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SON OF STAR WARS:
A BACKGROUND PAPER ON NATIONAL MISSILE DEFENSE

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The concept of defending against ballistic missiles was conceived in the 1940s and became more publicly known and refined during the 1960s, shortly after missiles were introduced as carriers for nuclear warheads. It was called ballistic missile defense (BMD) and the interceptor used to counter ballistic missiles was called an anti-ballistic missile (ABM). Decades later and tens of billions of dollars poorer, the US is still trying to develop a workable ABM system.[1]

On 23 March 1983 President Ronald Reagan kicked off the Strategic Defense Initiative (SDI, or Star Wars) with a whopping increase of budget. SDI activities pertained to intercepting the long-range strategic missiles and were restricted by the ABM Treaty. Tactical, or theater, missile defense programs were compartmentalized by themselves because they are not subject to ABM Treaty guidelines.[2]

In May 1993 President Bill Clinton terminated SDI in name only, reverting to the original name of Ballistic Missile Defense, or BMD. Active SDI programs were transferred to the multi-service Ballistic Missile Defense Organization (BMDO). Since the word "strategic" no longer appeared in the title, tactical missile defense was also included. Now activities under the BMDO are blurred because some have to be ABM Treaty-compliant and some do not.

What is the difference between "strategic" and "tactical"? A missile's velocity is relative to its range. ICBMs and SLBMs have the longest range and need the biggest boost from rocket motors. Therefore, these long-range "strategic" weapons approach their target at a greater speed than the shorter-range "tactical" ballistic missiles. An interceptor could more easily maneuver to engage a short-range ballistic missile. Intermediate-range ballistic missiles are faster and would require a more agile interceptor. To destroy ICBMs and SLBMs traveling at great speed would require the most energetic interceptor. On the other hand, the shorter the missile's range, the shorter the flight time. This leaves less time to destroy slower, shorter-range missiles after they have been detected and tracked.

Current BMD activities focus mainly on National Missile Defense (NMD) to protect the US from a limited nuclear attack and Theater Missile Defense (TMD) to protect American and friendly forces overseas. This paper will only discuss National Missile Defense.[3]

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[1]For a more complete historical review of ABM activities, and a description of the ABM Treaty, see Aldridge, *First Strike*, pp. 193-196.

[2]See Aldridge, *Nuclear Empire*, pp. 92-105, for a summary of BMD activities during the Reagan and Bush administrations.

[3]This paper will only address National Missile Defense, the strategic aspect of BMD. See PLRC-000623 for Tactical Missile Defense.

NATIONAL MISSILE DEFENSE

The primary mission of NMD is to defend the United States against an attack consisting of several ballistic missiles launched from a terrorist nation. It would also have some capability against an accidental launch from nuclear powers such as Russia or China.[4] All development work is supposed to comply with ABM Treaty requirements. To deploy the NMD system as planned, however, will require revision to or abrogation of the Treaty.

NMD consists of ground-based interceptors (GBIs) carrying Exoatmospheric Kill Vehicles (EKVs), which will be alerted by upgraded Ballistic Missile Early Warning System (BMEWS) radars, X-band Ground Based Radar (GBRs), and the Space-Based Infrared System (SBIRS). All of these elements are to be coordinated by a Battle Management Command, Control and Communications System (BM/C3). 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). The Boeing team includes TRW and Raytheon. Boeing, as lead systems integrator, will oversee the design and testing of the NMD system. Negotiations to renew this contract began in November 2000.

The first site for a National Missile Defense system will probably be one of several locations in central Alaska, with a new X-band radar on Alaska's westernmost Shemya Island. Existing early warning radars in Greenland, Britain, and Alaska are to be updated as would the radars on the US east and west coasts. Deployment at this first site is divided into two steps. The first is called the Capability-1 (C-1) configuration, and was originally scheduled to be operational by 2005, but will now be later. It will consist of 20 interceptors, existing early warning radars, high-orbit space-based sensors, a new X-band GBR on Shemya Island in the Aleutians, and a BM/C3 system. Capability-2 (C-2) will add 80 interceptors and further radar/sensor upgrades by 2007 (maybe later now), bringing the total number of interceptors to 100. A site in Alaska is not permitted by the ABM Treaty. The Treaty will either have to be amended (which the Russians so far have refused to allow) or abrogated by the US.

Capability-3 (C-3) is to be in place by 2010 and comprises a second site, tentatively at Grand Forks in North Dakota, with 150 interceptors. Three more X-band GBRs and low-orbit space-based sensors will also be operational at this time. This deployment of a second site would take further renegotiation of the ABM Treaty, if it has not already been abrogated by this date.

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 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. 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

[4]As defined in GAO/NSIAD-98-153, p. 1.

perspective than the more commonly mentioned 25-30 countries with ballistic missile programs. General Henry Shelton, 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."[5]

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. (Emphasis added.) The report also said that short-range missiles launched from offshore ships could reach the US. 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.[6]

It soon became clear that the US National Intelligence Council was beating the war drums to counteract a stinging 40-page report by 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 four-star 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."[7] 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.

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."[8] The panel recommends 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. Now CIA estimates say that America will be vulnerable to a missile attack from North Korea by 2005, and later in the decade from Iran.

Then in April 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."[9]

Finding the target warhead masked by countermeasures is a major problem. In space the

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[5]Cited in Gronlund, p. 47.

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

[7]Cited in Graham.

[8]Cited in Graham.

[9]Cited in Bagger.

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.

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. US officials, requesting anonymity, said the study cited difficulty with plans to build an X-band radar base in Alaska by 2005.

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 small canisters, or bomblets, on each missile. Countermeasures would not be necessary. The sheer numbers would overwhelm even the planned C-3 configuration.

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.[10]

The 2000 decision by President Clinton on whether to proceed with NMD was made on 1 September 2000. He chose to pass the decision to his successor so construction of the Shemya Island radar will not be started in 2001 and will not be ready by 2005.

This decision by President Clinton was based on four criteria -- technical feasibility, threat, cost, and overall impact on national security. The President said he did not have absolute confidence in existing technology. With the warming relations between North and South Korea, and North Korea's offer to stop its missile program in exchange for economic aid, it was pretty difficult to concoct a threat that would justify deploying NMD by 2005. The $60 billion cost is ridiculous to protect against a terrorist attack that wouldn't be delivered by missiles. And the effect on national security would have been a new arms race as Russia scraps all arms reduction treaties enacted so far and China boosts its strategic missile force from about 20 to 200 in order to be able to overcome a US missile defense. If China does that, India will respond and that will bring Pakistan into the new arms race.[11]

Now the Pentagon denies it ever claimed a threat from North Korea would appear in 2005. By calling attention to an "version" of the 1999 National Intelligence Estimate which it has been placed on the CIA website, and doesn't mention a 2005 date, Assistant Defense Secretary Kenneth Bacon emphasizes that it doesn't mention a 2005 date (we don't know what the actual classified version states, or if that date originated in some secret CIA report).[12] It appears that the Pentagon is padding public opinion to save face.

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

[11]This new arms race is depicted in an August 2000 National Intelligence Estimate report entitled "Foreign Responses To US National Missile Defense Deployment," and cited in "Report: Missile Defense May Spur China," *Mercury News*, 10 August 2000, p. 7A.

[12]DOD News Briefing 10August2000.

The Pentagon requested $1.7 billion for fiscal year 2001 but the BMDO wants to add another $325 million to that. The Congressional Budget Office (CBO) estimates that deploying the C-1 configuration and maintaining it through 2015 will cost $29.5 billion, adjusted for inflation. Moving to C-2 and maintaining it through 2015 will up the total to $35.6 billion. The CBO estimate that the C-3 configuration and maintaining it through 2015 will bring the tally to $48.8 billion. That does not include $10.6 billion for SBIRS-Low, which then brings the total to $59.4 billion -- basically $60 billion. Then it will cost another $1.1 billion annually (in year 2000 dollars) to operate the system after 2015.[13] The National Missile Defense operating concept is illustrated in Appendix-A.

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 to engage hostile missiles, and fire the EKV to destroy the threatening warhead above the atmosphere by impact energy. Tests of the final GBI configuration will not take place until 2001.

1. Booster Stack.

On 27 July 1998 the Department of Defense (DOD) selected the GBI booster stack design that uses commercial off-the-shelf motor stages. These motors 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 booster test is scheduled for early fiscal year 2001. However, production delays in putting off-the-shelf motors together are threatening that date. Previously the first actual GBI booster stack was to fly on Integrated Flight Test-7 (IFT-7) but now it has been moved to IFT-8. Even that is doubtful because the booster development program has now been delayed as much as a year. It is estimated that each booster stack will cost $3 million.

2. Exoatmospheric Kill Vehicle (EKV).

In December 1998 Raytheon was selected as sole producer of the 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 bipropellant] propulsion, communications, guidance, and computers to support intercept targeting decisions and maneuvers.”[14] Cold gas thrusters are used to control the attitude (position) of the 55-inch-long, 130-pound EKV and aim its seeker as it approaches the target at 4,500 miles per hour. The EKV then has six to eight minutes to home on the target and destroy it with a combined impact velocity of 12,000-15,000 miles per hour. This collision takes place about 140 miles altitude.

In January 1998, Raytheon had two successful seeker flight test (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 started a series of three intercept flight tests (IFT-3 through IFT-5) on 2 October 1999, using a surrogate booster known as the Payload Launch Vehicle (PLV) made by Lockheed Martin Missiles & Space (Sunnyvale, CA), and carrying prototype kill vehicles, not the final EKV design. The actual BM/C3 is used later but some radars

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

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

are surrogate, including the shorter-range lower-powered surrogate GBR in Hawaii, which needs a signal from the target in order to see it. These tests were completed in July 2000

At first it was said that two of the three qualification tests must be successful before the GBI/EKV system can go into broader testing and development. Officials reported that IFT-3 on 2 October 1999 successfully intercepted its target -- which was one warhead coming from a known direction 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.[15,16]

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 target to draw fire away from it. Anyway, this balloon was proffered as a decoy but was actually a marker buoy to lure the kill vehicle close enough to see the target. When the EKV interceptor 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 signal and make a kill.[17] Here is how Under Secretary of Defense Dr. Jacques Gansler describes it:[18]

> 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 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.[19] 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 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, IFT-4 deployed one large balloon to flag the target warhead and used NAVSTAR

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[15]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.

[16]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)

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

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

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

GPS on both interceptor and target, to cue the EKV should the surrogate GBR be inadequate. 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 will also be a fix to the sensor cooling system. Each flight test costs $100 million.

IFT-5 also had to signal its position to the surrogate GBR in Hawaii. It and the target also carried the NAVSTAR GPS which, according to BMDO 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."[20] 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.[21]

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. It was convenient for the Pentagon that the separation failed. Had the kill vehicle been properly sent on its way, it would not have had a marker balloon to guide it to the target. That would have been much more politically embarrassing to explain.

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 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 nof these tests were, of course, reported successful.

Sixteen more IFT flights are scheduled. The next one will not be before January of 2001. We should be aware that when a demonstration is reported to have met all test objectives, it means only that. It is a planned test objective to deploy a large balloon with the target warhead. It is a planned test objective that the EKV first see the balloon so it can get on the correct course toward the target. It is a planned test objective to use NAVSTAR GPS to make certain the EKV finds its target. For a good reason one senior defense official stated during a briefing: "I am trying to avoid defining, 'What means success?'"[22]

GROUND-BASED RADAR (GBR).

The X-band GBR system is an Army program. After the improved early warning radars and space-based sensors detect hostile missile launches and provide some idea of where they are headed, the X-band radars take over for precise determination of what the threat is. Then they track the target and provide targeting information and kill assessment. They also help guide the interceptor to the target.

The first X-band radar will be built on Shemya Island in Alaska, the most western point in

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

[21]Bates.

[22]NMD Briefing 1/2000.

the US and in line with any missile attack on the US homeland from North Korea. Four other new X-band radars are planned for other areas of the globe for C-3 Capability -- probably including Fylingdales or Menwith Hill in England and Vardo in Norway. There are some reports that say nine x-band radar stations are envisioned which could include Pine Gap in Australia. Others could be in Japan and South Korea.

Radars which feed into the GBR are upgraded BMEWS and PAVE PAWS radars. Space based sensors will also support the GBR system.

1. Ballistic Missile Early Warning System (BMEWS).

The US will be updating the ultra-high frequency (UHF) phased-array BMEWS radars located in Alaska, Greenland and England. The BMEWS radar at Clear, Alaska and Thule, Greenland are two-faced phased-array radar which monitors 240 degrees of azimuth (each face of US phased-array radars monitor 120 degrees of azimuth from horizon to zenith). The BMEWS radar at RAF Fylingdales in Yorkshire, England is three-faced, and thus operates over a full 360-degree circle. They are made by Raytheon. That capability is also useful in detecting theater missiles launched at Western Europe.

There has been no formal request to Britain and Denmark to upgrade the BMEWS radars in England and Greenland, but those two countries have sent out warnings that they will not approve any installation that does not comply with existing treaties -- including the ABM Treaty -- and that the US should not assume unqualified cooperation for deploying NMD. This seems to have the US worried and it is assessing alternative plans, including placing X-band radars on commercial container ships based in international waters.

2. Perimeter Acquisition of Vehicle Entry Phased-array Warning System (PAVE PAWS) Radars.

PAVE PAWS sensors are also ultra-high frequency (UHF) phased-array radars. They remain at two locations in the continental United States to provide early warning of SLBM attack. The locations are Cape Cod Air Force Station, Massachusetts; and Beale Air Force Base, California. These are two-faced, phased-array radars are also manufactured by Raytheon, and will be updated for NMD.

3. Possible New Early Warning Radars.

In November 2000 the BMDO asked Boeing Company to investigate replacement or supplemental radars for NMD's five ground-based early-warning radars (BMEWS and PAVE PAWS). These alternative radars would still be UHF but smaller, lighter, and more powerful. This was a request for information only and the study should take about ten weeks.

SPACE BASED INFRARED SYSTEM (SBIRS).

The current space-based early warning system, called Defense Support Program (DSP) Satellites, have been continuously upgraded since there initial deployment. Three satellites are currently deployed in geosynchronous orbit over the equator -- one each over the Indian, Pacific and Atlantic Oceans. (There may be more as the actual number in orbit is secret.) Three replacement satellites are awaiting launch. The last is scheduled for launch in 2003. These spacecraft use infrared sensors to watch for ICBM and SLBM launches around the world. During the Persian Gulf war the DSP system was used to detect SCUD missile launches from Iraq.

Two layers of satellites are in work for future missile defense activities which will support both NMD and TMD. They are known as SBIRS-High and SBIRS-Low.. Besides detecting hostile missile launches, the fully integrated system (SBIRS-High and SBIRS-Low) will also track them and provide targeting information for defensive missiles, as well as provide technical intelligence and analyze battle situations, to say nothing about anti-satellite operations. SBIRS will be able to track missiles and warheads after the rocket motors burn out, something the present early warning satellites cannot do.

Another function of SBIRS could be to locate mobile targets. They may carry the Ground Moving Target Indicator and Synthetic Aperture Radar to provide near-continuous global coverage and precision mapping to detect mobile launch points before they launch missiles. One ground station that has been approved is Menwith Hill, Yorkshire, in England.

1. High Orbit Space-Based Infrared System (SBIRS-High).

In November 1994 the Pentagon approved the High Orbit Space-Based Infrared System. SBIRS-High is envisioned as a multi-layered constellation composed of four spacecraft in geosynchronous orbits around the equator and two satellites in highly-elliptical polar orbits to cover the more-northern regions more effectively. SBIRS-High will watch for the hot exhaust plume of missile launches and is slated to start replacing DSP in 2004. The global coverage and technical improvements of SBIRS-High over DSP will allow better determination of a missile's launch point, trajectory, and intended impact point.

A team led by Lockheed Martin Missiles & Space (Sunnyvale, CA) has a $2 billion Air Force contract to build six geosynchronous-orbit satellites and provide sensors to ride piggy back on other satellites. The first is to be launched in 2004 with the system operational by 2006. Follow-on highly-elliptical-polar-orbit satellites and replacements for geosynchronous orbit vehicles could stretch contracts out to 2020. Lockheed Martin is the prime contractor responsible for the spacecraft along with systems engineering & integration and the ground segment. Aerojet (Azusa, CA) and Northrop Grumman (Bethpage, NY) will provide the primary infrared sensor; Lockheed Martin Federal Systems (Gaithersburg, MD) and Aerojet will provide ground systems for mission data processing and message dissemination, mobile ground elements, satellite telemetry, and satellite tracking and control; and Honeywell Space Systems (Clearwater, FL) will provide on-board data processing and data handling for both the spacecraft and payload. The Guidance and Control Systems' Space and Launch unit of Litton Industries (Woodland Hills, CA) has a subcontract to manufacture the Guidance Reference Assembly.

The requested SBIRS-High budget for fiscal year 1997 was $173.3 million, and the fiscal year 1998 request is $338 million. $538 million was appropriated for fiscal year 1999. First launch of a geosynchronous satellite is planned for 2004.

2. Low Orbit Space Based Infrared System (SBIRS-Low).

SBIRS-Low satellites will compliment SBIRS-High by tracking hostile missiles and warheads through their long coast through space (the midcourse phase) after their booster motors burn out. This will provide better targeting and engagement of interceptors. SBIRS-Low will be a network of 24 to 32 small satellites in low orbit -- about 250 miles (400 kilometers) high. This is the low-orbit portion of the full Space-Based Infrared System.

Some SBIRS-Low sensors will use synthetic aperture radar to view through clouds and darkness. Others will use electronic cameras. Data will be relayed from one SBIRS-Low satellite to another by laser beam, to reach the relevant command center at the speed of light. The data would be handed over to the ground-based radar (GBR) which would in turn send trajectory information to the interceptors.

On 16 August 1999 the US Air Force awarded TRW Space and Electronics Group (Redondo Beach, CA) and Spectrum Astro (Gilbert AZ) each a $275-million, 38-month contract to design the SBIRS-low system. Raytheon Systems Co. (Arlington, VA), GenCorp's Aerojet segment (Sacramento, CA), Motorola, Agilent, Honeywell, Ball Aerospace & Technologies, Sparta, and PRA are on the TRW team. Spectrum Astro has Northrop Grumman Corp. (Los Angeles, CA) as its main partner.

In 2002 one of the companies will be chosen as prime contractor for the system which is scheduled to start launching in 2006. A production contract could range up to $5 billion. The Air Force intends to spend $11.8 billion on SBIRS-Low over its lifetime. By October 2001, SBIRS-Low will be shifted from the Air Force to the BMDO.

The Air Force is expected to tell Congress in December 2000 about a change in design for SBIRS-Low which will allow it to simultaneously track multiple missiles. The increased cost could be offset be requiring fewer satellites.

BATTLE MANAGEMENT, COMMAND, CONTROL AND COMMUNICATION (BM/C3).

BM/C3 is being designed to plan, coordinate, direct and control NMD weapons and sensors. It has been identified as possibly the most difficult aspect of the NMD program. Rather than being mostly a hardware development program, it is chiefly software oriented. Besides being certain there are no bugs in the millions of lines of programming, it cannot be realistically tested except under the actual hostile conditions. Consequently, it may not only be the most difficult aspect, but the most uncertain aspect as far as knowing if it will actually work.

NAVY COMPETITION.

During 1999 the US Navy threw its hat in the 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.[23] The Navy Theater Wide (NTW) system uses the SM-3 Standard missile equipped with the Lightweight Exoatmospheric Projectile launched from Aegis ships.[24]

Some writers are beginning to hint at Trident submarines being the only platform large enough to provide an adequate number of interceptors for NMD.[25] There is also a strong movement in Washington to convert four Trident subs to be Tomahawk cruise missile carriers.[26] The two could be combined because the Navy's Standard-3 missile, being designed as an interceptor for ballistic missiles, can be launched from the same tube as the Tomahawks. A converted Trident sub could launch either.

In February 2000 the Navy's top officer, Chief of Naval Operations Admiral Jay Johnson, wrote a memo to Defense Secretary William Cohen proposing that a layer of mobile ships would provide added protection and make the NMD more effective.[27] A sea-based strategic defense would, of course, further aggravate the hot debate over the ABM Treaty and would further complicate 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.

By July 2000 the Navy had completed the first part of a two-part definition study examining three interceptor concepts for a Sea-Based Adjunct to NMD. The first, called "Enhanced NTW,"

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

[24]The Navy Theater Wide system is described in PLRC-000623 on Tactical Missile Defense.

[25]See Newman.

[26]See PLRC-990610, *Trident Updates Useless*.

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

would use a 4.5-kilometer-per-second Standard-3 booster with an enhanced 30-kilogram Lightweight Exoatmospheric Projectile (LEAP) warhead. The second concept, called the "Improved 8-Pack," would have a larger, to-be-developed, 5.5-kilometer-per-second interceptor with a more robust (40-kilogram) warhead. Both of these concepts would fit 8-each into existing Navy launchers.

The third concept, called the "New 6-Pack," requires a larger launcher. It would have a 6.5-kilometer-per-second interceptor with a 50 kilogram warhead.

THE STRATEGIC TARGET SYSTEM (STARS)

Up to now the target missiles for NMD sensors and interceptors (launched from Kwajalein Missile Range) have been Minuteman missiles launched from Vandenberg Air Force Base in California. These missiles fly in a southwesterly direction toward Kwajalein in the Marshall Islands. They do not replicate the direction that missile attacking the US would be traveling, and they do not test the North American defense sensors.

To correct this situation the Pentagon is planning up to eight launches per year of the Strategic Target System (STARS) missile for at least five years beginning in 2001. Half of these launches will be from the Kauai Test Facility in Hawaii and the others from the Kodiak Launch Complex on Kodiak Island, Alaska. Some of the launches from Kodiak Island will be to test Navy TMD systems near Hawaii.

The STARS is a three-stage missile, of which the first two are renovated Polaris A-3 vintage motors. Polaris A-3 is the predecessor of Poseidon which in turn is the predecessor of Trident. During the mid-1990s there were four STARS launches from Kauai but these went southwesterly toward Kwajalein Missile Range. The upcoming launches are to be aimed east to northeast toward the northwest coast of the US. The launches 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 (between Vandenberg and Kwajalein). The latter will probably be to test Navy TMD interceptors.

CONCLUSION

National Missile Defense is a system designed to protect a hypothetical type of terrorism that is not likely to occur. If a terrorist country wished to deliver a weapon of mass destruction, it could be much easier and more economically done by smuggling. Regarding the threat of weapons of mass destruction, Defense Secretary William S. Cohen stated openly: "I think the act of terrorism taking place is more likely than intercontinental ballistic missile."[28]

Even if a terrorist country did deliver a weapons of mass destruction by missile, the weapon would more likely be biological than nuclear. Then the warhead would be numerous canisters or bomblets, something even the long-range plans for NMD would be useless against. This country is wasting grossly abnormal sums in money and talent to combat a form of terrorism that is not likely to happen.

According to the US Commission on National Security/21st Century, "for many years to come Americans will become increasingly less secure, and *much less secure than they now believe themselves to be*.[29] (Emphasis in original) Those are somber words to ponder and all the more scary coming from a government-mandated study. The commission continues:

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[28]DOD News Briefing 7/2000.

[29]*New World Coming*, p. 8.

> "...the most serious threat to our security may consist of unannounced attacks on American cities by sub-national groups using genetically engineered pathogens. Another may be a well-planned cyber-attack on the air traffic control system on the east coast of the United States, as some 200 commercial aircraft are trying to land safely in a morning's rain and fog. Other threats may inhere in assaults against an increasingly integrated and complex, but highly vulnerable, international economic infrastructure whose operation lies beyond the control of any single body. Threats may also loom from the unraveling of the fabric of national identity itself, and the consequent failure or collapse of several major countries.
>
> Taken together, the evidence suggests that threats to American security will be more diffuse, harder to anticipate, and more difficult to neutralize than ever before. Deterrence will not work as it once did; in many cases it will not work at all.[30]

That commission doesn't mention missiles. And it doesn't mention NMD. Yet there is a big push to get NMD started while the real threats are being neglected.

The public is also being deceived regarding flight testing. From the target warhead the test range officers are receiving NAVSTAR GPS positions and radar beacons -- ostensibly benign as far as testing is concerned, *unless something goes wrong*. And we are told about little animated warheads that talk to themselves about seeing balloons and how those balloons help them find their targets. No terrorist country is going to be so accommodating.

If all this business about a hoax is true, why do we have NMD? NMD continues because some people are making a lot of money, and the rest of us are too bewildered to object. It has become so profitable that our corporate-dominated government is considering trading off more nuclear warheads in START-3 in exchange for an ABM Treaty revision allowing a National Missile Defense. BMD has already cost American citizens way over $35 billion in direct budget items, and more in hidden programs. Projections indicate many tens of billions of dollars will be spent in the next five years alone. That is big business.

So let us not be deceived by this hoax. Many informed critics and professional organizations have pinpointed the ultimate goal -- that is, stop financing a system designed to prevent an unlikely form of terrorism. NMD will only enrich the weapons merchants, alienate America from friendly countries, wipe out hard-earned advances in arms reductions, initiate another arms race, and squander huge sums of money and talent that are vitally needed to satisfy critical human needs. By voice or by silence, by design or by default, the final decision will rest with the taxpaying public.

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GLOSSARY

ABM	Anti-Ballistic Missile. An interceptor of ballistic missiles.
BM/C3	Battle Management/Command, Control and Communication.
BMD	Ballistic Missile Defense.
BMDO	Ballistic Missile Defense Organization.
BMEWS	Ballistic Missile Early Warning System.
CBO	Congressional Budget Office.
DOD	Department of Defense (US).
DOE	Department of Energy (US).
DSP	Defense Support Program for early-warning satellites.
EKV	Exoatmospheric Kill Vehicle.
Endoatmospheric	Within the atmosphere.
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.
LEAP	Lightweight Exo-Atmospheric Projectile.
NASA	National Aeronautics and Space Administration (US).

NATO	North Atlantic Treaty Organization.
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.
SBIRS	Space-Based infrared System, a proposed constellation of early-warning and tracking satellites.
SDI	Strategic Defense Initiative, also dubbed "Star Wars."
SLBM	Submarine-Launched Ballistic Missile.
STARS	Strategic Target System.
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.
UHF	Ultra-High Frequency.
US	United States.

APPENDIX-A
NATIONAL MISSILE DEFENSE OPERATING CONCEPT
Source: GAO/NSIAD-00-131