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Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress

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October 25, 2016

Congressional Research Service
7-5700
www.crs.gov
RL33745

CRS REPORT
Prepared for Members and
Committees of Congress

Summary

The Aegis ballistic missile defense (BMD) program, which is carried out by the Missile Defense Agency (MDA) and the Navy, gives Navy Aegis cruisers and destroyers a capability for conducting BMD operations. Under MDA and Navy plans, the number of BMD-capable Navy Aegis ships is scheduled to grow from 33 at the end of FY2016 to 49 at the end of FY2021. The figure for FY2020 may include up to four BMD-capable Aegis cruisers in reduced operating status as part of a program to modernize 11 existing Aegis cruisers.

Under the Administration's European Phased Adaptive Approach (EPAA) for European BMD operations, BMD-capable Aegis ships are operating in European waters to defend Europe from potential ballistic missile attacks from countries such as Iran. BMD-capable Aegis ships also operate in the Western Pacific and the Persian Gulf to provide regional defense against potential ballistic missile attacks from countries such as North Korea and Iran.

The Aegis BMD program is funded mostly through MDA's budget. The Navy's budget provides additional funding for BMD-related efforts. MDA's proposed FY2017 budget requests a total of $1,774.8 million in procurement and research and development funding for Aegis BMD efforts, including funding for two Aegis Ashore sites in Poland and Romania that are to be part of the EPAA. MDA's budget also includes operations and maintenance (O&M) and military construction (MilCon) funding for the Aegis BMD program.

Issues for Congress regarding the Aegis BMD program include the following:

- required numbers of BMD-capable Aegis ships vs. available numbers of BMD-capable Aegis ships;
- whether the Aegis test facility in Hawaii should be converted into an operational Aegis Ashore site to provide additional BMD capability for defending Hawaii and the U.S. West Coast;
- burden-sharing—how European naval contributions to European BMD capabilities and operations compare to U.S. naval contributions to European BMD capabilities and operations;
- the lack of a target for simulating the endo-atmospheric (i.e., final) phase of flight of China's DF-21 anti-ship ballistic missile; and
- concurrency and technical risk in the Aegis BMD program.

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Introduction

This report provides background information and issues for Congress on the Aegis ballistic missile defense (BMD) program, which is carried out by the Missile Defense Agency (MDA) and the Navy, and gives Navy Aegis cruisers and destroyers a capability for conducting BMD operations. Congress's decisions on the Aegis BMD program could significantly affect U.S. BMD capabilities and funding requirements, and the BMD-related industrial base.

Background

Strategic and Budgetary Context

For an overview of the strategic and budgetary context in which the Aegis BMD program may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Aegis Ships

The Navy's cruisers and destroyers are called Aegis ships because they are equipped with the Aegis ship combat system—an integrated collection of sensors, computers, software, displays, weapon launchers, and weapons named for the mythological shield that defended Zeus. The Aegis system was originally developed in the 1970s for defending ships against aircraft, anti-ship cruise missiles (ASCMs), surface threats, and subsurface threats. The system was first deployed by the Navy in 1983, and it has been updated many times since. The Navy's Aegis ships include Ticonderoga (CG-47) class cruisers and Arleigh Burke (DDG-51) class destroyers.

Ticonderoga (CG-47) Class Aegis Cruisers

Overview

A total of 27 CG-47s (CGs 47 through 73) were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five ships in the class (CGs 47 through 51), which were built to an earlier technical standard in certain respects, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005, leaving 22 ships in operation (CGs 52 through 73).

"2-4-6" Program for Modernizing 11 Existing Aegis Cruisers

Congress has directed the Navy to implement the so-called "2-4-6" program for modernizing the 11 youngest Aegis cruisers. Under the 2-4-6 program, no more than two of the cruisers are to enter the modernization program each year, none of the cruisers is to remain in reduced status for modernization for more than four years, and no more than six of the cruisers are to be in the program at any given time. Among the 11 Aegis cruisers that are to be modernized under this program are four that are BMD-capable—CG-67 (*Shiloh*), CG-70 (*Lake Erie*), CG-72 (*Vella Gulf*), and CG-73 (*Port Royal*). The Navy, as part of its FY2017 budget submission, is proposing an alternate schedule for modernizing the 11 cruisers. Congress in the past has rejected this alternate schedule, but the Navy is once again asking Congress to adopt it as a replacement for the 2-4-6 plan.

Arleigh Burke (DDG-51) Class Aegis Destroyers[1]

Flight I/II and Flight IIA DDG-51s Procured in FY1985-FY2005

A total of 62 DDG-51s were procured for the Navy between FY1985 and FY2005; the first entered service in 1991 and the 62nd entered service in FY2012. The first 28 ships, known as Flight I/II DDG-51s, are scheduled to remain in service until age 35. The next 34 ships, known as Flight IIA DDG-51s, incorporate some design changes and are scheduled to remain in service until age 40.

No DDG-51s Procured in FY2006-FY2009

No DDG-51s were procured in FY2006-FY2009. The Navy during this period instead procured three Zumwalt (DDG-1000) class destroyers. The DDG-1000 design does not use the Aegis system and does not include a capability for conducting BMD operations. Navy plans do not call for modifying DDG-1000s to make them BMD-capable.

Flight IIA DDG-51s Procured in FY2010-FY2016

Procurement of Flight IIA DDG-51s resumed in FY2010. A total of 11 were procured in FY2010-FY2016. The 11th Flight IIA ship was one of two DDG-51s procured in FY2016.

Flight III DDG-51s Procured Starting in FY2016

Beginning with the second of the two DDG-51s procured in FY2016, the Navy has shifted DDG-51 procurement to a new version of the DDG-51 design called the Flight III version. The Flight III version is to be equipped with a new radar, called the Air and Missile Defense Radar (AMDR), that is more capable than the SPY-1 radar installed on all previous Aegis cruisers and destroyers.

Aegis Ships in Allied Navies

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, South Korea, Australia, Spain, and Norway.[2]

Aegis BMD System[3]

Aegis ships are given a capability for conducting BMD operations by incorporating changes to the Aegis system's computers and software, and by arming the ships with BMD interceptor missiles. In-service Aegis ships can be modified to become BMD-capable ships, and DDG-51s procured in FY2010 and subsequent years are to be built from the start with a BMD capability.

[1] For more on the DDG-51 program, see CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke.

[2] The Norwegian ships 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.

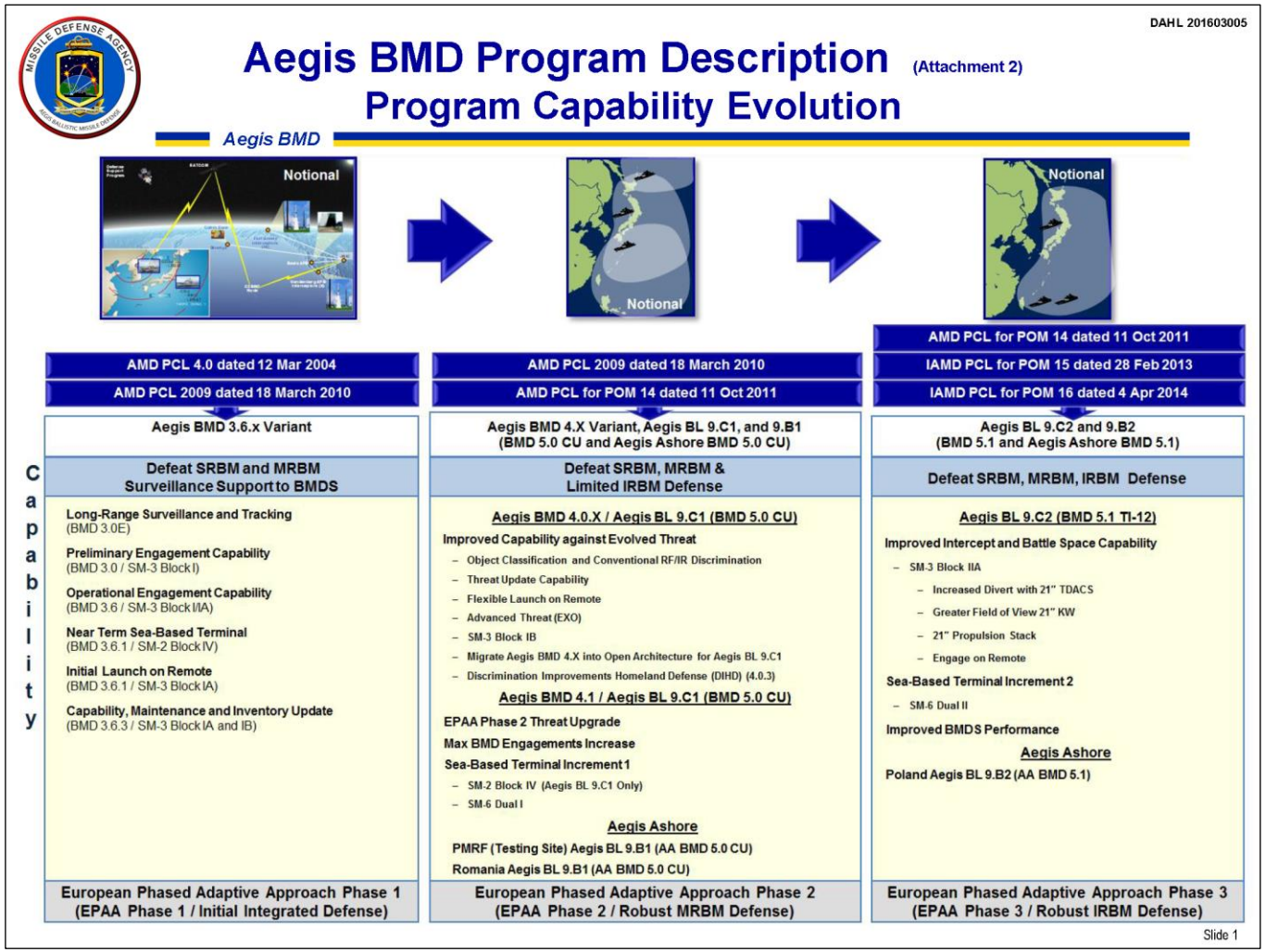
[3] Unless stated otherwise, information in this section is taken from MDA briefings on the Aegis BMD program given to CRS and CBO analysts on the MDA's FY2016 and prior-year budget submissions.

Versions of Aegis BMD System

The Aegis BMD system exists in several variants. Listed in order of increasing capability, these are the 3.6.X variant, the 4.X variant, the 5.0 CU (Capability Upgrade) variant, and the 5.1 variant. **Figure 1** summarizes the capabilities of these variants and correlates them with the phases of the European Phased Adaptive Approach (or EPAA; see below) for European BMD operations.

Figure 1. Aegis BMD System Variants

Summary of capabilities



Source: MDA briefing slide provided to CRS on March 25, 2016.

Aegis BMD Interceptor Missiles

The BMD interceptor missiles used by Aegis ships are the Standard Missile-3 (SM-3) and the Standard Missile-2 Block IV (SM-2 Block IV). The SM-2 Block IV is to be succeeded in coming years by a BMD version of the new SM-6 interceptor.

SM-3 Midcourse Interceptor

The SM-3 is designed to intercept ballistic missiles above the atmosphere (i.e., exo-atmospheric intercept), in the midcourse phase of an enemy ballistic missile's flight. It is equipped with a "hit-to-kill" warhead, called a kinetic vehicle, that is designed to destroy a ballistic missile's warhead by colliding with it.

MDA and Navy plans call for fielding increasingly capable versions of the SM-3 in coming years. The current version, called the SM-3 Block IA, is now being supplemented by the more capable SM-3 Block IB. These are to be followed by the even more capable SM-3 Block IIA.

Compared to the Block IA version, the Block IB version has an improved (two-color) target seeker, an advanced signal processor, and an improved divert/attitude control system for adjusting its course.

In contrast to the Block IA and 1B versions, which have a 21-inch-diameter booster stage at the bottom but are 13.5 inches in diameter along the remainder of their lengths, the Block IIA version has a 21-inch diameter along its entire length. The increase in diameter to a uniform 21 inches provides more room for rocket fuel, permitting the Block IIA version to have a burnout velocity (a maximum velocity, reached at the time the propulsion stack burns out) that is greater than that of the Block IA and IB versions,[4] as well as a larger-diameter kinetic warhead. The United States and Japan have cooperated in developing certain technologies for the Block IIA version, with Japan funding a significant share of the effort.[5]

MDA and Navy plans at one point called for the SM-3 Block IIA to be succeeded by a still-more-capable interceptor called the SM-3 Block IIB. The effort to develop that missile, however, was ended, and MDA reportedly is not pursuing any follow-on capabilities to the SM-3 Block IIA.[6]

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[4] Some press reports and journal articles, all of which are now a decade or more old, report unconfirmed figures on the burnout velocities of various SM-3 missile configurations (some of which were proposed but ultimately not pursued). See, for example, J. D. Marshall, *The Future Of Aegis Ballistic Missile Defense*, point paper dated October 15, 2004, accessed online at http://www.marshall.org/pdf/materials/259.pdf; "STANDARD Missile-3 Destroys a Ballistic Missile Target in Test of Sea-based Missile Defense System," Raytheon news release circa January 26, 2002; Gopal Ratnam, "U.S. Navy To Play Larger Role In Missile Defense, *Defense News*, January 21-27, 2002: 10; Hans Mark, "A White Paper on the Defense Against Ballistic Missiles," *The Bridge*, Summer 2001, pp. 17-26, accessed online at http://www.nae.edu/nae/bridgecom.nsf/weblinks/NAEW-63BM86/$FILE/BrSum01.pdf?OpenElement; Michael C. Sirak, "White House Decision May Move Sea-Based NMD Into Spotlight," *Inside Missile Defense*, September 6, 2000: 1; Henry F. Cooper and J.D. Williams, "The Earliest Deployment Option—Sea-Based Defenses," *Inside Missile Defense*, September 6, 2000 (guest perspective; including graphic on page 21); Robert Holzer, "DoD Weighs Navy Interceptor Options, *Defense News*, July 24, 2000: 1, 60 (graphic on page 1); and Robert Holzer, "U.S. Navy Gathers Strength, Allies in NMD Showdown," *Defense News*, March 15, 1999: 1, 42 (graphic on page 1).

[5] The cooperative research effort has been carried out under a U.S.-Japan memorandum of agreement signed in 1999. The effort 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. The Block IIA development effort includes the development of a missile, called the Block II, as a stepping stone to the Block IIA. As a result, the Block IIA development effort has sometimes been called the Block II/IIA development effort. The Block II missile is not planned as a fielded capability.

[6] See, for example, Justin Doubleday, "Missile Defense Agency Not Pursuing Follow-On to SM-3 Block IIA Interceptor," *Inside the Navy*, October 24, 2016.

SM-2 and SM-6 Terminal Interceptors

The SM-2 Block IV is designed to intercept ballistic missiles inside the atmosphere (i.e., endo-atmospheric intercept), during the terminal phase of an enemy ballistic missile's flight. It is equipped with a blast fragmentation warhead. The existing inventory of SM-2 Block IVs—72 as of February 2012—was created by modifying SM-2s that were originally built to intercept aircraft and ASCMs. A total of 75 SM-2 Block IVs were modified, and 3 were used in BMD flight tests.

MDA and Navy plans are now procuring a more capable terminal-phase BMD interceptor based on the SM-6 air defense missile (the successor to the SM-2 air defense missile). The SM-6 is a dual-capability missile that can be used for either air defense (i.e., countering aircraft and anti-ship cruise missiles) or ballistic missile defense.

European Phased Adaptive Approach (EPAA) for European BMD

On September 17, 2009, the Obama Administration announced a new approach for regional BMD operations called the Phased Adaptive Approach (PAA). The first application of the approach is in Europe, and is called the European PAA (EPAA). EPAA calls for using BMD-capable Aegis ships, a land-based radar in Europe, and eventually two Aegis Ashore sites in Romania and Poland to defend Europe against ballistic missile threats from countries such as Iran.

Phase I of EPAA involved deploying Aegis BMD ships and a land-based radar in Europe by the end of 2011. Phase II involves establishing the Aegis Ashore site in Romania with SM-3 IB interceptors in the 2015 timeframe. Phase 3 involves establishing the Aegis Ashore site in Poland with SM-3 IIA interceptors in the 2018 timeframe. Each Aegis Ashore site in the EPAA is to include a structure housing an Aegis system similar to the deckhouse on an Aegis ship and 24 SM-3 missiles launched from a re-locatable Vertical Launch System (VLS) based on the VLS that is installed in Navy Aegis ships.[7] The Aegis Ashore site in Romania was operationally certifiedon May 12, 2016.[8]

Although BMD-capable Aegis ships have deployed to European waters before 2011, the first BMD-capable Aegis ship officially deployed to European waters as part of the EPAA departed its home port of Norfolk, VA, on March 7, 2011, for a deployment to the Mediterranean that lasted several months.[9]

Planned Numbers of BMD-Capable Aegis Ships and SM-3 Interceptors

Table 1 shows planned numbers of BMD-capable Aegis ships and SM-3 interceptors under DOD's proposed FY2017 budget submission. Numbers of BMD-capable ships in the table reflect

[7] For additional discussion of the Aegis Ashore sites, see Edward Lundquist, "Aegis Ashore Adapts Sea-Based Missile Defense System to Protect Europe," *National Defense*, September 2016.

[8] See "Aegis Ashore Missile Defense System-Romania Operationally Certified, *Navy News Service*, May 12, 2016; Sam LaGrone, "Aegis Ashore Site in Romania Declared Operational," *USNI News*, May 12, 2016.

[9] Karen Parrish, "Milestone nears for European Missile Defense Plan," *American Forces Press Service*, March 2, 2011 (accessed online at http://www.defense.gov/news/newsarticle.aspx?id=62997); Untitled "Eye On The Fleet" news item, *Navy News Service*, March 7, 2011 (accessed online at http://www.navy.mil/view_single.asp?id=98184); "Warship With Radar Going To Mediterranean," *Washington Post*, March 2, 2011; Brock Vergakis, "US Warship Deploys to Mediterranean to Protect Europe Form Ballistic Missiles, *Canadian Press*, March 7, 2011.

the Navy's proposed schedule for modernizing Aegis cruisers rather than the congressionally directed 2-4-6 plan (see the above section ""2-4-6" Program for Modernizing 11 Existing Aegis Cruisers").

Table 1. Numbers of BMD-Capable Aegis Ships and SM-3 Missiles

	FY15	FY16	FY17 (req.)	FY18 (proj.)	FY19 (proj.)	FY20 proj.)	FY21 (proj.)
BMD-capable Aegis ships							
3.6 version	22	19	17	14	11	7	6
4.X version	8	10	10	12	15	19	20
5.0 CU version	3	4	7	11	9	4	2
5.1 version	0	0	0	0	5	13	21
Total	**33**	**33**	**34**	**37**	**40**	**43**	**49**
Aegis Ashore sites	**0**	**1**	**1**	**1**	**2**	**2**	**2**
SM-3 missile cumulative deliveries / inventory (including RDT&E purchases)							
Block I/IA	150/119	150/101	150/85	150/60	150/49	150/37	150/35
Block IB	59/49	107/92	146/128	185/166	221/202	256/236	295/271
Block IIA	0/0	0/0	0/0	4/2	15/11	17/12	20/14
Total	**209/168**	**257193**	**296/213**	**339/228**	**386/262**	**423/285**	**465/320**

Source: For numbers of BMD-capable Aegis ships and Aegis Ashore sites: Table prepared by CRS based on MDA briefing slide provided to CRS on March 25, 2016. For SM-3 cumulative deliveries/inventory: FY2017 MDA budget submission.

October 5, 2011, Announcement of Homeporting in Spain

On October 5, 2011, the United States, Spain, and NATO jointly announced that, as part of the EPAA, four BMD-capable Aegis ships are to be forward-homeported (i.e., based) at the naval base at Rota, Spain.[10] The four ships are the destroyers *Ross* (DDG-71) and *Donald Cook* (DDG-75), which moved to Rota in FY2014, and the destroyers *Carney* (DDG-64) and *Porter* (DDG-78), which moved to Rota in FY2015. The fourth and final ship to be moved, DDG-64, arrived at Rota on September 25, 2015.[11] The move involves an estimated 1,239 military billets (including 1,204 crew members for the four ships and 35 shore-based support personnel),[12] and about 2,100 family members.[13] The Navy estimates the up-front costs of transferring the four ships at $92

[10] "Announcement on missile defence cooperation by NATO Secretary General Anders Fogh Rasmussen, the Prime Minister of Spain, Jose Luis Rodriguez Zapatero and US Defense Secretary Leon Panetta," October 5, 2011, accessed October 6, 2011, at http://www.nato.int/cps/en/SID-107ADE55-FF83A6B8/natolive/opinions_78838.htm. See also "SECDEF Announces Stationing of Aegis Ships at Rota, Spain," accessed October 6, 2011, at http://www.navy.mil/search/display.asp?story_id=63109.

[11] Sam LaGrone, "Destroyer USS Carney Arrives in Rota Completing European Ballistic Missile Defense Quartet," USNI News, September 25, 2015.

[12] Source: Navy information paper dated March 8, 2012, provided by Navy Office of Legislative Affairs to CRS on March 9, 2012.

[13] Source: Navy briefing slides dated February 27, 2012, provided by the Navy to CRS on March 9, 2012.

million in FY2013, and the recurring costs of basing the four ships in Spain rather than in the United States at roughly $100 million per year.[14]

Rota is on the southwestern Atlantic coast of Spain, a few miles northwest of Cadiz, and about 65 miles northwest of the Strait of Gibraltar leading into the Mediterranean. U.S. Navy ships have been homeported at Rota at various points in the past, most recently in 1979.[15] For additional background information on the Navy's plan to homeport four BMD-capable Aegis destroyers at Rota, Spain, see **Appendix B**.

Aegis BMD Flight Tests

DOD states that since January 2002, the Aegis BMD system has achieved 28 successful exo-atmospheric intercepts in 35 attempts using the SM-3 missile (including 3 successful intercepts in 4 attempts by Japanese Aegis ships, and one successful intercept in one attempt using the Aegis Ashore system), and 5 successful endo-atmospheric intercepts in 5 attempts using the SM-2 Block IV missile and the SM-6 Dual I missile, making for a combined total of 33 successful intercepts in 40 attempts.

In addition, on February 20, 2008, a BMD-capable Aegis cruiser operating northwest of Hawaii used a modified version of the Aegis BMD system to shoot down an inoperable U.S. surveillance satellite that was in a deteriorating orbit.[16] Including this intercept in the count increases the totals to 29 successful exo-atmospheric intercepts in 36 attempts using the SM-3 missile, and 34

[14] Source: Navy briefing slides dated February 27, 2012, provided by the Navy to CRS on March 9, 2012. The briefing slides state that the estimated up-front cost of $92 million includes $13.5 million for constructing a new weapon magazine, $0.8 million for constructing a pier laydown area, $3.4 million for constructing a warehouse, $5.0 million for repairing an existing facility that is to be used as an administrative/operations space, and $69.3 million for conducting maintenance work on the four ships in the United States prior to moving them to Rota. The briefing states that the estimated recurring cost of $100 million per year includes costs for base operating support, annual PCS (personnel change of station) costs, a pay and allowances delta, annual mobile training team costs, ship maintenance work, the operation of a Ship Support Activity, and higher fuel costs associated with a higher operating tempo that is maintained by ships that are homeported in foreign countries.

[15] Source: Sam Fellman, "U.S. To Base Anti-Missile Ships in Spain," *Defense News*, October 10, 2011: 76.

[16] The modifications to the ship's Aegis BMD midcourse system reportedly involved primarily making changes to software. DOD stated that the modifications were of a temporary, one-time nature. Three SM-3 missiles reportedly were modified for the operation. The first modified SM-3 fired by the cruiser successfully intercepted the satellite at an altitude of about 133 nautical miles (some sources provide differing altitudes). The other two modified SM-3s (one carried by the cruiser, another carried by an engage-capable Aegis destroyer) were not fired, and the Navy stated it would reverse the modifications to these two missiles. (For additional information, see the MDA discussion available online at http://www.mda.mil/system/aegis_one_time_mission.html, and also Peter Spiegel, "Navy Missile Hits Falling Spy Satellite," *Los Angeles Times*, February 21, 2008; Marc Kaufman and Josh White, "Navy Missile Hits Satellite, Pentagon Says," *Washington Post*, February 21, 2008; Thom Shanker, "Missile Strikes A Spy Satellite Falling From Its Orbit," *New York Times*, February 21, 2008; Bryan Bender, "US Missile Hits Crippled Satellite," *Boston Globe*, February 21, 2008; Zachary M. Peterson, "Navy Hits Wayward Satellite On First Attempt," *NavyTimes.com*, February 21, 2008; Dan Nakaso, "Satellite Smasher Back At Pearl," *Honolulu Advertiser*, February 23, 2008; Zachary M. Peterson, "Lake Erie CO Describes Anti-Satellite Shot," *NavyTimes.com*, February 25, 2008; Anne Mulrine, "The Satellite Shootdown: Behind the Scenes," *U.S. News & World Report*, February 25, 2008; Nick Brown, "US Modified Aegis and SM-3 to Carry Out Satellite Interception Shot," *Jane's International Defence Review*, April 2008: 35.)

MDA states that the incremental cost of the shoot-down operation was $112.4 million when all costs are included. MDA states that this cost is to be paid by MDA and the Pacific Command (PACOM), and that if MDA is directed to absorb the entire cost, "some realignment or reprogramming from other MDA [program] Elements may be necessary to lessen significant adverse impact on [the] AEGIS [BMD program's] cost and schedule." (MDA information paper dated March 7, 2008, provided to CRS on June 6, 2008. See also Jason Sherman, "Total Cost for Shoot-Down of Failed NRO Satellite Climbs Higher," *InsideDefense.com*, May 12, 2008.)

successful exo- and endo-atmospheric intercepts in 41 attempts using both SM-3 and SM-2 Block IV missiles.

The Aegis BMD development effort, including Aegis BMD flight tests, is often described as following a development philosophy long-held within the Aegis program office of "build a little, test a little, learn a lot," meaning that development is done in manageable steps, then tested and validated before moving on to the next step.[17]

A January 2016 report on various DOD acquisition programs from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2015—stated the following in the section on the Aegis BMD program:

> **Assessment**
>
> • In FY15 and 1QFY16, the Aegis Afloat system underwent DT/OT and operational flight testing of that system's exo-atmospheric engagement capabilities (during FTX-20, FTM-25, and FTO-02 Event 2a) and its endo-atmospheric engagement capabilities with SM-6 Dual I and SM-2 Block IV missiles (during MMW Events 1 and 2). Testing demonstrated engagement capabilities against short-range ballistic missiles in both exo- and endo-atmospheric engagements. Additional flight testing and high-fidelity modeling and simulation analyses are needed to quantitatively evaluate the effectiveness of the Baseline 9 system at engaging ballistic missiles in the exo- and endo-atmospheric phases of flight for a range of scenarios.
>
> • FTM-25 demonstrated the use of Integrated Air and Missile Defense radar priority mode in a live engagement during which cruise missile and ballistic missile targets were simultaneously engaged, although only for a less-than-fully stressing case, with a single ballistic missile and a raid of two subsonic cruise missile targets.
>
> • Three of the MMW events (Events 1, 3, and 4) demonstrated that SM-6 Dual I missiles can be used to conduct sea-based terminal engagements against short-range non-separating ballistic missiles, and that they retain the air defense capabilities that were demonstrated during SM-6 IOT&E and FOT&E flight testing.
>
> • The MDA intended FTO-02 Event 2 and Event 2a to demonstrate the Aegis Afloat capability to prosecute a ballistic missile threat engagement as part of a layered BMDS in the presence of non-organic post intercept debris, while simultaneously conducting an anti-air warfare engagement in Integrated Air and Missile Defense priority mode. However, shortly following launch, the SM-3 Block IB Threat Update guided missile targeting the medium-range ballistic missile target failed. Prior to this, a THAAD interceptor intercepted the short-range ballistic missile target, generating debris that may enable accurate modeling and simulation of Aegis BMD combat system capability in the presence of post intercept debris. At the same time Aegis BMD was attempting to engage the ballistic missile target with the SM-3 missile, it succeeded in engaging an air-breathing target with two SM-2 Block IIIA guided missiles. An engineering Failure Review Board investigation is underway to determine the root cause of the SM-3 guided missile failure. A full assessment of the FTO-02 Event 2 and Event 2a test mission data with respect to Aegis BMD and BMDS operational effectiveness, operational suitability, and interoperability is ongoing.

[17] See, for example, "Aegis BMD: "Build a Little, Test a Little, Learn a Lot"," USNI blog, March 15, 2010, accessed September 11, 2013, at http://blog.usni.org/2010/03/15/aegis-bmd-build-a-little-test-a-little-learn-a-lot, and "Aegis Ballistic Missile Defense, Aegis Ballistic Missile Defense Overview for the George C. Marshall Institute, RADM Alan B. Hicks, USN, Aegis BMD Program Director, August 3, 2009, slide 16 of 20, entitled "Some of our Philosophies In a Nutshell (1 of 2)," accessed September 11, 2011, at http://www.marshall.org/pdf/materials/743.pdf.

• The Aegis BMD 4.0 system, which is the latest deployed version of Aegis BMD and is the primary sea-based firing asset for EPAA Phase 2, conducted follow-on testing in FY15 to supplement the IOT&E flight testing and modeling and simulation conducted in FY13 and FY14. The most significant capability demonstrated was the BMD 4.0 system's DWES, an automated engagement coordination capability, during the FTX-19 mission. In that mission, two Aegis BMD 4.0 ships demonstrated that the DWES capability can determine the preferred shooter for a given ballistic missile engagement when two Aegis BMD firing assets are present, thereby reducing missile wastage while ensuring BMD threat coverage.

• Prior IOT&E flight testing and supporting modeling and simulation demonstrated that Aegis BMD 4.0 has the capability to engage and intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase with SM-3 Block IB guided missiles. However, flight testing and modeling and simulation are not yet sufficient to assess the full range of expected threat types, threat ground ranges, and threat raid sizes. Details on the BMD 4.0 system's performance can be found in the classified December 2014 Aegis BMD 4.0 IOT&E report.

• Reliability, maintainability, and availability data collected during Baseline 9 BMD-related testing in early to mid FY15 shows that the Baseline 9 system does not currently meet its requirements for availability and the mean time to repair hardware, mostly due to a series of early Aegis Display System failures and an AN/SPY-1 radar coolant leak that downed the system for an extended period of time. The majority of the Aegis Display System problems have been resolved by the installation of new graphics cards for each console. Additional data collected during late FY15 to early FY16 are under review by data scoring boards. It is uncertain at present if additional data collection periods are needed to prove that the system's suitability is sufficient for operational use.

• The limited number of SM-3 Block IB firings (10 as of FTO-02 Event 2a) and the 2 TSRM failures (during FTM-16 Event 2 in FY11 and FTM-21 in FY13) lower certainty in overall SM-3 Block IB missile reliability in its currently fielded configuration. The program addressed and tested a correction for the first of the SM-3 TSRM failures when it modified the TSRM's inter-pulse delay time between axial thrust burns. This correction, which the MDA implemented following the FTM-16 Event 2 failure, did not prevent the TSRM failure in the second of two salvo-launched SM-3 Block IB guided missiles in FTM-21. The MDA established a Failure Review Board (FRB) to determine the root cause of this failure and the FRB uncovered enough evidence to determine that a redesign was needed for the TSRM aft nozzle. Ground testing of the new design began in FY14. Flight testing of the new design is expected in February 2016. The new nozzle design can be retrofitted into current SM-3 Block IA and Block IB missiles.

• The FTM-25 flight test and recent lot acceptance testing have shown that the TSRM Attitude Control System CGR, which the MDA re-designed following FTM-15, can produce anomalous low regulated pressure levels. In five flight tests following FTM-15, the TSRM showed no anomalous behavior. The CGR anomaly in FTM-25 did not preclude a successful intercept; however, the cold gas pressure observed was much lower than that commanded. If the regulated pressure from the CGR is too low, the Attitude Control System may not function properly. Analysis suggests that now defunct tooling procedures caused the FTM-25 CGR anomaly. The manufacturer built the CGR flown in FTM-25 using old tooling procedures (it was the second CGR built following the re-design after FTM-15). The MDA established an industry-led FRB to determine the root cause of the low pressure outputs from the CGRs, and its investigation is ongoing. The CGR anomaly is not related to the TSRM inter-pulse delay problem or the aft nozzle deficiency previously discussed.

• Flight testing, modeling and simulation, and ground testing have demonstrated the Aegis BMD 4.0 capability to perform the LRS&T mission. The Flight Test Ground-

Based Interceptor-07 (FTG-07) mission in FY13 highlighted the need to further explore and refine tactics, techniques, and procedures (TTPs) for the transmission and receipt of Aegis BMD track data for GMD use. The MDA demonstrated in GTI-06 Part 3 the Aegis BMD 4.0 software's ability to provide track data that GMD can use. The MDA will test Aegis Afloat systems in a future ground test.

• All components of the SM-3 Block IIA guided missile flight tested thus far during developmental testing have performed as designed. SCD CTV-01 in FY15 showed good missile performance from egress from the Vertical Launching System, to Stage 1 burn, to Stage 1/2 separation, to Second Stage Rocket Motor burn, to Stage 2/3 separation, to nosecone jettison, and to TSRM burn.

• At-Sea Demonstration-15 demonstrated that Aegis BMD can interoperate with North Atlantic Treaty Organization defenses, and exchange air and ballistic missile message information across operational communication architectures during cruise missile and ballistic missile engagements. In the live fire test, the Aegis BMD 3.6.3 ship detected, tracked, and intercepted a short-range non-separating ballistic missile target using an SM-3 Block IA guided missile.

• Cybersecurity testing results will be included in the classified 2015 BMDS Annual Report.

• The MDA continues to utilize Aegis BMD assets and HWIL representations in ground test events, which has helped to refine TTPs and overall interoperability of the system with the BMDS. However, the test events routinely demonstrated that inter-element coordination and interoperability are still in need of improvement.

Recommendations

• Status of Previous Recommendations. The program:

1. Partially addressed the first recommendation from FY13 to conduct flight testing of the Aegis BMD 4.0 remote engagement authorized capability against a medium- or intermediate-range ballistic missile target using an SM-3 Block IB guided missile, when it conducted FTO-02 Event 2a. This assumes that DOT&E can use modeling and simulation results to determine if the Aegis combat system successfully supported the engagement. Although the MDA conducted FTO-02 Event 2a with an Aegis BMD 5.0 with Capability Upgrade destroyer, rather than a BMD 4.0 ship, the Aegis BMD 4.0 and Aegis Afloat remote engagement capabilities are similar. Due to the SM-3 guided missile failure during FTO-02 Event 2a, the MDA should plan to conduct an end-to-end remote engagement authorized flight test using track data from a forward-based sensor.

2. Partially addressed the second recommendation from FY13 to conduct operationally realistic testing that exercises Aegis BMD 4.0's improved engagement coordination with THAAD and Patriot when it conducted FTO-02 Event 2a using Aegis Afloat and THAAD firing assets. The flight test did not include a Patriot firing asset, so engagement coordination with Patriot has not been flight tested to date.

3. Addressed the fourth recommendation from FY13 to use the FRB process to identify the failure mechanism responsible for the FTM-21 second missile failure and determine the underlying root cause that may be common to both the FTM-16 Event 2 and FTM-21 second missile failures by completing the FRB process for the TSRM failures encountered to date. The MDA plans to flight-test the redesigned aft nozzle area of the TSRM in February 2016.

4. Addressed the fifth recommendation from FY13 to deliver sufficient Aegis BMD 4.0 validation data and evidence to support BMDS modeling and simulation verification, validation, and accreditation (VV&A) of the Aegis HWIL and digital models. The program did so when the Commander, Operational Test and Evaluation Force provided VV&A evidence for the digital models used for element-level performance analyses in

support of the operational assessment of the Aegis BMD 4.0 system with SM-3 Block IB guided missiles.

5. Addressed the first recommendation from FY14 to conduct flight tests or high-fidelity modeling and simulation analyses to demonstrate the Aegis BMD 4.0 system's capability to perform LRS&T of a raid of long-range threats. The Aegis BMD 4.0.3 update improves the LRS&T of long-range threats and the MDA tested this capability in GTI-06 Part 3 for various raid sizes.

6. Has partially addressed the second recommendation from FY14 to determine the appropriate LRS&T TTPs for the transmission and receipt of Aegis BMD 4.0 track data for GMD use. The MDA added GTI-06 Part 3 to the Integrated Master Test Plan to demonstrate that GMD can use data provided by Aegis BMD 4.0.3, which has improved LRS&T capability, when the data are transmitted as per design.

7. Has partially addressed the third recommendation from FY14 to ensure that sufficient flight testing of the Aegis Afloat system is conducted to allow for VV&A of the modeling and simulation suite to cover the full design to Aegis BMD battlespace of threat ballistic missiles. Flight testing in FY15 and early FY16 provided additional VV&A data, but the BMDS Operational Test Agency has not accredited the high fidelity modeling and simulation suite for performance across the entire design battlespace.

8. Has partially addressed the fourth recommendation from FY14 to conduct sufficient ground and flight testing of the redesign of insulation components in the nozzle of the SM-3 Block IB TSRM after completion and installation of the new design concept to prove the new design works under the most stressing operational flight conditions, when it began ground testing the new TSRM nozzle design. Flight testing is planned in February 2016.

• FY15 Recommendations. The program should:

1. Use the industry-led FRB process to identify the root cause of the low cold gas pressure anomalies from recent lot acceptance testing of the SM-3 Block IB CGR, and determine the appropriate corrective actions needed to ensure proper functioning of that SM-3 component.

2. Conduct stressing simultaneous air and ballistic missile defense engagements with the Aegis Afloat system operating in Integrated Air and Missile Defense radar priority mode, with multiple ballistic missiles and anti-ship cruise missile threats being simultaneously engaged.

3. Perform high-fidelity modeling and simulation analysis over the expected Aegis Ashore engagement battlespace for EPAA Phase 2 to allow for a broad quantitative evaluation of engagement capability.[18]

For further discussion of Aegis BMD flight tests—including a May 2010 magazine article and supplementary white paper in which two professors with scientific backgrounds criticize DOD claims of successes in Aegis (and other DOD) BMD flight tests—see **Appendix A**.

Allied Participation and Interest in Aegis BMD Program

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

[18] Director, Operational Test and Evaluation, *FY 2015 Annual Report*, January 2016, pp. 363-366.

before falling into the Pacific.[19] In addition to cooperating with the United States on development of technologies for the SM-3 Block IIA missile, Japan is modifying all six of its Aegis destroyers with Aegis BMD system, and in November 2013 announced plans to procure two additional Aegis destroyers and equip them as well with the Aegis BMD system, which will produce an eventual Japanese force of eight BMD-capable Aegis destroyers. Japanese BMD-capable Aegis ships have conducted four flight tests of the Aegis BMD system using the SM-3 interceptor, achieving three successful exo-atmospheric intercepts.

Other Countries

Other countries that MDA views as potential naval BMD operators (using either the Aegis BMD system or some other system of their own design) include the United Kingdom, the Netherlands, Spain, Germany, Denmark, South Korea, and Australia. As mentioned earlier, Spain, South Korea, and Australia 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.

For additional background information on allied participation and interest in the Aegis BMD program, see **Appendix C**.

FY2017 MDA Funding Request

The Aegis BMD program is funded mostly through MDA's budget. The Navy's budget provides additional funding for BMD-related efforts. As shown in **Table 2**, MDA's proposed FY2017 budget requests a total of $1,774.8 million in procurement and research and development funding for Aegis BMD efforts, including funding for the two Aegis Ashore sites that are to be part of the EPAA, which is referred to in the table as funding for the land-based SM-3. MDA's budget also includes operations and maintenance (O&M) and military construction (MilCon) funding for the Aegis BMD program.

[19] 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*, coordinated by Emma Chanlett-Avery.

Table 2. MDA Funding for Aegis BMD Efforts, FY2016-FY2021

(In millions of dollars, rounded to nearest tenth; totals may not add due to rounding)

	FY16	FY17 (req.)	FY18 (proj.)	FY19 (proj.)	FY20 (proj.)	FY21 (proj.)
Procurement funding						
Aegis BMD (line 24)	566.7	463.8	727.3	962.4	1,079.9	1,221.1
Aegis Ashore Phase III (line 28)	30.6	57.5	69.9	0	0	0
Aegis BMD hardware and software (line 30)	145.3	50.1	139.5	93.2	122.0	86.0
SUBTOTAL Procurement	**742.6**	**571.4**	**936.7**	**1,055.6**	**1,201.9**	**1,307.1**
Aegis BMD (PE 0603892C) (line 79)	830.6	959.1	841.7	700.6	592.9	528.7
Aegis BMD Test (PE 0604878C) (line 107)	78.5	95.0	127.7	91.5	88.2	98.5
Land-based SM-3 (PE 0604880C) (line 109)	35.0	43.3	29.0	19.3	21.3	21.6
Aegis SM-3 IIA (PE 0604881C) (line 110)	172.6	106.0	0	0	0	0
SUBTOTAL RDT&E	**1,116.7**	**1,203.4**	**998.4**	**811.4**	**702.4**	**648.8**
TOTAL	**1,859.3**	**1,774.8**	**1,935.1**	**1,867.0**	**1,904.3**	**1,955.9**

Source: Table prepared by CRS based on FY2017 MDA budget submission.

Issues for Congress

Required vs. Available Numbers of BMD-Capable Aegis Ships

One potential issue for Congress concerns required numbers of BMD-capable Aegis ships vs. available numbers of BMD-capable Aegis ships. Some observers are concerned about the potential operational implications of a shortfall in the available number of BMD-capable relative to the required number. A March 13, 2015, Navy information paper states:

> The 2014 update to the 2012 [Navy] Force Structure Assessment sets the requirement at 40 advanced capable BMD (Baseline 9+) ships [i.e., ships equipped with the Baseline 9 version of the Aegis system, or later versions, and a BMD capability], as part of the 88 large surface combatant requirement [i.e., the Navy's requirement for the fleet to have a total of 88 cruisers and destroyers of all types], to meet Navy unique requirements to support defense of the sea base and limited expeditionary land base sites.
>
> The basic and intermediate capable BMD ships remaining in inventory will continue to contribute to the sourcing of Combatant Commander (CCDR) requests independent of the Navy unique requirement. This CCDR demand has increased from 44 in FY12-14 to 77 in FY16. Navy continues to be challenged to meet all CCDR demand for BMD ships, but will meet 100% of Secretary of Defense adjudicated requirements in FY16. To better meet CCDR demand and the Navy unique requirement, Navy is building advanced BMD capability in new construction ships and modernizing existing destroyers with advanced BMD capability....
>
> The minimum requirement for 40 advanced capable BMD ships is based on the Navy unique requirement as follows. It accepts risk in the sourcing of CCDR requests for defense of land.
>
> — 27 to meet CVN escort demand for rotational deployment of the carrier strike groups

— 9 in FDNF Japan to meet operational timelines in PACOM

— 4 in FDNF Europe for rotational deployment in EUCOM[20]

The issue of required numbers of BMD-capable Aegis ships vs. available numbers of BMD-capable Aegis ships was discussed at some length at a June 17, 2015, hearing on U.S. Navy surface combatant capacity before the Seapower and Projection Forces subcommittee of the House Armed Services Committee. At this hearing, the Navy witnesses stated in their prepared testimony that

> The 2014 update to the 2012 FSA resulted in a total requirement of 308 ships [of all types].... Of particular note, the combination of employment cycle changes, home porting of additional LSCs forward, shifting of the Ballistic Missile Defense (BMD) of land mission to ashore assets, and independent deployment of DDG 1000s results in no change to the LSC objective of 88 ships. However, the 2014 FSA update did provide the additional detail that 40 LSCs require advanced BMD capabilities to meet Navy-unique requirements to provide defense of the sea base and expeditionary land base sites, and 11 LSCs require the ability to support an embarked Air Defense Commander....
>
> Navy BMD continues to be in high demand, as COCOM demand has increased from 44 in FY 2012-2014 to 77 in FY 2016. As mentioned previously, the 2014 update to the 2012 Force Structure Assessment sets the requirement at 40 advanced capable BMD ships, as part of the 88 LSC requirement, to meet Navy unique requirements to support defense of the sea base and limited expeditionary land base sites. To better meet COCOM demand and the Navy unique requirement, Navy is building advanced BMD capability in new construction destroyers and modernizing existing destroyers with advanced BMD capability. The basic and intermediate capable BMD ships remaining in inventory will continue to contribute to the sourcing of COCOM requests independent of the Navy unique requirement. Navy continues to meet 100% of Secretary of Defense adjudicated requirements.[21]

During the discussion portion of the hearing, one of the Navy witnesses—Rear Admiral Peter Fanta, Deputy Chief of Naval Operations, Director, Surface Warfare Division—when asked about the situation, stated:

> My requirement at this point is 40 advanced capability ships that have the capability of both knocking down an incoming ballistic missile while simultaneously looking for and firing upon an incoming cruise missile that's at the surface of the ocean. So that is a minimum of 40 advanced capability ballistic missile ships.
>
> I have approximately 33 ballistic missile capable ships. That is not to say they are advanced to that level. And we will reach that in a current build rate of that 40 ships in approximately the mid-2020s at this point, of those advanced capability ships, sir.[22]

In a subsequent exchange, Fanta stated that

[20] Navy information paper dated March 13, 2015, entitled "BMD Capable Ships Requirement," posted April 14, 2015, at InsideDefense.com (subscription required). See also Lara Seligman, "Memo To Congress: Navy 'Challenged' To Meet Soaring Demand For Missile Defense," *InsideDefense.com Defense Alert*, April 14, 2015.

[21] Statement of Rear Admiral Victorino Mercado, Deputy Chief of Naval Operations, Director, Assessment Division, and Rear Admiral Peter Fanta, Deputy Chief of Naval Operations, Director, Surface Warfare Division, Before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Capacity of the U.S. Navy to Project Power With large Surface Combatants, June 17, 2015, pp. 2, 3.

[22] Spoken testimony of Rear Admiral Fanta, as reflected in transcript of hearing. See also Lara Seligman, "Surface Warfare Chief: Navy Won't Meed BMD Ship Requirement Until 2026," *Inside the Navy*, June 22, 2015.

> the advanced capability ships are primarily used to defend Navy assets in a high-end fight at sea against a near-peer competitor with advanced capabilities. BMD ships that I spoke of earlier that we have in the low 30s right now and continue to build more, are primarily for COCOM requests to defend other assets such as defended asset lists in various parts of the world.
>
> So they are perfectly capable of handling advanced threats, but just in that one BMD capability. What we don't want to do is mix the peacetime presence requirement of those—I won't call them lesser capable, but baseline capability ballistic missile ships with the advanced ones. I need to beat a high-end competitor at sea in the middle of a fight in the middle of the ocean.[23]

Potential Aegis Ashore Site in Hawaii

Another potential issue for Congress is whether the Aegis test facility in Hawaii should be converted into an operational Aegis Ashore site to provide additional BMD capability for defending Hawaii and the U.S. West Coast. It was reported in January 2016 that some DOD officials, including Admiral Harry Harris, commander of Pacific Command (PACOM), are interested in studying this option.[24]

Burden Sharing: U.S. vs. European Naval Contributions to European BMD

Another potential oversight issue for Congress concerns burden sharing—how European naval contributions to European BMD capabilities and operations compare to U.S. naval contributions to European BMD capabilities and operations, particularly in light of constraints on U.S. defense spending, worldwide operational demands for U.S. Navy Aegis ships, and calls by some U.S. and European observers (particularly after Russia's actions in March 2014 to gain control of Crimea) for increased defense efforts by NATO countries in Europe. Potential oversight issues for Congress include the following:

- How does the total value of European naval contributions to European BMD capabilities and operations compare to the total value of the U.S. naval contributions (including the Aegis Ashore sites) to European BMD capabilities and operations?
- Given constraints on U.S. defense spending, worldwide operational demands for U.S. Navy Aegis ships,[25] and calls by some U.S. and European observers for

[23] Spoken testimony of Rear Admiral Fanta, as reflected in transcript of hearing. See also Lance M. Bacon, Missile Defense Ships Face Arms Race, High Op Tempo," *Navy Times*, January 31, 2015; Megan Eckstein, "Stackley: Fleet Needs More BMD Ships to Meet Demand," *USNI News*, March 4, 2015; Megan Eckstein, "Navy Officials: Current BMD Strategy 'Unsustainable'; Greenert Asked Hagel for Review," *USNI News*, March 19, 2015; Lance M. Bacon, "BMD Mission Demands Outstrip Fleet's Capabilities," *Defense News*, April 13, 2015; Lara Seligman, "Navy Tells Congress It's Struggling To Meet Soaring Need For BMD Ships," *Inside the Navy*, April 17, 2015; Sydney J. Freedberg, Jr., "Aegis Ambivalence: Navy, Hill Grapple Over Missile Defense Mission," *Breaking Defense*, June 30, 2015; Sydney J. Freedberg, "Aegis Ashore: Navy Needs Relief From Land," *Breaking Defense*, July 2, 2015.

[24] See, for example, Andrea Shalal, "Exclusive: U.S. Weighs Making Hawaii Missile Test Site Operatioal—Sources," reuters, January 22, 2016; Wyatt Olson, "PACOM Commander Harris Supports Study of Aegis Missile Defense for Hawaii," *Stars and Stripes*, January 28, 2016; Michael Fabey, "Pacom Chief Eyes More Missile Defense In Asia-Pacific, *Aerospace Daily & Defense Report*, January 28, 2016: 3.

[25] See, for example, Lance M. Bacon, "Missile Defense Ships Face Arms Race, High Op Tempo," *Navy Times*, January 31, 2015.

increased defense efforts by NATO countries in Europe—as well as the potential for European countries to purchase or build BMD-capable Aegis ships, upgrade existing ships with BMD capabilities, or purchase Aegis ashore systems—should the United States seek increased investment by European countries in their regional BMD capabilities so as to reduce the need for assigning BMD-capable U.S. Navy Aegis ships to the EPAA? Why should European countries not pay a greater share of the cost of the EPAA, since the primary purpose of the EPAA is to defend Europe against theater-range missiles?

Target for Simulating Endo-Atmospheric Flight of DF-21 ASBM

Another potential oversight issue for Congress concerns the lack of a target for simulating the endo-atmospheric (i.e., final) phase of flight of China's DF-21 anti-ship ballistic missile. DOD's Director, Operational Test and Evaluation (DOT&E), in a December 2011 report (DOT&E's annual report for FY2011), stated:

> **Anti-Ship Ballistic Missile Target**
>
> A threat representative Anti-Ship Ballistic Missile (ASBM) target for operational open-air testing has become an immediate test resource need. China is fielding the DF-21D ASBM, which threatens U.S. and allied surface warships in the Western Pacific. While the Missile Defense Agency has exo-atmospheric targets in development, no program currently exists for an endo-atmospheric target. The endo-atmospheric ASBM target is the Navy's responsibility, but it is not currently budgeted. The Missile Defense Agency estimates the non-recurring expense to develop the exo-atmospheric target was $30 million with each target costing an additional $30 million; the endo-atmospheric target will be more expensive to produce according to missile defense analysts. Numerous Navy acquisition programs will require an ASBM surrogate in the coming years, although a limited number of targets (3-5) may be sufficient to validate analytical models.[26]

A February 28, 2012, press report stated:

> "Numerous programs will require" a test missile to stand in for the Chinese DF-21D, "including self-defense systems used on our carriers and larger amphibious ships to counter anti-ship ballistic missiles," [Michael Gilmore, the Pentagon's director of operational test and evaluation] said in an e-mailed statement....
>
> "No Navy target program exists that adequately represents an anti-ship ballistic missile's trajectory," Gilmore said in the e-mail. The Navy "has not budgeted for any study, development, acquisition or production" of a DF-21D target, he said.
>
> Lieutenant Alana Garas, a Navy spokeswoman, said in an e-mail that the service "acknowledges this is a valid concern and is assessing options to address it. We are unable to provide additional details."...
>
> Gilmore, the testing chief, said his office first warned the Navy and Pentagon officials in 2008 about the lack of an adequate target. The warnings continued through this year, when the testing office for the first time singled out the DF-21D in its annual public report....
>
> The Navy "can test some, but not necessarily all, potential means of negating anti-ship ballistic missiles," without a test target, Gilmore said.[27]

[26] Department of Defense, Director, Operational Test and Evaluation, *FY 2011 Annual Report*, December 2011, p. 294.

[27] Tony Capaccio, "Navy Lacks Targets To Test U.S. Defenses Against China Missile," *Bloomberg Government* (*bgov.com*), February 28, 2012.

The December 2012 report from DOT&E (i.e., DOT&E's annual report for FY2012) did not further discuss this issue; a January 21, 2013, press report stated that this is because the details of the issue are classified.[28]

Concurrency and Technical Risk in Aegis BMD Program

Another potential oversight issue for Congress is development-production concurrency and technical risk there is in the Aegis BMD program. Below are comments from Government Accountability Office (GAO) reports and a Missile Defense Executive Board report to Congress and on concurrency and technical risk in certain parts of Aegis BMD program.

Aegis System Modernized Software

An April 2014 GAO report on BMD programs stated the following regarding efforts to develop modernized software for the Aegis system:

> [A] Seventeen-month delay in associated development efforts by the Navy increased MDA program cost. To offset this increase, MDA reduced its engineering support which could affect its ability to resolve development challenges if significant issues arise prior to delivery.
>
> Discovery of software defects continues to outpace the program's ability to fix them; fixes may have to be implemented after software is delivered.[29]

SM-3 Block IB Missile

An April 28, 2016, GAO report on BMD testing stated:

> MDA continued to make progress towards achieving its individual elements' asset delivery goals in fiscal year 2015. For instance, Aegis BMD delivered Aegis Ashore in Romania and most planned SM-3 Block IB interceptors. GMD delivered all planned CE-II interceptors. THAAD, however, experienced setbacks in delivering interceptors, only delivering 3 out of 44, due to delays to address memory and shelf-life issues. Once corrections were made and testing was completed, deliveries resumed.
>
> MDA took actions to mitigate some acquisition risks in fiscal year 2015. Specifically, MDA delayed the production decision for the Aegis BMD SM-3 Block IB interceptor in order to conduct testing for a redesigned component. Further, it delayed the full-rate production decision until after these tests. MDA took these actions in response to our recommendation, which we made to strengthen and improve its Aegis BMD SM-3 acquisitions and outcomes. In addition, MDA successfully conducted an intercept flight test prior to restarting production of the GMD CE-II interceptors. Delaying production of the interceptors until after a successful test was a positive step, because it minimized the risk of having to recall interceptors to fix any issues identified during testing.
>
> However, MDA continues to use acquisition practices that put BMDS elements at risk for cost growth and performance shortfalls. In the past we have found that MDA has used some high risk acquisition approaches that do not build knowledge before program commitments and test before production is initiated. As an example, MDA awarded a production contract for the Aegis BMD SM-3 Block IB interceptors prior to finalizing the

[28] Christopher J. Castelli, "DOD Testing Chief Drops Public Discussion Of ASBM Target Shortfall," *Inside the Navy*, January 21, 2013.

[29] Government Accountability Office, *Missile Defense[:]Mixed Progress in Achieving Acquisition Goals and Improving Accountability*, GAO-14-351, April 2014, p. 14.

costs for a redesigned component and testing software and hardware upgrades. Consequently, costs could increase if additional design changes are needed after flight testing this component in fiscal year 2016.[30]

SM-3 Block IIA Missile

A July 2013 report to Congress by the Missile Defense Executive Board stated the following regarding concurrency in the SM-2 Block IIA missile:

> In 2010, MDA began an acquisition oversight process to establish SM-3 Block IIA and ABMD [Aegis BMD] 5.1 in the technology development phase and set initial technology acquisition baselines.
>
> The program office will complete development and initial testing of the SM-3 Block IIA using a structured systems engineering approach that aligns with MDA acquisition policy and processes. In February 2010, the SCD [SM-3 Block IIA Cooperative Development] Executive Steering Committee approved the SCD KP [Knowledge Point] plan. The 33 identified KPs define the critical knowledge required during development to ensure successful design and initial testing. The structured systems engineering and knowledge-based approach eliminates development concurrency for required capability delivery within planned cost and schedule. Additionally, the program office's progress towards mitigating concurrency is reviewed quarterly by the MDA Director during the SM-3 Block IIA BER [Baseline Execution Review].
>
> The program office has begun a robust development and test process using hardware; major test events and KPs precede major acquisition milestones. For example, the program office successfully demonstrated subsystem functional performance and completed subsystem preliminary design reviews (PDRs) for all critical SM-3 Block IIA subsystems (e.g., third stage rocket motor (TSRM), second stage rocket motor (SSRM), booster, nosecone, divert attitude control system (DACS), and the KW [kinetic warhead]) well in advance of the March 2012 system PDR. The subsystem reviews used data from computer in the loop (CIL) tests and data fro[m] hardware testing from two full-duration DACS valve hot-fire tests, three Japanese rocket motor firings, and Japanese nosecone separation testing.
>
> SM-3 Block IIA will continue this rigorous engineering review process focused on hardware performance to prepare and inform the move from the technology development phase to product development. The SCD critical design review (CDR) of the interface with the Aegis BMD 5.1 weapon system for organic operation will be complete before the full SM-3 Block IIA production development decision in the 2nd Quarter FY 2014. The SCD CDR will use data from both hardware in the loop (HIL) and CIL tests, and data from hardware tests like a restrained firing of the MK-72 booster, a propulsion test vehicle test, and hot-fire test events on the DACS, SSRN, and TSRM. The full system CRS (planned for 1st Quarter FY 2015) will incorporate results from the missile system CDRs, VLS CDRs, canister CDR, KPs, and testing, using organic ABMD 5.1 weapon and missile system interface.
>
> The rigorous engineering process will continue to inform decisions as SM-3 Block IIA moves from product development to the production phase. Performance data from HIL and CIL tests will be augmented with flight test data to support knowledge-based decisions. Initial flight tests will focus on validating propulsion system performance in flight using CTVs [control test vehicles]. Subsequent flight tests will demonstrate missile functionality and intercept capability, and prior to a full production decision, will

[30] Government Accountability Office, *Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities*, GAO-16-339R, April 28, 2016, pp. 5-6.

> culminate in an initial operational test and evaluation in accordance with title 10, U.S.C. Flight tests will be spaced from 1 year to 6 months so that lessons learned are incorporated into the design before the next test.[31]

An April 2013 GAO report stated the following regarding the SM-3 Block IIA missile:

> MDA has taken steps to reduce acquisition risk by decreasing the overlap between technology development and product development for two of its programs—the Aegis BMD SM-3 Block IIA and the [now-terminated] SM-3 Block IIB programs. Reconciling gaps between requirements and available resources before product development begins makes it more likely that a program will meet cost, schedule, and performance targets.
>
> • The Aegis BMD SM-3 Block IIA program added time and money to the program to extend development. Following significant technology development problems with four components, MDA delayed the system preliminary design review—during which a program demonstrates that the technologies and resources available are aligned with requirements—for more than 1 year, thereby reducing its acquisition risk. As a result, in March 2012, following additional development of the four components, the program was able to successfully complete the review.[32]

The April 2013 GAO report includes an appendix with additional in-depth discussion of concurrency and technical risk in the SM-3 Block IIA program.[33]

Aegis Ashore

An April 2014 GAO report on BMD programs states the following regarding the Aegis Ashore development effort:

> MDA plans to complete development of the first operational facility and award a contract to begin the second before flight testing demonstrates that the facility works with the Aegis modernized weapon system software and interceptors as intended.
>
> Flight test delays and cancellations, as well as challenges with development of the Aegis modernized weapon system software increase the risk of discovering performance issues that may require fixes after operational deployment.[34]

A July 2013 report to Congress by the Missile Defense Executive Board stated the following regarding concurrency in the SM-2 Block IB missile:

> The Aegis Ashore element is leveraging and reusing the development and design from several United States Navy programs with similar components. For example, the Aegis Ashore vertical launch system (VLS) is the same system previously procured for the cruiser and destroyer programs. The deckhouse design is similar to the destroyer configuration for the Aegis SPY radar arrays. The Aegis Ashore program office will also use a number of BMDS KPs [Knowledge Points] and flight tests, including an

[31] *Missile Defense Executive Board Report to Congress on Concurrency in Development of Ballistic Missile Defense System Capability*, July 2013, pp. 9-10. Posted online at InsideDefense.com (subscription required), September 27, 2013. The report was directed by page 82 of the House Armed Services Committee's report (H.Rept. 112-479 of May 11, 2012) on H.R. 4310, the FY2013 National Defense Authorization Act.

[32] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, p. 21.

[33] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, Appendix IV on pp. 70-72.

[34] Government Accountability Office, *Missile Defense[:]Mixed Progress in Achieving Acquisition Goals and Improving Accountability*, GAO-14-351, April 2014, p. 14.

> operational test at the Pacific Missile Range Facility, from other MDA elements to mitigate risk and inform major program decisions....
>
> In June 2010, through the MDA acquisition oversight process, Aegis Ashore was established in the product development phase and initial acquisition baselines were set. The current Aegis Ashore acquisition strategy has balanced development concurrency with flight tests, military construction and component procurement decisions. It has an appropriately aligned strategy with the necessary levels of testing, monitored by knowledge-based decision points. Aegis Ashore uses ongoing development from United State navy ASW [Aegis Weapon System] program. The AWS supporting Aegis Ashore is the same system supporting all Aegis shipbuilding programs (past and present). Before the first Aegis Ashore flight test, the SM-3 Block IB missile will have been tested several times with the AWS.
>
> Significant activities during the Aegis Ashore product development phase include integrating the MK41 VLS launcher. The VLS housing is a stell modular structure because there is no ship structure to surround the launcher. This structure design is new, but replicates what was field-tested with other variant of the [S]tandard [M]issile at the White Sands Missile Range, New Mexico. The program office does not expect Aegis Ashore flight-testing to affect the technical design of the MK 41 VLS or the VLS housing.
>
> The deckhouse contains the AWS and hosts the operators who execute the Aegis Ashore mission. This structure is new, not based on an existing design, yet replicates the height and spacing of the Aegis SPY radar arrays similar to a destroyer configuration. Flight-testing is not expected to affect the technical design of the deckhouse.
>
> Aegis Ashore testing includes both weapon system testing to verify performance as the deckhouse is built up, and flight tests to verify communication and controlled fly out of the SM-3 from the MK 41 LVS launcher and will conclude with an operational test at the Pacific Missile Range Facility. This test approach is the same process used in Navy ship construction shake-down trials and combat systems qualifications.
>
> Planning continues for the production of the next and final Aegis Ashore system (based on current requirements and funding). This last system will support EPAA Phase 3. MDA notified USD(AT&L) of their intent to use procurement appropriation funding for Navy program offices to acquire material for this system. The Aegis Ashore program office expects to procure long lead material in 1st Quarter FY 2014. Although the previous Aegis Ashore system will not be completely developed and constructed before the final system begins construction, the last Aegis Ashore system is also based on existing Navy programs and incorporate[s] updates from the previous developmental system. Ground and flight tests from the previous developmental system and other SM-3 flight tests are not expected to impact the design of the final Aegis Ashore system. Progress in maintaining mitigation of potential concurrency risks is reviewed quarterly by the MDA Director during the Aegis Ashore BER [Baseline Execution Review].[35]

An April 2013 GAO report stated the following regarding the Aegis Ashore program:

> The Aegis Ashore program, as we reported in April 2012, initiated product development and established cost, schedule, and performance baselines prior to completing the preliminary design review. Further, we reported that this sequencing increased technical risks and the possibility of cost growth by committing to product development with less

[35] *Missile Defense Executive Board Report to Congress on Concurrency in Development of Ballistic Missile Defense System Capability*, July 2013, pp. 3 and 10-11. Posted online at InsideDefense.com (subscription required), September 27, 2013. The report was directed by page 82 of the House Armed Services Committee's report (H.Rept. 112-479 of May 11, 2012) on H.R. 4310, the FY2013 National Defense Authorization Act.

> technical knowledge than recommended by acquisition best practices and without ensuring that requirements were defined, feasible, and achievable within cost and schedule constraints. In addition, the program committed to buy components necessary for manufacturing prior to conducting flight tests to confirm the system worked as intended. As a result, any design modifications identified through testing would need to be retrofitted to produced items at additional cost. However, the MDA Director stated in March 2012 that the Aegis Ashore development is low risk because of its similarity to the sea-based Aegis BMD.41 Nonetheless, this concurrent acquisition plan means that knowledge gained from flight tests cannot be used to guide the construction of Aegis Ashore installations or the procurement of components for operational use.[36]

The April 2013 GAO report also stated:

> As we reported in April 2012, the instability of content in the Aegis Ashore program's resource baseline obscures our assessment of the program's progress. MDA prematurely set the baseline before program requirements were understood and before the acquisition strategy was firm. The program established its baseline for product development for the Romania and Hawaii facilities in June 2010 with a total cost estimate of $813 million. However 3 days later, when the program submitted this baseline to Congress in the 2010 BAR [BMDS (ballistic missile defense system) Accountability Report], it increased the total cost estimate by 19 percent, to $966 million. Since that time, the program has added a significant amount of content to the resource baseline to respond to acquisition strategy changes and requirements that were added after the baseline was set. Because of these adjustments, from the time the total estimated cost for Aegis Ashore in Romania and Hawaii was first approved in June 2010 at $813 million, it has nearly doubled to its estimate of $1.6 billion reported in the February 2012 BAR. These major adjustments in program content made it impossible to understand annual or longer-term program progress.
>
> These adjustments also affected the schedule baseline for Aegis Ashore. For example, many new activities were added to the baseline in 2012. In addition, comparing the estimated dates for scheduled activities listed in the 2012 BAR to the dates baselined in the 2010 BAR is impossible in some cases because activities from the 2010 BAR were split into multiple events, renamed, or eliminated all together in the 2012 BAR. MDA also redistributed planned activities from the Aegis Ashore schedule baselines into several other Aegis BMD schedule baselines. For example, activities related to software for Aegis Ashore were moved from the Aegis Ashore baseline and were split up and added to two other baselines for the second generation and modernized Aegis weapon systems software. Rearranging content made tracking the progress of these activities against the prior year and original baseline very difficult and in some cases impossible. As a result, appendix III contains a limited schedule assessment of near-term and long-term progress based on activities we were able to track in the BAR.[37]

The April 2013 GAO report also stated:

> Developing and deploying new missile defense systems in Europe to aid in defense of Europe and the United States is a highly complex effort. We reported last year that several of the individual systems that comprise the current U.S. approach to missile defense in Europe—called the European Phased Adaptive Approach—have schedules that are highly concurrent. Concurrency entails proceeding into product development before technologies are mature or into production before a significant amount of

[36] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, pp. 24-25.

[37] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, pp. 33-34.

independent testing has confirmed that the product works as intended. Such schedules can lead to premature purchases of systems that impair operational readiness and may result in problems that require extensive retrofits, redesigns, and cost increases. A key challenge, therefore, facing DOD is managing individual system acquisitions to keep them synchronized with the planned time frames of the overall U.S. missile defense capability planned in Europe. MDA still needs to deliver some of the capability planned for the first phase of the U.S. missile defense in Europe and is grappling with delays to some systems and/or capabilities planned in each of the next three major deployments. MDA also is challenged by the need to develop the tools, the models and simulations, to understand the capabilities and limitations of the individual systems before they are deployed. Because of technical limitations in the current approach to modeling missile defense performance, MDA recently chose to undertake a major new effort that it expects will overcome these limitations. However, MDA and the warfighters will not benefit from this new approach until at least half of the four planned phases have deployed....

As we reported in December 2010, the U.S. missile defense approach in Europe commits MDA to delivering systems and associated capabilities on a schedule that requires concurrency among technology, design, testing, and other development activities. We reported in April 2012 that deployment dates were a key factor in the elevated levels of schedule concurrency for several programs. We also reported at that time that concurrent acquisition strategies can affect the operational readiness of our forces and risk delays and cost increases.

DOD declared Phase 1 operational in December 2011, but the systems delivered do not yet provide the full capability planned for the phase. MDA deployed, and the warfighter accepted, Phase 1 with the delivery of an AN/TPY-2 radar, an Aegis BMD ship with SM-3 Block IA missiles, an upgrade to C2BMC, and the existing space-based sensors. Given the limited time between the September 2009 announcement of the U.S. missile defense in Europe and the planned deployment of the first phase in 2011, that first phase was largely defined by existing systems that could be quickly deployed. MDA planned to deploy the first phase in two stages—the systems described above by December 2011 and upgrades to those systems in 2014. Although the agency originally planned to deliver the remaining capabilities of the first phase in 2014, an MDA official told us that MDA now considers these capabilities to be part of the second phase and these capabilities may not be available until 2015.

In addition, independent organizations determined that some of the capabilities that were delivered did not work as intended. For example, the Director, Operational Test and Evaluation reported that there were some interoperability and command and control deficiencies. This organization also reported that MDA is currently investigating these deficiencies.

According to MDA documentation, systems and associated capabilities for the next phases are facing delays, either in development or in integration and testing.

• For Phase 2, some capabilities, such as an Aegis weapon system software upgrade, may not be available. MDA officials stated they are working to resolve this issue.

• For Phase 3, some battle management and Aegis capabilities are currently projected to be delayed and the initial launch of a planned satellite sensor system—PTSS—is delayed.

• For [the now-terminated] Phase 4, deployment of the SM-3 Block IIB missile [was] delayed from 2020 to 2022, and full operational capability of PTSS [was] delayed to no sooner than 2023.[38]

[38] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, pp. 35 and 37-38.

The April 2013 GAO report includes an appendix with additional in-depth discussion of concurrency and technical risk in the Aegis Ashore program.[39]

Legislative Activity for FY2017

Summary of Action on FY2017 MDA Funding Request

Table 3 summarizes congressional action on the FY2016 request for MDA procurement and research and development funding for the Aegis BMD program.

Table 3. Summary of Congressional Action on FY2017 Request for MDA Procurement and RDT&E Funding for Aegis BMD Program

(In millions of dollars, rounded to nearest tenth; totals may not add due to rounding)

		Authorization			Appropriation		
	Request	HASC	SASC	Conf.	HAC	SAC	Conf.
Procurement							
Aegis BMD (line 24)	463.8	528.8	463.8		463.8	513.8	
Aegis Ashore Phase III (line 28)	57.5	82.5	57.5		57.5	57.5	
Aegis BMD hardware and software (line 30)	50.1	50.1	50.1		50.1	50.1	
Subtotal Procurement	**571.4**	**661.4**	**571.4**		**571.4**	**621.4**	
Research and Development							
Aegis BMD (PE 0603892C) (line 79)	959.1	959.1	959.1		929.1	924.1	
Aegis BMD Test (PE 0604878C) (line 107)	95.0	95.0	95.0		95.0	95.0	
Land-based SM-3 (PE0604880C) (line 109)	43.3	43.3	43.3		43.3	43.3	
Aegis SM-3 IIA (PE0604881C) (line 110)	106.0	106.0	106.0		106.0	106.0	
Subtotal RDT&E	**1,203.4**	**1,203.4**	**1,203.4**		**1,173.4**	**1,168.4**	
TOTAL	**1,774.8**	**1,864.8**	**1,774.8**		**1,744.8**	**1,789.8**	

Source: Table prepared by CRS based on DOD's FY2017 budget submission and committee and conference reports.

Notes: HASC is House Armed Services Committee; **SASC** is Senate Armed Services Committee; **HAC** is House Appropriations Committee; **SAC** is Senate Appropriations Committee; **Conf.** is conference agreement.

FY2017 National Defense Authorization Act (H.R. 4909/S. 2943)

House

The House Armed Services Committee, in its report (H.Rept. 114-537 of May 4, 2016) on H.R. 4909, recommended the funding levels shown in the HASC column of **Table 3**. The recommended increase of $60 million for Aegis BMD (line 24) is for "Increasing BMD capability

[39] Government Accountability Office, *Missile Defense[:] Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432, April 2013, Appendix III on pp. 60-69.

of Aegis ships." (Page 464) The recommended increase of $25 million for Aegis Ashore Phase III (line 28) is for "Classified adjustment." (Page 464)

Section 1654 of H.R. 4909 as reported states:

> SEC. 1654. Maximizing Aegis Ashore capability.
>
> (a) Anti-air warfare capability of Aegis Ashore sites.—
>
> (1) EVALUATION.—The Secretary of Defense shall conduct a complete evaluation of the optimal anti-air warfare capability—
>
> (A) for each current Aegis Ashore site by not later than 180 days after the date of the enactment of this Act; and
>
> (B) as part of any future deployment by the United States of an Aegis Ashore site after the date of such enactment.
>
> (2) ASSESSMENTS INCLUDED.—Each evaluation under paragraph (1) shall include an assessment of the potential deployment of enhanced sea sparrow missiles, standard missile block 2 missiles, standard missile block 6 missiles, or the SeaRAM missile system.
>
> (3) CONSISTENCY WITH ANNEX.—The Secretary shall carry out this subsection consistent with any classified annex accompanying this Act.
>
> (b) Aegis Ashore capability evaluation.—Not later than 120 days after the date of the enactment of this Act, the Secretary of Defense and the Chairman of the Joint Chiefs of Staff shall jointly submit to the congressional defense committees an evaluation of each of the following:
>
> (1) The ballistic missile and air threat against the continental United States and the efficacy (including with respect to cost, ideal and optimal deployment locations, and potential deployment schedule) of deploying one or more Aegis Ashore sites and Aegis Ashore components for the ballistic and cruise missile defense of the continental United States.
>
> (2) The ballistic missile and air threat against the Armed Forces on Guam and the efficacy (including with respect to cost and schedule) of deploying an Aegis Ashore site on Guam.
>
> (c) Aegis ashore site on the Pacific Missile Range Facility.—
>
> (1) LIMITATION.—The Secretary of Defense may not reduce the manning levels or test capability, as such levels and capability existed on January 1, 2015, of the Aegis Ashore site at the Pacific Missile Range Facility in Hawaii, including by putting such site into a "cold" or "stand by" status.
>
> (2) ENVIRONMENTAL IMPACT STATEMENT.—
>
> (A) Not later than 60 days after the date on which the Director of the Missile Defense Agency submits to the congressional defense committees the report under section 1689(b)(2) of the National Defense Authorization Act for Fiscal Year 2016 (Public Law 114–92; 129 Stat. 1144), the Director shall notify such committees on whether the preferred alternative for fielding a medium range ballistic missile defense sensor for the defense of Hawaii identified by such report would require an update to the environmental impact statement required for constructing the Aegis Ashore site at the Pacific Missile Range Facility.
>
> (B) If the Director determines that an updated environmental impact statement, a new environmental impact statement, or another action is required or recommended pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. et seq.), the Director shall

commence such action by not later than 60 days after the date on which the Director makes the notification under subparagraph (A).

(3) EVALUATION.—Not later than 60 days after the date of the enactment of this Act, the Secretary of Defense and the Chairman of the Joint Chiefs of Staff shall jointly submit to the congressional defense committees an evaluation of the ballistic missile and air threat against Hawaii (including with respect to threats to the Armed Forces and installations located in Hawaii) and the efficacy (including with respect to cost and potential alternatives) of—

(A) making the Aegis Ashore site at the Pacific Missile Range Facility operational;

(B) deploying the preferred alternative for fielding a medium range ballistic missile defense sensor for the defense of Hawaii described in paragraph (2)(A); and

(C) any other alternative the Secretary and the Chairman determine appropriate.

(d) Forms.—The evaluations submitted under subsections (b) and (c)(3) shall each be submitted in unclassified form, but may each include a classified annex.

Regarding Section 1654, H.Rept. 114-537 states:

Section 1654—Maximizing Aegis Ashore Capability

This section would require the Secretary of Defense to conduct an evaluation of the optimal anti-air warfare capability for each current Aegis Ashore Site by not later than 180 days after the date of the enactment of this Act. This section would also require that such evaluation is a part of the future deployment of an Aegis Ashore site. The assessment of Aegis Ashore anti-air warfare capability would include use of enhanced sea-sparrow missiles, standard missile block 2 missiles, standard missile block 6 missiles, or the SeaRAM missile system. The Secretary of Defense would be required to carry out this subsection consistent with the classified annex accompanying this Act.

The Secretary of Defense and the Chairman of the Joint Chiefs of Staff would also be required to submit to the congressional defense committees not later than 120 days after the date of enactment of this Act an evaluation to include:

(1) The ballistic missile and air threat against the continental United States and the efficacy of deploying one or more Aegis Ashore sites and Aegis Ashore components for the ballistic and cruise missile defense of the continental United States; and

(2) The ballistic missile and air threat against Guam, and the cost and efficacy of deploying Aegis Ashore there.

Regarding the Aegis Ashore site on the Pacific Missile Range Facility (PMRF) in Hawaii, this section would restrict the Secretary from reducing the manning levels or test capability of that site as they were on January 1, 2015, or to put the site into a "cold" or "stand by" status. This section would also require the Director of the Missile Defense Agency to notify the congressional defense committees if the preferred alternative for fielding a medium-range ballistic missile defense sensor for the defense of Hawaii, identified through the study conducted by the Director pursuant to section 1689(b)(2) of the National Defense Authorization Act for Fiscal Year 2016 (Public Law 114–92), would require any study or assessment pursuant to the National Environmental Policy Act of 1969 (Public Law 91–190). The Director would be required to initiate that study or analysis not later than 60 days after his notification.

Lastly, this section would also require the Secretary and the Chairman to jointly submit to the congressional defense committees not later than 60 days after the enactment of this Act an evaluation of the ballistic and air threat to Hawaii; the efficacy (including with respect to cost and potential alternatives) of making the Aegis Ashore site at PMRF operational; deploying the preferred alternative for fielding a medium-range ballistic

missile defense sensor for the defense of Hawaii; and any other alternative the Secretary and Chairman determine appropriate. (Pages 330-331)

Section 1663 of H.R. 4909 as reported states:

SEC. 1663. Procurement of medium-range discrimination radar to improve homeland missile defense.

(a) The Director of the Missile Defense Agency shall issue a request for proposals for such radar by not later than October 1, 2017.

(b) The Director shall plan to procure a medium-range discrimination radar or equivalent sensor for a location the Director determines will improve homeland missile defense for the defense of Hawaii from the limited ballistic missile threat (including accidental or unauthorized launch) and plan for such radar to be fielded by not later than December 31, 2021.

Regarding Section 1663, H.Rept. 114-537 states:

Section 1663—Procurement of Medium-Range Discrimination Radar To Improve Homeland Missile Defense

This section would require the Director of the Missile Defense Agency to issue a request for proposals for a medium-range discrimination radar by not later than October 1, 2017. This section would also require the Director to plan to procure a medium-range discrimination radar or equivalent sensor to improve the ballistic missile defense of Hawaii. (Pages 334-335)

Section 1666 of H.R. 4909 as reported states:

SEC. 1666. Sense of Congress on initial operating capability of phase 2 of European Phased Adaptive Approach to missile defense.

(a) Findings.—Congress finds the following:

(1) President Obama, during his announcement of the European Phased Adaptive Approach on September 17, 2009, stated, "This approach is based on an assessment of the Iranian missile threat," and "the best way to responsibly advance our security and the security of our allies is to deploy a missile defense system that best responds to the threats we face and that utilizes technology that is both proven and cost-effective.".

(2) The 2010 Ballistic Missile Defense review stated that "The [European] Phased Adaptive Approach utilizes existing and proven capabilities to meet current threats and then will improve upon these capabilities over time by integrating new technology.".

(3) Secretary of Defense Leon Panetta, during a speech in Brussels on October 5, 2011, stated, "The United States is fully committed to building a missile defense capability for the full coverage and protection of all our NATO European populations, their territory and their forces against the growing threat posed by ballistic missiles.".

(4) Secretary of Defense Chuck Hagel, during a press conference on March 15, 2013, stated, "The missile deployments the United States is making in phases one through three of the European Phased Adaptive Approach, including sites in Romania and Poland, will still be able to provide coverage of all European NATO territory as planned by 2018.".

(b) Sense of Congress.—It is the sense of Congress that—

(1) the United States is committed to the defense of deployed members of the Armed Forces of the United States and to the defense of the European allies of the Unites States by increasing the ballistic missile defense capability of the North Atlantic Treaty Organization (in this section referred to as "NATO");

> (2) phase 2 of the European Phased Adaptive Approach will provide NATO with a substantial increase in ballistic missile defense capability since NATO declared Interim Ballistic Missile Defense Capability at the Chicago Summit in 2012, and such phase consists of—
>
> (A) Aegis Ashore in Romania;
>
> (B) four Aegis ballistic missile defense capable ships homeported at Rota, Spain; and
>
> (C) a more capable SM–3 interceptor;
>
> (3) NATO is moving forward with the modernization of the defense capabilities of NATO that is responsive to 21st century threats to the territory and populations of member states of NATO;
>
> (4) the member states of NATO recognize the importance of this contribution, which sends a clear signal that NATO will not allow potential adversaries to threaten the use of ballistic missile strikes to coerce NATO or deter NATO from responding to aggression against the interests of NATO; and
>
> (5) phase 2 of the European Phased Adaptive Approach is ready for 24-hour-a-day, seven-day-a-week operation, with proven military systems and command and control capability, and should be so declared at the July 2016 NATO Summit in Warsaw, Poland.

A May 16, 2016, statement of Administration policy regarding H.R. 4909 as reported states that

> the Administration objects to section 1663, which would direct the Director of the Missile Defense Agency (MDA) to issue a request for proposal to procure a medium-range discrimination radar or equivalent sensor for the defense of Hawaii. DOD is conducting a study to determine the appropriate balance of sensors and locations to best defend the homeland, including Hawaii; it will be completed in the fourth quarter of FY 2016. Section 1663 could limit the Administration's ability to defend the entire homeland and the flexibility to apply the best capabilities to address rapidly evolving threats.[40]

Senate

The Senate Armed Services Committee, in its report (S.Rept. 114-255 of May 18, 2016) on S. 2943, recommended the funding levels shown in the SASC column of **Table 3**.

Section 1011 of S. 2943 as reported states (see parts in bold):

> SEC. 1011. Availability of funds for retirement or inactivation of cruisers or dock landing ships.
>
> (a) Limitation on availability of funds.—Except as provided in subsections (b) through (g), none of the funds authorized to be appropriated by this Act or otherwise made available for fiscal year 2017 may be obligated or expended to retire, prepare to retire, or inactivate a TICONDEROGA–class cruiser, WHIDBEY ISLAND–class dock landing ship, or HARPERS FERRY–class dock landing ship.
>
> **(b) Certification of requirement for operational cruisers and dock landing ships.—The Chief of Naval Operations shall certify to the congressional defense committees the Navy requirement for operational cruisers and dock landing ships, as provided under subsection (d)(1), from fiscal year 2017 through fiscal year 2030. The certification shall also state the requirement for basic (BMD 3.X), intermediate**

[40] Executive Office of the President, *Statement of Administration Policy*, H.R. 4909—*National Defense Authorization Act for Fiscal Year 2017*, May 16, 2016, p. 8.

(BMD 4.X), and advanced (BMD 5.X) ballistic missile defense capability on operational cruisers from fiscal year 2017 through fiscal year 2030.

(c) Ship modernization, operations, and sustainment fund (smosf).—Funds within the Ship Modernization, Operations, and Sustainment Fund (SMOSF) shall only be used for 11 TICONDEROGA-class cruisers (CG–63 through CG–73) and 3 WHIDBEY ISLAND-class dock landing ships (LSD–41, LSD–42, and LSD–46).

(d) Phased modernization.—The Secretary of the Navy shall retain the current inventory of 22 TICONDEROGA-class cruisers and 12 WHIDBEY ISLAND- or HARPERS FERRY-class dock landing ships until the end of their service lives, as follows:

(1) OPERATIONAL FORCES.—Through fiscal year 2030, the Navy shall maintain not less than the Chief of Naval Operations' requirement for operational cruisers certified under subsection (b) or 11 operational cruisers, whichever is greater. The Navy shall maintain no less than the Chief of Naval Operations' requirement for dock landing ships certified under subsection (b) or 9 operational dock landing ships, whichever is greater.

(2) PHASED MODERNIZATION.—The Navy is authorized to conduct phased modernization of not more than 11 cruisers and 3 dock landing ships. During the phased modernization period, the Navy may reduce manning on these ships to the minimal level necessary to ensure safety and security of the ship and to retain critical skills. Only the ships listed in subsection (c) may undergo phased modernization. Ships undergoing phased modernization shall comply with subsection (e).

(3) TRANSITION FROM PHASED MODERNIZATION TO OPERATIONAL FORCES.—Each of the cruisers described under paragraph (1) may be decommissioned at the end of its service life concurrent with being replaced by a cruiser that completes phased modernization pursuant to paragraph (2). After being reintroduced into the operational fleet, each of the cruisers modernized pursuant to paragraph (2) may be decommissioned upon reaching its expected service life.

(4) AVAILABILITY FOR WORLDWIDE DEPLOYMENT.—For purposes of this subsection, an operational cruiser or dock landing ship is available for worldwide deployment other than during routine or scheduled maintenance or repair.

(e) Requirements and limitations on phased modernization.—

(1) IN GENERAL.—During the period of phased modernization authorized under subsection (d), the Secretary of the Navy shall—

(A) continue to maintain the ships in a manner that will ensure the ability of the ships to re-enter the operational fleet in accordance with paragraph (3) of such subsection;

(B) conduct planning activities to ensure scheduled and deferred maintenance and modernization work items are identified and included in maintenance availability work packages;

(C) conduct hull, mechanical, and electrical (HM&E) and combat system modernization necessary to achieve a service life of 40 years;

(D) conduct basic (BMD 3.X), intermediate (BMD 4.X), and advanced (BMD 5.X) ballistic missile defense capability upgrades to meet or exceed the Chief of Naval Operations' requirement certified under subsection (b); and

(E) complete maintenance and modernization of the cruisers, including required testing and crew training, to allow for a one-for-one replacement of operational cruisers in accordance with subsection (d)(3).

(2) RESTRICTED ACTIVITIES.—During the period of phased modernization authorized under subsection (d), the Secretary of the Navy may not—

(A) permit removal or cannibalization of equipment or systems, unless planned for full replacement or upgrade during phased modernization, other than equipment or systems explicitly identified as—

(i) rotatable pool equipment; or

(ii) necessary to support urgent operational requirements approved by the Secretary of Defense;

(B) make any irreversible modifications that will prohibit the ship from re-entering the operational fleet;

(C) through fiscal year 2030, reduce the quantity of operational cruisers below the number certified to be required by the Chief of Naval Operations under subsection (b) or 11 operational cruisers, whichever is greater;

(D) through fiscal year 2030, reduce the quantity of operational dock landing ships below the number certified to be required by the Chief of Naval Operations under subsection (b) or 9 operational dock landing ships, whichever is greater; and

(E) through fiscal year 2030, reduce the basic, intermediate, or advanced ballistic missile defense capability on operational cruisers below the quantities certified to be required by the Chief of Naval Operations under subsection (b).

(f) Report required.—The Secretary of the Navy shall submit to the congressional defense committees an annual report on the status of the phased modernization program. This report shall accompany the budget of the President submitted to Congress under section 1105(a) of title 31, United States Code. The report shall include, with respect to the ships undergoing phased modernization pursuant to subsection (d)(2), the following information:

(1) The status of modernization efforts, by vessel, including availability schedules, equipment procurement schedules, and annual funding requirements from the fiscal year of induction into the phased modernization program through the fiscal year of planned re-entry into the operational fleet.

(2) Each vessel's current readiness, operational, and manning status.

(3) An assessment of each vessel's current materiel condition.

(4) A list of rotatable pool equipment that is identified across the classes of cruisers and dock landing ships as necessary to support operations on a continuing basis.

(5) A list of equipment, other than rotatable pool equipment, removed from each vessel, including a justification for the removal, the disposition of the equipment, and plan for restoration of the equipment.

(6) A list of planned obligations and expenditures, by vessel, for the fiscal year of the budget of the President submitted to Congress.

(g) Notification required.—The Secretary of the Navy shall notify the congressional defense committees in writing 30 days prior to executing any deviations to the plans provided pursuant to paragraphs (1) and (6) of subsection (f) of the most recent report required under such subsection.

Regarding Section 1011, S.Rept. 114-255 states:

Availability of funds for retirement or inactivation of cruisers or dock landing ships (sec. 1011)

The committee recommends a provision that would prohibit fiscal year 2017 funds from being used to retire, prepare to retire, or inactivate a Ticonderoga-class cruiser, Whidbey

Island-class dock landing ship, or Harpers Ferry-class dock landing ship, unless prescribed criteria are met.

First, the Chief of Naval Operations would be required to certify to the congressional defense committees the requirement for operational cruisers, dock landing ships, and ballistic missile defense-capable cruisers from fiscal year 2017 through 2030.

Second, funds within the Ship Modernization, Operations, and Sustainment Fund (SMOSF) could only be used for 11 Ticonderoga-class cruisers (CG–63 through CG–73) and 3 Whidbey Island-class dock landing ships (LSD–41, LSD–42, and LSD–46).

Third, the Secretary of the Navy would be required to retain the current inventory of 22 cruisers and 12 dock landing ships until the end of their service lives with the following restrictions. Through fiscal year 2030, the Navy would be required to maintain not less than the Chief of Naval Operations' requirement for operational cruisers or 11 operational cruisers, whichever is greater. The Navy would be required to maintain no less than the Chief of Naval Operations' requirement for dock landing ships or 9 operational dock landing ships, whichever is greater. The Navy would be authorized to conduct phased modernization of not more than 11 cruisers and 3 dock landing ships.

Fourth, the Secretary of the Navy would be required to adhere to five requirements and five restrictions during the phased modernization period.

Fifth, the Secretary of the Navy would be required to submit an annual report with the President's budget on the status of the phased modernization program.

Sixth, the Secretary of the Navy would be required to notify the congressional defense committees in writing 30 days prior to executing any deviations to the plans provided in the most recent annual report.

The committee does not support a smaller fleet and notes the Navy stands at 272 ships this year, far below the 308 ship requirement. However, the committee does recognize the fiscal pressure the Navy is under to maintain the readiness of the current force while continuing to modernize for future threats, including the requirement to procure the Ohio-class replacement submarine program. The committee also notes the Navy has fully funded this budget request's phased modernization plan, unlike past budget submissions. The committee would not be supportive of any effort to decommission any cruiser or dock landing ship earlier than provided for in this provision and views this provision as necessary to ensure the ships that enter phased modernization are returned to service. (Pages 264-265)

FY2017 DOD Appropriations Act (H.R. 5293/S. 3000)

House

The House Appropriations Committee, in its report (H.Rept. 114-577 of May 19, 2016) on H.R. 5293, recommended the funding levels shown in the HAC column of **Table 3**. The recommended reduction of $30 million for Aegis BMD (PE 0603892C) (line 79) is for "Aegis BMD 6.x development excess growth" ($10 million) and "SM-3 IIA development excess growth" ($20 million). (Page 261)

H.Rept. 114-577 states:

SM–3 BLOCK IB AND IIA INVENTORIES

The Committee is concerned by the continual erosion in quantities programmed across the future years defense program for SM–3 Block IB and SM–3 Block IIA production. After the fiscal year 2015 and 2016 budgets substantially reduced the quantity of SM–3 Block IB interceptors requested, Congress added more than $340,000,000 to add back 31

> interceptors to the production line to maintain an economically efficient production rate. The lack of an inventory objective for this critical missile defense system makes it particularly challenging for the congressional defense committees to assess annual progress towards meeting warfighter requirements. The Committee directs the Director of the Missile Defense Agency, in coordination with the Secretary of the Navy, to establish and report the inventory objective required to satisfy warfighter requirements for the SM–3 Block IB and Block IIA missile as part of the fiscal year 2018 and subsequent budget requests. (Page 198)

Senate

The Senate Appropriations Committee, in its report (S.Rept. 114-263 of May 26, 2016) on S. 3000, recommended the funding levels shown in the SAC column of **Table 3**. The recommended increase of $50 million for Aegis BMD (line 24) is for "Program increase: Obsolescence upgrades." (Page 135) The recommended reduction of $35 million for Aegis BMD (PE 0603892C) (line 79) includes a reduction of $10 million for "Restoring acquisition accountability: SM–3 Block IIA FTM–29 flight test integration not required due to program delays," and a reduction of $25 million for "Maintain program affordability: SM–3 Block IIA excess cost growth." (Page 179)

S.Rept. 114-263 states:

> *SM–3 Block IIA Interceptor*.—The fiscal year 2017 President's budget request includes $254,700,000 for the continued manufacturing of seventeen SM–3 Block IIA interceptors as well as $213,300,000 for continued SM–3 Block IIA development and $106,038,000 for SM–3 Block IIA co-development with the Government of Japan. The Committee notes that since the previous budget request, programmed costs for manufacturing of the initial SM–3 Block IIA interceptors have increased 40 percent and costs for SM–3 Block IIA development have increased 29 percent. Further, delivery of SM–3 Block IIA interceptors has been delayed by over three fiscal quarters, resulting in at least one missed flight test.
>
> As previously stated in Senate Report 114–63 and in Senate Report 113–211, the Committee has grave reservations with MDA's acquisition approach for SM–3 Block IIA interceptors and its inability to control costs for this program, which are in direct contradiction to MDA's stated goals of "getting ahead of the cost curve," as the Director, MDA testified before the Committee. The Committee recognizes the importance of the SM–3 Block IIA to the European Phased Adaptive Approach and continues to support the program; however, the Committee believes that greater acquisition rigor is required to contain program costs and manage the industrial base, which produces the SM–3 Block IIA interceptor concurrently with the SM–3 Block IB interceptor. Therefore, the Committee directs the Director, Missile Defense Agency, in coordination with the Assistant Secretary of the Navy (Research, Development and Acquisition), to provide with the fiscal year 2018 President's budget request an acquisition objective for the SM–3 Block IB and Block IIA programs, as well as a report on steps taken by MDA and the Department of the Navy to control costs while improving program performance. (Page 186)

Appendix A. Aegis BMD Flight Tests

Summary of Test Flights

Table A-1 presents a DOD summary of Aegis BMD flight tests since January 2002. As shown in the table, DOD states that since January 2002, the Aegis BMD system has achieved 28 successful exo-atmospheric intercepts in 35 attempts using the SM-3 missile (including 3 successful intercepts in 4 attempts by Japanese Aegis ships, and one successful intercept in one attempt using the Aegis Ashore system), and 5 successful endo-atmospheric intercepts in 5 attempts using the SM-2 Block IV missile and the SM-6 Dual I missile, making for a combined total of 33 successful intercepts in 40 attempts.

In addition, on February 20, 2008, a BMD-capable Aegis cruiser operating northwest of Hawaii used a modified version of the Aegis BMD system to shoot down an inoperable U.S. surveillance satellite that was in a deteriorating orbit. Including this intercept in the count increases the totals to 29 successful exo-atmospheric intercepts in 36 attempts using the SM-3 missile, and 34 successful exo- and endo-atmospheric intercepts in 41 attempts using both SM-3 and SM-2 Block IV missiles.

Table A-1. Aegis BMD Flight Tests From January 2002 to the Present

Date	Country	Name of flight test	Ballistic Missile Target	Successful?	Cumulative successes	Cumulative attempts
Exo-atmospheric (using SM-3 missile)						
1/25/02	US	FM-2	Unitary TTV short-range target	Yes	1	1
6/13/02	US	FM-3	Unitary TTV short-range target	Yes	2	2
11/21/02	US	FM-4	Unitary TTV short-range target	Yes	3	3
6/18/03	US	FM-5	Unitary TTV short-range target	**No**	3	4
12/11/03	US	FM-6	Unitary TTV medium-range target	Yes	4	5
2/24/05	US	FTM 04-1 (FM-7)	Unitary TTV short-range target	Yes	5	6
11/17/05	US	FTM 04-2 (FM-8)	Separating medium-range target	Yes	6	7
6/22/06	US	FTM 10	Separating medium-range target	Yes	7	8
12/7/06	US	FTM 11	Unitary TTV short-range target	**No**	7	9
4/26/07	US	FTM 11 Event 4	Unitary ARAV-A short-range target	Yes	8	10
6/22/07	US	FTM 12	Separating medium-range target	Yes	9	11
8/31/07	US	FTM-11a	Classified	Yes	10	12
11/6/07	US	FTM 13	Unitary ARAV-A short-range target	Yes	11	13
			Unitary ARAV-A short-range target	Yes	12	14
12/17/07	Japan	JFTM-1	Separating medium-range target	Yes	13	15
11/1/08	US	Pacific Blitz	Short-range target	Yes	14	16
			Short-range target	**No**	14	17
11/19/08	Japan	JFTM-2	Separating medium-range target	**No**	14	18
7/30/09	US	FTM-17	Unitary ARAV-A short-range target	Yes	15	19
10/27/09	Japan	JFTM-3	Separating medium-range target	Yes	16	20
10/28/10	Japan	JFTM-4	Separating medium-range target	Yes	17	21
4/14/11	US	FTM-15	LV-2 intermediate range target	Yes	18	22
9/1/11	US	FTM-16	Short-range target	**No**	18	23
5/9/12	US	FTM-16 E2a	Unitary ARAV-A short-range target	Yes	19	24
6/26/12	US	FTM-18	Separating medium-range target	Yes	20	25
10/25/12	US	FTI-01	Short-range target	**No**	20	26
2/12/13	US	FTM-20	Unitary medium-range target	Yes	21	27
5/15/13	US	FTM-19	Separating short-range target	Yes	22	28
9/10/13	US	FTO-01	Medium-range target	Yes	23	29
9/18/13	US	FTM-21	Complex separating short-range target	Yes	24	30
10/3/13	US	FTM-22	Medium-range target	Yes	25	31
11/6/14	US	FTM-25	Short-range target	Yes	26	32
6/25/15	US	FTO-02 E1	Medium-range target	n/a[a]	26	32
10/4/15	US	FTO-02 E2	Separating medium-range target	n/a b	26	32
10/20/15	US	ASD-15 E2	Separating short-range target	Yes	27	33
11/1/15	US	FTO-02 E2a	Separating medium-range target	No	27	34
12/9/15	US	FTO02 E1a	Medium-range target	Yes	28	35
	(Aegis Ashore)					
Endo-atmospheric (using SM-2 missile Block IV missile and [for MMW Event 1] SM-6 Dual 1 missile)						
5/24/06	US	Pacific Pheonix	Unitary short-range target	Yes	1	1
6/5/08	US	FTM-14	Unitary short-range target	Yes	2	2
3/26/09	US	Stellar Daggers	Short-range target	Yes	3	3
7/28/15	US	MMW Event 1	Short-range target	Yes	4	4
7/29/15	US	MMW Event 2	Short-range target	Yes	5	5
Combined total for exo- and endo-atmospheric above tests					33	40

Source: Table adapted from table presented in MDA fact sheet, "Aegis Ballistic Missile Defense Testing," accessed on November 10, 2015, at http://www.mda.mil/global/documents/pdf/aegis_tests.pdf.

Notes: TTV is target test vehicle; **ARAV** is Aegis Readiness Assessment Vehicle. In addition to the flight tests shown above, there was a successful use of an SM-3 on February 20, 2008, to intercept an inoperative U.S. satellite—an operation called Burnt Frost. Including this intercept in the count increases the totals to 29 successful exo-atmospheric intercepts in 36 attempts using the SM-3 missile, and 34 successful exo- and endo-atmospheric intercepts in 41 attempts using both SM-3 and SM-2 Block IV missiles.

a. MDA's table shows this as a test that did not result in the launch of an SM-3. MDA as of August 3, 2015, had not issued a news release discussing this event. MDA's count of 31 successful intercepts in 37 launches through July 29, 2015, does not appear to include this test, suggesting that this was considered a "no test" event—a test in which there was a failure that was not related to the Aegis BMD system or the SM-3 interceptor. News reports state that the test was aborted due to a failure of the target missile. (Andrea Shalal, "U.S. Skips Aegis Ashore Missile Test After Target Malfunction," *Reuters*, June 26, 2015.) MDA's table similarly shows the test of December 7, 2006, as a test that did not result in the launch of an SM-3. MDA issued a news release on this test, which stated that an SM-3 was not launched "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 [SM-3] 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." MDA counts the test of December 7, 2006, as an unsuccessful intercept in its count of 31 successful intercepts in 37 launches through July 29, 2015.

b. MDA's table shows this as a test that did not result in the launch of an SM-3. MDA as of November 10, 2015, had not issued a news release discussing this event. MDA's count of 32 successful intercepts in 39 launches through November 1, 2015, does not appear to include this test, suggesting that this was considered a "no test" event—a test in which there was a failure that was not related to the Aegis BMD system or the SM-3 interceptor.

May 2010 Criticism of Claimed Successes in Flight Tests

In a May 2010 magazine article and supplementary white paper, two professors with scientific backgrounds—George Lewis and Theodore Postol—criticized DOD claims of successes in Aegis (and other DOD) BMD flight tests, arguing that

> the Defense Department's own test data show that, in combat, the vast majority of "successful" SM-3 experiments would have failed to destroy attacking warheads. The data also show potential adversaries how to defeat both the SM-3 and the GMD [ground-based missile defense] systems, which share the same serious flaws that can be readily exploited by adversaries.[41]

[41] George N. Lewis and Theodore A. Postol, "A Flawed and Dangerous U.S. Missile Defense Plan," *Arms Control Today*, May 2010: 24-32. The quoted passage appears on p. 26. The associated white paper is George N. Lewis and Theodore A. Postol, *A Technically Detailed Description of Flaws in the SM-3 and GMD Missile Defense Systems Revealed by the Defense Department's Ballistic Missile Test Data*, May 3, 2010, 13 pp.

The criticisms made by Lewis and Postol were reported in a May 18, 2010, *New York Times* article.[42] In response to the criticisms and the *New York Times* article, MDA issued a press release and other information defending the flight tests and arguing that the criticisms are based on inaccurate or incomplete information.[43]

Details on Selected Exo-Atmospheric (SM-3) Flight Tests Since June 2006

June 22, 2006, Test. This was the first test to use the 3.6 version of the Aegis BMD system.[44]

December 7, 2006, Test. This was the first unsuccessful flight test since June 2003. MDA stated 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.[45]

A news article about the ninth 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

[42] William J. Broad and David E. Sanger, "Review Cites Flaws In U.S. Antimissile Program," *New York Times*, May 18, 2010: 1.

[43] Missile Defense Agency news release entitled "Missile Defense Agency Responds to New York Times Article," 10-News-0005, May 18, 2010; Missile Defense Agency, *Missile Defense Agency Response to Request for Information, Standard Missile – 3 Interceptor Testing*, May 18, 2010, 2 pp.; Missile Defense Agency, *Missile Defense Agency Response to Request for Information, Response to New York Times May 18, 2010, Article Regarding SM-3 Testing*, May 18, 2010, 3 pp.; Richard Lehner, "Missile Defense Agernecy Responds to New York Times Article*," DOD Live* (http://www.dodlive.mil), May 18, 2010; Transcript of Department of Defense Bloggers Roundtable With Richard Lehner, Spokesman, Missile Defense Agency (MDA), Subject: Standard Missile 3 Test Program, May 18, 2010.

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

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

> 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.[46]

A subsequent news article stated:

> 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.
>
> 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.[47]

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."[48]

April 26, 2007, Test. MDA states that this 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....

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

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

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

> 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.[49]

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.[50]

June 22, 2007, Test. MDA states that this 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.[51]

August 31, 2007, Test. MDA has publicly noted the occurrence of this test and the fact that it resulted in a successful intercept,[52] but states that the details about the test are classified.[53] MDA does not appear to have issued a news release about this flight test following the completion of the test, as it has for other Aegis BMD flight tests.[54]

November 6, 2007, Test. MDA states that this test involved:

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

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

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

[52] See for example, slide 8 in the 20-slide briefing entitled "Ballistic Missile Defense Program Overview For The Congressional Breakfast Seminar Series," dated June 20, 2008, presented by Lieutenant General Trey Obering, USAF, Director, Missile Defense Agency. Source for briefing: *InsideDefense.com* (subscription required). Each slide in the briefing includes a note indicating that it was approved by MDA for public release on June 13, 2008. Slide 8 lists Aegis BMD midcourse flight tests conducted since September 2005, including a test on August 31, 2007. The slide indicates with a check mark that the flight test was successful. A success in this test is also needed to for the total number of successful intercepts to match the reported figure.

[53] An email from MDA to CRS dated June 30, 2008, states that the flight test "was a hit to kill intercept test but details about the test are classified."

[54] MDA's website, when accessed on June 30, 2008, did not show a news release issued on of soon after August 31, 2007, that discusses this 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 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.[55]

December 17, 2007, Test. In this flight test, 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.[56]

November 1, 2008, Test. This flight test was reportedly the first U.S. Navy Aegis BMD flight test conducted by the Navy, without oversight by MDA. The test involved two Aegis ships, each attempting to intercept a ballistic missile. The SM-3 fired by the first Aegis ship successfully intercepted its target, but the SM-3 fired by the second Aegis ship did not intercept its target. A press release from the U.S. Third Fleet (the Navy's fleet for the Eastern Pacific) states that

> Vice Adm. Samuel J. Locklear, Commander, U.S. Third Fleet announced today the successful Navy intercept of a ballistic missile target over the Pacific Ocean during Fleet Exercise Pacific Blitz. This was the first Fleet operational firing to employ the Standard Missile-3 (SM-3) against a ballistic missile target. Command and control of this mission resided with Commander, U.S. Third Fleet, based in San Diego, Calif.
>
> Pearl Harbor-based Aegis destroyers, USS Paul Hamilton (DDG 60) and USS Hopper (DDG 70), which have been upgraded to engage ballistic missiles, fired SM-3 missiles at separate targets. During this event, a short-range ballistic missile target was launched from the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. Upon detecting and tracking the target, USS Paul Hamilton, launched a SM-3 missile, resulting in a direct-hit intercept. Following USS Paul Hamilton's engagement, PMRF launched another target. USS Hopper successfully detected, tracked and engaged the target. The SM-3 followed a nominal trajectory, however intercept was not achieved. Extensive analysis of the flight mission will be used to improve the deployed Aegis BMD system.[57]

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

[56] 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, December 17, 2007.

[57] Commander, U.S. Third Fleet, Public Affairs Office, press release 23-08, dated November 1, 2008, entitled "Navy Intercepts Ballistic Missile Target in Fleet Exercise Pacific Blitz." See also Dave Ahearn, "One of Two Missiles Hit In (continued...)

November 19, 2008, Test. This was the second Japanese flight test, and involved a single ballistic missile target. The test did not result in a successful intercept. MDA states that

> Rear Admiral Tomohisa Takei, Director General of Operations and Plans, for the Japanese Maritime Staff Office (MSO), Japan Maritime Self Defense Force (JMSDF), and Lt. General Henry "Trey" Obering, United States Missile Defense Agency director, announced the completion today of a cooperative sea-based Aegis Ballistic Missile Defense intercept flight test off the coast of Kauai in Hawaii. The event, designated Japan Flight Test Mission 2 (JFTM-2), marked the second attempt by an Allied naval ship to intercept a ballistic missile target with the sea-based midcourse engagement capability provided by Aegis Ballistic Missile Defense. Target performance, interceptor missile launch and flyout, and operation of the Aegis Weapon System by the crew were successful, but an intercept was not achieved.
>
> The JFTM-2 was a test of the newest engagement capability of the Aegis Ballistic Missile Defense configuration of the recently upgraded Japanese destroyer, JS CHOKAI (DDG-176). At approximately 4:21 pm (HST), 11:21 am (Tokyo time) a ballistic missile target was launched from the Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii. JS CHOKAI crew members detected and tracked the target using an advanced on-board radar. The Aegis Weapon System then developed a fire control solution, and at approximately 4:24 pm (HST), 11:24 am (Tokyo time) on Nov 20, a single Standard Missile -3 (SM-3) Block IA was launched. Approximately two minutes later, the SM-3 failed to intercept the target. There is no immediate explanation for the failed intercept attempt. More information will be available after a thorough investigation. The JS CHOKAI crew performance was excellent in executing the mission. JFTM-2 was the second time that a Japanese ship was designated to launch the interceptor missile, a major milestone in the growing cooperation between Japan and the U.S.[58]

A November 21, 2008, press report states that

> An Aegis ballistic missile defense (BMD) test by the Japanese destroyer Chokai (DDG-176) ended in failure when the Standard Missile-3 Block 1A interceptor lost track of the target missile in the final seconds before a planned hit-to-kill.
>
> The Chokai and its crew performed well throughout the test, and the SM-3 also performed flawlessly through its first three stages, according to Rear Adm. Brad Hicks, the U.S. Navy Aegis ballistic missile defense program director. He spoke with several reporters in a teleconference around midnight ET Wednesday-Thursday, after the test in the area of the Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii.
>
> This was the second Aegis BMD test failure in less than a month.
>
> These latest two failures come as some Democrats in Congress are poised to cut spending on missile defense programs when they convene next year to consider the Missile Defense Agency budget for the fiscal year ending Sept. 30, 2010....
>
> Still, in the coming money debates next year, missile defense advocates will be able to point out that even including the Hopper and Chokai failures, the record for the Aegis tests is an overwhelming 16 successful hits demolishing target missiles out of 20 attempts.

(...continued)

Aegis Test; Navy For First Time Runs Test Instead of MDA," *Defense Daily*, November 4, 2008: 1-2.

[58] Missile Defense Agency press release 08-News-0087, dated November 19, 2008, entitled "Japan/U.S. Missile Defense Flight Test Completed."

> Those successes included the first Japanese attempt. The Japanese destroyer Kongo (DDG-173) successfully used its SM-3 interceptor to kill a target missile. The difference in tests is that the Kongo crew was advised beforehand when the target missile would be launched, while the Chokai crew wasn't....
>
> [Hicks] said a board will be convened to examine why the latest test failed. Hicks declined to speculate on why the SM-3 interceptor missed the target. "I'm confident we'll find out the root cause" of the Chokai interceptor failure to score a hit, he said.
>
> However, he was asked by *Space & Missile Defense Report* whether the prior SM-3 successes make it unlikely the Chokai failure stems from some basic design flaw in all SM-3s, and whether it is more likely that the Chokai SM-3 failed because of some flaw or glitch in just that one interceptor.
>
> Hicks said that is likely.
>
> "Obviously, we believe this is hopefully related to this one interceptor," and doesn't reflect any basic design flaw in the SM-3 interceptors, he said.
>
> The Chokai test failure cost Japan a $55 million loss, he said, adding, "It wasn't cheap."...
>
> In the Chokai test, the target missile was launched from Barking Sands, and about three minutes later the Chokai crew had spotted the target, the Aegis system had developed a tracking and hit solution, and the SM-3 interceptor was launched.
>
> The first, second and third stages of the interceptor performed nominally, without problems, but then came the fourth stage. The nosecone components opened to expose the kill vehicle area, and somehow the program to track the target missile failed.
>
> "It lost track," Hicks said, only seconds before the hit would have been achieved.
>
> If the kill had occurred, it would have been about 100 nautical miles (roughly 115 statute miles) above Earth, and some 250 miles away from Barking Sands, Hicks said.
>
> It took the interceptor about two minutes flight time to reach the near miss with the target missile.
>
> Meanwhile, the Hamilton was nearby watching the test. The Hamilton Aegis system successfully spotted and tracked the target, and developed a simulated solution and simulated interceptor launch that, if it had been real, would have resulted in a successful hit on the target, Hicks said. The Hamilton didn't cue the Chokai, however. "It was strictly Chokai's engagement," Hicks said.[59]

July 30, 2009, Test. MDA states that

> In conjunction with the Missile Defense Agency (MDA), U.S. Pacific Fleet ships and crews successfully conducted the latest Aegis Ballistic Missile Defense (BMD) at-sea firing event on July 30. During this event, entitled Stellar Avenger, the Aegis BMD-equipped ship, USS Hopper (DDG 70), detected, tracked, fired and guided a Standard Missile -3 (SM-3) Block (Blk) IA to intercept a sub-scale short range ballistic missile. The target was launched from the Kauai Test Facility, co-located on the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai. It was the 19th successful intercept in 23 at-sea firings, for the Aegis BMD Program, including the February 2008 destruction of the malfunctioning satellite above the earth's atmosphere. Stellar Avenger was part of the continual evaluation of the certified and fielded Aegis BMD system at-sea today.

[59] Dave Ahearn, "Japanese Aegis Missile Defense Test Fails, But Aegis Record Is 16 Hits In 20 Tries," Defense Daily, November 21, 2008: 5-6.

> At approximately 5:40 pm (HST), 11:40 pm (EDT), a target was launched from PMRF. Three U.S. Navy Aegis BMD-equipped ships, the cruiser, USS Lake Erie (CG 70) and destroyers USS Hopper (DDG 70) and USS O'Kane (DDG 77) detected and tracked the target with their SPY radars. Each developed fire control solutions. At 5:42 pm (HST), 11:42 pm (EDT) the crew of USS Hopper fired one SM-3 Blk IA missile. The USS Hopper's Aegis BMD Weapon System successfully guided the SM-3 to a direct body to body hit, approximately two minutes after leaving the ship. The intercept occurred about 100 miles above the Pacific Ocean. USS O'Kane conducted a simulated engagement of the target. USS Lake Erie, with its recently installed upgraded Aegis BMD 4.0.1 Weapons System, detected and tracked the same target.[60]

A July 31, 2009, press report states:

> The test was the first Aegis BMD exercise to feature two versions of the software in a single event, according to Lisa Callahan, Lockheed's vice president for ballistic missile defense programs.
>
> A goal of the exercises was to test the Aegis system's ability to discern all the different parts and pieces of a ballistic missile, Nick Bucci, Lockheed's director for Aegis BMD development programs, told reporters July 29 during a pre-exercise conference call.
>
> Three more flight tests this fall will further test the system's discrimination capabilities, Bucci added, with each test becoming more complex. The last test will "be against a pretty darn complex target," he said.
>
> The July 30 tests also validated fixes put in place after a BMD test last November involving a missile launched from the Aegis BMD Japanese destroyer Chokai failed to intercept its target, according to MDA spokesman Chris Taylor. The improvements—which were successful in the most recent test—involved fixes to the Solid Divert Attitude Control System.
>
> The Chokai is the second of four Japanese Aegis ships being upgraded with BMD capability. A third ship, the Myoko, is scheduled to carry out a BMD test this fall.[61]

An August 3, 2009, press report states:

> This test was added to the schedule to evaluate changes made after last year's failed attempt to intercept a target with an SM-3 Block IA launched by a Japanese Aegis-equipped ship .... After the Nov. 19 test, MDA officials said, "Target performance, interceptor missile launch and flyout, and operation of the Aegis Weapon System by the crew were successful, but an intercept was not achieved."
>
> A root cause has not been identified, and an MDA spokesman did not say whether fixes have been made to hardware or operational procedures resulting from the failure review. It is also unclear why a subscale target was used in the July 30 trial.[62]

An August 4, 2009, press report states:

> [Rear Admiral Alan "Brad" Hicks, Aegis/SM-3 program manager for MDA], said that a November [2008] failure of an SM-3 Block IA... during a flight-test was attributable to poor adherence to processes on Raytheon's assembly line in Tucson, Ariz.
>
> This was isolated to that missile, and it was the result of perturbations to the build process encountered when shifting from development to production operations.

[60] Missile Defense Agency press release 09-News-0015, dated July 31, 2009, entitled "Aegis Ballistic Missile Defense Test Successful."

[61] Christopher P. Cavas, "Aegis BMD Test Successful," *DefenseNews.com*, July 31, 2009.

[62] Amy Butler, "SM-3 Scores Hit After Fixes Implemented," *Aerospace Daily & Defense Report*, August 3, 2009: 5.

> During the November test, a Japanese Aegis-equipped ship fired the interceptor and it flew "perfectly," Hicks said. In the endgame, a failure of the divert and attitude control system on the unitary kill vehicle led to a miss.
>
> The July 30 demonstration using a U.S. ship "restored confidence" for the Japanese that the miss last fall was an isolated incident, he says.[63]

October 27, 2009, Test. This was the third Japanese flight test, and it involved a single ballistic missile target. MDA states that

> The Japan Maritime Self-Defense Force (JMSDF) and the United States Missile Defense Agency (MDA) announced the successful completion of an Aegis Ballistic Missile Defense (BMD) intercept flight test, in cooperation with the U.S. Navy, off the coast of Kauai in Hawaii. The event, designated Japan Flight Test Mission 3 (JFTM-3), marked the third time that a JMSDF ship has successfully engaged a ballistic missile target, including two successful intercepts, with the sea-based midcourse engagement capability provided by Aegis BMD.
>
> The JFTM-3 test event verified the newest engagement capability of the Japan Aegis BMD configuration of the recently upgraded Japanese destroyer, JS MYOKO (DDG-175). At approximately 6:00pm (HST), 1:00 pm Tokyo time on Oct 28, a separating, medium-range ballistic missile target was launched from the Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii. JS MYOKO crew members detected and tracked the target. The Aegis Weapon System then developed a fire control solution and, at approximately 6:04pm (HST), 1:04 pm Tokyo time a Standard Missile-3 (SM-3) Block IA interceptor missile was launched. Approximately 3 minutes later, the SM-3 successfully intercepted the target approximately 100 miles above the Pacific Ocean. JFTM-3 is a significant milestone in the growing cooperation between Japan and the U.S. in the area of missile defense.
>
> Also participating in the test, were the Pearl Harbor-based USS Lake Erie (CG 70) and USS Paul Hamilton (DDG 60) which detected and tracked the target and conducted a simulated engagement.[64]

October 28, 2010, Test. This was the fourth Japanese flight test, and it involved a single ballistic missile target. MDA states that

> The Japan Maritime Self-Defense Force (JMSDF) and the United States Missile Defense Agency (MDA) announced the successful completion of an Aegis Ballistic Missile Defense (BMD) intercept flight test, in cooperation with the U.S. Navy, off the coast of Kauai in Hawaii.
>
> The event marked the fourth time that a JMSDF ship has engaged a ballistic missile target, including three successful intercepts, with the sea-based midcourse engagement capability provided by Aegis BMD.
>
> The JFTM-4 test event verified the newest engagement capability of the Japan Aegis BMD configuration of the recently upgraded Japanese destroyer, JS KIRISHIMA. At approximately 5:06 p.m. (HST), 12:06 p.m. Tokyo time on Oct. 29, 2010, a separating

[63] Amy Butler, "SM-3 Upgrade Program Cost Increases," *Aerospace Daily & Defense Report*, August 4, 2009: 1-2. See also Dan Taylor, "Navy Conducts Aegis BMD Test, New Baseline System Participates," *Inside the Navy*, August 3, 2009; Daniel Wasserbly, "US Aegis BMD System Achieves Trial Success," *Jane's Defence Weekly*, August 5, 2009: 8.

[64] Missile Defense Agency press release 09-News-0021, dated October 28, 2009, entitled "Japan/U.S. Missile Defense Flight Test Successful." See also Christopher P. Cavas, "Japanese Destroyer Conducts Successful BMD Test," *NavyTimes.com*, October 28, 2009; and Amy Butler and Michael Bruno, "SM-3 Scores Hit In Japanese Test," *Aerospace Daily & Defense Report*," October 29, 2009: 3.

> 1,000 km class ballistic missile target was launched from the Pacific Missile Range Facility at Barking Sands, Kauai, Hawaii.
>
> JS KIRISHIMA crew members detected and tracked the target. The Aegis Weapon System then developed a fire control solution and launched a Standard Missile -3 (SM-3) Block IA missile. Approximately three minutes later, the SM-3 successfully intercepted the target approximately 100 miles above the Pacific Ocean. JFTM-4 is a significant milestone in the growing cooperation between Japan and the U.S. in the area of missile defense.
>
> Also participating in the test was USS LAKE ERIE and USS RUSSELL, Aegis ships which cooperated to detect, track and conduct a simulated intercept engagement against the same target.[65]

April 15, 2011, Test. MDA states that this flight test "was the most challenging test to date, as it was the first Aegis BMD version 3.6.1 intercept against an intermediate-range target (range 1,864 to 3,418 [statute] miles) and the first Aegis BMD 3.6.1 engagement relying on remote tracking data." MDA states that

> The Missile Defense Agency (MDA), U.S. Navy sailors aboard the Aegis destroyer USS O'KANE (DDG 77), and Soldiers from the 94th Army Air and Missile Defense Command operating from the 613th Air and Space Operations Center at Hickam Air Force Base, Hawaii, successfully conducted a flight test of the Aegis Ballistic Missile Defense (BMD) element of the nation's Ballistic Missile Defense System, resulting in the intercept of a separating ballistic missile target over the Pacific Ocean. This successful test demonstrated the capability of the first phase of the European Phased Adaptive Approach (EPAA) announced by the President in September, 2009.
>
> At 2:52 a.m. EDT (6:52 p.m. April 15 Marshall Island Time), an intermediate-range ballistic missile target was launched from the Reagan Test Site, located on Kwajalein Atoll in the Republic of the Marshall Islands, approximately 2,300 miles southwest of Hawaii. The target flew in a northeasterly direction towards a broad ocean area in the Pacific Ocean. Following target launch, a forward-based AN/TPY-2 X-band transportable radar, located on Wake Island, detected and tracked the threat missile. The radar sent trajectory information to the Command, Control, Battle Management, and Communications (C2BMC) system, which processed and transmitted remote target data to the USS O'KANE. The destroyer, located to the west of Hawaii, used the data to develop a fire control solution and launch the SM-3 Block IA missile approximately 11 minutes after the target was launched.
>
> As the IRBM target continued along its trajectory, the firing ship's AN/SPY-1 radar detected and acquired the ballistic missile target. The firing ship's Aegis BMD weapon system uplinked target track information to the SM-3 Block IA missile. The SM-3 maneuvered to a point in space as designated by the fire control solution and released its kinetic warhead. The kinetic warhead acquired the target, diverted into its path, and, using only force of a direct impact, destroyed the threat in a "hit-to-kill" intercept.
>
> During the test the C2BMC system, operated by Soldiers from the 94th Army Air and Missile Defense Command, received data from all assets and provided situational awareness of the engagement to U.S. Pacific Command, U.S. Northern Command and U.S. Strategic Command.

[65] Missile Defense Agency press release 10-News-0016, dated October 29, 2010, entitled "Joint Japan-U.S. Missile Defense Flight Test Successful." See also Marina Malenic, "Japanese Aegis Destroyer Successfully Completes Missile-Intercept Test," *Defense Daily*, November 1, 2010: 6.

> The two demonstration Space Tracking and Surveillance Satellites (STSS), launched by MDA in 2009, successfully acquired the target missile, providing stereo "birth to death" tracking of the target.
>
> Today's event, designated Flight Test Standard Missile-15 (FTM-15), was the most challenging test to date, as it was the first Aegis BMD version 3.6.1 intercept against an intermediate-range target (range 1,864 to 3,418 [statute] miles) and the first Aegis BMD 3.6.1 engagement relying on remote tracking data. The ability to use remote radar data to engage a threat ballistic missile greatly increases the battle space and defended area of the SM-3 missile.
>
> Initial indications are that all components performed as designed. Program officials will spend the next several months conducting an extensive assessment and evaluation of system performance based upon telemetry and other data obtained during the test.[66]

September 1, 2011, Test. This flight test, which did not result in an intercept, was the first flight test of the SM-3 Block IB interceptor. MDA states that it

> was unable to achieve the planned intercept of a ballistic missile target during a test over the Pacific Ocean exercising the sea-based element of the Ballistic Missile Defense System (BMDS).
>
> At approximately 3:53 a.m. Hawaii Standard Time (9:53 a.m. EDT) a short-range ballistic missile target was launched from the U.S. Navy's Pacific Missile Range Facility on Kauai, Hawaii. Approximately 90 seconds later, a Standard Missile 3 (SM-3) Block 1B interceptor missile was launched from the cruiser USS LAKE ERIE (CG-70) but an intercept of the target was not achieved.
>
> This was the first flight test of the advanced SM-3 Block 1B interceptor missile. Program officials will conduct an extensive investigation to determine the cause of the failure to intercept.[67]

May 9, 2012, Test. MDA states that this flight test "was the first successful live fire intercept test of the SM-3 Block IB interceptor and the second-generation Aegis BMD 4.0.1 weapon system." MDA states that

> The Missile Defense Agency (MDA) and U.S. Navy sailors aboard the USS LAKE ERIE (CG 70) successfully conducted a flight test of the Aegis Ballistic Missile Defense (BMD) system, resulting in the first intercept of a short-range ballistic missile target over the Pacific Ocean by the Navy's newest Missile Defense interceptor, the Standard Missile – 3 (SM-3) Block IB.
>
> At 8:18 p.m. Hawaiian Standard Time (2:18 a.m. EDT May 10) the target missile was launched from the Pacific Missile Range Facility, located on Kauai, Hawaii. The target flew on a northwesterly trajectory towards a broad ocean area of the Pacific Ocean. Following target launch, the USS LAKE ERIE detected and tracked the missile with its onboard AN/SPY-1 radar. The ship, equipped with the second-generation Aegis BMD 4.0.1 weapon system, developed a fire control solution and launched the Standard Missile-3 (SM-3) Block IB interceptor.

[66] Missile Defense Agency press release 11-News-0007, dated April 15, 2011, entitled "Sea-based Missile Defense Flight Test Results in Successful Intercept."

[67] Missile Defense Agency press release 11-News-0016, dated September 1, 2011, entitled "Sea-Based Missile Defense Test Conducted." See also Amy Butler, "Upgraded Ballistic Missile Killer Fizzles In First Flight Test," *Aerospace Daily & Defense Report*, September 2, 2011: 3; and Mike McCarthy, "Sea-Based Missile Defense Test Fails," *Defense Daily*, September 2, 2011: 2-3.

> The USS LAKE ERIE continued to track the target and sent trajectory information to the SM-3 Block IB interceptor in-flight. The SM-3 maneuvered to a point in space, as designated by the fire control solution, and released its kinetic warhead. The kinetic warhead acquired the target, diverted into its path, and, using only the force of a direct impact, engaged and destroyed the threat in a hit-to-kill intercept.
>
> Today's event, designated Flight Test Standard Missile-16 (FTM-16) Event 2a, was the first successful live fire intercept test of the SM-3 Block IB interceptor and the second-generation Aegis BMD 4.0.1 weapon system. Previous successful intercepts were conducted with the Aegis BMD 3.6.1 weapon system and the SM-3 Block IA interceptor, which are currently operational on U.S. Navy ships deployed across the globe....
>
> Initial indications are that all components performed as designed. Program officials will conduct an extensive assessment and evaluation of system performance based upon telemetry and other data obtained during the test.[68]

June 26, 2012, Test. MDA states that this flight test "was the second consecutive successful intercept test of the SM-3 Block IB missile and the second-generation Aegis BMD 4.0.1 weapon system." MDA states that

> The Missile Defense Agency (MDA) and U.S. Navy sailors in the USS LAKE ERIE (CG 70) successfully conducted a flight test of the Aegis Ballistic Missile Defense (BMD) system, resulting in the intercept of a separating ballistic missile target over the Pacific Ocean by the Navy's newest missile defense interceptor missile, the Standard Missile-3 (SM-3) Block IB.
>
> At 11:15 pm Hawaii Standard Time, June 26 (5:15 am EDT June 27), the target missile was launched from the Pacific Missile Range Facility, located on Kauai, Hawaii. The target flew on a northwesterly trajectory towards a broad ocean area of the Pacific Ocean. Following target launch, the USS LAKE ERIE detected and tracked the missile with its onboard AN/SPY-1 radar. The ship, equipped with the second-generation Aegis BMD 4.0.1 weapon system, developed a fire control solution and launched the SM-3 Block IB missile.
>
> The USS LAKE ERIE continued to track the target and sent trajectory information to the SM-3 Block IB missile in-flight. The SM-3 maneuvered to a point in space, as designated by the fire control solution, and released its kinetic warhead. The kinetic warhead acquired the target, diverted into its path, and, using only the force of a direct impact, engaged and destroyed the threat in a hit-to-kill intercept.
>
> Today's test event was the second consecutive successful intercept test of the SM-3 Block IB missile and the second-generation Aegis BMD 4.0.1 weapon system. The first successful SM-3 Block IB intercept occurred on May 9, 2012. Today's intercept is a critical accomplishment for the second phase of the President's European Phased Adaptive Approach consisting of the SM-3 Block IB interceptor employed in an Aegis Ashore system in Romania in 2015.
>
> Initial indications are that all components performed as designed resulting in a very accurate intercept.[69]

October 25, 2012, Test. MDA states that in this flight test,

[68] Missile Defense Agency press release 12-News-0007, dated May 9, 2012, entitled "Second-Generation Aegis Ballistic Missile Defense System Completes Successful Intercept Flight Test."

[69] Missile Defense Agency press release 12-News-0008, dated June 27, 2012, entitled "Second-Generation Aegis Ballistic Missile Defense System Completes Second Successful Intercept Flight Test."

> The Missile Defense Agency (MDA), U.S. Army soldiers from the 94th and 32nd Army Air and Missile Defense Command (AAMDC); U.S. Navy sailors aboard the USS FITZGERALD (DDG 62); and airmen from the 613th Air and Space Operations Center successfully conducted the largest, most complex missile defense flight test ever attempted resulting in the simultaneous engagement of five ballistic missile and cruise missile targets. An integrated air and ballistic missile defense architecture used multiple sensors and missile defense systems to engage multiple targets at the same time....
>
> The USS FITZGERALD successfully engaged a low flying cruise missile over water. The Aegis system also tracked and launched an SM-3 Block 1A interceptor against a Short-Range Ballistic Missile. However, despite indication of a nominal flight of the SM-3 Block 1A interceptor, there was no indication of an intercept of the SRBM.[70]

February 12, 2013, Test. MDA states that in this flight test,

> The Missile Defense Agency (MDA) and U.S. Navy sailors aboard the USS LAKE ERIE (CG 70) successfully conducted a flight test of the Aegis Ballistic Missile Defense (BMD) system, resulting in the intercept of a medium-range ballistic missile target over the Pacific Ocean by a Standard Missile-3 (SM-3) Block IA guided missile.
>
> At 11:10 p.m. HST (4:10 a.m. EST) a unitary medium-range ballistic missile target was launched from the Pacific Missile Range Facility, on Kauai, Hawaii. The target flew northwest towards a broad ocean area of the Pacific Ocean.
>
> The in-orbit Space Tracking and Surveillance System-Demonstrators (STSS-D) detected and tracked the target, and forwarded track data to the USS LAKE ERIE. The ship, equipped with the second-generation Aegis BMD weapon system, used Launch on Remote doctrine to engage the target.
>
> The ship developed a fire control solution from the STSS-D track and launched the SM-3 Block IA guided missile approximately five minutes after target launch. The SM-3 maneuvered to a point in space and released its kinetic warhead. The kinetic warhead acquired the target reentry vehicle, diverted into its path, and, using only the force of a direct impact, engaged and destroyed the target.
>
> Initial indications are that all components performed as designed. Program officials will assess and evaluate system performance based upon telemetry and other data obtained during the test.
>
> Today's event, designated Flight Test Standard Missile-20 (FTM-20), was a demonstration of the ability of space-based assets to provide mid-course fire control quality data to an Aegis BMD ship, extending the battlespace, providing the ability for longer range intercepts and defense of larger areas.[71]

May 16, 2013, Test. MDA states that in this flight test,

> The Missile Defense Agency (MDA) and U.S. Navy sailors aboard the USS LAKE ERIE (CG-70) successfully conducted a flight test today of the Aegis Ballistic Missile Defense (BMD) system, resulting in the intercept of a separating ballistic missile target over the Pacific Ocean by the Aegis BMD 4.0 Weapon System and a Standard Missile-3 (SM-3) Block IB missile.

[70] Missile Defense Agency press release 12-News-0011, dated October 25, 2012, entitled "Ballistic Missile Defense System Engages Five Targets Simultaneously During Largest Missile Defense Flight Test in History."

[71] Missile Defense Agency press release 13-News-0002, dated February 13, 2013, entitled "Aegis Ballistic Missile Defense Intercepts Target Using Space Tracking and Surveillance System-Demonstrators (STSS-D) Data." See also Troy Clarke, "Space-Based Sensors Star in "Stellar Eyes" Missile Defense Test," *Navy News Service*, February 13, 2013.

> At 5:25 p.m. (Hawaii Time, 11:25 p.m. EDT), May 15, a separating short-range ballistic missile target was launched from the Pacific Missile Range Facility, on Kauai, Hawaii. The target flew northwest towards a broad ocean area of the Pacific Ocean. Following target launch, the USS LAKE ERIE (CG-70) detected and tracked the missile with its onboard AN/SPY-1 radar. The ship, equipped with the second-generation Aegis BMD weapon system, developed a fire control solution and launched the SM-3 Block IB missile. The SM-3 maneuvered to a point in space based on guidance from Aegis BMD Weapons Systems and released its kinetic warhead. The kinetic warhead acquired the target reentry vehicle, diverted into its path, and, using only the force of a direct impact, engaged and destroyed the target.
>
> Initial indications are that all components performed as designed. Program officials will assess and evaluate system performance based upon telemetry and other data obtained during the test.
>
> This test exercised the latest version of the second-generation Aegis BMD Weapon System and Standard Missile, providing capability for engagement of longer-range and more sophisticated ballistic missiles.
>
> Last night's event, designated Flight Test Standard Missile-19 (FTM-19), was the third consecutive successful intercept test of the Aegis BMD 4.0 Weapon System and the SM-3 Block IB guided missile. Previous successful ABMD 4.0 SM-3 Block IB intercepts occurred on May 9, 2012 and June 26, 2012. Other Aegis BMD intercepts have employed the ABMD 3.6 and 4.0 with the SM-3 Block IA missile, which is currently operational on U.S. Navy ships deployed across the globe.[72]

September 10, 2013, Test. MDA states that in this flight test,

> The Missile Defense Agency (MDA), Ballistic Missile Defense System (BMDS) Operational Test Agency, Joint Functional Component Command for Integrated Missile Defense, and U.S. Pacific Command, in conjunction with U.S. Army soldiers from the Alpha Battery, 2nd Air Defense Artillery Regiment, U.S. Navy sailors aboard the guided missile destroyer USS Decatur (DDG-73), and U.S. Air Force airmen from the 613th Air and Operations Center successfully conducted a complex missile defense flight test, resulting in the intercept of two medium-range ballistic missile targets. The flight test was planned more than a year ago, and is not in any way connected to events in the Middle East.
>
> The test was conducted in the vicinity of the U.S. Army Kwajalein Atoll/Reagan Test Site and surrounding areas in the western Pacific. The test stressed the ability of the Aegis Ballistic Missile Defense (BMD) and Terminal High Altitude Area Defense (THAAD) weapon systems to function in a layered defense architecture and defeat a raid of two near-simultaneous ballistic missile targets.
>
> The two medium-range ballistic missile targets were launched on operationally realistic trajectories towards a defended area near Kwajalein. Along with overhead space assets providing launch alerts, an Army-Navy/Transportable Radar Surveillance and Control (AN/TPY-2) radar in Forward Based Mode detected the targets and relayed track information to the Command, Control, Battle Management, and Communications (C2BMC) system for further transmission to defending BMDS assets.
>
> The USS Decatur with its Aegis Weapon System detected and tracked the first target with its onboard AN/SPY-1 radar. The Aegis BMD weapon system developed a fire control

[72] Missile Defense Agency press release 13-News-0005, dated May 16, 2013, entitled "Aegis Ballistic Missile Defense System Completes Successful Intercept Flight Test." See also Mike McCarthy, "Aegis Missile Intercept Successful," *Defense Daily*, May 17, 2013: 7-8; and Amy Butler, "MDA Conducts Two Successful Flight Tests," *Aerospace Daily & Defense Report*, May 17, 2013: 3.

solution, launched a Standard Missile-3 (SM-3) Block IA missile, and successfully intercepted the target.

In a demonstration of BMDS layered defense capabilities, a second AN/TPY-2 radar in Terminal Mode, located with the THAAD weapon system, acquired and tracked the target missiles. THAAD developed a fire control solution, launched a THAAD interceptor missile, and successfully intercepted the second medium-range ballistic missile target. THAAD was operated by soldiers from the Alpha Battery, 2nd Air Defense Artillery Regiment. As a planned demonstration of THAAD's layered defense capabilities, a second THAAD interceptor was launched at the target destroyed by Aegis as a contingency in the event the SM-3 did not achieve an intercept.

Initial indications are that all components performed as designed. MDA officials will extensively assess and evaluate system performance based upon telemetry and other data obtained during the test.

The event, a designated Flight Test Operational-01 (FTO-01), demonstrated integrated, layered, regional missile defense capabilities to defeat a raid of two threat-representative medium-range ballistic missiles in a combined live-fire operational test. Soldiers, sailors, and airmen from multiple combatant commands operated the systems, and were provided a unique opportunity to refine operational doctrine and tactics while increasing confidence in the execution of integrated air and missile defense plans.[73]

September 18, 2013, Test. MDA states that in this flight test,

The Missile Defense Agency (MDA), U.S. Pacific Command, and U.S. Navy sailors aboard the USS Lake Erie (CG 70) successfully conducted a flight test today of the Aegis Ballistic Missile Defense (BMD) system, resulting in the intercept of a complex separating short-range ballistic missile target over the Pacific Ocean by the Aegis BMD 4.0 Weapon System and a Standard Missile-3 (SM-3) Block IB guided missile.

At approximately 2:30 p.m. Hawaii Standard Time (8:30 p.m. EDT), a complex separating short-range ballistic missile target was launched from the Pacific Missile Range Facility on Kauai, Hawaii. The target flew northwest towards a broad ocean area of the Pacific Ocean. Following target launch, the USS Lake Erie detected and tracked the missile with its onboard AN/SPY-1 radar. The ship, equipped with the second-generation Aegis BMD weapon system, developed a fire control solution and launched two SM-3 Block IB guided missiles to engage the target. The first SM-3 that was launched successfully intercepted the target warhead. This was the first salvo mission of two SM-3 Block IB guided missiles launched against a single separating target.

Program officials will assess and evaluate system performance based upon telemetry and other data obtained during the test.

This test exercised the latest version of the second-generation Aegis BMD Weapon System, capable of engaging longer range and more sophisticated ballistic missiles. This was an operationally realistic test, in which the target's launch time and bearing are not known in advance, and the target complex was the most difficult target engaged to date.[74]

[73] Missile Defense Agency press release 13-News-0007, dated September 10, 2013, entitled "Successful Missile Defense Test Against Multiple Targets." See also Megan Eckstein, "Aegis BMDS, THAAD Successful In Complex MDA Flight Test," *Defense Daily*, September 11, 2013: 1; and Amy Butler, "MDA Goes Two For Two In Operational Test," *Aerospace Daily & Defense Report*, September 11, 2013: 4.

[74] Missile Defense Agency press release 13-News-0008, dated September 18, 2013, entitled "Aegis Ballistic Missile Defense System Completes Successful Intercept Flight Test." See also Mike McCarthy, "Pentagon Succeeds At Sea-Based Missile Defense Test," *Defense Daily*, September 20, 2013: 1; Amy Butler, "Aegis Intercepts In First-Ever Salvo Test," *Aerospace Daily & Defense Report*, September 20, 2013: 3; and Jason Sherman and John Liang, "Missile Defense Agency's SM-3 Block IB Intercepts Target In Salvo Fire," *Inside the Navy*, September 23, 2013.

October 3, 2013, Test. MDA states that in this flight test,

> The Missile Defense Agency (MDA), U.S. Pacific Command, and U.S. Navy sailors aboard the USS Lake Erie (CG 70) successfully conducted an operational flight test of the Aegis Ballistic Missile Defense (BMD) system, resulting in the intercept of a medium-range ballistic missile target over the Pacific Ocean by the Aegis BMD 4.0 Weapon System and a Standard Missile-3 (SM-3) Block IB guided missile.
>
> At approximately 7:33 p.m. Hawaii Standard Time, Oct. 3 (1:33 a.m. EDT, Oct.4), a medium-range ballistic missile target was launched from the Pacific Missile Range Facility on Kauai, Hawaii. The target flew northwest towards a broad ocean area of the Pacific Ocean. Following target launch, the USS Lake Erie detected and tracked the missile with its onboard AN/SPY-1 radar. The ship, equipped with the second-generation Aegis BMD weapon system, developed a fire control solution and launched the SM-3 Block IB guided missile to engage the target. The SM-3 maneuvered to a point in space and released its kinetic warhead. The kinetic warhead acquired the target reentry vehicle, diverted into its path, and, using only the force of a direct impact, engaged and destroyed the target.
>
> Program officials will assess and evaluate system performance based upon telemetry and other data obtained during the test.
>
> This test exercised the latest version of the second-generation Aegis BMD Weapon System, capable of engaging longer range and more sophisticated ballistic missiles.[75]

November 6, 2014, Test. MDA states that in this flight test,

> The Missile Defense Agency, U.S. Pacific Command, and U.S. Navy Sailors aboard the USS John Paul Jones (DDG 53) successfully conducted a flight test today of the Aegis Ballistic Missile Defense (BMD) system, resulting in three successful near-simultaneous target engagements over the Pacific Ocean by the Aegis Baseline (BL) 9.C1 (BMD 5.0 Capability Upgrade) Weapon System configured ship. One short-range ballistic missile target was intercepted by a Standard Missile-3 (SM-3) Block IB guided missile, while two low-flying cruise missile targets were engaged by Standard Missile-2 (SM-2) Block IIIA guided missiles near-simultaneously.
>
> At approximately 12:03 p.m. (Hawaii Standard Time, 5:03 p.m. Eastern Standard Time) one short-range ballistic missile target and two cruise missile targets were launched from the Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Following the target launches, the USS John Paul Jones, in Integrated Air and Missile Defense (IAMD) Radar Priority Mode, detected and tracked the missiles with its onboard AN/SPY-1 radar.
>
> The ship, equipped with the Aegis BMD weapon system, developed a fire control solution and launched one SM-3 Block IB guided missile to engage the ballistic missile target. The SM-3 missile maneuvered to a point in space and released its kinetic warhead. The kinetic warhead acquired the target's reentry vehicle, diverted into its path, and destroyed the target with the sheer energy and force of direct impact. The ship also launched two SM-2 Block IIIA guided missiles to successfully engage the cruise missile targets.
>
> Program officials will evaluate system performance based upon telemetry and other data obtained during the test.

[75] Missile Defense Agency press release 13-News-0009, dated October 4, 2013, entitled "Aegis Ballistic Missile Defense System Completes Successful Intercept Flight Test." See also Michael Fabey, "Aegis Completes Another Intercept Test," *Aerospace Daily & Defense Report*, October 7, 2013: 2; Jason Sherman, "SM-3 Block IB Completes IOT&E With A Bang, Full-Rate Production Review," *Inside the Navy*, October 7, 2013; Mike McCarthy, "Aegis Missile Defense Test Scores Hit," *Defense Daily*, October 7, 2013: 4.

> This test, designated Flight Test Standard Missile-25 (FTM-25), was the first live-fire event of the Aegis Weapon System in IAMD Radar Priority Mode, engaging a ballistic missile target and a raid of cruise missile targets.[76]

June 25, 2015, Test. MDA's summary table of Aegis BMD flight tests[77] shows this as a test that did not result in the launch of an SM-3. MDA as of August 3, 2015, had not issued a news release discussing this event. MDA's count of 31 successful intercepts in 37 launches through July 29, 2015, does not appear to include this test, suggesting that this was considered a "no test" event—a test in which there was a failure that was not related to the Aegis BMD system or the SM-3 interceptor. A June 26, 2015, news report states:

> The U.S. Missile Defense Agency on Friday said a target malfunction caused it to abort a key intercept test of the Aegis Ashore missile defense system, built by Lockheed Martin Corp, that is due to be installed in Romania this year.
>
> "Due to a target malfunction, the test wasn't conducted and an interceptor wasn't launched," said Rick Lehner, a spokesman for the U.S. Defense Department agency....
>
> It was not immediately clear what caused the target to malfunction, or when the test would be rescheduled.[78]

October 4, 2015, Test. MDA as of November 10, 2015, had not issued a news release discussing this event. MDA's count of 32 successful intercepts in 39 launches through November 1, 2015, does not appear to include this test, suggesting that this was considered a "no test" event—a test in which there was a failure that was not related to the Aegis BMD system or the SM-3 interceptor.

October 20, 2015, Test. Regarding this test, the Navy states:

> USS Ross (DDG 71) successfully intercepted a ballistic missile in the North Atlantic Ocean during the Maritime Theater Missile Defense (MTMD) Forum's At Sea Demonstration (ASD) Oct. 20, 2015.
>
> This is first time a Standard Missile-3 (SM-3) Block IA guided interceptor was fired on a non-U.S. range and the first intercept of a ballistic missile threat in the European theater.
>
> For the scenario, a short-range Terrier Orion ballistic missile target was launched from Hebrides Range and was inflight simultaneously with two anti-ship cruise missiles fired at the coalition task group. Ross fired a SM-3 and successfully engaged the ballistic missile target in space. In its air defense role, USS The Sullivans (DDG 68) fired a SM-2, which is the first time a SM-2 was fired on the Hebrides Range....
>
> "ASD-15 shows that with communication, collaboration and commitment nations can come together and flawlessly defend against a complex threat scenario." [said] Vice Adm. James Foggo, Commander, U.S. 6th Fleet....

[76] Missile Defense Agency press release 14-News-0012, dated November 6, 2014, entitled "Aegis Ballistic Missile Defense System Completes Successful Intercept Flight Test." See also Andrea Shalal, "U.S. Aegis System Zaps Cruise, Ballistic Missile Targets in Test," *Reuters (www.reuters.com)*, November 6, 2014; Mike McCarthy, "Aegis BMD Hits Three Targets In Simultaneous Test," *Defense Daily*, November 10, 2014.

[77] "Aegis Ballistic Missile Defense Test Firing Record," accessed August 3, 2015, at http://www.mda.mil/global/documents/pdf/aegis_tests.pdf.

[78] Andrea Shalal, "U.S. Skips Aegis Aegis Ashore Missile Test After Target Malfunction," *Reuters*, June 26, 2015. See also "First Aegis Ashore Intercept Test Aborted. Does this Raise Issues for Planned 2015 Deployment Date for the Romanian Aegis Ashore Site?" *Mostly Missile Defense*, June 27, 2015.

ASD-15 is a U.K.-hosted, U.S.-facilitated, multi-national demonstration of coalition Integrated Air and Missile Defense capability....

There are a number of firsts associated with this event including:

-- First intercept of a ballistic missile target in the European theater

-- First SM-3 fired on a non-U.S. range

-- The first firing of an SM-2 and SM-3 on the Hebrides Range, United Kingdom

-- First use of multi-national beyond line of sight link architecture for IAMD purposes in the European theater

-- First international ship (Netherlands and Spain) transmissions of BMD cues to a U.S. BMD guided missile destroyer

-- First time coalition IAMD used in a scenario with simultaneous attack from anti-ship cruise and ballistic missiles.

This test demonstrates the commitment of the United States to the defense of Europe through our four Aegis ships forward deployed to Rota, Spain, and shore station in Romania.

The 10 MTMD Forum member nations are: Australia, Canada, France, Germany, Italy, The Netherlands, Norway, Spain, United Kingdom, and the United States.

Eight nations provided ships and aircraft for ASD-15 including Canada, France, Italy, The Netherlands, Norway, Spain, United Kingdom, and the United States with Germany providing personnel to augment the Forum's multi-national Combined Task Group staff.

The tactical data link used in ASD-15 covers over 5.7 million square miles.

USS Mount Whitney (LCC-20), flag ship for U.S. 6th Fleet, served as the viewing platform for officials representing participating coalition nations during ASD-15; delegates from seven MTMD Forum nations, Denmark, and Japan watched the missile intercept on a live video feed aboard the ship.

The Maritime Theater Missile Defense forum was established in 1999 as a co-operative body for participating navies to develop improved cooperation and promote interoperability in sea-based missile defense.[79]

November 1, 2015, Test. Regarding this test, MDA states:

The U.S. Missile Defense Agency (MDA), Ballistic Missile Defense System (BMDS) Operational Test Agency, Joint Functional Component Command for Integrated Missile Defense, U.S. European Command, and U.S. Pacific Command conducted a complex operational flight test of the BMDS demonstrating a layered defense architecture.

The test, designated Flight Test Operational-02 Event 2a, was conducted in the vicinity of Wake Island and surrounding areas of the western Pacific Ocean. The test stressed the ability of Aegis Ballistic Missile Defense (BMD) and Terminal High Altitude Area Defense (THAAD) weapon systems to negate two ballistic missile threats while Aegis BMD simultaneously conducted an anti-air warfare operation.

This was a highly complex operational test of the BMDS which required all elements to work together in an integrated layered defense design to detect, track, discriminate, engage, and negate the ballistic missile threats.

[79] U.S. Naval Forces Europe-Africa/U.S. 6th Fleet Public Affairs, "USS Ross Successfully Intercepts Ballistic Missile Target During Coalition Test," *Navy News*, October 20, 2015.

BMDS assets included: a THAAD battery consisting of a THAAD Fire Control and Communications (TFCC) unit, THAAD launcher, and an Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) radar in terminal mode; a second AN/TPY-2 radar in forward-based mode; Command, Control, Battle Management and Communications (C2BMC); and the USS JOHN PAUL JONES (DDG-53) Aegis BMD-configured ship with its onboard AN/SPY-1 radar.

At approximately 11:05 pm EDT (October 31), a Short Range Air Launch Target (SRALT) was launched by a U.S. Air Force C-17 aircraft southeast of Wake Island. The THAAD AN/TPY-2 radar in terminal mode detected the target and relayed track information to the TFCC to develop a fire control solution and provide track information for use by other defending BMDS assets. The THAAD weapon system developed a fire control solution, launched a THAAD interceptor missile, and successfully intercepted the SRALT target.

While THAAD was engaging the SRALT, an extended Medium Range Ballistic Missile (eMRBM) was air-launched by another Air Force C-17. The eMRBM target was detected and tracked by multiple BMDS assets including the AN/TPY-2 in forward-based mode, and the USS JOHN PAUL JONES with its AN/SPY-1 radar. Shortly after eMRBM launch, a BQM-74E air-breathing target was also launched and tracked by the USS JOHN PAUL JONES.

As a demonstration of layered defense capabilities, both Aegis BMD and THAAD launched interceptors to engage the eMRBM. The USS JOHN PAUL JONES successfully launched a Standard Missile-3 (SM-3) Block IB Threat Upgrade guided missile, but an anomaly early in its flight prevented a midcourse intercept. However, the THAAD interceptor, in its terminal defense role, acquired and successfully intercepted the target. Concurrently, Aegis BMD successfully engaged the BQM-74E air-breathing target with a Standard Missile-2 Block IIIA guided missile. A failure review is currently underway to investigate the SM-3 anomaly.

Several other missile defense assets observed the launches and gathered data for future analysis. Participants included the Command, Control, Battle Management, and Communications (C2BMC) Experimental Lab (X-Lab), C2BMC Enterprise Sensors Laboratory (ESL), and the Space Tracking and Surveillance System-Demonstrators (STSS-D).

The MDA will use test results to improve and enhance the BMDS.[80]

December 9, 2015, Test. Regarding this test, MDA states:

The Missile Defense Agency (MDA) and the Ballistic Missile Defense System (BMDS) Operational Test Agency, in conjunction with U.S. Pacific Command, U.S. European Command, and Joint Functional Component Command for Integrated Missile Defense, successfully conducted the first intercept flight test today (December 9, Hawaii Standard Time) of a land-based Aegis Ballistic Missile Defense (BMD) weapon system and Standard Missile (SM)-3 Block IB Threat Upgrade guided missile, launched from the Aegis Ashore Missile Defense Test Complex at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii.

During the test, a target representing a medium-range ballistic missile was air-launched from a U.S. Air Force C-17 aircraft over the broad ocean area southwest of Hawaii. An AN/TPY-2 radar in Forward Based Mode, located at PMRF, detected the target and relayed target track information to the Command, Control, Battle Management, and

[80] Missile Defense Agency press release 15-News-0008, dated November 1, 2015, entitled "Ballistic Missile Defense System Demonstrates Layered Defense While Conducting Multiple Engagements in Operational Test."

> Communication (C2BMC) system. The Aegis Weapon System at the Aegis Ashore site received track data from C2BMC and used its component AN/SPY-1 radar to acquire, track, and develop a fire control solution to engage the target. The Aegis Weapon System then launched the SM-3 Block IB Threat Upgrade guided missile from its Vertical Launch System. The SM-3's kinetic warhead acquired the target reentry vehicle, diverted into its path, and destroyed the target using the kinetic force of a direct impact.
>
> The primary purpose of the test, designated Flight Test Operational-02 Event 1a, was to assess the operational effectiveness of the Aegis Ashore capability as part of a larger BMDS architecture. Aegis Ashore uses a nearly identical configuration of the Vertical Launch System, fire control system, and SPY-1 radar currently in use aboard Aegis BMD cruisers and destroyers deployed at sea around the world.
>
> Vice Admiral James D. Syring, MDA Director, said, "Today's test demonstrated that the same Aegis Ballistic Missile Defense capability that has been fielded at sea and operational for years, will soon be operational ashore as part of the European Phased Adaptive Approach (EPAA) Phase 2 capability in Romania. I am very proud of the tremendous effort by the entire government/industry team in executing this vitally important mission for our Nation and our allies."[81]

Endo-Atmospheric (SM-2 Block IV) Flight Tests

The Aegis BMD system using the SM-2 Block IV interceptor and the SM-6 Dual I interceptor has achieved five successful endo-atmospheric intercepts in five at-sea attempts, the first occurring on May 24, 2006,[82] the second on June 5, 2008,[83] the third on March 26, 2009,[84] and the fourth and fifth on July 28 and 29, 2015. Regarding the intercepts of July 28 and 29, 2015, MDA states:

> The Missile Defense Agency (MDA), U.S. Pacific Command, and U.S. Navy Sailors aboard the USS John Paul Jones (DDG 53) successfully conducted a series of four flight test events exercising the Aegis Ballistic Missile Defense (BMD) element of the nation's Ballistic Missile Defense System (BMDS). The flight test, designated Multi-Mission Warfare (MMW) Events 1 through 4, demonstrated successful intercepts of short-range ballistic missile and cruise missile targets by the USS John Paul Jones, configured with Aegis Baseline 9.C1 (BMD 5.0 Capability Upgrade) and using Standard Missile (SM)-6 Dual I and SM-2 Block IV missiles. All flight test events were conducted at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii.
>
> MDA Director Vice Adm. James D. Syring said, "This important test campaign not only demonstrated an additional terminal defense layer of the BMDS, it also proved the robustness of the multi-use SM-6 missile on-board a Navy destroyer, further reinforcing the dynamic capability of the Aegis Baseline 9 weapon system."
>
> Event 1

[81] Missile Defense Agency press release 15-NEWS-0011, dated December 10, 2015, entitled "Standard Missile Completes First Intercept Test from Aegis Ashore Test Site."

[82] 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.

[83] See Missile Defense Agency, "Successful Sea-Based Missile Defense Intercept," June 5, 2008 (08-NEWS-0068); Dave Ahearn, "Aegis, SM-2 Interceptors Kill Target Missile In Terminal-Phase Success," *Defense Daily*, June 6, 2008.

[84] "Navy Completes Air and Ballistic Missile Exercise," *Navy News Service*, March 26, 2009.

On July 28, at approximately 10:30 p.m. Hawaii Standard Time (July 29, 4:30 a.m. Eastern Daylight Time), a short-range ballistic missile (SRBM) target was launched from PMRF in a northwesterly trajectory. The USS John Paul Jones, positioned west of Hawaii, detected, tracked, and launched a SM-6 Dual I missile, resulting in a successful target intercept.

Event 2

On July 29, at approximately 8:15 p.m. Hawaii Standard Time (July 30, 2:15 a.m. Eastern Daylight Time), a short-range ballistic missile (SRBM) target was launched from PMRF in a northwesterly trajectory. The USS John Paul Jones detected, tracked, and launched a SM-2 Block IV missile, resulting in a successful target intercept.

Event 3

On July 31, at approximately 2:30 p.m. Hawaii Standard Time, (8:30 p.m. Eastern Daylight Time) an AQM-37C cruise missile target was air-launched to replicate an air-warfare threat. The USS John Paul Jones detected, tracked, and successfully engaged the target using an SM-6 Dual I missile.

Event 4

On August 1, at approximately 3:45 p.m. Hawaii Standard Time, (9:45 p.m. Eastern Standard Time), a BQM-74E cruise missile target was launched from PMRF. The USS John Paul Jones detected, tracked, and successfully engaged the target using an SM-6 Dual I missile. The SM-6's proximity-fuze warhead was programmed not to detonate after reaching the lethal distance from the target, thus providing the ability to recover and reuse the BQM-74E target....

MMW Event 1 was the first live fire event of the SM-6 Dual I missile.

MMW Events 1 and 2 were the 30th and 31st successful ballistic missile defense intercepts in 37 flight test attempts for the Aegis BMD program since flight testing began in 2002.[85]

[85] See Missile Defense Agency, "Aegis Ballistic Missile Defense System Completes Successful Series of Intercept Flight Test Events, August 3, 2015 (15-NEWS-0007).

Appendix B. Homeporting of U.S. Navy Aegis BMD Ships at Rota, Spain

This appendix presents additional background information on the Navy's plan to homeport four BMD-capable Aegis destroyers at Rota, Spain.

As part of the October 5, 2011, U.S.-Spain joint announcement of the plan, the Prime Minister of Spain, Jose Luis Rodriguez Zapatero, stated in part:

> This meeting marks a step forward on the path that we set for ourselves less than a year ago at the Lisbon Summit, aiming to make NATO an Alliance that is "more effective, engaged and efficient than ever before", in the words of [NATO] Secretary-General Rasmussen.
>
> At that historic Summit, decisions of enormous importance for the future of the Alliance were taken, such as the New Strategic Concept to face the new challenges of the 21st century, and the establishment of a new command structure that is leaner and more flexible, and improved.
>
> Besides these two important innovations, and as a consequence of them, the allies decided to develop an Anti-Missile Defence System.…
>
> As you will recall, as a consequence of this new structure launched in Lisbon, Spain obtained an installation of great importance within NATO's Command and Control Structure: the Combined Air Operations Centre (CAOC) in Torrejón de Ardoz, Spain.
>
> This Centre, together with the Centre in Uedem, Germany, will form part of the air command and control system which is to include the anti-missile defence that the Alliance is going to implement.
>
> Together with this land-based component of the new air defence system, I can inform you that Spain is also going to support, starting in 2013, an important part of the system's naval element.
>
> In recent months, the different options have been studied, and finally, it was decided that Spain should be the site for this component of the system, due to its geostrategic location and its position as gateway to the Mediterranean.
>
> Specifically, the United States is going to deploy, as its contribution to NATO's Anti-Missile Defence System, a total of four vessels equipped with the AEGIS system, to be based in Rota.
>
> This means that Rota is going to become a support centre for vessel deployment, enabling them to join multinational forces or carry out NATO missions in international waters, particularly in the Mediterranean….
>
> Moreover, this initiative will have a positive impact, in socio-economic terms, on our country, and most especially on the Bay of Cadiz.
>
> Permanently basing four vessels in Rota will require investing in the Base's infrastructure, and contracts with service providers, thus generating approximately a thousand new jobs, both directly and indirectly.
>
> For the shipyards, and for Spain's defence industry, the foreseeable impact will also be highly positive, as the USA is considering conducting the vessels' maintenance and

> upkeep at the nearby San Fernando shipyards, in the province of Cadiz. In addition, there will be significant transfer of state-of-the-art technology, from which Spain can benefit.[86]

As part of the same joint announcement, Secretary of Defense Leon Panetta stated in part:

> With four Aegis ships at Rota, the alliance is significantly boosting combined naval capabilities in the Mediterranean, and enhancing our ability to ensure the security of this vital region. This relocation of assets takes place as part of the United States' ongoing effort to better position forces and defensive capabilities in coordination with our European allies and partners.
>
> This announcement should send a very strong signal that the United States is continuing to invest in this alliance, and that we are committed to our defense relationship with Europe even as we face growing budget constraints at home.…
>
> Alongside important agreements that were recently concluded with Romania, Poland, and Turkey, Spain's decision represents a critical step in implementing the European Phased Adaptive Approach, as our leaders agreed to in Lisbon.…
>
> Beyond missile defense, the Aegis destroyers will perform a variety of other important missions, including participating in the Standing NATO Maritime Groups, as well as joining in naval exercises, port visits, and maritime security cooperation activities….
>
> The agreement also enables the United States to provide rapid and responsive support to the U.S. Africa and U.S. Central Commands, as needed.[87]

An October 5, 2011, press report stated:

> A senior U.S. defense official said making the [ships'] base at Rota, on Spain's southwestern Atlantic coast near Cadiz, would reduce the numbers of [BMD-capable Aegis] ships needed for the [EPAA] system.
>
> "You [would] probably need 10 of these ships if they were based in the eastern U.S. to be able to ... transit across the ocean back and forth to [keep the same number on] patrol in the Med," he said.
>
> The U.S. official said the United States was committed to having at least one ship on station at all times in the eastern Mediterranean, where their anti-missile missiles would be most effective. Having them based in Rota would enable more than one to be in the eastern Mediterranean as needed.
>
> The ships also would be part of the pool of vessels available to participate in standing NATO maritime groups, which are used to counter piracy and for other missions, he said.[88]

An October 10, 2011, press report stated:

> "Our plan is to have the first couple [of ships] there in 2014 and the next two in about 2015," said Cmdr. Marc Boyd, spokesman for [U.S. Navy] 6th Fleet. Boyd added: "It's

[86] "Announcement on missile defence cooperation by NATO Secretary General Anders Fogh Rasmussen, the Prime Minister of Spain, Jose Luis Rodriguez Zapatero and US Defense Secretary Leon Panetta," October 5, 2011, accessed October 6, 2011, at http://www.nato.int/cps/en/SID-107ADE55-FF83A6B8/natolive/opinions_78838.htm.

[87] "Announcement on missile defence cooperation by NATO Secretary General Anders Fogh Rasmussen, the Prime Minister of Spain, Jose Luis Rodriguez Zapatero and US Defense Secretary Leon Panetta," October 5, 2011, accessed October 6, 2011, at http://www.nato.int/cps/en/SID-107ADE55-FF83A6B8/natolive/opinions_78838.htm. See also "SECDEF Announces Stationing of Aegis Ships at Rota, Spain," accessed October 6, 2011, at http://www.navy.mil/search/display.asp?story_id=63109.

[88] David Brunnstrom and David Alexander, "Spain To Host U.S. Missile Defense Ships," *Reuters*, October 5, 2011. Ellipsis as in original.

really early in the process and we haven't selected any of the ships yet." Boyd said the shift will bring an estimated 1,300 sailors and Navy civilians and 2,100 dependents to Naval Station Rota, which would double the base's ranks. Naval Station Rota spokesman Lt. j.g. Jason Fischer said the base now has 1,067 sailors….

The three piers at the base primarily support Navy ships passing through on port calls.

Boyd said 6th Fleet is considering plans to add base infrastructure and maintenance facilities to support the ships, as well as additional housing for crews, "but the base is pretty suited as it is now."[89]

[89] Sam Fellman, "U.S. To Base Anti-Missile Ships in Spain," *Defense News*, October 10, 2011: 76.

Appendix C. Allied Participation and Interest in Aegis BMD Program

This appendix presents additional background information on allied participation and interest in the Aegis BMD program.

Japan[90]

A September 16, 2014, press report states:

> The Japanese Defense Ministry is interested in acquiring Lockheed Martin's Aegis Ashore ballistic missile defense (BMD) battery, according to an August report from the Japanese newspaper, Mainichi Shimbun.
>
> The paper reported the Defense Ministry is expected to spend "tens of millions of yen" as part of the Fiscal Year 2015 state budget for research into Aegis Ashore—which combines the Lockheed Martin SPY-1D radar with a battery of Raytheon Standard Missile-3 missiles.
>
> "The ministry intends to introduce new ground-based SM-3 missiles, in addition to the sea-based SM-3s that the Maritime Self-Defense Force (MSDF) already possesses, to enhance Tokyo's readiness to intercept ballistic missiles heading toward Japan," according to the report....
>
> Currently, Japan uses a combination of four Kongo-class Aegis-equipped guided missile destroyers armed with SM-3s for longer-range ballistic missile threats and Lockheed Martin Patriot Advanced Capability-3 (PAC-3) mobile ground based interceptors for missiles closer to their targets.
>
> "There are concerns that PAC3s could not respond if a massive number of ballistic missiles were to be simultaneously launched toward Japan," read the Mainichi report.
>
> Japan intends to double the amount of BMD destroyers to eight by 2018, according to local press reports.
>
> The Kongos ships use a legacy Aegis BMD configuration that do not allow the Aegis combat system to operate as BMD defense platforms and as anti-air warfare ships simultaneously.
>
> Japan is also exploring upgrading at least some of its ships to a more advanced Baseline 9 configuration that would allow the ships to simultaneously act as a BMD and AAW platform.
>
> Aegis Ashore operates with a version of Baseline 9 that doesn't include an AAW component, but given the similarities of the ground based system and the Aegis combat system onboard U.S. and Japanese ships, those capabilities could expand.
>
> "This is the Aegis weapon from a ship. It can do AAW, terminal defense and mid-course intercept," Navy Capt. Jeff Weston, the Aegis Ashore program manager for the Missile Defense Agency (MDA) said last year during a USNI News interview at Lockheed Martin's Aegis testing facility in Moorestown, N.J.

[90] For a research paper providing additional background information U.S.-Japan cooperation in ballistic missile defense, see Rachel Hoff, "U.S.-Japan Missile Defense Cooperation: Increasing Security and Cutting Costs," American Action Forum, December 2, 2015.

> At the time, Weston said an U.S. Aegis Ashore battery would only concentrate on BMD. "We're not going to do anti-air warfare in someone else's country," he said.
>
> However, a Japanese run installation could expand the missile offerings beyond the BMD optimized SM-3s.
>
> Depending on the configuration of the Aegis Ashore installation, the site could conceivably be expanded to include other AAW capabilities that would allow the site to handle multiple air threats in addition to a BMD mission.[91]

Other Countries[92]

An October 3, 2016, press report states that MDA is examining how allied countries in Europe could be brought into the European Aegis missile defense architecture. The report states that

> MDA is studying how the Netherlands' new SMART-L long-range naval radar could be integrated into U.S. ballistic missile defense architectures, namely the Aegis Ashore system in Europe, according to Rear Adm. Johnny Wolfe, the program executive officer for Aegis BMD at MDA. He said the agency is also looking at how to loop the United Kingdom's Type 45 destroyers and Spain's Aegis destroyers -- which do not have BMD capabilities of their own -- into the U.S. network.[93]

A September 6, 2016, press report states:

> A trio of planned South Korean guided missile destroyers will be built with the capability to intercept ballistic missile threats, USNI News has learned.
>
> The addition of the capability will give the Republic of Korea (RoK) Navy a powerful organic BMD capability in addition to U.S. Army ground-based interceptors peppered throughout South Korea.
>
> Under the plan, the three remaining ships in the Sejong the Great-class will be able to simultaneously intercept traditional air warfare threats while adding a ballistic missile defense capability through a series of hardware and software upgrades over the current class of ship, several sources confirmed to USNI News.
>
> The destroyers will be fitted with the U.S. Navy's Baseline 9 version of the Aegis Combat System that combines modern computing architecture to allow the ship's AN/SPY-1D(v) radar to detect and track aircraft, cruise missiles and ballistic missiles at the same time.
>
> The capability will likely be paired with Raytheon Standard Missile 3 BMD interceptors the ships can pair with the combat system to detect and destroy medium-range ballistic missile threats. Several Korean press outlets have reported the military is seeking to install SM-3s on the three new ships.

[91] Sam LaGrone, "Report: Japan Interested in Aegis Ashore for Ballistic Missile Defense," *USNI News* (http://news.usni.org), September 16, 2014. See also "Defense Ministry Mulls Introducing Ground-Based SM-3 Interceptor Missiles," *Mainichi* (http://mainichi.jp), August 9, 2014.

[92] In addition to the press reports shown in this section, see Robert Holzer and Scott Truver, "Aegis, Missile Defense and the US Pivot," *The Diplomat*, July 30, 2014, for a discussion of developments in Australia, Japan, and South Korea.

[93] Justin Doubleday, "MDA Looking to Integrate European Allies into Missile Defense Architecture," *Inside the Navy*, October 3, 2016. See also Ellen Mitchell, "Missile Defense Agency Seeks More Aegis Integration in Europe," *Politico Pro Defense Report*, September 30, 2016.

> Officials with Aegis combat system developer Lockheed Martin told USNI News the new Korean ships would have an "integrated air and missile defense" (IAMD) capability installed aboard but would not elaborate on any other details of the combat system.[94]

An October 26, 2015, press report states:

> The U.S. Navy and its NATO counterparts are discussing how to make maritime ballistic missile defense (BMD) training a routine event in Europe, in the hopes that countries will grow more comfortable working with one another in this warfare area and even invest in greater capabilities, the head of American ballistic missile defense in Europe told USNI News.
>
> Last week's Maritime Theater Missile Defense (MTMD) Forum Integrated Air and Missile Defense (IAMD) At Sea Demonstration [i.e., the October 20, 2015 Aegis BMD flight test] was the first of its kind but will not be the last—the U.S. Navy is both planning a 2016 follow-up to coincide with the annual Rim of the Pacific (RIMPAC) exercise, and working with NATO to develop an ongoing maritime ballistic missile defense exercise program, Capt. Jeffrey Wolstenholme, commodore of Task Force 64, told USNI News in an interview from aboard USS Ross (DDG-71) in the U.S. 6th Fleet area of operations.
>
> Wolstenholme said BMD had for a long time been considered a land-based mission set. The U.S. Army and Air Force, as well as their counterparts in Europe, have a variety of assets across the continent to track and engage incoming missiles – including the Raytheon Patriot surface-to-air missile system and the Lockheed Martin Terminal High-Altitude Area Defense (THAAD) system.
>
> "The (MTMD) forum was started because of the emphasis that was starting to be placed on maritime ballistic missile defense," he said.
>
> "We have Patriot missile defense capabilities, THAAD missile defense capabilities that are primarily in the Army and Air Force realm. Maritime has always kind of played second fiddle to that, but with the advent of the Aegis ship and what we have brought forward with the ballistic missile defense capability within in the U.S. Navy, now maritime is really coming to the forefront.
>
> "And the other nations are starting to get involved in this warfare area as well," he continued.
>
> "We're seeing a lot of development in the Netherlands. The Spanish are showing a lot of interest, as well as the United Kingdom and the Italians. And to some degree the French, who have been watching this."
>
> Though NATO is not affiliated with the MTMD Forum, most of the 10 forum members are in NATO—Australia, Canada, France, Germany, Italy, The Netherlands, Norway, Spain, United Kingdom and the United States. Australia did not participate in the demo and Germany sent personnel to support the exercise but not any military platforms.
>
> NATO is in the midst of discussions about how to improve theater missile defense, Wolstenholme said, and was watching the nine-country live fire demonstration closely.
>
> "There's a lot of discussion going on throughout the NATO community. In fact, just earlier this month there was a conference in Spain … and there was a lot of discussion

[94] Sam LaGrone, "New South Korean Destroyers to Have Ballistic Missile Defense Capability," *USNI News*, September 6, 2016. See also Sam LaGrone, "Report: South Kore Wants BMD Capability for Guided Missile Destroyers," *USNI News*, August 15, 2016; Bradley Perrett and Kim Minseok, "Adding Interceptors, SM-3 May Join Missile Defenses in South Korea," *Aviation Week & Space Technology*, August 15-28, 2016: 49.

about where do we go next after this At-Sea Demo in developing an exercise program," he said.

"And there's several proposals being discussed right now to figure out how we get this stood up and make it more mature."....

The exercise included the first launch of a Standard Missile-3 in Europe, and securing the region for the ballistic missile target launch and the SM-3 intercept was no easy undertaking—commercial air traffic in and out of Europe typically flies right over the Hebrides Range in Scotland and had to be diverted to the south, and U.S. Navy P-3s and P-8s and U.K. E-3Ds scanned the water to ensure the seas were clear of all boat traffic....

Mary Keifer, Lockheed Martin's Aegis in-service and fleet readiness program director, said after the at-Sea demonstration that the company was working with NATO and MTMD Forum members to improve their ships on a budget. After working with the Spanish Navy in 2007 to demonstrate a carry-on/carry-off temporary solution to help Spain's Aegis-equipped ships track ballistic missiles, Keifer said the company again worked with Spain ahead of the demonstration to do a partial upgrade to some Aegis BMD tracking capabilities.[95]

A July 28, 2014, press report states:

The Italian navy is working to develop the ballistic missile defense (BMD) capability of its Orizzonte-class air-defense ships and pave the way for BMD systems to be installed on a new class of ship to be launched in the early 2020s.

Software engineers at the Italian navy's programming center—known as Maricenprog—near the navy's main dockyard at Taranto, have been developing tactical BMD capabilities for the ship as part of the country's participation in the wider NATO tactical BMD program. The Italian defense ministry supports the effort with the land-based TPS-77 radar system and the SAMP-T ground-based air defense system, but wants to back up these efforts at sea with the Orizzonte or Horizon-class ships.

According to Gianpaolo Blasi, director of Maricenprog, the program has already completed two of what NATO describe as Ensemble Tests (ET), which pave the way for entry into the NATO BMD program. The navy is preparing for a trial due to take place in 2015 that will see the Orizzonte-class vessel ITN Doria supporting and defending another—as yet unconfirmed—BMD-capable ship that will track and potentially engage a ballistic missile target. During the trials the Doria will act as shotgun, defending the missile-tracking vessel from conventional air threats that the other ship cannot deal with as it tracks the ballistic missile.

The Doria will be able to transmit details of the engagement around the fleet through a tactical data link modified to carry BMD data.[96]

A June 13, 2014, press report states:

Talks between the U.S. and Australia have given fresh momentum to Washington's plans to create a larger ballistic-missile defense shield for its allies in Asia.

According to a U.S. statement overnight, discussions between President Barack Obama and visiting Australian Prime Minister Tony Abbott resulted in a commitment from Canberra for help in pushing forward with expanded missile-defense plans as a counter to North Korea....

[95] Megan Eckstein, "NATO Hopes To Boost Collective Maritime BMD Capability Through Exercises, Investments," *USNI News*, October 26, 2015.

[96] Tony Osborne, "Italian Navy Paves Way For Ship-Based BMD Capability," *Aerospace Daily & Defense Report*, July 28, 2014: 1-2.

> Washington's statement on Thursday [June 12] said the U.S. was now examining ways for Australia to participate in a bigger regional system using the country's coming fleet of missile destroyers equipped with advanced Aegis radar capability.
>
> "We are…working to explore opportunities to expand cooperation on ballistic missile defense, including working together to identify potential Australian contributions to ballistic-missile defense in the Asia-Pacific region," the U.S. statement said.
>
> Australia is building a new fleet of warships that could be equipped to shoot down hostile missiles, as part of an ambitious military buildup that includes investments in new stealth-fighter aircraft, cruise missiles, amphibious carriers and submarines. The revamp will cost close to 90 billion Australian dollars (US$85 billion) over a decade.
>
> "This might mean the Australian Defence Force could end up mounting advanced missiles on its Aegis-equipped air-warfare destroyers," said security analyst James Brown of Australia's Lowy Institute.[97]

A September 16, 2013, press report states:

> One of the UK Royal Navy's new Type 45 destroyers is conducting tests to establish whether the warships could provide British forces with theater ballistic-missile defense (TBMD) capabilities for the first time, according to the head of the Royal Navy.
>
> First Sea Lord Adm. Sir George Zambellas said during a speech to industry executives and military personnel on the opening day of the DSEi defense exhibition that the "type is on trials in the Pacific to explore the ballistic-missile defense capabilities that are ready to be exploited, bringing strategic opportunities to the vessel."
>
> The Type 45 destroyer Daring, one of six Type 45s built by BAE Systems for the Royal Navy, has been in the Pacific for several weeks, having departed its Portsmouth base this summer for a wide-ranging nine-month deploy-ment, which the Royal Navy said in May would include science and technology trials. The work is being done as part of a US Missile Defense Agency (MDA) research and development test....
>
> In May, the UK Defence Ministry confirmed it was talking to Aster 30 partners France and Italy about developing an extended-range version of a missile already used by the French and Italian armies to intercept incoming missiles While there is no program to adapt the Type 45 to include TBMD capability, the trials support the possibility of such a move once a decision whether to go down that route is made by the British government.[98]

A March 18, 2013, press report states:

> Raytheon has discussed a possible pooling arrangement with three navies in northern Europe to make its SM-3 ballistic missile inter-ceptor more affordable, according to a senior company executive.
>
> Speaking after a successful test of a new data link enabling the SM-3 to communicate with X-band radars operated by Dutch, Danish and Ger-man warships, George Mavko, director of European missile defense at Raytheon Missile Systems, said the idea of a pooling arrangement had been raised by the company, even though none of the countries are pursuing procurement at this point....
>
> While all three European navies have expressed an interest in the capability of the SM-3 to engage ballistic missiles at ranges outside the atmosphere, none appear close to actually procuring the missiles....

[97] Rob Taylor, "U.S. and Australia to Cooperate on Asian Missile-Defense Plans," *Wall Street Journal* (http://online.wsj.com), June 13, 2014.

[98] Andrew Chuter, "UK Royal Navy Examines BMD Capabilities," *Defense News*, September 16, 2013: 38.

> Instead, led by the Dutch, the initial moves appear focused on updating naval X-band radars and other systems so they can provide target data to SM-3 missiles even if they can't prosecute their own attack....
>
> Aside from the pooling idea, Raytheon also recently opened discussions with the U.S. Missile Defense Agency over co-production of SM-3 systems in Europe to sweeten any future deal, Mavko said....
>
> Small bits of the missile are already produced in Europe, although it was "too early to imply the U.S. is willing to release any major subsystems to other countries for co-production," Mavko said....
>
> Raytheon has been cooperating with the Dutch Navy for several years, exploring the potential of the SM-3 to talk to X-band radars. The Dutch have co-funded a study with the U.S. government on the feasibil-ity of a dual-band data link; the study is due to be extended into a second phase. The German government has agreed to participate this time.[99]

A March 11, 2013, press report states:

> The Eurosam SAMP/T surface-to-air missile system has destroyed a representative theater ballistic missile during a test in France.
>
> The March 6 test saw a joint Italian and French team engage an aircraft-launched target using an Aster 30 missile fired from the Biscarosse missile test center on the Bay of Biscay coast.
>
> According to French government defense procurement agency the DGA, the operational evaluation firing was jointly carried out by the Italian 4th Artillery Regiment of Mantova with the French military airborne test center (CEAM) of Mont-de-Marsan. In a change from previous interceptions, the SAMP/T used Link 16 data links to provide target information. The test also was the first to use what Eurosam calls a NATO environment in terms of command and control of the weapon, rather than simply using French sensors.
>
> The company says the firing was as "close to what would be an operational use for an anti-theater ballistic missile mission under the aegis of the alliance Active Layered Theater Ballistic Missile Defense program."
>
> The company adds, "The NATO Ballistic Missile Defense Operations Cell, located in Ramstein, Germany, was in the loop via Link 16 network."[100]

Another March 11, 2013, press report states:

> Joint US and European testing of command, control, communications and radar systems are underway to demonstrate the feasibility of integration of European radars and command and control systems into a future missile defense systems based on the planned European Phased Adaptive Approach (EPAA) utilizing the several AEGIS destroyers or cruisers to be based in Spain, land-based SM-3 interceptors to be stationed in Romania and Poland, along with SPY-2 radars sites. These assets are to be complemented by a number of European deployed radar sites.
>
> In recent weeks tests were carried out to evaluate such integration. Last week Raytheon reported about a recent trial that showed that a radar used by Dutch, German and Danish navies could provide target information to the interceptor. The current radar installed on the Dutch frigates is incompatible with the AEGIS/SM-3 link operating over S-band. The

[99] Andrew Chuter, "Raytheon Pushes European SM-3 Missile Pool," *Defense News*, March 18, 2013: 4.

[100] Tony Osborne, "European SAMP/T Destroys Ballistic Missile In Test," *Aerospace Daily & Defense Report*, March 11, 2013: 3.

> demonstration which took place at the Den Helder military test range validated a datalink that allows the missile to receive information from the Thales sensor while retaining the ability to communicate with Aegis combat ships used by the U.S. Navy. Generally, The Dutch, German and Danish navies datalinks are operating on X bands, while Norway, Spain and the U.S. operate AEGIS frigates communicating with their interceptors over the S band. To avoid unique configurations of missiles, Raytheon has developed a dual-band datalink which enables the same missile to communicate in both bands. This dual-band datalink was first tested in 2011.[101]

A March 8, 2013, press report states:

> The British Royal Navy is exploring the possibility of outfitting its newest class of destroyers with a ballistic missile defense capability.
>
> The Defence Ministry said this week it wants to examine the potential for the Type 45 destroyers to play a role in defending the United Kingdom and allies from the threat of ballistic missiles. The ministry said it will build on its relationship with the Pentagon's Missile Defense Agency to look at the option....
>
> The joint Defence Ministry and industry-run U.K. Missile Defence Center (MDC) plans to take part in a trial that for the first time will use a Type 45 in a research and development program with their American counterparts.
>
> That will involve testing the Sampson radar, which is part of the Sea Viper missile system, in detecting and tracking ballistic missiles, the ministry said.
>
> The is no program to deploy ballistic missile defense on Type 45s but the MDC has in recent years been exploring the option for the destroyers.
>
> "It will be a step change to be able to work so closely with such a ship in an emerging area of defense," MDC head Simon Pavitt said in a statement. "Working with an operational platform will make a significant difference to our level of understanding and could contribute both financially and technically towards any future program."[102]

An October 2012 article stated:

> The Royal Netherlands Navy's (RNLN's) four De Zeven Provincien-class LCF air defence and command frigates are to receive a substantially upgraded and rearchitectured SMART-L D-band volume search radar that will give the ships a ballistic missile defence (BMD) early warning capability.
>
> Thales Nederland received a EUR116 million (USD145 million) contract from the Netherlands' Defence Materiel Organisation (DMO) in June 2012 for the new extended-range sensor known as 'SMART-L EWC'. This new variant of SMART-L, which builds oni the results of a previous Extended Long Range (ELR) capability demonstration, will push instrumented range out to 2,000 km; improve elevation coverage; introduce new wave forms and processing optimised for the detection and tracking of very-high-velocity ballistic missile targets at altitude; and enable estimation of trajectories, launch sites and

[101] Tamir Eshel, "Integrating European Radars with AEGIS/SM-3 Missile Defenses," *Defense Update* (http://defense-update.com), March 11, 2013, accessed March 20, 2013, at http://defense-update.com/20130311_integrating-european-radars-with-aegissm-3-missile-defenses.html.

[102] Mike McCarthy, "U.K. Examining Sea-Based Missile Defense," *Defense Daily*, March 8, 2013: 10. See also "British Destroyer to Participate in U.S. Missile Defense Trials," *Defense Update* (http://defense-update.com), March 7, 2013, accessed March 27, 2013, at http://defense-update.com/20130307_british-destroyer-to-participate-in-u-s-missile-defense-trials.html.

points of impact. At the same time, all SMART-L volume air search functionality will be retained.[103]

A journal article published in the summer of 2012 states:

> Today the steady growth of Aegis-capable ships in the U.S. Navy—as well as an increasing number of world navies fielding such ships—presents new opportunities and challenges....
>
> ... the Aegis BMD capabilities present in the navies of U.S. allies and friends can now provide the Global Maritime Partnership with a means to address the "high end" of the kill chain with combined, coordinated, ballistic-missile defense: the Aegis BMD Global Enterprise.
>
> This potential is already manifest in the Asia-Pacific region in the close working relationship between the United States and Japan. Korea and Australia could well join this Aegis network soon, giving the four governments the means to address not only territorial BMD but also coordinated BMD of fleet units operating together. In Europe, plans are well along to provide robust territorial defense of European nations with ALTBMD [active layered theater BMD] and the EPAA. Together, these systems provide a nascent BMD capability today and promise an even more robust capability as the EPAA evolves over the next decade and a half.
>
> But as demonstrated in Iraq, Afghanistan, and now Libya, NATO and the nations of Europe have equities often well beyond the territorial boundaries of the European continent. Also, a European military deployed beyond Europe's borders will always have a naval component. This is therefore a propitious time to begin to link European allies more completely into an Aegis BMD Global Enterprise in much the same way the U.S. Navy is linked to its Asia-Pacific partners—Japan today, Korea soon, and thereafter Australia in the near future—in a high-end Aegis BMD Global Maritime Partnership....
>
> The diffusion of Aegis BMD capability abroad is occurring quietly. Governments that have made naval force-structure investment decisions based primarily on inwardly focused national interests have discovered that their investments also enable them to combine their resources in collective defense....
>
> This effort to create a broad BMD enterprise builds on the current participation of allied navies in the Aegis program. This global effort started with a foreign military sales relationship with Japan, subsequently expanded to relationships with Australia and Korea, and now includes a commercial connection with Spain as well as an enterprise between Norway and Spain.22 Several other states have expressed interest in acquiring the Aegis weapon system and Aegis BMD. Importantly, Australia and other countries that are acquiring the Aegis system are stipulating that the systems they buy must have the capability of adding BMD in the future....
>
> In Europe, the decision as to whether and how to connect the European NATO allies' short- and medium-range theater missile-defense systems to the U.S. long-range missile defense system will be critical to the coherence of alliance-wide BMD. A high level of commitment to international partnership on the parts of both the United States and its allies—already evinced by ALTBMD and C2BMC shared situational-awareness tests—will encourage interoperability initiatives. This interoperability will, in turn, help ensure the success of the U.S. Phased Adaptive Approach....
>
> Close cooperation in the area of Aegis BMD between the United States and Japan, possibly Korea, and potentially Australia does not in itself qualify as an "Aegis BMD

[103] Kate Tringham, "Warning Signs: Netherlands Evolves SMART-L Radar For Ballistic Missile Defence Mission," *Jane's International Defence Review*, October 2012: 28-29.

> Global Enterprise." But to include European nations in an Aegis-afloat enterprise of capabilities approaching those planned for the ALTBMD/EPAA system would....
>
> European navies are now deployed worldwide fulfilling the vision of a Global Maritime Partnership: supporting operations in Iraq and Afghanistan, fighting in Libya, conducting antipiracy patrols in the Horn of Africa and elsewhere, and supporting humanitarian assistance operations around the world. There could be no more propitious time to begin to link more completely European allies in an Aegis BMD Global Enterprise, in much the same way the U.S. Navy is now linked to its Asia-Pacific partners in a high-end Aegis BMD Global Maritime Partnership....
>
> But it is unlikely that such a venture would succeed without ongoing U.S. leadership, the same sort of leadership that is supporting sea-based Aegis BMD for territorial and fleet ballistic-missile defense today in the northeast Pacific as well as sea-based and land-based ballistic territorial missile defense in Europe. Clearly, U.S. leadership could be what accelerates the morphing of a now-nascent Aegis BMD Global Enterprise in Europe into a global Aegis BMD afloat capability....
>
> There is a growing worldwide commitment to Aegis ballistic-missile defense, a commitment with broad potential to field an international global enterprise capable of defending against the most imminent, and growing, threat to nations and navies, on land and at sea alike—the threat of ballistic missiles, particularly those armed with weapons of mass destruction.[104]

A May 7, 2012, press report states:

> The German Navy's fleet of frigates could be upgraded to deploy Raytheon's [RTN] Standard Missile-3 to participate in NATO's ballistic missile defense program if the modifications were approved by the government, Germany's top naval officer recently said.
>
> Vice Admiral Axel Schimpf, the counterpart to the U.S. Navy's chief of naval operations, said in a recently published article that the F124 frigates are capable of being upgraded to play a vital role in ballistic missile defense (BMD).
>
> "The German Navy, with the F124 Frigates in their current configuration, has a weapon system at their disposal which forms the basis for capability enhancements for (German) armed forces' participation in various roles," according to a translation of an article he penned in Marine Forum, a publication of the German Maritime Institute.
>
> One option, Schimpf said, would be to upgrade the F124s' SMART-L and Active Phased Array Radar (APAR) combat management system, along with the Mk-41 vertical launch system to accommodate the SM-3....
>
> The enhancements would be one way for Germany to participate in the Obama administration's European Phased Adaptive Approach (EPAA) embraced by NATO, and could be done in cooperation with Denmark or the Netherlands, Schimpf said....
>
> The German government has not made on decisions on whether to adapt its frigates for ballistic missile defense, and Germany's role in EPAA is the source of ongoing political discussions in Berlin ahead of NATO's May 20-21 summit in Chicago....
>
> Only a handful of NATO allies deploy the Aegis combat system on ships, and Germany is not one of them. Germany's combat system does not operate on an S-band frequency

[104] Brad Hicks, George Galdorisi, and Scott C. Truver, "The Aegis BMD Global Enterprise," *Naval War College Review*, Summer 2012: 65-80.

used on Aegis. Raytheon, however, says it has developed a duel band data link that would allow the combat system on allied ships to talk to the SM-3 and guide it to targets.[105]

An October 3, 2011, press report stated that

> The Netherlands, which has had a longtime interest in a missile shield, is pressing ahead to build up its own capabilities. The Dutch defense ministry plans to expand the capabilities of the Thales Smart-L radar on Dutch frigates to take on BMD roles. The program's value is estimated at €100-250 million, including logistics support and spares.
>
> Other European navies using the sensor may follow the Dutch lead.
>
> Dutch Defense Minister Hans Hillen notes that the Smart-L effort would help address the BMD sensor shortage within the NATO alliance. Citing NATO's decision last year to take a more expansive approach to BMD, Hillen says Smart-L could give the ALTBMD [Active Layered Theater BMD] command-and control backbone the required long-range target-detection analysis to help identify where a threat originates.
>
> The Netherlands has already carried out a sensor trial for the expanded role in cooperation with the U.S. Navy. The move does not include the purchase of Raytheon Standard Missile SM-3 interceptors.
>
> Both hardware and software modifications to the combat management system are needed. All four [of the Dutch navy's] De Zeven Provincien-class frigates would be modified to ensure that two can be deployed, even as one is in maintenance and the fourth is being readied for operations.
>
> Thales is due to complete a series of studies to prepare for the acquisition of the upgrade in the third quarter of 2012. The goal is to have the first frigates ready for operations by 2017. All four should be upgraded by the end of that year.
>
> Although the Netherlands is leading the program, other Smart-L users, including the German navy and Denmark, have been monitoring the effort. France also has shown interest in the system, Hillen said in a letter to legislators.
>
> France also wants to upgrade its Aster 30 interceptor to give it a basic BMD capability, although a formal contract has not been awarded….
>
> Raytheon, meanwhile, is still fighting to win a foothold for its Standard Missile 3 (SM-3) in Europe. The company continues its push to persuade continental navies to embrace the SM-3 Block 1B for missile defense roles, and says it has largely validated the dual-mode data link that would be key to the concept.
>
> The data link would feature both S- and X-band capability—the former to support the Aegis radar system used by the U.S. and others, and the latter for the Smart-L/APAR (active phased array radar) combination used, for instance, by the Dutch navy.[106]

A September 2011 press report states:

> The gulf in sea-based ballistic missile defence (BMD) capability between the navies of NATO's European member states and the US Navy (USN) was brought into stark relief by the recent deployment of the Ticonderoga-class cruiser USS Monterey to the

[105] Mike McCarthy, "Raytheon's SM-3 An Option For German Role In Missile Defense, Admiral Says," *Defense Daily*, May 7, 2012: 9.

[106] Robert Wall, Amy Svitak, and Amy Butler, "Supporting Role," *Aviation Week & Space Technology*, October 3, 2011: 28-29. A shorter version of the story was published as Robert Wall, "Dutch Press Forward On Ship-Based Missile Defense Effort," *Aerospace Daily & Defense Report*, September 27, 2011: 4. See also Menno Steketee, "Dutch Frigates to Gain BMD Capability," *Jane's Navy International* (*Janes.com*), September 28, 2011. (The print version of the report appeared under the same article title in the November 2011 issue of *Jane's Navy International*, page 8.

Mediterranean and Black Sea region, as the first element of the United States' European Phased Adaptive Approach (EPAA) for missile defence....

However, this situation is about to change as European NATO nations are committing their naval assets to BMD in response to evolving alliance policy towards developing a BMD architecture to protect the continent from perceived threats emanating from the Middle East.

NATO embarked on an Active Layered Theatre Ballistic Missile Defence System (ALTBMDS) programme in September 2005, following a two-year feasibility study. Its initial focus was the protection of deployed alliance forces and high-value assets against short- and medium-range threats. At the November 2010 Lisbon Summit, political leaders from NATO states committed to expanding that remit to include the defence of the alliance's European territory.

ALTBMD is providing a C2 framework on which to build a scalable and adaptable BMD 'system of systems' architecture, integrating new national systems as they are committed to the alliance and enabling a complete lower- and upper-layer capability covering Europe to be fielded. The first of these, Capability 1, with initial operational capability planned for the 2012 timeframe, integrates C2 infrastructure, sensors and ground-based Patriot interceptors. The expansion to provide upper-layer defence is due to achieve full operational capability between 2015 and 2016.

The US contribution to this architecture is the EPAA set out by the Obama administration in September 2009....

There is evidence that the EPAA has acted as a spur for some European nations to make a more coherent contribution to the NATO BMD construct, particularly in the maritime domain, as they seek to maintain sovereignty in the development and integration of indigenous BMD systems and defence of their territories.

A number of classes of the latest generation of anti-air warfare (AAW) combatants with the potential to acquire a BMD capability are either operational or entering service in the navies of Denmark, France, Germany, Italy, the Netherlands, Norway, Spain and the UK. These offer the attributes of flexibility in deployment, mobility and sustainability inherent in naval platforms and could operate as effective sensor nodes even without an organic intercept capability.

They would be able to forward deploy close to the origin of the threat and act as force multipliers in this role by providing early warning of launches and cueing of off-board interceptor systems with the provision of timely and accurate impact point prediction and missile tracks, together with launch point prediction for counter-targeting.[107]

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[107] Charles Hollosi, "European Fleets Respond to Ballistic Missile Threats," *Jane's Navy International*, September 2011: 23-24, 26-30.