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

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SUMMARY

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

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. The number of BMD-capable Aegis ships has been growing over time. MDA's FY2023 budget submission states that "by the end of FY 2023 there will be 50 total BMDS [BMD Systems] capable [Aegis] ships requiring maintenance support."

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 FY2023 budget requests a total of $1,659.1 million (i.e., about $1.7 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 annual procurement and research and development funding requests for the program;
- the adequacy of MDA's cost estimating and its reporting of costs;
- what role the Aegis BMD program should play in defending the U.S. homeland against attack from ICBMs;
- required 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 additional 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;
- the role of the Aegis BMD program in a new missile defense system architecture for Guam;
- whether to convert the Aegis test facility in Hawaii into an operational land-based Aegis BMD site;
- the potential for ship-based lasers 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.

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). The Navy's FY2023 budget submission proposes retiring five of the 22 ships in FY2023, 12 more in FY2024-FY2027, and the remaining five in years after FY2027.

Arleigh Burke (DDG-51) Class Aegis Destroyers

The Navy began procuring DDG-51s in FY1985, and a total of 89 have been procured through FY2022. The first DDG-51 entered service in 1991, and a total of 70 have been delivered as of February 2022. Under the Navy's FY2023 budget submission, the first DDG-51 is to be retired in FY2027.

The DDG-51 design has been updated multiple times over the years. The first 28 DDG-51s are known as Flight I/II DDG-51s. The next 34, known as Flight IIA DDG-51s, incorporate some significant design changes, including the addition of a helicopter hangar. The version currently being procured, called the Flight III DDG-51 design, incorporates a new radar, called the SPY 6 radar (and prior to that, the Air and Missile Defense Radar, or AMDR), that is more capable than the SPY-1 radar installed on CG-47s and earlier DDG-51s.

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

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.[1]

Aegis Ships in Allied Navies

Sales of the Aegis system to allied countries began in the late 1980s. Allied countries that now operate, are building, or are planning to build Aegis-equipped ships include Japan, South Korea, Australia, Spain, and Norway.[2] 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[3]

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

Versions and Capabilities of Aegis BMD System

Overview

The Aegis BMD system exists in multiple variants whose ascending numerical designations indicate ascending levels of capability. As part of MDA's FY2022 budget submission, the designations of Aegis BMD system variants were changed and consolidated to 4.X, 5.X, and 6.X, with the X indicating multiple subvariants. (The 4.X variant, for example, includes the 4.1 and 4.2 subvariants.[4])

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 more recent BMD variants and their correlation to Aegis system baselines as of 2019. Because **Figure 1** was prepared in 2019, it uses the older designations for Aegis BMD system variants, rather than the new designations that were introduced as part of the MDA's FY2022 budget submission.

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

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

[2] The Norwegian ships are somewhat smaller than the other Aegis ships, and consequently carry a reduced-size version of the Aegis system that includes a smaller, less-powerful version of the SPY-1 radar.

[3] Unless stated otherwise, information in this section is taken from MDA briefings on the Aegis BMD program given to CRS and CBO analysts on the MDA's FY2023 and prior-year budget submissions.

[4] The 4.X variant is the new designation for the variants previously designated 3.6.X, 4.0.X, 4.1, and 4.2. The 5.X variant is the new designation for the variants previously designated 5.0CU (with the CU standing for Capability Upgrade) and 5.1. The 6.X variant is the new designation for the variant previously designated 6.0.

missiles, detection and tracking data collected by the Aegis BMD system's radar might be passed 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.

Aegis BMD Interceptor Missiles

The BMD interceptor missiles used by Aegis ships are the Standard[5] Missile-3 (SM-3) 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] The Standard Missile is so named because it was originally developed, decades ago, as a surface-to-air (i.e., air defense) missile to serve as the common (i.e., standard) successor to the Navy's then-existing collection of Talos, Terrier, and Tartar air defense missiles, which were sometimes referred to collectively as the 3-T missiles.

to-kill" warhead, called a kinetic vehicle, that is designed to destroy a ballistic missile's warhead by colliding with it. The current versions of the SM-3 missile include the SM-3 Block IA, the SM-3 Block IB, and the SM-3 Block IIA.[6]

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 cooperated in developing certain technologies for the Block IIA version, with Japan funding a significant share of the effort.[7]

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."[8]

SM-6 Terminal Interceptor (Overview)

The SM-2 Block IV was MDA's and the Navy's initial sea-based terminal-phase BMD interceptor. It was 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 was equipped with a blast fragmentation warhead. A limited number of these missiles were produced years ago.[9] The SM-2 Block IV has now been replaced by the SM-6.

The SM-6 is MDA's and the Navy's more capable next-generation sea-based terminal-phase (i.e., endo-atmospheric) BMD interceptor. It is based on the SM-6 air defense missile (the Navy's 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 ASCMs) or ballistic missile defense. A July 23, 2018, press report states the following:

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[6] 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 years ago, and MDA at the time was reportedly 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.)

[7] The cooperative research effort was carried out under a U.S.-Japan memorandum of agreement signed in 1999. The effort 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.

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

[9] The inventory of SM-2 Block IVs 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 through February 2012.

> 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 [2018], 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]

SM-6 Terminal Interceptor (Hypersonic Threat Intercept Capability)

MDA testified in May 2022:

> We are investing in defensive capabilities to counter regional hypersonic missile threats by upgrading sensors and C2BMC [Command and Control, Battle Management and Communications] for early warning, identification, and tracking of regional and strategic hypersonic threats from space (e.g., HBTSS [Hypersonic and Ballistic Tracking Space Sensor]). We also are leveraging existing systems where possible (including proven engage-on-remote and launch-on-remote capabilities) and pursuing a Glide Phase Intercept (GPI) demonstration. We are working closely with the Navy to develop, field, and upgrade the SBT [sea-based terminal defense] capability to counter regional maneuvering and hypersonic threats in the terminal phase of flight. The SBT program already provides an initial terminal defensive capability to counter hypersonic threats, and additional improvements are scheduled for 2024. Today, the SM-6 missile is the only weapon in the country's arsenal capable of engaging highly-maneuverable hypersonic threats. In FY 2023, Aegis SBT will demonstrate a simulated engagement against a hypersonic target (FTX-40) and in FY 2024 will demonstrate a salvo engagement firing two SM-6 Block IA Upgraded guided missiles against a Hypersonic Glide Vehicle target (FTM-43). Complementing this terminal capability, in FY 2023, MDA will continue to develop and plan a GPI demonstration and leverage the Aegis Weapon System to provide the U.S. Warfighter increasingly capable regional defensive capabilities.[11]

An April 14, 2021, press report stated

> The Missile Defense Agency, together with the U.S. Navy, plan to test an SM-6 missile against an "advanced maneuvering threat," a term that has been used in relation to unpowered hypersonic boost-glide vehicles, later this year. The Pentagon says that unspecified versions of the SM-6 have already demonstrated some degree of capability against these types of weapons, examples of which Russia and China have already begun putting to service. A new variant of the SM-6, the Block IB, is already under development and will itself be able to reach hypersonic speeds.
>
> Barbara McQuiston, a senior U.S. official currently performing the duties of the Under Secretary of Defense for Research and Engineering, including mention of the scheduled SM-6 test in her testimony before the Senate Appropriations Committee's Subcommittee on Defense yesterday….
>
> "MDA [the Missile Defense Agency], in cooperation with the U.S. Navy, demonstrated early capability against maneuvering threats during flight-testing of the Standard Missile (SM)-6 Sea-Based Terminal (SBT) defense, and it will further demonstrate this capability against an advanced maneuvering threat-representative target later this year," according to McQuiston's written testimony. "We will continue to advance our SBT capability to

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

[11] [Statement of] Vice Admiral Jon A. Hill, USN, Director, Missile Defense Agency, Before the Senate Armed Services Committee, Strategic Forces Subcommittee, May 18, 2022, p. 10.

> address the regional hypersonic threat and will test that capability in the FY 2024 timeframe."…
>
> This is not the first time the Pentagon has publicly discussed using a variant of the SM-6 for hypersonic defense. In March 2020, Mike Griffin, then the Under Secretary of Defense for Research and Engineering, first revealed that this missile was among those being considered for this role and that there were plans to test one of them against an actual hypersonic boost-glide vehicle sometime in the 2023 Fiscal Year. It's not clear whether the test Griffin was referring to is the one now scheduled for this year or the one that MDA now plans to carry out in the 2024 Fiscal Year.[12]

Development of New Hypersonic Threat Interceptor for Aegis System

A June 24, 2022, press report stated

> Raytheon Technologies and Northrop Grumman have each won contracts to continue developing hypersonic weapons interceptors in a Missile Defense Agency-led competition, according to a June 24 Pentagon contract announcement....
>
> In November 2021, the MDA chose the two companies along with Lockheed Martin to design the Glide Phase Interceptor (GPI) for regional hypersonic missile defense. Through other transactional agreements, the companies entered an "accelerated concept design" phase.
>
> The interceptors are intended to counter a hypersonic weapon during its glide phase of flight, a challenge as the missiles can travel more than five times the speed of sound and can maneuver, making it hard to predict a missile's trajectory.
>
> The interceptors will be designed to fit into the U.S. Navy's current Aegis Ballistic Missile Defense destroyers. It will be fired from its standard Vertical Launch System and integrated with the modified Baseline 9 Aegis Weapon System that detects, tracks, controls and engages hypersonic threats.[13]

Numbers of BMD-Capable Aegis Ships

The number of BMD-capable Aegis ships has been growing over time. MDA's FY2023 budget submission states that "by the end of FY 2023 there will be 50 total BMDS [BMD Systems] capable [Aegis] ships requiring maintenance support."[14]

BMD-Capable Aegis Destroyers Forward-Homeported in Spain

On October 5, 2011, the United States, Spain, and NATO jointly announced that four BMD-capable U.S. Navy Aegis destroyers were to be forward-homeported (i.e., based) at the naval base

[12] Joseph Trevithick, "Navy SM-6 Missile Will Attempt To Swat Down A Mock Hypersonic Weapon," *The Drive*, April 14, 2021.

[13] Jen Judson, "Raytheon, Northrop Advance in Competition to Develop Hypersonic Weapons Interceptor," *Defense News*, June 24, 2022. See also Jason Sherman, "MDA Selects Raytheon, Northrop to Advance in GPI Design Contest; Lockheed Sidelined," *Inside Defense*, June 24, 2022.

[14] Missile Defense Agency, *Fiscal Year 2023 Budget Estimates, Missile Defense Agency*, April 2022, p. 11. (This is the FY2023 budget justification book for MDA's portion of the Operation and Maintenance, Defense-Wide appropriation account.)

at Rota, Spain.[15] The initial set of four ships was transferred to Rota in FY2014 and FY2015.[16] They are being replaced at Rota by a new set of four BMD-capable U.S. Navy Aegis destroyers in 2020-2022.[17]

Navy officials said 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, 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 was considering forward-homeporting an additional two BMD-capable Aegis destroyers at Rota, which would make for a total of six destroyers at the site.[18] Navy officials testified in 2020 that they supported the idea.[19] On June 28, 2022, the Biden Administration announced that two additional Aegis destroyers would be homeported at Rota.[20] The Navy confirmed that the two additional Aegis destroyers will be BMD-capable.[21]

Aegis Ashore Sites

Two Navy-Operated Sites in 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,

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[15] "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 May 18, 2022, 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 May 18, 2022, 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.)

[16] The four ships were 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.

[17] See, for example, Mallory Shelbourne, "USS Arleigh Burke Arrives in Spain, USS Donald Cook Will Head to Mayport," *USNI News*, April 12, 2021.

[18] 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.

[19] See, for example, David B. Larter, "The US Navy's Top Officer Declares Support for Basing 6 Destroyers in Spain," *Defense News*, March 5, 2020. See also John Vandiver, "Rota to Gain Two US Destroyers by Middle of the Decade, EUCOM Chief Says," *Stars and Strip*es, April 15, 2021.

[20] White House, "Press Gaggle by Press Secretary Karine Jean-Pierre and National Security Advisor Jake Sullivan En Route Madrid, Spain," June 28, 2022. See also Mallory Shelbourne, "Biden Administration Basing Two More Destroyers in Rota, Spain," *USNI News*, June 28 (updated June 29), 2022; Justin Katz, "'A Powerful Signal:' What It Means to Send Two More DDGs to Spain," *Breaking Defense*, July 1, 2022; Aaron Mehta, "US Increasing Troop Presence in Europe, While New NATO Strategy Eyes China," *Breaking Defense*, June 29, 2022; Geoff Ziezulewicz (Associated Press), "Two More Navy Destroyers Will Be Homeported in Rota, Spain," *Navy Times*, June 29, 2022.

[21] Source: Navy Office of Legislative Affairs email to CRS, July 1, 2022.

and 24 SM-3 missiles launched from a relocatable Vertical Launch System (VLS) based on the VLS that is installed in Navy Aegis ships.[22]

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.[23] The site in Poland began construction in May 2016[24] and was initially scheduled to be completed in 2018. Its completion, however, has been delayed to 2023 by construction contractor performance issues.[25] An April 2021 GAO report on deliveries and testing of U.S. missile defense systems in FY2020 stated the following:

> According to MDA officials, the Aegis Ashore site in Poland continues to experience delays owing to poor performance by the main construction contractor. Based on MDA's latest estimate of completion no earlier than fiscal year 2022, the site will be between three and four years late. According to MDA, in February 2020, the Army Corps of Engineers (which manages construction at the site) notified the main contractor that earnings from all future invoices would be retained, and released only upon the completion of certain key activities. MDA stated that the contractor did not meet these benchmarks and as a result had not been paid since February 2020.
>
> MDA currently attributes $79 million in cost increases to these delays.[26]

Navy Interest in Divesting Aegis Ashore Sites It Operates

On January 11, 2021, the Chief of Naval Operations (CNO), Admiral Michael Gilday, released a guidance document for the Navy entitled *CNO NavPlan* (with NavPlan being short for navigation plan) that states

> To remain ahead of our competitors, we will divest ourselves of legacy capabilities that no longer bring sufficient lethality to the fight. This includes divestment of experimental Littoral Combat Ship hulls, legacy Cruisers, and older Dock Landing Ships. It also includes divesting non-core Navy missions like Aegis-ashore. Transferring shore-based Ballistic Missile Defense sites to ground forces enables Sailors to focus on their core missions at sea and frees up resources to increase our lethality.[27]

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[22] 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.

[23] 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 May 18, 2022, at https://missiledefenseadvocacy.org/defense-systems/aegis-ashore/; US Naval Forces Europe-Africa, "Aegis Ashore Missile Defense System (AAMDS)-Romania Operationally Certified," Defense-Aerospace.com, May 12, 2016.

[24] See, for example, "Aegis Ashore," Missile Defense Advocacy Alliance, accessed May 18, 2022, at https://missiledefenseadvocacy.org/defense-systems/aegis-ashore/.

[25] Source: [Statement of] Vice Admiral Jon A. Hill, USN, Director, Missile Defense Agency, Before the Senate Armed Services Committee, Strategic Forces Subcommittee, May 18, 2022, p. 8. Earlier reporting said construction of the Poland site would be complete by the end of 2022. See, for example, Rich Abott, "Aegis Ashore Poland Set To Be Operational By End Of 2022," *Defense Daily*, November 22, 2021; Jen Judson, "Construction of Aegis Ashore in Poland Nearing Completion," *Defense News*, March 9, 2022. See also Daniel Wasserbly, "US MDA Plans to Turn On Polish Aegis Ashore Site in June, After Years of Delay," *Jane's Defence Weekly*, May 24, 2022.

[26] Government Accountability Office, *Missile Defense[:] Fiscal Year 2020 Delivery and Testing Progressed, but Annual Goals Unmet*, GAO 21-314, April 2021, p. 24.

[27] U.S. Navy, Chief of Naval Operations, *CNO NavPlan*, January 2021, p. 10. See also Richard R. Burgess, "CNO: Divest Aegis Ashore Sites to Ground Forces," *Seapower*, January 11, 2021.

A January 12, 2021, press report states

> The chief of naval operation's new call to focus on sea control and power projection could lead the service to shed other non-core missions the Navy conducts today, such as manning Aegis Ashore missile defense sites.
>
> The biggest problem is, no one else has agreed to take over that mission yet….
>
> … no one else operates Aegis systems today, and no one has yet agreed to take over Aegis Ashore, Rear Adm. Paul Schlise, the director of surface warfare on the CNO's staff (OPNAV N96), said today during a panel presentation at the Surface Navy Association's annual symposium.
>
> "It's been an ongoing discussion in the building here. Right now we've got the Aegis Ashore sites in Europe, and there's discussions about potentially more sites in other places. The general discussion has been, this is not a core Navy mission. Sailors really belong at sea serving in ships. And we've got a good number of highly qualified folks serving in those sites, they're going a great job," he said.
>
> "But I think what the CNO teed up is, is this a core Navy mission? I don't think it is. And so there's been some discussion with the Army. The Army, of course, has some missile defense capability and of course great soldiers that serve in those roles. But they don't have any experience with that [Aegis Combat System], the systems that have been installed or are in progress in Romania and Poland. So that's been a running discussion."
>
> Schlise said the discussion is taking place at the Office of the Secretary of Defense level. Without any final decisions, though, the Navy could not shed Aegis Ashore spending in its most recent budgeting work, the Fiscal Year 2022 request that will come out after the Biden administration comes in and can review it.
>
> "For the purposes of this past budget cycle, it was just kind of tabled. So we'll have to see where that discussion goes. As always, here in the building, it's about money. So if that transition were to be considered and approved for moving forward, to transition it to another service, 'who's going to pay' will of course be part of the discussion," Schlise said.[28]

Japan Planned and Later Canceled Two Sites

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).[29] 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.[30] On June 15, 2020, however, Japan announced that it had suspended implementation of its Aegis Ashore initiative due to cost growth and technical concerns.[31] On June 25, 2020, Japan

[28] Megan Eckstein, "Navy Wants to Shed Aegis Ashore Mission, But Army Still Hasn't Agreed to Take It," *USNI News*, January 12, 2021.

[29] 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.

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

[31] 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,

confirmed that it had canceled the plan for deploying the two Aegis Ashore sites.[32] A December 6, 2020, press report stated

> Japan will put new powerful Aegis radars on warships to upgrade its defences against possible ballistic missiles fired by North Korea after it cancelled plans to deploy them at two ground-based stations, the Asahi newspaper reported.
>
> Prime Minister Yoshihide Suga's government is likely to approve the recommendation by the country's National Security Council before the end of the year, although any decision on type of vessel or cost will be left until next year, the paper said, citing unidentified sources….
>
> Deploying the new Aegis radars could cost twice as much and take up to three years longer to complete than the ground-based versions, which were expected cost of around $2 billion to build, a source with knowledge of the proposal told Reuters earlier….
>
> Fitted with Lockheed Martin Corp SPY-7 radars that will have at least three times the range of older Aegis systems deployed on Japanese navy destroyers, the upgrade will allow Japan to use new interceptor missiles to target warheads in space fired by North Korea or other potential foes, including China and Russia.[33]

An August 19, 2021, press report stated

> A sea-based Aegis missile defense system could be the next program to be abandoned by Tokyo.

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 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.)

[32] 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.

[33] Reuters staff, "Japan to Put New Aegis Radars on Warships after Cancelling Ground Stations: Asahi," *Reuters*, December 6, 2020. See also Agence France-Presse, "Japan Weighs Ships For Aegis Missile Defence System," *Barron's*, December 9, 2020; Kyodo, "Cabinet Set to Approve Destroyers as Alternative to Aegis Ashore," *Japan Times*, November 28, 2020.

> The Japanese Defense Ministry does not plan to seek funds for it in the upcoming fiscal 2022 budget. Citing government sources, the Asahi Shimbun newspaper said such a budget request will "likely be impossible over the next few years."[34]

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, with each step being tested and validated before moving on to the next step.[35]

An April 2021 GAO report on deliveries and testing of U.S. missile defense systems in FY2020 stated the following about testing of the Aegis BMD system:

> In fiscal year 2020, the Aegis BMD program did not conduct any of the six planned flight tests, deleting one and delaying the remaining five. Most notably, a major operational flight test—FTO-03—was deleted, leaving the SM-3 Block IIA interceptor to enter initial production with a single operational flight test. Some flight tests were initially delayed due to range availability and higher priority flights tests (such as FEX-01) and delays were then exacerbated by pandemic-driven travel restrictions. A congressionally mandated flight test—FTM-44—pitting an SM-3 Block IIA interceptor against a simple ICBM, was delayed, but executed in November 2020.
>
> The Aegis BMD program participated in three of five planned ground tests in fiscal year 2020. The two ground tests were delayed due to the pandemic and the unavailability of the Poland Aegis Ashore site, respectively.
>
> All seven cybersecurity tests scheduled for fiscal year 2020 were consolidated into a single test, which was subsequently delayed.[36]

For a summary of reported Aegis BMD flight tests since 2002, see **Table A-1** in **Appendix**.

Allied Participation and Interest in Aegis BMD Program

Japan

Eight BMD-Capable Aegis Destroyers

Japan operates eight BMD-capable Aegis destroyers—the eighth was commissioned into service in March 2021.[37] 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**).

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[34] Chen Chuanren, "Japan's Sea-Based Aegis System Faces Ax," *Aviation Week Network*, August 19, 2021.

[35] See, for example, "Aegis BMD: "Build a Little, Test a Little, Learn a Lot," USNI blog, March 15, 2010, accessed May 18, 2022, at http://blog.usni.org/2010/03/15/aegis-bmd-build-a-little-test-a-little-learn-a-lot, and "Aegis Ballistic Missile Defense, Aegis Ballistic Missile Defense Overview for the George C. Marshall Institute, RADM Alan B. Hicks, USN, Aegis BMD Program Director, August 3, 2009, slide 16 of 20, entitled "Some of our Philosophies In a Nutshell (1 of 2)," accessed May 18, 2022, at https://web.archive.org/web/20100706133017/https:/www.marshall.org/pdf/materials/743.pdf.

[36] Government Accountability Office, *Missile Defense[:] Fiscal Year 2020 Delivery and Testing Progressed, but Annual Goals Unmet*, GAO 21-314, April 2021, p. 24.

[37] See, for example, Xavier Vavasseur, "Japan Commissions New Maya-Class AEGIS Destroyer JS Haguro はぐろ DDG-180," *Naval News*, March 19, 2021; Yomiuri Shimbun, "Japan Commissions 8th Aegis Destroyer Haguro," *Japan News*, March 20, 2021.

Cooperative Development of SM-3 Block IIA Missile

As mentioned earlier, 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."[38]

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."[39]

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.

FY2023-FY2027 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 Aegis BMD-related efforts. **Table 1** shows requested (FY2023) and projected (FY2024-FY2027) MDA procurement and research and development funding for Aegis BMD efforts under MDA's FY2023 budget submission. Research and development funding in the table 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.

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

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

Table 1. FY2023-FY2027 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)

	FY23 (req.)	FY24 (proj.)	FY25 (proj.)	FY26 (proj.)	FY27 (proj.)
Procurement					
Aegis BMD (line 32)	402.2	378.7	362.8	496.9	506.8
(SM-3 Block IB missile quantity)	*(47)*	*(27)*	*(24)*	*(43)*	*(43)*
Aegis BMD Advance Procurement (line 33)	0	0	0	0	0
SM-3 Block IIA (line 35)	338.0	458.2	479.2	460.5	457.9
(SM-3 Block IIA missile quantity)	*(10)*	*(12)*	*(12)*	*(12)*	*(12)*
Aegis Ashore Phase III (line 39)	30.1	2.4	1.0	0	0
Aegis BMD hardware and software (line 41)	78.2	115.8	116.0	61.7	32.7
SUBTOTAL Procurement	**848.5**	**955.1**	**959.0**	**1,019.1**	**997.4**
Research and development					
Aegis BMD (PE 0603892C) (line 83)	600.1	658.8	574.0	570.0	580.5
Aegis BMD Test (PE 0604878C) (line 113)	182.8	173.5	159.1	203.9	187.5
Land-based SM-3 (PE 0604880C) (line 115)	27.7	26.9	26.0	26.8	27.4
SUBTOTAL RDT&E	**810.6**	**859.2**	**759.1**	**800.7**	**795.4**
TOTAL	**1,659.1**	**1,814.3**	**1,718.1**	**1,819.8**	**1,792.8**

Source: Table prepared by CRS based on FY2023 MDA budget submission.

Issues for Congress

Annual Funding Request

One issue for Congress is whether to approve, reject, or modify MDA's annual 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 the fiscal year in question is properly scoped and scheduled, and accurately priced.

Estimating and Reporting Costs

Another issue for Congress concerns the adequacy of MDA's cost estimating and its reporting of costs. A February 2022 GAO report on MDA's cost estimating and reporting of costs for missile defense programs, including the Aegis BMD program, states

> The Department of Defense's (DOD) Missile Defense Agency (MDA) is continuing efforts to deliver systems to the warfighter that will protect against enemy missiles. However, shortfalls persist with MDA's program and flight test cost estimates and reporting.
>
> **Program cost estimates.** MDA continues to omit the military services' operations and sustainment costs from the program life-cycle cost estimates.... By omitting these costs, MDA limits decision-makers' insight into the full financial commitments needed for affordability and funding determinations....
>
> *Flight test cost estimates.* Accuracy issues linger with MDA's flight test cost estimates that could skew the agency's annual $1.3 billion [flight test] funding request, such as not being regularly updated with actual costs. However, MDA is taking steps to improve these cost estimates by using a new cost model, among other things....

> **Program cost reporting.** MDA continues to adjust program baselines without clear traceability over time. MDA also forgoes recurrent comparisons to the original baseline. Such adjustments and omissions impede decision-makers' awareness of each program's cost performance and total system cost....
>
> **Flight test cost reporting.** Congress required MDA to report on flight test costs, but we found the information lacking due to the agency's reporting methodology. MDA only accounted for about $1.3 billion of at least $3.5 billion in funding the agency requested for flight testing between March 2017 and September 2020. Moreover, the reporting requirement ended in December 2021. Without further reporting on complete flight test costs, Congress does not have information needed to facilitate holding the agency accountable for its spending.[40]

Potential for Intercepting ICBMs

Another issue for Congress is what role the Aegis BMD program should play in defending the U.S. homeland against attack from ICBMs. With the advent of the SM-3 Block IIA interceptor, 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 stated 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.[41]

On November 16, 2020, MDA announced that the congressionally directed ICBM-intercept flight test, called FTM-44, had been conducted on that date and had resulted in a successful intercept of the ICBM-representative target. MDA stated that "FTM-44, originally scheduled for May 2020, was delayed due to restrictions in personnel and equipment movement intended to reduce the spread of COVID-19. FTM-44 satisfies a Congressional mandate to evaluate the feasibility of the SM-3 Block IIA missile's capability to defeat an ICBM threat before the end of 2020."[42] A November 17, 2020, press report about the flight test stated that "the unarmed ICBM was a replica of a target flown against the Ground-based Midcourse Defense system during a March

[40] Government Accountability Office, *Missile Defense[:] Addressing Cost Estimating and Reporting Shortfalls Could Improve Insight into Full Costs of Programs and Flight Tests*, GAO-22-104344, February 2022, highlights page (PDF page 2 of 58).

[41] 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.

[42] Missile Defense Agency News release 20NEWS-0003, "U.S. Successfully Conducts SM-3 Block IIA Intercept Test Against an Intercontinental Ballistic Missile Target," November 16, 2020.

2019 flight test that featured a salvo launch of a pair of interceptors."[43] An April 2021 GAO report on deliveries and testing of U.S. missile defense systems in FY2020 stated the following:

> MDA's effort to include the SM-3 Block IIA interceptor in a new "layered" homeland defense against intercontinental ballistic missile (ICBM) threats targeting the U.S. could introduce considerable cost, schedule, and performance uncertainty to a program that has just entered initial production. The GMD weapon system currently provides defense against ICBMs, but this new effort would add the SM-3 Block IIA and THAAD weapon system as layers underneath that provided by GMD. For further details on the GMD and THAAD weapon systems see their respective appendixes.
>
> ICBM intercepts are more challenging than the IRBM intercepts for which the SM-3 IIA was originally designed. MDA's most recent attempt to create a system for intercepting ICBMs, known as the Redesigned Kill Vehicle (RKV), re-used some parts from the SM-3 Block IIA. DOD cancelled the RKV before it could complete development after significant cost and schedule overruns and questions about the ability of the design to overcome specific performance risks. Parts re-used from the SM-3 Block IIA were implicated in some of the RKV's performance shortfalls. Even so, planning for an anti-ICBM capability for the SM-3 Block IIA continued during and even after the RKV's termination.
>
> Achieving such a capability will require surmounting several challenges. According to MDA, during the November 2020 flight test named FTM-44, the SM-3 Block IIA struck a simple ICBM target. This was not an operational test, however, and it was executed under highly favorable conditions. More development work is needed for the SM-3 Block IIA to support a layered homeland defense capability. MDA documents show that the agency now plans to develop and procure an upgraded version of the SM-3 Block IIA for the specific purpose of fulfilling the homeland defense mission.[44]

A May 13, 2021, press report stated

> The Missile Defense Agency proved that a Navy destroyer with a Standard Missile-3 Block IIA can stop a simple intercontinental ballistic missile threat, but more work remains to prove whether this combination could contribute to homeland defense, the MDA director said Wednesday [May 12].
>
> Vice Adm. Jon Hill described the Flight Test Aegis Weapon System (FTM) 44, which took place in the Pacific in November after pandemic-related delays earlier in the year: A simple ICBM target was launched from the Army's Ronald Reagan Ballistic Missile Defense Test Site on the Kwajalein Atoll in the Marshall Islands. Satellites detected the launch, and a slew of satellites and sensors, including on the Pacific Missile Range Facility in Hawaii, tracked the target. Arleigh Burke-class destroyer USS John Finn (DDG-113), positioned hundreds of miles east of Hawaii, launched an SM-3 Block IIA missile from its deck based on its best fire control solution at the time, and the missile itself maneuvered to successfully hit the target as it received more information in flight.
>
> The goal of the test, Hill said while speaking at the annual McAleese FY 2022 Defense Programs Conference, was "to prove that we have the ability to leverage the robustness in the [Aegis] program, so that was really the first test just to see if it's feasible. And we learned a lot."
>
> Hill said the crew of John Finn, with limited data due to limited sensor coverage across the vast Pacific, maneuvered the ship to get the highest probability of kill.

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[43] Jason Sherman, "SM-3 Block IIA Intercepts ICBM Target, Validating Potential for Homeland Defense 'Underlayer,'" *Inside Defense*, November 17, 2020.

[44] Government Accountability Office, *Missile Defense[:] Fiscal Year 2020 Delivery and Testing Progressed, but Annual Goals Unmet*, GAO 21-314, April 2021, p. 24. See also Jen Judson, "Watchdog Expresses Concern over Using US Navy Interceptor for Homeland Missile Defense," *Defense News*, April 29, 2021.

"It maneuvered, shot the missile; lots of uncertainty because of lack of sensor coverage for such a long-range flight where we were doing the exercise. So what we actually saw was a really high divert [from the missile]. So kind of two walkaways from that first test, which is why I think it was really important, was that it was the longest propagated error or uncertainty that we've ever seen in any test. And then we had the highest divert—that meant the [SM-3 IIA] missile was maneuvering to actually take it out, and it still took it out, which is really great," Hill continued.

"In terms of feasibility, did we accomplish the mission? Absolutely. Every test objective achieved in November."

Hill was asked about an April Government Accountability Office report that cited concerns about the Aegis Combat System/SM-3 IIA pairing for the homeland defense mission—as opposed to the regional defense mission it was built for, to protect a high-value asset such as an aircraft carrier from an intermediate-range missile—and whether the simple ICBM target used in the November test was representative of the real world.

"So what's next? What's next is to go against a more complex intercontinental ballistic missile threat, and maybe even change the scenario. This scenario was a defense of Hawaii scenario against a rogue nation—you guess which one out there in the Pacific—and in the future we're going to go to a more complex [threat], and that's within the next couple years," he said.

"So we're still analyzing data from November, and then we're going to make upgrades and changes to the combat system, and we'll make changes to the missile in terms of threat set to take on a higher end class threat."

MDA and the military services would have to further integrate systems together to make this a credible layer in the homeland defense network, Hill said. During the November test, the MDA commanded and controlled the event from the Missile Defense Interoperability and Operations Center in Colorado Springs, Colo., using the Command and Control Battle Management and Communication System (C2BMC) to receive satellite and sensor data and feed it to John Finn, which fired its missile on remote without having access to the sensor data itself. While that worked in a controlled environment, for a permanent homeland defense mission the ship would need to be better integrated into U.S. Northern Command's network to fully share information and targeting data.

Hill said that Aegis has been integrated to operate with the Terminal High Altitude Area Defense system, and THAAD has been integrated with the Patriot missile defense system, but MDA hasn't integrated all the regional defense systems with homeland defense systems.

Beyond the actual integration and engineering work, Hill added that there was a policy question to answer, too.

"Do we want ships in that role of being off the West Coast … defending against ICBMs as a layer to the Ground-Based Mid-Course Defense? That's an incredible conversation, we're having that now, and it's hard to predict where it will go."

Asked on Thursday during the Naval Postgraduate School's acquisition research symposium if the Navy has the capacity and appetite to use destroyers for homeland defense, Hill said much of it comes down to what ships are available for the mission.

"I think if you asked Gen. [Glen] VanHerck from NORTHCOM about his confidence in defending the nation today, the answer would be confident. But as the threat evolves, right, you start to see a little change in that view. And so it's been viewed for a while that the Navy can play a role in that area, but it becomes an asset problem," Hill said. "There are

> only so many ships we have up there. And they're multi-mission ships, and they have a lot of roles around the globe to execute."[45]

A June 22, 2021, press report stated

> The Pentagon's No. 2 official has ordered 11 missile interceptors transferred from research and development for possible deployment on Navy ships in the Pacific or European regions after a test in November indicated they could stop an intercontinental ballistic missile.
>
> In the test, the USS John Finn intercepted a mock ICBM intended to simulate one that could be launched at Hawaii by North Korea. The destroyer, operating near Hawaii, fired off one of the Standard Missile-3 model Block IIA interceptors built by Raytheon Technologies Corp. at the target launched from Kwajalein Atoll in the Marshall Islands.
>
> Deputy Defense Secretary Kathleen Hicks informed Congress May 27 of her rationale for transferring the interceptors, although she didn't disclose it publicly.
>
> "The missiles have conducted successful intercept tests and their deployment is in the important interest of our national security," Hicks spokesman Jamal Brown said in an email this month. The transfer to the Navy marks the first major missile defense initiative of the Biden administration.
>
> Although the Navy's Aegis combat system, which launched the missile, and the interceptor "were not designed to defeat an ICBM-class target, this test demonstrated some potential limited capability," Vice Admiral Jon Hill, director of the Missile Defense Agency, said in testimony to Congress last week.[46]

Required vs. Available Numbers of BMD-Capable Aegis Ships

Another potential issue for Congress concerns required versus available numbers of BMD-capable Aegis ships. Some observers have expressed concern 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][47] 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

[45] Megan Eckstein, "MDA: Test of DDG, Standard Missile-3 IIA a Good Start, But More Work Needed on Homeland Defense Mission," *USNI News*, May 13, 2021. See also Jason Sherman, "MDA Planning Second SM-3 Block IIA Flight Test Against ICBM Target; New Development and Upgraded Interceptor Needed," *Inside Defense*, May 12, 2021; Rich Abott, "MDA Planning Second Test of SM-3 IIA Against ICBM Target," *Defense Daily*, May 17, 2021.

[46] Anthony Capaccio, "U.S. Navy Ships Close to Getting Interceptors That Could Stop an ICBM," *Bloomberg*, June 22, 2021.

[47] 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.

- 9 in forward deployed naval forces (FDNF) Japan to meet operational timelines in USINDOPACOM

- 4 in FDNF Europe for rotational deployment in EUCOM.[48]

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.
>
> "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.

[48] 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.

> "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.[49]

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 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

[49] 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.

> 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."[50]

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."[51]

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

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

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.
>
> "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.[52]

Role of Aegis BMD in New Guam Missile Defense Architecture

Another issue for Congress is the role of the Aegis BMD program in a new missile defense system architecture for Guam. After studying various possible BMD system architectures for Guam, DOD is proposing a system that would combine elements of the Aegis BMD system with elements of Army BMD systems. MDA's proposed FY2023 budget requests funding to begin implementing its this BMD architecture for Guam. A March 30, 2022, press report states

> The Missile Defense Agency's initial plan for the architecture to protect Guam turns to proven systems to help the agency meet a 2026 fielding deadline, according Vice Adm. Jon Hill, the agency's director.
>
> The defense of Guam from potential ballistic, cruise and hypersonic missile attacks has become a priority for the MDA, which is seeking $539 million in fiscal 2023 to continue to design and develop multiple-land based radar systems, procure weapon system components and initiate military construction planning and design activity.
>
> "Current forces are capable of defending Guam against today's North Korean ballistic missile threats," Dee Dee Martinez, the MDA's comptroller said in a March 28 Pentagon budget briefing. "However, the regional threat to Guam, including from China, continues to rapidly evolve."...
>
> The architecture will not be a fixed missile defense site like Aegis Ashore in Romania and Poland, Hill said. "Think of it as a distributed system." He added that the agency is interested in using mobile launchers.
>
> The architecture will include Navy SM-3 and SM-6 missiles, the Patriot air-and-missile defense system and the Army's Terminal High Altitude Area Defense System (THAAD). A THAAD battery has been operating on Guam since 2013.
>
> Those elements will be connected through the Army's Integrated Battle Command System, a command-and control-system that connects sensors and shooters on the battlefield. The agency will also use the Aegis weapon system's fire control capability, Hill said.
>
> "Patriot [has] a fabulous capability for cruise missile defense, and that's our first focus area," Hill said. "And we have the ability within Aegis to enable that, but, right now, we are doing ballistic missiles, hypersonic, on the Aegis part of that overall integrated architecture and then the cruise missile piece will be with the Army systems."
>
> While MDA is focused on using existing technology to make up the architecture, it will consider new technology, including the Mid-Range Capability missile the Army will field in FY23, as it becomes available, according to Hill....
>
> "That topology of the island … it is a tough place," Hill said. "An Aegis Ashore site is limited in what it can do because of the the rise and the fall of the hills, you got radar, it's not a flat earth, and it's certainly not flat on Guam, so we've done some really incredible

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

> work and analysis over the last couple years ... by dispersing the systems and making sure everything's networked."[53]

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 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.[54]

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.[55]

Potential Contribution from Lasers

Another potential issue for Congress concerns the potential for ship-based lasers 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 for performing various missions, including, potentially, terminal-phase BMD operations.[56]

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.

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[53] Jen Judson, "MDA's Plan to Protect Guam Relies on Field-Proven Systems," *Defense News*, March 30, 2022. See also Jason Sherman, "OMB Reveals Land-Based VLS Also Part of New Guam Missile Defense Architecture," *Inside Defense*, July 13, 2022; Rich Abott, "MDA Decides On Guam Defense Architecture," *Defense Daily*, March 29, 2022; Jason Sherman, "DOD Picks SPY-7 for Land-Based Aegis, Giving Lockheed First U.S. Customer for New Radar," *Inside Defense*, May 6, 2022.

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

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

[56] See CRS Report R44175, *Navy Shipboard Lasers: Background and Issues for Congress*, by Ronald O'Rourke.

June 2022 GAO Report

A June 2022 GAO report on U.S. BMD systems, including the Aegis BMD system, stated the following:

> **Deliveries**
>
> The Aegis Ashore site in Poland was originally planned to be delivered in fiscal year 2018, but has experienced significant construction delays due to contractor under-performance, according to Missile Defense Agency (MDA) officials. The program currently estimates that this site will be delivered no earlier than fiscal year 2022.
>
> An AWS [Aegis Weapon System] software spiral—Aegis Baseline 9.C2.1—was delivered as planned in fiscal year 2021. The program noted, however, that these capabilities will not be available until Command, Control, Battle Management, and Communications (C2BMC) spiral 8.2-5 and the Navy's upgraded SM-6 Dual II missiles are fielded....
>
> SM-3 interceptors experienced production issues that led to delays in deliveries for fiscal year 2021. SM-3 Block IIA production was halted to investigate multiple test and component anomalies, some of which required re-work of delivered interceptors. An incremental production decision planned for fiscal year 2021 was delayed pending a revised cost estimate.
>
> **COVID-19**
>
> Aegis Ashore experienced increased travel and labor costs for all three sites due to travel restrictions, but the program does not anticipate these issues for fiscal year 2022.
>
> According to program officials, AWS software installations were disrupted by ship yard availability and deployment dates and quarantine requirements for contractors performing the installations led to a $554,000 cost increase.
>
> SM-3 Block IIA interceptors experienced delays at test facilities due to pandemic quarantine requirements.
>
> **Testing**
>
> Aegis BMD conducted eight flight tests in fiscal year 2021. One test—FTM-44—demonstrated the SM-3 Block IIA's ability to intercept an intercontinental range target for a potential homeland defense scenario. Another test demonstrated the SM-3 Block IIA's new guidance electronics unit, which has previously experienced performance issues. Aegis BMD conducted two tests using SM-6 missiles, but both have ongoing failure review boards. FTM-31 E1—a salvo (two missiles) against a medium-range target—failed as neither missile intercepted the target. FTM-33—a salvo (4 missiles in total) against a raid of two short-range targets—had one success and one failure. Aegis BMD also participated in a series of international tests to demonstrate interoperability with North Atlantic Treaty Organization partners; all of which were successful.
>
> Aegis BMD participated in three ground tests in fiscal year 2021. Two assessed AWS's ability to track certain space objects and the other provided data on its search, track, and remote engagement capabilities. Remaining tests were delayed due to COVID-19.
>
> Aegis BMD did not plan to conduct operational cybersecurity tests in fiscal year 2021, though the program did conduct several developmental cybersecurity tests.
>
> **Other Program Information**
>
> ***Layered Homeland Defense***
>
> A flight test in fiscal year 2021—FTM-44—was part of an effort to evaluate if the SM-3 Block IIA interceptor, either in its current form or upgraded, could contribute to a layered homeland defense capability against intercontinental threat missiles.... This flight test was successful and MDA was able to use the results to support the planning and analysis for

> this capability. However, further planning for this capability is largely on hold pending DOD approval of a report on the possible concepts of operations for this capability, additional funding, and direction from Congress according to MDA officials.[57]

Regarding deliveries of interceptors, the report stated that of the 32 SM-3 Block IB missiles that were scheduled for delivery in FY2021, 23 were delivered, and that "Remaining deliveries were halted due to a recent flight test failure of the SM-6 missile, which shares major components with the SM-3 Block IB." The report stated that of the seven SM-3 Block IIA missiles that were scheduled for delivery in FY2021, three were delivered, with "Production temporarily halted due to missile assembly issues."[58]

January 2021 DOT&E Report[59]

A January 2022 report from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2021—did not include a section specifically on the Aegis BMD program.

The January 2021 report from DOT&E—its annual report for FY2020—stated the following in its section on the Aegis BMD program:

> **Assessment**
>
> • Aegis BMD continues to demonstrate a capability to intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase of flight with SM-3 missiles. Aegis BMD has also demonstrated a capability to intercept select ballistic missiles in the terminal phase of flight with SM-6 missiles. However, flight testing and M&S [modeling and simulation] have not addressed all expected threat types, ground ranges, and raid sizes. The MDA has used M&S to explore Aegis BMD raid engagement performance, but DOT&E has less confidence in these results because COMOPTEVFOR [the Navy Commander, Operational Test and Evaluation Force] has been unable to accredit the models due to the lack of validation data from live fire raid engagements and lack of post-intercept debris modeling.
>
> • During Pacific Dragon—2020 [a Navy fleet exercise in August 2020], the MDA demonstrated Aegis BMD interoperability with Republic of Korea naval assets while conducting simulated ballistic missile engagements. The AAMDTC [Aegis Ashore Missile Defense Test Complex] demonstrated Aegis interoperability with Australian naval assets while tracking ballistic missile targets.
>
> • DOT&E will provide an assessment of the FTM-44 [flight] test results and of the SBT [sea-based terminal] Increment 2 capability (based on the results of FTM-31 E1 and FTM-33) [flight tests] in separate reports.
>
> • MDA ground tests have routinely shown that inter-element coordination and interoperability need improvement to improve engagement efficiency; however, flight testing with multi-element engagement coordination has been limited. Aegis BMD has exercised rudimentary engagement coordination with Terminal High-Altitude Area Defense [THAAD] [BMD] firing units, but not with [the] Patriot [BMD system]. The MDA plans to exercise engagement coordination between those three theater elements during

[57] Government Accountability Office, *Missile Defense[:] Better Oversight and Coordination Needed for Counter-Hypersonic Development*, GAO-22-105075, June 2022, pp. 39-40.

[58] Government Accountability Office, *Missile Defense[:] Better Oversight and Coordination Needed for Counter-Hypersonic Development*, GAO-22-105075, June 2022, p. 39. See also Jason Sherman, "MDA Missed Mark for Advanced Aegis Interceptor Deliveries, Including No. 1 Unfunded Priority," *Inside Defense*, June 29, 2022.

[59] DOT&E's annual report for FY2021, which is dated January 2022, includes a section that discusses missile defense systems in general but does not include a section specifically discussing the Aegis BMD system.

Flight Test Operational (FTO)-05, but that flight test has been repeatedly delayed and is currently planned for FY28.

• DOT&E and USD(R&E) [Under Secretary of Defense for Research and Engineering] have prompted the MDA to establish a ground testing approach to support assessments of missile reliability. DOT&E cannot assess SM-3 missile reliability with confidence until the MDA is able to provide additional ground test data that simulate the in-flight environment.

• The MDA delivered results from a subset of the high-fidelity M&S operational test runs for record for the SM-3 IIA missile. The MDA found a problem in one of the models used to conduct the M&S runs. The MDA has identified a fix action and the test runs will be re-run and delivered in FY21. The data from these re-executed runs will support the DOT&E assessment of the operational effectiveness of the SM-3 Block IIA missile in FY21.

• COVID-19 impacts have delayed delivery of high-fidelity M&S operational test runs for record to support an assessment of SBT Increment 2 operational effectiveness. Verification and validation data from flight testing will not be available until FY21 to support model accreditation. M&S operational test runs for record will not be available until FY22.

• The developmental AN/SPY-6(V)1 radar continues to track ballistic missiles during MDA flight tests. The radar detected and tracked the HGV [hypersonic glide vehicle] target in FEX-01.

Recommendations

The MDA should:

1. Prioritize resources for FTO-05 to ensure this critical flight test occurs as soon as possible.

2. Conduct Aegis BMD midcourse and terminal phase flight testing with live fire intercepts of raids of two or more ballistic missile targets to aid in the validation of M&S tools.

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

4. Provide data from high-fidelity ground tests to DOT&E to inform SM-3 Block IB Threat Upgrade and Block IIA missile reliability estimates.

5. Work with DOT&E and USD(R&E) to establish a ground testing approach to support assessments of missile reliability.[60]

Regarding the SM-6 missile, the January 2021 DOT&E report also stated the following:

Assessment

• As reported in the FY18 DOT&E SM-6 BLK I FOT&E [Follow-on Operational Test and Evaluation] 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 and two additional problems discovered during FY17 SM-6 BLK [block] I testing to verify corrected deficiencies. The SM-6 BLK IA FOT&E analysis is consistent with prior reporting.

• While post-flight test data appears promising, DOT&E will assess the results of the developmental/engineering flight test to examine corrective actions to a classified performance deficiency discovered during FY17 SM-6 BLK verification of correction of deficiency tests. This assessment will occur in FY21.

Recommendations

The Navy should:

[60] Department of Defense, Director, Operational Test & Evaluation, *FY2020 Annual Report*, January 2021, p. 218.

1. Fully assess the corrective actions implemented to address the additional problems encountered during FY17 SM-6 BLK I verification of corrected deficiency tests by conducting a verification of deficiency operational flight test.

2. Plan and conduct lethality assessments for the SM-6 FCD [Future Capabilities Demonstration] capabilities.[61]

Legislative Activity for FY2023

Summary of Action on FY2023 MDA Funding Request

Table 2 summarizes congressional action on the FY2023 request for MDA procurement and research and development funding for the Aegis BMD program.

Table 2. Summary of Congressional Action on FY2023 MDA Funding Request

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

		Authorization			Appropriation		
	Request	**HASC**	**SASC**	**Enacted**	**HAC**	**SAC**	**Enacted**
Procurement							
Aegis BMD (line 32)	402.2	425.7	402.2		402.2	402.2	
(SM-3 Block IB missile quantity)	*(47)*	*(47)*	*(47)*			*(47)*	
Aegis BMD Advance Procurement (line 33)	0	0	0		0	0	
SM-3 Block IIA (line 35)	338.0	338.0	653.0		338.0	670.0	
(SM-3 Block IIA missile quantity)	*(10)*	*(10)*	*(18)*			*(24)*	
Aegis Ashore Phase III (line 39)	30.1	30.1	30.1		30.1	30.1	
Aegis BMD hardware and software (line 41)	78.2	100.2	78.2		78.2	78.2	
Subtotal Procurement	**848.5**	**894.0**	**1,163.5**		**848.5**	**1,180.5**	
Research, development, test, and evaluation (RDT&E)							
Aegis BMD (PE 0603892C) (line 83)	600.1	600.1	600.1		606.1	575.5	
Aegis BMD test (PE 0604878C) (line 113)	182.8	192.8	182.8		175.6	152.8	
Land-based SM-3 (PE 0604880C) (line 115)	27.7	27.7	27.7		27.7	27.7	
Subtotal RDT&E	**810.6**	**820.6**	**810.6**		**809.4**	**756.0**	
TOTAL	**1,659.1**	**1,714.6**	**1,974.1**		**1,657.9**	**1,936.5**	

Source: Table prepared by CRS based on DOD's original FY2023 budget submission, committee and conference reports, and explanatory statements on FY2023 National Defense Authorization Act and FY2023 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.

[61] Department of Defense, Director, Operational Test & Evaluation, *FY2020 Annual Report*, January 2021, p. 168.

FY2023 National Defense Authorization Act (H.R. 7900/S. 4543)

House

The House Armed Services Committee, in its report (H.Rept. 117-397 of July 1, 2022) on H.R. 7900, recommended the funding levels and missile quantities shown in the HASC column of **Table 2**. The recommended increase of $23.5 million for line 32 is for "Procure Replacement IMU [Inertial Measurement Unit]," and the recommended increase of $22.0 million for line 41 is for "SPY–1 Low Noise Amplyfier [sic: amplifier]." (Page 454) The recommended increase of $10 million for line 113 is for "Continued participation in ASD–23 [At-Sea Demonstration 23]." (Page 505)

Section 1648 of H.R. 7900 as reported by the committee states (emphasis added)

> SEC. 1648. RISK REDUCTION IN PROCUREMENT OF GUAM MISSILE DEFENSE SYSTEM.
>
> (a) SENSE OF CONGRESS.—It is the sense of Congress that—
>
> (1) the defense of Guam and the Armed Forces that operate there is of key strategic significance and is one of the top priorities for United States Indo-Pacific Command and the United States;
>
> (2) the most severe adversary threat to Guam consists of long-range hypersonic and cruise missiles launched from a variety of air, land, and sea-based platforms;
>
> (3) the current plan of the Missile Defense Agency using a mixed architecture which, when applied to the launcher systems, relies on numerous road-mobile transport erector launchers for launching, and is an unproven and high-risk plan; and
>
> (4) **the existing vertical launch system, which can accommodate the standard missile–3 and the standard missile–6, is a more capable and tested system and provides reasonable risk reduction to the short-term missile defense of Guam, and in the long term provides much needed capacity increase.**
>
> (b) **AUTHORITY FOR PROCUREMENT.—Except as provided by subsection (c), not later than December 31, 2023, the Secretary of Defense, acting through the Director of the Missile Defense Agency, shall rapidly procure and field up to three vertical launching systems that can accommodate planned interceptors operated by the Navy as of the date of the enactment of this Act.**
>
> (c) WAIVER.—The Secretary may waive the requirement under subsection (b) if—
>
> (1) the Secretary determines that the waiver is in the best interest of the national security of the United States;
>
> (2) the Secretary submits to the congressional defense committees a notification of such waiver, including a justification; and
>
> (3) a period of 120 days has elapsed following the date of such notification.

Section 1705 of H.R. 7900 as reported by the committee states (emphasis added)

> SEC. 1705. FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER ANALYSIS OF DEPARTMENT OF DEFENSE CAPABILITY AND CAPACITY TO REPLENISH MISSILE AND MUNITION INVENTORIES.
>
> (a) SENSE OF CONGRESS.—It is the sense of Congress that—
>
> (1) the ongoing war in Ukraine has highlighted the importance of understanding the defense industrial base gaps and limitations of replenishing inventories of critical, preferred, and precision-guided weapon systems; and

(2) the ability of the Department of Defense to replenish critical munitions in the event of a conflict with a strategic competitor lasting not less than six months is of critical importance to the national security interests of the United States.

(b) FFRDC STUDY.—

(1) IN GENERAL.—Not later than 30 days after the date of the enactment of this Act, the Secretary of Defense shall seek to enter into an agreement with an appropriate federally funded research and development center for the conduct of a detailed analysis of the capability of the Department of Defense replenish inventory of the weapons described in paragraph (3) to address long-range strike capabilities, including against naval surface and subsurface, as well as land-based forces, air superiority, interdiction, air and missile defense, and hard and deeply buried target mission areas. Such an agreement shall provide that an analysis conducted pursuant to the agreement shall be completed within 180 days.

(2) MATTERS FOR CONSIDERATION.—An analysis conducted pursuant to an agreement under paragraph (1) shall include a consideration of each of the following with respect to the weapons described in paragraph (3):

(A) Any gaps in current or near-term production capability through 2025 or capacity due to the loss, impending loss, or obsolescence of manufacturers or suppliers of items, raw materials, or software, along with recommendations to address the highest priority gaps.

(B) The capability to significantly increase current levels of production beyond steady-state demand requirements, including an assessment of sub-tier supplier capacity, capability, and rates of production.

(C) The predicted production capability and capacity during the time period beginning in 2025 and ending in 2035, including the capability and any recommendations to significantly increase production during that time period.

(D) The reliance of the United States on materials and parts that are produced or sourced in foreign countries, particularly in the case of such reliance on a sole-source producer or supplier, an identification of countries of origin of such materials and parts, and associated recommendations to address any priority vulnerabilities.

(E) The capacity of the organic industrial base, including both Government-operated and contractor-operated facilities, to support surge production, and an identification of the weapons that each such facilities is equipped, or could be equipped, to produce.

(3) WEAPONS DESCRIBED.—The weapons described in this paragraph are each of the following:

(A) Evolved sea sparrow missile.

(B) MK 48 heavyweight torpedo.

(C) Standard missile variants (SM-6, SM-3 block IB and SM-3 block IIA).

(D) Patriot guided missiles.

(E) Terminal high altitude area defense interceptors.

(F) Guided and ballistic missiles fired from the multiple launch rocket system (MLRS) or the high mobility artillery rocket system (HIMARS).

(G) Javelin missile.

(H) Stinger missile.

(I) Air intercept missile (AIM)-9X-Sidewinder.

(J) AIM-120D - Advanced medium range air-to-air missile (AMRAAM).

(K) Air to ground (AGM)-114 - hellfire missile.

(L) Small diameter bomb II.

(M) Joint direct attack munition.

(N) Advanced penetrating bombs.

(O) Enhanced fragmentation bombs.

(P) Low collateral damage bombs.

(Q) Tomahawk land attack missile.

(R) Maritime strike tomahawk.

(S) Long range anti-ship missile.

(T) Naval strike missile.

(U) Joint air-to-surface standoff missile-extended range.

(V) Harpoon anti-ship missile.

(W) Any other weapon that the Secretary of Defense or the federally funded research and development center determine should be included in the analysis.

(4) REPORT.—

(A) IN GENERAL.—Not later than 180 days after entering into an agreement under subsection (a), the Secretary shall submit to the congressional defense committees a report containing the unaltered results of the analysis completed pursuant to the agreement.

(B) FORM.—The report required under subparagraph (A) shall be submitted in unclassified form, but may include a classified annex.

Section 1708 of H.R. 7900 as reported by the committee states (emphasis added)

SEC. 1708. STUDY ON STOCKPILES AND PRODUCTION OF CRITICAL GUIDED MUNITIONS.

(a) STUDY.—Not later than one year after the date of the enactment of this Act, the Secretary of Defense shall complete a study to determine how rapidly stockpiles of the United States of critical guided munitions would become depleted in the event of the involvement of the United States in a large-scale conflict.

(b) MATTERS.—The study under subsection (a) shall include, at a minimum, the following:

(1) Modeling of the monthly munitions expenditure of the United States in the scenario of a large-scale conflict (lasting for a period of at least 180 days) in Europe during fiscal year 2025, at various levels of conflict intensity, including conflicts involving 25, 50, and 75 percent of the force structure of the land, naval, and air forces of the active Armed Forces.

(2) Modeling of the monthly munitions expenditure of the United States in the scenario of a large-scale conflict (lasting for a period of at least 180 days) in East Asia during fiscal year 2025, at various levels of conflict intensity, including conflicts involving 25, 50, and 75 percent of the force structure of the land, naval, and air forces of the active Armed Forces.

(3) An analysis of how rapidly stockpiles of the United States of critical guided munitions would become depleted in each of the scenarios referred to in paragraphs (1) and (2) for, at a minimum, the following munitions:

(A) Air Intercept Missile-260.

(B) Joint Direct Attack Munition.

(C) Long Range Anti-Ship Missile.

(D) Naval Strike Missile.

(E) Standard Missile-2.

(F) Standard Missile-6.

(G) Harpoon Anti-ship Missile.

(H) MK-48 torpedo.

(I) Each variant of the following:

(i) Air Intercept Missile-9.

(ii) Air Intercept Missile-120.

(iii) Army Tactical Missile System.

(iv) Guided Multiple Launch Rocket System.

(v) Javelin.

(vi) Joint Air-to-Surface Standoff Missile.

(vii) Patriot Missile.

(viii) Precision Strike Missile.

(ix) Stinger.

(x) Tomahawk Cruise Missile.

(4) An analysis of the time and resources that would be necessary to restart production lines for the critical guided munitions specified in paragraph (3) that, as of the period during which the study is conducted, are not in production by the United States.

(5) An analysis of the time and resources that would be necessary to increase the monthly production of critical guided munitions to meet the expenditure rates projected pursuant to the modeling under paragraphs (1) and (2).

(c) REPORT AND BRIEFING.—

(1) IN GENERAL.—Not later than 120 days after the date of the completion of the study under sub section (a), the Secretary of Defense shall submit to the congressional defense committees a report, and provide to the congressional defense committees a briefing, on the study. Such report shall contain the following:

(A) A summary of the findings of the study.

(B) Recommendations to expedite the production of the munitions specified in subsection (b)(3).

(2) FORM.—The report under paragraph (1) shall be submitted in unclassified form, but may contain a classified annex.

(d) CRITICAL GUIDED MUNITION.—In this section, the term ‘‘critical guided munition’’ means—

(1) any munition specified in subsection (b)(3); and

(2) any other munition designated as such by the Secretary of Defense.

Senate

The Senate Armed Services Committee, in its report (S.Rept. 117-130 of July 18, 2022) on S. 4543, recommended the funding levels and missile quantities shown in the SASC column of **Table 2**. The recommended increase of $315.0 million for line 35 is for “Capacity expansion—test equipment” ($63.0 million) and “Production increase” ($252.0 million). (Page 429) S.Rept. 117-130 states:

Standard Missile–3 Block IIA

> The budget request included $338.0 million in line number 35 of Procurement, Defense-wide (PDW) to procure 10 Standard Missile–3 (SM–3) Block IIA missiles.
>
> The committee recommends an increase of $252.0 million in PDW line number 35 for eight additional SM–3 Block IIA missiles and $63.0 million for SM–3 Block IIA test equipment to increase production capacity to 36 missiles per year. (Page 19)

FY2023 DOD Appropriations Act (H.R. 8236/S. 4663)

House

The House Appropriations Committee, in its report (H.Rept. 117-388 of June 24, 2022) on H.R. 8236, recommended the funding levels shown in the HAC column of **Table 2**. The recommended increase of $6.0 million for line 83 is for "Program increase - lightweight telescope for advanced AEGIS Interceptor." (Page 240) The recommended reduction of $7.157 million for line 113 is for "Excess growth." (Page 241)

Senate

The explanatory statement for S. 4663 released by the Senate Appropriations Committee on July 28, 2022, recommended the funding levels shown in the SAC column of **Table 2**.

The recommended increase of $332.0 million for line 35 is for "Program increase: 14 additional SM–3 IIA interceptors." (Page 155)

The recommended reduction of $24.529 million for line 83 is for "Cyber operations previously funded" ($2.793 million), "Program operational growth" ($1.5 million), "Lack of schedule clarity for AEGIS BMD 5.x ($16.041 million), and "BMD 6.x cost previously funded" ($4.195 million). (Page 220)

The recommended reduction of $30.0 million for line 113 is for "Prior year test adjustments." (Page 221)

Appendix. Reported Aegis BMD Flight Tests

Table A-1 presents a summary of reported Aegis BMD flight tests since January 2002. In addition to the flight tests shown in the table, 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.

Table A-1. Reported 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

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?	Cumulative successes	Cumulative attempts
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
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[b]	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
11/16/20	US	FTM-44	ICBM target	Yes	34	43
5/26 and 30/2021	US-Netherlands	ASD/FS21[c]	Non-separating MRBM target	Yes[c]	35[c]	44[c]
8/9/22	US	Part of Pacific Dragon exercise	ARAV-B SRBM target	Yes	36	45
Endo-atmospheric (using SM-2 missile Block IV missile and [for MMW E1 and subsequent] 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

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?	Cumulative successes	Cumulative attempts
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
5/29/21	US	FTM-31	Medium-range target (MRBM)	**No**	7	8
7/24/21	US	FTM-33	Two SRBM targets	Yes and **unconfirmed**[d]	8 and unconfirmed[d]	9 and 10

Sources: Table presented in MDA fact sheet, "Aegis Ballistic Missile Defense Testing," February 2017, accessed on May 18, 2022, 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, Jason Sherman, "U.S. Intercepted Ballistic Missile Target over Pacific while China Exercised around Taiwan," *Inside Defense*, August 12, 2022; and Wyatt Olson, "Missile-Defense Exercise Off Hawaiian Island Includes First Live-Fire Intercept," *Stars and Stripes*, August 16, 2022.

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.

a. MDA's table shows this as a test that did not result in the launch of an SM-3. MDA as of August 3, 2015, had not issued a news release discussing this event. MDA's count of 31 successful intercepts in 37 launches through July 29, 2015, does not appear to include this test, suggesting that this was considered a "no test" event—a test in which there was a failure that was not related to the Aegis BMD system or the SM-3 interceptor. News reports state that the test was aborted due to a failure of the target missile. (Andrea Shalal, "U.S. Skips Aegis Ashore Missile Test After Target Malfunction," *Reuters*, June 26, 2015.) MDA's table similarly shows the test of December 7, 2006, as a test that did not result in the launch of an SM-3. MDA issued a news release on this test, which stated that an SM-3 was not launched "due to an incorrect system setting aboard the Aegis-class cruiser USS *Lake Erie* prior to the launch of two interceptor missiles from the ship. The incorrect configuration prevented the fire control system aboard the ship from launching the first of the two [SM-3] interceptor missiles. Since a primary test objective was a near-simultaneous launch of two missiles against two different targets, the second interceptor missile was intentionally not launched." MDA counts the test of December 7, 2006, as an unsuccessful intercept in its count of 31 successful intercepts in 37 launches through July 29, 2015.

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

c. ASD/FS21 was an at-sea demonstration that occurred during a multilateral naval exercise called Formidable Shield 2021. In the demonstration, a Dutch frigate used its radar to provide early warning track data to a U.S. Navy destroyer that used the data to calculate a firing solution and launch its interceptor. Some press reports state that ASD/FS21 involved two successful ballistic missile intercepts, rather than the one shown in the table.

d. MDA stated that "based on initial observations, one target was successfully intercepted. At this time, we cannot confirm the second target was destroyed." ("MDA Test Intercepts Target," MDA News Release 21-NEWS-0012, July 24, 2021.)

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