Source: Missile Defense Agency. | GAO-21-314

[1]We did not assess the Aegis BMD SM-3 Block IA because it has been in production since 2005 and it is currently operational for regional defense of Europe, as well as other regions. ►

PROGRAM OVERVIEW

Aegis Ballistic Missile Defense (Aegis BMD)

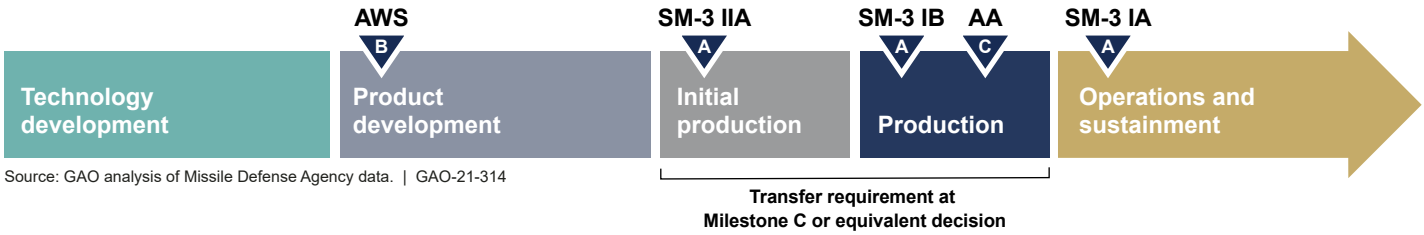
Aegis BMD includes ship- and land-based missile defense capabilities as follows:

A. Standard Missile-3 interceptors (SM-3)—IA , IB, and IIA—are designed to defend against short-, medium-, and intermediate-range enemy missiles.[1]

B. Aegis Weapon System (AWS) consists of software spirals jointly developed by MDA and the Navy to provide integrated and improved capabilities over time.

C. Aegis Ashore (AA) is a land-based version with three sites: Hawaii, Poland, and Romania.

MDA and the Navy have a transfer plan for some portions of Aegis BMD. Most portions of Aegis BMD are in production or beyond, but have not transferred to the Navy in line with an existing legislative requirement. Rather, MDA is seeking relief from this requirement to retain Aegis BMD.



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

DELIVERIES

The Aegis BMD program delivered all 35 planned SM-3 Block IB interceptors for fiscal year 2020. However, the program only delivered 5 of 11 planned SM-3 Block IIA interceptors due to the need to investigate and remediate an anomaly with the interceptor's thruster detected during flight test FTI-03. The first two SM-3 Block IIA interceptors that the program delivered for the year—a primary and spare—were necessary to complete the flight test FTM-44. MDA also successfully delivered the Aegis BMD 4.1.2 software spiral to the Navy in fiscal year 2020, consistent with its planned baseline.

Aegis BMD Fiscal Year 2020 Deliveries

	Planned	Status
SM-3 IB	35 interceptors	35 interceptors delivered
SM-3 IIA	11 interceptors	5 interceptors delivered
AWS	1 software delivery	1 software delivery
AA	Poland site construction complete	Delayed to fiscal year 2022 at the earliest

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- Among the Aegis BMD programs, COVID-19 impacts have largely been limited to test delays. SM-3 Block IB and IIA program officials reported no direct impact to their production schedules, although in the case of the SM-3 Block IIA there have been impacts on certain suppliers. AWS program officials reported that some ship-board software upgrades would be delayed due to travel restrictions and isolation requirements.
- MDA officials stated that neither the U.S. nor Polish governments imposed any COVID-19 restrictions that would have limited construction activities at the Aegis Ashore site in Poland.

FISCAL YEAR 2020 TESTING OVERVIEW

Aegis BMD Fiscal Year 2020 Testing

Test	Conducted	Delayed	Deleted
Flight		◈ ◈ ◈ ◈ ◈	◈
Ground	■ ■ ■	■ ■	
Cybersecurity		● ● ● ● ● ● ●	

◆ Non-intercept flight test ◈ Intercept flight test

■ Ground test ● Operational cybersecurity test

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

In fiscal year 2020, the Aegis BMD program did not conduct any of the six planned flight tests, deleting one and delaying the remaining five. Most notably, a major operational flight test—FTO-03—was deleted, leaving the SM-3 Block IIA interceptor to enter initial production with a single operational flight test. Some flight tests were initially delayed due to range availability and higher priority flights tests (such as FEX-01) and delays were then exacerbated by pandemic-driven travel restrictions. A congressionally mandated flight test—FTM-44—pitting an SM-3 Block IIA interceptor against a simple ICBM, was delayed, but executed in November 2020.

The Aegis BMD program participated in three of five planned ground tests in fiscal year 2020. The two ground tests were delayed due to the pandemic and the unavailability of the Poland Aegis Ashore site, respectively.

All seven cybersecurity tests scheduled for fiscal year 2020 were consolidated into a single test, which was subsequently delayed.

OTHER PROGRAM INFORMATION

Efforts to Include the SM-3 Block IIA in a Homeland Defense Role Introduce New Risk

MDA's effort to include the SM-3 Block IIA interceptor in a new "layered" homeland defense against intercontinental ballistic missile (ICBM) threats targeting the U.S. could introduce considerable cost, schedule, and performance uncertainty to a program that has just entered initial production. The GMD weapon system currently provides defense against ICBMs, but this new effort would add the SM-3 Block IIA and THAAD weapon system as layers underneath that provided by GMD. For further details on the GMD and THAAD weapon systems see their respective appendixes.

ICBM intercepts are more challenging than the IRBM intercepts for which the SM-3 IIA was originally designed. MDA's most recent attempt to create a system for intercepting ICBMs, known as the Redesigned Kill Vehicle (RKV), re-used some parts from the SM-3 Block IIA. DOD cancelled the RKV before it could complete development after significant cost and schedule overruns and questions about the ability of the design to overcome specific performance risks. Parts re-used from the SM-3 Block IIA were implicated in some of the RKV's performance shortfalls. Even so, planning for an anti-ICBM capability for the SM-3 Block IIA continued during and even after the RKV's termination.

Achieving such a capability will require surmounting several challenges. According to MDA, during the November 2020 flight test named FTM-44, the SM-3 Block IIA struck a simple ICBM target. This was not an operational test, however, and it was executed under highly favorable conditions. More development work is needed for the SM-3 Block IIA to support a layered homeland defense capability. MDA documents show that the agency now plans to develop and procure an upgraded version of the SM-3 Block IIA for the specific purpose of fulfilling the homeland defense mission.

Delays at the Aegis Ashore Site in Poland Continue

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

MDA currently attributes $79 million in cost increases to these delays.

MDA Awarded a Multiyear Procurement Contract for the SM-3 Block IB

The SM-3 Block IB received full production authorization in fiscal year 2018. MDA planned to award both a sustainment contract to provide ongoing support as well as a multi-year procurement contract shortly afterward (previous contracts had been largely annual), in fiscal year 2019. MDA awarded neither contract in fiscal year 2019. While MDA requested and Congress provided multi-year procurement authority, officials said the program did not receive the funding to award a contract in fiscal year 2019.

MDA expected to be able to award the contract in the third quarter of fiscal year 2019, but did not do so until March 2020. MDA stated that production was not affected by this delay.

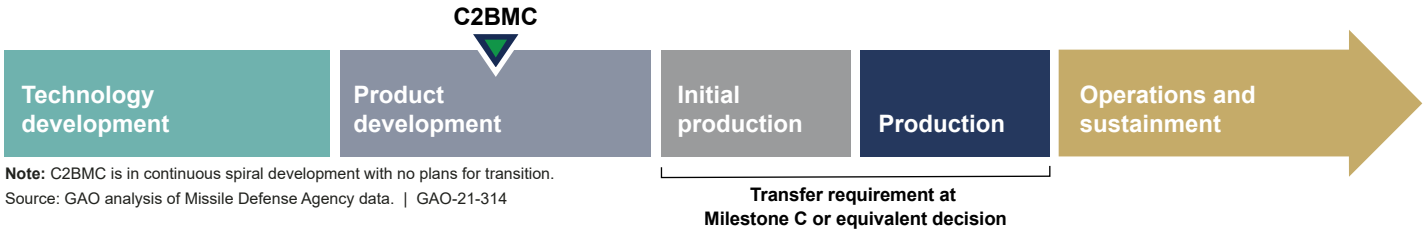
Source: Missile Defense Agency. | GAO-21-314

PROGRAM OVERVIEW

Command, Control, Battle Management, And Communications (C2BMC)

C2BMC, a global system of hardware—workstations, servers, and network equipment—and software, is the integrating element of the Missile Defense System (MDS). As the integrator, C2BMC allows users to plan operations, see the battle develop, and manage certain MDS sensors across regional and global networks. Moreover, C2BMC enables defense of an area larger than those covered by the individual MDS elements and against more missiles simultaneously, thereby conserving interceptor inventory. MDA is developing C2BMC in spirals, or software and hardware upgrades, that build upon prior capabilities. Spiral 8.2-3, fielded in fiscal year 2019, is currently in use while spiral 8.2-5 is in development.[1] Spiral 8.2-7 is in early development and has yet to be baselined.

[1]C2BMC spiral deliveries are associated with BMDS Overhead Persistent Infrared Architecture (BOA) upgrades—a system within the C2BMC enterprise. Spiral 8.2-3 is utilizing BOA 6.1 while Spirals 8.2-5 with BOA 7.0 and 8.2-7 with BOA 7.1 are currently in development.



Note: C2BMC is in continuous spiral development with no plans for transition.
Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

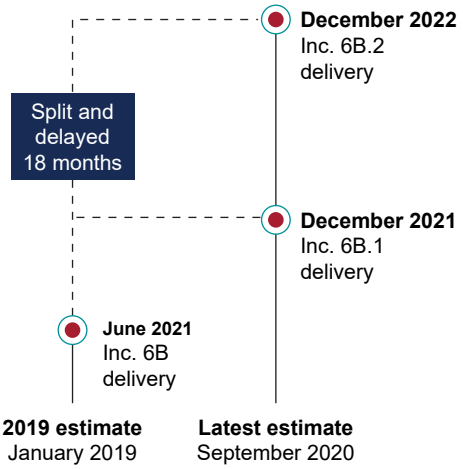
DELIVERIES

While no C2BMC spiral deliveries were planned or delivered in fiscal year 2020, the program delivered post-fielding updates for Spiral 8.2-3. In addition, in October 2019, C2BMC demonstrated initial hardware interoperability with THAAD and NATO command and control systems during NATO Ensemble Test 19, a simulated multinational test.

Spiral 8.2-5 is being developed to provide various capabilities in support of Homeland Defense, including control of the Long Range Discrimination Radar (LRDR) and hypersonic threat tracking reporting. This spiral will be delivered in two sets to synchronize with the replan of related MDS capability and to offset COVID-19 impacts.[2] Fielding of C2BMC functionality in support of Increment 6B.1 is planned for December 2021 while fielding of functionality corresponding to Increment 6B.2 is set for December 2022, a delay of approximately 18 months from the original delivery estimate. Among this spiral's fiscal year 2020 accomplishments are installation of Spiral 8.2-5 hardware and software at Cheyenne Mountain and Clear Air Force stations completed between March and August 2020.

[2]MDS level integrated capabilities are organized by increments. MDA has delivered Increment 1-5. Increment 6B, currently in development, was replanned and split into Increment 6B.1 and Increment 6B.2 in 2019. Both Increment 6B.1 and 6B.2 capabilities center on the use of long range discrimination radar in support of Homeland Defense.

Delayed Delivery of C2BMC Spiral 8.2-5



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- Spiral 8.2-5's development is behind schedule due to COVID-19 workforce restrictions in Colorado and Alabama that affected MDA testing.
- Spiral 8.2-7's development has been delayed due to government staffing and classified environment restrictions. As a result, the content presented during the August 2020 Spiral 8.2-7 systems requirements review was less than planned and a supplemental review was required.
- Operational cyber updates and a number of sustainment projects on deployed Spiral 8.2-3 assets were delayed due to personnel availability and travel restrictions and are replanned for 2021.
- Severity and duration of C2BMC's COVID-19 cost and schedule related impacts are yet to be assessed.

FISCAL YEAR 2020 TESTING OVERVIEW

C2BMC Fiscal Year 2020 Testing

Test	Conducted	Delayed	Deleted
Flight	△	▲ ○	▲
Ground[a]	▲ ▲ ▲	▲ △	
Cybersecurity		▲ ▲ △	

▲ S8.2-3 △ S8.2-5 ○ 8.2-7

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

[a]C2BMC supports multiple test types, but its capabilities are primarily assessed via ground tests.

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

In fiscal year 2020, C2BMC participated in four MDS test events, one of which utilized an experimental version of Spiral 8.2-5 and gathered critical data for development against advanced threats. However, C2BMC officials delayed the planned ground test campaign, GTI-08, the first integrated MDS level test of Spiral 8.2-5. The test delay was caused by the inability to perform element software testing as well as delayed hardware in the loop testing due to COVID impacts.[3] In order to mitigate the delay and address this spiral's technical risk—lack of select element models--MDA inserted an integration phase prior to the start of GTI-08 campaign. This risk reduction event, initiated in September 2020, will provide the necessary environment to verify software updates, address interoperability issues and observe more complex element level test cases. Its results will inform the final GTI-08 schedule along with all subsequent ground tests.

[3]Hardware in the loop testing is a type of interactive simulation that includes one or more actual system components operating in conjunction with simulated components.

OTHER PROGRAM INFORMATION

Cybersecurity

In fiscal year 2020, none of the three planned C2BMC's operational cybersecurity assessments were conducted, as MDA is restructuring its cyber test planning approach. Moving forward, cyber tests will be planned and documented via the same agency process used for flight and ground tests in order to streamline test planning and resource allocation. Lack of fiscal year 2020 operational cyber testing of Spiral 8.2-5 has delayed the cyber certification of its software development architecture—originally planned for fiscal year 2019—which added schedule risk to the program and may delay the operational fielding of the spiral.

During fiscal year 2020, C2BMC continued software development updates to meet Spiral 8.2-5 cybersecurity baseline requirements. In September 2020, BMDS OTA proposed that MDS elements conduct developmental cyber tests since no operational testing events were performed during the fiscal year. In late September 2020, C2BMC conducted the initial cooperative vulnerability identification test, a developmental event utilizing Spiral 8.2-5 in support of the GTI-08 risk reduction event discussed above.[4] The follow-on adversarial developmental test is scheduled for January 2021.

According to MDA, C2BMC's cyber challenges are rooted in the rapid pace of technological innovation and development of new capabilities. The program implemented an Agile software development process, discussed below, and is working toward a development capability named DevSecOps in order to mitigate these challenges. DevSecOps, an extension of Agile principles, is an iterative software development practice whose goal is a more rapid delivery of safer software. DevSecOps uses automation to increase collaboration between development, security and operations and focuses on frequent delivery of secure software to the warfighter. According to MDA, the continued pursuit of DevSecOps, estimated for implementation in fiscal year 2022, will allow for faster secure cyber changes without impacts to warfighter capability deliveries.

Software Development

Spiral 8.2-5 is the first C2BMC spiral to utilize the Agile development approach, designed to deliver more frequent and responsive capability drops and updates. According to MDA, this iterative development approach is designed to provide a shorter find-to-fix cycle and decrease the risk of defects by emphasizing continuous assessment of performance and real time feedback from the Warfighter on the adequacy of upgrades and fixes. Although designed to reduce risk, the transition to this approach has presented MDA with challenges. For example, the lack of synchronization between C2BMC and other elements' developmental versions along with agency wide operational schedules has contributed to delays in testing and capability verification events. According to the office of Director, Operational Test and Evaluation, MDA is mitigating these challenges by building schedules that account for these restrictions, and we will continue to assess whether the adjustments will be enough to offset the delays.

Program Risk

As noted above, Spiral 8.2-5's fiscal year 2020 technical risk centers around the lack of select MDA element models. As of September 2020, C2BMC is missing model representations of the latest developmental versions of GMD, AN/TPY-2, and BOA. A representation of BOA 7.0 model is undergoing integration for use in developmental testing, but the AN/TPY-2 model will not be available until 2021 and there are no plans for the receipt of the GMD model. According to the prime contractor, lack of adequate GMD capability testing during development may trigger 8.2-5 code rework late in the process resulting in negative cost and schedule impacts. The C2BMC program is employing mitigations, such as early integration events, inter-element testing, and the use of element model representations and recorded re-plays from prior test events in lieu of system models.

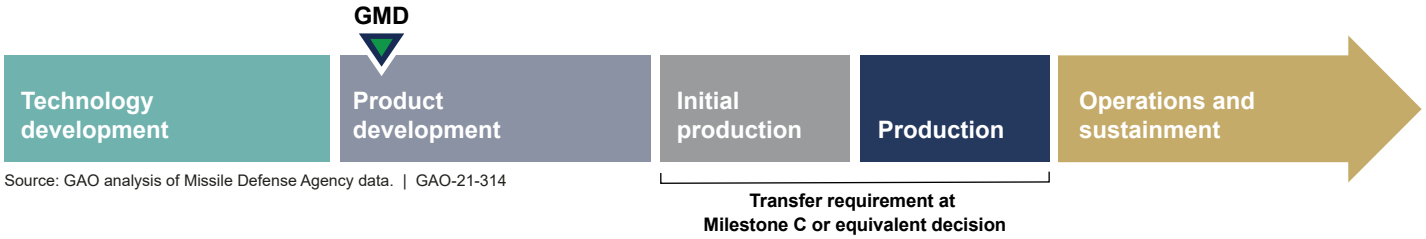
[4]Cybersecurity developmental testing consists of two assessments: Cooperative Vulnerability Identification (CVI) and an Adversarial Cybersecurity Developmental Test and Evaluation (ACD). CVI is used to collect data needed to identify vulnerabilities and plan mitigations. ACD event uses realistic threat scenarios in a representative operating cyber environment to identify vulnerabilities.

Source: Army Sgt. Jack W. Carlson III | GAO-21-314

PROGRAM OVERVIEW

Ground-Based Midcourse Defense (GMD)

The Missile Defense Agency (MDA) is developing the GMD system to defend the United States against a limited ballistic missile attack from rogue states such as North Korea and Iran. To counter such threats, GMD, in conjunction with a network of ground-, sea-, and space-based sensors and command and control systems, launches Ground-Based Interceptors (GBI) from missile fields based in Fort Greely, Alaska and Vandenberg Air Force Base, California. GBIs boost toward the predicted location of an incoming enemy missile and release kill vehicles to find and destroy the threat. Over the past two decades, MDA developed and fielded a fleet of 44 GBIs and a ground system consisting of fire-control consoles, interceptor launch facilities, and a communications network. MDA is developing a new GMD interceptor, called the Next Generation Interceptor (NGI) to defeat future missile threats. GMD is in the product development phase, although it has ongoing activities in all phases of the acquisition life cycle. MDA currently has no plans to transfer GMD to the U.S. Army.



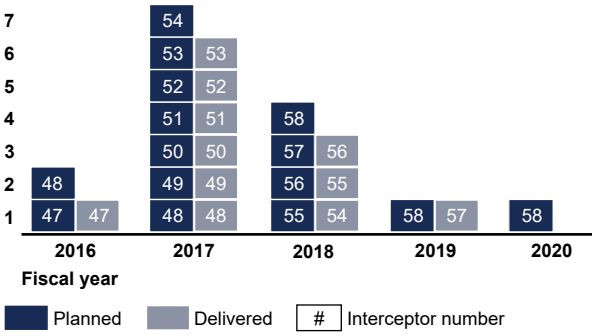
Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

DELIVERIES

MDA did not deliver the one GBI planned for fiscal year 2020. Production delays originate from an issue in 2018 where the boost vehicle contractor mishandled a key avionics component of the boost vehicle.[1] The contractor made progress in 2020 resolving production issues but also experienced further setbacks qualifying electronic parts from a new vendor. These electronic parts are necessary to build a new booster avionics module to replace the one that was mishandled. Once completed, the boost vehicle can be assembled and integrated with the kill vehicle. MDA has re-baselined its plans to deliver the GBI as part of a future increment of capability delivery. MDA now plans for the GBI to be delivered in the fourth quarter of fiscal year 2021, three years later than originally planned.

[1]For more information on the delays, see GAO, *Missile Defense: Delivery Delays Provide Opportunity for Increased Testing to Better Understand Capability*, GAO-19-387 (Washington, D.C.: June 6, 2019), 12; and *Missile Defense: Assessment of Testing Approach Needed as Delays and Changes Persist*, GAO-20-432 (Washington, D.C.: July 23, 2020), 13.

GMD Interceptor Deliveries, Fiscal Years 2016-2020



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- The GMD system maintained 24/7 operational availability throughout the COVID-19 pandemic in fiscal year 2020.
- MDA implemented a plan to reduce the impacts of COVID-19 on mission objectives, including allowing access to facilities and travel for essential work with guidelines to ensure safety of the workforce.
- The GMD program experienced delays on a number of development, sustainment, and construction activities as a direct result of the COVID-19 pandemic. Some activities were delayed by a month or less while others were delayed five to eight months.

FISCAL YEAR 2020 TESTING OVERVIEW

GMD Fiscal Year 2020 Testing

Test	Conducted	Delayed	Deleted
Flight		◆	
Ground	■	■	
Cybersecurity			

◆ Non-intercept flight test ◈ Intercept flight test

■ Ground test ● Operational cybersecurity test

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

Note: GM BVT-03 and GTI-08 (N/I) were not planned activities in the April 2019 Ballistic Missile Defense System (BMDS) Accountability Report (BAR) for GMD. The tests are associated with Increment 6b, which MDA had not yet baselined at the time the report was released. However, the tests were included in the February 2019 Integrated Master Test Plan version 20.1, which is the formal test plan for the BMDS. Moreover, according to MDA, the April 2019 BAR was aligned with IMTP version 20.1. As such, we included these tests in our review of GMD's planned fiscal year 2020 activities.

In fiscal year 2020, GMD did not conduct its one planned flight test, GMD Booster Vehicle Test (GM BVT)-03, because of challenges developing a 2-/3-stage selectable GBI functionality (see section below on GMD performance improvements for further details). The program intends to use a mock kill vehicle for GM BVT-03, which MDA has assessed will have minimal-to-no impact on the test and will allow a tactical kill vehicle to remain in the fielded fleet. According to MDA, the GMD program's technical direction agent agreed with this approach but noted that it was a missed opportunity to discover any unknown kill vehicle issues in the flight test environment.

Also in fiscal year 2020, GMD conducted Ground Test Integrated (GTI)-07c but did not conduct GTI-08 as planned. GTI-07c supported the fielding of a software upgrade for an older configuration of the GMD kill vehicle that remains in the fielded interceptor fleet. GTI-08 was split into two separate tests and delayed, in part, by complications of the COVID-19 pandemic.

OTHER PROGRAM INFORMATION

Next Generation Interceptor

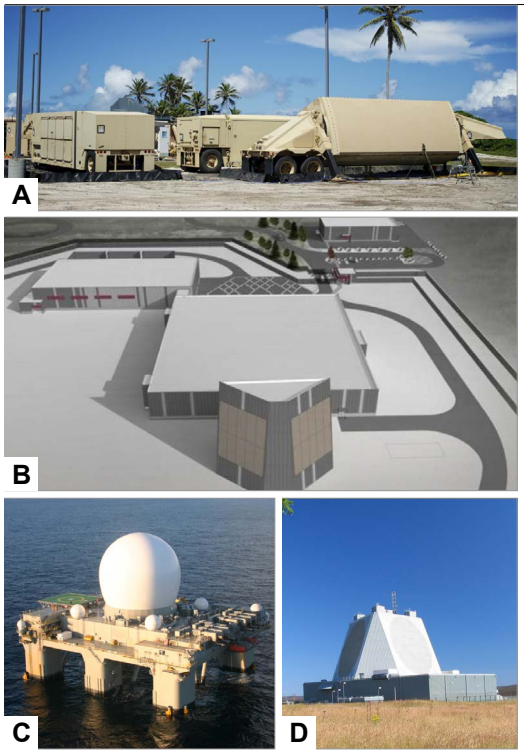
MDA plans to award contracts to two contractors in the second quarter of fiscal year 2021 to develop separate NGI solutions. According to MDA, the agency recommends carrying the two contractors through the critical design review phase of the program when the system's design is expected to be mature and stable. The GMD program then intends to continue with one contractor into flight testing and production. The program generally expects the NGI development competition will be completed in early fiscal year 2026. The program would then conduct qualification testing and two intercept flight tests in fiscal year 2027, which, if successful, would allow NGI production to start. The program plans for 21 tactical NGIs (1 of which is planned to be used for testing) to be delivered starting in the fourth quarter of fiscal year 2028 and completed by the end of fiscal year 2030. According to MDA, the actual development schedule will be established by the selected contractors following source selection. MDA's initial cost estimate for NGI is $11.3 billion. The estimate includes 8 development NGIs and 21 production NGIs intended to, in part, expand GMD's inventory.

GMD Performance Improvements

The GMD program is developing a capability to expand GMD's battlespace by enabling the GBI to fly out using two of the interceptor's three booster stages. The program refers to this as the 2-/3-stage selectable GBI functionality. According to the MDA Director, this functionality would provide the warfighter with more flexibility because it allows the option of burning all three of the booster stages to shoot further out or burning only two of the booster stages to shoot at incoming missiles as they continue to approach and fly overhead. The program plans to achieve the functionality through an update to the system's software. In 2019, the program realized that a known design limitation on the kill vehicle would create significant performance risk if the 2-stage flyout functionality were employed as initially envisioned. The program considered redesigning hardware on the kill vehicle and then retrofitting the fielded fleet with the redesign in order to achieve the 2-stage flyout functionality. However, MDA officials told us in January 2021 that the prime contractor's initial estimate for the effort was nearly $1 billion. MDA subsequently revisited the 2-stage performance requirements and instead decided to pursue a software-only solution that program officials stated would achieve roughly half of the battlespace expansion previously expected. According to MDA, this approach was a much simpler path that allows the program to achieve performance gains that effectively balances overall mission trades.

Homeland Defense Underlay

MDA is considering plans to augment GMD's defense of the U.S. homeland, in part, by utilizing the Aegis Weapon System and its Standard Missile (SM)-3 Block IIA interceptors and Terminal High Altitude Area Defense (see respective appendixes for additional information). According to MDA, these systems could be positioned and operated as a series of independent shooters to achieve an initial layered defense capability and updated later to become integrated. Currently, GMD's fire control and engagement planning does not take into account any other interceptor systems. Consequently, according to the GMD prime contractor, GMD's fire control software would have to be optimized to work with other interceptor systems. Moreover, managing an engagement between multiple interceptor systems would require more cohesive integration with overall battle planning by the command and control element of the Missile Defense System than currently exists today. Updating GMD's software to fight with other interceptor systems would likely be a complex endeavor for the program and require a robust development and testing program at a time when the program is focused on developing the NGI. Coordination with other interceptor systems would also be challenging because the GBI has hardware constraints that limit communication opportunities with ground systems while in flight. Although MDA's initial approach is based on GMD acting independent of other interceptor systems, the agency has not yet demonstrated whether and how the GMD system would perform in such a scenario and the implications on warfighter concepts of operation.



Source: Missile Defense Agency. | GAO-21-314

PROGRAM OVERVIEW

Sensors

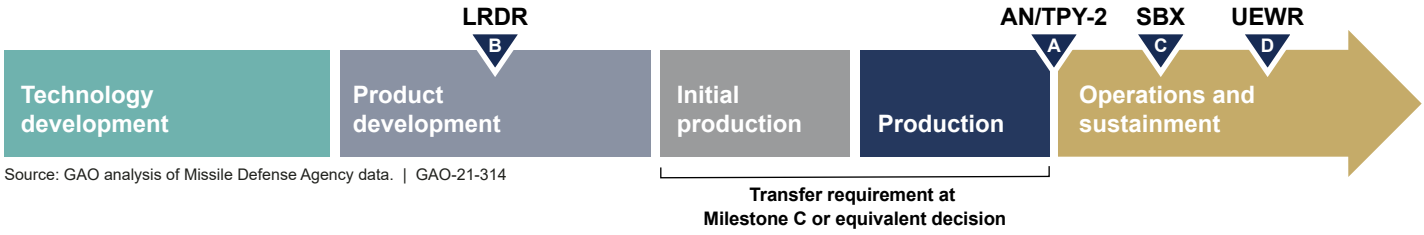
A. Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) is a transportable X-band, high-resolution radar capable of tracking ballistic missiles of all ranges.

B. Long Range Discrimination Radar (LRDR) will be an S-band radar in a fixed location to track incoming missiles and improve discrimination of the warhead-carrying vehicle from decoys and other non-lethal objects.

C. Sea Based X-Band (SBX) is a mobile radar aboard an ocean-going, semi-submersible platform that can be positioned to cover any region of the globe and is capable of tracking, discriminating, and assessing the flight of ballistic missiles.

D. Upgraded Early Warning Radar (UEWR) is a phased-array radar in five fixed locations to detect and track land- or sea-launched long-and intercontinental-range ballistic missiles. Locations include Beale, California; Fylingdales, United Kingdom; Thule, Greenland; Clear, Alaska; and Cape Cod, Massachusetts.

There are transfer plans with the Army and Navy, respectively, for AN/TPY-2 and SBX. There is currently no transfer plan with the Air Force for LRDR. UEWR transferred to the Air Force in 2013.



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

DELIVERIES

The Sensors program accomplished some of its planned goals in fiscal year 2020, including the delivery of two upgraded x86 electronic equipment units and the acceptance of SBX software XBR 4.0.1 to support improved discrimination. LRDR completed installation of four of ten primary array panels and all ten secondary array panels. UEWR upgrades at the Clear and Cape Cod sites completed operational acceptance-1 (OA-1), which, according to MDA, verifies that the temporarily installed system hardware and software work on site.

However, the remaining UEWR events planned for fiscal year 2020 were delayed until future fiscal years. According to MDA, OA-1 for Fylingdales and BMDS certification of Cape Cod are delayed until fiscal year 2021 due to COVID-19. Further, OA-1 for Thule is delayed until fiscal year 2021 due to COVID-19 and operational scheduling delays, and BMDS certification of Clear is delayed until fiscal year 2022 due to on-site construction delays, COVID-19, and operational scheduling delays.

Sensors Fiscal Year 2020 Delivery Plans

	Planned	Status
AN/TPY-2	2 upgraded x86 electronic equipment units	Completed
LRDR	Installation of primary and secondary array panels	Partially completed
SBX	XBR 4.0.1 software fielding	Completed
UEWR	Clear Operational Acceptance-1 (OA-1) and Cape Cod OA-1	Completed
	Fylingdales OA-1 and Thule OA-1	Delayed
	Clear and Cape Cod BMDS Certifications	Delayed

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- Evacuation of personnel from Clear Air Force Station affected the planned work for LRDR.
- Operational acceptance of upgrades at Fylingdales and Thule UEWR sites were delayed.
- BMDS certification of Clear and Cape Cod UEWR sites were delayed.

FISCAL YEAR 2020 TESTING OVERVIEW

Sensors Fiscal Year 2020 Testing

Test	Conducted	Delayed	Deleted
Flight	◆ ◈	◈ ◈ ◈	◈
Ground	■ ■ ■ ■	■ ■	
Cybersecurity		● ● ● ● ● ●	

◆ Non-intercept flight test ◈ Intercept flight test

■ Ground test ● Operational cybersecurity test

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

In fiscal year 2020, AN/TPY-2 participated in two flight tests—FTX-39 and FTP-27 E2. The objectives for both tests were to demonstrate interoperability between Terminal High Altitude Area Defense (THAAD) and Patriot in support of an urgent warfighter capability. In FTX-39, the range safety team terminated the Army-supplied short-range target after it drifted off course, preventing AN/TPY-2 in terminal mode from collecting data. In FTP-27 E2, AN/TPY-2 in terminal mode demonstrated the ability to detect, track, discriminate threat missiles and transmit the data to Patriot. For additional details on THAAD, see Appendix VI.

The Sensors program participated in three ground tests—GTI-20 Sprint 1, GTI-20 Sprint 2, and GTI-07c—demonstrating capabilities for the defense of the homeland, deployed U.S. forces, and regional allies. Additionally, MDA conducted a System Integration and Checkout (SICO) of a new AN/TPY-2 forward-based mode radar site in support of U.S. Central Command (CENTCOM) verifying operational communications.

MDA delayed all operational cybersecurity assessments planned for fiscal year 2020, which included three for AN/TPY-2, one for LRDR, and two for SBX. According to MDA, a new approach for cyber testing is being implemented, which they believe will improve cyber system requirements while streamlining cyber test planning, resource allocation, and results analysis.

OTHER PROGRAM INFORMATION

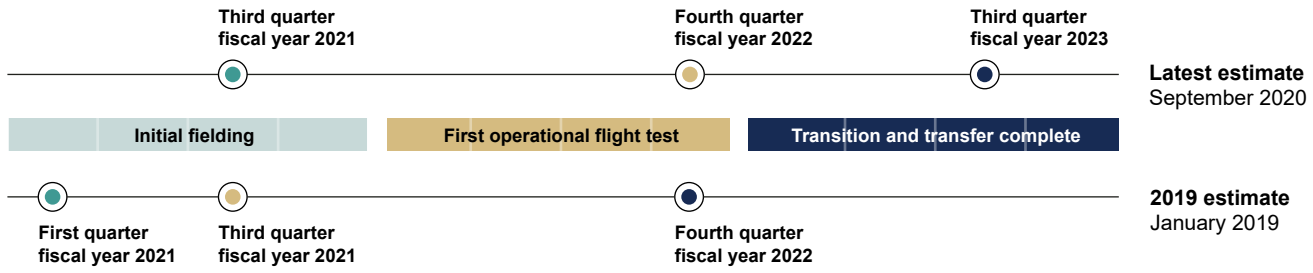
Early LRDR Progress Derailed by COVID-19 Shutdown, Delaying Key Upcoming Dates

LRDR made progress during fiscal year 2020, as the prime contractor completed installation of four of ten primary array panels and all ten secondary array panels. Integration of radar electronics, cooling, communications, and power equipment also began, but was not finished as planned. As we reported in July 2020, LRDR program officials were monitoring risks during fiscal year 2019 that could threaten the transfer of LRDR to the government. These risks included manufacturing of the array panels, subarray assembly suite modules, and auxiliary power group cabinets. During fiscal year 2020, production of the subarray assembly suites and auxiliary power group cabinets were completed; however, the contractor experienced positive COVID-19 cases on its array panel production line, delaying completion from August 2020 to October 2020 due to shift quarantines. According to the contractor, installation of the remaining primary array panels were subsequently completed during the first quarter of fiscal year 2021.

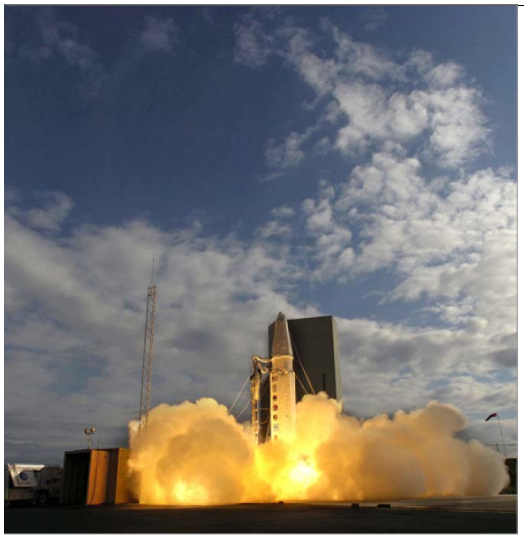
The onset of COVID-19 paused work in March 2020 and LRDR personnel were evacuated from Clear Air Force Station. According to MDA, revisions to State of Alaska travel restrictions in June 2020 led to remobilization of personnel, which completed in August 2020. This pause derailed progress during the second half of the fiscal year for LRDR and, according to agency officials, negotiations with the contractor are ongoing to address additional costs. According to the contractor, the increase included the costs to maintain critical staff on site to monitor the radar and equipment during the evacuation period, as well as production impacts, redeployment, and the performance impacts to the overall contract.

Initial fielding, the first operational flight test, and completion of the transition and transfer process to the U.S. Air Force have all been delayed, in part due to the COVID-19 disruptions. See figure below.

Long Range Discrimination Radar Delays



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314



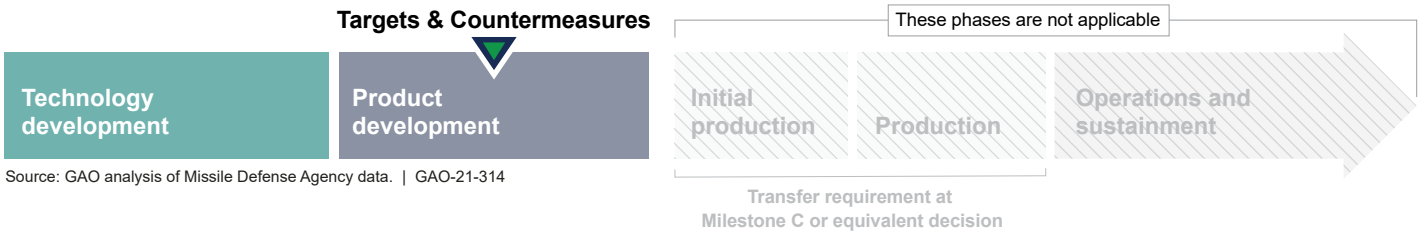
Source: Missile Defense Agency. | GAO-21-314

PROGRAM OVERVIEW

Targets and Countermeasures

The Targets and Countermeasures program (hereafter referred to as the Targets program) supplies short-, medium-, intermediate-, intercontinental-range missiles to represent enemy threat missiles during the developmental and operational testing of missile defense weapon systems. The target ranges in kilometers are: short (less than 1,000), medium (1,000-3,000), intermediate (3,000-5,500), and intercontinental (greater than 5,500). The quantity of targets each fiscal year is based on the requirements set forth in MDA's flight test schedule and the quality and availability of the targets is essential for the agency to successfully conduct planned flight testing.

Targets are solely test assets and are not operationally fielded. As such, this program will remain in product development and transfer to a military service is not applicable.



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

DELIVERIES

The Targets program delivered 3 of 8 planned targets for flight testing in fiscal year 2020, but none of these targets flew as planned due to travel and other restrictions driven by the pandemic, according to program officials. However, Targets program officials cited notable steps to ensure that an ICBM target was on-site and ready for FTM-44—a congressionally directed flight test to assess an Aegis BMD SM-3 IIA interceptor's capabilities against an ICBM. For example, the Targets program ensured personnel remained on-site to safeguard the target until the test was conducted in November 2020. Three targets planned for delivery in fiscal year 2020 were for an operational test—FTO-03—that was canceled and Targets program officials said they will work to repurpose these unused targets for future flight tests. The remaining targets planned for delivery in fiscal 2020 were delayed (see table, Targets Fiscal Year 2020 Deliveries, to the right).

Targets Fiscal Year 2020 Deliveries

Planned	Delivery Status
2 SRBM	**Delayed.** Two SRBM T4-G targets were postponed due to development challenges and the pandemic, per program officials.
3 MRBM	**Partially delivered.** One MRBM T3c2 was delivered for a test program officials said was delayed due to the pandemic. One MRBM T4-B was no longer required. One MRBM T1 was delayed because the test it was planned for—FTO-03—was canceled.
2 IRBM	**Partially delivered.** Both IRBM targets were planned for use in FTO-03—a major operational test that was cancelled. One was delivered, but not used. Program officials said both targets will be repurposed for a future flight test.
1 ICBM	**Delivered.** An ICBM was delivered and later flown in FTM-44, a congressionally directed test to demonstrate capabilities of the Aegis BMD SM-3 IIA interceptor—a broader capability than the intended design of this interceptor (see appendix I).
Planned: 8	**Delivered. 3**

SRBM = Short-range ballistic missile, **MRBM** = Medium-range ballistic missile, **IRBM** = Intermediate-range ballistic missile, and **ICBM** = Intercontinental ballistic missile

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- Targets program officials are still assessing the schedule impacts from the pandemic. So far, they have made adjustments to the program's target delivery schedules for several delayed flight tests. Specifically, some assets will now remain with the contractor in storage until personnel are available to safely and properly process and use the assets. In addition, travel restrictions and mandatory quarantines have prevented key personnel from participating in testing.
- The Targets program reported an up to at least $34 million cost impact from the pandemic. For example, there were additional costs to redeploy personnel to support and safeguard the ICBM target for FTM-44 while awaiting the execution of the flight test and reconfiguration of production and integration facilities to accommodate social distancing and other safety protocols.

FISCAL YEAR 2020 TESTING OVERVIEW

The Targets program did not fly any targets in fiscal year 2020 to support weapon system testing.

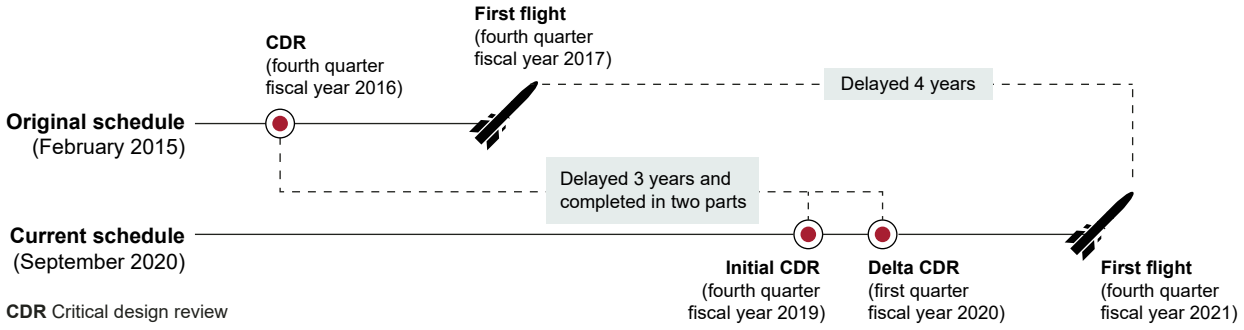
However, the Army supplied two SRBM targets—Black Daggers—for flight tests executed in fiscal year 2020—FTX-39 and FTP-27 E2. The Army supplied these targets because Patriot was the primary weapon system under test. For FTX-39, the target drifted outside of acceptable flight safety boundaries and was terminated by the range safety team. As such, MDA declared this event a no-test. For FTP-27 E2, the target was successful, but the Patriot interceptors failed due to incomplete flight test software on a compact disk being loaded on the interceptors.

OTHER PROGRAM INFORMATION

Critical Design Review Finalized for SRBM T4-G Target

Targets program officials finalized the critical design review (CDR) for the SRBM T4-G target in fiscal year 2020, three years later than originally planned. A CDR assesses the final design of a target to ensure it can proceed into production and testing and meet its performance requirements within cost and schedule. Program officials said they conducted this CDR in two parts—an initial and delta review—August and October 2019, respectively. According to program officials, the delays were primarily due to technical challenges with this unique and complex target. Thus, the delays in finalizing the CDR postponed the first flight test with this target for an Aegis program (not assessed in this report) by four years, as shown in figure below.

Targets Program Finalizes Critical Design Review for the SRBM T4-G Target After Multiple Delays

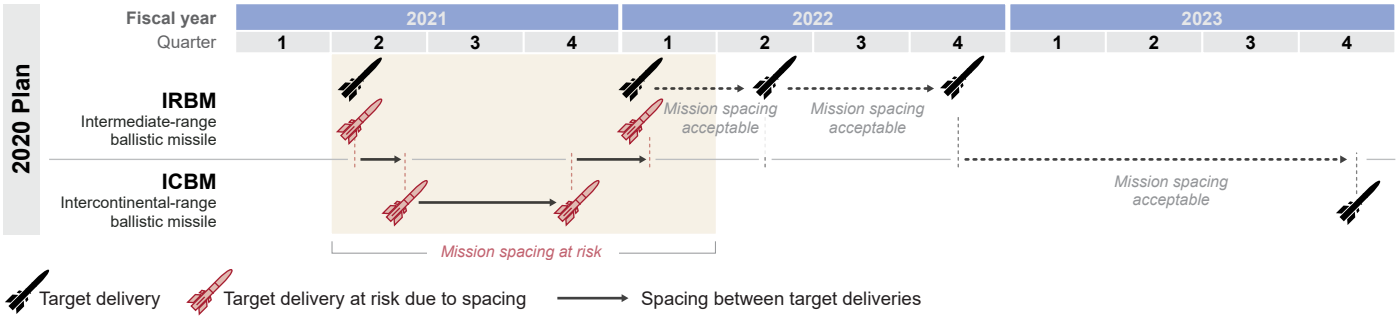


Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

Availability Risks for Intermediate- and Intercontinental-Range Targets

Some IRBMs and ICBMs through fiscal year 2022 are at risk of not being available as planned because, in some instances, the Targets program has not adhered to the contractor's target delivery spacing. While not contractual, the delivery spacing is necessary due to processing, storage, and transport limitations. For example, these limitations dictate at least 9 months between ICBM deliveries, which is currently not the case between the second and fourth quarter of fiscal year 2021, per a delivery schedule the Targets program provided to us in October 2020. Officials from the contractor are working with the Targets program and will likely mitigate this issue and they are also considering solutions, such as procuring additional equipment to transport or process the targets and expanding storage, to avoid such occurrences in the future.

Planned Intermediate- and Intercontinental-Range Targets Deliveries through Fiscal Year 2023



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

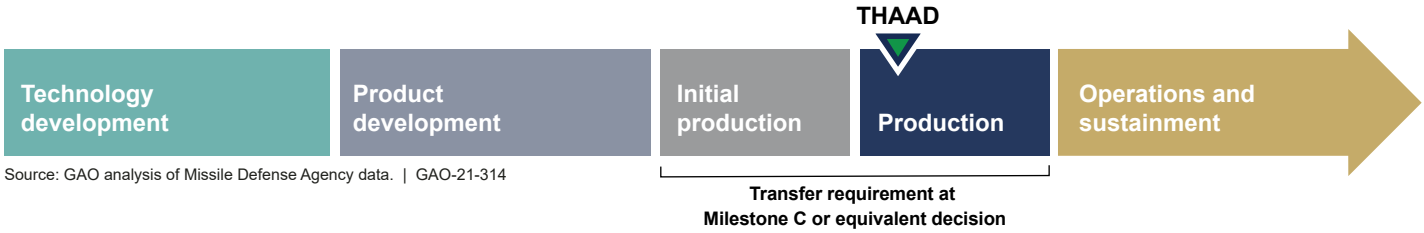
Source: Missile Defense Agency. | GAO-21-314

PROGRAM OVERVIEW

Terminal High Altitude Area Defense (THAAD)

THAAD is a rapidly-deployable, globally-transportable, ground-based system to defend against short-, medium-, and limited intermediate-range ballistic missile attacks. A THAAD battery is comprised of: launchers, a fire control unit, a communications system, a radar, and interceptors. The current program of record includes seven batteries and interceptor quantities that can extend up to 910 based on the full-rate production decision in October 2020. THAAD has delivered all seven batteries to the Army for operational use and plans to continue production through fiscal year 2029 for remaining items, such as interceptors and software upgrades.

MDA and the Army have a transfer agreement and are taking steps to prepare for the transfer of THAAD to the Army per the National Defense Authorization Act for Fiscal Year 2018. However, DOD is requesting relief from the requirement to transfer as MDA is seeking to retain this program.

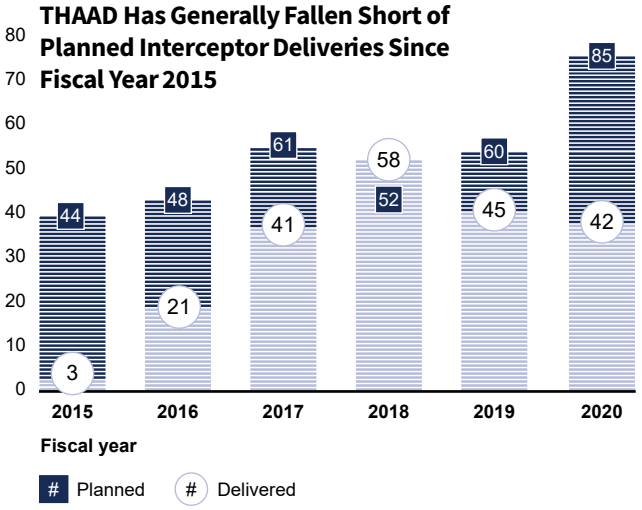


Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

DELIVERIES

THAAD delivered 42 of 85, or 49 percent, of planned interceptors for fiscal year 2020 and halted further deliveries June through September while awaiting a qualified replacement for a part that is no longer available. THAAD's contractor proceeded with production while working to qualify the replacement part, which was a risk to the program if the qualification was not successful. Yet, the qualification was successful and interceptor deliveries resumed in October 2020.

Production setbacks have previously hindered the program's ability to meet its goals each fiscal year. However, THAAD officials are working to improve production and increase throughput. For example, program officials are planning to build a production facility annex which will provide a separate space for stockpile reliability testing, recertification of interceptors, and production surges. In addition, THAAD received full-rate production approval from the Under Secretary of Defense for Acquisition and Sustainment in October 2020.



Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

COVID-19 IMPACTS

- The THAAD program faced challenges executing standard program mission requirements due to workspace limitations and quarantine requirements, but the full impacts to cost and schedule are currently unknown.
- The THAAD program experienced issues ordering and receiving parts from some suppliers, but was able to work with the contractor to identify mitigations and minimize disruptions to production.
- THAAD program officials developed workarounds to continue conducting audits of the program's suppliers since travel restrictions have prevented on-site audits. However, these workarounds have been less than optimal and prolonged delays will increase risks to the program.
- THAAD supported contributions to the pandemic by working with one of its suppliers to leverage an existing technology that could be used in masks and filtration devices.

FISCAL YEAR 2020 TESTING OVERVIEW

THAAD Fiscal Year 2020 Testing

Test	Conducted	Delayed	Deleted
Flight	◆ ◈	◈	◈
Ground	■ ■ ■	■	
Cybersecurity		●	

◆ Non-intercept flight test ◈ Intercept flight test

■ Ground test ● Operational cybersecurity test

Source: GAO analysis of Missile Defense Agency data. | GAO-21-314

In fiscal year 2020, THAAD participated in two flight tests—FTX-39 and FTP-27 E2—that both demonstrated interoperable capabilities between THAAD and Patriot in support of an urgent warfighter need, despite some technical challenges.

Three ground tests were completed for the program to support the operational availability of capabilities for an urgent regional warfighter need, currently projected for February 2021. THAAD delayed the remaining ground test which was divided into two separate ground tests—GTI-08a and GTI-08b—to coincide with another capability delivery.

THAAD delayed its planned operational cybersecurity test—a cooperative vulnerability and penetration assessment (CVPA)—for fiscal year 2020 because MDA is restructuring how it plans cybersecurity testing. The CVPA is the first of two necessary tests for an operational cybersecurity assessment to support the fielding decision for a capability or asset. The information from this test provides data on the resilience of the system in an operational context, which is used for the subsequent Adversarial Assessment—the second of the two tests. This assessment characterizes the operational effects from a threat representative cyber-attack and the effectiveness of the defensive capabilities.

OTHER PROGRAM INFORMATION

Homeland Defense Underlay

MDA is considering the use of THAAD as an underlay in support of homeland defense—protection of the U.S. primarily from intermediate- and intercontinental-range threats. The Ground-based Midcourse Defense program is the principal provider of homeland defense, but in fiscal year 2019 the House Armed Services Committee requested detailed analysis and a report on how THAAD can contribute since it is a rapidly-deployable and globally-transportable system that can be sent where it is needed at the time. The committee noted that THAAD has previously been deployed to perform homeland defense in Hawaii when the threat dictated the need. THAAD officials said they had generated some initial analysis that shows THAAD's capability for homeland defense exists and could be improved with additional development. Thus, THAAD program officials are taking steps in preparation for an effort now known as THAAD Layered Homeland Defense (LHLD), to include developing the requisite plans and contracts. For example, THAAD program officials released a request for information in June 2020 and secured $350 million in funding for fiscal years 2021 through 2023. However, there are a number of significant upgrades and steps to address obsolescence that would be needed to enhance THAAD's performance and make it capable of performing such a mission. THAAD officials noted that they are leveraging foreign military sales with Saudi Arabia for some of these needed changes to offset the costs.