

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

Updated August 28, 2023

Congressional Research Service

<https://crsreports.congress.gov>

RL33745



RL33745

August 28, 2023

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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 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 FY2024 budget submission states that "by the end of FY 2024, there will be 53 total BMD 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 FY2024 budget requests a total of \$1,747.2 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;
- 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
- deliveries, testing, and technical risk in the Aegis BMD program.

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Introduction

This report provides background information and issues for Congress on the Aegis ballistic missile defense (BMD) program, 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). Retirements of these 22 ships began in FY2022. The Navy's FY2024 budget submission projects that 13 will remain in service at the end of FY2023, and proposes that these 13 ships be retired in FY2024 (five ships), FY2025 (three ships), FY2026 (three ships), and FY2027 (two ships).

Arleigh Burke (DDG-51) Class Aegis Destroyers

The Navy began procuring DDG-51s in FY1985, and a total of 92 have been procured through FY2023. The first DDG-51 entered service in 1991, and a total of 74 have been delivered as of August 2023. Under the Navy's FY2024 budget submission, retirements of older DG-51s are to begin in FY2028.

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 another significant change—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 System³

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	<ul style="list-style-type: none"> Addition of Standard Missile-3 (SM-3) Block 1B 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	<ul style="list-style-type: none"> BMD 5.0 CU capabilities for Aegis Ashore in Romania without Standard Missile (SM-6) Dual I 	2015
BMD 5.1	BL 9.C2	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> BMD 5.1 capabilities for Aegis Ashore in Romania and Poland 	2019
BMD 4.1	BL 5.4	<ul style="list-style-type: none"> Similar capabilities to BMD 5.0 CU capabilities, installed on legacy hardware 	2020
BMD 4.2	BL 5.X	<ul style="list-style-type: none"> Aegis SPY-1 radar refurbishment for improved tracking capability 	2023
BMD 6.0	BL 10.0	<ul style="list-style-type: none"> New SPY-8 radar with increased radar capacity and discrimination 	2023
		<ul style="list-style-type: none"> Performance against additional threats and larger raids Improved missile communications 	

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

^aLaunch 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.

^bSM-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.

^cEngage 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 Standard⁵ 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-to-kill" warhead, called a kinetic vehicle, that is designed to destroy a ballistic missile's warhead

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.

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 IB 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 (SBT) 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 SBT 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:

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

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.

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 and the Navy are developing a capability for the SM-6 to intercept hypersonic missiles. 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

MDA testified in May 2023

MDA plans to conduct a Tracking Exercise, Flight Test Other (FTX)-23, with two Aegis ships to perform target scene data collection of an MRBM with countermeasures. We will also demonstrate Aegis SBT with a salvo engagement in Flight Test Aegis Weapon System (FTM)-32, firing two (salvo) SM-6 Dual II software upgrade guided missiles against a MRBM. In FTX-40 we will fire a simulated SM-6 missile against a hypersonic glide vehicle....

We also are developing a layered defense capability against regional hypersonic threats and have initiated a development program for a Glide Phase Interceptor, leveraging existing systems where possible, including proven engage-on-remote and launch-on-remote capabilities. We are focusing on the proven Aegis Weapon System to provide the depth-of-fire needed for a layered defense against hypersonic threats. In FY 2024, MDA will continue to develop and mature the GPI capability and leverage the Aegis Weapon System. Today, MDA already provides the Navy an initial terminal defense capability. We also are working closely with the Navy to develop, field, and upgrade SBT defenses to counter more advanced maneuvering and hypersonic threats. We anticipate delivering these Increment 3 capabilities in 2025. In FY 2024, Aegis SBT will demonstrate an

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. See also Jason Sherman, "DOD Delays by Two Years Maiden Intercept Attempt of Hypersonic Glide Vehicle Target," *Inside Defense*, May 17, 2023.

engagement against an advanced target in the terminal phase (FTM-32) and a simulated engagement against a hypersonic glide vehicle (FTX-40). In FY 2025, SBT Increment 3 will demonstrate an engagement against a hypersonic glide vehicle firing an SM-6 Block IAU missile (FTM-43).¹²

Numbers of BMD-Capable Aegis Ships

The number of BMD-capable Aegis ships has been growing over time. MDA's FY2024 budget submission states that "by the end of FY 2024, there will be 53 total BMD capable [Aegis] ships requiring maintenance support."¹³

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 at Rota, Spain.¹⁴ The initial set of four ships was transferred to Rota in FY2014 and FY2015.¹⁵ They were replaced at Rota by a new set of four BMD-capable U.S. Navy Aegis destroyers in 2020-2022.¹⁶

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 releasing 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.¹⁷ Navy officials testified in 2020 that they supported the idea.¹⁸ On June 28, 2022, the Biden Administration announced that two additional Aegis destroyers

¹² [Statement of] Vice Admiral Jon A. Hill, USN, Director, Missile Defense Agency, Before the House Armed Services Committee Strategic Forces Subcommittee, May 9, 2023, pp. 8, 10-11.

¹³ Missile Defense Agency, *Fiscal Year 2024 Budget Estimates*, Missile Defense Agency, March 2023, p. 11. (This is the FY2024 budget justification book for MDA's portion of the Operation and Maintenance, Defense-Wide appropriation account.)

¹⁴ "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.)

¹⁵ 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.

¹⁶ See, for example, Mallory Shelbourne, "USS Arleigh Burke Arrives in Spain, USS Donald Cook Will Head to Mayport," *USNI News*, April 12, 2021.

¹⁷ 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.

¹⁸ 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 Stripes*, April 15, 2021.

would be homeported at Rota.¹⁹ The Navy confirmed that the two additional Aegis destroyers are to be BMD-capable.²⁰ An October 24, 2022, press report stated that “the U.S. and Spain will soon launch negotiations on a new defense pact for an expanded naval presence in Spain,” including the two additional BMD-capable Aegis destroyers. The report stated that “while an official timeline for the ships’ arrival in Spain hasn’t been set, U.S. military commanders have put 2025 or 2026 as target years.”²¹ On May 8, 2023, Spain and the United States reportedly signed the new agreement.²²

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, and 24 SM-3 missiles launched from a relocatable Vertical Launch System (VLS) based on the VLS that is installed in Navy Aegis ships.²³

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 2016.²⁴ The site in Poland began construction in May 2016²⁵ and was initially scheduled to be completed in 2018. Its completion, however, has been delayed by construction contractor performance issues.²⁶ An August 23, 2023, press report stated that MDA is aiming to turn the

¹⁹ 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.

²⁰ Source: Navy Office of Legislative Affairs email to CRS, July 1, 2022.

²¹ John Vandiver, “Talks on Addition of 2 Navy Destroyers at Base in Spain Expected to Start Soon,” *Stars and Stripes*, October 24, 2022.

²² Heather Mongilio, “U.S., Spain Agree to Host Two More Warships in Rota,” *USNI News*, May 9, 2023.

²³ 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.

²⁴ 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.

²⁵ See, for example, “Aegis Ashore,” Missile Defense Advocacy Alliance, accessed May 18, 2022, at <https://missiledefenseadvocacy.org/defense-systems/aegis-ashore/>.

²⁶ 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.

Polish site over to the Navy by the end of 2023, and to have the system be fully operational by the spring of 2024.²⁷

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.²⁸

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.²⁹

²⁷ Rich Abott, "Poland Aegis Ashore Site To Turn Over To Navy This Year, Operational In 2024," *Defense Daily*, August 23, 2023.

²⁸ 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.

²⁹ Megan Eckstein, "Navy Wants to Shed Aegis Ashore Mission, But Army Still Hasn't Agreed to Take It," *USNI News*, January 12, 2021.

Japan Planned and Later Canceled Two Sites

Prior to June 2020, Japan had planned to procure and operate two Aegis Ashore systems that reportedly were to have been located at Ground Self-Defense Force (GSDF) facilities in Akita Prefecture in eastern Japan and Yamaguchi Prefecture in western Japan, and were to have been operated mainly by the GSDF (i.e., Japan's army).³⁰ The two systems reportedly were to have been 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 2023.³¹ On June 15, 2020, however, Japan announced that it had suspended implementation of its Aegis Ashore initiative due to cost growth and technical concerns.³² On June 25, 2020, Japan confirmed that it had canceled the plan for deploying the two Aegis Ashore sites.

Rather than building the two Aegis Ashore systems, Japan now plans to instead build two additional BMD-capable Aegis ships that are to be dedicated to BMD operations. A September 6, 2022, press report states

Japan's Ministry of Defence is proposing to build a pair of ballistic missile defense ships—the [sic] among largest warships in the Japanese inventory since World War II—government officials said last week....

The two ships would be built instead of the land-based Aegis Ashore installations that the Japanese Self-Defense Force backed away from in 2020 based on risks of missile debris falling to the ground, USNI News reported at the time....

The two Aegis destroyers are expected to have a displacement of around 20,000 tons with a length of 690 feet and a beam of around 130 feet, making them one of the largest and heaviest ship that the JMSDF will operate. In comparison the Izumo class helicopter destroyers have a displacement 19,800 tons (27,000 tons with a full load) with a length of 800 feet and a beam of 124 feet while Japan's largest destroyers are the Maya class destroyers, which have a displacement of 8200 tons and a beam of 22.2 meters.

The ships are to have a crew of 110 personnel with personnel accommodations being enhanced to enable long deployments on station around Japan. The Ministry of Defense is likely pushing for the first ship to be commissioned in 2027, with the second in 2028, USNI News understands....

[Japan Defense Minister Yasukazu] Hamada said that the two destroyers would be large enough to enable operations that would be carried out in rough weather and enhanced crew quarters to allow the ships to conduct longer deployments. The Japanese defense chief also said that the ability to intercept hypersonic glide weapons would also be included in the ships' capabilities.

³⁰ 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.

³¹ Anthony Capaccio, "Japan in Talks With U.S. on Buying Aegis Missile Defense," *Bloomberg*, November 7, 2017.

³² See, for example, Rich Abbott, "Japan Suspends Aegis Ashore Due To Technical And Cost Concerns," *Defense Daily*, June 15, 2020; Sam LaGrone, "Japan Backing Away From Aegis Ashore," *USNI News*, June 15, 2020; Mari Yamaguchi, "Japan to Scrap Costly Land-Based US Missile Defense System," *Associated Press*, June 15, 2020; Mike Yeo, "Japan Suspends Aegis Ashore Deployment, Pointing to Cost and Technical Issues," *Defense News*, June 15, 2020; Brad Glosserman, "Canceling Aegis Ashore Raises Problems—and Hopes," *Japan Times*, June 17, 2020.

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

Hamada confirmed that the defense ministry was accelerating the acquisition process to get the two destroyers into service faster than usual.

“We believe it is an extremely important initiative to drastically strengthen our defense capabilities within five years,” he said.³³

A June 23, 2023, press report stated that once the two additional BMD-capable Aegis ships go into service for dedicated BMD operations, Japan’s other eight BMD-capable destroyers will revert to anti-air-warfare (AAW) operations.³⁴

Use of Aegis BMD Elements in Guam Missile Defense Architecture

After studying various possible BMD system architectures for Guam, DOD proposed a system combining elements of the Aegis BMD system with elements of Army BMD systems. 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....

³³ Dzirhan Mahadzir, “Japan to Build Two 20,000-ton Missile Defense Warships, Indian Carrier Commissions,” *USNI News*, September 6, 2022. See also Yoshihiro Inaba, “New Details On Japan’s Future BMD Vessels Revealed,” *Naval News*, September 12, 2022; Inder Singh Bisht, “Japan to Build Aegis-Equipped Ballistic Missile Defense Warships,” *Defense Post*, September 15, 2022; Sam LaGrone, “Japanese MoD Releases New Details on Ballistic Missile Defense Ships,” *USNI News*, December 27, 2022; Tyler Rogoway, “First Rendering Of Japan’s Ballistic Missile Defense Ship Concept Released,” *The Drive*, December 29, 2022; Yoshihiro Inaba, “Japan’s New ASEV Ships Will Boast An Impressive 128 VLS Cells,” *Naval News*, June 3, 2023.

³⁴ Ridzwan Rahmat, “Japan to Revert Aegis Destroyers for Air-Defence Roles Once BMD Ships Come Online,” *Janes Defence Weekly*, June 23, 2023.

“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 work and analysis over the last couple years ... by dispersing the systems and making sure everything’s networked.”³⁵

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.³⁶ For a summary of reported Aegis BMD flight tests since 2002, see **Table A-1** in the **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 As mentioned above, rather than building the two Aegis Ashore systems, Japan now plans to instead build two additional BMD-capable Aegis ships that are to be dedicated to BMD operations.³⁸ As also mentioned above, a June 23, 2023, press report stated that once the two additional BMD-capable Aegis ships go into service for dedicated BMD operations, Japan’s other eight BMD-capable destroyers will revert to anti-air-warfare (AAW) operations.³⁹ As also

³⁵ 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 Abbott, “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.

³⁶ 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>.

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.

³⁸ See, for example, Dzirhan Mahadzir, “Japan to Build Two 20,000-ton Missile Defense Warships, Indian Carrier Commissions,” *USNI News*, September 6, 2022; Yoshihiro Inaba, “New Details On Japan’s Future BMD Vessels Revealed,” *Naval News*, September 12, 2022; Inder Singh Bisht, “Japan to Build Aegis-Equipped Ballistic Missile Defense Warships,” *Defense Post*, September 15, 2022; Sam LaGrone, “Japanese MoD Releases New Details on Ballistic Missile Defense Ships,” *USNI News*, December 27, 2022; Tyler Rogoway, “First Rendering Of Japan’s Ballistic Missile Defense Ship Concept Released,” *The Drive*, December 29, 2022; Yoshihiro Inaba, “Japan’s New AEW Ships Will Boast An Impressive 128 VLS Cells,” *Naval News*, June 3, 2023.

³⁹ Ridzwan Rahmat, “Japan to Revert Aegis Destroyers for Air-Defence Roles Once BMD Ships Come Online,” *Janes Defence Weekly*, June 23, 2023.

mentioned above, 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**).⁴⁰

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."⁴¹

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."⁴²

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.

⁴⁰ 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.

⁴¹ Nikkei staff writers, "US Taps Japan Radar Tech to Double Missile Defense Range," *Nikkei Asian Review*, July 6, 2018.

⁴² Jeff Jeong, "South Korea to Buy Ship-Based Interceptors to Counter Ballistic Missile Threats," *Defense News*, October 12, 2018.

FY2024-FY2028 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 (FY2024) and projected (FY2025-FY2028) MDA procurement and research and development funding for Aegis BMD efforts under MDA's FY2024 budget submission.

Table 1. FY2024-FY2028 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)

	FY24 (req.)	FY25 (proj.)	FY26 (proj.)	FY27 (proj.)	FY28 (proj.)
Procurement					
Aegis BMD (line 33)	374.8	372.6	528.5	537.1	550.0
(SM-3 Block IB missile quantity)	(27)	(24)	(43)	(43)	(43)
Aegis BMD Advance Procurement (line 34)	0	0	0	0	0
SM-3 Block IIA (line 36)	432.8	507.7	464.1	457.9	467.1
(SM-3 Block IIA missile quantity)	(12)	(12)	(12)	(12)	(12)
Aegis Ashore Phase III (line 40)	2.4	1.0	0	0	0
Aegis BMD hardware and software (line 42)	27.8	44.9	28.4	35.5	31.8
SUBTOTAL Procurement	837.8	926.2	1,021.0	1,030.5	1,048.9
Research and development					
Aegis BMD (PE 0603892C) (line 83)	693.7	639.7	707.0	699.6	733.9
Aegis BMD Test (PE 0604878C) (line 114)	193.5	135.5	183.0	203.7	135.1
Land-based SM-3 (PE 0604880C) (line 116)	22.2	20.5	21.2	21.6	21.7
SUBTOTAL RDT&E	909.4	795.7	911.2	924.9	890.7
TOTAL	1,747.2	1,721.9	1,932.2	1,955.4	1,939.6

Source: Table prepared by CRS based on FY2024 MDA 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.

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.⁴³

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.⁴⁴

⁴³ 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).

⁴⁴ Department of Defense, *Missile Defense Review 2019*, 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.

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.”⁴⁵ 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 2019 flight test that featured a salvo launch of a pair of interceptors.”⁴⁶ 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 Redesignated 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.⁴⁷

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

⁴⁵ 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.

⁴⁶ Jason Sherman, “SM-3 Block IIA Intercepts ICBM Target, Validating Potential for Homeland Defense ‘Underlayer,’” *Inside Defense*, November 17, 2020.

⁴⁷ 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.

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.

“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."⁴⁸

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.⁴⁹

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]⁵⁰ 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....

⁴⁸ 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.

⁴⁹ Anthony Capaccio, "U.S. Navy Ships Close to Getting Interceptors That Could Stop an ICBM," *Bloomberg*, June 22, 2021.

⁵⁰ 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.

The minimum requirement for 54 BMD ships is based on the Navy unique requirement as follows. It accepts risk in the sourcing of combatant commander (CCDR) requests for defense of land.

- 30 to meet CVN escort demand for rotational deployment of the carrier strike groups
- 11 INCONUS for independent BMD deployment demand
- 9 in forward deployed naval forces (FDFN) Japan to meet operational timelines in USINDOPACOM
- 4 in FDFN Europe for rotational deployment in EUCOM.⁵¹

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,

⁵¹ 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.

an environment described in the Navy's comprehensive review into the two collisions that claimed the lives of 17 sailors in the disastrous summer of 2017.

Richardson said that as potential enemies double down on anti-access technologies designed to keep the U.S. Navy at bay, the Navy needed to focus on missile defense for its own assets.

"We're going to need missile defense at sea as we kind of fight our way now into the battle spaces we need to get into," he said. "And so restoring dynamic maneuver has something to do with missile defense."⁵²

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."...

⁵² 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.

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

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

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

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

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

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

In response to the threat and Defense Secretary Jim Mattis’ desire to use the force more dynamically, the Navy is looking at its options, the official said. “This includes taking a look at how we employ BMD ships through the lens of great power competition to compete, deter and win against those who threaten us.”⁵³

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

⁵³ David B. Larer, “As Threats Mount, US Navy Grapples with Costly Ballistic Missile Defense Mission,” *Defense News*, June 23, 2018.

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.”⁵⁴

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.

⁵⁴ Paul McLeary, “The Navy Has Had Enough of Missile Defense And Sees Its Chance,” *Breaking Defense*, January 28, 2019.

“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.⁵⁵

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.⁵⁶

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.⁵⁷

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

⁵⁵ Peter J. Brown, “Japan, US Silent over Ending Ballistic Missile Patrols,” *Asia Times*, December 12, 2018.

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

⁵⁷ Mallory Shelbourne, “DOD to Determine Funding Breakdown for Aegis Ashore Repurposing,” *Inside the Navy*, January 25, 2019.

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.⁵⁸

Program Deliveries, Testing, and Technical Risk

Another potential oversight issue for Congress concerns deliveries, testing, and technical risk in the Aegis BMD program.

May 2023 GAO Report

A May 2023 GAO report on U.S. BMD systems, including the Aegis BMD system, stated the following:

DELIVERIES

MDA did not meet its fiscal year 2022 goal for SM-3 Block IB interceptors as five planned interceptors were delivered after the fiscal year ended. MDA, however, delivered nine backlogged interceptors that were previously delayed due to a flight test failure. The Aegis program temporarily halted deliveries to investigate the failure, but missile production did not stop and deliveries subsequently resumed.

MDA also did not meet its goal for SM-3 Block IIA interceptors. Three interceptors planned for fiscal year 2022 were not delivered. MDA was able to deliver six backlogged interceptors that we previously reported were delayed due to missile assembly issues. The Aegis program addressed the issues, which allowed them to resume deliveries.

As reported by the agency, in August 2022, the Director, MDA approved an acquisition strategy to align SM-3 Block IB and Block IIA production under one contract. This production alignment is expected to maximize efficiencies in program management and obsolescence monitoring, among other synergies. According to MDA officials, they have not identified any disadvantages with this strategy. This acquisition strategy is currently under review by the Under Secretary of Defense for Acquisition and Sustainment to support a production decision for SM-3 Block IIA.

TESTING

Aegis BMD conducted four flight tests in fiscal year 2022, including a successful intercept test event that demonstrated its interoperability with Japanese and Korean systems. The last test—Flight Test Experiment Aegis Weapon System-01—gathered data while an SM-3 Block IIA interceptor engaged a modified medium range ballistic missile target in a non-intercept test.

Aegis BMD conducted two planned ground tests. Ground Test Integrated (GTI)-09 Sprint 1 provided data to support decisions related to system capabilities affecting United States European Command and United States Central Command. GTI-ISR 21 assessed the system's interoperability with Israeli missile defense systems. Aegis BMD also participated in GTI-08a—a delayed test originally planned for fiscal year 2020—which provided data to support system capabilities decisions for Aegis and other missile defense system elements.

A planned Aegis BMD operational cyber test was delayed to fiscal year 2024 due to MDA's changes to its test plan that affected planned ground and cyber tests.

OTHER PROGRAM INFORMATION

Aegis Ashore

⁵⁸ See CRS Report R44175, *Navy Shipboard Lasers: Background and Issues for Congress*, by Ronald O'Rourke.

We reported in June 2022 that delivery of the Aegis Ashore system to Poland was originally planned for fiscal year 2018, but that construction challenges delayed delivery.¹ Total projected costs increased by 12 percent, including additional costs for retaining engineering and security services during the delays. The site remains under construction, but MDA officials stated there are no known technical risks. In addition, the Aegis Ashore program recently met key milestones. Specifically, Aegis Light Off occurred in June 2022, which signifies the initial powering up of the weapon system to observe if all integrated systems are operational. The program completed physical installation of the system and demonstrated it in October 2022. MDA expects to declare the site safe and technically capable in early 2023 and Navy acceptance is anticipated for later in the year.

Safe Service Life Extension

The Aegis program has been able to extend the safe service life of SM-3 Block IA and Block IB interceptors to ensure the interceptors can be used with no additional safety risk. Under this effort, the safe service life of Block IA interceptors increased from 12 to 18 years and Block IB interceptors increased from 8 to 12 years. The safe service life of Block IIA interceptors is currently 12 years and MDA is assessing the possibility to increase this to 16, or possibly up to 20, years. MDA officials described the process to extend an interceptor's safe service life, which includes testing and analysis of aged missile components to determine their suitability for extended service. The testing and analysis is conducted by industry and government stakeholders and subject matter experts at various locations and laboratories. MDA officials said safe service life extensions have helped address the challenge of meeting the Navy's interceptor inventory requirements, which typically entail high volume procurements and consistent repair and recertification throughput.

Software Development

MDA officials stated the Navy started implementing a multi-stage Development, Security, and Operations strategy to deliver software upgrades to Aegis platforms. The Navy started using a software factory—an automated process to develop software—in fiscal year 2021 and now plans to eliminate their legacy system for developing and delivering coded software capability in fiscal year 2024.² According to MDA officials, by fiscal year 2030 the Navy intends for this approach to be the sole means for developing and delivering coded software capability to all Aegis platforms. MDA officials explained this strategy provides the opportunity to significantly increase the speed of software deliveries to the fleet, as well as reduce costs and cybersecurity risk by integrating security functions in the development process. They stated, however, there is risk since it is a significant transition from current development strategies. They said the transition would require extensive retraining and hiring of government personnel to fully execute the strategy, as well as additional costs to develop the new required tools, such as software, models, and infrastructure.⁵⁹

Regarding the development of a capability for the SM-6 to intercept hypersonic missiles, the GAO report stated:

MDA has two main efforts under development to defend against hypersonic weapons:

- Glide Phase Intercept (GPI) is a program that includes a missile being designed to be fired from Aegis-equipped ships to intercept a hypersonic weapon in the middle (or “glide”) phase of its flight path.
- Hypersonic and Ballistic Tracking Space Sensor (HBTSS) is an effort to develop space-based sensors to track and support the intercept of a hypersonic weapon....

GPI is expected to work with existing and future systems to provide hypersonic defense. After a missile launch, SDA's wide field of view satellites, capable of viewing large

⁵⁹ Government Accountability Office, *Missile Defense[:] Annual Goals Unmet for Deliveries and Testing*, GAO-23-106011, May 2023, pp. 22-23.

portions of the globe, detect the threat launch and send sensor measurement data to BOA, which generates track data with accuracy sufficient to cue HBTSS. HBTSS then acquires the deployed Hypersonic Glide Vehicle (HGV) and collects precision angle measurements. These measurements are processed by HBTSS, BOA, and Command, Control, Battle Management, and Communications (C2BMC) to provide fire control quality tracks on the HGV to Aegis for support of an engagement using GPI....

GPI STATUS AND CHALLENGES

Events and Milestones

By the early 2030s, the GPI program plans to deliver a prototype capability for testing, demonstration data to inform further development, and 10 interceptors to be used for testing. The program established a plan to acquire the capability and identified key events and milestones for tracking development. The plan includes competitive development of the GPI missile leveraging multiple contractors to begin the effort, but only one contractor is anticipated to be selected to complete delivery of the prototype capability. In fiscal year 2022, MDA reported that three contractors were awarded Other Transaction Agreements to initiate work on the GPI program.⁶¹ Later, in the fiscal year the program reported selecting two contractors to continue the development of GPI into the next phase of the acquisition process, technology development. In fiscal year 2023, the program expects to focus efforts on technology maturity and applying top level requirements to component level designs in preparation for the Preliminary Design Review....

The Preliminary Design Review is currently planned by the end of fiscal year 2027. The GPI program also anticipates down-selecting from two to one contractor near this date to continue until completing delivery of the prototype capability....

Challenges

Previously we found in June 2022 that MDA had not planned to conduct an Independent Cost Estimate (ICE) or Independent Technical Risk Assessment (ITRA) for the GPI program before the product development phase, which is after the technology development phase. These assessments are required for certain elements by DOD Directive-Type Memorandum 20-002 to mitigate risk. Since our reporting, MDA officials stated the Office of Cost Assessment and Program Evaluation (CAPE) completed a preliminary ICE for the GPI program in the August 2022 timeframe. As of February 2023, CAPE is working to finalize the ICE pending the final President's Budget program schedule. MDA officials also stated the Office of the Under Secretary of Defense for Research and Engineering completed an ITRA for the GPI program in the August 2022 timeframe as well. According to MDA, the ITRA found that the program should address technical risks earlier in the development schedule by building and testing hardware. The ITRA also recommended earlier testing. We plan to review the ICE and ITRA to assess whether MDA has acquired knowledge to manage risk for the GPI program.⁶⁰

January 2023 DOT&E Report⁶¹

A January 2023 report from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2022—states the following regarding the Aegis BMD system:

Aegis BMD has demonstrated that it can intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase of flight with Standard Missile-3 (SM-3) guided missiles, although flight testing and M&S have not addressed all expected threat types, ground ranges, and raid sizes. Aegis BMD has also demonstrated a

⁶⁰ Government Accountability Office, *Missile Defense[:] Annual Goals Unmet for Deliveries and Testing*, GAO-23-106011, May 2023, pp. 34-35.

⁶¹ *Director, Operational Test & Evaluation*, January 2023, 396 pp.

capability to intercept select ballistic missiles in the terminal phase of flight with SM-6 guided missiles. However, corrective actions are needed to address failure review board findings from the two Sea-Based Terminal Increment 2 flight tests in FY21. All fielded Aegis BMD variants have demonstrated sufficient reliability, with operational availabilities that exceed the specification. However, SM-3 Block IIA missile reliability is not known with a high degree of certainty, due to the relatively small number of live firings and ground test data collection events to date. The MDA is implementing a process to monitor the health and status of deployed SM-3 Block IIA missiles, which will provide additional reliability data for future assessments....

... In FY22, Aegis BMD, with AN/SPY-1, demonstrated the capability to detect, track, and report on resident space objects based on SDA tasking received by C2BMC [Command and Control, Battle Management, and Communications] during an at-sea demonstration. The AN/SPY-6(V)1 radar prototype at the Pacific Missile Range Facility continues to track all classes of ballistic missiles, as available, during MDS flight tests.⁶²

Legislative Activity for FY2024

Summary of Action on FY2024 MDA Funding Request

Table 2 summarizes congressional action on the FY2024 request for MDA procurement and research and development funding for the Aegis BMD program.

Table 2. Summary of Congressional Action on FY2024 MDA Funding Request

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

	Request	Authorization			Appropriation		
		HASC	SASC	Final	HAC	SAC	Final
Procurement							
Aegis BMD (line 33)	374.8	419.8	374.8		374.8	374.8	
(SM-3 Block IB missile quantity)	(27)	(27)	(27)		(27)	(27)	
Aegis BMD Advance Procurement (line 34)	0	0	0		0	0	
SM-3 Block IIA (line 36)	432.8	432.8	432.8		432.8	432.8	
(SM-3 Block IIA missile quantity)	(12)	(12)	(12)		(12)	(12)	
Aegis Ashore Phase III (line 40)	2.4	2.4	2.4		2.4	2.4	
Aegis BMD hardware and software (line 42)	27.8	27.8	27.8		27.8	27.8	
Subtotal Procurement	837.8	882.8	837.8		837.8	837.8	
Research, development, test, and evaluation (RDT&E)							
Aegis BMD (PE 0603892C) (line 83)	693.7	709.7	693.7		698.9	693.7	
Aegis BMD test (PE 0604878C) (line 114)	193.5	193.5	193.5		188.4	184.3	
Land-based SM-3 (PE 0604880C) (line 116)	22.2	22.2	22.2		22.2	22.2	
Subtotal RDT&E	909.4	925.4	909.4		909.5	900.2	
TOTAL	1,747.2	1,808.2	1,747.2		1,747.3	1,738.0	

⁶² Director, Operational Test & Evaluation, January 2023, pp. 307-308.

Source: Table prepared by CRS based on DOD's original FY2024 budget submission, committee and conference reports, and explanatory statements on FY2024 National Defense Authorization Act and FY2024 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.

FY2024 National Defense Authorization Act (H.R. 2670/S. 2226)

House

The House Armed Services Committee, in its report (H.Rept. 118-125 of June 30, 2023) on H.R. 2670, recommended the funding levels shown in the HASC column of **Table 2**.

The recommended increase of \$45.0 million for line 33 is for “MDA UPL [Unfunded Priorities list]—SM-3 Blk 1B Life Extension.” (Page 467)

The recommended net increase of \$16.0 million for line 83 includes a recommended increase of \$20.0 million for “PAC-3 [Patriot Advanced Capability 3] MSE [Missile Segment Enhancement]/AEGIS Weapon System Integration” and a recommended reduction of \$4.0 million for “Program decrease.” (Page 511)

Section 1667 of H.R. 2670 requires MDA to submit a report to the congressional defense committees on potential enhancements to Aegis Ashore sites in Poland and Romania.

Senate

The Senate Armed Services Committee, in its report (S.Rept. 118-58 of July 12, 2023) on S. 2226, recommended the funding levels shown in the SASC column of **Table 2**.

FY2024 DOD Appropriations Act (H.R. 4365/S. 2587)

House

The House Appropriations Committee, in its report (H.Rept. 118-121 of June 27, 2023) on H.R. 4365, recommended the funding levels shown in the HAC column of **Table 2**.

The recommended net increase of \$5.144 million for line 83 includes a recommended reduction of \$4.856 million for “Excess growth” and a recommended increase of \$10.0 million for “Program increase—lightweight, radiation-hardened, thermally insensitive sensors.” (Page 243)

The recommended reduction of \$5.049 million for line 114 is for “Excess growth.” (Page 244)

Senate

The Senate Appropriations Committee, in its report (S.Rept. 118-81 of July 27, 2023) on S. 2587, recommended the funding levels shown in the SAC column of **Table 2**.

The recommended reduction of \$9.231 million for line 114 is for “Prior year test adjustments.” (Page 252)

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?
Exo-atmospheric (using SM-3 missile)				
1/25/02	US	FM-2	Unitary short-range (TTV)	Yes
6/13/02	US	FM-3	Unitary short-range (TTV)	Yes
11/21/02	US	FM-4	Unitary short-range (TTV)	Yes
6/18/03	US	FM-5	Unitary short-range (TTV)	No
12/11/03	US	FM-6	Unitary short-range (TTV)	Yes
2/24/05	US	FTM 04-1 (FM-7)	Unitary short-range (TTV)	Yes
11/17/05	US	FTM 04-2 (FM-8)	Separating short-range (MRT)	Yes
6/22/06	US	FTM 10	Separating short-range (TTV)	Yes
12/7/06	US	FTM 11	Unitary short-range (TTV)	No
4/26/07	US	FTM 11 Event 4	Unitary short-range (ARAV-A)	Yes
6/22/07	US	FTM 12	Separating short-range (MRT)	Yes
8/31/07	US	FTM-11a	Classified	Yes
11/6/07	US	FTM 13	Unitary short-range (ARAV-A)	Yes
			Unitary short-range (ARAV-A)	Yes
12/17/07	Japan	JFTM-1	Separating short-range (MRT)	Yes
11/1/08	US	Pacific Blitz	Unitary short-range (ARAV-A)	Yes
			Unitary short-range (ARAV-A)	No
11/19/08	Japan	JFTM-2	Separating short-range (MRT)	No
7/30/09	US	FTM-17	Unitary short-range (ARAV-A)	Yes
10/27/09	Japan	JFTM-3	Separating short-range (MRT)	Yes
10/28/10	Japan	JFTM-4	Separating short-range (MRT)	Yes
4/14/11	US	FTM-15	Separating intermediate range (LV-2)	Yes
9/1/11	US	FTM-16 E2	Separating short-range (ARAV-B)	No
5/9/12	US	FTM-16 E2a	Unitary short-range (ARAV-A)	Yes
6/26/12	US	FTM-18	Separating short-range (MRT)	Yes
10/25/12	US	FTI-01	Separating short-range (ARAV-B)	No
2/12/13	US	FTM-20	Separating medium-range (MRBM-T3)	Yes
5/15/13	US	FTM-19	Separating short-range (ARAV-C)	Yes

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?
9/10/13	US	FTO-01	Separating medium-range (eMRBM-T1)	Yes
9/18/13	US	FTM-21	Separating short-range (ARAV-C++)	Yes
10/3/13	US	FTM-22	Separating medium-range (ARAV-TTO-E)	Yes
11/6/14	US	FTM-25	Separating short-range (ARAV-B)	Yes
6/25/15	US	FTO-02 E1	Separating medium-range (IRBM T1)	n/a ^a
10/4/15	US	FTO-02 E2	Separating medium-range (eMRBM)	n/a ^b
10/20/15	US	ASD-15 E2	Separating short-range (Terrier Orion)	Yes
11/1/15	US	FTO-02 E2a	Separating medium-range (eMRBM)	No
12/10/15	US (Aegis Ashore)	FTO02 E1a	Separating medium-range (IRBM T1)	Yes
2/3/17	US-Japan	SFTM-01	Separating medium-range (MRT)	Yes
6/21/17	US-Japan	SFTM-02	Medium-range target	No
10/15/17	US	FS17	Medium-range target	Yes
1/31/18	US (Aegis Ashore)	FTM-29	Intermediate-range target	No
9/11/18	Japan	JFTM-05	Simple separating target	Yes
10/26/18	US	FTM-45	Medium range target	Yes
12/10/18	US (Aegis Ashore)	FTI-03	Intermediate-range target	Yes
11/16/20	US	FTM-44	ICBM target	Yes
5/26 and 30/2021	US-Netherlands	ASD/FS21 ^c	Non-separating MRBM target	Yes ^c
4/9/22 ^f	US	FEM-01	Medium range target	Outcome not reported
8/9/22	US	Part of Pacific Dragon exercise	ARAV-B SRBM target	Yes
11/16/22 ^e	US-Japan	JFTM-07	Medium-range T4-E target	Yes
11/18 or 19/22 ^e	US-Japan	JFTM-07	Short-range target	Yes
Endo-atmospheric (using SM-2 missile Block IV missile and [for MMW E1 and subsequent] SM-6 Dual I missile)				
5/24/06	US	Pacific Phoenix	Unitary short-range target (Lance)	Yes
6/5/08	US	FTM-14	Unitary short-range target (FMA)	Yes
3/26/09	US	Stellar Daggers	Unitary short-range target (Lance)	Yes
7/28/15	US	MMW E1	Unitary short-range target (Lance)	Yes
7/29/15	US	MMW E2	Unitary short-range target (Lance)	Yes
12/14/16	US	FTM-27	Unitary short-range target (Lance)	Yes
8/29/17	US	FTM-27 E2	Medium-range target (MRBM)	Yes
5/29/21	US	FTM-31	Medium-range target (MRBM)	No

Date	Country	Name of flight test of exercise	Ballistic Missile Target	Successful?
7/24/21	US	FTM-33	Two SRBM targets	Yes and unconfirmed ^d
3/30/23	US	FTM-31 E1a	Medium-Range target (MRBM)	Yes (2-missile salvo)

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. Press 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.)
- e. A November 21, 2022, MDA new released stated: “The Japan Maritime Self-Defense Force (JMSDF) and the United States Missile Defense Agency (MDA) announce the successful completion of a two-week missile defense event incorporating two live fire exercises.” (Missile Defense Agency, “Japan Missile Defense Flight Test Successful,” 22-NEWS-0009, November 21, 2022.) Press reports stated that two intercept events occurred on November 16 and November 18 or 19. (Dzirhan Mahadzir, “Two Japanese Destroyers Score in Ballistic Missile Defense Test off Hawaii,” *USNI News*, November 21, 2022; Rich Abott, “Japanese Destroyers First Successfully Test SM-3 In Ballistic Missile Defense Test,” *Defense Daily*, November 22, 2022.)
- f. For a press report about the SM-3 flight test of April 9, 2022, see Jason Sherman, “MDA Acknowledges Clandestine SM-3 Block IIA Experiment of Classified Capability,” *Inside Defense*, January 26, 2023.

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