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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. BMD-capable Aegis ships operate in European waters to defend Europe from potential ballistic missile attacks from countries such as Iran, and in 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. Under the FY2021 budget submission, the number of BMD-capable Navy Aegis ships is projected to increase from 48 at the end of FY2021 to 65 at the end of FY2025.

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 FY2021 budget requests a total of $1,805.1 million (i.e., about $1.8 billion) in procurement and research and development funding for Aegis BMD efforts, including funding for two Aegis Ashore sites in Poland and Romania. MDA's budget also includes operations and maintenance (O&M) and military construction (MilCon) funding for the Aegis BMD program.

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

- whether to approve, reject, or modify MDA's FY2021 funding procurement and research and development funding requests for the program;
- the impact of the COVID-19 pandemic on the execution of Aegis BMD program efforts;
- required numbers of BMD-capable Aegis ships versus available numbers of BMD-capable Aegis ships;
- the burden that BMD operations may be placing on the Navy's fleet of Aegis ships, and whether there are alternative ways to perform BMD missions now performed by U.S. Navy Aegis ships, such as establishing more Aegis Ashore sites;
- allied burden sharing—how allied contributions to regional BMD capabilities and operations compare to U.S. naval contributions to overseas regional BMD capabilities and operations;
- whether to procure and install an Aegis Ashore system on Guam;
- whether to convert the Aegis test facility in Hawaii into an operational land-based Aegis BMD site;
- the potential for ship-based lasers, electromagnetic railguns (EMRGs), and hypervelocity projectiles (HVPs) to contribute in coming years to Navy terminal-phase BMD operations and the impact this might eventually have on required numbers of ship-based BMD interceptor missiles; and
- technical risk and test and evaluation issues in the Aegis BMD program.

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Introduction

This report provides background information and issues for Congress on the Aegis ballistic missile defense (BMD) program, a program carried out by the Missile Defense Agency (MDA) and the Navy that gives Navy Aegis cruisers and destroyers a capability for conducting BMD operations. The issue for Congress is whether to approve, reject, or modify Department of Defense (DOD) acquisition strategies and proposed funding levels for the Aegis BMD program. Congress's decisions on the Aegis BMD program could significantly affect U.S. BMD capabilities and funding requirements, and the BMD-related industrial base.

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

Background

Aegis Ships

All but three of 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 exceptions are the Navy's three Zumwalt [DDG-1000] class destroyers, which are discussed below.) 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 (CGs 47 through 73) were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five ships in the class (CGs 47 through 51), which were built to an earlier technical standard in certain respects, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005, leaving 22 ships in operation (CGs 52 through 73).

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

A total of 62 DDG-51s were procured for the Navy between FY1985 and FY2005; the first entered service in 1991 and the 62nd entered service in FY2012. The first 28 ships are known as Flight I/II DDG-51s. The next 34 ships, known as Flight IIA DDG-51s, incorporate some design changes, including the addition of a helicopter hangar.

No DDG-51s were procured in FY2006-FY2009. The Navy during this period instead procured the three above-mentioned Zumwalt (DDG-1000) class destroyers. The DDG-1000 design does

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

not use the Aegis system and does not include a capability for conducting BMD operations. Navy plans do not call for modifying the three DDG-1000s to make them BMD-capable.[2]

Procurement of DDG-51s resumed in FY2010, following procurement of the three Zumwalt-class destroyers. A total of 23 DDG-51s have been procured from FY2010 through FY2020. DDG-51s procured in FY2017 and subsequent years are being built to a new version of the DDG-51 design called the Flight III version. The Flight III version is to be equipped with a new radar, called the Air and Missile Defense Radar (AMDR) or the SPY-6 radar, that is more capable than the SPY-1 radar installed on all previous Aegis cruisers and destroyers.

Aegis Ships in Allied Navies

Sales of the Aegis system to allied countries began in the late 1980s. Allied countries that now operate, are building, or are planning to build Aegis-equipped ships include Japan, South Korea, Australia, Spain, and Norway.[3] Japan's Aegis-equipped ships are BMD-capable. The Aegis-equipped ships operated by South Korea, Australia, Spain, and Norway are currently not BMD-capable.

Aegis BMD System[4]

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 being built from the start with a BMD capability.

Versions and Capabilities of Aegis BMD System

Overview

The Aegis BMD system exists in several variants. Listed in chronological order of development and deployment (and ascending level of capability), these include (but are not necessarily limited to) the 3.6.X variant, the 4.0.3 variant, the 4.1 variant, the 4.2 variant, the 5.0 CU (Capability Upgrade) variant, the 5.1 variant, and the 6.0 or 6.X variant. The BMD system variants correlate with certain versions (i.e., baselines, or BLs) of the overall Aegis system, which have their own numbering system. The more recent BMD variants, in addition to being able to address more challenging BMD scenarios, give BMD-equipped ships a capability to simultaneously perform both BMD operations against ballistic missiles and anti-air warfare (AAW) operations (aka air-defense operations) against aircraft and anti-ship cruise missiles. **Figure 1** provides a 2019 Government Accountability Office (GAO) summary of the capabilities of the newer BMD variants and their correlation to Aegis system baselines.

The Aegis BMD system was originally designed primarily to intercept theater-range ballistic missiles, meaning short-, medium-, and intermediate-range ballistic missiles (SRBMs, MRBMs, and IRBMs, respectively). In addition to its capability for intercepting theater-range ballistic missiles, detection and tracking data collected by the Aegis BMD system's radar might be passed

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

[3] 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.

[4] Unless stated otherwise, information in this section is taken from MDA briefings on the Aegis BMD program given to CRS and CBO analysts on the MDA's FY2019 and prior-year budget submissions.

to other U.S. BMD systems that are designed to intercept intercontinental ballistic missiles (ICBMs), which might support intercepts of ICBMs that are conducted by those other U.S. BMD systems.

Figure 1. GAO Summary of Capabilities of Aegis BMD System Variants

Table 5: Aegis Ballistic Missile Defense (BMD) spirals with associated Aegis Weapons System Baselines and capabilities.

Aegis BMD spirals	Associated integrated Aegis Weapon System Baselines (BL)	Key Ballistic Missile Defense Capabilities	Delivery date
BMD 5.0 Capability Upgrade (CU)	BL 9.C1	• Addition of Standard Missile-3 (SM-3) Block IB Threat Upgrade interceptor • Launch on Remote[a] • Improved discrimination using infrared and radio wave data • Capability against more advanced threats • Ship battle group defense capability using Standard Missile (SM-6) Dual I[b]	2015
	BL 9.B1	• BMD 5.0 CU capabilities for Aegis Ashore in Romania without Standard Missile (SM-6) Dual I	2015
BMD 5.1	BL 9.C2	• Addition of SM-3 Block IIA • Engage on Remote[c] • Ship battle group defense capability using Standard Missile (SM-6) Dual II[b] •	2019
	BL 9.B2	• BMD 5.1 capabilities for Aegis Ashore in Romania and Poland	2019
BMD 4.1	BL 5.4	• Similar capabilities to BMD 5.0 CU capabilities, installed on legacy hardware	2020
BMD 4.2	BL 5.X	• Aegis SPY-1 radar refurbishment for improved tracking capability	2023
BMD 6.0	BL 10.0	• New SPY-6 radar with increased radar capacity and discrimination • Performance against additional threats and larger raids • Improved missile communications	2023

Source: GAO analysis of MDA data | GAO-19-387

[a]Launch on Remote allows Aegis BMD to launch its interceptor on tracks provided by off board sensor before its own radar acquires the threat, but the intercept itself is executed based on onboard the Aegis SPY-1 radar.

[b]SM-6 Dual I and SM-6 Dual II allow ship to defend itself and other nearby ships in a battle group. SM-6 Dual I and II baselines are not included in the Ballistic Missile Defense Accountability Report and thus fall outside the scope of this review.

[c]Engage on Remote increases the area defended by the BMDS, by allowing Aegis BMD to intercept a threat before it is visible to its own radar, based entirely on tracks from a forward-based sensor.

Source: Government Accountability Office, *Missile Defense[:] Delivery Delays Provide Opportunity for Increased Testing to Better Understand Capability*, GAO-19-387, June 2019, Table 5 on p. 31.

Potential for Intercepting ICBMs

With the advent of the Aegis BMD system's new SM-3 Block IIA interceptor (which is discussed further in the next section), DOD is evaluating the potential for the Aegis BMD system to intercept certain ICBMs. Section 1680 of the FY2018 National Defense Authorization Act (H.R. 2810/P.L. 115-91 of December 12, 2017) directed DOD to "conduct a test to evaluate and demonstrate, if technologically feasible, the capability to defeat a simple intercontinental ballistic missile threat using the standard missile 3 block IIA missile interceptor." DOD's January 2019 missile defense review report states the following:

> The SM-3 Blk IIA interceptor is intended as part of the regional missile defense architecture, but also has the potential to provide an important "underlay" to existing GBIs [ground-based interceptors] for added protection against ICBM threats to the homeland. This interceptor has the potential to offer an additional defensive capability to ease the

> burden on the GBI system and provide continuing protection for the U.S. homeland against evolving rogue states' long-range missile capabilities.
>
> Congress has directed DoD to examine the feasibility of the SM-3 Blk IIA against an ICBM-class target. MDA will test this SM-3 Blk IIA capability in 2020. Due to the mobility of sea-based assets, this new underlay capability will be surged in a crisis or conflict to further thicken defensive capabilities for the U.S. homeland. Land-based sites in the United States with this SM-3 Blk IIA missile could also be pursued.[5]

An August 5, 2020, press report states

> The Missile Defense Agency is nearing its planned defense-of-Hawaii test event with an Arleigh Burke destroyer and a Standard Missile-3 Block IIA, to prove the ship can serve as a back-up to ground-based homeland defense systems if needed.
>
> The FTM-44 flight test, which was planned for May but postponed due to COVID-19-related restrictions, would prove that the SM-3 IIA could go beyond its originally designed scope and be used to stop an intercontinental ballistic missile, MDA Director Vice Adm. Jon Hill said in a briefing online this week. If successful, the destroyer and SM-3 IIA pairing would add another layer to the layered homeland defense model the MDA is developing.
>
> An ICBM target is on station on Kwajalein Atoll in the Marshall Islands, and San Diego-based USS John Finn (DDG-113) is ready to conduct the test, Hill said.
>
> He did not specify when the test would take place but said that it's congressionally mandated to happen by the end of the year and that MDA and the Navy are making final adjustments based on ongoing COVID restrictions.
>
> "We'll be launching the ICBM, the ship will maneuver and launch an SM-3 Block IIA outside its design space to take on an intercontinental ballistic missile track. It's going to be a pretty great event and we're looking forward to that," he said, calling it "the first empirical data capture" event to prove that the SM-3 IIA can be successful against this type of threat.
>
> If successful, he said the Navy would have to work out how its warfighters would employ this homeland defense capability and which agencies they'd have to coordinate with, but he said the first step is proving it is technologically feasible.[6]

The flight test has reportedly been delayed to the end of 2020.[7]

Aegis BMD Interceptor Missiles

The BMD interceptor missiles used by Aegis ships are the Standard Missile-3 (SM-3), the SM-2 Block IV, and the SM-6.

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-

[5] Department of Defense, *Missile Defense Review 20*19, released January 17, 2019, p. 55. David Axe, "The U.S. Navy's New Missile Defense Is a Bad Idea," *National Interest*, January 17, 2019.

[6] Megan Eckstein, "MDA to Use Destroyer USS John Finn for Defense-of-Hawaii Missile Intercept Test," USNI News, August 5 (updated August 8), 2020.

[7] Jason Sherman, "Pandemic Sets Back FTM-44, Planned 2020 Marquee Missile Defense Flight Test," *Inside Defense*, August 25, 2020. See also Richard R. Burgess, "MDA Considering Navy's Aegis System for Homeland Missile Defense," *Seapowe*r, August 18, 2020.

to-kill" warhead, called a kinetic vehicle, that is designed to destroy a ballistic missile's warhead by colliding with it. MDA and Navy plans call for fielding increasingly capable versions of the SM-3 in coming years. The current versions, called the SM-3 Block IA and SM-3 Block IB, are to be supplemented in coming years by SM-3 Block IIA.

Compared to the Block IA version, the Block IB version has an improved (two-color) target seeker, an advanced signal processor, and an improved divert/attitude control system for adjusting its course. Compared to the Block IA and 1B versions, which have a 21-inch-diameter booster stage at the bottom but are 13.5 inches in diameter along the remainder of their lengths, the Block IIA version has a 21-inch diameter along its entire length. The increase in diameter to a uniform 21 inches provides more room for rocket fuel, permitting the Block IIA version to have a burnout velocity (a maximum velocity, reached at the time the propulsion stack burns out) that is greater than that of the Block IA and IB versions, 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.[8] A March 31, 2020, press report stated:

> Raytheon and the Missile Defense Agency are exploring options to extend the range of the Standard Missile-3 Block IB—pushing the ballistic missile interceptor to dramatically expand a defended area by allowing the weapon to communicate with off-board radars—a move that would require enhancing one of the Aegis ballistic missile defense system's newest features: Engage-on-Remote….
>
> MDA Director Vice Adm. Jon Hill told Congress earlier this month that the new Engage-on-Remote capability provides "a seven-fold increase in missile defense coverage when compared to an autonomous Aegis platform."[9]

SM-2 and SM-6 Terminal Interceptors

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

MDA and the Navy are now procuring a more-capable terminal-phase (endo-atmospheric intercept) BMD interceptor based on the SM-6 air defense missile (the successor to the SM-2 air defense missile). The SM-6 is a dual-capability missile that can be used for either air defense (i.e., countering aircraft and anti-ship cruise missiles) or ballistic missile defense. A July 23, 2018, press report states the following:

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[8] 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.

MDA and Navy plans at one point called for the SM-3 Block IIA to be succeeded by a still more capable interceptor called the SM-3 Block IIB. The effort to develop that missile, however, was ended, and MDA reportedly is not pursuing any follow-on capabilities to the SM-3 Block IIA. (See, for example, Justin Doubleday, "Missile Defense Agency Not Pursuing Follow-On to SM-3 Block IIA Interceptor," *Inside the Navy*, October 24, 2016.)

[9] Jason Sherman, "After MDA Demonstrates 7x Increase in Defended Area, Raytheon Pitching EOR for Older SM-3s," *Inside Defense*, March 31, 2020.

> The Defense Department has launched a prototype project that aims to dramatically increase the speed and range of the Navy's Standard Missile-6 by adding a larger rocket motor to the ship-launched weapon, a move that aims to improve both the offensive and defensive reach of the Raytheon-built system.
>
> On Jan. 17, the Navy approved plans to develop a Dual Thrust Rocket Motor with a 21-inch diameter for the SM-6, which is currently fielded with a 13.5-inch propulsion package. The new rocket motor would sit atop the current 21-inch booster, producing a new variant of the missile: the SM-6 Block IB.[10]

Numbers of BMD-Capable Aegis Ships

Under the FY2021 budget submission, the number of BMD-capable Navy Aegis ships is projected to increase from 48 at the end of FY2021 to 65 at the end of FY2025. The portion of the force equipped with earlier Aegis variants is decreasing, and the number equipped with later variants is increasing.

BMD-Capable Aegis Destroyers Forward-Homeported in Spain

On October 5, 2011, the United States, Spain, and NATO jointly announced that, as part of the EPAA, four BMD-capable U.S. Navy Aegis destroyers were to be forward-homeported (i.e., based) at the naval base at Rota, Spain.[11] The four ships were transferred to Rota in FY2014 and FY2015.[12] They are reportedly scheduled to return to the United States and replaced at Rota by a new set of four BMD-capable U.S. Navy Aegis destroyers in 2020-2022.[13] Navy officials have said that the four Rota-based ships can provide a level of level of presence in the Mediterranean for performing BMD patrols and other missions equivalent to what could be provided by about 10 BMD-capable Aegis ships that are homeported on the U.S. east coast. The Rota homeporting arrangement thus effectively releases about six U.S. Navy BMD-capable Aegis ships for performing BMD patrols or other missions elsewhere. In February and March 2020, DOD officials testified that DOD is considering forward-homeporting an additional two BMD-capable Aegis destroyers at Rota, which would make for a total of ships at the site.[14] Navy officials have testified that they support the idea.[15]

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[10] Jason Sherman, "Navy Looking to Increase Range, Speed of SM-6 with Larger Rocket Motor," *Inside the Navy*, July 23, 2018.

[11] "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 August 27, 2020, at https://web.archive.org/web/20120117065346/http:/www.navy.mil/search/display.asp?story_id=63109.

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 (prior to the current arrangement) in 1979. (Source: Sam Fellman, "U.S. To Base Anti-Missile Ships in Spain," Defense News, October 10, 2011: 76.)

[12] The four ships are the destroyers *Ross* (DDG-71) and *Donald Cook* (DDG-75), which moved to Rota in FY2014, and the destroyers *Carney* (DDG-64) and *Porter* (DDG-78), which moved to Rota in FY2015.

[13] See, for example, Sam LaGrone, "Navy to Station Advanced Warships, Helo Squadron in Spain," *USNI News*, June 5, 2019; Rich Abott, "Navy Cycling Four New Missile Defense Destroyers To Spain," *Defense Daily*, June 7, 2019.

[14] See, for example, Paul McCleary, "EUCOM Calls For Two More Ships For Spanish Port," *Breaking Defense*, February 25, 2020; David B. Larter, "Push to Base Six US Navy Destroyers in Spain Could Be Gaining Steam," *Defense News*, March 3, 2020.

[15] See, for example, David B. Larter, "The US Navy's Top Officer Declares Support for Basing 6 Destroyers in Spain,"

Aegis Ashore Sites

Europe: Romania and Poland

The land-based version of the Aegis BMD system is called Aegis Ashore. There are two Aegis Ashore sites in Europe—one in Romania, and one in Poland. The sites are intended to help defend Europe against ballistic missile threats from countries such as Iran. Each Aegis Ashore site includes a structure housing an Aegis system that is similar to the deckhouse on an Aegis ship, and 24 SM-3 missiles launched from a relocatable Vertical Launch System (VLS) based on the VLS that is installed in Navy Aegis ships.[16]

The plan to establish the two Aegis Ashore sites in Romania and Poland was announced in 2009, as part of a plan for providing regional BMD defense in Europe called the European Phased Adaptive Approach (EPAA). The Aegis Ashore site in Romania achieved operational certification in May 2016.[17] The site in Poland began construction in May 2016,[18] and it was initially scheduled to be completed in 2018. Its completion, however, has been delayed by four years, to 2022, due to construction contractor performance issues.[19]

Japan: Two Planned Sites (Now Canceled)

Japan had planned to procure and operate two Aegis Ashore systems that reportedly were to be located at Ground Self-Defense Force (GSDF) facilities in Akita Prefecture in eastern Japan and Yamaguchi Prefecture in western Japan, and would be operated mainly by the GSDF (i.e., Japan's army).[20] The two systems reportedly were to be equipped with a new Lockheed-made radar called the Long Range Discrimination Radar (LRDR) rather than the Raytheon-made SPY-6 AMDR that is being installed on U.S. Navy Flight III DDG-51s, and reportedly were to go into operation by 2023.[21] On June 15, 2020, however, Japan announced that it had suspended implementation of its Aegis Ashore initiative due to cost growth and technical concerns.[22] On June 25, 2020, Japan

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Defense News, March 5, 2020.

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

[17] See, for example, Amy Forsythe, "U.S. Navy Aegis Ashore Base in Romania Hosts NATO Country Ambassadors," Defense Visual Information Distribution Service (DVIDS), November 19, 2019; "Aegis Ashore," Missile Defense Advocacy Alliance, accessed August 27, 2020; US Naval Forces Europe-Africa, "Aegis Ashore Missile Defense System (AAMDS)-Romania Operationally Certified," Defense-Aerospace.com, May 12, 2016.

[18] See, for example, "Aegis Ashore," Missile Defense Advocacy Alliance, accessed August 27, 2020.

[19] See, for example, Rich Abott, "Delayed Poland Aegis Ashore Site Needs Two More Years," *Defense Daily*, February 12, 2020; Jen Judson, "Poland's Aegis Ashore Delayed to 2022 with New Way Forward Coming Soon," *Defense News*, February 18, 2020; Megan Eckstein, "MDA, Army Withholding Pay as Aegis Ashore Poland Construction Still Drags," *USNI News*, March 12, 2020; Seapower staff, "Navy Commissions Naval Support Facility Redzikowo, a Future Aegis Ashore Site," *Seapower*, September 3, 2020.

[20] Yomiuri Shimbun, "Akita, Yamaguchi to Get Aegis Ashore/GSDF Involvement Expected to Strengthen Missile Defense," *The Japan News*, November 11, 2017. See also Kyodo, "Japan Mulling News Missile Interceptor Deployment to Guard Against North Korea," *South China Morning Post*, November 11, 2017.

[21] Anthony Capaccio, "Japan in Talks With U.S. on Buying Aegis Missile Defense," *Bloomberg*, November 7, 2017.

[22] See, for example, Rich Abott, "Japan Suspends Aegis Ashore Due To Technical And Cost Concerns," *Defense Daily*, June 15, 2020; Sam LaGrone, "Japan Backing Away From Aegis Ashore," *USNI News*, June 15, 2020; Mari Yamaguchi, "Japan to Scrap Costly Land-Based US Missile Defense System," *Associated Press*, June 15, 2020; Mike Yeo, "Japan Suspends Aegis Ashore Deployment, Pointing to Cost and Technical Issues," *Defense News*, June 15, 2020; Brad Glosserman, "Canceling Aegis Ashore Raises Problems—and Hopes," *Japan Times*, June 17, 2020.

Prior to the June 15, 2020, announcement, Japan had announced in early May that it would evaluate alternatives to the

confirmed that it had canceled the plan for deploying the two Aegis Ashore sites.[23] An October 6, 2020, press report stated:

> The Japanese government has ordered officials to quickly come up with an alternative to the rejected U.S.-made Aegis Ashore missile-defense system, possibly one that can float on a platform at sea.…
>
> Prime Minister Yoshihide Suga has instructed Defense Minister Nobuo Kishi to come up with an alternative plan by the end of the year, according to Japan's Defense Ministry.
>
> Research on the plan, which would involve a floating platform, will start soon, a ministry spokesman said Tuesday [October 6].
>
> The ministry is seeking applications from private companies with the expertise to support the project, the spokesman said, adding that Japan is discussing the issue with the United States.
>
> Japanese officials quoted in the Asahi newspaper Tuesday expressed skepticism that a plan could be ready on time.[24]

Aegis BMD Development Philosophy and Flight Tests

The Aegis BMD development effort, including Aegis BMD flight tests, has been described as following a development philosophy long held within the Aegis program office of "build a little, test a little, learn a lot," meaning that development is done in manageable steps, then tested and validated before moving on to the next step.[25] For a summary of Aegis BMD flight tests since 2002, see **Appendix A**.

Akita Prefecture site due to strong local opposition to that site. (Masaya Kato, "Japan's Missile Shield Deployment Scuppered by Local Resistance," *Nikkei Asian Review*, May 7, 2020.)

[23] Mari Yamaguchi (Associated Press), "Japan Confirms It's Scrapping US Missile Defense System," *Defense News*, June 25, 2020; Megan Eckstein, "Japan Officially Ends Aegis Ashore Plans After National Security Council Deliberations," *USNI News*, June 26, 2020.

See also Grant Newsham "Abe's Aegis Ashore Cancellation Doesn't Add Up," *Asia Times*, June 30, 2020; Lucy Craft, "Why Japan Scrapped a $4 Billion Missile Defense Purchase from the U.S.," *CBS News*, July 2, 2020; Tim Kelly, "Explainer: Strike Capability, Other Military Options on Table after Japan's Aegis U-Turn," *Reuters*, July 2, 2020; Jeffrey W. Hornung, "Japan Is Canceling a U.S. Missile Defense System," *Foreign Policy*, July 2, 2020; Bruce Klingner, "Japan Undercuts Its Defense Against North Korean Missiles," Heritage Foundation, July 22, 2020; Tim Kelly and Yoshifumi Takemoto, "Exclusive: As Japan Weighs Missile-Defence Options, Raytheon Lobbies for Lockheed's $300 Million Radar Deal," Reuters, July 30, 2020; Rieko Miki, "The Price of Peace: Why Japan Scrapped a $4.2bn US Missile System," *Nikkei Asian Review*, August 5, 2020; Loren Thompson, "Japan's Rethink Of Aegis Ashore Could Tie Up Navy, Increase Costs And Cause Big Delays," *Forbes*, August 11, 2020.

On June 18, 2020, it was reported that the United States and Japan were in talks to address the technical issues Japan cited and explore potential paths forward for bolstering Japan's ballistic missile defense capability. See Lara Seligman, "U.S. and Japan in Talks about 'Alternatives' to Aegis Ashore Missile Defense System," *Politico Pro*, June 18, 2020; Idrees Ali, "U.S. in Talks with Japan after Aegis Ashore Missile Defense System Suspension: Official," *Reuters*, June 18, 2020; Jason Sherman, "MDA Hopes to 'Resolve' Japan's Aegis Ashore Concerns, Reinstate Project," *Inside Defense*, June 18, 2020; "U.S. Talking with Japan on Concerns over Halted Missile Defense Plan," *Kyodo News*, June 19, 2020. See also Asahi Shimbun, "Japan Eyes Offshore Options to Replace Aegis Defense System," *Asahi Shimbun*, September 10, 2020.

[24] Seth Robson and Hana Kusumoto, "Japan Hopes to Have Alternative to Aegis Ashore Missile-Defense System by Year's End," *Stars and Stripes*, October 6, 2020.

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

Allied Participation and Interest in Aegis BMD Program

Japan[26]

Eight BMD-Capable Aegis Destroyers

Japan plans to operate a force of eight BMD-capable Aegis destroyers. Seven of the ships are in service. In June 2020, it was reported that the eighth ship had started sea trials and is scheduled to enter service in 2021.[27] Japanese BMD-capable Aegis ships have participated in some of the flight tests of the Aegis BMD system using the SM-3 interceptor (see **Table A-1** in **Appendix A**).

Cooperative Development of SM-3 Block IIA Missile

Japan cooperated with the United States on development the SM-3 Block IIA missile. Japan developed certain technologies for the missile, and paid for the development of those technologies, reducing the missile's development costs for the United States. A July 6, 2018, press report states that "the U.S. and Japan are looking to jointly develop next-generation radar technology that would use Japanese semiconductors to more than double the detection range of the Aegis missile defense system."[28]

Two Aegis Ashore Sites (Canceled)

As mentioned earlier, Japan had planned to procure and operate two Aegis Ashore systems, but announced in June 2020 that it had canceled the plan.

South Korea

An October 12, 2018, press report states that "the South Korean military has decided to buy ship-based SM-3 interceptors to thwart potential ballistic missile attacks from North Korea, a top commander of the Joint Chiefs of Staff revealed Oct. 12.[29]

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, and Australia. 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.

Nutshell (1 of 2)," accessed August 27, 2020, at https://web.archive.org/web/20100706133017/https:/www.marshall.org/pdf/materials/743.pdf.

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

[27] Mike Yeo, "Japan's New Missile Defense Destroyer Starts Sea Trials amid Aegis Ashore Saga," *Defense News*, June 23, 2020.

[28] Nikkei staff writers, "US Taps Japan Radar Tech to Double Missile Defense Range," *Nikkei Asian Review*, July 6, 2018.

[29] Jeff Jeong, "South Korea to Buy Ship-Based Interceptors to Counter Ballistic Missile Threats," *Defense News*, October 12, 2018.

FY2021-FY2025 MDA Procurement and R&D Funding

The Aegis BMD program is funded mostly through MDA's budget. The Navy's budget provides additional funding for BMD-related efforts. **Table 1** shows FY2021-FY2025 MDA procurement and research and development funding for Aegis BMD efforts. Research and development funding for the land-based SM-3 is funding for Aegis Ashore sites. MDA's budget also includes additional funding not shown in the table for operations and maintenance (O&M) and military construction (MilCon) for the Aegis BMD program.

Table 1. FY201-FY2025 MDA Procurement and R&D Funding for Aegis BMD Efforts

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

	FY21 (req.)	FY22 (proj.)	FY23 (proj.)	FY24 (proj.)	FY25 (proj.)
Procurement					
Aegis BMD (line 34)	356.2	348.1	413.4	440.9	438.6
(SM-3 Block IB missile quantity)	*(34)*	*(35)*	*(41)*	*(34)*	*(33)*
Aegis BMD Advance Procurement (line 35)	44.9	17.5	0	0	0
SM-3 Block IIA (line 37)	218.3	131.9	127.0	1,180.1	1,108.2
(SM-3 Block IIA missile quantity)	*(6)*	*(3)*	*(3)*	*(51)*	*(50)*
Aegis Ashore Phase III (line 40)	39.1	26.2	3.9	2.4	1.0
Aegis BMD hardware and software (line 42)	104.2	109.2	103.2	126.0	124.5
SUBTOTAL Procurement	**762.7**	**632.9**	**647.5**	**1,749.4**	**1,744.3**
Research and development					
Aegis BMD (PE 0603892C) (line 82)	814.9	674.8	553.4	478.0	449.1
Aegis BMD Test (PE 0604878C) (line 113)	170.9	191.7	163.1	179.9	217.7
Land-based SM-3 (PE 0604880C) (line 115)	56.6	43.7	29.1	31.5	27.9
SUBTOTAL RDT&E	**1,042.4**	**910.2**	**745.6**	**689.4**	**694.7**
TOTAL	**1,805.1**	**1,543.1**	**1,393.1**	**2,438.8**	**2,439.0**

Source: Table prepared by CRS based on FY2021 MDA budget submission.

Issues for Congress

FY2021 Funding Request

One issue for Congress is whether to approve, reject, or modify MDA's FY2021 procurement and research and development funding requests for the program. In considering this issue, Congress may consider various factors, including whether the work that MDA is proposing to fund for FY2021 is properly scheduled for FY2021, and whether this work is accurately priced.

COVID-19 Impact

Another issue for Congress concerns the impact of the COVID-19 pandemic on the execution of Aegis BMD program efforts. A DOD point paper on COVID-19 impacts to DOD acquisition programs from March 15, 2020, through June 20, 2020, stated that the impacts included, among other things, "Aegis Program delays: SM-3 Block IIA production deliveries; Aegis Ashore Poland

construction (further delays); and Aegis Testing delays for Flight Test Missile (FTM)-44 (Aegis), FTM-31, and FTM-33."[30]

Required vs. Available Numbers of BMD-Capable Aegis Ships

Another potential issue for Congress concerns required numbers of BMD-capable Aegis ships versus available numbers of BMD-capable Aegis ships. Some observers are concerned about the potential operational implications of a shortfall in the available number of BMD-capable relative to the required number. Regarding the required number of BMD-capable Aegis ships, an August 15, 2018, Navy information paper states the following:

> The [Navy's] 2016 Force Structure Assessment [FSA][31] sets the requirement [for BMD-capable ships] at 54 BMD-capable ships, as part of the 104 large surface combatant requirement, to meet Navy unique requirements to support defense of the sea base and limited expeditionary land base sites….
>
> The minimum requirement for 54 BMD ships is based on the Navy unique requirement as follows. It accepts risk in the sourcing of combatant commander (CCDR) requests for defense of land.
>
> - 30 to meet CVN escort demand for rotational deployment of the carrier strike groups
>
> - 11 INCONUS for independent BMD deployment demand
>
> - 9 in forward deployed naval forces (FDNF) Japan to meet operational timelines in USINDOPACOM
>
> - 4 in FDNF Europe for rotational deployment in EUCOM.[32]

Burden of BMD Mission on U.S. Navy Aegis Ships

A related potential issue for Congress is the burden that BMD operations may be placing on the Navy's fleet of Aegis ships, particularly since performing BMD patrols requires those ships to operate in geographic locations that may be unsuitable for performing other U.S. Navy missions, and whether there are alternative ways to perform BMD missions now performed by U.S. Navy Aegis ships, such as establishing more Aegis Ashore sites. A June 16, 2018, press report states the following:

> The U.S. Navy's top officer wants to end standing ballistic missile defense patrols and transfer the mission to shore-based assets.
>
> Chief of Naval Operations Adm. John Richardson said in no uncertain terms on June 12 that he wants the Navy off the tether of ballistic missile defense patrols, a mission that has put a growing strain on the Navy's hard-worn surface combatants, and the duty shifted towards more shore-based infrastructure.

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[30] Department of Defense, "FY 2020 DoD COVID-19 Response and Stimulus & COVID-19 Recovery Acquisition Contract Cost Overrun," undated point paper, 4 pp., posted at *Inside Defense* on August 6, 2020. For additional discussion of COVID-19 impacts to Navy programs, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[31] The FSA is the Navy's analysis, performed every few years, that establishes the Navy's ship force structure requirements. For further discussion, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[32] Navy information paper dated August 15, 2018, entitled "Ballistic Missile Defense (BMD) Capable Ships requirement," provided by Navy Office of Legislative Affairs to CBO and CRS on August 15, 2018. The information paper was requested by CBO.

> "Right now, as we speak, I have six multi-mission, very sophisticated, dynamic cruisers and destroyers—six of them are on ballistic missile defense duty at sea," Richardson said during his address at the U.S. Naval War College's Current Strategy Forum. "And if you know a little bit about this business you know that geometry is a tyrant.
>
> "You have to be in a tiny little box to have a chance at intercepting that incoming missile. So, we have six ships that could go anywhere in the world, at flank speed, in a tiny little box, defending land."
>
> Richardson continued, saying the Navy could be used in emergencies but that in the long term the problem demands a different solution.
>
> "It's a pretty good capability and if there is an emergent need to provide ballistic missile defense, we're there," he said. "But 10 years down the road, it's time to build something on land to defend the land. Whether that's AEGIS ashore or whatever, I want to get out of the long-term missile defense business and move to dynamic missile defense."
>
> The unusually direct comments from the CNO come amid growing frustration among the surface warfare community that the mission, which requires ships to stay in a steaming box doing figure-eights for weeks on end, is eating up assets and operational availability that could be better used confronting growing high-end threats from China and Russia.
>
> The BMD mission was also a factor in degraded readiness in the surface fleet. Amid the nuclear threat from North Korea, the BMD mission began eating more and more of the readiness generated in the Japan-based U.S. 7th Fleet, which created a pressurized situation that caused leaders in the Pacific to cut corners and sacrifice training time for their crews, an environment described in the Navy's comprehensive review into the two collisions that claimed the lives of 17 sailors in the disastrous summer of 2017.
>
> Richardson said that as potential enemies double down on anti-access technologies designed to keep the U.S. Navy at bay, the Navy needed to focus on missile defense for its own assets.
>
> "We're going to need missile defense at sea as we kind of fight our way now into the battle spaces we need to get into," he said. "And so restoring dynamic maneuver has something to do with missile defense.[33]

A June 23, 2018, press report states the following:

> The threats from a resurgent Russia and rising China—which is cranking out ships like it's preparing for war—have put enormous pressure on the now-aging [U.S. Navy Aegis destroyer] fleet. Standing requirements for BMD patrols have put increasing strain on the U.S. Navy's surface ships.
>
> The Navy now stands at a crossroads. BMD, while a burden, has also been a cash cow that has pushed the capabilities of the fleet exponentially forward over the past decade. The game-changing SPY-6 air and missile defense radar destined for DDG Flight III, for example, is a direct response to the need for more advanced BMD shooters. But a smaller fleet, needed for everything from anti-submarine patrols to freedom-of-navigation missions in the South China Sea, routinely has a large chunk tethered to BMD missions.
>
> "Right now, as we speak, I have six multimission, very sophisticated, dynamic cruisers and destroyers—six of them are on ballistic missile defense duty at sea," Chief of Naval Operations Adm. John Richardson said during an address at the recent U.S. Naval War College's Current Strategy Forum. "You have to be in a tiny little box to have a chance at

[33] David B. Larter, "The US Navy Is Fed Up with Ballistic Missile Defense Patrols," *Defense News*, June 16, 2018. See also Paul McLeary, "Will Budget Crunch Pentagon Laser & Space Investments?" *Breaking Defense*, November 13, 2018.

intercepting that incoming missile. So we have six ships that could go anywhere in the world, at flank speed, in a tiny little box, defending land."

And for every six ships the Navy has deployed in a standing mission, it means 18 ships are in various stages of the deployment cycle preparing to relieve them.

The Pentagon, led by Defense Secretary Jim Mattis, wants the Navy to be more flexible and less predictable—"dynamic" is the buzzword of moment in Navy circles. What Richardson is proposing is moving standing requirements for BMD patrols away from ships underway and all the associated costs that incurs, and toward fixed, shore-based sites, and also surging the Navy's at-sea BMD capabilities when there is an active threat....

In a follow-up response to questions posed on the CNO's comments, Navy spokesman Cmdr. William Speaks said the Navy's position is that BMD is an integral part of the service's mission, but where long-term threats exist, the Navy should "consider a more persistent, land-based solution as an option."

"This idea is not about the nation's or the Navy's commitment to BMD for the U.S. and our allies and partners—the Navy's commitment to ballistic missile defense is rock-solid," Speaks said. "In fact, the Navy will grow the number of BMD-capable ships from 38 to 60 by 2023, in response to the growing demand for this capability.

"The idea is about how to best meet that commitment. In alignment with our national strategic documents, we have shifted our focus in an era of great power competition—this calls us to think innovatively about how best to meet the demands of this mission and optimize the power of the joint force."...

While the idea of saving money by having fixed BMD sites and freeing up multimission ships is sensible, it may have unintended consequences, said Bryan McGrath, a retired destroyer skipper and owner of the defense consultancy The FerryBridge Group.

"The BMD mission is part of what creates the force structure requirement for large surface combatants," McGrath said on Twitter after Defense News reported the CNO's comments. "Absent it, the number of CG's and DDG's would necessarily decline. This may in fact be desirable, depending on the emerging fleet architecture and the roles and missions debate underway. Perhaps we need more smaller, multi-mission ships than larger, more expensive ones.

"But it cannot be forgotten that while the mission is somewhat wasteful of a capable, multi-mission ship, the fact that we have built the ships that (among other things) do this mission is an incredibly good thing. If there is a penalty to be paid in peacetime sub-optimization in order to have wartime capacity—should this not be considered a positive thing?"

McGrath went on to say that the suite of combat systems that have been built into Aegis have been in response to the BMD threat. And indeed, the crown jewels of the surface fleet—Aegis Baseline 9 software, which allows a ship to do both air defense and BMD simultaneously; the Aegis common-source library; the forthcoming SPY-6; cooperative engagement—have come about either in part or entirely driven by the BMD mission....

A Navy official who spoke on condition of anonymity, to discuss the Navy's shifting language on BMD, acknowledged the tone had shifted since the 2000s when the Navy latched onto the mission. But the official added that the situation more than a decade later has dramatically shifted.

"The strategic environment has changed significantly since the early 2000s—particularly in the western Pacific. We have never before faced multiple peer rivals in a world as interconnected and interdependent as we do today," the official said. "Nor have we ever seen technologies that could alter the character of war as dramatically as those we see emerging around us. China and Russia have observed our way of war and are on the move to reshape the environment to their favor."

> In response to the threat and Defense Secretary Jim Mattis' desire to use the force more dynamically, the Navy is looking at its options, the official said. "This includes taking a look at how we employ BMD ships through the lens of great power competition to compete, deter and win against those who threaten us."[34]

A January 29, 2019, press report states the following:

> The Navy is looking to get out of the missile defense business, the service's top admiral said today, and the Pentagon's new missile defense review might give the service the off-ramp it has been looking for to stop sailing in circles waiting for ground-based missile launches.
>
> This wasn't the first time Adm. John Richardson bristled in public over his ships sailing in "small boxes" at sea tasked with protecting land, when they could be out performing other missions challenging Chinese and Russian adventurism in the South China Sea and the North Atlantic….
>
> "We've got exquisite capability, but we've had ships protecting some pretty static assets on land for a decade," Richardson said at the Brookings Institute. "If that [stationary] asset is going to be a long-term protected asset, then let's build something on land and protect that and liberate these ships from this mission."
>
> Japan is already moving down the path of building up a more robust ground-based sensor and shooter layer, while also getting its own ships out to sea armed with the Aegis radar and missile defense system, both of which would free up American hulls from what Richardson on Monday called "the small [geographic] boxes where they have to stay for ballistic missile defense."[35]

Allied Burden Sharing: U.S. vs. Allied Contributions to Regional BMD Capabilities

Another related potential issue for Congress concerns allied burden sharing—how allied contributions to regional BMD capabilities and operations compare to U.S. naval contributions to overseas regional BMD capabilities and operations, particularly in light of constraints on U.S. defense spending, worldwide operational demands for U.S. Navy Aegis ships, and calls by some U.S. observers for increased allied defense efforts. The issue can arise in connection with both U.S. allies in Europe and U.S. allies in Asia. Regarding U.S. allies in Asia, a December 12, 2018, press report states the following:

> In June, US Navy Chief of Naval Operations (CNO) Admiral John Richardson said during a speech at the US Naval War College that the US Navy should terminate its current practice of dedicating several US Navy warships solely for Ballistic Missile Defense (BMD).
>
> Richardson wanted US warships to halt BMD patrols off Japan and Europe as they are limiting, restrictive missions that could be better accomplished by existing land-based BMD systems such as Patriot anti-missile batteries, the US Terminal High Altitude Area Defense (THAAD) anti-missile system and the Aegis Ashore anti-missile system.
>
> In the months since dropping his bombshell, Richardson—and much of the debate—has gone quiet.

[34] David B. Larter, "As Threats Mount, US Navy Grapples with Costly Ballistic Missile Defense Mission," *Defense News*, June 23, 2018.

[35] Paul McLeary, "The Navy Has Had Enough of Missile Defense And Sees Its Chance," *Breaking Defense*, January 28, 2019.

> "My guess is the CNO got snapped back by the Pentagon for exceeding where the debate actually stood," one expert on US naval affairs told Asia Times.
>
> But others agree with him. Air Force Lt Gen Samuel A Greaves, the director of the US Missile Defense Agency (MDA), acknowledges Richardson's attempts to highlight how these BMD patrols were placing unwelcome "strain on the (US Navy's) crews and equipment."
>
> But there are complications. While it may free US Navy warships for sea-control, rather than land defense, there is a concern that next- generation hypersonic cruise missiles could defeat land-based BMD systems, such as Aegis Ashore, while the US Navy's Aegis-equipped warships offer the advantages of high-speed mobility and stealth, resulting in greater survivability overall.
>
> As Japan prepares to acquire its first Aegis Ashore BMD system – and perhaps other systems such as the THAAD system which has been deployed previously in Romania and South Korea – the possibility that the US Navy will end its important BMD role represents abrupt change….
>
> Japan's decision to deploy Aegis Ashore can fill in any gap created by a possible US Navy cessation of BMD patrols. "The land-based option is more reliable, less logistically draining, and despite being horrendously expensive, could be effective in the sense that it provides a degree of reassurance to the Japanese people and US government, and introduces an element of doubt of missile efficacy into [North Korean] calculations," said [Garren Mulloy, Associate Professor of International Relations at Daito Bunka University in Saitama, Japan], adding, however, that these systems could not cover Okinawa.
>
> "Fixed sites in Japan could be vulnerable, and the Aegis vessels provide a flexible forward-defense, before anything enters Japanese airspace, but with obviously limited reactions times," Mulloy said. "Aegis Ashore gives more reaction time – but over Japanese airspace."…
>
> The silence about this sudden possible shift in the US defense posture in the western Pacific is understandable: it is a sensitive topic in Washington and Tokyo. However, the Trump administration has urged its allies to pay more for their own defense needs and to support US troops deployed overseas.
>
> Meanwhile, Tokyo needs to proceed cautiously given the likelihood that neighbors might view a move on BMD as evidence that Tokyo is adopting an increasingly aggressive defense posture in the region.
>
> But for them, it is a no-win situation. If the US does ditch the BMD patrol mission, China and North Korea might view the shift as equally menacing given that it greatly enhances the US Navy's maritime warfare capabilities.[36]

Potential Aegis Ashore Site on Guam

Another issue for Congress is whether to procure and install an Aegis Ashore system on Guam. A July 21, 2020, press report stated:

> The head of U.S. Indo-Pacific Command told reporters today he wants the Aegis Ashore ballistic missile defense system to bolster the defense of Guam from Chinese missiles.
>
> The Aegis Ashore Baseline 10 system should be "the backbone of [a] homeland defense system" for Guam, Adm. Phil Davidson said during a Defense Writers Group virtual roundtable.

[36] Peter J. Brown, "Japan, US Silent over Ending Ballistic Missile Patrols," *Asia Times*, December 12, 2018.

> "The reason I'm a key advocate for that is first: it is technology that is available to us now and could be delivered by 2026, when I believe the threat will require us to have a much more robust capability than the combination of [Terminal High Altitude Area Defense], which is deployed there now, and an Aegis ship in response can provide," Davidson said.
>
> Davidson said the current defense system for Guam is not adequate to thwart potential Chinese missiles.
>
> "When you look at the way the threat capability, threat capacity, is manifesting from China in the future—whether it's ballistic missiles from the land or whether it's ballistic or cruise missiles from air and maritime platforms—you are going to need a complete clock, a 360-degree coverage in order to help defend Guam," the admiral said.[37]

A September 18, 2020, press report states

> Guam urgently needs an Aegis Ashore missile defense system to protect vital military assets from an increasingly aggressive China, according to the head of U.S. Indo-Pacific Command.
>
> "There are billions of dollars in defense capability on Guam," Adm. Phil Davidson said Thursday [September 17] during an online forum organized by the Missile Defense Advocacy Alliance. "There needs to be some investment in defending that."
>
> The U.S. territory is home to air and naval bases and serves as a launching point for strategic bombers. The Navy is also building facilities to house a Marine Corps air-ground task force to accommodate a planned drawdown of Marines on Okinawa….
>
> China's ability to launch missiles from submarines ranging farther from shore means Guam needs the 360-degree protection that Aegis can provide, he said.
>
> Guam's Terminal High Altitude Area Defense, or THAAD, missile defense battery can sense targets only within a 120-degree range, and it's pointed at North Korea, Davidson said.
>
> "It's going to require a much deeper 360-degree persistent capability," he said, adding that it's important to invest in Guam's missile defense now.
>
> "It is not necessarily about designing or creating a defensive system that is impenetrable or invulnerable against the entire missile inventory of a potential adversary. Rather it is about developing a combat credible deterrent."
>
> INDOPACOM, in a report to Congress, put the cost of a system providing 360-degree air-missile defense on Guam at just under $1.7 billion.
>
> Davidson has requested funding for the system starting in the next fiscal year as part of a Pacific Deterrence Initiative that parallel's a similar program in Europe designed to deter Russia.
>
> Building Aegis Ashore is a pathway to defending against hypersonic missiles, Davidson said, adding that China's rocket force fires and exercises more often than that of any other nation….

[37] Mallory Shelbourne, "Protecting Guam from Chinese Missiles is Top Priority for INDO-PACOM's Davidson," *USNI News*, July 21, 2020. See also Mandy Mayfield, "Web Exclusive: Commander Wants Aegis Ashore Funding to Defend Guam," *National Defense*, July 21, 2020; Jason Sherman, "INDOPACOM: Aegis Ashore with SPY-6 Needed on Guam by 2026 to Counter Chinese Ballistic, Cruise Missiles," *Inside Defense*, July 21, 2020; and Aaron Mehta, "INDOPACOM Head Wants Aegis Ashore in Guam by 2026," *Defense News*, July 22, 2020. See also Bradley Bowman and Maj. Shane Praiswater, "Guam needs Aegis Ashore," *Defense News*, August 25, 2020.

> Rapidly growing capability in China and North Korea requires that Aegis be the starting point for the defense of Guam, Davidson said.
>
> "We can't … wait for some perfect solution to manifest itself in 2035 or 2040. We are in the threat environment now," he said.[38]

A September 22, 2020, press report states

> The Aegis Ashore ballistic missile defense system being eyed to bolster protection of Guam could potentially be armed for strike missions to offset China's current ballistic and cruise missile advantage against U.S. forces, according to the top U.S. military official in the region.
>
> Adm. Phil Davidson, commander of U.S. Indo-Pacific Command, broached the possibility of using Aegis Ashore for offense during a Sept. 17 online discussion hosted by the Missile Defense Advocacy Alliance, acknowledging a capability the Defense Department disavowed for years while the Intermediate-Range Nuclear Forces (INF) Treaty remained in force.[39]

Other observers have argued that an Aegis Ashore site at Guam would not be the most cost-effective option for bolstering Guam's defenses against potential missile attacks. A July 30, 2020, opinion article states

> The head of U.S. Indo-Pacific Command said last week his top priority is establishing an Aegis Ashore system on Guam by 2026. New air defenses will help protect U.S. citizens and forces in Guam; but as Japan's government found, Aegis Ashore may not be the best option to protect military and civilian targets from growing and improving Chinese and North Korean missile threats….
>
> Although the current Terminal High Altitude Area Defense battery on Guam can defend against some ballistic missiles, its single AN/TPY-2 radar is vulnerable and cannot provide 360-degree coverage. Moreover, THAAD's focus on high altitudes makes it a poor fit to defeat lower-flying aircraft or cruise missiles that would likely be used by China's military against Guam. The island needs a new air defense architecture.
>
> egis Ashore is highly capable, but has its own limitations. Designed primarily to counter small numbers of ballistic missiles, its fixed missile magazine and radar would be vulnerable to attack and would fall short against the bombardment possible from China.
>
> Instead of installing one or more Aegis Ashore systems on Guam, a more effective air and missile defense architecture would combine the latest version of the Aegis Combat System with a disaggregated system of existing sensors, effectors, and command-and-control nodes. A distributed architecture would also be scalable, allowing air and missile defenses to also protect U.S. citizens and forces operating in the Northern Marianas.
>
> Guam's geography enables longer-range sensing than would be possible from a ship or a single Aegis Ashore radar. Fixed, relocatable and mobile radio frequency sensors should be positioned around the island's perimeter, such as compact versions of SPY-6 or Lower Tier Air and Missile Defense Sensor radars and the passive Army Long-Range Persistent Surveillance system. During periods of heightened tension, passive and active radio frequency and electro-optical/infrared sensors could also be deployed on unmanned aircraft and stratospheric balloons to monitor over-the-horizon threats. This mixed architecture would provide better collective coverage and be more difficult to defeat compared to one or two fixed Aegis Ashore deckhouses.

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[38] Seth Robson, "Indo-Pacific Command Leader Underscores Need for Stronger Missile Defense on Guam," *Stars and Stripes*, September 18, 2020.

[39] Jason Sherman, "INDOPACOM Chief: Aegis Ashore Guam Could One Day Be Armed for Strike to Counter China," *Inside Defense*, September 22, 2020.

> To shoot down enemy missiles and aircraft, the architecture should field mobile, containerized launchers for long-range interceptors like the SM-6 and SM-3 rather than Aegis Ashore's finite and targetable in-ground vertical launch magazines. They should be complemented by medium- to short-range engagement systems to protect high-value targets such as the Patriot, the National Advanced Surface-to-Air Missile System or the Army's planned Indirect Fire Protection Capability, as well as non-kinetic defenses such as high-powered microwave weapons and electronic warfare systems that could damage or confuse the guidance systems on incoming missiles.
>
> Today, destroyers patrol the waters around Guam to provide ballistic missile defense capacity beyond that available with THAAD. A new distributed architecture would place more capacity ashore to free surface combatants from missile defense duty. In a crisis or conflict, the architecture could add capacity with surface action groups and combat air patrols capable of intercepting threats at longer ranges.
>
> Instead of Aegis Ashore's large, single C2 node, a distributed architecture would virtualize the Aegis Combat System to allow multiple facilities or mobile vehicles to serve as miniature air operations centers. The mobility of sensors, effectors and C2 nodes in this architecture would enable the employment of camouflage, concealment and deception, including decoys, to complicate enemy targeting and increase the number of weapons needed to ensure a successful attack.
>
> INDOPACOM's plan for implementing new Guam air defenses should also apply lessons from Japan's aborted Aegis Ashore program, whose accelerated timeline contributed to the selection of the least expensive and technically risky option—two fixed Aegis Ashore systems—and the discounting of alternatives. Adm. Phil Davidson's 2026 goal of improving Guam's defenses faces a similar risk.
>
> Bound by an iron triangle, Guam's air and missile defenses can be good, fast or cheap—but not all three. If 2026 is held as a rigid constraint, the only solution able to meet the schedule and requirements may be the familiar, and ineffective, fixed Aegis Ashore architecture.
>
> Compared to one or two Aegis Ashore sites, a distributed architecture may require slightly more time to develop or funds to field. But a phased approach could introduce new systems as funding becomes available and allow expanding the system's capability to meet the evolving threat. For example, SPY-6 radars, C2 bunkers and composite THAAD-Patriot-NASAMS batteries could be fielded before 2026, quickly followed by the introduction of mobile assets.
>
> Guam and the Northern Marianas are essential to U.S. strategy and operations in the Western Pacific. Their defenses have long been ignored, and Adm. Davidson should be lauded for charting a path forward. A disaggregated architecture, however, will be more likely to realize INDOPACOM's vision of resilient and scalable air and missile defense.[40]

Conversion of Hawaii Aegis Test Site

Another potential issue for Congress is whether to convert the Aegis test facility in Hawaii into an operational land-based Aegis BMD site. DOD's January 2019 missile defense review report states, in a section on improving or adapting existing BMD systems, that

> Another repurposing option is to operationalize, either temporarily or permanently, the Aegis Ashore Missile Defense Test Center in Kauai, Hawaii, to strengthen the defense of Hawaii against North Korean missile capabilities. DoD will study this possibility to further evaluate it as a viable near-term option to enhance the defense of Hawaii. The United States

[40] Timothy A. Walton and Bryan Clark, "Guam's Air Defense Should Learn Lessons from Japan's Aegis Ashore," *Defense News*, July 30, 2020.

> will augment the defense of Hawaii in order to stay ahead of any possible North Korean missile threat. MDA and the Navy will evaluate the viability of this option and develop an Emergency Activation Plan that would enable the Secretary of Defense to operationalize the Aegis Ashore test site in Kauai within 30 days of the Secretary's decision to do so, the steps that would need to be taken, associated costs, and personnel requirements. This plan will be delivered to USDA&S, USDR&E, and USDP within six months of the release of the MDR.[41]

A January 25, 2019, press report states the following:

> The Defense Department will examine the funding breakdown between the Navy and the Missile Defense Agency should the government make Hawaii's Aegis Ashore Missile Defense Test Center into an operational resource, according to the agency's director.
>
> "Today, it involves both Navy resources for the operational crews—that man that site—as well as funds that come to MDA for research, development and test production and sustainment," Lt. Gen. Sam Greaves said of the test center when asked how the funding would shake out between the Navy and MDA should the Pentagon move forward with the recommendation.[42]

Potential Contribution from Lasers, Railguns, and Guided Projectiles

Another potential issue for Congress concerns the potential for ship-based lasers, electromagnetic railguns (EMRGs), and gun-launched guided projectiles (GLGPs, previously known as hypervelocity projectiles [HVPs]) to contribute in coming years to Navy terminal-phase BMD operations and the impact this might eventually have on required numbers of ship-based BMD interceptor missiles. Another CRS report discusses the potential value of ship-based lasers, EMRGs, and GLGPs for performing various missions, including, potentially, terminal-phase BMD operations.[43]

Technical Risk and Test and Evaluation Issues

Another potential oversight issue for Congress is technical risk and test and evaluation issues in the Aegis BMD program.

July 2020 GAO Report

A July 2020 GAO report on the testing of U.S. BMD systems, including the Aegis BMD system, stated the following:

> Aegis BMD demonstrated various capabilities in fiscal year 2019 tests and achieved independent accreditation for all its models used in operational ground tests. The Missile Defense Agency (MDA) conducted five Aegis Ballistic Missile Defense (BMD) intercept flight tests in fiscal year 2019, successfully intercepting two ballistic missile targets and three cruise missiles. Additionally, MDA also conducted Aegis BMD non-intercept flight tests with live or simulated interceptors and targets, as well as five model-based ground

[41] Department of Defense, *Missile Defense Review 2019*, released January 17, 2019, pp. 55-56.

[42] Mallory Shelbourne, "DOD to Determine Funding Breakdown for Aegis Ashore Repurposing," *Inside the Navy*, January 25, 2019.

[43] See CRS Report R44175, *Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress*, by Ronald O'Rourke.

tests that provided data on Aegis BMD interoperability and weapon system functionality in various regional and Homeland Defense scenarios….

Aegis BMD testing also had some limitations. For instance, while most testing limitations are classified, DOT&E noted in its fiscal year 2019 assessment of Aegis BMD that MDA ground tests have routinely shown the need for improved inter-element coordination and interoperability to enhance engagement efficiency. Moreover, for the second year in a row, DOT&E noted that flight testing and models and simulations did not address all expected threat types, ground ranges, and raid sizes for Aegis BMD. For instance, while Aegis BMD M&S tools were accredited for many scenarios, there were limitations for raid engagements due to the lack of validation data from live fire raid engagements and lack of post-intercept debris modeling. As we reported in June 2019, MDA planned to assess Aegis BMD 5.1 raid performance for the first time in December 2018, but the test was de-scoped to a single intercept due, in part, to a test range safety asset malfunction. While MDA planned to conduct a raid the fourth quarter of fiscal year 2020, according to technical comments we received from MDA at the end of our audit, that plan has been canceled. In the meantime, the warfighter will have reduced information about how Aegis BMD 5.1 performs in these real-world-like scenarios.

MDA stayed on track to deliver the next generation of Aegis BMD capabilities. For instance, MDA plans to deliver BMD 6.0 in the 2023 time frame to provide capabilities against larger raids, better discrimination, and improved communication with its interceptors. Additionally, BMD 6.0 takes advantage of the Navy's effort to replace the Aegis AN/SPY-1 radar with a more capable AN/SPY-6 (V)1 and to overhaul the entire Aegis combat system. As we reported in June 2019, MDA and the Navy re-planned AWS Baseline 10.0, after a funding reduction of $31.45 million against BMD 6.05. While the reduction resulted in delays to completion of some technical content, its delivery time frame did not change. In fiscal year 2019, the program remained on schedule, completing a planned review and participated in a Navy-funded developmental test of AN/SPY-6(V)1 and FTX-34, demonstrating ballistic missile tracking capabilities. MDA efforts to deliver integrated AWS Baseline 5.4 were also on track in fiscal year 2019 after the program readjusted its schedule in fiscal year 2018….

According to MDA, the Aegis BMD SM-3 Block IB program considers the schedule for awarding a multi-year procurement contract, and enduring subcontractor quality issues, to be the two main risks facing the program. MDA officials stated that they expected to award the multi-year procurement contract in the first quarter, fiscal year 2020. MDA had also stated that a delay in the award could cause production delays both to the United States and to foreign military sales. MDA's current plans call for the multi-year procurement award in the second quarter, fiscal year 2020.

In addition, as we reported in 2019, MDA officials have noted that the Aegis BMD SM-3 Block IB's prime contractor has had difficulty ensuring that all subcontracted components meet defined specifications. Similar issues occurred in fiscal year 2019, each of which required resolution on a case-by-case basis. For example, MDA officials reported that an important actuator was found to have contaminated lubricant, requiring the source of the contamination to be tracked to a specific facility within the supply chain and the procurement of new hardware. In addition, a divert valve was experiencing an increased reject rate, slowing down deliveries of the Third Stage Rocket Motor. The program and the contractor developed and implemented three corrective actions to address this issue and accelerate deliveries. Even so, problems such as these can result in months-long delays, and MDA reported that the introduction of improved quality controls drove up costs in fiscal year 2019….

Following the failure of FTM-29 in January 2018, MDA re-organized the SM-3 Block IIA schedule to allow it to identify the cause of the failure, implement changes, and then test these changes to validate their efficacy. As we reported in May 2019, as a result of the test

failure, MDA and the government of Japan convened a failure review board to investigate the causes of the test failure. The board's conclusions identified the source of the failure.

To test the fixes identified through the FTM-29 failure review board, MDA added a new flight test to its schedule, FTM-45. Despite criticism from Department of Defense stakeholders that FTM-45 would not be taxing enough to make up for the failure of FTM-29, MDA successfully conducted the test, and thus validated the corrective actions, in October 2018.

Two months later, in December 2018, MDA conducted FTI-03, the first successful SM-3 Block IIA intercept of an Intermediate-Range Ballistic Missile (IRBM), and the first successful SM-3 Block IIA intercept to use remote sensor data to guide the engagement, known as Engage on Remote. However, as mentioned previously, the test's initial plan was an intercept of two targets, but it was scaled down due to range safety issues.

MDA achieved its objective in FTI-03 by intercepting the target, but a more detailed review of the system's performance revealed at least one issue. During the interceptor's flight, the attitude control system in the third stage rocket motor experienced a fault whereby a valve failed to respond to electronic instructions. A failure review board isolated the fault to a specific component failing to provide adequate electric current. Seeking to avoid unnecessary work, the prime contractor temporarily suspended its operations in order to identify the root cause and then develop and implement corrective actions. This suspension has affected delivery schedules for both third stage rocket motors and completed interceptors.

MDA originally planned for an initial production decision in December 2018, but two issues delayed this decision. First, owing to the fact that the canceled Redesigned Kill Vehicle re-used parts from the SM-3 Block IIA program, the Undersecretary of Defense for Research and Engineering requested a study to determine if the SM-3 Block IIA could be affected by the issues which resulted in the RKV's cancellation. Second, DOD officials recommended against any initial production decision until the issue observed in FTI-03 was resolved.

MDA documents indicated that its officials believed an initial production decision was possible before the end of fiscal year 2019. The SM-3 Block IIA received a positive initial production decision in October 2019.[44]

December 2019 DOT&E Report

A December 2019 report from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2019—stated the following in its section on the Aegis BMD program:

Assessment

• Results from flight testing, high-fidelity M&S [modeling and simulation], and HWIL [hardware-in-the-loop] testing demonstrate that Aegis BMD can intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase of flight. However, flight testing and M&S did not address all expected threat types, ground ranges, and raid sizes.

• [Flight test] FTM-45 demonstrated that Aegis destroyers can organically engage and intercept MRBMs with SM-3 Block IIA missiles. [Flight test] FTI-03 demonstrated, for the first time in an end-to-end test, Aegis BMD's capability to intercept an IRBM using EOR [engage-on-remote capability] and an SM-3 Block IIA missile.

[44] Government Accountability Office, *Missile Defense[:] Assessment of Testing Approach Needed as Delays and Changes Persist*, GAO-20-432, July 2020, pp. 44, 45-46, 48-49, 51-52.

• OPTEVFOR [the Navy Commander, Operational Test and Evaluation Force] accredited Aegis BMD high-fidelity M&S tools for many scenarios, but it noted limitations for raid engagements due to the lack of validation data from live fire raid engagements and lack of post-intercept debris modeling.

• During the four events that comprised FS-19 [Formidable Shield-19], the MDA demonstrated Aegis BMD interoperability with NATO partners over the U.S. European Command Operational Tactical Data Link communication architecture during cruise missile and ballistic missile engagements. An Aegis destroyer twice engaged a simulated MRBM target with live SM-3 Block IA missiles, performed engagement support surveillance and track, organically engaged a live SRBM target with a simulated SM-6 Block 1 guided missile, and organically engaged a lofted SRBM target with simulated SM-3 Block IB (Threat Update) missiles. During the last engagement, the geo-repositioned AAMDTC [Aegis Ashore Missile Defense Test Complex] launched a simulated SM-3 Block IIA guided missile at the target, using track data from the BL [Baseline] 9.C2 ship in an EOR scenario.

• Aegis BMD has exercised rudimentary engagement coordination with Terminal High-Altitude Area Defense [THAAD] firing units, but not with Patriot. MDA ground tests have routinely shown that inter-element coordination and interoperability need improvement to enhance engagement efficiency.

• The MDA has been collaborating with DOT&E and the USD(R&E) [Under Secretary of Defense, Research and Engineering] to establish an affordable ground testing approach to support assessments of reliability. DOT&E cannot assess SM-3 missile reliability with confidence until the MDA is able to provide additional ground test data that simulates the in-flight environment. In FY19, the MDA identified possible data sources to inform reliability estimates, but the data will not be available until CY21 [calendar year 2021].

• A December 2017 SM-3 Block IB Acquisition Decision Memorandum [ADM] requires the MDA and DOT&E to ensure periodic flight testing of the Block IB throughout the life of the program in the Integrated Master Test Plan. DOT&E and the MDA agreed that periodic testing would occur at approximately 2 year intervals. The MDA conducted two surveillance firings of the SM-3 Block IB missile in FY18, and two Stockpile Surveillance and Reliability program firings of the SM-3 Block IA missile in FY19.

• AN/SPY-6(V)1 [radar, aka Air and Missile Defense Radar, or AMDR] participated in its final Navy-funded BMD developmental test, FTX-34. This tracking exercise was the last of five SPY-6(V)1 BMD tracking exercises at the U.S. Navy's Advanced Radar Development Evaluation Laboratory (ARDEL). ARDEL does not have the most recent Aegis combat system (i.e., BL [baseline] 10), precluding future integration testing with the AN/SPY-6 radar at that facility.

Recommendations

The MDA should:

1. Provide data from high-fidelity ground test venues in the near term to help inform SM-3 Block IB Threat Upgrade and Block IIA missile reliability estimates.

2. Continue to conduct periodic (approximately every 2 years) SM-3 Block IB firings throughout the life of the program to demonstrate missile reliability.

3. Conduct Aegis BMD flight testing with live fire intercepts of raids of two or more ballistic missile targets to aid in the validation of M&S tools for raid engagements.

4. Improve Aegis BMD high-fidelity M&S tools to incorporate post-intercept debris modeling to better assess engagement performance in raid scenarios.

5. Coordinate with the Navy to fund an Aegis BL10 combat system at ARDEL for use in future combat system integration testing with the AN/SPY-6 radar.[45]

Regarding the SM-6 missile, the December 2019 DOT&E report also stated the following:

Assessment

• As reported in the FY18 DOT&E SM-6 BLK I FOT&E Report, the SM-6 remains effective and suitable with the exception of the classified deficiency identified in the FY13 IOT&E [Initial Operational Test and Evaluation] Report. The SM-6 BLK I satisfactorily demonstrated compatibility with AWS [Aegis Weapon System] Baseline 9 Integrated Fire Control capability.

• The Navy is not planning operational testing or lethality assessments for SM-6 BLK I and BLK IA FCD [Future Capabilities Demonstration]. The FCD represent significant warfighting improvements for Aegis destroyers and cruisers. DOT&E, with the Navy's concurrence, actively participated in the planning and execution of the FY19 and planned future developmental test events, and will report, as appropriate, on these warfighting enhancements.

• Data analysis is underway on the completed SM-6 BLK IA live fire and M&S FOT&E events. DOT&E will report on SM-6 BLK 1A FOT&E [Follow-On Operational Test and Evaluation] in FY20.

Recommendations

The Navy should:

1. Continue to improve software based on results investigating the classified performance deficiency discovered during IOT&E, perform corrective actions, and verify corrective actions with flight tests. This includes correcting the two new problems identified during FY17 SM-6 BLK I Verification of Corrected Deficiency tests.

2. Plan FOT&E testing and lethality assessments for SM-6 BLK I and BLK IA FCD.[46]

Legislative Activity for FY2021

Summary of Action on FY2021 MDA Funding Request

Table 2 summarizes congressional action on the FY2021 request for MDA procurement and research and development funding for the Aegis BMD program.

[45] Department of Defense, Director, Operational Test & Evaluation, *FY2019 Annual Report*, December 20, 2019, pp. 216-217.

[46] Department of Defense, Director, Operational Test & Evaluation, *FY2019 Annual Report*, December 20, 2019, pp. 163-164.

Table 2. Summary of Congressional Action on FY2021 MDA Funding Request

(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 34)	356.2	356.2	356.2		356.2		
(SM-3 Block IB missile quantity)	*(34)*	*(34)*	*(34)*		*(34)*		
Aegis BMD Advance Procurement (line 35)	44.9	44.9	44.9		44.9		
SM-3 Block IIA (line 37)	218.3	333.3	346.3		318.3		
(SM-3 Block IIA missile quantity)	*(6)*	*(10)*	*(11)*		*(6+)*		
Aegis Ashore Phase III (line 40)	39.1	39.1	39.1		34.6		
Aegis BMD hardware and software (line 42)	104.2	104.2	104.2		104.2		
Subtotal Procurement	**762.7**	**877.7**	**890.7**		**858.1**		
Research, development, test, and evaluation (RDT&E)							
Aegis BMD (PE 0603892C) (line 82)	814.9	804.9	814.9		771.3		
Aegis BMD test (PE 0604878C) (line 113)	170.9	95.9	170.9		139.3		
Land-based SM-3 (PE 0604880C) (line 115)	56.6	56.6	133.4		56.6		
Subtotal RDT&E	**1,042.4**	**957.4**	**1,119.2**		**967.2**		
TOTAL	**1,805.1**	**1,835.1**	**2,009.9**		**1,825.3**		

Source: Table prepared by CRS based on DOD's original FY2021 budget submission, committee and conference reports, and explanatory statements on FY2021 National Defense Authorization Act and FY2021 DOD Appropriations Act.

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

FY2021 National Defense Authorization Act (H.R. 6395/S. 4049)

House

The House Armed Services Committee, in its report (H.Rept. 116-442 of July 9, 2020) on H.R. 6395, recommended the funding levels shown in the HASC column of **Table 2**. The recommended increase of $115.0 million for line 37 is for "Increase SM–3 Block IIA quantities." (Page 366) The recommended reduction of $10.0 million for line 82 is for "Program decrease." (Pages 415-416) The recommended reduction of $75.0 million for line 113 is for "Unjustified cost growth." (Page 417.)

Senate

The Senate Armed Services Committee, in its report (S.Rept. 116-236 of June 24, 2020) on S. 4049, recommended the funding levels shown in the SASC column of **Table 2**. The recommended increase of $128.0 million for line 37 is for "Additional SM–3 Block IIA interceptors." (Page 478) The recommended increase of $76.8 million for line 115 is for "PDI [Pacific Deterrence Initiative]: Guam Defense System—systems engineering." (Page 529)

Regarding the recommended funding level for line 37, S.Rept. 116-236 states

SM–3 IIA procurement

The budget request included $218.3 million in line number 37 of Procurement, Defense-Wide (PDW), for SM–3 Block IIA missiles.

The committee believes that procuring higher quantities of this interceptor each year (including foreign military sales) is prudent, given existing requirements for Aegis Ashore and Aegis Ballistic Missile Defense ships, the capacity and efficiencies of the industrial base, and the potential for additional land-based SM–3 systems. The committee also notes that this increased procurement was included on the unfunded priorities list submitted by the Director of the Missile Defense Agency.

Accordingly, the committee recommends an increase of $128.0 million in line number 37 of PDW for SM–3 Block IIA missiles. (Pages 40-41)

Regarding the recommended funding level for line 115, S.Rept. 116-236 states

PDI: Guam Defense System

The budget request did not include funding in Research, Defense, Test, and Evaluation (RDT&E), Defense-wide, for PE 64880C Land-Based SM–3 for a Guam Defense System (GDS).

The committee notes that this project was included on the unfunded priorities list submitted by the Commander, U.S. Indo-Pacific Command, who stated that Guam is both the western-most territory of the U.S. homeland and a critical location for posture and operations in the Indo-Pacific area of responsibility. The committee agrees with the Commander that protection of U.S. assets and personnel on Guam is critical for effective operations in the region.

Accordingly, the committee recommends an increase of $76.8 million in RDT&E, Defense-wide, for PE 64880C Land-Based SM–3 for GDS.

In addition, the committee expects the Missile Defense Agency (MDA), along with U.S. Strategic Command (STRATCOM) and U.S. Indo-Pacific Command (INDOPACOM), to continue to analyze and refine the plan for a defense architecture against the range of missile threats to Guam while also beginning the work described above.

Accordingly, not later than January 31, 2021, the committee directs the Secretary of Defense, in consultation with the Director of the MDA and the Commanders, STRATCOM and INDOPACOM, to submit to the congressional defense committees an assessment of the architecture required for the defense of Guam from air and missile threats, including ballistic, hypersonic, and cruise missiles. The assessment shall include the following elements:

(1) An analysis of existing and projected air and missile threats to U.S. forces, assets, and infrastructure located on Guam;

(2) An analysis of impacts to the ability of U.S. forces to conduct operations in the INDOPACOM area of operations if systems and assets on Guam are vulnerable to air and missile threats;

(3) An analysis of systems currently available for procurement or deployment that could contribute to the defense of Guam from these threats not later than the end of 2025;

(4) An analysis of new systems currently in development, or modifications to existing systems, that could enhance or substitute for existing options in contributing to this mission;

(5) Estimated cost and schedule for the various options studied; and

(6) Anything else the Secretary deems relevant. (Page 119)

Section 1664 of S. 4049 as reported by the committee states (emphasis added):

SEC. 1664. REPORT ON AND LIMITATION ON EXPENDITURE OF FUNDS FOR LAYERED HOMELAND MISSILE DEFENSE SYSTEM.

(a) REPORT REQUIRED.—

(1) IN GENERAL.—Not later than March 1, 2021, the Director of the Missile Defense Agency shall submit to the congressional defense committees

a report on the proposal for a layered homeland missile defense system included in the budget justification materials submitted to Congress in support of the budget for the Department of Defense for fiscal year 2021 (as submitted with the budget of the President for such year under section 1105(a) of title 31, United States Code).

(2) ELEMENTS REQUIRED.—The report required by paragraph (1) shall include the following:

(A) A description of the approved requirements for a layered homeland missile defense system, based on an assessment by the intelligence community of threats to be addressed at the time of deployment of such a system.

(B) An assessment of how such requirements addressed by a layered homeland missile defense system relate to those addressed by the existing ground-based midcourse defense system, including deployed ground-based interceptors and planned upgrades to such ground based interceptors.

(C) **An analysis of interceptor solutions to meet such requirements, to include land-based Standard Missile 3 (SM–3) Block IIA interceptor systems** and the Terminal High Altitude Area Defense (THAAD) system, with the number of locations required for deployment and the production numbers of interceptors and related sensors.

(D) A site-specific fielding plan that includes possible locations, the number and type of interceptors and radars in each location, and any associated environmental or permitting considerations, including an assessment of the locations evaluated pursuant to section 227(b) of the National Defense Authorization Act for Fiscal Year 2013 (126 Stat. 1679; Public Law 112–239) for inclusion in the layered homeland missile defense system.

(E) Relevant policy considerations for deployment of such systems for defense against intercontinental ballistic missiles in the continental United States.

(F) A cost estimate and schedule for options involving a land-based Standard Missile 3 Block IIA interceptor system and the Terminal High Altitude Area Defense system, including required environmental assessments.

(G) A feasibility assessment of the necessary modifications to the Terminal High Altitude Area Defense system to address such requirements.

(H) An assessment of the industrial base capacity to support additional production of either a land-based Standard Missile 3 Block IIA interceptor system or the Terminal High Altitude Area Defense system.

(3) CONSULTATION.—In preparing the report required by paragraph (1), the Director shall consult with the following:

(A) The Under Secretary of Defense for Policy.

(B) The Under Secretary of Defense for Acquisition and Sustainment.

(C) The Vice Chairman of the Joint Chiefs of Staff, in Vice Chairman's capacity as the Chair of the Joint Requirements Oversight Council.

(D) The Commander, United States Strategic Command.

(E) The Commander, United States Northern Command.

(b) LIMITATION ON USE OF FUNDS.—Not more than 50 percent of the amounts authorized to be appropriated by this Act for fiscal year 2021 for the Missile Defense Agency for the purposes of a layered homeland missile defense system may be obligated or expended until the Director submits to the congressional defense committees the report required by subsection (a).

(c) INTELLIGENCE COMMUNITY DEFINED.—In this section, the term ''intelligence community'' has the meaning given such term in section 3 of the National Security Act of 1947 (50 U.S.C. 3003).

Regarding Section 1664, S.Rept. 116-236 states

Report on and limitation on expenditure of funds for layered homeland missile defense system (sec. 1664)

The committee recommends a provision that would require the Director of the Missile Defense Agency (MDA) to submit a report to the congressional defense committees no later than March 1, 2021, on the layered homeland missile defense system proposed in the President's fiscal year 2021 budget request. The report would include cost estimates, schedule options, requirements, and an analysis of possible architecture solutions, in addition to relevant policy considerations. The provision would prohibit the obligation or expenditure of more than 50 percent of fiscal year 2021 funds authorized for this purpose until the required report is submitted.

The committee supports the Department of Defense's efforts to seek additional homeland missile defense coverage in the mid-2020s; however, the committee notes that the Department has provided very little information or analysis to support this proposal, despite including substantial funding within the MDA budget for this purpose. The $260.0 million as requested is authorized elsewhere in this Act. (Page 353)

FY2021 DOD Appropriations Act (H.R. 7617)

House

The House Appropriations Committee, in its report (H.Rept. 116-453 of July 16, 2020) on H.R. 7617, recommended the funding levels shown in the HAC column of **Table 2**. The recommended increase of $100.0 million for line 37 is for "Program increase—additional SM-3 Block IIA interceptors." (Page 232) The recommended reduction of $4.485 million for line 40 is for "Excess growth." (Page 232) The recommended reductions of $43.6 million for line 82 and $31.537 million for line 113 are for "Excess growth." (Page 314)

Appendix A. Aegis BMD Flight Tests

Table A-1 presents a summary of Aegis BMD flight tests since January 2002. As shown in the table, since January 2002, the Aegis BMD system has achieved 33 successful exo-atmospheric intercepts in 42 attempts using the SM-3 missile (including 4 successful intercepts in 5 attempts by Japanese Aegis ships, and 2 successful intercepts in 3 attempts attempt using the Aegis Ashore system), and 7 successful endo-atmospheric intercepts in 7 attempts using the SM-2 Block IV and SM-6 missiles, making for a combined total of 40 successful intercepts in 49 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 with the SM-3 missile to shoot down an inoperable U.S. surveillance satellite that was in a deteriorating orbit. Including this intercept in the count increases the totals to 34 successful exo-atmospheric intercepts in 43 attempts using the SM-3 missile, and 41 successful exo- and endo-atmospheric intercepts in 50 attempts using SM-3, SM-2 Block IV, and SM-6 missiles.

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

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?	Cumulative successes	Cumulative attempts
Exo-atmospheric (using SM-3 missile)						
1/25/02	US	FM-2	Unitary short-range (TTV)	Yes	1	1
6/13/02	US	FM-3	Unitary short-range (TTV)	Yes	2	2
11/21/02	US	FM-4	Unitary short-range (TTV)	Yes	3	3
6/18/03	US	FM-5	Unitary short-range (TTV)	**No**	3	4
12/11/03	US	FM-6	Unitary short-range (TTV)	Yes	4	5
2/24/05	US	FTM 04-1 (FM-7)	Unitary short-range (TTV)	Yes	5	6
11/17/05	US	FTM 04-2 (FM-8)	Separating short-range (MRT)	Yes	6	7
6/22/06	US	FTM 10	Separating short-range (TTV)	Yes	7	8
12/7/06	US	FTM 11	Unitary short-range (TTV)	**No**	7	9
4/26/07	US	FTM 11 Event 4	Unitary short-range (ARAV-A)	Yes	8	10
6/22/07	US	FTM 12	Separating short-range (MRT)	Yes	9	11
8/31/07	US	FTM-11a	Classified	Yes	10	12
11/6/07	US	FTM 13	Unitary short-range (ARAV-A)	Yes	11	13
			Unitary short-range (ARAV-A)	Yes	12	14
12/17/07	Japan	JFTM-1	Separating short-range (MRT)	Yes	13	15
11/1/08	US	Pacific Blitz	Unitary short-range (ARAV-A)	Yes	14	16
			Unitary short-range (ARAV-A)	**No**	14	17
11/19/08	Japan	JFTM-2	Separating short-range (MRT)	**No**	14	18
7/30/09	US	FTM-17	Unitary short-range (ARAV-A)	Yes	15	19
10/27/09	Japan	JFTM-3	Separating short-range (MRT)	Yes	16	20
10/28/10	Japan	JFTM-4	Separating short-range (MRT)	Yes	17	21
4/14/11	US	FTM-15	Separating intermediate range (LV-2)	Yes	18	22
9/1/11	US	FTM-16 E2	Separating short-range (ARAV-B)	**No**	18	23
5/9/12	US	FTM-16 E2a	Unitary short-range (ARAV-A)	Yes	19	24
6/26/12	US	FTM-18	Separating short-range (MRT)	Yes	20	25
10/25/12	US	FTI-01	Separating short-range (ARAV-B)	**No**	20	26
2/12/13	US	FTM-20	Separating medium-range (MRBM-T3)	Yes	21	27
5/15/13	US	FTM-19	Separating short-range (ARAV-C)	Yes	22	28
9/10/13	US	FTO-01	Separating medium-range (eMRBM-T1)	Yes	23	29
9/18/13	US	FTM-21	Separating short-range (ARAV-C++)	Yes	24	30
10/3/13	US	FTM-22	Separating medium-range (ARAV-TTO-E)	Yes	25	31

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?	Cumulative successes	Cumulative attempts
11/6/14	US	FTM-25	Separating short-range (ARAV-B)	Yes	26	32
6/25/15	US	FTO-02 E1	Separating medium-range (IRBM T1)	n/a[a]	26	32
10/4/15	US	FTO-02 E2	Separating medium-range (eMRBM)	n/a[c]	26	32
10/20/15	US	ASD-15 E2	Separating short-range (Terrier Orion)	Yes	27	33
11/1/15	US	FTO-02 E2a	Separating medium-range (eMRBM)	**No**	27	34
12/10/15	US (Aegis Ashore)	FTO02 E1a	Separating medium-range (IRBM T1)	Yes	28	35
2/3/17	US-Japan	SFTM-01	Separating medium-range (MRT)	Yes	29	36
6/21/17	US-Japan	SFTM-02	Medium-range	**No**	29	37
10/15/17	US	FS17	Medium-range target	Yes	30	38
1/31/18	US (Aegis Ashore)	FTM-29	Intermediate-range target	**No**	30	39
9/11/18	Japan	JFTM-05	Simple separating target	Yes	31	40
10/26/18	US	FTM-45	Medium range	Yes	32	41
12/10/18	US (Aegis Ashore)	FTI-03	Intermediate-range target	Yes	33	42
Endo-atmospheric (using SM-2 missile Block IV missile and [for MMW Event 1] SM-6 Dual 1 missile)						
5/24/06	US	Pacific Phoenix	Unitary short-range target (Lance)	Yes	1	1
6/5/08	US	FTM-14	Unitary short-range target (FMA)	Yes	2	2
3/26/09	US	Stellar Daggers	Unitary short-range target (Lance)	Yes	3	3
7/28/15	US	MMW E1	Unitary short-range target (Lance)	Yes	4	4
7/29/15	US	MMW E2	Unitary short-range target (Lance)	Yes	5	5
12/14/16	US	FTM-27	Unitary short-range target (Lance)	Yes	6	6
8/29/17	US	FTM-27 E2	Medium-range target (MRBM)	Yes	7	7
Combined total for exo- and endo-atmospheric above tests					40	49

Sources: Table presented in MDA fact sheet, "Aegis Ballistic Missile Defense Testing," February 2017, accessed on August 27, 2020, at https://web.archive.org/web/20170929180757/https:/www.mda.mil/global/documents/pdf/aegis_tests.pdf, and (for flight tests subsequent to February 2017) MDA news releases.

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 31 successful exo-atmospheric intercepts in 40 attempts using the SM-3 missile, and 38 successful exo- and endo-atmospheric intercepts in 47 attempts using SM-3, SM-2 Block IV, and SM-6 missiles.

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

b. issued a news release on this test, which stated that an SM-3 was not launched "due to an incorrect system setting aboard the Aegis-class cruiser USS *Lake Erie* prior to the launch of two interceptor missiles from the ship. The incorrect configuration prevented the fire control system aboard the ship from launching the first of the two [SM-3] interceptor missiles. Since a primary test objective was a near-simultaneous launch of two missiles against two different targets, the second interceptor missile was intentionally not launched." MDA counts the test of December 7, 2006, as an unsuccessful intercept in its count of 31 successful intercepts in 37 launches through July 29, 2015.

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

Author Information

Ronald O'Rourke
Specialist in Naval Affairs

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