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# CRS Report for Congress

## Sea-Based Ballistic Missile Defense — Background and Issues for Congress

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# Sea-Based Ballistic Missile Defense — Background and Issues for Congress


## Summary

As part of its effort to develop a global ballistic missile defense (BMD) system, the Department of Defense (DOD) is modifying 18 Navy cruisers and destroyers for BMD operations, and has deployed a large BMD radar — the Sea-Based X-Band Radar (SBX) — on a modified floating oil platform. The eventual role of sea-based systems in the worldwide U.S. BMD architecture has not been determined. The overall issue for Congress discussed in this report is: What should be the role of sea-based systems in U.S. ballistic missile defense, and are DOD's programs for sea-based BMD capabilities appropriately structured and funded?

The Aegis BMD system in its current (i.e., Block 2004) configuration is intended to track ballistic missiles of all ranges, including intercontinental ballistic missiles (ICBMs), and to intercept shorter-ranged ballistic missiles. The Block 2004 configuration is not intended to intercept ICBMs. Current DOD plans call for modifying 3 Aegis cruisers and 15 Aegis destroyers with the Aegis BMD capability by the end of 2009. Future versions of the Aegis BMD system are to include a faster interceptor designed to intercept certain ICBMs. The Aegis BMD system has achieved 11 successful exo-atmospheric intercepts in 13 attempts. Japan is acquiring the Aegis BMD system, and some other allied navies have expressed an interest in adding BMD capabilities to their ships.

The Aegis BMD program received $1,122.7 million in FY2007 Missile Defense Agency (MDA) research and development funds. For FY2008, MDA requested $1,059.1 million in research and development funds for the program. The program also receives additional Navy funds.

Potential specific issues for Congress regarding sea-based BMD systems include the number of Aegis BMD ships, the role of Aegis BMD in European missile defense, whether there should be a new acquisition program to fully replace the canceled Navy Area Defense (NAD) sea-based terminal-defense BMD program, the number of SM-3 interceptors planned for procurement, the proposal to equip the SM-3 Block IIA missile with a Multiple Kill Vehicle (MKV), the potential role of the Kinetic Energy Interceptor (KEI) in sea-based BMD operations, procurement of the planned CG(X) cruiser, development and testing of the Aegis BMD system, and potential allied sea-based BMD programs. This report will be updated as events warrant.

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## Introduction

As part of its effort to develop a global ballistic missile defense (BMD) system, the Department of Defense (DOD) is modifying 18 Navy cruisers and destroyers for BMD operations, and has deployed a large BMD radar — the Sea-Based X-Band Radar (SBX) — on a modified floating oil platform. The eventual role for sea-based systems in the world-wide U.S. BMD architecture has not been determined.

The overall issue for Congress discussed in this report is: What should be the role of sea-based systems in U.S. ballistic missile defense, and are DOD's programs for sea-based BMD capabilities appropriately structured and funded? Decisions that Congress reaches on this issue could affect U.S. BMD capabilities and funding requirements; the size, capabilities, and operational patterns of the Navy and the other services; and the shipbuilding industrial base.

## Background

### Rationale for Sea-Based BMD Systems

DOD's overall BMD plan includes ground-based, sea-based, airborne, and space-based systems, each of which have potential strengths and limitations. DOD believes that a combination of these systems will provide a more capable BMD architecture. For a discussion of the potential strengths and limitations of sea-based BMD systems, see **Appendix A**. For a discussion of arms control considerations relating to sea-based BMD systems, see **Appendix B**.

### Aegis BMD Program In General[1]

The Aegis Ballistic Missile Defense (Aegis BMD) program is DOD's primary sea-based BMD program. The program includes the Aegis BMD midcourse program and the Aegis BMD sea-based terminal program. Each of these is discussed below.

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[1] Unless otherwise stated, information on the Aegis BMD program is taken from an April 2006 Missile Defense Agency (MDA) briefing on the Aegis BMD program — "Aegis Ballistic Missile Defense, Aegis BMD Update and Plans, Briefing to the Future Naval Plans & Requirements Conference," Scott Perry, Aegis BMD [Program Office], April 26, 2006, 22 pp.

## Aegis BMD Midcourse Program

**Program Origin.** The Aegis BMD midcourse program was created by the Missile Defense Agency (MDA) in 2002. Earlier names for the program include the Sea-Based Midcourse program, the Navy Theater Wide Defense program, and the Sea-Based Upper Tier program. The program is the successor to earlier sea-based BMD development efforts dating back to the early 1990s.[2]

The Aegis BMD program office is an MDA directorate that reports directly to the director of MDA. MDA provides direction, funding, and guidance to the Aegis BMD program office and is the acquisition executive for the program. To execute the program, the Aegis BMD program office was established as a Naval Sea Systems Command (NAVSEA) field activity. NAVSEA provides administrative support (e.g., contracting, comptroller, and security) to the Aegis BMD program office.

**Intended Capabilities.** The Aegis BMD system in its current configuration (called the Block 2004 configuration; see discussion below) is designed to:

- detect and track ballistic missiles of any range, including ICBMs, and
- intercept short- and medium-range ballistic missiles (SRBMs and MRBMs) above the atmosphere (i.e., exo-atmospherically) during their midcourse phase of flight.

When tracking ICBMs, Aegis BMD ships are to act as sensor platforms providing fire-control-quality tracking data to the overall U.S. BMD architecture.

The Aegis BMD system in its current configuration is *not* designed to:

- intercept intercontinental ballistic missiles (ICBMs) or
- intercept ballistic missiles inside the atmosphere, during either their initial boost phase of flight or their final (terminal) phase of flight.

In contrast to the current configuration of the Aegis BMD system, the ground-based midcourse BMD program, with interceptors based in Alaska and California,

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[2] The Aegis BMD program is the successor to the Aegis LEAP Intercept (ALI) Flight Demonstration Project (FDP), which in turn was preceded by the Terrier Lightweight Exo-Atmospheric Projectile (LEAP) Project, an effort that began in the early 1990s. Terrier is an older Navy SAM replaced in fleet use by the Standard Missile. Although succeeded by the Standard Missile in fleet use, the Navy continued to use the Terrier missile for development and testing.

As mentioned in an earlier footnote (see section on arms control considerations), the ABM Treaty, which was in force until 2002, prohibited sea-based defenses against strategic (i.e., long-range) ballistic missiles. Navy BMD development activities that took place prior to 2002 were permissible under the ABM treaty because they were not aimed at developing technologies for countering long-range ballistic missiles.

is designed to intercept ICBMs in the midcourse phase of flight. Discussions comparing the current configuration of the Aegis BMD system and the ground-based midcourse program have not always noted this basic difference in the kinds of ballistic missiles they are intended to intercept.

**Aegis Ships.** The Aegis BMD system builds on the capabilities of the Navy's Aegis ship combat system, which was originally developed for defending ships against aircraft, anti-ship cruise missiles (ASCMs), surface threats, and subsurface threats.[3] The Aegis system was first deployed by the Navy in 1983, and has been updated several times since. The part of the Aegis combat system for countering aircraft and ASCMs is the called the Aegis Weapon System. Key components of the Aegis Weapon System relevant to this discussion include the following:

- the SPY-1 radar — a powerful, phased-array, multifunction radar that is designed to detect and track multiple targets in flight, and to provide midcourse guidance to interceptor missiles;

- a suite of computers running the Aegis fire control and battle-management computer program; and

- the Standard Missile (SM) — the Navy's longer-ranged surface-to-air missile (SAM), so called because it was first developed many years ago as a common, or standard, replacement for a variety of older Navy SAMs.[4]

The version of the Standard Missile currently used for air-defense operations is called the SM-2 Block IV, meaning the fourth upgrade to the second major version of the Standard Missile. The Navy is developing a new version of the Standard Missile for future air-defense operations called the SM-6 Extended Range Active Missile (SM-6 ERAM).

U.S. Navy ships equipped with the Aegis system include Ticonderoga (CG-47) class cruisers and Arleigh Burke (DDG-51) class destroyers. A total of 27 CG-47s were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five, which were built to an earlier technical standard, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005. The Navy currently plans to modernize the remaining 22 ships and keep them in service to age 35.

A total of 62 DDG-51s were procured for the Navy between FY1985 and FY2005; the first entered service in 1991 and the 62$^{nd}$ is scheduled to enter service

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[3] The Aegis system is named after the mythological shield carried by Zeus.

[4] For more on the Aegis system and its principal components as originally deployed, see CRS Report 84-180 F, *The Aegis Anti-Air Warfare System: Its Principal Components, Its Installation on the CG-47 and DDG-51 Class Ships, and its Effectiveness*, by Ronald O'Rourke. (October 24, 1984) This report is out of print and is available directly from the author.

in late 2010 or early 2011. The Navy currently plans to modernize these ships and keep them in service to age 35.[5]

Between 2010/2011, when the 62nd DDG-51 enters service, and 2021, when the first of the 22 remaining CG-47s reaches age 35, the Navy plans to maintain a force of 84 Aegis ships — 22 cruisers and 62 destroyers.

Sales of the Aegis system to allied countries began in the late 1980s. Allied countries that now operate, are building, or are planning to build Aegis-equipped ships include Japan (the first foreign buyer, with 4 destroyers in service and 2 more under construction), South Korea (3 destroyers under construction or planned), Australia (3 destroyers planned), Spain (4 frigates in service and 1 or 2 more planned), and Norway (1 frigate in service and 4 more under construction or planned).[6] The Norwegian frigates are somewhat smaller than the other Aegis ships, and consequently carry a reduced-size version of the Aegis system that includes a smaller, less-powerful version of the SPY-1 radar.

**Modification Schedule and Initial Deployments.** Modifying an Aegis ship for BMD operations involves making two principal changes:

- changing the Aegis computer program to permit the SPY-1 radar to detect and track high-flying ballistic missiles; and
- arming the ship with a BMD version of the Standard Missile called the SM-3 Block 1A.

A ship with the first modification is referred to as having a long-range search and track (LRS&T) capability. A ship with both modifications is referred to as an engage-capable ship. Modifying each ship reportedly takes about six weeks and costs about $10.5 million.[7]

The SM-3 Block IA is equipped with a "hit-to-kill" warhead that is designed to destroy a ballistic missile's warhead by colliding with it outside the atmosphere, during the enemy missile's midcourse phase of flight. It is intended to intercept SRBMs and MRBMs. An improved version, the Block IB, is to offer some capability for intercepting intermediate-range ballistic missiles (IRBMs). The Block IA and IB do not fly fast enough to offer a substantial capability for intercepting ICBMs.[8]

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[5] For more on the Navy's plan for modernizing the Aegis cruisers and destroyres, see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

[6] Source: *Jane's Fighting Ships 2006-2007*. Numbers of ships are planned eventual totals.

[7] Jack Dorsey, "Navy On Front Line Of Missile Defense," *Norfolk Virginian-Pilot*, October 21, 2006.

[8] Longer-range ballistic missiles generally fly faster than shorter-range ballistic missiles. Consequently, intercepting a longer-range missile generally requires a faster-flying (continued...)

A faster-flying version of the SM-3, called the Block II/IIA, is now being developed (see discussion below). The Block II/IIA version is intended to give Aegis BMD ships an improved capability for intercepting IRBMs and some capability for intercepting ICBMs.

Current DOD plans call for modifying 18 U.S. Aegis ships — 3 cruisers and 15 destroyers — with the Aegis BMD capability. **Table 1** shows the planned installation schedule as of October 2006. Under this schedule, some of the 18 ships will be modified in two steps, with the LRS&T capability being added first, and the SM-3 missile being added at a later point. Thus, in **Table 1**, some ships shown as LRS&T ships in earlier years migrate to the engage-capable category in later years. As can be seen in the table, the schedule calls for the Navy to have 18 engage-capable ships by the end of calendar 2009.

## Table 1. Aegis BMD Installation Schedule

(as of October 4, 2006)

| | Cumulative total by end of calendar year | | | | | |
|---|---|---|---|---|---|---|
| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| ***LRS&T ships*** | | | | | | |
| CG-47s | 1 | 0 | 0 | 0 | 0 | 0 |
| DDG-51s | 5 | 9 | 10 | 8 | 1 | 0 |
| Subtotal | 6 | 9 | 10 | 8 | 1 | 0 |
| ***Engage-capable ships*** | | | | | | |
| CG-47s | 0 | 2[a] | 3 | 3 | 3 | 3 |
| DDG-51s | 0 | 0 | 3 | 6 | 14 | 15 |
| Subtotal | 0 | 2[a] | 6 | 9 | 17 | 18 |
| ***Total LRS&T Engage-capable ships*** | | | | | | |
| | 6 | 11 | 16 | 17 | 18 | 18 |

**Source:** U.S. Navy data provided to CRS by Navy Office of Legislative Affairs, October 11, 2006.
a. Emergency (i.e., preliminary) engage capability.

Rear Admiral Alan Hicks, the Aegis BMD program director, stated in late-November 2007

> that all 18 ships designated to receive the Aegis system would have them installed by the end of calendar year 2008 — six months earlier than previously anticipated.
>
> "We will complete by the end of next calendar year the final install on the remaining eight Aegis ships that are programmed as part of the program of

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[8] (...continued)
interceptor than is required for intercepting a shorter-range ballistic missile. The SM-3 Block IA and 1B fly fast enough to intercept TBMs, but not fast enough to provide an effective capability for intercepting ICBMs.

> record, so we will have 18 ships by the end of the calendar year," he said. "The training and certification may take until January or February, but the installs will be complete by the end of the next calendar year, and we are on track to do that."
>
> Hicks said installation teams and industry partners had "done better than we had planned — the material is coming in a little bit earlier than we had planned."[9]

LRS&T Aegis destroyers began operating in September 2004. Engage-capable Aegis cruisers began operating in September 2005.[10]

**Development, Testing, and Certification.** ***Block Development Strategy.*** Consistent with the approach used for other parts of DOD's BMD acquisition effort, the Aegis BMD system is being developed and deployed in a series of increasingly capable versions, or blocks, that are named after their approximate anticipated years of deployment:

- The current **Block 2004** version includes the SM-3 Block IA missile and a version of the Aegis computer program called Aegis BMD 3.6, which allows the ship to perform BMD operations and other warfare operations (such as air defense) at the same time. (The previous 3.0 version of the computer program did not permit this.)[11] The Block 2004 version is intended to counter SRBMs and MRBMs.

- The **Block 2006/2008** version is to include various improvements, including the Block IB version of the SM-3 and the Aegis BMD signal processor (Aegis BSP) — a radar signal and data processor that improves the SPY-1's ballistic missile target-discrimination performance. The improvements are intended to, among other things, give the system a limited ability to intercept IRBMs.

- The **Block 2010/2012/2014** version is to include further improvements, including the Block II version of the SM-3 around 2013, and the Block IIA version in 2015. The improvements are intended to, among other things, give the system and improved ability to intercept IRBMs and some ability to counter ICBMs. This version will also incorporate changes intended to make the system suitable for broader international ship participation.

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[9] Dan Taylor, "Navy Still Interested in Second MKV, MDA Will Talk to Congress," *Inside the Navy*, December 3, 2007.

[10] The engage-capable cruisers conducted their first operations with an emergency (i.e., preliminary) version of the engagement capability. See also Megan Scully, "FY08 Funding Boost To Help Navy Deploy Missile Defenses," *National Journal's CongressDailyPM*, November 28, 2007.

[11] For further discussion of the multimission capability of the 3.6 program see Christopher P. Cavas, "U.S. Warships To Get Missile Defense Upgrades," *Defense News*, October 9, 2006: 4.

***"Test A Little, Learn A Lot" Development Approach.*** The Aegis BMD program is employing a development approach that the program office characterizes as "test a little, learn a lot." The Aegis BMD program office has stated:

> We have an expression in the Navy and the Aegis BMD program, "test a little, learn a lot." Test more and more and more.... More importantly, the Navy has chosen to work with the Test and Evaluation community to get the most operationally relevant scenarios we can. The [engage-capable Aegis cruiser] USS Lake Erie, on our last few shots, was on a simulated patrol mission. It had a window of vulnerability — read hours — that they could launch. That was all the pre-alert they had, with the exception that the captain was notified of that launch time for safety. Only the ships' crews man the consoles; there are no technicians there from outside to help the crew. The forward deployed [BMD-equipped Aegis] ships are operating with this capability.[12]

MDA similarly stated that:

> The test program for Aegis BMD has focused on the philosophy of "test a little, learn a lot" since its inception in the early 1990's with the TERRIER Lightweight Exo-Atmospheric Projectile (LEAP) Project. TERRIER LEAP included four flight tests between 1992 and 1995, and was successful in demonstrating that LEAP technology could be integrated into a sea-based tactical missile for exoatmospheric ballistic missile defense.
>
> The lessons learned from TERRIER LEAP evolved into the Aegis LEAP Intercept (ALI) Flight Demonstration Project (FDP), the goal of which was to utilize the Aegis Weapons System and Standard Missile 3 (SM-3) to hit a ballistic missile in the exoatmosphere. The ALI test objectives were achieved with two successful descent phase intercepts of a ballistic missile during Flight Mission 2 (FM-2) and FM-3 in January 2002 and June 2002 respectively firing an SM-3 from the [Aegis cruiser] USS LAKE ERIE.
>
> The transition of ALI to an Aegis BMD capability commenced with FM-4 in November of 2002 with USS LAKE ERIE, executing the first successful ascent phase intercept of a short range ballistic missile (SRBM) by the Aegis BMD element.[13]

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[12] A. Brad Hicks, *Aegis Ballistic Missile Defense (BMD) System*. Washington, George C. Marshall Institute, 2005(?). (Washington Roundtable on Science & Public Policy, December 19, 2005) p. 13.

[13] "Aegis Ballistic Missile Defense," MDA fact sheet, January 30, 2004.

***Flight Tests.*** From January 2002 through November 2007, the Aegis BMD system has achieved 11 successful exo-atmospheric intercepts in 13 attempts.[14] These attempts are summarized below.

*Seven Tests Between January 2002 and November 2005.* **Table 2** below summarizes seven ALI and Aegis BMD flight tests (called FTM-2 through FTM-8, with the FTM standing for "flight test mission[15]) conducted between January 2002 and November 2005. As shown in the table, six of the seven tests resulted in successful intercepts.

*Eighth Test (June 2006).* On June 22, 2006, an Aegis BMD flight test called FTM-10 resulted in a seventh successful exo-atmospheric intercept in eight attempts. This was the first test to use the Aegis 3.6 computer program.[16]

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[14] Another CRS report, based on historical flight test data provided by MDA to CRS in June 2005, summarizes early sea-based BMD tests as follows:

> The Navy developed its own indigenous LEAP program, which flight tested from 1992-1995. Three non-intercept flight tests achieved all primary and secondary objectives. Of the five planned intercept tests, only the second was considered a successful intercept, however. Failures were due to various hardware, software, and launch problems. Even so, the Navy determined that it achieved about 82% of its primary objectives (18 of 22) and all of its secondary objectives in these tests.
>
> (CRS Report RL33240, *Kinetic Energy Kill for Ballistic Missile Defense: A Status Overview*, by Steven A. Hildreth.)

[15] In some presentations, the flight tests are referred to as FM-2, etc., without the "T."

[16] Missile Defense Agency, "Missile Defense Test Results in Successful 'Hit To Kill' Intercept,"June 22, 2006 (06-NEWS-0018).

## Table 2. ALI and Aegis BMD Flight Tests

| Test name | FTM-2 | FTM-3 | FTM-4 | FTM-5 | FTM-6 | FTM-7 | FTM-8 |
|---|---|---|---|---|---|---|---|
| Date | 1/22/02 | 6/13/02 | 11/21/02 | 6/18/03 | 12/11/03 | 2/24/05 | 11/17/05 |
| Target apogee | 300km | 300km | 160km | 160km | 160km | 160km | 227km |
| Target range | 500km | 500km | 600km | 600km | 600km | 600km | 925km |
| Aegis computer program | ALI 1.2 | ALI 1.2 | ALI 2.0 | ALI 2.0 | ALI 2.2.2 | BMD 3.0 | BMD 3.0 |
| SM-3 version | Block 0 | Block 0 | Block 0 | Block 0 | Block 0 | Block 1 | Block 1 |
| Engagement sequence | Uncued | Uncued | Uncued | Cued* | Cued* | Uncued | Uncued |
| Intercept down range | 430km | 430km | 250km | 250km | 482km | 250km | 462km |
| Intercept cross range | 240km | 240km | 200km | 150km | 248km | 150km | 150km |
| Crew disclosure | Yes | Yes | Yes | Yes | No | No | No |
| Ship's heading | Steady | Steady | Steady | Steady | Maneuv-ering | Maneuv-ering | Maneuv-ering |
| Target flight phase | Descent | Descent | Ascent | Ascent | Descent | Descent | Descent |
| Lethal aimpont | No | No | Aimpoint shift | Yes | Yes | Yes | Yes |
| **Kinetic warhead intercept** | **Yes** | **Yes** | **Yes** | **No** | **Yes** | **Yes** | **Yes** |

**Source:** "Aegis Ballistic Missile Defense, Aegis BMD Update and Plans," Briefing to the Future Naval Plans & Requirements Conference, Scott Perry, Aegis BMD [Program], April 26, 2006, slide 11.
* Aegis ship to Aegis ship and external sensor to Aegis ship.

*Ninth Test (December 2006).* On December 7, 2006, an Aegis BMD flight test called FTM-11 was not successful, and was the first unsuccessful flight test since June 2003. MDA states that the ninth test

> was not completed due to an incorrect system setting aboard the Aegis-class cruiser USS Lake Erie prior to the launch of two interceptor missiles from the ship. The incorrect configuration prevented the fire control system aboard the ship from launching the first of the two interceptor missiles. Since a primary test objective was a near-simultaneous launch of two missiles against two different targets, the second interceptor missile was intentionally not launched.
>
> The planned test was to involve the launch of a Standard Missile 3 against a ballistic missile target and a Standard Missile 2 against a surrogate aircraft target. The ballistic missile target was launched from the Pacific Missile Range Facility, Kauai, Hawaii and the aircraft target was launched from a Navy aircraft. The USS Lake Erie (CG 70), USS Hopper (DDG 70) and the Royal Netherlands Navy frigate TROMP were all successful in detecting and tracking their respective targets. Both targets fell into the ocean as planned.

After a thorough review, the Missile Defense Agency and the U.S. Navy will determine a new test date.[17]

A news article about the test stated:

"You can say it's seven of nine, rather than eight of nine," Missile Defense Agency spokesman Chris Taylor said of the second failure in tests of the system by the agency and the Navy....

The drill was planned to demonstrate the Navy's ability to knock down two incoming missiles at once from the same ship.

"In a real world situation it is possible, maybe even probable, that in addition to engaging a ballistic missile threat that was launched, you may be engaging a surface action," said Joe Rappisi before the test. He is director for the Aegis Ballistic Missile Defense system at Lockheed Martin, the primary contractor for the program.

The test would have marked the first time a ship has shot down one target in space and another target in the air at the same time.

The test presented a greater challenge to the ship's crew and the ballistic missile defense system than previous tests, Rappisi said. The multiple target scenario is also closer to what sailors might actually face in battle.

The U.S. Pacific Fleet has been gradually installing missile surveillance and tracking technology on many of its destroyers and cruisers amid concerns about North Korea's long-range missile program.

It is also installing interceptor missiles on many of its ships, even as the technology to track and shoot down incoming missiles is being developed and perfected.

The Royal Netherlands Navy joined the tracking and monitoring off Kauai to see how its equipment works. The Dutch presence marked the first time a European ally has sent one of its vessels to participate in a U.S. ballistic missile defense test.[18]

A subsequent news article stated that:

the test abort of the Aegis Ballistic Missile Defense system Dec. 7 resulted from human error, [MDA Director USAF Lt. Gen. Henry] Obering says.... Both the ballistic missile and aircraft targets launched as planned, but the first interceptor failed to fire because an operator had selected an incorrect setting for the test. Officials then aborted before the second could boost.

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[17] Untitled Missile Defense Agency "For Your Information" statement dated December 7, 2006 (06-FYI-0090).

[18] David Briscoe, "Test Interceptor Missile Fails To Launch," *NavyTimes.com*, December 8, 2006.

> Aegis missile defense system tests are at a standstill until officials are able to identify an appropriate ballistic missile target. The one used Dec. 7 was the last of its kind, Obering says, leaving them empty handed in the near future.[19]

Another article stated:

> Philip Coyle, a former head of the Pentagon's testing directorate, gives the Navy credit for "discipline and successes so far" in its sea-based ballistic missile defense testing program. Coyle is now a senior adviser at the Center for Defense Information.
>
> "The U.S. Navy has an enviable track record of successful flight intercept tests, and is making the most of its current, limited Aegis missile defense capabilities in these tests," Coyle told [*Inside the Navy*] Dec. 7.
>
> "Difficulties such as those that delayed the latest flight intercept attempt illustrate the complexity of the system, and how everything must be carefully orchestrated to achieve success," Coyle added. "Nevertheless, this particular setback won't take the Navy long to correct."[20]

*Tenth Test (April 2007).* On April 26, 2007, an Aegis BMD flight test called FTM-11b (or FTM Event 4) resulted in the eighth successful exo-atmospheric intercept in ten attempts. MDA states that the test

> involved the simultaneous engagements of a ballistic missile "unitary" target (meaning that the target warhead and booster remain attached) and a surrogate hostile air target....
>
> The test demonstrated the [Aegis ship's] ability to engage a ballistic missile threat and defend itself from attack at the same time. The test also demonstrated the effectiveness of engineering, manufacturing, and mission assurance changes in the solid divert and attitude control system (SDACS) in the kinetic kill weapon. This was the first flight test of all the SM-3 Block IA's upgrades, previously demonstrated in ground tests.[21]

A press report on the test stated that the hostile air target was an anti-ship cruise missile. The article stated that the scenario for the test

> called for the [Aegis ship] to come under attack from a cruise missile fired by an enemy plane.... A Navy plane fired the cruise missile target used in the test.[22]

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[19] Amy Butler, "GMD Trial Delayed Until Spring; Aegis Failure Human Error," *Aerospace Daily & Defense Report*, December 19, 2006.

[20] Zachary M. Peterson, "Sea-Based Missile Defense Test Fails Due To 'Incorrect Configuration,'" *Inside the Navy*, December 11, 2006.

[21] Missile Defense Agency, "Successful Sea-Based Missile Defense 'Hit to Kill' Intercept," April 26, 2007 (07-NEWS-0032).

[22] Audrey McAvoy, "Aegis Missile Test Successful," *NavyTimes.com*, April 27, 2007.

*Eleventh Test (June 2007).* On June 22, 2007, an Aegis BMD flight test called FTM-12 resulted in the ninth successful exo-atmospheric intercept in 11 attempts. MDA states that the test

> was the third intercept involving a separating target and the first time an Aegis BMD-equipped destroyer was used to launch the interceptor missile. The USS Decatur (DDG 73), using the operationally-certified Aegis Ballistic Missile Defense Weapon System (BMD 3.6) and the Standard Missile-3 (SM-3) Block IA missile successfully intercepted the target during its midcourse phase of flight....
>
> An Aegis cruiser, USS Port Royal (CG 73), a Spanish frigate, MÉNDEZ NÚÑEZ (F-104), and MDA's Terminal High Altitude Area Defense (THAAD) mobile ground-based radar also participated in the flight test. USS Port Royal used the flight test to support development of the new Aegis BMD SPY-1B radar signal processor, collecting performance data on its increased target detection and discrimination capabilities. MÉNDEZ NÚÑEZ, stationed off Kauai, performed long-range surveillance and track operations as a training event to assess the future capabilities of the F-100 Class. The THAAD radar tracked the target and exchanged tracking data with the Aegis BMD cruiser.
>
> This event marked the third time that an allied military unit participated in a U.S. Aegis BMD test, with warships from Japan and the Netherlands participating in earlier tests.[23]

*Twelfth Test (November 2007).* On November 6, 2007, an Aegis BMD flight test called FTM-13 that involved intercepting two SRBMs resulted in the 10th and 11th successful exo-atmospheric intercepts in 13 attempts. MDA states that the test:

> a multiple simultaneous engagement involving two ballistic missile targets.... For the first time, the operationally realistic test involved two unitary "non-separating" targets, meaning that the target's warheads did not separate from their booster rockets....
>
> At approximately 6:12 p.m. Hawaii Standard Time (11:12 p.m. EST), a target was launched from the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. Moments later, a second, identical target was launched from the PMRF. The USS Lake Erie's Aegis BMD Weapon System detected and tracked the targets and developed fire control solutions.
>
> Approximately two minutes later, the USS Lake Erie's crew fired two SM-3 missiles, and two minutes later they successfully intercepted the targets outside the earth's atmosphere more than 100 miles above the Pacific Ocean and 250 miles northwest of Kauai....
>
> A Japanese destroyer also participated in the flight test. Stationed off Kauai and equipped with the certified 3.6 Aegis BMD weapon system, the guided missile destroyer JS Kongo performed long-range surveillance and tracking exercises. The Kongo used the test as a training exercise in preparation for the

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[23] Missile Defense Agency, "Sea-Based Missile Defense 'Hit to Kill' Intercept Achieved," June 22, 2007 (07-NEWS-0037).

first ballistic missile intercept test by a Japanese ship planned for later this year. This event marked the fourth time an allied military unit participated in a U.S. Aegis BMDS test.[24]

*Scheduled Future Tests.* As of December 2007, future Aegis BMD flight tests were scheduled for June 2008 (FTM-14 — a test of terminal defense against an SRBM), March 2009 (FTM-15 — a test for engaging an IRBM based on information received from a tactical digital information link [TADIL]), and September 2009 (FTM-16, a test for engaging an MRBM with an SM-3 BLock IB interceptor).[25]

***Certification.*** On September 11, 2006, the Navy and MDA certified the version of the Aegis BMD system using the Aegis BMD 3.6 computer program for tactical deployment.[26]

***SM-3 Block II/IIA Missile (Cooperative Program With Japan).*** Under a memorandum of agreement signed in 1999, the United States and Japan have cooperated in researching technologies for the Block II/IIA version of the SM-3. The cooperative research has focused on risk reduction for four parts of the missile: the sensor, an advanced kinetic warhead, the second-stage propulsion, and a lightweight nose cone. Japan has funded a significant share of the effort.

In contrast to the Block IA/1B version of the SM-3, which has a 21-inch-diameter booster stage but is 13.5 inches in diameter along the remainder of its length, the Block II/IIA version would have a 21-inch diameter along its entire length. The increase in diameter to a uniform 21 inches provides more room for rocket fuel and is to give the missile a burnout velocity (a maximum velocity, reached at the time the propulsion stack burns out) that is 45% to 60% greater than that of the Block IA/IB version.[27] The Block IIA version would also include an

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[24] Missile Defense Agency, "Sea-Based Missile Defense "Hit to Kill" Intercept Achieved," November 6, 2007 (07-NEWS-0051).

[25] Source: Navy briefing chart as reprinted in Aerospace Daily & Defense Report, December 3, 2007: 6.

[26] See Missile Defense Agency, "Aegis Ballistic Missile Defense Weapon System Gains Fleet Certification," September 1, 2006 (06-FYI-0082); and Lockheed Martin, "Aegis Ballistic Missile Defense Weapon System Gains Fleet Certification," September 11, 2006.

[27] The 13.5-inch version has a reported burnout velocity of 3.0 to 3.5 kilometers per second (kps). See, for example, J. D. Marshall, *The Future Of Aegis Ballistic Missile Defense*, point paper dated October 15, 2004, available at [http://www.marshall.org/pdf/materials/259.pdf]; "STANDARD Missile-3 Destroyers a Ballistic Missile Target in Test of Sea-based Missile Defense System," Raytheon news release circa January 26, 2002, available on the Internet at [http://www.prnewswire.com/cgi-bin/micro_stories.pl?ACCT=683194&TICK=RTN4&STORY=/www/story/01-26-2002/0001655926&EDATE=Jan+26,+2002]; and Hans Mark, "A White Paper on the Defense Against Ballistic Missiles," *The Bridge*, summer 2001, pp. 17-26, available on the Internet at [http://www.nae.edu/nae/bridgecom.nsf/weblinks/NAEW-63BM86/$FILE/BrSum01.pdf?OpenElement]. See also the section on "Sea-Based Midcourse" in CRS Report RL31111, *Missile Defense: The Current Debate*, coordinated by Steven A. Hildreth.

improved kinetic warhead.[28] MDA states that the Block II/IIA version could "engage many [ballistic missile] targets that would outpace, fly over, or be beyond the engagement range" of earlier versions of the SM-3, and that

> the net result, when coupled with enhanced discrimination capability, is more types and ranges of engageable [ballistic missile] targets; with greater probability of kill, and a large increase in defended "footprint" or geography predicted.... The SM-3 Blk II/IIA missile with it[s] full 21-inch propulsion stack provides the necessary fly out acceleration to engage IRBM and certain ICBM threats.[29]

MDA estimates that the Block II version of the missile could enter service around 2013, and the Block IIA version in 2015.

## Aegis BMD Sea-Based Terminal Program

In addition to the midcourse program described above, which is intended to intercept ballistic missiles outside the atmosphere, during the midcourse phase of flight, the Aegis BMD program includes a second effort, called the sea-based terminal capability, to develop a complementary sea-based capability for intercepting TBMs in the final, or descent, phase of flight, after the missiles have reentered the atmosphere, so as provide local-area defense of U.S. ships as well as friendly forces, ports, airfields, and other critical assets ashore. The sea-based terminal effort is the successor to an earlier effort to achieve such a capability that was called the Navy Area Defense (NAD) program or Navy Area TBMD (Theater BMD) program, and before that, the Sea-Based Terminal or Navy Lower Tier program.

The NAD system was to have been deployed on Navy Aegis ships. The program involved modifying the SM-2 Block IV air-defense missile. The missile, as modified, was called the Block IVA version. The system was designed to intercept descending missiles endo-atmospherically (i.e., within the atmosphere) and destroy them with the Block IVA missile's blast-fragmentation warhead.

In December 2001, DOD announced that it had canceled the NAD program. In announcing its decision, DOD cited poor performance, significant cost overruns, and substantial development delays. DOD stated that the program's unit acquisition and unit procurement costs had risen 57% and 65%, respectively.[30]

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[28] Source for information on SM-3: Missile Defense Agency, "Aegis Ballistic Missile Defense SM-3 Block IIA (21-Inch) Missile Plan (U), August 2005," a 9-page point paper provided by MDA to CRS, August 24, 2005.

[29] "Aegis Ballistic Missile Defense SM-3 Block IIA (21-Inch) Missile Plan (U), August 2005," op. cit, pp. 3-4.

[30] Acquisition cost is the sum of procurement cost plus research, development, test and evaluation (RDT&E) cost. In announcing the cancellation, DOD cited the Nunn-McCurdy provision (10 USC §2433), a defense acquisition law enacted in 1981. Under the provision as it existed in 2001, a major defense acquisition program experienced what is called a Nunn-McCurdy unit cost breach when its projected unit cost increased by at least 15%. If the increase reached 25%, the Secretary of Defense, to permit the program to continue, must

(continued...)

Following cancellation of the NAD program, DOD officials stated that the requirement for a sea-based terminal BMD system remained intact. This led some observers to believe that a replacement for the NAD program might be initiated. In May 2002, however, DOD announced that instead of starting a replacement program, MDA had instead decided on a two-part strategy to (1) modify the SM-3 missile to intercept ballistic missiles at somewhat lower altitudes, and (2) modify the fuzes on the Navy's inventory of about 100 SM-2 Block IV air defense missiles so that these missiles can cover some of the remaining portion of the sea-based terminal defense requirement. The modified Block IV missile uses a blast-fragmentation warhead. DOD officials said the two modified missiles could together provide much (but not all) of the capability that was to have been provided by the Block IVA missile. One aim of the modification strategy, DOD officials suggested, was to avoid the added costs to the BMD program of starting a replacement sea-based terminal defense program.[31]

MDA stated in 2006 that:

> There is currently no sea-based terminal ballistic missile defense capability. The Navy Area [Defense] Theater Ballistic Missile Defense (TBMD) Program, had been under development, but was terminated in December 2001. In ballistic missile defense, the modified Aegis Weapon System, with a modified SM-2 Block IV missile provides a near term, limited emergency capability against a very specific segment of the ballistic missile threat. The Navy and MDA consider it vital to develop a more robust capability for terminal ballistic missile defense of the joint sea base and friendly force embarkation points ashore.[32]

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[30] (...continued)
certify that the program is essential to national security, that there are no alternatives to the program that would provide equal or greater military capability at less cost, that new estimates of the program's unit acquisition cost or unit procurement cost appear reasonable, and that the management structure for the program is adequate to control the program's unit acquisition or unit procurement cost.

Edward C. "Pete" Aldridge, the Under Secretary of Defense for Acquisition, Technology and Logistics — the Pentagon's chief acquisition executive — concluded, after examining the NAD program, that he could not recommend to Secretary of Defense Donald Rumsfeld that he make such a certification. Rumsfeld accepted Aldridge's recommendation and declined to issue the certification, triggering the program's cancellation. This was the first defense acquisition program that DOD officials could recall having been canceled as a result of a decision to not certify under a Nunn-McCurdy unit cost breach. ("Navy Area Missile Defense Program Cancelled," Department of Defense News Release No. 637-01, December 14, 2001; James Dao, "Navy Missile Defense Plan Is Canceled By the Pentagon," *New York Times*, December 16, 2001; Gopal Ratnam, "Raytheon Chief Asks DOD To Revive Navy Program," *Defense News*, January 14-20, 2002: 10.)

[31] Zachary M. Peterson, "Navy To Field Terminal Pahse, Sea-Based Missile Defense Capability," *Inside the Navy*, June 5, 2006; Gopal Ratnam, "U.S. Studies New Solution To Naval Missile Defense," *Defense News*, May 13-19, 2002: 4; Randy Woods, "DOD Scraps Navy Area Requirements, Will Expand Midcourse System," *Inside the Navy*, May 6, 2002.

[32] Missile Defense Agency, "First at-Sea Demonstration of Sea-Based Terminal Capability Successfully Completed," May 24, 2006 (06-FYI-0079).

MDA's FY2008 budget submission for the Aegis BMD program divides the sea-based terminal program into a near-term (Block 2008) capability and a far-term (Block 2014) capability. The Block 2008 capability includes the fuze-modified SM-2 Block IV and is to provide a near-term sea-based terminal capability against a finite set of SRBMs. The Navy (not MDA) is funding the modification of 100 SM-2 Block IV missiles. This capability is scheduled to enter service in FY2009. MDA states that the Block 2014 capability is envisioned as including a new type of missile, the design of which is not yet determined, that is to provide a more capable and robust sea-based terminal capability.

A modified Block SM-2 IV missile successfully intercepted a target ballistic missile inside the atmosphere, during the terminal phase of flight, in a test conducted on May 24, 2006.[33]

In late-November 2007, Rear Admiral Alan Hicks, the Aegis BMD program director, stated that

> a "near-term [sea-based terminal] capability" would be ready late next year.
>
> "We have also programmed and budgeted for a far-term capability to give us sea-based terminal in the 2015 time frame to follow this, so we're very pleased about that," he said....
>
> The Navy will initiate development on the far-term capability this fiscal year, he said.
>
> "We're going to start announcing the plan this year, hopefully in the spring," he said. "We're in the process of briefing it up."[34]

## Aegis BMD Program Funding

The Aegis BMD program received $1,122,7 million in FY2007 Missile Defense Agency (MDA) research and development funds. For FY2008, MDA requested $1,059.1 million in research and development funds for the program. The program also receives additional Navy funds for efforts such as modifying the SM-2 Block IV missiles to be used in the near-term (Block 2008) sea-based terminal capability.

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[33] See Missile Defense Agency, "First at-Sea Demonstration of Sea-Based Terminal Capability Successfully Completed," May 24, 2006 (06-FYI-0079); Gregg K. Kakesako, "Missile Defense System Makes History," *Honolulu Star-Bulletin*, May 25, 2006; Audrey McAvoy, "Ship Shoots Down Test Missile For The First Time," *NavyTimes.com*, May 25, 2006; "Navy, MDA Announce First Terminal Sea-Based Intercept," *Aerospace Daily & Defense Report*, May 26, 2006; Zachary M. Peterson, "Navy Conducts First Sea-Based Terminal Phase Missile Defense Test," *Inside the Navy*, May 29, 2006; and Jeremy Singer, "Sea-Based Terminal May Boost U.S. Missile Defense Capability," *Space News (www.space.com)*, June 12, 2006.

[34] Dan Taylor, "Navy Still Interested in Second MKV, MDA Will Talk to Congress," *Inside the Navy*, December 3, 2007.

**Table 3** shows actual or programmed annual funding for the Aegis BMD program from FY1995 through FY2013. **Table 4** shows FY2006-FY2013 MDA funding for the Aegis BMD program by individual line item. In addition to the figures shown in **Table 4**, it was reported in February 2007 that MDA planned to seek congressional approval to transfer an additional $20 million in FY2007 funding into the sea-based terminal program from other MDA accounts. The plan is consistent with congressional report language on the FY2007 defense budget.[35] The figures in **Table 3** and **Table 4** do not include Navy funding for efforts such as modifying 100 SM-2 Block IV missiles for the near-term (Block 2008) sea-based terminal capability.

## Table 3. Aegis BMD Program Funding, FY1995-FY2013

(millions of dollars, rounded to the nearest tenth)

| | |
|---|---|
| FY95 | 75.0 |
| FY96 | 200.4 |
| FY97 | 304.2 |
| FY98 | 410.0 |
| FY99 | 338.4 |
| FY00 | 380.0 |
| FY01 | 462.7 |
| FY02 | 476.0 |
| FY03 | 464.0 |
| FY04 | 726.2 |
| FY05 | 1,159.8 |
| FY06 | 893.0 |
| FY07 | 1,122.7 |
| *FY08* | *1,059.1* |
| *FY09* | *1,129.4* |
| *FY10* | *1,030.5* |
| *FY11* | *987.8* |
| *FY12* | *1,205.5* |
| *FY13* | *1,059.3* |

**Sources:** For FY1995 through FY2005: DOD Information Paper provided to CRS by Navy Office of Legislative Affairs, November 14, 2006. For FY2006-FY2013: FY2008 MDA budget justification book for Aegis BMD program.

[35] Chris Johnson, "MDA To Reprogram Funds For Aegis Sea-Based Terminal Missile Defense," *Inside the Navy*, February 26, 2007.

**Table 4. Detailed MDA Aegis BMD Program Funding**
(millions of dollars, rounded to nearest tenth)

| | FY06 | FY07 | FY08 | FY09 | FY10 | FY11 | FY12 | FY13 |
|---|---|---|---|---|---|---|---|---|
| Aegis Block 2004 | 136.3 | 23.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aegis Block 2006 | 448.9 | 395.3 | 75.4 | 42.6 | 0 | 0 | 0 | 0 |
| Aegis Block 2008 | 254.0 | 575.6 | 721.1 | 592.9 | 166.1 | 31.4 | 0 | 0 |
| Aegis Block 2010 | 0 | 40.4 | 71.5 | 162.8 | 450.6 | 324.9 | 32.0 | 29.5 |
| Aegis Block 2012 | 0 | 8.7 | 26.7 | 130.3 | 316.8 | 412.7 | 687.8 | 758.2 |
| Sea-based terminal Block 2004 | 0 | 15.0 | 62.0 | 10.0 | 0 | 0 | 0 | 0 |
| Sea-based terminal Block 2014 | 0 | 0 | 13.0 | 39.0 | 60.0 | 65.0 | 230.0 | 163.0 |
| Japanese Cooperative Program | 34.8 | 50.6 | 74.4 | 134.9 | 206.2 | 221.5 | 193.7 | 127.0 |
| Program-Wide Support | 19.1 | 14.0 | 15.0 | 16.9 | 22.0 | 12.1 | 11.3 | 11.4 |
| Amount included in PE 0904903D | 0 | 0 | 0 | 0 | -191.2 | -79.8 | -29.3 | -29.8 |
| **TOTAL** | **893.0** | **1122.7** | **1059.1** | **1129.4** | **1030.5** | **987.8** | **1025.5** | **1059.3** |

**Source:** FY2008 MDA budget justification book for Aegis BMD program.

## DOD Inspector General Report

A March 2006 DOD Inspector General Report on system engineering for DOD's overall missile effort stated:

> Although the Aegis BMD element manager (the element manager) followed many of the systems engineering processes described in the Defense Acquisition Guidebook, she had not completed several systems engineering documents and processes that are important to transition the Aegis BMD Element (the element) capabilities for Block [20]04 to the Navy.[36]

## Government Accountability Office (GAO) Report

A March 2007 Government Accountability Office (GAO) report assessing the status of selected weapon programs stated of the Aegis BMD program:

> According to program officials, the Block 1A missile being fielded during 2006-2007 has mature technologies and a stable design. However, we believe that two critical technologies are less mature because full functionality of these two capabilities of the new missile has not been demonstrated in a realistic environment. If events occur that require the new capability, program officials believe the upgrades will perform as expected. Even without them, officials noted that the missile provides a credible defense against the Block 2004 threat set and some of the Block 2006 threat set. All drawings have been released to

[36] Department of Defense, Office of Inspector General, *Acquisition: System Engineering Planning for the Ballistic Missile Defense System (D-2006-060)*, March 2, 2006 (redacted version), p. 9. The report elaborates on the situation in detail on pages 9-16.

manufacturing. The program is not collecting statistical data on its production process of the Block 1A missile but is using other means to gauge production readiness....

*Technology Maturity*

Program officials believe that all three technologies critical to the SM-3 Block 1A missile are mature. However, we believe that two of these critical technologies are less mature. The warhead's seeker has been fully demonstrated in flight tests and is mature. We believe two other technologies, which were upgraded to create the SM-3 Block 1A, are less mature: the Solid Divert and Attitude Control System (SDACS) and the Third Stage Rocket Motor. While some modes of these technologies have been demonstrated in flight tests, the "pulse mode" of the SDACS, which provides endgame divert for the kinetic warhead, and the "zero pulse mode" of the Third Stage Rocket Motor, which increases the missile's capability against shorter-range threats, have not been successfully flight-tested. The SDACS operation in pulse mode failed during a June 2003 flight test. According to program officials, the test failure was a result of multiple issues with the original design. The program has implemented changes to address these problems. While recent ground tests have demonstrated performance of the new configuration, the changes have not yet been flight tested. A flight test in December 2006 that would have partially demonstrated the pulse SDACS was not completed because the missile failed to launch. A flight test that will fully test the new SDACS design is not planned until 2008.

The Third Stage Rocket Motor is capable of three modes of operation, two of which have been added in Block 2006. While both new modes failed initial ground testing, one was later successfully flight tested in June 2006 after design changes. The second, zero pulse mode, has also undergone design changes. While program officials believe they have a working design and that the missile can use this mode if needed, it has not yet been flight-tested. The first flight-test that could demonstrate this capability is not scheduled until fiscal year 2009.

*Design Stability*

Program officials reported that the design for the SM-3 Block 1A missiles being produced during Block 2006 is stable with 100 percent of its drawings released to manufacturing. Although two upgrades to the SM-3 Block 1A missile have not been fully flight-tested, the program does not anticipate any additional design changes related to these upgrades.

*Production Maturity*

We did not assess the production maturity of the 22 SM-3 missiles being procured for Block 2006. Program officials stated that the contractor's processes are not yet mature enough to statistically track production processes. The Aegis BMD program is using other means to assess progress in production and manufacturing, such as tracking rework hours, cost of defects per unit, and other defect and test data.

*Other Program Issues*

The Aegis BMD element builds upon the existing capabilities of Aegis-equipped Navy cruisers and destroyers. Planned hardware and software upgrades to these ships will enable them to carry out the ballistic missile defense mission. In particular, the program is upgrading Aegis destroyers for long-range surveillance and tracking of intercontinental ballistic missiles. The program plans to complete the upgrade of 14 destroyers by the end of the Block 2006 period. In several events, this functionality has been successfully tested, but it has never been validated in an end-to-end flight test with the GMD system, for which it is providing long-range surveillance and tracking. Since our last assessment, Aegis BMD's planned budget through fiscal year 2009 increased by $362.4 million (4.2 percent), primarily in fiscal years 2008 and 2009.[37]

## Allied Programs and Interest

**Japan.** Japan's interest in BMD, and in cooperating with the United States on the issue, was heightened in August 1998, when North Korea test-fired a Taepo Dong-1 ballistic missile that flew over Japan before falling into the Pacific.[38] In addition to cooperating with the United States on development of technologies for the SM-3 Block II/IIA missile, Japan is modifying four of its Aegis destroyers with the Aegis BMD 3.6 Block 2004 BMD system between FY2007 and early FY2011, at a pace of about one ship per year. Under this plan, Japan would have an opportunity in FY2011 and subsequent years to upgrade the ships' BMD capability to a later Block standard, and to install the Aegis BMD capability on its two remaining Aegis destroyers.

A Japanese Aegis ship participated as a tracking platform in FTM-10, the June 22, 2006, flight test of the Aegis BMD system. This was the first time that an allied military unit participated in a U.S. Aegis BMD intercept test.[39] A Japanese ship again tracked a target missile in FTM-11, in December 2006. On December 17, 2008, in a test called Japan Flight Test Mission 1 (JFTM-1), a BMD-capable Japanese Aegis destroyer used an SM-3 Block IA missile to successfully intercept a ballistic missile target in a flight test off the coast of Hawaii. It was the first time that a non-U.S. ship had intercepted a ballistic missile using the Aegis BMD system.[40]

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[37] Government Accountability Office, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-07-406SP, March 2007, pp. 27-28.

[38] For a discussion, see CRS Report RL31337, *Japan-U.S. Cooperation on Ballistic Missile Defense: Issues and Prospects*, by Richard P. Cronin. This archived report was last updated on March 19, 2002. See also CRS Report RL33436, *Japan-U.S. Relations: Issues for Congress*, by Emma Chanlett-Avery, Mark E. Manyin, and William H. Cooper.

[39] Missile Defense Agency, "Missile Defense Test Results in Successful 'Hit To Kill' Intercept," June 22, 2006 (06-NEWS-0018).

[40] John Liang, "Japanese Destroyer Shoots Down Ballistic Missile Test Target," *Inside Missile Defense*, December 19, 2007; "Japanese Aegis Destroyer Wins Test By Killing Target Missile With SM-3 Interceptor," *Defense Daily*, December 18, 2007; Reuters, "Japanese Ship Downs Missile In Pacific Test," *New York Times*, December 18, 2007: 8; Audrey McAvoy, "Japan Intercepts Missile In Test Off Hawaii," NavyTimes.com,

(continued...)

**Other Countries[41].** Other countries that DOD views as potential naval BMD operators include South Korea, Australia, the UK, Germany, the Netherlands, Spain, and Italy. As mentioned earlier, South Korea, Australia, and Spain either operate, are building, or are planning to build Aegis ships. The other countries operate destroyers and frigates with different combat systems that may have potential for contributing to BMD operations.[42]

The United States has conducted high-level discussions with South Korea about equipping South Korea's Aegis destroyers with a BMD capability. South Korea has expressed interest in a sea-based terminal capability.

The United States signed a memorandum of understanding (MOU) on BMD with Australia in 2004. The United States and Australia are conducting some cooperative projects relating to sea-based BMD.

The United States signed an MOU on BMD with the UK in 2003, and the two countries have conducted a study on a potential BMD capability for the UK's planned Type 45 destroyers.

Germany plans to implement a long-range search and track (LRS&T) BMD capability on some of its ships.

The United States provided pricing data to the Netherlands, and conducted initial discussions with the Dutch to assess the potential for installing a BMD capability on certain Dutch ships. The Netherlands is looking at the potential for integrating the SM-3 missile onto these ships. A Dutch ship participated as a tracking platform in FTM-11, in December 2006.[43]

## Sea-Based X-Band Radar (SBX)

The Sea-Based X-Band Radar (SBX) is DOD's other principal sea-based BMD element. It is a midcourse fire-control radar designed to support long-range BMD systems. Its principal functions are to detect and establish precise tracking information on ballistic missiles, discriminate missile warheads from decoys and

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[40] (...continued)
December 17, 2007.

[41] Primary sources for this section: Missile Defense Agency, Frequently Asked Questions, available online at [http://www.mda.mil/mdalink/html/faq.html]; a briefing on the Aegis BMD program by Rear Admiral Brad Hicks, Aegis BMD Program Director, to the RUSI 8th Missile Defense Conference, February 27, 2007.

[42] For an article discussing six European nations that reportedly have an option for giving their ships an early-warning capability for maritime BMD (MBMD) operations, see "European AAW Ships Get MBMD Option," *Jane's International Defence Review*, February 2007: 8, 10, 12.

[43] For an article on the Dutch ship's participation in this flight test, see "Netherlands Proves SMART-L Extended Long Range Mode In Live Tests Off Hawaii," *Jane's International Defence Review*, February 2007: 14-15.

debris, provide data for updating ground-based interceptors in flight, and assess the results of intercept attempts. SBX is intended to support more operationally realistic testing of the ground-based midcourse system and enhance overall BMD system operational capability.

SBX is a large, powerful, phased-array radar operating in the X band, a part of the radio frequency spectrum that is suitable for tracking missile warheads with high accuracy. The radar is mounted on a modified, self-propelled, semi-submersible oil platform that can transit at a speed of 8 knots and is designed to be stable in high winds and rough seas.[44]

SBX was completed in 2005 for the Missile Defense Test Bed. The semi-submersible platform was designed by a Norwegian firm and built in Russia. It was purchased for the SBX program, and modified and integrated with the SBX radar in Texas.[45] SBX underwent sea trials and high-power radiation testing in the Gulf of Mexico in 2005. It was then moved by a heavy transport vessel to Hawaii, arriving there in January 2006. Technical issues in 2006 with the SBX's semi-submersible platform delayed the SBX's transfer from Hawaii to its planned home port of Adak, Alaska.[46] The SBX reportedly departed Hawaii on January 3, 2007, and arrived in Alaska's Aleutian Islands on February 7, 2007.[47]

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[44] The platform is 238 feet wide and 398 feet long. It measures 282 from its submerged keel to the top of the radar dome. The SBX has a total displacement of almost 50,000 tons — about one-half the full load displacement of a Navy aircraft carrier. SBX is operated by a crew of about 75.

[45] The platform was designed by Moss Maritime, a Norwegian firm, and built for Moss in 2001-2002 by Vyborg shipbuilding, which is located in Vyborg, Russia (a city north of St. Petersburg, on the Gulf of Finland, that is near the Finnish border). Vyborg Shipbuilding's products include semi-submersible oil platforms. Moss sold the platform to Boeing. Boeing and a subcontractor, Vertex RSI (a part of General Dynamics), modified the platform at the Keppel AMFELS shipyard in Brownsville, TX. The platform was then moved to Kiewit Offshore Services of Corpus Christi, TX, where the radar was added by a combined team of Boeing, Raytheon, Vertex RSI, and Kiewit. ("MDA Completes Integration of X-Band Radar On Sea-Going Platform," *Defense Daily*, April 5, 2005; and "Sea-Based X-band Radar," *GlobalSecurity.org*.)

[46] Jonathan Karp, "A Radar Unit's Journey Reflects Hopes, Snafus In Missile Defense," *Wall Street Journal*, November 28, 2006: 1. See also Kirsten Scharnberg, "Radar Staying Longer Than Planned," *Chicago Tribune*, September 3, 2006. The article was also published in the *Honolulu Advertiser*. See also *SBX-1 Operational Suitability and Viability Assessment, An Independent Assessment*. Arlington (VA), SYColeman, 2006, pp. i-ii. (Final Report, June 2, 2006, Submitted to: Director, Mission Readiness Task Force, Missile Defense Agency, Submitted by: Independent Assessment Team, Prepared by: SYColeman, A Wholly Owned Subsidiary of L-3 Communications). The report is available online at [http://www.pogo.org/m/dp/dp-SBXOVA-06022006.pdf]

[47] "Way Up North," *Defense Daily*, February 12, 2007.

MDA announced on March 21, 2007, that on March 20, the SBX (and also the SPY-1 radars on two Aegis ships) had successfully tracked a target ballistic missile in a test of radars being incorporated into the overall U.S. BMD system.[48]

In April 2007, it was reported that the Navy and MDA had reached a preliminary agreement for the Navy to assume control of the SBX program.[49]

Regarding other potential uses of the SBX, a March 2006 press report stated:

> Boeing missile defense officials refuse to answer questions about whether they are developing techniques to produce high-energy weapon effects from the SBX sea-based radar. However, since large distributed-array devices [like the SBX] can be focused to deliver large spikes of energy, powerful enough to disable electronic equipment, the potential is known to exist and is being fielded on a range of U.S., British and Australian aircraft.[50]

# Potential Issues for Congress

## Number of Aegis BMD Ships

*How many Aegis ships should be equipped for BMD operations?*

One potential oversight issue for Congress concerns the number of Aegis ships that should be equipped for BMD operations. The eventual U.S. BMD architecture is to be defined by U.S. Strategic Command (USSTRATCOM) — the U.S. military command responsible for "synchronized DoD effects to combat adversary weapons of mass destruction worldwide," including integrated missile defense[51] — in consultation with MDA. Under the evolutionary acquisition approach adopted for the overall U.S. BMD program, it likely will be a number of years before USSTRATCOM and MDA define the eventual BMD architecture.[52] Until then, the absence of an objective architecture might complicate the task of assessing whether the types and numbers of sea-based BMD systems being acquired are correct.

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[48] Missile Defense Agency News Release, 07-NEWS-0028, 21 March 2007, "Missile Defense Flight Test Successfully Completed."

[49] Emelie Rutherford, "Navy To Assume Responsibility For Sea-Based X-Band Radar Program," *Inside the Navy*, April 16, 2007.

[50] "Radar Weapons," *Aerospace Daily & Defense Report*, March 20, 2006.

[51] For more on USSTRATCOM, see CRS Report RL33408, *Nuclear Command and Control: Current Programs and Issues*, by Robert D. Critchlow. See also USSTRATCOM's website at [http://www.stratcom.mil/], from which the quoted passage is taken.

[52] For more on evolutionary acquisition in general, see CRS Report RS21195, *Evolutionary Acquisition and Spiral Development in DOD Programs: Policy Issues for Congress*, by Gary J. Pagliano and Ronald O'Rourke. As ballistic missile threats change over time, it is possible that the U.S. BMD architecture may never be fully defined.

If the role of sea-based systems in the eventual U.S. BMD architecture turns out to be greater than what DOD has assumed deciding to equip 18 Aegis ships with BMD capabilities, then additional funding might be needed to expand the scope of the program to include more than 18 ships. The issue could also affect the required total number of Navy cruisers and destroyers. If the role of sea-based systems in the eventual U.S. BMD architecture turns out to be greater than what the Navy has assumed in calculating its 88-ship cruiser-destroyer requirement, then the requirement might need to be increased to something more than 88 ships.

A November 5, 2007 press report stated:

> the admiral who runs the Aegis Ballistic Missile Defense program for the Missile Defense Agency is asking to expand the upgrade effort — even before the large-scale Aegis upgrade planned to start in 2012.
>
> "The question right now is: With 18 ships, is that an adequate number? I'm not sure it is," said Rear Adm. Alan Hicks, who noted that Navy plans call for basing all but two of the BMD ships in the Pacific. "One of the concerns I have today is that if we had to surge for both a North Korean and Iranian scenario, you would end up taking ships [that would be used for] defense against North Korea. You have to augment the two Atlantic fleet ships to do anything in either the [Persian] Gulf or Mediterranean if there was an Iranian threat."
>
> Hicks approached Adm. Mike Mullen when Mullen was the chief of naval operations about adding more BMD ships to handle simultaneous missile threats from North Korea and Iran. Mullen agreed to a series of discussions as the Navy builds its portion of the 2009 White House budget request.
>
> Fifteen of the 18 ships in the current Aegis BMD plan are destroyers, and so the obvious option is to add more cruisers. "Right now, we have three BMD cruisers," Hicks said. "Will [Navy officials] make a decision to upgrade any more of the cruisers? That's what they'll be discussing."
>
> So far, Lockheed Martin reports it has completed 16 Aegis BMD ships, with the final two scheduled to be ready by mid-2008. Hicks said the full contingent must be ready for fielding by early 2009.
>
> These ships are a stopgap, or "pre-modernization," measure until Navy and Pentagon officials decide how to incorporate ballistic missile defense into the massive Aegis modernization program scheduled to start in 2012. At that time, all 62 destroyers and 22 cruisers in the Aegis fleet will begin rotating into port for 40-week computer modernization programs. How many of those modernized ships will be equipped to fire missile interceptors is another topic for talks, Hicks said.[53]

Similarly, in a speech in late-November 2007, Rear Admiral Alan Hicks reportedly

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[53] Ben Iannotta, "Admiral Wants Bigger Anti-Missile Upgrade," *NavyTimes.com*, November 5, 2007. Bracketed material as in the original.

described the 18 ships as "inadequate" to meet missile defense needs, and said the Navy was trying to solve that problem.

"When the Aegis production line ends, I think there will be 84 ships — we're looking at 2012, 2013," he told ITN [*Inside the Navy*]. "How many of those ships needed to be BMD-capable is a decision for the chief of naval operations and the secretary of defense, but the Navy knows 18 is inadequate. Therefore, they've made a decision already that the ships that start DDG [destroyers] modernization, 2012 and out, will have BMD added to that."

The Navy is also reviewing its [Aegis] cruiser modernization program to determine how many of them will get the system, he said.[54]

A January 21, 2008 press report stated:

The Navy is looking into the possibility of adding Aegis Ballistic Missile Defense systems to its entire fleet of cruisers and destroyers, the service's top surface warfare official said last week in a presentation to the Surface Navy Association's annual symposium in Arlington, VA.

Fifteen destroyers and three cruisers will be equipped with the BMD capability "by the end of next year," but the service wants to go well beyond those 18 ships, said Rear Adm. Victor Guillory, director of the surface warfare division (N86), in his Jan. 15 presentation to symposium attendees.

"The DDG modernization program is funded to add BMD capability to the remaining 47 destroyers, and we will be examining options [to add BMD to the] remaining cruisers in POM-10 [program objective memorandum]," he said.[55]

Potential oversight questions for Congress include the following: In the absence of a defined U.S. BMD architecture, what was the basis for deciding that 18 Aegis ships should be equipped for BMD operations? What is the likelihood that 18 BMD-equipped Aegis ships will turn out to be too many or not enough? What kinds of BMD operations were factored into the Navy requirement for maintaining a force of at least 88 cruisers and destroyers? If BMD operations by Navy ships turn out to be more significant than what the Navy assumed in calculating the 88-ship figure, will the figure need to be increased, and if so, by how much?

## Role Of Aegis BMD In European Missile Defense

*What should be the role of Aegis BMD in European missile defense?*

Another potential oversight issue for Congress concerns the potential role of the Aegis BMD system as a partial or complete alternative to the ground-based midcourse defense (GMD) system that the Bush Administration has proposed to establish in Poland and the Czech Republic. Russian President Vladimir Putin

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[54] Dan Taylor, "Navy Still Interested in Second MKV, MDA Will Talk to Congress," *Inside the Navy*, December 3, 2007.

[55] Dan Taylor, "Navy Considering Equipping Cruiser and Destroyer Fleet With Aegis BMD," *Inside the Navy*, January 21, 2008. Material in brackets as in original.

opposes a ground-based GMD system in Europe and has suggested that the United States explore certain alternative approaches, including the use of BMD-capable Aegis ships. A June 21, 2007, press report states:

> The US has been less receptive to the idea of placing missile interceptors in Turkey, Iraq, or on Aegis ships, as Mr Putin suggested. The Missile Defence Agency says Turkey and Iraq are too close too Iran for interceptors to be able to catch an incoming missile from Iran.
>
> But the idea of using Aegis ships has seen more debate. Duncan Hunter, the top Republican on the House armed services committee, recently said Mr Putin's proposal about sea-based missile defences was "promising", although only as an additional capability to ground-based missile interceptors in Poland.
>
> "The Navy's Aegis ship-based defensive systems could be based in existing Black Sea ports, either in Ukraine, Russia or Turkey," said Mr Hunter.
>
> General Trey Obering, MDA director, has argued that the Aegis ships are currently configured to intercept short- and medium-range threats, and could not counter against long-range intercontinental ballistic missiles that could target the US without costly modifications, which would take a considerable amount of time. His critics say the Iranian threat is far enough in the future to provide the US time.
>
> Gen Obering also argues that the US would need to deploy tens of ships for the system to be feasible. But several people familiar with a study prepared by Raytheon, which is manufacturing missile interceptors for the Aegis ships, said it concluded that as few as five ships could provide a defence against an Iranian threat. Raytheon declined to comment.[56]

A November 29, 2007 press report states:

> It would take a large number of U.S. Navy Aegis weapons system ships to shield Europe against enemy missiles from the Middle East, if the United States attempted to use the sea-based system to guard Europe instead of the Ground-based Midcourse missile Defense (GMD) system proposed for the Czech Republic and Poland.
>
> That was the assessment yesterday of Rear Adm. Alan Hicks, program director of the Aegis ballistic missile defense (BMD) system, at a symposium of the George C. Marshall Institute, a Washington think tank, held at the National Press Club.
>
> "Certainly by the near-term capability, between now and 2015, that's a lot of ships, and I wouldn't recommend it," he said.
>
> Further, those ships wouldn't be stationed in an ideal location, so that the interceptors they would fire to take down enemy weapons would "run out of juice" in pursuing those threats.

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[56] Demetri Sevastopulo, Guy Dinmore, and Neil Buckley, "Experts Sceptical [sic] On Chances For Missile Deal," *Financial Times*, June 21, 2007.

> He added, though, that the Aegis sea-based system could be deployed as a complement to the European GMD system when the ships aren't needed for other missions. The European GMD system has yet to win final approval from the Czechs and Poles.
>
> One key point is that it is not a stretch for the GMD system, with a radar in the Czech Republic and 10 interceptors in silos in Poland, to provide 24-7 protection of Europe. But it would be difficult to have a sufficient number of ships on station, on point, all the time, he said.[57]

As noted in the Legislative Activity section of this CRS report, the House-reported version of the FY2008 defense authorization bill (H.R. 1585) calls for two reports on the Administration's proposed European BMD system. Both of the reports are to examine potential alternative ways to provide the defensive capabilities that would be provided by the European-based BMD system, including use of the Aegis BMD system.

For more on the debate concerning the European-based BMD system, see CRS Report RL34051, *Long-Range Ballistic Missile Defense in Europe*, by Steven A. Hildreth and Carl Ek.

Potential oversight questions for Congress include the following: To what extent could sea-based BMD systems perform functions that would be carried out by the Administration's proposed European BMD system? How many aegis BMD ships would be required? What would be the comparative advantages and disadvantages of the Aegis BMD system as a partial or complete alternative to the proposed European BMD system?

## Replacement for Navy Area Defense (NAD) Program

*Has DOD programmed a sufficiently robust sea-based terminal capability to replace the canceled NAD program?*

As discussed in the background section, MDA has programmed a near-term (Block 2008) and far-term (Block 2014) sea-based terminal capability as the replacement for the canceled Navy Area Defense (NAD) program. The Block 2014 capability is envisioned as including a new type of missile whose design is not yet determined. The potential question for Congress is whether DOD's Block 2008/Block 2014 program is sufficiently robust in terms of the sea-based terminal capability it will provide, adequate in terms of annual funding levels, and sufficiently aggressive in terms of the schedule for fielding the planned far-term capability.

Reported options for a new sea-based terminal missile include a system using a modified version of the Army's Patriot Advanced Capability-3 (PAC-3) interceptor

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[57] Dave Ahearn, "Large Number of Aegis Ships WOuld Be Needed To Shield Europe: Admiral," *Defense Daily*, November 29, 2007.

or a system using a modified version of the SM-6 Extended Range Active Missile (SM-6 ERAM) air defense missile being developed by the Navy.[58]

In October 2002, it was reported that senior Navy officials

> continue to speak of the need for a sea-based terminal BMD capability "sooner rather than later" and have proposed a path to get there. "The cancellation of the Navy Area missile defence programme left a huge hole in our developing basket of missile-defence capabilities," said Adm. [Michael] Mullen. "Cancelling the programme didn't eliminate the warfighting requirement."
>
> "The nation, not just the navy, needs a sea-based area missile defence capability, not to protect our ships as much as to protect our forces ashore, airports and seaports of debarkation" and critical overseas infrastructure including protection of friends and allies.[59]

The above-quoted Admiral Mullen became the Chief of Naval Operations (CNO) on July 22, 2005, and is scheduled to become Chairman of the Joint Chiefs of Staff in October 2007.

In July 2004 it was reported that:

> The Navy's senior leadership is rebuilding the case for a sea-based terminal missile defense requirement that would protect U.S. forces flowing through foreign ports and Navy ships from short-range missiles, according to Vice Adm. John Nathman, the Navy's top requirements advocate.
>
> The new requirement, Nathman said, would fill the gap left when the Pentagon terminated the Navy Area missile defense program in December 2001.... However, he emphasized the Navy is not looking to reinstate the old [NAD] system. "That's exactly what we are not talking about," he said March 24....
>
> The need to bring back a terminal missile defense program was made clear after reviewing the "analytic case" for the requirement, he said. Though Nathman could only talk in general terms about the analysis, due to its classified nature, he said its primary focus was "pacing the threat" issues. Such issues involve threats that are not a concern today, but could be in the future, he said. Part of the purpose of the study was to look at the potential time line for those threats and the regions where they could emerge.[60]

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[58] See, for example, Jason Ma and Christopher J. Castelli, "Adaptation Of PAC-3 For Sea-Based Terminal Missile Defense Examined," *Inside the Navy*, July 19, 2004; Malina Brown, "Navy Rebuilding Case For Terminal Missile Defense Requirement," *Inside the Navy*, April 19, 2004.

[59] Michael Sirak, "Sea-Based Ballistic Missile Defence: The 'Standard' Response," *Jane's Defence Weekly*, October 30, 2002.

[60] Malina Brown, "Navy Rebuilding Case For Terminal Missile Defense Requirement," *Inside the Navy*, April 19, 2004.

Supporters of DOD's planned program could argue that it replaces enough of the planned NAD capability, and does so soon enough, to provide Navy ships with a sufficient degree of terminal defense capability. They could also argue that attempting to accelerate the Block 2014 effort could increase development risks or require reducing funding for other BMD programs or other DOD priorities, increasing operational risks in other areas.

Supporters of programming a more robust sea-based terminal capability could argue that a full capability for intercepting missiles in the terminal phase could prove useful, if not critical, for intercepting missiles — such as SRBMs or ballistic missiles fired along depressed trajectories — that do not fly high enough to exit the atmosphere and consequently cannot be intercepted by the SM-3. They could also argue a full NAD replacement program would provide a more robust ability to counter potential Chinese TBMs equipped with maneuverable reentry vehicles (MaRVs) capable of hitting moving ships at sea.[61]

## Number of SM-3 Missiles Planned for Procurement

*Is the number of SM-3 interceptors that DOD plans to procure sufficient?*

DOD is currently planning to procure a total of 147 SM-3 interceptors. One potential oversight issue for Congress is whether this planned total is sufficient in light of potential wartime demands for sea-based BMD interceptors. A May 2007 press report stated that:

> A preliminary DOD study points to the need for more Standard Missile-3 (SM-3) sea-based missile defense interceptors and Terminal High-Altitude Area Defense (THAAD) interceptors, according to Lt. Gen. Kevin Campbell, commander of U.S. Army Space and Missile Defense Command (SMDC).
>
> The study examined various major combat operations around the world, estimating the percentages of enemy missiles that would be taken out by conventional forces or felled by system failures. The current SM-3/THAAD interceptor inventory then was compared to a list of critical assets identified by DOD combatant commanders that need to be defended.
>
> Near-term U.S. missile defense capabilities are "limited" primarily by interceptor inventory, Campbell said at a May 16 breakfast in Washington sponsored by National Defense University. In addition to SM-3s and THAAD

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[61] As discussed in another CRS report, China may now be developing TBMs equipped with maneuverable reentry vehicles (MaRVs). Observers have expressed strong concern about this potential development, because such missiles, in combination with a broad-area maritime surveillance and targeting system, would permit China to attack moving U.S. Navy ships at sea. The U.S. Navy has not previously faced a threat from highly accurate ballistic missiles capable of hitting moving ships at sea. Due to their ability to change course, MaRVs would be more difficult to intercept than non-maneuvering ballistic missile reentry vehicles. See CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities — Background and Issues for Congress*, by Ronald O'Rourke.

> interceptors, DOD also needs more Patriot battalions and ground-based interceptors, according to Campbell.[62]

In late November 2007, Rear Admiral Alan Hicks, Aegis BMD program director, reportedly stated that

> that even with 132 Standard Missiles (SMs) expected in the inventory by 2013, there should be more to meet potential global requirements.
>
> "We need more than that," he said Nov. 28. "Inventory is inadequate to meet our needs." ...
>
> But the admiral acknowledged that Aegis SM inventory also must be weighed against Theater High Altitude Area Defense and Patriot Advanced Capability missile inventories.[63]

Another press report based on the same speech by Hicks stated that

> Hicks observed that the military will have 153 short- and mid-term missile interceptors in the inventory by the end of 2009, but added that he believes the Navy needs to expand the program beyond current plans. "Is it enough? No," Hicks said. Inventory's inadequate to meet our needs.[64]

## Multiple Kill Vehicle (MKV) for SM-3 Block IIA Missile

*Should the Block IIA version of the Standard Missile 3 (SM-3) interceptor missile be equipped with the Multiple Kill Vehicle (MKV) now in development?*

The warhead currently planned for the SM-3 Block IIA interceptor is intended to destroy a single BMD target. MDA is developing a new BMD interceptor warhead, called the Multiple Kill Vehicle (MKV), that could permit a single interceptor to destroy more than one BMD target. MDA is considering whether to equip certain interceptors, including the SM-3 Block IIA, with the MKV. One potential issue for Congress is whether the SM-3 Block IIA should be equipped with the MKV instead of the currently planned single-target-capable warhead, and if so, what effect this might have on the cooperative program with Japan for developing the SM-3 Block IIA and the schedule for deploying the interceptor. A December 3, 2007 press report stated:

> The Missile Defense Agency likely will make another attempt next year to secure money for Raytheon's multiple kill vehicle (MKV) for the Navy's ballistic missile defense program, which had its funding axed by Congress in this

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[62] Jefferson Morris, "Study Points To Need For More SM-3s, THAAD Interceptors," *Aerospace Daily & Defense Report*," May 17, 2007: 3.

[63] Michael Bruno, "Aegis BMD Program Chief Calls for More Missiles," *Aerospace Daily & Defense Report*, November 29, 2007: 1-2.

[64] Megan Scully, "FY08 Funding Boost To Help Navy Deploy Missile Defenses," *National Journal's CongressDailyPM*, November 28, 2007.

year's budget, the Aegis BMD program director said during a talk at the National Press Club Nov. 28.

"Within the MDA, we're going to look for opportunities" to talk with Congress about the issue again in the near future, Rear Adm. Alan Hicks told attendees of the round table discussion, which was sponsored by the George C. Marshall Institute to discuss the status of the Aegis program....

"I think we will talk within the administration once the [fiscal year 2009] budget's all solidified and get a position, and then we will go to Congress and talk and see what they feel, how they feel," he said in an interview with Inside the Navy after his presentation.

The unitary version of the SM-3 missile was "priority one," but "to get an extra kill vehicle or two on top of the SM-3 and provide options against more advanced threats in the future is something, obviously, I'd like to have as an option," Hicks told attendees. "So we'll see how that plays out over the year."[65]

## Kinetic Energy Interceptor (KEI)

*If the Kinetic Energy Interceptor (KEI) is developed for land-based BMD operations, should it also be based at sea? If so, what kind of sea-based platform should be used?*

Another potential issue for Congress concerns the Kinetic Energy Interceptor (KEI) — a new BMD interceptor now in development that could be used as a ground-based BMD interceptor and perhaps subsequently as a sea-based BMD interceptor. Compared to the SM-3, the KEI would be much larger (reportedly 40 inches in diameter and almost 39 feet in length) and would have a much higher burnout velocity. Because of its much higher burnout velocity, it might be possible to use a KEI based on a forward-deployed ship to attempt to intercept ballistic missiles during the boost and early ascent phases of their flights. Under current DOD plans, the land-based version of the KEI could become available use in 2014.[66]

The issue is whether the KEI, if developed, should be based at sea, and if so, what kind of sea-based platform should be used. Basing the KEI on a ship would require the ship to have missile-launch tubes that are bigger than those currently installed on Navy cruisers, destroyers, and attack submarines. Potential sea-based platforms for the KEI include, but are not necessarily limited to, the following:

- ballistic missile submarines (which have launch tubes large enough to accommodate the KEI);
- surface combatants equipped with newly developed missile-launch tubes large enough for the KEI; and

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[65] Dan Taylor, "Navy Still Interested in Second MKV, MDA Will Talk to Congress," *Inside the Navy*, December 3, 2007.

[66] For more on the KEI, see Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, March 2007 (GAO-07-406SP), pp. 97-98.

- a non-combat DOD ship (perhaps based on a commercial hull) or floating platform.

Supporters of deploying the KEI at sea could argue that it would be more capable than the SM-3 Block II/IIA for intercepting ICBMs and that it could enable navy ships to attempt to intercept certain missiles during the boost phase of flight. Skeptics could argue that in light of other planned BMD capabilities, the need for basing the KEI at sea is not clear.

Among supporters of basing the KEI at sea, supporters of basing it on ballistic missile submarines could argue that submarines can operate close to enemy coasts, in positions suitable for attempting to intercept missiles during their boost phase of flight, while remaining undetected and less vulnerable to attack than surface platforms. Skeptics of basing the KEI on ballistic missile submarines could argue that communication links to submarines are not sufficiently fast to support boost-phase intercept operations, and that launching the KEI could give away the submarine's location, making it potentially vulnerable to attack.

Supporters of basing the KEI on surface combatants equipped with missile-launch tubes large enough for the KEI could argue that surface ships have faster communication links than submarines and more capability to defend themselves than non-combat ships or floating platforms. Skeptics could argue that surface combatants might not be able to get close enough to enemy coasts to permit boost-phase intercepts, and that the defensive capabilities of a surface combatant are excessive to what would be needed for a KEI platform operating in the middle of the ocean, far from potential threats, for the purpose of using the KEI for midcourse intercepts.

Supporters of a non-combat ship or floating platform could argue that a non-combat ship or floating platform would be suitable for basing the KEI in mid-ocean locations, far from potential threats, for the purpose of using the KEI for midcourse intercepts. Skeptics could argue that using such a platform could not be used close to an enemy coast, for the purpose of attempting a boost-phase intercept, unless it were protected by other forces.

One potential surface-combatant candidate for carrying the KEI is the Navy's planned CG(X) cruiser, whose primary missions are to be air defense and ballistic missile defense. The Navy is studying design options for the CG(X) in a study called the CG(X) Analysis of Alternatives (AOA), which is scheduled to be completed by the end of 2007. According to a July 2007 press article, the CG(X) AOA will recommend that the CG(X) not carry the KEI:

> [Sources] say the analysis will recommend dropping the Kinetic Energy Interceptor (KEI) from the CG(X) program....
>
> The KEI is much larger than the SM-3 Standard missile developed by Raytheon to arm Navy cruisers and destroyers for the BMD role. The 40-inch diameter KEI is nearly 39 feet long, while the 21-inch diameter SM-3 stands just over 21 feet tall. Both missiles use a kinetic energy warhead, intended to ram an enemy missile.

Sources said a missile launch tube for a KEI would need to be so large it would take the place of six SM-3 launch cells.

"That's a poor exchange ratio," said one naval analyst familiar with the AoA.[67]

## CG(X) Cruiser

*Should procurement of the planned CG(X) cruiser be accelerated?*

As a replacement for its 22 Aegis cruisers, the Navy plans to procure 19 new CG(X) cruisers. The radar capabilities of the CG(X) are to be greater than that of the Navy's Aegis ships, and the CG(X) has been justified primarily in connection with future air defense and BMD operations. Under Navy plans, the first CG(X) is to be procured in FY2011, and the final ship in FY2023. If procured as planned, the first CG(X) might enter service in 2017, and the final ship might enter service in 2029.[68]

A potential issue for Congress is whether the planned CG(X) procurement profile would be sufficient to achieve the desired level of sea-based BMD capability in a timely manner. If not, then one option would be to accelerate procurement of some of the later ships in the CG(X) program.[69]

## Development and Testing of Aegis BMD System

*Are there lessons from development and testing of the Aegis BMD system that can be applied to programs for developing and testing land-based systems?*

With 11 successful exo-atmospheric intercepts in 13 attempts, the Aegis BMD program has achieved a higher rate of successful intercepts than has the ground-based midcourse system. At least some part of the Aegis BMD program's higher success rate may be due to two factors:

- The configuration of the Aegis BMD system that has been tested to date is intended to shoot down shorter-range ballistic missiles. In general, shorter-range missiles fly at lower speeds than longer-ranged missiles, and interceptors intended to shoot down shorter-ranged ballistic missiles don't need to be as fast as interceptors intended to shoot down longer-ranged ballistic missiles. Consequently, the closing speeds[70] involved in intercepts of shorter-ranged ballistic missiles are generally lower than those for intercepts of longer-ranged

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[67] Christopher P. Cavas, "U.S. May Build 25,000-Ton Cruiser, Analysis of Alternatives Sees Nuclear BMD Vessel," Defense News, July 23, 2007.

[68] For more on the CG(X) program, see CRS Report RL34179, *Navy CG(X) Cruiser Program: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

[69] For a discussion of this option, see CRS Report RL34179, op cit.

[70] Closing speed is the relative speed at which the missile warhead and the interceptor kinetic kill vehicle approach one another.

ballistic missiles. Intercepts involving lower closing speeds can be less difficult to attempt than intercepts involving higher closing speeds. In BMD tests over more than 20 years, tests of shorter-range kinetic-energy BMD systems has generally been more successful than tests of longer-range BMD systems.[71]

- The Aegis BMD system is being developed as an extension of the existing Aegis air defense system, and can thus benefit from the proven radar, software, and interceptor technology of that system, whereas the ground-based midcourse system is being developed essentially as a relatively new weapon system.

The potential question is whether these two factors account completely for the difference in success rates for testing of the Aegis BMD program and the ground-based midcourse program. If they do not, then one potential issue for Congress is whether there is something about the approach adopted for developing and testing the Aegis BMD capability, compared to that of the ground-based midcourse program, that accounts for part of the difference.

As mentioned earlier, the Aegis BMD program says it has focused since its inception on the philosophy of "test a little, learn a lot." It can also be noted that the Navy has a long history of air-defense missile development programs, and has established a record of technical discipline, rigorousness, and excellence in areas such as nuclear propulsion and submarine-launched ballistic missiles. Potential questions for Congress include the following:

- How do the Aegis BMD and ground-based midcourse programs compare in terms of their approaches for system development and testing?

- Are there features of the Aegis BMD program's approach that, if applied to the ground-based midcourse program or other U.S. BMD programs, could improve the development and test efforts for these programs?

## Cooperation With Allies

*Should current U.S. efforts for helping to establish BMD capabilities in allied navies be reduced, accelerated, or maintained at current levels?*

An additional potential issue for Congress is whether U.S. efforts for helping to establish BMD capabilities in allied navies should be reduced, accelerated, or maintained at current levels. Potential oversight questions for Congress include the following:

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[71] For a discussion, see CRS Report RL33240, *Kinetic Energy Kill for Ballistic Missile Defense: A Status Overview*, by Steven A. Hildreth.

- What are the potential military and political advantages and disadvantages of establishing BMD capabilities in allied navies?

- To what degree, if any, would these capabilities be integrated into the overall U.S. BMD architecture? How, in terms of technology, command and control, doctrine, and training, would such an integration be accomplished? If these capabilities are not integrated into the U.S. architecture, what kind of coordination mechanisms might be needed to maximize the collective utility of U.S. and allied sea-based BMD capabilities or to ensure that they do not work at cross-purposes?

- How might the establishment of BMD capabilities in allied navies affect U.S. requirements for sea-based BMD systems? To what degree, if any, could allied BMD ships perform BMD operations now envisaged for U.S. Aegis ships?

- What are the potential implications for regional security of missile proliferation and proliferation of BMD systems?

# Legislative Activity for FY2008

## FY2008 Defense Authorization Bill (H.R. 1585/S. 1547)

**House.** The House Armed Services Committee, in its report (H.Rept. 110-146 of May 11, 2007) on H.R. 1585, recommended increasing DOD's FY2008 research and development funding request for the Aegis BMD program by $78 million. Of the additional $78 million, $20 million would be for facility upgrades to increase the SM-3 production capacity to four missiles per month, $36 million would be for "long-lead procurement" of 12 additional SM-3 Block IB missiles, and $22 million would be for accelerating Aegis BMD signal processor (Aegis BSP) upgrades. (Pages 225 and 235) The report states:

> Aegis BMD is intended to provide protection against short-, medium-, and intermediate-range ballistic missiles. The committee believes that Aegis BMD provides a near-term capability that will help defend our forward deployed forces and allies and notes that the recent Capabilities Mix Study completed by U.S. Strategic Command has indicated that combatant commanders require twice as many SM-3 interceptors than the 147 that are currently planned. (Page 235)

**Section 223** of the House-reported version of the FY2008 defense authorization bill (H.R. 1585) states:

> SEC. 223. LIMITATION ON USE OF FUNDS FOR REPLACING WARHEAD ON SM-3 BLOCK IIA MISSILE.
>
> None of the funds appropriated or otherwise made available pursuant to an authorization of appropriations in this Act may be obligated or expended to

> replace the unitary warhead on the SM-3 Block IIA missile with the Multiple Kill Vehicle until after the Secretary of Defense certifies to Congress that —
>
> (1) the United States and Japan have reached an agreement to replace the unitary warhead on the SM-3 Block IIA missile; and
>
> (2) replacing the unitary warhead on the SM-3 Block IIA missile with the Multiple Kill Vehicle will not delay the expected deployment date of 2014-2015 for that missile.

The House Armed Services Committee, in its report (H.Rept. 110-146 of May 11, 2007) on H.R. 1585, stated the following regarding the MKV:

> The budget request contained $271.1 million in PE [research and development program element] 63894C for the Multiple Kill Vehicle (MKV).
>
> The committee notes that the request is more than double the amount of funding in fiscal year 2007. The committee believes the amount of the request to be excessive for a program that is orientated toward longer-term threats. The committee also notes that the current family of exo-atmospheric kill vehicles are capable of dealing with the near- to mid-term threats that the nation is likely to face from rogue nations such as Iran and North Korea. Additionally, in budget justification materials, the Missile Defense Agency (MDA) notes that it plans to replace the unitary warhead on the SM-3 Block IIA missile, which the United States is co-developing with Japan, with the MKV. The committee is concerned that MDA has taken this decision without fully consulting with the Japanese Government and that this decision has the potential to delay the fielding the SM-3 Block IIA missile, a system that the committee believes is vital to the security of the United States and our allies around the world.
>
> The committee recommends $229.1 million, a decrease of $42.0 million, in PE 63894C for the Multiple Kill Vehicle. (Pages 240-241)

**Section 225** of the House-reported version of H.R. 1585 requires the Secretary of Defense to contract with a Federally Funded Research and Development Center (FFRDC) to conduct a study on the political, technical, operational, force structure, and budgetary implications of deploying a long-range missile defense system in Europe. The study is to "provide a full analysis of the Administration's proposal to protect forward-deployed radars, Europe, and the United States by deploying, in Europe, interceptors and radars of the Ground-Based Midcourse Defense (GMD) system," and is to include "a full analysis of alternative systems that could be deployed to fulfill, in whole or in part, the protective purposes of the Administration's proposal. The alternative systems shall include a range of feasible combinations of other missile defense systems that are available or are expected to be available as of 2020." The House Armed Services Committee's report states that "These options should include an examination of existing missile defense systems such as Aegis Ballistic Missile Defense system and Terminal High-Altitude Area Defense system, as well as explore new concepts such as a mobile launch platform." (Page 260)

The House Armed Services Committee's report on H.R. 1585 (H.Rept. 110-146 of May 11, 2007) requires a second report on the European BMD system:

> The committee directs the Secretary of Defense and the Secretary of State to submit a report to the Senate Committee on Armed Services and the House Committee on Armed Services by January 31, 2008. The report shall include the Administration's plans for obtaining NATO's support for its proposal [to establish a ground-based, midcourse (GMD) interceptor site in Europe]; how the proposed system will interoperate with the NATO missile defense system; its plan for providing missile defense protection for areas of Southern Europe; how other missile defense capabilities, such as Aegis Ballistic Missile Defense, Terminal High Altitude Area Defense, and Kinetic Energy Interceptor, could contribute to the defense of Europe; the reasons for moving to a two-stage booster; the risk reduction strategy for that booster; the suitability of deploying the two-stage booster at Ft. Greely and Vandenberg Air Force Base; and the plan for testing the two-stage booster prior to deployment....
>
> The committee also notes the importance it attaches to receiving, in a timely manner, the independent assessment of European missile defense options as described in section 225 of this Act. (Pages 239-240)

With regard to the Kinetic Energy Interceptor (KEI) and to international cooperation on BMD, the report stated:

> *Kinetic Energy Interceptor*
>
> The budget request contained $227.5 million in PE 63886C for the Kinetic Energy Interceptor (KEI) program.
>
> The KEI program successfully met its fiscal year 2006 knowledge points with no major delays. These successes involved the direct downlink from overhead and terrestrial sensors, and the static firings of the first and second stages of the booster. The KEI program is on schedule to conduct its first booster flight test during the fourth quarter of fiscal year 2008. Given the committee's decision with regard to the Airborne Laser, the committee recommends that the Department of Defense designate KEI as its prime boost phase defense system. Furthermore, the committee notes that KEI will also have the capability to intercept ballistic missiles in their midcourse phase of flight and could serve as an eventual replacement for the existing ground-based interceptor. The Missile Defense Agency is also examining future options for providing a mobile KEI capability. The committee believes that there is an inherent flexibility in having mobile missile defense systems and recommends that the future KEI development efforts be focused on the development of mobile options. However, given the importance of nearer-term missile defense priorities, the committee has recommended a reduction of the KEI program, with the understanding that the program will continue towards a booster flight test demonstration in 2008.
>
> The committee recommends $177.5 million in PE 63886C for the KEI, a decrease of $50.0 million.
>
> *Missile defense cooperation with Japan and Australia*
>
> The committee strongly supports the Department of Defense's on-going missile defense cooperative efforts with Japan and Australia. The committee encourages the Department to build on and expand such engagements with other allies in the Asia-Pacific region, and around the world, as a key part of the

> nation's comprehensive strategy for responding to the threat posed by the proliferation of ballistic missiles and weapons of mass destruction. (Page 240)

**Senate.** The Senate Armed Services Committee, in its report (S.Rept. 110-77 of June 5, 2007) on S. 1547, recommended increasing DOD's FY2008 research and development funding request for the Aegis BMD program by $75 million. Of the additional $75 million, $20 million would be for facility upgrades to increase the SM-3 production capacity to four missiles per month, $45 million would be for "long-lead procurement" of 15 additional SM-3 Block IB missiles, and $10 million would be for accelerating development of the Aegis BMD signal processor (Aegis BSP) and open architecture software for the Aegis weapon system. (Page 264) The report states:

> The committee notes that the Aegis BMD system, and its SM-3 interceptor, is deployed today and provides an important missile defense capability against short- and medium-range missiles deployed widely in theaters where U.S. forces are forward deployed. The system is planned for significant capability improvements in the future.
>
> The Missile Defense Agency (MDA) increased the planned funding for SM-3 missiles in fiscal year 2008 to fund missiles it had previously cut for budget reasons. Currently MDA plans to procure only some 147 SM-3 missiles of all Block I varieties. The Commander, Joint Forces Component Command for Integrated Missile Defense (JFCC-IMD) testified in April 2007 that recent analyses indicate a need to nearly double the number of planned SM-3 interceptors. The committee urges MDA to plan and budget for increased numbers of SM-3 interceptors to meet the needs of regional combatant commanders, as indicated by the Commander, JFCC-IMD. (Page 264)

**Conference.** **Section 224** of the conference report (H.Rept. 110-477 of December 6, 2007) on H.R. 1585 states:

> SEC. 224. LIMITATION ON USE OF FUNDS FOR REPLACING WARHEAD ON SM — 3 BLOCK IIA MISSILE.
>
> None of the funds appropriated or otherwise made available pursuant to an authorization of appropriations in this Act may be obligated or expended to replace the unitary warhead on the SM-3 Block IIA missile with the Multiple Kill Vehicle until after the Secretary of Defense certifies to Congress that —
>
> (1) the United States and Japan have reached an agreement to replace the unitary warhead on the SM-3 Block IIA missile; and
>
> (2) replacing the unitary warhead on the SM-3 Block IIA missile with the Multiple Kill Vehicle will not delay the expected deployment date of 2014 — 2015 for that missile.

**Section 226** of the conference report requires the Secretary of Defense to "select a federally funded research and development center to conduct an independent assessment of options for ballistic missile defense for forward deployed forces of the United States and its allies in Europe and for the United States homeland." The study is to provide, among other things, "a full analysis of alternative systems that could

be deployed to fulfill, in whole or in part, the protective purposes of the Administration's proposal. The alternative systems shall include a range of feasible combinations of other missile defense systems that are available or are expected to be available as of 2015 and 2020." The alternative systems to be examined are to include, among other things, "The Aegis Ballistic Missile Defense system, with all variants of the Standard Missile-3 interceptor."

Regarding Section 224, the report states:

> The conferees note that the Missile Defense Agency (MDA) has indicated an interest in replacing the unitary kill vehicle development program, which is specified in the agreement with Japan, with a new MKV development program. This would have undermined the agreed program of cooperation between the United States and Japan on joint development of the SM-3 Block IIA interceptor missile. It is important to support the joint development program in accordance with the agreed program of record, which currently specifies a unitary kill vehicle.
>
> This provision does not restrict the MDA from conducting research, development, analysis, or testing of MKV technologies, including those which could be used in the future with the SM-3 Block IIA missile. It also does not restrict MDA from conducting analysis and discussions with Japanese officials to consider the possibility of including MKV on the SM-3 Block IIA. (Page 829)

Regarding Section 226, the report stated in part:

> The Commander of the Joint Forces Component Command for Integrated Missile Defense, a component of United States Strategic Command, informed Congress that in order to fulfill the combatant commanders' operational requirements to defend against existing short- and medium-range missile threats the U.S. would require almost twice the number of Terminal High Altitude Area Defense (THAAD) and Standard Missile-3 (SM-3) interceptors as currently planned for and budgeted. The independent assessment required in this provision will examine the full range of threats and missile defense options to meet these threats, including the THAAD and SM-3 systems. (Page 831)

Regarding funding for the Aegis BMD program, the report states:

> The conferees note that the Missile Defense Agency (MDA) recently informed Congress that the Aegis BMD program will experience a major funding shortfall in its fiscal year 2008 program. This shortfall has caused MDA to modify its plans for Aegis BMD for fiscal year 2008, which include, among other things, delaying the introduction of the Standard Missile-3 (SM-3) Block IB missile by a year, deferring the upgrades of four Aegis BMD ships until 2010, and possibly reducing the number of flight tests. The MDA had previously told Congress that no additional money was needed for the Aegis BMD program.
>
> As Congress made clear in section 223 of the John Warner National Defense Authorization Act for Fiscal Year 2007 (Public Law 109-364), the emphasis of our missile defense efforts should be on the current generation of missile defense capabilities, even if this comes at the expense of longer-term development efforts. Furthermore, in testimony before Congress earlier this year, combatant commanders noted the importance of attaching priority to deploying

missile defense systems like Aegis BMD, which are designed to provide a wide-area defense capability against existing short- and medium-range ballistic missile threats to our forward-deployed forces, allies, and other friendly nations.

The conferees urge MDA to address the funding shortfall by identifying funds to "buy back" schedule, with priority placed on resolving technical issues with the SM-3 Block IA missile program, returning the SM-3 Block IB missile to its previous schedule, and ensuring that all original test objectives for fiscal year 2008 are met.

The conferees direct that no later than January 31, 2008, MDA provide a report to the congressional defense committees detailing the specific reasons for the funding shortfall in the Aegis BMD program, its plan for identifying funds to place the program back on schedule, and its plans for ensuring that the Aegis BMD program is fully funded in the future.

Over the past several years, Congress has been clear on the importance it attaches to the Aegis BMD program and other near-term missile defense systems. The conferees expect the Department's fiscal year 2009 budget request to reflect that priority. (Page 819)

## FY2008 Defense Appropriations Bill (H.R. 3222/P.L. 110-116)

**House.** The House Appropriations Committee, in its report (H.Rept. 110-279 of July 30, 2007), recommended increasing by $57 million the Administration's FY2008 research and development funding request for the Aegis BMD program, with the increase going toward "Ballistic Signal Processor/Open Architecture" ($22 million), "Upgrade 2 additional Aegis DDG's" ($20 million), and "Asymmetric Defense Initiative" ($15 million). (Page 379) The report recommended increasing the Administration's FY2008 research and development funding request for BMD System Interceptor by $2 million for "CG(X) Modular Launch System." (Page 378) The report states the following:

AEGIS BALLISTIC MISSILE DEFENSE SYSTEM

The Committee commends the MDA for showing progress and promise in continued success in its Aegis Ballistic Missile Defense System. In this bill, the Committee has included additional funding for the continuation of the Open Architecture and Ballistic Missile Signal Processor. Additionally, the Committee has included funding to upgrade two additional Aegis Destroyers to a Long Range Track and Surveillance (LRT&S) and Engage capability specifically for the Atlantic Fleet by the end of 2009. The Committee strongly urges that MDA refrain from transferring funds out of the Aegis program to other missile defense programs; MDA shall fully fund and execute the Aegis program as Congress intends.

MULTIPLE KILL VEHICLE

The Committee has provided $272,151,000 only for the Multiple Kill Vehicle (MKV) program. The Committee encourages the Missile Defense Agency to accelerate development and delivery of the MKV capability. The Committee designates the MKV program as congressional special interest items subject to prior approval reprogramming procedures.

ASYMMETRIC MISSILE DEFENSE

The Committee has previously noted its concern about and responded to the possibility of an asymmetric missile threat against the United States homeland, defined by a terrorist or other non-state actor lau[n]ching a cruise or short-range ballistic missile from air or sea-based platforms to the United States' territory. In fiscal years 2006 and 2007, the Committee provided additional funding targeted specifically at this potential threat.

The Committee believes that while the MDA has made valuable contributions in conducting studies and analyses and providing recommendations for potential means to address the threats, much additional work remains to be done within the U.S. government. As a result, the Committee recommends an additional $15,000,000 to continue the Missile Defense Agency's efforts to conduct experiments, develop prototypes, test concepts of operations, and recommend deployment options for an integrated asymmetric missile defense capability that would protect population centers. In additional to the current efforts, the Committee directs the MDA to conduct an operationally realistic test using sea-based assets. The MDA shall develop a recommended architecture and concept of operations for homeland asymmetric missile defense to include progressions for spiral technology upgrades that would enhance cruise and ballistic missile defense capabilities over time. The Director, MDA, in consultation with Commanders, U.S. Northern Command and U.S. Strategic Command, shall provide a report to the congressional defense committees not later than March 1, 2008 on results of the efforts to date along with a recommended program plan for further development, to include recommended knowledge points to guide further investment in the critical capability. (Pages 385-386)

The report also states the following:

KINETIC ENERGY INTERCEPTOR

The Committee has included $372,853,000 for the Kinetic Energy Interceptor (KEI) program, an increase of $145,354,000 above the budget request. In the fiscal year 2008 request, the Missile Defense Agency (MDA) reduced the planned funding by $178,009,000 to $227,499,000. Additionally, the MDA drastically descoped the program. Even though the KEI program has met each knowledge point while remaining on schedule and on budget, it has been used as an offset on numerous occasions for other more high risk programs. As originally conceived, the KEI mission is as a boost phase defense weapon with mobile capability on land and sea. In the current request, the KEI has been descoped to a booster program aimed at replacing the Ground-based Midcourse Interceptor. The Committee disagrees with this change and has provided additional funding in an effort to accelerate this much-needed capability. (Pages 383-384)

**Senate.** Section 8133 of the Senate-passed version of H.R. 3222, which the Senate added by amendment during its consideration of H.R. 3122, as reported by the Senate Appropriations Committee,[72] states:

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[72] Section 8133 was added by S.Amdt. 3141, which was agreed to in the Senate by (continued...)

> Sec. 8133. Of the amount appropriated or otherwise made available by title IV under the heading 'Research, Development, Test, and Evaluation, Defense-Wide', up to $75,000,000 may be available for Program Element 063892C for the Aegis Ballistic Missile Defense System, of which —
>
> (1) $20,000,000 may be for an increase in the production rate of the SM-3 interceptor to four interceptors per month;
>
> (2) $45,000,000 may be for long-lead production of an additional 15 SM-3 interceptors; and
>
> (3) $10,000,000 may be for an acceleration in the development of the Aegis Ballistic Missile Defense Signal Processor and Open Architecture software for the Aegis Ballistic Missile Defense system.

The Senate Appropriations Committee, in its report (S.Rept. 110-155 of September 14, 2007) on H.R. 3222, recommended approving the Administration's FY2008 research and development funding request for the Aegis BMD program (page 251).

Regarding the Multiple Kill Vehicle (MKV), the report stated in part that:

> the Committee is concerned that MDA has not fully consulted the Japanese about their intention to replace the Standard Missile-3 (SM-3) Block IIA program with MKV. The Japanese have already committed to funding half of the $2,500,000,000 SM-3 Block IIA development effort with the United States. The Standard Missile is performing extremely well in the Aegis sea-based tests, and upgrades to that system are less risky and will provide near-term capability sooner than moving to an unproven, technically immature MKV for the Aegis system.
>
> The Committee directs that no funding in the Aegis BMD program element can be used for the MKV program. (Pages 269-270)

Regarding the Kinetic Energy Interceptor (KEI), the report stated in part that:

> According to the budget justification materials, KEI has three objectives: "(1) to develop a midcourse interceptor capable of replacing the current fixed Ground-based interceptor (GBI) when the deployed GBIs become obsolete; (2) to develop this interceptor so that it could be strategically deployed as an additional midcourse capability with mobile land- or sea-based launchers; and (3) to assume the boost- and ascent-phase intercept mission within the Ballistic Missile Defense System (BMDS) if the Airborne Laser (ABL) fails to meet its performance objectives." The Committee believes that these objectives are premature, that existing systems can achieve the same goals, and that the missile is not suitable for Navy platforms....
>
> The Committee is concerned that MDA is developing KEI as a replacement for the GBI's prematurely since the GBI's are still under development, the

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[72] (...continued)
unanimous consent on October 3, 2007.

> fielded GBI's undergo continuous upgrades and retrofits, and the GBI's still have to undergo significant testing. Furthermore, additional midcourse capability can be achieved with upgrading current mobile systems, such as Theater High Altitude Area Defense [THAAD]. In addition, a study is currently underway on sea-basing the KEI, including an examination of Navy platforms suitable for hosting the large KEI. The Committee has not been informed that any current or future Navy ship will be outfitted with the KEI, and it appears that there are few, if any, viable platforms. Therefore, the Committee recommends a reduction of $30,000,000 for the KEI program. (Page 268)

**Conference.** The conference report (H.Rept. 110-434 of November 6, 2007) on H.R. 3222/P.L. 110-116 of November 13, 2007 increased the FY2008 research and development funding request for the Aegis BMD program by $75 million, including $49 million for Aegis upgrades for the SM-3 missile and ship installations and upgrades; $16 million for ballistic signal processor/open architecture, and $10 million for an asymmetric defense initiative. The conference report also reduced to zero the $62.9-million the FY2008 research and development funding request, within the line item for multiple kill vehicles, for the multiple engagement payload (MEP) for the SM-3. (Page 341). The report stated:

> MULTIPLE KILL VEHICLE
>
> The conferees agree to reduce the budget request for the Multiple Engagement Payload (MEP) for the Standard Missile-3 by $62,900,000, the entire budget request for that program. The conferees are concerned that the Missile Defense Agency (MDA) does not have the resources to adequately fund both MEP and the Multiple Kill Vehicle (MKV) for the Ground-Based Interceptor (GBI) and the Kinetic Energy Interceptor (KEI). Thus, the conferees agree to increase the MKV for the GBI and KEI by $25,000,000 in order to restore reductions that the MDA has annually taken out of this program. The conferees further agree with the Senate language that directs that no funding in the Aegis Ballistic Missile Defense program element can be used for the MKV program. Additionally, the conferees direct that the Multiple Kill Vehicle, PE 0603894 is designated as a congressional special interest item subject to prior approval reprogramming procedures. (Page 346)

# Appendix A. Strengths and Limitations of Sea-Based BMD Systems

**Potential Strengths.** Potential strengths of sea-based BMD systems compared to other BMD systems include the following:

- **Advantageous locations at sea.** Sea-based systems can conduct BMD operations from locations at sea that are potentially advantageous for BMD operations but inaccessible to ground-based BMD systems.

- **Base access and freedom of action.** Sea-based systems can be operated in forward (i.e., overseas) locations in international waters without need for negotiating base access from other governments, and without restrictions from foreign governments on how they might be used.

- **Visibility.** Sea-based systems can operate over the horizon from observers ashore, making them potentially less visible and less provocative.

- **Mobility.** Navy ships with BMD systems can readily move themselves to respond to changing demands for BMD capabilities or to evade detection and targeting by enemy forces, and can do so without placing demands on U.S. airlift assets.

Regarding the first of these potential strengths, there are at least four ways that a location at sea can be advantageous for U.S. BMD operations:

- The location might lie along a ballistic missile's potential flight path, which can facilitate tracking and intercepting the attacking missile.

- The location might permit a sea-based radar to view a ballistic missile from a different angle than other U.S. BMD sensors, which might permit the U.S. BMD system to track the attacking missile more effectively.

- If a potential adversary's ballistic missile launchers are relatively close to its coast, then a U.S. Navy ship equipped with BMD interceptors that is operating relatively close to that coast could attempt to defend a large down-range territory against potential attack by ballistic missiles fired from those launchers.[73] One to four Navy ships operating in the Sea of Japan, for example, could attempt

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[73] The ship's potential ability to do this is broadly analogous to how a hand casts a shadow in a candle-lit room. The closer that the hand (i.e., the Navy ship) is moved to the candle (the ballistic missile launcher), the larger becomes the hand's shadow on the far wall (the down-range area that the ship can help defend against ballistic missile attack). In BMD parlance, the area in shadow is referred to as the defended footprint.

to defend most or all of Japan against theater-range ballistic missiles (TBMs)[74] fired from North Korea.

- If a Navy ship were equipped with very fast interceptors (i.e., interceptors faster than those the Navy is currently deploying), and if that ship were deployed to an overseas location relatively close to enemy ballistic missile launchers, the ship might be able to attempt to intercept ballistic missiles fired from those launchers during the missiles' boost phase of flight — the initial phase, during which the ballistic missiles' rocket engines are burning. A ballistic missile in the boost phase of flight is a relatively large, hot-burning target that might be easier to intercept (in part because the missile is flying relatively slowly and is readily seen by radar), and the debris from a missile intercepted during its boost phase might be more likely to not fall on or near the intended target of the attacking missile.

**Potential Limitations.** Potential limitations of sea-based BMD systems compared to other BMD systems include the following:

- **Conflicts with other ship missions.** Using multimission Navy cruisers and destroyers for BMD operations might reduce their ability to perform other missions, such as air-defense operations against aircraft and anti-ship cruise missiles (ASCMs), land-attack operations, and anti-submarine warfare operations, for four reasons:
  - — Conducting BMD operations might require a ship to operate in a location that is unsuitable for performing one or more other missions.
  - — Conducting BMD operations may reduce a ship's ability to conduct air-defense operations against aircraft and cruise missiles due to limits on ship radar abilities.
  - — BMD interceptors occupy ship weapon-launch tubes that might otherwise be used for air-defense, land-attack, or anti-submarine weapons.
  - — Launching a BMD interceptor from a submarine might give away the submarine's location, which might make it more difficult for the submarine to perform missions that require stealthy operations (and potentially make the submarine more vulnerable to attack).

- **Costs relative to ground-based systems.** A sea-based system might be more expensive to procure than an equivalent ground-based system due to the potential need to engineer the sea-based

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[74] TBMs include, in ascending order of range, short-range ballistic missiles (SRBMs), which generally fly up to about 600 kilometers (about 324 nautical miles), medium-range ballistic missiles (MRBMs), which generally fly up to about 1,300 kilometers (about 702 nm), and intermediate-range ballistic missiles (IRBMs), which generally fly up to about 5,500 kilometers (about 2,970 nm). Intercontinental ballistic missiles (ICBMS) are longer-ranged missiles that can fly 10,000 kilometers (about 5,400 nm) or more. Although ICBMs can be used to attack targets within their own military theater, they are not referred to as TBMs.

system to resist the corrosive marine environment, resist electromagnetic interference from other powerful shipboard systems and meet shipboard safety requirements, or fit into a limited space aboard ship. A BMD system on a ship or floating platform that is dedicated to BMD operations might be more expensive to operate and support than an equivalent ground-based system due to the maintenance costs associated with operating the ship or platform in the marine environment and the need for a crew of some size to operate the ship or platform.

- **Ship quantities for forward deployments.** Maintaining a standing presence of a Navy BMD ship in a location where other Navy missions do not require such a deployment, and where there is no nearby U.S. home port, can require a total commitment of several Navy ships, due to the mathematics of maintaining Navy ship forward deployments.[75]

- **Vulnerability to attack.** A sea-based BMD system operating in a forward location might be more vulnerable to enemy attack than a ground-based system, particularly a ground-based system located in a less-forward location. Defending a sea-based system against potential attack could require the presence of additional Navy ships or other forces.

- **Rough waters.** Very rough waters might inhibit a crew's ability to operate a ship's systems, including its BMD systems, potentially creating occasional gaps in BMD coverage.

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[75] For more on the mathematics of Navy ship forward deployments, see CRS Report RS21338, *Navy Ship Deployments: New Approaches — Background and Issues for Congress*, by Ronald O'Rourke.

# Appendix B. Arms Control Considerations

No arms control treaty currently in force limits sea-based BMD systems. The U.S.-Soviet Anti-Ballistic Missile (ABM) Treaty, which was in force from 1972 until the United States withdrew from the treaty in 2002, prohibited sea-based defenses against strategic (i.e., long-range) ballistic missiles. Article V of the treaty states in part: "Each Party undertakes not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based." Article II defines an ABM system as "a system to counter strategic ballistic missiles or their elements in flight trajectory...." For more on the ABM Treaty, see CRS Report RL33865, *Arms Control and Nonproliferation: A Catalog of Treaties and Agreements*, by Amy F. Woolf, Sharon Squassoni, and Steve Bowman. The United States withdrew from the ABM Treaty in 2002, according to the treaty's procedures for doing so. For a discussion, see CRS Report RS21088, *Withdrawal from the ABM Treaty: Legal Considerations*, by David M. Ackerman. crsphpgw