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

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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 24 at the end of FY2011 to 36 at the end of FY2018.

Under the Administration's European Phased Adaptive Approach (EPAA) for European BMD operations, BMD-capable Aegis ships have begun operating in European waters to defend Europe from potential ballistic missile attacks from countries such as Iran. 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 Rota, Spain, in FY2014 and FY2015. 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 FY2013 budget requests a total of $2,303.0 million in procurement and research and development funding for Aegis BMD efforts, including funding for Aegis Ashore sites that are to be part of the EPAA.

Issues for Congress for FY2013 include the reduction under the proposed FY2013 budget in the ramp-up rate for numbers of BMD-capable Aegis ships over the next few years; the U.S. economic impact of shifting four Aegis ships to Rota, Spain; U.S. vs. European naval contributions to European BMD; 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; the capability of the SM-3 Block IIB Aegis BMD interceptor; and technical risk in the Aegis 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

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

A total of 27 CG-47s were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five (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.

As a cost-saving measure, the Navy's FY2013 budget proposes retiring 7 of the remaining 22 Aegis cruisers in FY2013 and FY2014, more than a decade before the end of their 35-year expected service lives.[1] One of these seven ships has been given a capability for BMD operations;[2] some or all of the other six were scheduled to be modified for BMD operations at some point.

[1] The seven ships are *Cowpens* (CG-63), *Anzio* (CG-68), *Vicksburg* (CG-69), and *Port Royal* (CG-73), which are proposed for retirement in FY2013, and *Gettysburg* (CG-64), *Chosin* (CG-65), and *Hue City* (CG-66), which are proposed for retirement in FY2014. These ships entered service between 1991 (*Cowpens*) and 1994 (*Port Royal*); their 35-year service lives would extend to between 2026 and 2029. *Port Royal* was the last of the 27 ships in the class (i.e., it is the youngest ship in the class). Of the 22 Aegis cruisers currently in service, the oldest is *Bunker Hill* (CG-52), which entered service in 1986.

[2] The ship that has already been given a capability for BMD operations is *Port Royal* (CG-73).

Arleigh Burke (DDG-51) Class Aegis Destroyers[3]

62 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 is scheduled to enter 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.

10 Flight IIA DDG-51s Procured or Programmed for FY2010-FY2016

Procurement of DDG-51s resumed in FY2010. One Flight IIA DDG-51 was procured in FY2010, two more were procured in FY2011, and a fourth was procured in FY2012. Navy plans call for procuring six more Flight IIA DDG-51s in FY2013-FY2016. The ship procured in FY2010 is scheduled to enter service in FY2016.

Flight III DDG-51s Programmed Starting in FY2016

Navy plans call for shifting to procurement of a new version of the DDG-51, called the Flight III version, starting in FY2016.[4] 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.

Projected Aegis Ship Force Levels

The Navy's FY2013 30-year (FY2013-FY2042) shipbuilding plan projects that the total number of Aegis cruisers and destroyers will decline from 80 ships in FY2013 to 77 ships in FY2014-FY2015, grow to a peak of 87 ships in FY2027, decline to 75 ships in FY2034, and grow back to 85 or 86 ships in FY2039-FY2042. These figures are for Aegis cruisers and destroyers only; they do not include the three DDG-1000s procured in FY2006-FY2009.[5]

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[3] 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.

[4] Of the two DDG-51s scheduled for procurement in FY2016, one is to be the final Flight IIA ship, and the other is to be the first Flight III ship.

[5] The three DDG-1000s are scheduled to enter service in FY2014, FY2016, and FY2018, and remain in service beyond the end of the 30-year period. For a table showing the total number of cruisers and destroyers each year from FY2013 through FY2042 (including the three DDG-1000s), see CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke. A similar table can be found in CRS (continued...)

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.[6]

Aegis BMD System[7]

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.

Versions of Aegis BMD System

Currently fielded versions of the Aegis BMD system are called the 3.6.1 version and the newer and more capable 4.0.1 version. MDA and Navy plans call for fielding increasingly capable versions in coming years; these planned versions are called 5.0, 5.1, and 5.2. Improved versions feature improved processors and software, and are to be capable of using improved versions of the SM-3 interceptor missile (see **Table 1**).

MDA states that an in-service Aegis ship with a 3.6.1 BMD capability can be upgraded to a 4.0.1 BMD capability for about $45 million to $55 million.

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 warhead, that is designed to destroy a ballistic missile's warhead by colliding with it.

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Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[6] 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.

[7] Unless stated otherwise, information in this section is taken from MDA briefings on the Aegis BMD program given to CRS and CBO analysts in March 2010, March 2011, and March 2012.

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 SM-3 Block IIA and the SM-3 Block IIB.

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 is to have 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,[8] 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.[9]

Compared to the Block IIA, the Block IIB version is to include a lighter kill vehicle, flexible propulsion, and upgraded fire control software.[10]

MDA states that that SM-3 Block IBs have an estimated unit procurement cost of about $12 million to $15 million, and that SM-3 Block IIAs have an estimated unit procurement cost of about $20 million to $24 million.

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.

[8] Some press reports and journal articles, most 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).

[9] 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.

[10] Source: H.Rept. 111-491 of May 21, 2010 (the House Armed Services Committee report on H.R. 5136, the FY2011 defense authorization bill), p. 196.

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 three have been used in BMD flight tests, leaving the current remaining inventory of 72.

MDA and Navy plans call for developing and 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 initial version of the SM-6 BMD interceptor, called Increment 1, is to enter service around 2015; a subsequent version, called Increment 2, is to enter service around 2018.

Table 1 summarizes the various versions of the Aegis BMD system and correlates them with the phases of the European Phased Adaptive Approach (or EPAA; see below) for European BMD operations.

Table 1. Versions of Aegis BMD System

EPAA Phase	Phase I	Phase II		Phase III	Phase IV
Version of Aegis BMD system	**3.6.1**	**4.0.1**	**5.0/5.0.1**	**5.1/5.1.1**	**5.1/5/1.1**
Certified for initial use	2006	2012	2014	2018	2020
OTE assessment	2008	2014	2016	2020	2022
Mid-course interceptor(s) used					
SM-3 Block IA	X	X	X	X	X
SM-3 Block IB		X	X	X	X
SM-3 Block IIA				X	X
SM-3 Block IIB					X
Terminal-phase interceptor used					
SM-2 Block IV	X			X	
SM-6 Increment 1			X		
SM-6 Increment 2				X	X
Types of ballistic missiles that can be engaged					
SRBM	Yes	Yes	Yes	Yes	Yes
MRBM	Yes	Yes	Yes	Yes	Yes
IRBM	Limited	Yes	Yes	Enhanced	Enhanced
ICBM	No[a]	No[a]	No[a]	Limited	Limited
Launch or engage on remote capability					
Launch on remote	Initial	Enhanced	Yes	Yes	Yes
Engage on remote	No	No	No	Yes	Yes

Source: MDA briefings to CRS and the Congressional Budget Office (CBO), March 2010, March 2011, March 2012.

Notes: OTE is operational test and evaluation. **SRBM** is short-range ballistic missile; **MRBM** is medium-range ballistic missile; **IRBM** is intermediate-range ballistic missile; **ICBM** is intercontinental ballistic missile. **Launch on remote** is the ability to launch the interceptor using data from off-board sensors. **Engage on remote** is the ability to engage targets using data from off-board sensors.

a. Cannot intercept ICBMs, but the system has a long-range search and track (LRS&T) capability—an ability to detect and track ballistic missiles at long ranges.

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. MDA states that:

> The Department [of Defense] met its commitment for EPAA Phase 1 by deploying Aegis BMD ships and a land-based radar in Europe by the end of 2011. Deliveries in the next three EPAA phases include:
>
> - Aegis Ashore in Romania with SM-3 IB interceptors in the 2015 timeframe (Phase 2),
> - Aegis Ashore in Poland with SM-3 IIA interceptors in the 2018 timeframe (Phase 3), and
> - SM-3 IIB interceptors and early intercept capability in the 2020 timeframe (Phase 4)
>
> The United States will also pursue phased adaptive approaches in the Asia Pacific and the Middle East by building on current efforts.[11]

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.

Although BMD-capable Aegis ships have deployed to European waters in the past, 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.[12]

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

As shown in **Table 2**, under the proposed FY2013 budget, the number of BMD-capable Navy Aegis ships is scheduled to grow from 24 at the end of FY2011 to 36 at the end of FY2018.

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[11] Department of Defense, *Department of Defense, Fiscal Year (FY) 2013 President's Budget Submission, Missile Defense Agency, Justification Book Volume 2a, Research, Development, Test & Evaluation, Defense-Wide*, February 2012, pp. xix-xx.

[12] 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.

Table 2. Numbers of BMD-Capable Aegis Ships and SM-3 Missiles

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
BMD-capable Aegis ships										
BMD conversions of existing Aegis cruisers and destroyers (cumulative totals)										
3.6.1 version[a]	22	24	23	19	17	16	13	11	TBD	TBD
4.0.1 version	2	4	6	9	9	9	9	9	TBD	TBD
5.0 version	0	1	3	4	6	7	10	11	TBD	TBD
5.1 version	0	0	0	0	0	0	0	1	TBD	TBD
Subtotal	24	29	32	32	32	32	32	32	TBD	TBD
New Aegis destroyers procured in FY2010 and beyond, with BMD installed during ship's construction (cumulative totals)										
5.0 version	0	0	0	0	0	1[b]	3[b]	4[b]	6[b]	7[b]
TOTAL	**24**	**29**	**32**	**32**	**32**	**33**	**35**	**36**	**TBD + 6**	**TBD + 7**
SM-3 missile procurement (annual quantities)										
Block IA	26	0	0	0	0	0	0	0	0	0
Block IB	0[c]	46	29	69	82	77	72	72	72	72
Block IIA	0	0	0	0	22[d]	0	12	36	48	TBD
Block IIB	0	0	0	0	0	0	0	0	TBD	TBD
Total	26	46	29	69	104	77	84	108	120 + TBD	72 + TBD
SM-3 missile deliveries/inventory[e]										
Block I/IA	107/87	113/92	113/91	136/114	136/105	136/88	136/70	136/45	136/27	136/16
Block IB	1/0	16/12	25/18	61/49	100/83	169/152	251/234	328/311	400/381	472/453
Block IIA	0/0	0/0	0/0	0/0	0/0	0/0	7/7	19/13	3121	70/60
Block IIB	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Total	**108/87**	**129/104**	**138/109**	**197/163**	**236/188**	**305/240**	**394/311**	**483/369**	**567429**	**678/529**

Source: DOD budget submissions for FY2013 and prior years, and (for certain SM-3 annual procurement quantities) telephone consultation with MDA, March 19, 2012.

Notes: TBD is to be determined.

a. Declining totals for 3.6.1 ships after FY2012 reflect the upgrading of some of these ships to more advanced versions of the Aegis BMD system.

b. Figures taken from the Navy's FY2013 budget submission. MDA shows two ships as being in service by FY2016 (as opposed to the one ship shown in the Navy's budget submission as being in service by then).

c. 25 Block IB missiles (including 1 Pathfinder missile) funded prior to the 46 shown for FY2012.

d. 22 Block IIA missiles to be funded with research and development in FY2015.

e. Deliveries figures are cumulative and include missiles procured prior to FY2011 through both RDT&E and procurement funds. Inventory figures reflect missiles used or projected to be used in Aegis BMD flight tests.

Home Ports of BMD-Capable Aegis Ships

Pacific vs. Atlantic Fleet Homeporting

As of February 2012, 16 of the Navy's 24 BMD-capable Aegis ships were homeported in the Pacific, including 5 at Yokosuka, Japan, 6 at Pearl Harbor, HI, and 5 at San Diego, CA. The other eight BMD-capable Aegis ships were homeported in the Atlantic, with seven at Norfolk, VA, and one at Mayport, FL.

Reflecting the implementation of the EPAA, the number of BMD-capable Aegis ships homeported in the Atlantic is scheduled to grow over time. By the end of FY2012, the Navy is to still have 16 BMD-capable Aegis ships homeported in the Pacific, but the number of Aegis-BMD ships homeported in the Atlantic is to grow to 13, including 11 at Norfolk and 2 at Mayport.

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.[13] The four ships are the destroyers *Ross* (DDG-71) and *Donald Cook* (DDG-75), which are to move to Rota in FY2014, and the destroyers *Carney* (DDG-64) and *Porter* (DDG-78), which are to move to Rota in FY2015. As of early 2012, *Carney* was homeported at Mayport, FL, and the other three ships were homeported at Norfolk.[14] The move is to involve an estimated 1,239 military billets (including 1,204 crew members for the four ships and 35 shore-based support personnel),[15] and about 2,100 family members.[16]

The Navy estimates the up-front costs of transferring the four ships at $92 million in FY2013, and the recurring costs of basing the four ships in Spain rather than in the Untied States at roughly $100 million per year.[17]

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[13] "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.

[14] See "Navy Names Forward Deployed Ships to Rota, Spain," *Navy News Service*, February 16, 2012, accessed online at http://www.navy.mil/search/display.asp?story_id=65393; Kate Wiltrout, "Three Norfolk-Based Navy Ships To Move To Spain," *Norfolk Virginian-Pilot*, February 17, 2012; "Bound for Spain, *Inside the Navy*, February 20, 2012.

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

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

[17] 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 adminsitrative/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.

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.[18]

As part of the October 5, 2011, joint announcement, 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.

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

> 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.[19]

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.[20]

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.

[19] "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.

[20] "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.

> 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.[21]

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 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."[22]

Aegis BMD Flight Tests

DOD states that since January 2002, the Aegis BMD system has achieved 18 successful exo-atmospheric intercepts in 23 attempts using the SM-3 missile (including three successful intercepts in four attempts by Japanese Aegis ships), and 3 successful endo-atmospheric intercepts in 3 attempts using the SM-2 Block IV missile, making for a combined total of 21 successful intercepts in 26 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.[23] Including this intercept in the count increases the totals to 19 successful exo-atmospheric intercepts in 24

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

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

[23] 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.)

attempts using the SM-3 missile, and 22 successful exo- and endo-atmospheric intercepts in 27 attempts using both SM-3 and SM-2 Block IV missiles.

A December 2011 report on various DOD acquisition programs from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2011—stated, in the section on the Aegis BMD program, that

> In FY[20]11, Aegis BMD demonstrated, for the first time, the capability to engage an intermediate-range separating ballistic missile in the midcourse phase with an SM-3 Block IA interceptor. In that engagement, the firing ship used track data forwarded by C2BMC from an AN/TPY-2 (FBM) radar to develop a firing solution. The engagement, which exercised Aegis BMD 3.6.1 launch-on-remote functionality, demonstrated an important type of engagement capability needed to support Phase 1 of the PAA for defense of Europe. Cued engagements against longer-range targets would be expected in the European theater.
>
> Anomalous behavior was observed during the flyout of the SM-3 Block IA interceptor in FTM-15, but the anomaly did not preclude an intercept. If the anomaly occurred under different engagement conditions, it could have had an impact on the success of the engagement. However, it should be noted that the anomaly was not observed in any of the 21 previous SM-3 flyouts. The cause of the anomaly is under investigation by the program.
>
> Aegis BMD continues to improve its interoperability with other BMDS elements and sensors, as demonstrated in recent ground testing. Improvements in interoperability are still needed, however, to ensure that Aegis BMD can send and receive cues and track data of sufficient quality to support PAA Phase 1, which will be deployed at the end of CY11.
>
> FTM-16 Event 2 failed to demonstrate the capability to intercept a ballistic missile with the new SM-3 Block IB interceptor fired from an Aegis BMD 4.0.1 ship. Although the interceptor failed to intercept the target, many of the new capabilities of the Aegis BMD 4.0.1 system were exercised during the mission, and functioned as designed. FTM-16 Event 2 was the first developmental firing mission with the Aegis BMD 4.0.1 system. A Failure Review Board is determining the root cause.[24]

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 the **Appendix**.

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 before falling into the Pacific.[25] 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

[24] Director, Operational Test and Evaluation, *FY 2011 Annual Report*, December 2011, p. 257.

[25] 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.

with an approximate equivalent of the 3.6.1 version Aegis BMD system. (Japan's previous plans called for modifying four of the six ships.) As of December 2010, four of Japan's Aegis ships had received the modification.[26] 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.

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….

[26] John Liang, "Japan To Increase Aegis BMD Ship Fleet From Four To Six," *Inside the Navy*, December 27, 2010.

> 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.[27]

FY2013 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 3**, MDA's proposed FY2013 budget requests a total of $2,303.0 million in procurement and research and development funding for Aegis BMD efforts, including funding for 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.

Table 3. MDA Funding for Aegis BMD Efforts, FY2012-FY2017

(In millions of dollars, rounded to nearest tenth; totals may not add due to rounding; FY2012 is actual; FY2013 is requested; FY2014-FY2017 are programmed)

	FY12	FY13	FY14	FY15	FY16	FY17
Procurement						
Aegis BMD (Line 31)	565.4	389.6	757.0	834.3	775.7	1,003.0
Research, development, test & evaluation (RDT&E)						
Next-generation Aegis missile (SM-3 IIB) (PE 0603902C, line 65)	13.4	224.1	295.2	455.4	508.4	430.2
Aegis BMD (PE 0603892C, line 86)	988.9	992.4	960.9	950.1	1,030.2	958.7
Land-based SM-3 (LBSM3) (PE0604881C, line 107)	306.2	276.3	127.2	113.7	47.7	56.2
Aegis SM-3 IIA Co-development (PE0604881C, line 108)	473.8	420.6	273.9	200.7	185.0	46.1
SUBTOTAL RDT&E	**1,782.3**	**1,913.4**	**1,657.2**	**1,719.9**	**1,771.3**	**1,491.2**
TOTAL	**2,347.7**	**2,303.0**	**2,414.2**	**2,554.2**	**2,547.0**	**2,494.2**

Source: FY2013 budget-justification books for MDA for Research, Development, Test & Evaluation, Defense-Wide (Volume 2a) and for Procurement, Defense-Wide (Volume 2b).

[27] 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.

Issues for Congress

Reduction in Ramp-Up Rate for BMD-Capable Aegis Ships

One potential oversight issue for Congress concerns a reduction under the proposed FY2013 budget in the ramp-up rate for numbers of BMD-capable Aegis ships over the next few years. **Table 4** shows projected numbers of BMD-capable Aegis ships under the FY2013 compared to projected numbers under the FY2012 budget.

Table 4. Numbers of BMD-Capable Aegis Ships Under FY2012 and FY2013 Budgets

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
FY2012 budget										
Conversions	23	28	32	36	37	38	38	37	37	37
New-built DDG-51s	0	0	0	0	1[a]	3	4	6	6	6
Total	**23**	**28**	**32**	**36**	**38**	**41**	**42**	**43**	**43**	**43**
FY2013 budget										
Conversions	24	29	32	32	32	32	32	32	TBD	TBD
New-built DDG-51s	0	0	0	0	0	1[b]	3[b]	4[b]	6[b]	7[b]
Total	**24**	**29**	**32**	**32**	**32**	**33**	**35**	**36**	**TBD + 6**	**TBD + 6**
FY2013 plan compared to FY2012 plan										
	+1	**+1**	**NC**	**-4**	**-6**	**-8**	**-7**	**-7**	**not clear**	**not clear**

Source: FY2012 and FY2013 budget submissions.

Notes: TBD is to be determined; **NC** is no change.

a. Navy budget-justification documents for FY2012 showed the DDG-51 procured in FY2010 entering service in FY2016, not FY2015 as shown in this table.

b. Figures taken from Navy's FY2013 budget submission. MDA shows two ships as being in service by FY2016 (as opposed to the one ship shown in the Navy's budget submission as being in service by then).

As can be seen **Table 4**, under the FY2013 budget, there are to be 36 BMD-capable Aegis ships by FY2018, or 7 less than projected under the FY2012 budget for FY2018.

The proposal under the FY2013 budget to retire seven Aegis cruisers early, in FY2013 and FY2014 (see "Ticonderoga (CG-47) Class Aegis Cruisers" in "Background"), may explain part of the difference between the ramp-up rates under the two budget plans: as mentioned earlier, one of these seven ships has been given a capability for BMD operations, and some or all of the other six were scheduled to be modified for BMD operations at some point.

Some observers have been concerned that demands for BMD-capable Aegis ships are growing faster than the number of BMD-capable Aegis ships. The reduction in the ramp-up rate for

numbers of BMD-capable Aegis ships under the proposed FY2013 budget compared to the FY2012 budget might, other things held equal, reinforce such concerns. On the other hand, as mentioned earlier (see "October 5, 2011, Announcement of Homeporting in Spain" in "Background"), a DOD official has been quoted in the press as saying that the EPAA mission to be performed by the four BMD-capable Aegis ships to be homeported at Rota, Spain, would instead require 10 U.S.-homeported BMD-capable Aegis ships to perform. On that basis, it would appear that homeporting four BMD-capable Aegis ships at Rota, Spain, would, other things held equal, reduce demands for BMD-capable Aegis ships by a net six ships. On that basis, in terms of the balance between demands for BMD-capable Aegis ships and available numbers of BMD-capable Aegis ships, the decline in the ramp-up rate in the number of BMD-capable Aegis ships under the proposed FY2013 budget compared to the FY2012 budget might be viewed as offset to a substantial degree, at least in certain years, by the plan to forward-homeport four BMD-capable Aegis ships at Rota.

Concerning demands for BMD-capable Aegis ships in general, a September 16, 2011, press report stated:

> "The BMD ships between now and 2017 are basically deployed for seven months, home for seven months, deployed for seven months, home for seven months for the next six years," [Chief of Naval Operations Admiral Gary Roughead] said. "With the retention environment we're in now, we're not seeing the effects of that on our people yet, but when the economy turns, that's a pretty brutal pace."[28]

An April 2011 Navy report to Congress on naval force structure and BMD stated the following:

> The Navy currently has sufficient capacity to meet the most critical demands for multi-mission surface combatants. However, the Navy does not have the capacity to meet all GCC [Global Combatant Commander] demands for BMD-capable surface combatants without breaking currently established Chief of Naval Operations Personnel Tempo program limits for deployment lengths, dwell and homeport tempo. Navy's funded BMD upgrade plan is structured to balance the need to meet current multi-mission and Aegis BMD operational requirements against the need to increase Aegis BMD capacity and upgrade existing BMD-capable Aegis ships to pace the future threat.
>
> The Navy, in conjunction with the Missile Defense Agency (MDA), has established a plan to increase the number of BMD-capable Aegis ships from 23 in FY2011 to 41 in FY2016 to begin to address this shortfall. This plan increases capacity through a combination of installing Aegis BMD 3.6.1 / 4.0.1 / 5.0 suites in existing Aegis ships (Aegis Modernization Program) and new construction commencing with DDG-113. This combined upgrade/new construction approach is designed to mitigate both the near term operational demand for multi-mission (including BMD) large surface combatants and the increasing Aegis BMD capability and capacity demand in the future.
>
> The analytical work associated with the Navy's ongoing Force Structure Analysis has progressed to the point that a FY2024 requirement for 94 multi-mission large surface combatants has been established. The global proliferation of land-attack ballistic missiles and the anticipated proliferation of anti-ship ballistic missiles underpins a related requirement for all multi-mission large surface combatants with Aegis weapon systems to be BMD-capable beyond ~2025….

[28] Dan Taylor, "CNO: Biggest Concern Is That Shrinking Budgets Will Stretch Force Thin," *Inside the Navy*, September 19, 2011.

The Navy and Missile Defense Agency (MDA) have concluded that the Geographic Combatant Commanders' (GCCs) demand for surface combatants with Aegis BMD capability will outpace capacity through approximately 2018. This conclusion was reached based on an assessment that considered the current and projected ballistic missile threat; current and projected requests from the GCCs including the Phased Adaptive Approach (PAA) for defense of Europe directed by the President; other force generation factors such as maintenance availabilities necessary to ensure the ships reach their expected service lives, training requirements and deployment lengths; and the deployment of Aegis Ashore to offset some of the growing demand for BMD capability….

BMD-capable large surface combatant requirements are independently determined by each GCC based on theater operational planning and mission analyses that consider unique regional factors such as the ballistic missile threat, threat dispersal, geography, size of the defended area, and the specific number and disposition of defended assets. Each GCC submits their fiscal year Aegis BMD requirement to the Joint Staff for validation. Once validated, U.S. Fleet Forces Command provides a consolidated sourcing solution for large surface combatants, to include those that are BMD-capable. The annual requirements and sourcing solutions are reviewed by a Global Force Management Board which ensures competing GCC requirements are properly prioritized based on overarching global defense priorities and that the Navy's limited BMD capacity is applied to the most critical needs.

The Global Force Management Board submits its requirements/sourcing recommendation to SECDEF for approval, in the form of a Global Force Management Allocation Plan which allocates Aegis BMD surface combatants to the GCC's for specified timeframes. Emergent GCC requirements for Aegis BMD combatants in response to unforeseen crises are subject to a similar approval process, without the Global Force Management Board review. In this case, SECDEF decisions represent adjustments to the annual Global Force Management Allocation Plan.

The total number of ships required to support the Phased Adaptive Approach to ballistic missile defense of Europe will be based on the operational planning and mission analysis factors noted above, combined with force generation factors such as maintenance, training and forward stationing or rotational model considerations. US European Command's operational plan for the ballistic missile defense of Europe has not been approved as of the date of this report….

US European Command's operational plan for the ballistic missile defense of Europe has not yet been approved, but could incorporate up to two Aegis Ashore batteries. Using a standard rotational BMD force structure model of five ships to sustain 1.0 presence, each Aegis Ashore battery could make up to five ships available to service Aegis BMD combatant requirements that would otherwise go unresourced….

All Aegis BMD surface combatants undergo the training, deployment and maintenance phases that comprise the Fleet Response Plan. These phases are balanced to ensure each crew is proficient across the full spectrum of missions the ship is capable of performing; to meet the operational requirements of the GCCs; and to ensure these capital assets reach their expected service life. In the near term, this balance will entail deployments for BMD-capable surface combatants of about seven months.[29]

[29] U.S. Navy, Office of the Chief of Naval Operations, Director of Strategy and Policy (N51), *Report to Congress On Naval Force Structure and Missile Defense*, April 2011, 12 pp.

Demands for Aegis Ships in General

Another potential oversight issue for Congress concerns demands from U.S. regional military commanders for Aegis ships in general. Some observers are concerned that demands for Aegis ships for conducting BMD operations could strain the Navy's ability to provide regional military commanders with Aegis ships for performing non-BMD missions in various locations around the world.

The Navy's Aegis ships are multi-mission platforms that are used for performing a range of non-BMD missions, including forward-deployed presence for regional deterrence, reassurance, and stabilization; partnership-building activities; humanitarian assistance and disaster response (HADR) operations; maritime security operations (including anti-piracy operations in the Gulf of Aden); intelligence, surveillance, and reconnaissance (ISR) operations; counter-terrorism operations; and (if need be) conventional warfighting operations. In conventional warfighting operations, Aegis ships could be called upon to perform a variety of non-BMD functions, including anti-air warfare, anti-surface warfare, strike warfare and naval surface fire support, and antisubmarine warfare. Locations that are good for performing BMD operations might not be good for performing non-BMD operations, and vice versa.

The Navy's force-level goal for cruisers and destroyers is to achieve and maintain a force of about 90 ships. The Navy's FY2013 30-year (FY2013-FY2042) shipbuilding plan does not contain enough destroyers to maintain a force of about 90 cruisers and destroyers consistently over the long run. The Navy projects that implementing the 30-year plan would result in a cruiser-destroyer force that remains below 90 ships every year in the 30-year plan except FY2027, and that reaches a minimum of 78 ships (i.e., 12 ships, or about 13%, below the required figure of about 90 ships) in FY2014-FY2015 and again in FY2034. The projected cruiser-destroyer shortfall is the largest projected shortfall of any ship category in the Navy's 30-year shipbuilding plan. Another CRS report discusses the projected cruiser-destroyer shortfall in greater detail.[30]

Rear Admiral Archer Macy, the director of the Joint Integrated Air and Missile Defense Organization, testified to the Senate Armed Services Committee on April 20, 2010, that DOD does not plan to give BMD-capable Aegis ships a strict role of performing BMD operations only. He also stated, however, that it was possible, depending on ballistic missile threats, that BMD-capable Aegis ships might sometimes be constrained to certain operating areas.[31]

As mentioned earlier (see "October 5, 2011, Announcement of Homeporting in Spain" in "Background"), Secretary of Defense Leon Panetta stated the following as part of the October 5, 2011, joint announcement about homeporting four BMD-capable Aegis ships at Rota, Spain, as part of the EPAA:

> 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….

[30] CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke.

[31] Dan Taylor, "Macy: Navy Increases Total Aegis BMD Assets Over FYDP To 38 Ships," *Inside the Navy*, April 26, 2010.

> 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.[32]

An April 2011 Navy report to Congress on naval force structure and BMD stated the following:

> The Navy's operating concept for maritime BMD features a graduated readiness posture that allows BMD-capable Aegis ships to be on a BMD mission tether and employed concurrently in other missions such as strike warfare, air defense, anti-submarine warfare, surface warfare, information warfare, high value asset protection, or maritime interdiction to contribute to overall GCC [Global Combatant Commander] naval requirements. While Aegis ships performing a BMD mission do not lose the capability to conduct these other missions, specific mission effectiveness may be affected by optimizing the ships' position for BMD and/or application of the ship's radar resources to the BMD mission.
>
> The Navy currently has sufficient capacity to meet the most critical demands for multi-mission surface combatants….
>
> The analytical work associated with the Navy's ongoing Force Structure Analysis has progressed to the point that a FY2024 requirement for 94 multi-mission large surface combatants has been established. This requirement assumed that the Phased Adaptive Approach for the ballistic missile defense of Europe would incorporate two Aegis Ashore batteries….
>
> Each GCC's multi-mission surface combatant requirement, including the BMD mission, is constantly evolving to reflect changes in the global security environment, our National Military Strategy, and other Department of Defense guidance related to operations and contingency plans. Within this context, BMD-capable surface combatant requirements are independently determined by each GCC based on mission analyses that consider unique regional factors such as the ballistic missile threat, threat dispersal, geography, size of the defended area, and the specific number and disposition of defended assets. Other mission requirements are similarly derived and the GCC's total surface combatant requirement is ultimately determined considering specific operational objectives and the extent to which supporting schemes of maneuver accommodate multi-mission employment of Aegis BMD surface combatants.[33]

A January 4, 2010, news report stated:

> No sooner did the Aegis ballistic missile defense (BMD) system become operational in 2008 than U.S. combatant commanders started asking for BMD-equipped ships to begin patrolling their areas.
>
> Central Command needed a "shooter" in the northern Arabian Gulf. European Command wanted one in the eastern Mediter-ranean. Pacific Command already had Aegis ships with limited BMD capabilities on guard around Japan for a potential launch from North Korea.

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[32] "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.

[33] U.S. Navy, Office of the Chief of Naval Operations, Director of Strategy and Policy (N51), *Report to Congress On Naval Force Structure and Missile Defense*, April 2011, 12 pp.

The demand for BMD ships is only expected to increase, driven in part by rising concerns about Iran's intentions and the U.S. decision in September to cancel an anti-missile system in Poland and the Czech Republic and rely instead on Aegis.

But the Navy has a relatively small number of such ships, and those destroyers and cruisers are designed to carry out a wide range of war-fighting tasks.

As a result, while Navy commanders are pleased with the expanding capabilities of their Aegis ships, they're also somewhat guarded about trumpeting the advances.

"We can't constrain assets to one mission," a senior officer said last month. "They need to do a variety of other missions." Worries that valuable Aegis ships might be locked into the BMD mission were discussed in December at a two-day seminar at the National Defense University (NDU) in Washington. Reporters were allowed to quote comments made at the seminar under the condition that no speaker be identified.

"Sea-based ballistic missile defense is a necessary component of any theater defense," said the senior officer. "We need to find ways to get folks to use the ships in ways consistent with their being a ship—to realize they are not a point-defense asset." One analyst added, "The demand signal is ahead of the pot of ships." U.S. Navy spokesman Lt. Tommy Buck said the service is working to manage the demand.

"Combatant commanders need to understand BMD-capable ships are multimission-capable. BMD is one available asset," Buck said Dec. 18.

The Navy is also working on how to respond, said Vice Adm. Samuel Locklear, director of the Navy Staff.

"We have a small Navy today—the smallest since 1916—yet we have a growing global demand for maritime forces, maritime security operations. And now we have a growing demand for maritime ballistic missile defense. Our ships and our crews and our systems are up to the challenge, but it's a capacity issue for us," Locklear said to a reporter during the NDU seminar.

"As the capacity grows faster than we can grow the number of ships we have—which is always difficult, particularly in the demanding fiscal environment we're in—we have to look at ways to deploy these ships so that we can get the job done and still have a reasonable expectation that we can take care of the ship and the crew," Locklear said. "So we're looking at a lot of different options as to how we'll do that as this demand grows. But we are limited in capacity." Locklear said that despite meeting demands from joint commanders, the Navy has "to some degree preserved the command and control. Navy component commanders still command and control these ships." But, he added, "What we've had to do is to spread these multimission platforms more thinly across a growing number of demands globally."

27 BMD Ships By 2013

Twenty-one cruisers and destroyers will have been upgraded with the Aegis BMD capability by early 2010, and six more destroyers are to receive the upgrade in 2012 and 2013. But at least one senior officer at the seminar noted "there will be no more new ships for missile defense." The demand has already affected deployments. Early in 2009, for example, The Sullivans, a Florida-based destroyer on deployment with a carrier group, moved to Japan for a few weeks to pick up the exercise schedule of a Japan-based BMD destroyer that was called on by Central Command to guard the northern Ara-bian Gulf.

> This fall, a San Diego-based ship, the destroyer Higgins, deployed to the eastern Mediterranean to provide BMD defense for European Command and take part in exercises.
>
> Both moves are unusual, as it's rare for an Atlantic Fleet ship to visit Japan or for a Pacific ship to patrol the Mediterranean. Such cross-deployments require more coordination by fleet planners.
>
> "Effective global force management requires global visibility on requirements," Buck said. "U.S. Fleet Forces Command [headquartered in Norfolk, Va.] and Pacific Fleet [headquartered in Pearl Harbor, Hawaii] collaborate, coordinate and communicate to have more complete knowledge of location and status of fleet capabilities and work to best employ those capabilities to meet global combatant commander requirements to include BMD." The senior officer said one way to manage demand is to encourage combatant commanders to give "sufficient warning to have ships on station. We need to remind [combatant commanders] that these are multimission ships." The BMD cruisers and destroyers are also equipped to handle anti-submarine, land-attack, air-defense and other tasks.[34]

U.S. Economic Impact of Shifting Four Aegis Ships to Rota, Spain

Another potential oversight issue for Congress concerns the U.S. economic impact of the plan to shift the homeport of four BMD-capable Aegis ships to Rota, Spain (see "October 5, 2011, Announcement of Homeporting in Spain" in "Background"). As mentioned earlier, the Prime Minister of Spain, as part of the October 5, 2011, joint announcement of this plan, stated that

> this initiative will have a positive impact, in socio-economic terms, on our country, and most especially on the Bay of Cadiz [area near Rota].
>
> 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.[35]

Assessing the U.S. economic impact of the plan to shift the homeport of four BMD-capable Aegis ships to Rota, Spain, could include accounting for, among other things, the economic impact of

- U.S. personnel and their families spending their paychecks in Spain rather than in the current home port areas;
- the Navy performing overhaul, maintenance, and repair work on the ships in Spain rather than in the United States; and

[34] Christopher P. Cavas, "U.S. Navy Juggles Ships To Fill BMD Demands," *Defense News*, January 4, 2010. Material in brackets as in original.

[35] "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.

- the Navy purchasing supplies for these ships in Spain rather than from sources in the current home port areas.

Regarding the first item above, CRS asked the Navy for the total dollar value of personnel pay and allowances per year associated with the four destroyers designated to be homeported at Rota. The Navy replied that:

> The annual military personnel cost for the four DDGs designated to deploy as Forward Deployed Naval Forces (FDNF) in Rota is provided below. All personnel are ships force [i.e., ship crew members].

$ millions	FY 2013	FY 2014	FY 2015	FY 2016	FY2017
MPN/RPN	$0	$67.1	$131.6	$134.0	$137.7[36]

Regarding second item above, the Navy states that

> The annual ship maintenance cost [in millions] for the four DDGs designated to deploy as Forward Deployed Naval Forces (FDNF) in Rota is provided in Table 1.

	FY14	FY15	FY16	FY17
FDNF-based[1, 2]	$40.79	$44.99	$47.50	$43.06
CONUS-based	$49.04	$51.10	$40.85	$38.77
Cost Differential	-$8.25	-$6.11	$6.65	$4.29

> Table 1. Total Annual Maintenance Cost for Four DDGs Deploying as FDNF-based Forces vs. their Total Annual Maintenance Cost as CONUS-based Forces.
>
> Notes:
>
> 1. Prior to FDNF deployment, all vessels receive a large maintenance availability to correct known deficiencies and groom Ballistic Missile Defense systems. Consequently, some of the depot maintenance work originally scheduled for accomplishment in FY14 and FY15 has been moved to FY12 and/or FY13, and the cost differential is lower than normal. Cost differentials in FY16 and FY17 are more representative of expected future year differential maintenance costs.
>
> 2. Incremental maintenance costs are based on two ships deploying in FY14, followed by two additional ships in FY15, and account for a change in maintenance availability periodicity from 32 months CONUS-based to 17 months FDNF-based. Costs include continuous maintenance, emergent and other restricted technical availabilities, voyage repairs, fly-away teams and regional maintenance center support.[37]

Regarding the third item above, the Navy states that:

[36] Source: Navy information paper dated February 29, 2012, provided by Navy Office of Legislative Affairs to CRS on March 19, 2012. MPN and RPN are the Military Personnel, Navy, and Reserve Personnel, Navy, appropriations accounts.

[37] Source: Navy information paper dated March 19, 2012, provided by Navy Office of Legislative Affairs to CRS on March 19, 2012. The information paper expressed the cost figures in thousands (e.g., $40,790 for FDNF-based in FY2014); they are converted here into millions (e.g., $40.79 million). CONUS is continental United States.

A Forward Deployed Naval Force of four DDGs is expected to spend a total of approximately $7.2M per year on direct Navy purchases in Rota, Spain, that otherwise would have been spent in CONUS. These purchases consist of:

- Utilities $6M per year
- Consumables $1.2M per year (only open purchases made by ships' company)[38]

U.S. vs. European Naval Contributions to European BMD

Another potential oversight issue for Congress concerns European naval contributions to European BMD capabilities and operations compared to U.S. naval contributions to European BMD capabilities and operations. 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. contributions to European BMD capabilities and operations?
- Given anticipated reductions in planned levels of U.S. defense spending resulting from the Budget Control Act of 2011 (S. 365/P.L. 112-25 of August 2, 2011), as well as the potential for giving BMD capabilities to European navy ships (see "Allied Participation and Interest in Aegis BMD Program" in "Background"), should the United States seek increased investment by European countries in their naval BMD capabilities so as to reduce the need for assigning BMD-capable U.S. Navy Aegis ships to the EPAA?

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 2001 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.[39]

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

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

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.[40]

Capability of SM-3 Block IIB Interceptor

Another potential oversight issue for Congress concerns the prospective capability of the SM-3 Block IIB interceptor for conducting certain kinds of intercepts called "early intercepts" as part of the EPAA. A June 13, 2011, press report stated:

> When asked what the Pentagon's plan is for countermeasures if early intercept does not materialize with the [SM-3 Block] IIB in 2020, Missile Defense Agency (MDA) officials simply state: "We fully expect to have a viable early-intercept capability with the SM-3 Block IIB in the 2020 time period."...
>
> At issue today is whether the architecture as envisioned is achievable; and the piece most critics question is the plan to achieve early intercept and protect the Eastern U.S. from an Iranian ICBM attack.
>
> USAF Gen. (ret.) Lester Lyles, who led the MDA when it was called the Ballistic Missile Defense Organization, is co-chairing a Defense Science Board task force review of the early-intercept strategy with Adm. (ret.) William Fallon, who headed U.S. Pacific Command. The report is being written and will likely be briefed to Pentagon leaders in the fall.
>
> Lyles declines to discuss his findings until they are briefed to the Pentagon. Industry and government sources familiar with the study have different views on what the findings will be. Some say the task force questions the ability to achieve early intercept with the time and money available. Others say the report will outline what can be achieved with the current strategy.

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

> Whatever the outcome, the results are likely to influence the SM-3 IIB program, whether it moves forward and, if it does, what the missile will look like. The IIB is the notional long-range missile killer that will be fielded in Phase IV by 2020 for early intercept to fulfill the promise of protecting the Eastern U.S. and most of Europe from an Iranian ICBM attack....
>
> GMD advocates point to the option of placing interceptors at Fort Drum, N.Y., to provide a deeper magazine and coverage for the Eastern U.S.....
>
> The question of whether a IIB missile can achieve early intercept, and how to do it, is likely be to sorted out this summer. The Defense Science Board will report its findings, and the MDA is likely to request funding for the IIB strategy in the fiscal 2013 budget proposal that is due to Congress next February.[41]

A June 17, 2011, press report states:

> A Defense Science Board (DSB) report on early missile intercept is already prompting discussion on Capitol Hill over how U.S. strategic forces are funded.
>
> The Obama administration is pursuing the European Phased Adaptive Approach to missile defense, which by 2020 would develop the SM-3 Block IIB interceptor to protect the U.S. and Europe against long-range missiles from North Korea and Iran. In April, Boeing, Lockheed Martin and Raytheon each won concept definition and program planning awards worth at least $41 million.
>
> But the DSB study, led by retired Air Force Gen. Lester Lyles and retired Navy Adm. William Fallon, casts doubt on a central capability of that interceptor—primarily the ability to hit an incoming missile before it deploys countermeasures, according to Senate Republican aides. The study's unclassified version also finds that the goal of early interception may lead to a less-capable system overall and rather than investing in the interceptor, improvements to radars, satellites and communications are also important, an aide says.
>
> With that information, already a critical question is emerging on Capitol Hill: During a deficit crisis, should the government be spending $1.7 billion over the next five years to develop the SM-3 Block IIB if its ultimate goal is in doubt?
>
> At least the rationale for pursuing the interceptor—replacing a missile defense site based in Poland and the Czech Republic—is in line for scrutiny.
>
> "If the administration continues to sell early interceptors as a way of going after countermeasures, that's not going to work," one aide says.
>
> So in that case, does it make sense to continue working on the IIB missile for other reasons? And if not, what are the alternatives?
>
> One camp could emerge in support of upgrades to the current Ground-based Midcourse Defense system or the creation of a site in the eastern United States. Another group may want to improve on the capabilities of the Raytheon-led SM-3 Block IIA.[42]

[41] Amy Butler, "End Game," *Aviation Week & Space Technology*," June 13, 2011: 40.

[42] Jen DiMascio, "DSB Report Raises Questions About SM-3 Block IIB Costs," *Aerospace Daily & Defense Report*, June 17, 2011: 4.

A July 6, 2011, letter to the editor from the two co-chairmen of the DSB task force in question and the chairman of the full DSB stated:

> The Defense Science Board (DSB) is now completing a review on Science and Technology Issues of Early Intercept (EI) Ballistic Missile Defense Feasibility as a concept to enhance missile defense....
>
> In previous work, the DSB found the EI concept helpful in national missile defense against long-range ballistic missiles. In the current review, EI, as defined by the study's terms of reference, was judged less helpful in regional missile defense against shorter range regional ballistic missiles....
>
> The DSB concluded that the Missile Defense Agency is on the right track in developing European Phased Adapted Approach (EPAA) options, including continued evolution of the SM-3 family of missiles, which will expand the battle space and provide more engagement opportunities in the regional defense provided by the EPAA. The DSB also examined the potential in the EPAA context for EI in regional defense against short-range missiles before threat payloads could be deployed, and concluded that this was not a viable option because of technical constraints - primarily related to the very short payload deployment times and the present absence of adequate sensors/Ballistic Missile C3 to overcome this.
>
> The fact that this form of EI is not viable in shorter-range regional applications does not imply that either SM-3 family interceptors or the EPAA concept are flawed. In general, EI, including intercepts of longer- range missiles before the threat missile reaches apogee, can provide for multiple engagement opportunities and more effective defenses.
>
> MDA is on the right track in pursuing this capability for national missile defense, and examining the potential application in regional defense as a function of the range of threat missiles.
>
> The DSB did not conclude that EI is flawed. Nor did they conclude that the EPAA approach or the SM-3 family were flawed. The DSB did conclude that EI would have a very limited role in regional defense against shorter range missile threats.[43]

Technical Risk in Aegis BMD Program

Another potential oversight issue for Congress is how much technical risk there is in the Aegis BMD program. A March 2012 Government Accountability Office (GAO) report assessing major DOD weapon acquisition programs[44] provided assessments of the technical risk in four Aegis BMD development efforts; these assessments are presented below.

SM-3 Block IB Missile

The March 2012 GAO report stated the following regarding the SM-3 Block IB missile:

[43] Letter to the editor from Admiral William J. Fallon, U.S. Navy, retired, task force co-chairman; General Lester Lyles, U.S. Air Force, retired, task force co-chairman and DSB vice chairman; and Paul G. Kaminski, DSB chairman, published under the title "'Early Intercept' Not Flawed," *Washington Times*, July 6, 2011: B2.

[44] Government Accountability Office: *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-12-400SP, March 2012, 188 pp.

The SM-3 IB will be at continued risk of cost growth, schedule delays, and performance shortfalls unless it demonstrates that the missile's critical technologies and design perform as expected before committing to further production. In 2011, the SM-3 IB failed during its first developmental flight test. At the time of the failure, MDA had contracted for 25 SM-3 IB interceptors, 18 of which were dedicated to flight testing. As a result of the flight test failure, MDA halted acceptance of SM-3 IB deliveries, convened a failure review board, and delayed key program decisions. In addition, two critical technologies—the throttleable divert attitude control system and third-stage rocket motor—still may not be mature. The attitude control system has not completed developmental testing or been successfully flight tested and the third-stage rocket motor may need to be redesigned....

According to the program, all five of its critical technologies—the third-stage rocket motor, throttleable divert attitude control system, reflective optics, two-color warhead seeker, and kinetic warhead advanced signal processor—are mature. However, the attitude control system has not completed qualification testing or been demonstrated in a realistic flight environment. In addition, the third-stage rocket motor, which was previously considered the most mature technology, may need to be redesigned to address issues discovered in flight testing. In its first developmental flight test in September 2011, the SM-3 IB experienced a failure involving one of its critical technologies and did not intercept the target. A failure review board is investigating the cause. The program plans to redo the failed test and conduct two additional intercept flight tests in 2012. Program officials expect that all SM-3 IB technologies will be flight-qualified and demonstrated through testing by the program's planned fiscal year 2013 production decision.

Design Maturity

The SM-3 IB's design has been relatively stable since its critical design review in May 2009, although design changes may be necessary to address issues discovered in testing. In addition, the program has not demonstrated that the missile's design can perform as intended through developmental testing. As a result, it remains at risk for further design changes, cost growth, and schedule delays.

Production Maturity

MDA has delayed the official start of operational missile production from February 2010 to the fourth quarter of fiscal year 2013. According to officials, MDA will not make this production decision until it completes initial developmental testing with production-representative missiles and shipboard systems.

The program has already contracted for 25 missiles, 18 of which will be used for developmental testing. The seven additional missiles could require costly rework and retrofits if the program decides to use them as operational assets as planned. According to MDA, additional missiles will also be used to prove manufacturing processes and for other purposes. MDA is also planning to purchase 46 additional missiles in fiscal year 2012. Any additional missiles ordered in fiscal year 2012 before the completion of flight tests needed to validate the missile's performance would be at higher risk of cost growth and schedule delays.

The flight-test failure investigation and possible redesigns are delaying both developmental and operational missile production. The program's acceptance of developmental missile deliveries and the production of certain missile components are on hold pending the results of the investigations. Program officials estimate that the failure investigations, design modifications, and additional testing will increase costs and they have not yet determined how many missiles may need to be refurbished.

Other Program Issues

MDA originally planned to stop production of the SM-3 IA in 2010 and begin production of the SM-3 IB. However, SM-3 IB developmental issues have required MDA to twice delay the purchase of SM-3 IB missiles, purchase additional SM-3 IA missiles to avoid production gaps and keep SM-3 suppliers active, and reduce the planned initial purchase quantity of SM-3 IBs. The program's acceptance of SM-3 IA deliveries and the production of a missile component have been halted since April 2011, when an SM-3 IA missile experienced an anomaly during a flight test. The anomaly may have occurred in a component that is common to the SM-3 IA and SM-3 IB.

Program Office Comments

In commenting on a draft of this assessment, MDA provided technical comments, which were incorporated as appropriate.[45]

SM-3 Block IIA Missile

The March 2012 GAO report stated the following regarding the SM-3 Block IIA missile:

Technology Maturity

The SM-3 Block IIA program faces significant technology development challenges. The majority of the SM-3 Block IIA components are new technology compared to the SM-3 Block IB. The program must develop a new propulsion system with a much greater thrust, a new divert and attitude control system, a more capable seeker, and use new solid fuel, all of which pose significant technological challenges. The development of similar components has been a challenge for previous SM-3 interceptors.

The SM-3 Block IIA program has identified eight critical technologies—six of which are immature and require additional development and testing before they can be demonstrated in a system prototype. The program held subsystem preliminary design reviews during fiscal year 2011, which demonstrated that some critical technologies required redesign or other adjustments. The program has plans in place to rebalance SM-3 Block IIA requirements or replace certain technology components. For example, the program has moved away from a component that has caused problems for the SM-3 Block IB. The program completed new reviews for the four technologies that failed to complete the initial reviews by early fiscal year 2012. In addition, two critical technologies—the second- and third-stage rocket motors—have experienced problems during testing. The program was investigating the causes of those problems and the potential effects at the end of fiscal year 2011. According to the program, all critical technologies will be nearing maturity by its planned September 2013 critical design review.

Other Program Issues

The SM-3 Block IIA program has extended its development schedule by more than a year, which likely will increase program costs, but lower the risk of further cost growth and schedule delays in the future. The program adjusted its system-level preliminary and critical design reviews after several key components failed their preliminary design reviews. The

[45] Government Accountability Office: *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-12-400SP, March 2012, pp. 53-54.

adjustment may reduce acquisition risk and the potential for future cost growth by providing the program more time to reconcile gaps between requirements and resources; demonstrate technical knowledge; and ensure that requirements are defined, feasible, and achievable before committing to product development. The new schedule also lowers risk in other ways, such as building in more recovery time between program reviews and flight tests. Under the revised schedule, flight tests will be delayed from 2015 to late 2016. The SM-3 Block IIA is still planned to be deployed with Aegis Weapons System 5.1 as part of the European Phased Adaptive Approach Phase III in the 2018 time frame.

Program Office Comments

In commenting on a draft of this assessment, Aegis BMD program management officials noted the SM-3 Block IIA program held 60 component-level preliminary design reviews in fiscal year 2011, of which 4 did not receive a pass during the first evaluation. This result drove a schedule adjustment of 1 year. The officials further noted the program used this additional time to implement a more robust engineering process. Actions the program took resulted in the completion of the four component-level reviews and support the completion of the system-level preliminary design review in March 2012. The rebalancing of the component-level requirements that occurred has not affected system-level requirements. Finally, the officials note that the program is on schedule to achieve its European Phased Adaptive Approach objectives. MDA also provided technical comments, which were incorporated as appropriate.[46]

SM-3 Block IIB Missile

The March 2012 GAO report stated the following regarding the SM-3 Block IIB missile:

Current Status

The SM-3 Block IIB program entered technology development in July 2011 and awarded three contracts to conduct trade studies, define missile configurations, and produce development plans. One contractor will be selected for system development in 2013. The SM-3 Block IIB program is developing advance seeker and other technologies that cut across the SM-3's variants through a technology risk-reduction program.

According to a tentative schedule, the SM-3 Block IIB program plans to enter system development prior to holding a preliminary design review, raising the possibility of cost and schedule growth. The program is conducting a series of reviews to receive engineering insight into each contractor's design. While these reviews will provide important knowledge, we have reported that before starting system development, programs should hold key engineering reviews, culminating in the preliminary design review, to ensure that the proposed design can meet defined, feasible requirements within cost, schedule, and other system constraints. Beyond the crosscutting technologies the program is developing, it is taking steps to develop technology maturation plans that will include demonstrating technologies in a relevant environment using a representative model or prototype before the SM-3 Block IIB enters system development. The three contractors' plans are expected to outline the level of investment required to demonstrate this degree of technology maturity by 2014. Program officials have not yet defined the specific critical technologies for the SM-3 Block IIB, which could hamper these efforts. Unlike most major defense acquisition programs, MDA programs are not required to demonstrate technologies in a relevant

[46] Government Accountability Office: *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-12-400SP, March 2012, p. 56.

environment prior to system development, so decision makers will have to hold the program accountable for ensuring the technologies mature as intended....

Program Office Comments: In commenting on a draft of this assessment, MDA noted the SM-3 Block IIB's primary mission is early intercept of long-range ballistic missiles. One system development contract will be competitively awarded in fiscal year 2014. MDA has identified key missile technologies and made investments to reduce development risks. Prior to system development, there will be a government-only system requirements review. MDA also provided technical comments, which were incorporated as appropriate.[47]

Aegis Ashore

The March 2012 GAO report stated the following regarding the Aegis Ashore sites:

> Aegis Ashore is following a concurrent acquisition approach by entering system development prior to holding a preliminary design review and purchasing operational components prior to completing testing—both of which increase the risk of cost growth and schedule delays. The program office has now assessed its five critical technologies as mature or nearing maturity. However, several of these technologies may be less mature than reported. The system's design was stable by February 2012, but the risk of design changes will remain until it demonstrates the design can perform as expected by flight testing, which will not occur until 2014. Program management stated that the development is low risk because the technologies are already used by Aegis BMD ships and the program's ground and flight test schedule will confirm the capability by the time it is deployed....
>
> **Technology Maturity**
>
> According to the Aegis Ashore program office, all five of its critical technologies are mature or nearing maturity. The program has assessed the SPY-1 radar, command and control system, SM-3 Block IB interceptor, and vertical launching system as mature and the multimission signal processor as nearing maturity. However, the maturity of some of these technologies may be overstated. The SPY-1 radar requires modifications for its use on land and other changes may be necessary due to host nation radar frequency issues. Program management officials stated at least some of these changes are software modifications, but the frequency issues may require other changes. The launch system must also be modified for use both on land and at a greater distance from the deckhouse. In addition, the maturity of SM-3 Block IB may be overstated because some of its component technologies have not been flight tested or have experienced failures in testing. The multimission signal processor also faces development challenges, and the Defense Contract Management Agency has identified its schedule as high risk. We have previously reported that a significant percentage of its software still needs to be integrated.
>
> **Design Maturity**
>
> The deckhouse design was 100 percent complete in February 2012, prior to the planned award of the deckhouse fabrication contract in the third quarter of fiscal year 2012. However, the program does not plan to demonstrate the design can perform as expected by flight testing until 2014, although there will be ground testing to demonstrate Aegis Ashore component integration prior to the flight test. As a result, the risk of design changes will remain until developmental testing is complete.

[47] Government Accountability Office: *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-12-400SP, March 2012, p. 140.

Other Program Issues

The Aegis Ashore program is following an acquisition approach that increases the risk of cost growth and schedule delays. The program began system development 14 months before completing its preliminary design review. We have previously reported that this review should be held prior to starting development to ensure that requirements are defined, feasible, and achievable within cost, schedule, and other system constraints. The program also contains concurrency between development and production, which increases the risk of late and costly design changes and retrofits. For example, the program is simultaneously acquiring the developmental test deckhouse and the operational deckhouse and is constructing the operational deckhouse first. In addition, the first developmental flight test of Aegis Ashore is scheduled for the second quarter of fiscal year 2014, at which point two deckhouses will have been constructed and other components will already be in production. Program management officials stated its concurrent schedule is low risk given its use of technology already used by Aegis BMD and modifications can be made to the deckhouse before it is installed in Romania. In addition, it stated that the current strategy has cost benefits and construction and testing efficiency advantages.

The program has experienced cost growth because of additional requirement costs. In 2011, the unit cost of Aegis Ashore grew, which the program attributed to costs for the reconstitutable deckhouse design that were not included in its baseline and the addition of hardware for a third site in Poland.

Program Office Comments

In commenting on a draft of this assessment, MDA provided technical comments, which were incorporated as appropriate.[48]

Legislative Activity for FY2013

Summary of Action on FY2013 MDA Funding Request

Table 5 summarizes congressional action on the FY2013 request for MDA procurement and research and development funding for the Aegis BMD program.

[48] Government Accountability Office: *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-12-400SP, March 2012, pp. 51-52.

Table 5. Summary of Congressional Action on FY2013 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 31)	389.6						
Research, development, test and evaluation (RDT&E)							
Next-generation Aegis missile (SM-3 IIB) (PE 0603902C, line 65)	224.1						
Aegis BMD (PE 0603892C, line 86)	992.4						
Land-based SM-3 (LBSM3) (PE0604881C, line 107)	276.3						
Aegis SM-3 IIA Co-development (PE0604881C, line 108)	420.6						
Subtotal RDT&E	**1,913.4**						
TOTAL	**2,303.0**						

Source: For request: FY2013 budget-justification books for MDA for Research, Development, Test & Evaluation, Defense-Wide (Volume 2a) and for Procurement, Defense-Wide (Volume 2b).

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.

Appendix. 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 18 successful exo-atmospheric intercepts in 23 attempts using the SM-3 missile (including 3 successful intercepts in 4 attempts by Japanese Aegis ships), and 3 successful endo-atmospheric intercepts in 3 attempts using the SM-2 Block IV missile, making for a combined total of 21 successful intercepts in 26 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—an operation called Burnt Frost. Including this intercept in the count increases the totals to 19 successful exo-atmospheric intercepts in 24 attempts using the SM-3 missile, and 22 successful exo- and endo-atmospheric intercepts in 27 attempts using both SM-3 and SM-2 Block IV missiles.

Table A-1. Aegis BMD Flight Tests Since January 2002

Date	Country	Name of flight test	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 short-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 missile target	Yes	14	16
			Short-range missile 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 missile target	**No**	18	23
Endo-atmospheric (using SM-2 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 ballistic missile target	Yes	3	3
Combined total for exo- and endo-atmospheric above tests					21	26

Source: Table adapted from table presented in MDA fact sheet, "Aegis Ballistic Missile Defense Testing," dated November 2010, accessed on November 19, 2010, 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 19 successful exo-atmospheric intercepts in 24 attempts using the SM-3 missile, and 22 successful exo- and endo-atmospheric intercepts in 27 attempts using both SM-3 and SM-2 Block IV missiles.

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.[49]

The criticisms made by Lewis and Postol were reported in a May 18, 2010, *New York Times* article.[50] 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.[51]

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

June 22, 2006, Test. This was the first test to use the 3.6 version of the Aegis BMD system.[52]

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.[53]

A news article about the ninth test stated:

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[49] 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.

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

[51] 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.

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

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

> "You can say it's seven of nine, rather than eight of nine," Missile Defense Agency spokesman Chris Taylor said of the second failure in tests of the system by the agency and the Navy....
>
> The drill was planned to demonstrate the Navy's ability to knock down two incoming missiles at once from the same ship.
>
> "In a real world situation it is possible, maybe even probable, that in addition to engaging a ballistic missile threat that was launched, you may be engaging a surface action," said Joe Rappisi before the test. He is director for the Aegis Ballistic Missile Defense system at Lockheed Martin, the primary contractor for the program.
>
> The test would have marked the first time a ship has shot down one target in space and another target in the air at the same time.
>
> The test presented a greater challenge to the ship's crew and the ballistic missile defense system than previous tests, Rappisi said. The multiple target scenario is also closer to what sailors might actually face in battle.
>
> The U.S. Pacific Fleet has been gradually installing missile surveillance and tracking technology on many of its destroyers and cruisers amid concerns about North Korea's long-range missile program.
>
> It is also installing interceptor missiles on many of its ships, even as the technology to track and shoot down incoming missiles is being developed and perfected.
>
> The Royal Netherlands Navy joined the tracking and monitoring off Kauai to see how its equipment works. The Dutch presence marked the first time a European ally has sent one of its vessels to participate in a U.S. ballistic missile defense test.[54]

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.[55]

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.

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

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

> "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."[56]

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....
>
> 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.[57]

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.[58]

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.[59]

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

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

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

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

August 31, 2007, Test. MDA has publicly noted the occurrence of this test and the fact that it resulted in a successful intercept,[60] but states that the details about the test are classified.[61] 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.[62]

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

> 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.[63]

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.[64]

(...continued)

0037).

[60] 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.

[61] An e-mail 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."

[62] 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.

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

[64] 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.

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.[65]

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

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

launch the interceptor missile, a major milestone in the growing cooperation between Japan and the U.S.[66]

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.
>
> 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.

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

> 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.[67]

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.
>
> 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.[68]

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.

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

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

> 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.[69]

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.[70]

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.
>
> 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.[71]

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

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

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

[71] 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.

> 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.[72]

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 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.

[72] 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.

> 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.[73]

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.
>
> 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

[73] 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.

> 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.[74]

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.[75]

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

The Aegis BMD system using the SM-2 Block IV interceptor has achieved three successful endo-atmospheric intercepts in three at-sea attempts, the first occurring on May 24, 2006,[76] the second on June 5, 2008,[77] and the third between March 24 and March 26, 2009.[78]

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

[75] 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.

[76] 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.

[77] 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.

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

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