the problems gradually seeped through to the public.

On July 18th, four days after the test, the New York Times reported that the Prototype X-band radar at Kwajalein Atoll malfunctioned. According to BMDO (now MDA) it worked OK during the tracking phase but the software snarled up when it came time to confirm that the target had been hit. According to Phillip E. Coyle III, former director of testing for the Pentagon, if this had happened during a real attack the battle commander would have continued firing precious missiles at a target that had already been destroyed.[20]

On July 27th, discussion began again about a GPS beacon helping to put the target and EKV on a collision course. BMDO (now MDA) admits that a beacon was used, and will be used for at least four more tests, but that the EKV used its own sensors to find the target. Of course this was only after the two vehicles had been guided close enough together for those sensors to be effective. And what would have been the case if the sensors hadn't worked?

Integrated Flight Test-7 (IFT-7) took place with little fanfare on 3 December 2001. It was essentially the same as IFT-6 and, not unexpectedly, was reported successful. Likewise, IFT-8 made its predictable intercept on 15 March 2002. It was the same as IFT-7 except that it had three "decoy" balloons.

IFT-9 is scheduled for August 2002. IFT-10 will probably take place during the last quarter of 2002. There are scheduled a total of 26 IFTs in the program, to extend to the end of fiscal year 2006 (September 2006). The cost of each test is about $100 million. The cost for all 26 tests will use up about $2.6 billion of the taxpayer's money.

Critics of the NMD (the Ground-Based Midcourse) have pointedly exposed many fallacies and inconsistencies, if not outright deception, in the test that have taken place to date. In early June

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[19] *Washington Post*, 15 July 2001, p. A1.

[20] *New York Times*, 18 July 2001.

the White House announced that details of NMD will henceforth be kept secret. What will be announced is the public notice before a test along with whether the test was successful. Details about intercepts and decoys will be secret. The Bush administration has removed another of its activities from public scrutiny and congressional oversight.

SEA-BASED MIDCOURSE SEGMENT

The Sea-Based Midcourse Segment was formerly know as Navy Theater Wide (NTW). It was previously classified as an upper tier system under Theater Missile Defense (which is now re-named Terminal Missile Defense). The old NTW had a greater range than other upper tier systems so it has been reclassified as a midcourse system -- a range of 600-1000 kilometers (370-620 miles)so it can intercept missiles above the atmosphere, or exoatmospheric.

During 1999 the US Navy threw its hat in the national missile defense (NMD) ring. The unclassified version of a report on a Pentagon study, called "Summary of Report to Congress on Utility of Sea-Based Assets to National Missile Defense," proposed that the Navy Theater Wide system with Aegis ships supplement the ground-based system.[21] In February 2000 the Chief of Naval Operations at the time, Admiral Jay Johnson, wrote a memo to then Defense Secretary William Cohen proposing that a layer of mobile ships would provide added protection and make the NMD more effective.[22] A sea-based strategic defense does, of course, further aggravate the hot debate over the ABM Treaty and further complicates arms reduction initiatives. On 5 July 2000 Admiral Johnson announced a new Navy Missile Defense Office under the directorship of Rear Admiral Rodney P. Rempt. He also announced that the Aegis guided missile cruiser *USS Lake Erie* (CG-70), home ported at Pearl Harbor, will for the next two years be dedicated to Navy missile defense tests.

1. Navy Theater Wide (NTW) Missile Defense.

What was previously known as the NTW upper-tier system will consist of improvements to the Aegis system's SPY-1 radar and development of a Standard-3 missile to carry the Lightweight Exoatmospheric Projectile (LEAP) as a warhead.[23] A sea-based upper-tier defense requires space-based and/or airborne early-warning sensors in order to engage incoming warheads at that altitude. However, the Navy claims that sea-based systems are quicker and easier to move around than ground-based.

The Standard-3 is a four-stage missile which fits into the standardized 21-inch diameter launchers of surface ships and submarines. The first two stages boost the interceptor out of the atmosphere. The solid-fuel third stage fires in two spurts to boost the interceptor farther into the exoatmospheric region. Prior to each spurt it takes a reading from NAVSTAR GPS satellites to correct course for approaching the target. The fourth stage is the LEAP kill vehicle which uses infrared sensors to close on the target and ram it. It is produced by Raytheon Missile Systems (Tucson, Arizona).

LEAP is a 20-pound hit-to-kill warhead which destroys its target by impact. It is being jointly developed by Boeing Co. (Downey, California) and Raytheon Co's. missile systems unit (Tucson,

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[21]Cited in *Defense News*, 6 September 1999.

[22]*Washington Post* dispatch in San Jose *Mercury News*, 28 February 2000, p. 16A.

[23]The further improvements over Aegis and its SPY-1 radar are in addition to what is being upgraded for the Navy Area Defense described in a companion paper on Terminal-Phase Intercepts.

Arizona). Boeing's responsibility is the guidance system and integration of the infrared seeker, built by Raytheon, into the warhead.

Lockheed Martin Corp's. Naval Electronics and Surveillance Systems (Moorestown, NJ) is teamed with Raytheon Co's. missile systems unit (Tucson, AZ) to develop a testing system, known as the NTW Test Bed, as part of the Block-1 program. Raytheon is building the missiles and Lockheed Martin is modifying the Aegis radar software. Lockheed Martin also makes the vertical launch system.

Aegis/LEAP tests were to begin in September 2001 but there was a delay. The last test flight to validate the Standard-3 missile was to have taken place during the summer of 2001 but went through a series of delays. The fourth and final of those validation tests (the third reported successful) took place on 25 January 2002 from the Aegis cruises *USS Lake Erie* against an Aries target missile launched from Kauai, Hawaii. It was the first intercept of a target although an intercept was not considered part of the program (then why was a target missile launched?). Presumably there was help to make the hit that invalidated it as a test objective. Another successful intercept was reported on 13June 2002. Four more flight tests are planned -- the next one for November 2002. Full rate production is scheduled for 2007 although there is talk of a rudimentary deployment as early as 2004 to intercept intermediate-range ballistic missiles with ranges up to 3,500 kilometers (1,889 nautical miles).

Up to the June 2002 test, the SM-3.Aegis has been tested in the descent (later) portion of the midcourse phase of the target missile's trajectory. MDA is considering testing it to intercept in the ascent (early) portion. MDA is also considering a common hit-to-kill warhead for the GBI and SM-3 -- possibly the Exoatmospheric Kill Vehicle (EKV).

The NTW budgets for fiscal years 1997, 1998, and 1999 were $304.2 million, $410 million, and $368.4 million respectively. $328.8 million was requested for fiscal year 2000 -- Congressional appropriators approved $379 million while the authorizers permitted $419 million. The Administration's fiscal year 2001 request of $382.7 million was increased to $462.7 million by Congress. The fiscal year 2002 budget request for the Sea-Based Midcourse Segment is $656 million.

2. Navy Theater Wide Transitions into a Strategic Defense.

By March of 2001 the Navy was proposing a 4-step evolution of a sea-based adjunct to NMD. The following is what the Navy claims it can do.

a) Extended Air Defense. The first step could be to station a couple Aegis destroyers carrying 30 Standard Missile-2, Block-4 interceptors (the interceptor originally designed for the now-canceled Navy's Area Defense system) near Japan to protect against North Korea's Taepo Dong missiles. This could be the initial deployment desired for 2004.

b) Enhanced Theater Wide. This step would use two Aegis cruisers loaded with 50 or more of the Standard Missile-3, Block-1 interceptors except they would have improved infrared radar capability. They would also carry enhanced 30-kilogram (66-pound) Lightweight Exoatmospheric Projectile (LEAP) warheads. This system would have a 1,000-kilometer (620-mile) range and the interceptors would have a speed of 4.5-kilometers per second. Eight would fit into existing 21-inch Navy launchers and could be available by 2005-2008 for an additional $1.4 - $1.8 billion.

c) Improved Theater Wide. Also called the "Improved Eight-Pack," the Standard Missile-3, Block-2 interceptor would have a larger, to-be-developed, second-stage motor giving it a 5.5-kilometer-per-second velocity and a range of 1,500 kilometers (930 miles). It would also have a more robust, 40-kilogram (88-pound) warhead. It would also have better discrimination with integrated guidance and an advanced seeker. Two or more Aegis cruisers carrying 60 of these interceptors would be able to intercept more advanced missiles from Iran or North Korea in their boost phase. The Improved 8-Pack could be available by 2008-2009 for $3.5 - $4.5 billion.

d) Navy Regional Defense. This concept, also called the "New 6-Pack," requires a larger launcher. It would involve a new missile dubbed the Standard Missile-"27" because it would be 27 inches diameter. It would have range of more than 1,500 kilometers (930 miles) and a speed of 6.5-kilometers-per-second carrying a 50-kilogram (110-pound) kill vehicle. This system could be available by 2010-2012 for a cost of $8 - $10 billion.

Funding for a larger sea-based interceptor will probably appear in the fiscal year 2004 budget request.

3. Joint Navy Missile Defense with Japan

North Korea's launch of its 1000-kilometer (620-mile) range Nodong-1 missile, along with a perceived threat from Chinese IRBMs, sparked US-Japan talks in September 1993 about deploying a Japanese anti-missile system. Chinese intimidation of Taiwan in 1996 has also fueled Japan's TMD push. But as time passed and the cost of missile defense was closer examined, Japan's sense of urgency diminished. Japan did not want to offend China or Russia who oppose missile defense systems they cannot afford.

On 1 April 1995 Japan created a BMD Study Office to coordinate efforts with the US BMDO and the US Pacific Command. That study was completed by mid-1997 but Japan again lapsed from the project under its fiscal austerity plan. It was not until North Korea launched a medium-range Taepo-Dong missile over the Japanese mainland in August 1998 that Japan changed its thinking on military spending. Missile defense -- focused on the US Navy's Theater Wide Defense scheme -- was allocated 962 million yen in 1999 and 2.05 billion in 2000. This was boosted to 3.71 billion yen (US$29.4 million) for 2001.

In August 1999 Japan signed a cooperative agreement with the US for developing a TMD system based on the US Navy's Theater Wide Defense System using the SM-3, Block-2 interceptor. Since Japan already has 4 Kongo-class Aegis destroyers, it will share in development of the system. Also, between 2001 and 2005 Japan plans to buy at least two more Aegis vessels with full TMD capabilities. Unofficial cost estimates of the joint research effort is $400 million to $524 million over the years and split equally between the two countries. Four major components for missile theater defense will be jointly developed under this agreement: the infrared sensor that tracks incoming missiles, the LEAP kinetic kill warhead, the second stage motor for the Standard-3 missile, and the lightweight missile nose cone. Originally planned for completion in 2003 or 2004, and then reaching a decision on whether to go on to develop a TMD system, the study and the TMD decision have now been delayed until 2006 or later.

THE "MIDCOURSE TEST BED"

Up to now the target missiles for NMD sensors and interceptors have used the Pacific Missile Range in the Pacific, with some intercepts of a target vehicle launched during the early 1990s from

Kauai in the Hawaiian Islands. Now the Pentagon plans to extend the testing area to what is called the Midcourse Test Bed.

1. The Pacific Missile Range.

Traditionally, this test range extended from Vandenberg Air Force Base in California to Kwajalein Atoll in the Republic of the Marshall Islands. Target warheads are launched on Minuteman missiles from Vandenberg. These missiles fly in a southwesterly direction toward Kwajalein Atoll some 4,800 miles away. From Kwajalein Atoll the interceptor missile carrying the exoatmospheric kill vehicle is launched. In the case of current NMD tests, the missile launched from Vandenberg is called the Multi-Service Launch System (MSLS). In the early 1990s the Strategic Target System (STARS) -- launched from Kauai, Hawaii toward Kwajalein Atoll -- was added to provide a more north-south trajectory.

2. The Strategic Target System (STARS).

Tests from Vandenberg to Kwajalein Atoll did not replicate the northern-southerly direction that missile attacking the US would be traveling, and they do not test the North American defense sensors. To help correct this situation the Pentagon opened a corridor between Kauai, Hawaii and Kwajalein Atoll. Barking Sands Naval Station on Kauai is the launch point for a target vehicle called the Strategic Target System).

STARS is a three-stage missile with a range of 3,400 miles. The first two stages are renovated Polaris A-3 vintage motors. Polaris A-3 is the predecessor of Poseidon which in turn is the predecessor of Trident. The Orbis 3rd stage can duplicate a variety of hostile rocket maneuvers including firing down through reentry to simulate the speed of long-range strategic missiles. During the early- to mid-1990s there were four STARS launches from Kauai, the last in 1996. These went southwesterly toward Kwajalein Missile Range.

With the Midcourse Test Bed, the Pentagon plans to aim STARS east to northeast toward the northwest coast of the US. MDA is planning up to eight launches per year of the STARS missile for at least five years beginning in 2001. But only half of these launches will be from the Kauai Test Facility in Hawaii. The others will be from a new Kodiak Launch Complex on Kodiak Island, Alaska. Some of the launches from Kodiak Island will be to test Navy TMD systems from Aegis ships near Hawaii.

3. Kodiak Island and Fort Greely -- Completing the Midcourse Test Bed.

The Midcourse Test Bed will be a combination of new ranges extending from Kodiak Island (250 miles south of Anchorage, Alaska) and Fort Greely (100 miles southeast of Fairbanks, Alaska) toward Vandenberg, Kwajalein Atoll, and Kauai. The four STARS launches per year from Kodiak Island will be in three directions. One trajectory is southeast along the Canadian and US coasts to impact off the coast of Mexico. A second will be southwesterly toward Kwajalein Atoll and Kwajalein Missile Range. The third will be towards the south to impact north of the Pacific Missile Range. The latter will probably be to test Navy TMD interceptors launched from Aegis ships near Hawaii.

In addition to target missiles, interceptor missile are also planned to be launched from Kodiak Island. Launching interceptors from Alaska violates the ABM Treaty. Two test missile silos are planned for Kodiak Island. In addition to local protests, there is concern about the construction of these silos being illegal. In a letter to the BMDO (now MDA) director, US Representatives John

Spratt, Ike Skelton, and Norm Dicks wrote: "It is our understanding that the construction of two test silos on Kodiak Island was not included in the Environmental Assessment completed for the commercial launch facility at Kodiak. We are advised that the National Environmental Protection Act probably requires an Environmental Impact Statement for live-fire intercept testing at Kodiak Island, not just an Environmental Assessment."[24] [25]

MDA also plans to build five interceptor silos at Fort Greely in preparation for an operational system there. Test missiles cannot be fired from that location because of safety reasons. It is not known where the first-stage booster motor will fall after it is separated. So no launches are planned but work will commence on an operational site. Nevertheless, the MDA emphasizes the importance of Fort Greely to the Midcourse Test Bed. General Kadish explains that although the actual test launches would be from Kodiak Island, "that doesn't negate the importance of Fort Greely for other activities of communication, logistics, construction, timelines and a whole host of other things."[26]

Work began on 27 August 2001 to clear the land where the silos will be installed. Since this involves removing trees that were damaged in a recent forest fire -- trees implied to be irreparably damaged with removal urgent -- along with other general site preparation, the Bush administration claims it will not violate the ABM Treaty. A site preparation contract of almost $5 million was awarded to Aglaq Construction Enterprises, a local company which is a subsidiary of Tikigaq Native Corp. The contract calls for clearing trees, building a main access road, drilling two water wells, and other work including soil excavation and grading. Work is to be completed by mid-December.

Representatives Spratt, Skelton, and Dicks also raised legal problems with construction at Fort Greely: "It is our understanding that the Environmental Impact Statement prepared by the Clinton administration for constructing missile interceptor silos at Fort Greely applied only to deployment, and did not address the impact of a test facility. If Fort Greely is primarily a test facility, the National Environmental Protection Act seems not to have been met, and at a minimum the Environmental Impact Statement must be amended."[27]

The Midcourse Test Bed is to be operational by 2004. Initial funding is in the fiscal year 2002 budget request, but the amount has not been announced. However, with the demise of the ABM Treaty and buoyed by the "success" of IFT-8, the Bush administration planes to have a rudimentary missile defense system installed at Fort Greely by October 2004. Groundbreaking took place on 15 June 2002.

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[24]Spratt.

[25]An Environmental Assessment is the Pentagon's short cut to meeting the requirements of the National Environmental protection Act -- it requires little or no public input. An Environmental Impact Statement, on the other hand, requires scoping hearings with maximum public participation.

[26]Kadish-7/2001.

[27]Spratt.

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GLOSSARY

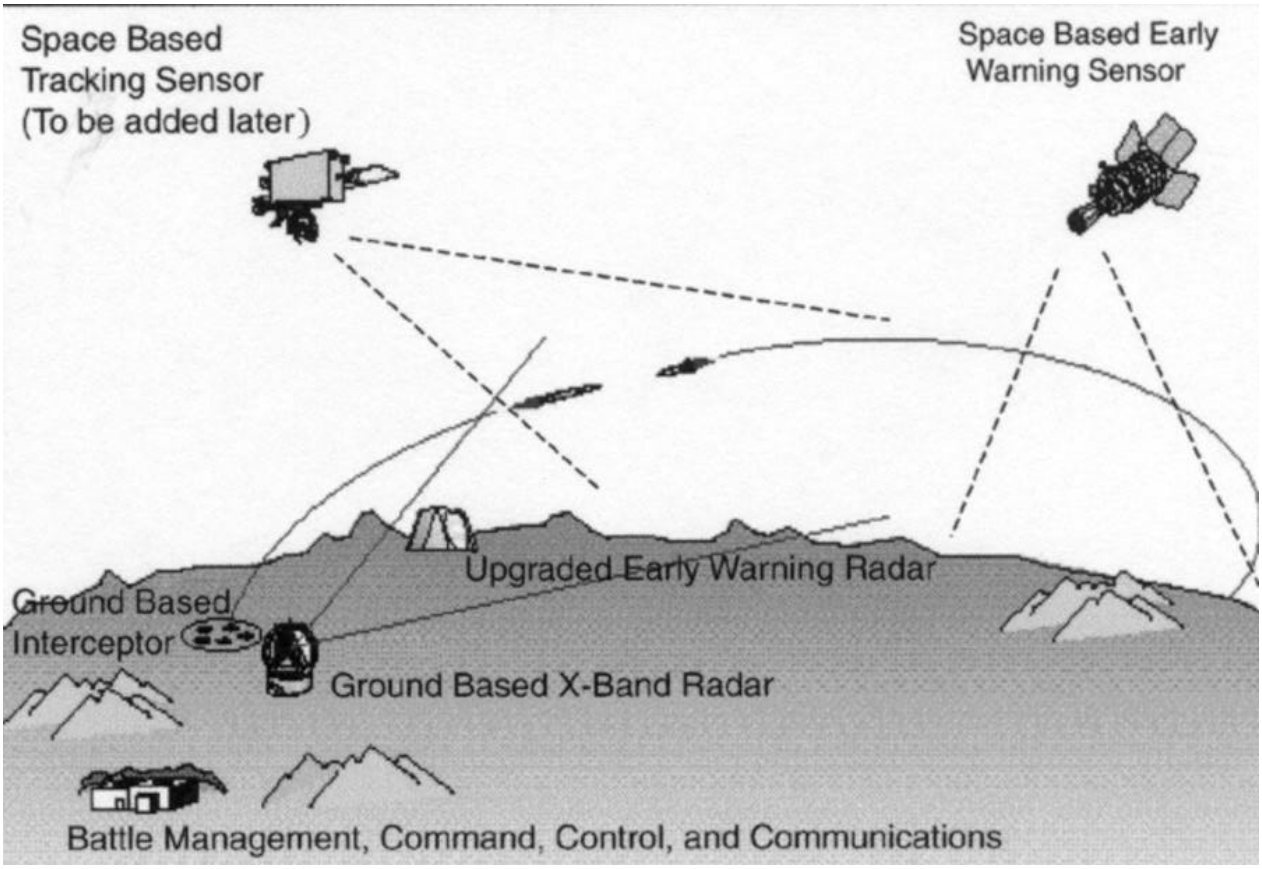
ABM	Anti-Ballistic Missile. An interceptor of ballistic missiles.
AFB	Air Force Base.
AFS	Air Force Station.
ATBM	Anti-Tactical Ballistic Missile. Also called ATM.
ATM	Anti-Tactical Missile. Also called ATBM.
BM/C3	Battle Management/Command, Control and Communication.
BMD	Ballistic Missile Defense.
BMDO	Ballistic Missile Defense Organization
CBO	Congressional Budget Office.
DOD	Department of Defense (US).
DOE	Department of Energy (US).
EKV	Exoatmospheric Kill Vehicle.

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.
GPS	Global Positioning System.
HOE	Homing Overlay Experiment
ICBM	Inter-Continental Ballistic Missile.
IFT	Integrated Flight Test.
IRBM	Intermediate-Range Ballistic Missile.
LEAP	Lightweight Exo-Atmospheric Projectile.
MDA	Missile Defense Agency.
MSLS	Multi-Service Launch System.
NAD	Navy Area Defense.
NAVSTAR	NAVigation System Timing And Ranging -- a navigation satellite in the GPS constellation.
NMD	National Missile Defense.
Nodong-1	A North Korean SRBM. Sometimes called Scud-C.
NTW	Navy Theater Wide upper-tier missile defense system.
PAVE PAWS	Perimeter Acquisition of Vehicle Entry Phased-Array Warning System.
PLV	Payload Launch Vehicle.
SDI	Strategic Defense Initiative, also dubbed "Star Wars."
SLBM	Submarine-Launched Ballistic Missile.
SM-2	The US Navy Standard-2 missile.
SM-3	The US Navy Standard-3 missile.
STARS	Strategic Target System.
START	STrategic Arms Reduction Talks.
START-2	The second STrategic Arms Reduction Treaty.
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.
TMD-GBR	Theater Missile Defense -- Ground-Based Radar.
UHF	Ultra-High Frequency.
US	United States.

APPENDIX-A

GROUND-BASED MIDCOURSE DEFENSE OPERATING CONCEPT

Source: GAO/NSIAD-00-131



APPENDIX-B

MIDCOURSE TEST BED CONCEPT

Source: Kadish 6/2002, Briefing Slide #10