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Report to Congressional Committees

April 2013

MISSILE DEFENSE

Opportunity to Refocus on Strengthening Acquisition Management

GAO

Accountability * Integrity * Reliability

GAO-13-432

April 2013

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Opportunity to Refocus on Strengthening Acquisition Management

GAO Accountability * Integrity * Reliability

Highlights

Highlights of GAO-13-432, a report to congressional committees

Why GAO Did This Study

Since 2002 MDA has spent approximately $90 billion to provide protection from enemy ballistic missiles by developing battle management systems, sensors that identify incoming threats, and missiles to intercept them. MDA plans to spend about $8 billion per year through 2017. For nearly a decade, we have reported on MDA's progress and challenges in developing and fielding the Ballistic Missile Defense System.

GAO is mandated by law to assess the extent to which MDA has achieved its acquisition goals and objectives, as reported through acquisition baselines. This report examines the agency's progress and remaining challenges in (1) selecting new programs in which to invest; (2) putting programs on a sound development path; (3) establishing baselines that support oversight; and (4) developing and deploying U.S. missile defense in Europe for defense of Europe and the United States. To do this, GAO examined MDA's acquisition reports, analyzed baselines reported over several years to discern progress, and interviewed a wide range of DOD and MDA officials.

What GAO Recommends

GAO makes four recommendations to DOD to ensure MDA (1) fully assesses alternatives before selecting investments, (2) takes steps to reduce the risk that unproven target missiles can disrupt key tests, (3) reports full program costs, and (4) stabilizes acquisition baselines. DOD concurred with two recommendations and partially concurred with two, stating the decision to perform target risk reduction flight tests should be weighed against other programmatic factors and that its current forum for reporting MDA program costs should not include non-MDA funding. GAO continues to believe the recommendations are valid as discussed in this report.

View GAO-13-432. For more information-contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

Although the Missile Defense Agency (MDA) has made some progress, the new MDA Director faces challenges developing and deploying new systems to achieve increasingly integrated capabilities as well as supporting and upgrading deployed systems while providing decision makers in the Department of Defense (DOD) and Congress with key oversight information in an era of fiscal constraints.

Challenge: Improve Investment Decisions

Determining the most promising and cost effective new missile defense systems to buy—considering technical feasibility and cost—remains a challenge for MDA. While MDA has conducted some analyses that consider alternatives in selecting which acquisitions to pursue, it has not conducted robust analyses of alternatives for two of its new programs. Because of its acquisition flexibilities, MDA is not required to do so. Robust analyses, however, could be particularly useful to DOD and congressional decision makers as they decide how to manage the portfolio of missile defense acquisitions. GAO has reported in the past that without analyses of alternatives, programs may not select the best solution for the warfighter, are at risk for cost increases, and can face schedule delays.

Challenge: Expand on Steps Taken to Place Investments on a Sound Footing

In the past year, MDA gained important knowledge by successfully conducting several important tests, including a test to show how well its systems will operate together. MDA has also taken steps to lower the acquisition risks of two newer programs by adding more development time. However, development issues discovered after three programs prematurely committed to production continue to disrupt both interceptor production and flight test schedules. In addition, two other programs plan to make premature commitments to production before testing confirms their designs work as intended. MDA is planning to fly targets for the first time in its first operational test using several systems, adding risk that key information may not be obtained in this major test.

Challenge: Ensure Program Baselines Support Oversight

While MDA has made substantial improvements to the clarity of its cost and schedule baselines since first reporting them in 2010, they are still not useful for decision makers to gauge progress. For example, the information they include is not sufficiently comprehensive because they do not include operation and support costs from the military services. By not including these costs, the life cycle costs for some MDA programs could be significantly understated.

Challenge: Developing and Deploying U.S. Missile Defense in Europe

DOD declared the first major deployment of U.S. missile defense in Europe operational in December 2011, but MDA is faced with resolving some issues to provide the full capability and is facing delays to some systems planned in each of the next three major deployments. MDA has also struggled for years to develop the tools—the models and simulations—to credibly assess operational performance of systems before they are deployed. It recently committed to a new approach to resolve this problem.

Contents

Letter		1
	Background	3
	Challenge: Improve Investment Decisions	13
	Challenge: Expand on Steps Already Taken to Place Investments on a Sound Footing	18
	Challenge: Ensure Program Baselines Support Oversight	26
	Challenge: Developing and Deploying U.S. Missile Defense in Europe	35
	Conclusions	40
	Recommendations for Executive Action	41
	Agency Comments and Our Evaluation	42
Appendix I	Scope and Methodology	47
Appendix II	Aegis Ballistic Missile Defense (BMD) with Standard Missile-3 (SM-3) Block IB and Second Generation Weapon System Software	52
Appendix III	Aegis Ashore with Modernized Weapon System Software	60
Appendix IV	Aegis BMD SM-3 Block IIA with Third Generation Aegis Weapons System Software	70
Appendix V	Aegis BMD SM-3 Block IIB with Third Generation Aegis Weapons System Software	73
Appendix VI	BMDS Sensors	79
Appendix VII	Ground-based Midcourse Defense	85

Appendix VIII Precision Tracking Space System (PTSS) 93

Appendix IX Targets and Countermeasures 100

Appendix X Terminal High Altitude Area Defense (THAAD) 107

Appendix XI Comments from the Department of Defense 115

Appendix XII GAO Contact and Staff Acknowledgments 118

Tables

Table 1: MDA's Acquisition Life-Cycle Phases for the BMDS 7
Table 2: Description of Selected BMDS Elements 8
Table 3: Estimated Costs to Demonstrate and Fix CE-II Capability 90

Figures

Figure 1: Primary Roles of Selected BMDS Elements against a Threat Missile 12
Figure 2: Time Frames and Defensive Capabilities for the U.S. Missile Defense in Europe 36
Figure 3: Comparison of 2010 and 2012 BAR Reported SM-3 Block IB Unit Costs 57
Figure 4: Schedule Assessment for Selected Aegis BMD SM-3 Block IB Activities in the BMDS Accountability Report 58
Figure 5: Comparison of 2010 and 2012 BAR Reported Aegis BMD Second Generation Weapon System Software Unit Costs 59
Figure 6: Schedule Assessment for Selected Aegis Ashore Activities in the BMDS Accountability Report 66
Figure 7: Comparison of 2010 and 2012 BAR Reported Aegis BMD Modernized Weapon System Software Unit Costs 68

Figure 8: Schedule Assessment for Selected Modernized Aegis Weapon System Software Activities in the BMDS Accountability Report 69
Figure 9: Schedule Assessment for Selected BMDS Sensor Program's AN/TPY-2 Activities in the BMDS Accountability Report 84
Figure 10: Planned Demonstration of CE-II Capability Delayed at Least Five and a Half Years 86
Figure 11: Schedule Assessment for Selected GMD Activities in the BMDS Accountability Report 92
Figure 12: Comparison of 2011 and 2012 BAR Reported E-LRALT Unit Costs 104
Figure 13: Comparison of 2011 and 2012 BAR Reported eMRBM Unit Costs 105
Figure 14: Schedule Assessment for Selected Targets and Countermeasures eMRBM and E-LRALT Activities in the BMDS Accountability Report 106
Figure 15: Comparison of 2010 and 2012 BAR Reported THAAD Unit Costs to Develop and Produce Items 111
Figure 16: Comparison of 2010 and 2012 BAR Reported THAAD Unit Costs to Produce Items 112
Figure 17: Schedule Assessment for Selected THAAD Activities in the BMDS Accountability Report 114

Abbreviations

Aegis BMD	Aegis Ballistic Missile Defense
AN/TPY-2	Army Navy/Transportable Radar Surveillance and Control Model 2
AOA	analysis of alternatives
BAR	BMDS Accountability Report
BMDS	Ballistic Missile Defense System
C2BMC	Command, Control, Battle Management, and Communications
CE-I	Capability Enhancement-I
CE-II	Capability Enhancement-II
DOD	Department of Defense
E-LRALT	Extended Long-Range Air-Launched Target
eMRBM	Extended Medium-Range Ballistic Missile
FTG	Flight Test GMD
FTI	Flight Test Integrated
FTM	Flight Test Standard Missile
GMD	Ground-based Midcourse Defense
MDA	Missile Defense Agency
PTSS	Precision Tracking Space System
SBX	Sea-Based X-Band
SM-3	Standard Missile-3
TDACS	Throttleable Divert and Attitude Control System
THAAD	Terminal High Altitude Area Defense

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G A O
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

April 26, 2013

Congressional Committees

Since 2002, the Missile Defense Agency (MDA) has been developing and deploying the Ballistic Missile Defense System (BMDS) to defend the United States, our deployed forces, allies, and friends by destroying missiles in flight. MDA has spent approximately $90 billion and plans to continue spending around $8 billion per year through 2017 to develop a highly complex group of systems comprised of land-, sea-, and space-based sensors to track missiles, as well as ballistic missile interceptors and a battle management system. These systems can be integrated in different ways to provide protection in various regions of the world. For nearly a decade, we have reported on MDA's progress and challenges in developing and fielding BMDS capabilities as well as other transparency, accountability, and oversight issues. Going forward, MDA and the Department of Defense (DOD) could continue to face important challenges in acquiring the BMDS as they decide how to strengthen their investment decisions, improve acquisition management of the BMDS effort and U.S. missile defense in Europe, and increase the transparency they provide to congressional decision makers.

Since the 2002 National Defense Authorization Act, we have been mandated to prepare annual assessments of MDA's progress toward its acquisition goals.[1] To date, we have delivered assessments of MDA's progress covering fiscal years 2003 through 2011 and are currently mandated to continue through fiscal year 2016. The National Defense Authorization Act for Fiscal Year 2012 requires us to report on our assessment of the extent to which MDA has achieved its stated acquisition goals and objectives, as reported through their acquisition baselines, and also to include any other findings and recommendations on MDA acquisition programs and accountability as appropriate.[2]

[1]National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107, § 232(g) (2001); Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Pub. L. No. 108-375, § 233 (2004); National Defense Authorization Act for Fiscal Year 2006, Pub. L. No. 109-163, § 232; John Warner National Defense Authorization Act for Fiscal Year 2007, Pub. L. No. 109-364, § 224 (2006); and National Defense Authorization Act for Fiscal Year 2008, Pub. L. No. 110-181, § 225.

[2] Pub. L. No. 112-81, § 232 (2011).

With the appointment of a new Director of MDA and the growing scrutiny of defense budgets by Congress, our report examines MDA's investment strategy challenges as well as MDA's challenges in developing and fielding the U.S. portions of missile defense in Europe. Specifically, this report highlights the agency's progress as well as any remaining challenges that face the new Director, including (1) selecting new programs in which to invest; (2) putting programs on a sound development path; (3) establishing baselines needed to support oversight; and (4) developing and deploying U.S. missile defense in Europe for defense of Europe and the United States. In addition, we provide detailed information on MDA's progress acquiring individual systems, which MDA refers to as elements of the BMDS, in the individual appendices.

To assess MDA's progress and related challenges, we examined the acquisition accomplishments of individual missile defense programs and supporting efforts that MDA is currently developing and fielding.[3] For programs in the early acquisition stages, we reviewed documentation of MDA and DOD reviews that program management officials considered similar to an analysis of alternatives, and compared this documentation to acquisition best practices for analysis of alternatives and DOD acquisition guidance.[4] We examined the agency's Integrated Master Test Plan and discussed the element- and BMDS-level test programs and test results with the BMDS Operational Test Agency and the Department of Defense's Office of the Director of Operational Test and Evaluation as well as with element program offices and MDA functional directorates, such as the Directorates for Engineering and Testing. We also reviewed MDA element acquisition strategies and compared them to our best practice criteria.[5] We interviewed individual element program offices and

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[3]This report does not contain an assessment of the Patriot Advanced Capability-3 because its initial development is complete and it has been transferred to the Army for production, operation, and sustainment. MDA is also developing other systems for Israeli programs, which are not covered in this report.

[4]GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, GAO-09-665 (Washington, D.C.: Sept. 24, 2009); and *Homeland Security: DHS Requires More Disciplined Investment Management to Help Meet Mission Needs*, GAO-12-833 (Washington, D.C.: Sept. 18, 2012).

[5] GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-12-400SP, (Washington, D.C.: Mar. 29, 2012); and *Best Practices: Using a Knowledge-Based Approach to Improve Weapon Acquisition*, GAO-04-386SP (Washington, D.C.: January 2004).

reviewed management briefings and responses to GAO data collection instruments which detailed key accomplishments for fiscal year 2012. To gauge MDA element cost and schedule progress, we compared the resource and schedule baselines as presented in the 2012 BMDS Accountability Report (BAR) to the 2010 baselines presented in the June 2010 BAR. We also met with officials in MDA's Acquisition Directorate and Operations Directorate to discuss how the agency is establishing and managing its internal baselines. We met with officials in MDA's systems engineering directorate, independent assessors, and the Northern and Strategic Combatant Commands to discuss the progress of the BMDS for homeland and regional defense in Europe. In addition, we reviewed MDA's modeling and simulation master plan as well as system-level verification and validation plans. We also met with MDA officials at the Missile Defense Integration and Operations Center as well as officials with the BMDS Operational Test Agency to understand the status of MDA's modeling and simulation program, progress in resolving past issues, and future plans. The results of these reviews are presented in detail in the appendixes to this report, and are also integrated as appropriate in our findings.

Towards the end of our audit work, in March 2013, the Secretary of Defense announced a significant adjustment to existing plans for developing and deploying missile defense systems in Europe and the United States for the protection of the United States. In addition, DOD proposed canceling two MDA programs in April 2013, as reflected in the Fiscal Year 2014 President's Budget Submission. Because the proposed cancellations occurred in the last few weeks of our audit, we were not able to assess the effects and incorporate this information into our report. For more details on our scope and methodology, see appendix I.

We conducted this performance audit from March 2012 to April 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The BMDS is designed to counter ballistic missiles of all ranges—short, medium, intermediate, and intercontinental. Short-range ballistic missiles have a range of less than 621 miles; medium-range ballistic missiles have a range from 621 to1,864 miles; intermediate-range ballistic missiles have a range from 1,864 to 3,418 miles; and intercontinental ballistic missiles have a range greater than 3,418 miles. Since ballistic missiles have different ranges, speeds, sizes, and performance characteristics, MDA is developing a variety of systems that, when integrated, provide multiple opportunities to destroy ballistic missiles in flight. The BMDS includes space-based sensors, ground- and sea-based radars, ground- and sea-based interceptor missiles, and a command and control system that provides communication links to the sensors and interceptor missiles. Once a ballistic missile has been launched, these sensors and interceptors are coordinated to track or engage the threat missile during its flight.

MDA's Flexible Acquisition Approach and Past Steps Taken to Address Transparency

DOD develops its major defense acquisition systems through an acquisition process in which programs move through significant phases in their life-cycle.[6] DOD programs have

- a materiel solution analysis phase during which DOD analyzes and recommends materiel solutions for the identified need;
- a technology development phase, during which DOD reduces technology risk and determines the appropriate set of technologies to be integrated into the full system;
- a product development phase, formally known as engineering and manufacturing development, which represents program initiation, and during which the program focuses on integrating the system design, developing system capability, and demonstrating the manufacturing processes;
- a production and deployment phase for the purpose of achieving an operational capability that satisfies the mission need; and
- an operations and support phase, where DOD works to sustain the system in the most cost-effective manner.

[6]The BMDS program meets the definition of a major defense acquisition program, which is defined in 10 U.S.C. § 2430 and implemented by DOD in its 5000 series. A major defense acquisition program is an acquisition program that is not a highly sensitive classified program and is designated as a major defense acquisition program or is estimated to require an eventual total expenditure for research, development, test, and evaluation, including all planned increments, of more that $365 million in fiscal year 2000 constant dollars or, for procurement, including all planned increments, of more than $2.190 billion in fiscal year 2000 constant dollars.

When MDA was established in 2002, the Secretary of Defense granted it exceptional flexibility to set requirements and manage the acquisition of the BMDS in order to meet a presidential directive to deliver an initial defensive capability against ballistic missiles in 2004. This decision postponed application of DOD acquisition policy for BMDS elements until they were mature enough to begin production and deployment. Because BMDS's entrance into DOD's acquisition cycle is deferred, MDA is exempt from certain laws and policies triggered by the phases of the acquisition life-cycle that generally require major defense acquisition programs to take steps such as the following:

- Prior to beginning the technology development phase and product development phase, conduct an analysis of alternatives to compare potential solutions and determine the most cost-effective weapon system to acquire.[7]
- Before the program begins the product development phase, document key program performance, cost, and schedule goals in a baseline that has been approved by a higher-level DOD official.[8] The baseline is considered the program's initial business case—evidence that the concept of the program can be developed and produced within existing resources. The baseline provides decision makers with the program's total cost for an increment of work, average unit costs for systems to be delivered, key dates associated with a capability, and the weapon's intended performance parameters.
- Once a baseline has been approved, measure the program against the approved baseline or obtain the approval of a higher-level acquisition executive before making changes.

[7] 10 U.S.C. § 2366a and § 2366b.

[8] 10 U.S.C. § 2435 requires an approved program baseline description for major defense acquisition programs before the program enters system development and demonstration (now known as engineering and manufacturing development), production and deployment, and full-rate production. (Because the BMDS has not yet formally entered the acquisition cycle, it has not yet been required to meet these requirements.)

- Once a baseline has been approved, report certain increases in unit cost measured from the original and the current program baseline.[9] Unit cost is the cost divided by the quantity produced.

- Prior to beginning the product development and/or production and deployment phases of the DOD acquisition cycle, obtain an independent life-cycle cost estimate.[10]

While these flexibilities give MDA latitude to manage the BMDS and enable it to rapidly develop and field new systems, we have previously reported that the agency has used these flexibilities to employ acquisition strategies with high levels of concurrency (that is, overlapping activities such as testing and production) and they have also hampered oversight and accountability.

Congress and DOD have taken steps to address concerns over MDA's acquisition management strategy, accountability, and oversight. Although MDA is not yet required to establish an acquisition program baseline pursuant to 10 U.S.C. § 2435 and related DOD policy because of the acquisition flexibilities it has been granted, Congress has enacted legislation requiring MDA to establish some baselines. MDA reported baselines for several BMDS programs to Congress for the first time in its June 2010 BMDS Accountability Report to respond to statutory requirements in the National Defense Authorization Act for Fiscal Year 2008.[11] Most recently, the National Defense Authorization Act for Fiscal Year 2012 required MDA to establish and maintain baselines for program elements or major portions of such program elements.[12] The act specified information to be included in the baselines such as total quantities and quantities by fiscal year, and required an annual report of these baselines to Congress.

In 2010, MDA created a new review process in which the agency identified five phases of acquisition as seen in table 1.

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[9]10 U.S.C. § 2433, also known as "Nunn-McCurdy." Because MDA is not required to prepare a baseline under 10 U.S.C. § 2435, there is no basis for determining unit costs under 10 U.S.C. § 2433.

[10]10 U.S.C. § 2434.

[11]Pub. L. No. 110-181, § 223(g), *repealed by* Pub. L. No. 112-81, § 231(b) (2011).

[12]Pub. L. No. 112-81, § 231(a) (2011), *codified* at 10 U.S.C. § 225.

Table 1: MDA's Acquisition Life-Cycle Phases for the BMDS

Material solution analysis	Technology development	Product development	Initial production	Production
An analysis period to develop potential alternative solutions.	For developing and maturing technology solutions for a capability shortfall.	To further develop the potential BMDS component to refine and mature the design and manufacturing issues.	Used primarily to provide an initial base for production and provide articles for continued testing.	For producing final operational end items to satisfy Warfighter-capability requirements.

Source: MDA Directive 5010.18; GAO (presentation).

The agency has documented the key knowledge that is needed prior to the technology development, product development, initial production, and production phases. For example, as part of the process, MDA requires a program to identify alternatives to meet the mission's needs before it can proceed to MDA's technology development phase. MDA officials have stated in the past that they expect that aligning the development efforts with the phases will help to ensure that they obtain the appropriate level of knowledge before allowing the acquisitions to move from one phase to the next.

U.S. Missile Defense in Europe

One of the most significant new thrusts in BMDS acquisitions is the development and deployment of systems to aid in the defense of Europe and to augment the current protection of the United States. In September 2009, the president announced a new approach called the European Phased Adaptive Approach, which is structured around Aegis ship and Aegis Ashore systems in addition to other various BMDS sensors. The BMDS in Europe is planned to be deployed over time as the systems become more mature. The final phase of U.S. missile defense in Europe is planned to enhance the limited defense of the United States against intercontinental ballistic missiles currently provided by the U.S. based Ground-based Midcourse Defense (GMD) system. Towards the end of our audit work, in March 2013, the Secretary of Defense made an announcement that canceled the final phase of U.S. missile defense in Europe that had planned to use Aegis BMD SM-3 Block IIB interceptors, and announced several other plans including deploying additional ground based interceptors in Fort Greely, Alaska, and deploying a second AN/TPY-2 radar in Japan. Because this announcement occurred late in our audit, we were not able to assess the effects and incorporate this information into our report.

The DOD 2010 Ballistic Missile Defense Review stated that other regional missile defenses are to be developed, each tailored to a specific region of the world and its particular threats and circumstances.[13] The BMDS in Europe is the first such approach to missile defense to be developed. We reported in January 2011 that DOD was planning for additional regional defenses in East Asia and the Middle East.[14]

Description of BMDS Elements

Table 2 describes BMDS elements discussed in this report, the defensive capabilities each currently provides or plans to provide for a particular mission, and their current MDA acquisition phase.

Table 2: Description of Selected BMDS Elements

BMDS element/ supporting effort	Description and key components	Planned defensive capability	MDA acquisition phase and operational status
Aegis Ballistic Missile Defense (Aegis BMD) with Standard Missile-3 (SM-3) Block IA and Aegis BMD first generation weapon system software[a]	Aegis BMD is a sea-based system developed for ballistic missile defense and other missions. MDA is developing several versions of missiles and associated ship-based software and processors. All sea-based Aegis BMD systems include the shipboard SPY-1 radar, Aegis BMD weapon system software, and command and control systems, and Standard Missile-3 (SM-3) interceptors.	Against short-, medium-, and intermediate-range ballistic missiles in the middle part of their flight.	In production since 2005. Currently operational for regional defense in Europe as well as other regions.
Aegis BMD with SM-3 Block IB missiles and second generation weapon system software	As a sea-based missile defense system, the SM-3 Block IB features additional capabilities over the Block IA to identify, discriminate, and track objects during flight. The Aegis BMD second generation weapon system software also provides increased capabilities with its ability to more accurately locate, discriminate, and track more sophisticated threat objects as well as uplink that data to the SM-3 Block IB faster than the previous version. For more details about the Aegis BMD SM-3 Block IB program, see appendix II.	Against short-, medium-, and intermediate-range ballistic missiles in the middle part of their flight.	Being concurrently developed and produced. Plans to be operational in 2014 and available for regional defense in Europe and other regions in 2015.

[13]The Ballistic Missile Defense Review is the end product from a comprehensive review of ballistic missile strategy and policy. It was published in February 2010.

[14]GAO, *Ballistic Missile Defense: DOD Needs to Address Planning and Implementation Challenges for Future Capabilities in Europe*, GAO-11-220 (Washington, D.C.: Jan. 26, 2011).

BMDS element/ supporting effort	Description and key components	Planned defensive capability	MDA acquisition phase and operational status
Aegis Ashore with SM-3 missiles and modernized weapon system software	A land-based, or ashore, version of Aegis BMD initially using SM-3 Block IB missiles, with plans to use various versions of SM-3 missiles and Aegis weapon system software as they become available. Aegis Ashore will initially be deployed with the upgraded version of the third generation Aegis weapons software, which is designed to counter more advanced threats. Key components include SM-3 missiles, a vertical launch system, an enclosure that houses the SPY-1 radar and command and control system, and Aegis BMD weapon system software. For more details about the Aegis Ashore program, see appendix III.	Initially, Aegis Ashore with the SM-3 Block IB is planned to defend against short-, medium- and intermediate-range ballistic missiles in the middle part of their flight. It will add capability as the SM-3 Block IIA and SM-3 Block IIB become available.	Being concurrently developed and produced. Plans for initial version to be operational for regional defense in Europe in 2015.
Aegis BMD SM-3 Block IIA with third generation weapon system software	Another SM-3 version to be developed for use on Aegis BMD ships as well as with Aegis Ashore. The SM-3 Block IIA is planned to be larger than the SM-3 Block IB and is planned to have increased velocity, range, and discrimination capabilities. The third generation software also provides increased capabilities to use sensors other than its SPY-1 radar to engage a threat. For more details about the Aegis BMD SM-3 Block IIA program, see appendix IV.	Against medium- and intermediate-range ballistic missiles in the middle part of their flight.	In technology development. Plans to be operational for regional defense in Europe and other regions in 2018.
Aegis BMD SM -3 Block IIB with third generation weapon system software[b]	A new SM-3 concept is in the early stages of development, but, based on current plans, it is planned to address different threats and have more advanced capabilities than earlier SM-3 versions. Key components have not been finalized given the early stage of the program. For more details about the Aegis BMD SM-3 Block IIB program, see appendix V.	Early intercept capabilities against some intercontinental ballistic missiles. Defense in the middle part of their flight for medium- and intermediate-range ballistic missiles.	In technology development. Plans to be operational for regional defense in Europe in 2022 at the earliest.
BMDS Sensors	MDA has fielded and/or upgraded a variety of sensors that support various elements of the BMDS. Some of the key sensors include, but are not limited to: the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) radar in forward-based mode to support Aegis BMD and Ground-based Midcourse Defense or in the terminal mode used with Terminal High Altitude Area Defense; the Sea-Based X-Band radar for tracking and discriminating threats; upgraded early warning radars and the Cobra Dane radar for tracking and classifying objects, and cueing other BMDS elements. For more details about the BMDS Sensors program, see appendix VI.	These various sensors are designed to identify and continuously track ballistic missiles in all phases of flight.	The Sea-Based X-Band radar is in limited test support (it remains available to be recalled to operational status, if necessary), while the other radars are operational. All of the BMDS sensors are currently being utilized for regional defense and/or defense of the United States.

BMDS element/ supporting effort	Description and key components	Planned defensive capability	MDA acquisition phase and operational status
Command, Control, Battle Management, and Communications (C2BMC)a	C2BMC is a global network that links and integrates individual missile defense elements. It also allows users to plan ballistic missile defense operations, see the battle develop, and manage networked sensors and weapon systems to achieve mission objectives. MDA has released several versions of the software, known as spirals, which continue to improve on the C2BMC's ability to manage information among the BMDS elements. The network also includes some hardware such as high-end workstations, servers, and network equipment.	Supports all of the elements to defeat ballistic missiles of all ranges in all phases of flight.	Software upgrades do not enter a production phase. The latest operational spiral, known as Spiral 6.4, has been operational in the Pacific Command, Northern Command, and European Command since 2011 and in Central Command since 2012. The next version, Spiral 8.2, is in product development with plans to be operational in 2017.
Ground-based Midcourse Defense (GMD)	A ground-based missile defense system designed to defend the United States. GMD interceptors are located at Fort Greely, Alaska and Vandenberg, California. Key components include (1) a system to formulate battle plans and direct BMDS radars, and (2) the interceptor that consists of a 3-stage booster with a kill vehicle on top. The kill vehicle uses its sensors and divert capabilities to steer itself into the threat missile to destroy it. There are currently two versions of the kill vehicle: the initial design known as the Capability Enhancement-I (CE-I) and the upgraded design known as the Capability Enhancement-II (CE-II). For more details about the GMD program, see appendix VII.	Against intermediate and intercontinental ballistic missiles in the middle part of their flight.	GMD configured with a CE-I is operational for the defense of the United States. CE-II is being concurrently developed and produced.
Precision Tracking Space System (PTSS)[b]	A space-based constellation of nine satellites in orbit at the same time along with a ground station. PTSS is being designed to provide persistent coverage of approximately 70 percent of the earth's surface while tracking more advanced missiles and larger raid sizes than current ground or sea-based radar sensors. It is being designed to provide high-quality track information on threat missiles to other ballistic missile defense systems that can use the data to engage the threat. PTSS is also planned to improve ballistic missile defense by expanding the operating areas for Aegis BMD ships. For more details about the PTSS program, see appendix VIII.	Designed to track medium-, intermediate-, and intercontinental range ballistic missile threats after boost and through the middle part of their flight.	Plans to begin technology development in 2013 and be operational for regional defense of Europe and defense of the United States no sooner than 2023.
Targets and Countermeasures	MDA develops and manufactures highly complex targets to present realistic threat scenarios during BMDS flight tests. MDA develops and manufactures a variety of targets for short-, medium-, intermediate-, and eventually intercontinental ranges. Our report focuses on two medium-range air-launched targets being flown for the first time in fiscal years 2012 and 2013: the extended medium-range ballistic missile target and the extended long-range air-launched target. For more details about these new targets, see appendix IX.	To aid other BMDS elements to hone their defensive capabilities, the targets are designed to emulate threat missile ranges and capabilities.	Extended medium-range ballistic missile target in development. First flight planned in 2013. Extended long-range air-launched target first flight in 2012.

BMDS element/ supporting effort	Description and key components	Planned defensive capability	MDA acquisition phase and operational status
Terminal High Altitude Area Defense (THAAD)	THAAD is a mobile, ground-based missile defense system. THAAD is organized as a battery. Key components of a THAAD battery include interceptors, launchers, an AN/TPY-2 radar, a fire control and communications system, and other support equipment. For more details about the THAAD program, see appendix X.	Against short- and medium-range ballistic missiles during the late middle and end of their flight.	In production. Two batteries are operational.

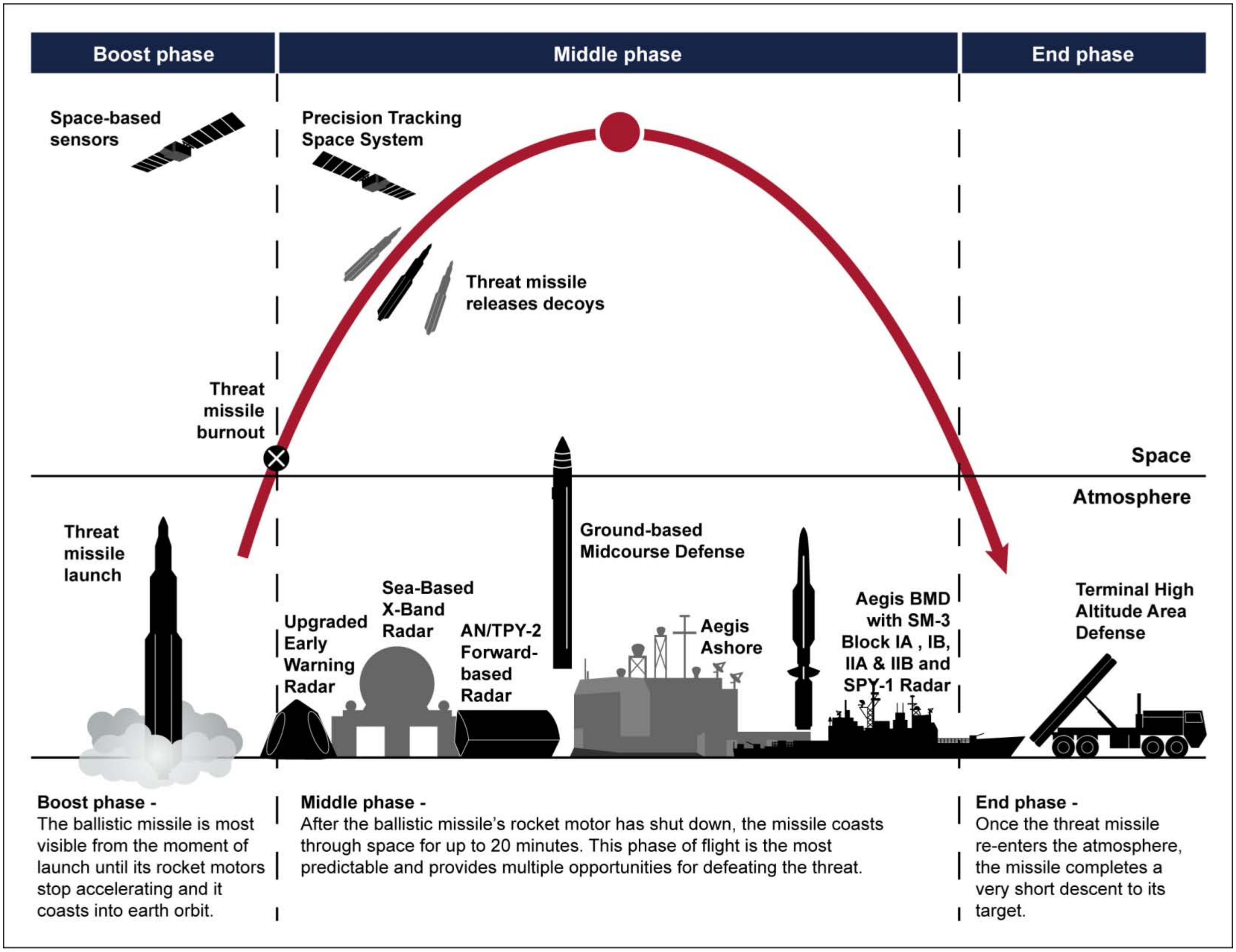
Source: MDA (data); GAO (presentation).

[a]Details on the acquisition progress of the Aegis BMD SM-3 Block IA and C2BMC elements are not covered in this report.

[b]In April 2013, DOD proposed canceling the PTSS and Aegis BMD SM-3 Block IIB programs in the Fiscal Year 2014 President's Budget Submission. Because these proposed cancellations occurred in the last few weeks of our audit, we were not able to assess the effects and incorporate this information into our report.

Figure 1 depicts the BMDS elements that could be used to engage a threat missile during the course of its flight.

Figure 1: Primary Roles of Selected BMDS Elements against a Threat Missile



Source: GAO analysis of DOD data (data); GAO (images).

Note: The BMDS elements are depicted in their primary defensive role during a threat missile's phase of flight. BMDS elements may provide some defensive capabilities in other phases of flight.

An engagement scenario using the Aegis BMD element, for example, could occur as follows:

- After the launch of a threat missile, the Space Based Infrared System, an Air Force system of satellites that detect ballistic missile launches, detects the launch and sends a cue to the Command, Control, Battle Management, and Communications system.
- The Command, Control, Battle Management, and Communications system tells one or more Army Navy/Transportable Radar Surveillance and Control Model 2 radars to track the threat missile.
- The radars provide track information to the Command, Control, Battle Management, and Communications system which develops system track data to support Aegis BMD engagements.
- Relying on data provided by the Army Navy/Transportable Radar Surveillance and Control Model 2 radars and its own SPY-1 radar, the Aegis BMD ship uses SM-3 missiles to intercept and attempt to destroy the threat.

Challenge: Improve Investment Decisions

A key challenge DOD and MDA's new Director face is ensuring that the Department is getting the best value for its missile defense investments, particularly as MDA faces growing fiscal pressure as it develops new programs while supporting and upgrading its existing systems. We have frequently reported on the importance of establishing a sound basis before committing resources to developing a new product.[15] We have also reported that part of a sound basis is a full analysis of alternatives (AOA).[16] An AOA also helps ensure that key DOD and congressional decision makers understand why the chosen system was selected in order to prioritize limited investment dollars to achieve a balanced BMDS portfolio. Because of MDA's acquisition flexibilities, its programs are not required to complete an AOA. While MDA has performed some limited

[15] GAO, *Defense Acquisitions: Sound Business Case Needed to Implement Missile Defense Agency's Targets Program*, GAO-08-1113 (Washington, D.C.: Sept. 26, 2008); *Defense Acquisitions: Improved Business Case Is Needed for Future Combat System's Successful Outcome*, GAO-06-367 (Washington, D.C.: Mar. 14, 2006); and *Tactical Aircraft: Air Force Still Needs Business Case to Support F/A-22 Quantities and Increased Capabilities*, GAO-05-304 (Washington, D.C.: Mar. 15, 2005).

[16] GAO-09-665 and GAO-12-833.

analyses that consider alternatives, it has not conducted a robust AOA for its new programs. We have reported that without AOAs, programs may not select the best solution for the warfighter, are at risk for cost increases, and can face schedule delays.[17] However, some progress was made in January 2013 when Congress directed DOD to conduct a comprehensive assessment of PTSS alternatives.[18]

Limited Analyses of Alternatives Put BMDS Programs at Risk

An AOA can help establish a sound basis for an acquisition by comparing potential solutions and determining the most promising and cost-effective weapon system to acquire. As such, major defense acquisition programs are generally required by law and DOD's acquisition policy to conduct an AOA before they are approved to enter the technology development phase. A robust AOA can provide decision makers with the information they need by helping establish a sound basis that is used to assess whether a concept can be developed and produced within existing resources and if it is the best solution to meet the warfighter's needs. It accomplishes this by providing a foundation for developing and refining the program's requirements, and giving insight into the technical feasibility and costs of alternatives.[19] Specifically, an AOA should address key questions, such as the following:

- Did an AOA occur at the appropriate time?
- What alternatives meet the warfighter's needs?
- Are the alternatives operationally suitable and effective?
- Can the alternatives be supported?
- What are the programmatic (e.g., cost or schedule), technical, and operational risks for each alternative?
- What are the development, production, deployment, and support costs for each alternative?
- How do the alternatives compare to one another?

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[17] GAO-09-665.

[18] Pub. L. No. 112-239, § 224.

[19] GAO-09-665.

In addition, as we reported in September 2009 and again in September 2012, AOAs should be completed early enough in the acquisition cycle, prior to the start of technology development, to provide time for adjustments to requirements before those requirements are finalized.[20]

Because of the flexibilities that have been granted to MDA, its programs are not required to complete an AOA before starting technology development. Nevertheless, MDA's acquisition directive requires programs to show they have identified competitive alternative materiel solutions before they can proceed to MDA's technology development phase. However, this directive provides no specific guidance on how this alternatives analysis should be conducted or what criteria should be used to identify and assess alternatives, such as risks and costs. According to DOD, the office of the Director for Cost Assessment and Program Evaluation develops and approves study guidance for AOAs for other major defense acquisition programs. MDA could look to that office for support should it decide to undertake more robust analyses of alternatives.

While MDA has conducted some analyses that consider alternatives, it has not conducted robust AOAs for its new programs—the Aegis BMD SM-3 Block IIB and PTSS programs.

- We recently reported the SM-3 Block IIB program did not conduct an AOA prior to beginning technology development.[21] While the program assessed some alternatives that could potentially achieve early intercept, it did not include other key aspects of an AOA, such as considering a broad range of alternatives and performing a cost-effectiveness assessment of the concepts considered. Recent MDA technical analysis has led to changes in the initial program assumptions about how to use the SM-3 Block IIB and suggests additional development and investment by the program will be needed to defend the United States. Further, potential missile configurations that are under consideration may provide increased capability for the SM-3 Block IIB but also pose significant cost and safety risks. To some extent, these program issues may have been driven by the early decision to narrow solutions without the benefit of an AOA.

[20]GAO-09-665 and GAO-12-833.

[21]GAO, *Standard Missile-3 Block IIB Analysis of Alternatives*, GAO-13-382R, (Washington, D.C.: February 2013).

- Although the PTSS program has conducted a number of studies in the past, none can be considered a robust AOA because they either assessed too narrow a range of alternatives or did not fully assess program and technical risks. Congress included a requirement in the National Defense Authorization Act for Fiscal Year 2013[22] for DOD to evaluate PTSS alternatives partially in response to concerns raised by the National Academy of Sciences last year about the costs and benefits of the PTSS program.[23] DOD's Cost Assessment and Program Evaluation office is currently in the process of conducting a comprehensive review of PTSS that may include many aspects of an AOA, but it is unclear at this point if it will be thorough enough to determine the best concept.

By not conducting robust AOAs, these programs are at risk for developing weapon systems that may not be the best solution to meet the warfighter's needs and having cost, schedule, and technical problems. It also means that key DOD and congressional decision makers may have a limited understanding of the reason these systems were selected.

AOAs Could Help MDA Balance and Prioritize Its Portfolio of Investments

In the past few years, MDA has had declining budgets, some program cancellations, and curtailment of other programs partially because of affordability concerns. Looking forward, MDA faces important decisions about how it will balance and prioritize its portfolio of BMDS investments as it increasingly develops new programs while supporting and upgrading existing deployed systems. We have previously reported that successful organizations follow a disciplined process to assess alternatives to help them achieve a balanced portfolio that spreads risk across products, aligns with strategic goals and objectives, and maximizes return on investment.[24] To this end, AOAs help decision-makers prioritize limited investment dollars by assessing operational benefits against technical and affordability challenges of individual systems before committing

[22]Pub. L. No. 112-239, § 224.

[23]National Research Council, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives*, National Research Council of the National Academies, Washington, D.C., 2011.

[24]GAO, *Best Practices: An Integrated Portfolio Management Approach to Weapon System Investments Could Improve DOD's Acquisition Outcomes,* GAO-07-388 (Washington, D.C.: Mar. 30, 2007).

resources in order to achieve a balanced portfolio that meets strategic goals within available resources. AOAs are therefore a key first step in establishing a sound basis for acquisitions.

MDA's annual budget peaked in fiscal year 2007 at $9.4 billion but has since trended downwards to a requested $7.8 billion in fiscal year 2013. Since fiscal year 2009, DOD canceled three programs because of technical issues, schedule delays, and concerns about the cost-effectiveness or operational role of the programs. In fiscal year 2009, DOD terminated the Kinetic Energy Interceptors program, which was developing a high velocity booster rocket designed to intercept missiles in the boost and middle phases of flight, and the Multiple Kill Vehicle program, which was developing a way to place multiple kill vehicles on an interceptor. DOD terminated these programs after spending approximately $2.5 billion on their development. In addition, in fiscal year 2012, DOD canceled the Airborne Laser program, which placed a high-energy chemical laser onboard an airplane designed to intercept missiles, after spending over $5 billion on its development.

To improve acquisition outcomes and achieve strategic goals for the United States and regional missile defense, MDA faces continuing portfolio challenges during this period of continuing fiscal pressure. DOD already curtailed several existing BMDS programs in fiscal year 2012 because of affordability concerns. For example, after approximately $2 billion had been spent in several years of development, the SBX sea-based radar was downgraded from operational status to a limited test status because of funding limitations.[25] Despite demand for THAAD batteries from military commands, MDA reduced the number of such purchases from nine to six to meet budget constraints. Partially as a result, procurement of the AN/TPY-2, a ground-based radar component of the THAAD battery as well as a stand-alone forward-based sensor, was also reduced from 18 to 11.

Balancing its portfolio of investments going forward will be a challenge as MDA plans to develop a number of new systems, such as PTSS and multiple versions of advanced interceptors for the Aegis BMD program, during the next few years while at the same time beginning full production

[25]While in limited test status, the radar can be recalled to active, operational status if necessary,

for several new weapon systems, such as Aegis Ashore and the Aegis BMD SM-3 Block IB missile. In addition, it will continue to fund full operation and support costs for the GMD element. MDA also plans to share some of those costs with the services for other elements that are already being produced, such as the AN/TPY-2 radar and THAAD. AOAs could play a constructive role as MDA manages its portfolio of acquisitions.

Challenge: Expand on Steps Already Taken to Place Investments on a Sound Footing

GAO-09-338

We recommended that the Secretary of Defense direct MDA to synchronize the development, manufacturing, and fielding schedules of BMDS assets with the testing and validation schedules to ensure that items are not manufactured for fielding before their performance has been validated through testing.

MDA gained important knowledge through its test program and took some positive steps to reduce acquisition risks for two of its programs. MDA increased its understanding of BMDS performance after successfully conducting its most complex integrated air and missile defense flight test to date as well as other important tests for the THAAD and Aegis BMD SM-3 Block IB programs. MDA also reduced the acquisition risk for two programs by delaying commitments to development until after the programs could demonstrate that the technologies and resources available are aligned with requirements. However, the Director of MDA faces continuing challenges addressing issues that stem from previous premature production commitments and minimizing further use of high risk acquisition strategies. We reported in March 2009 that MDA was pursuing a concurrent development, manufacturing, and fielding strategy in which assets are produced and fielded before they are fully demonstrated through testing and modeling.[26] We have previously reported that committing to production and fielding before development is complete is a high risk strategy that often results in performance shortfalls, unexpected cost increases, schedule delays, and test problems.[27] Moreover, best practices of successful organizations include a knowledge-based process in which each successive knowledge point builds on the preceding one, giving decision makers the knowledge they need, when they need it, to make decisions about whether to invest significant funds to move forward.[28] High levels of acquisition risk

[26]GAO, *Defense Acquisitions: Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned*, GAO-09-338 (Washington, D.C.: Mar. 13, 2009).

[27]GAO, *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002); and *Defense Acquisitions: Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned*, GAO-09-338 (Washington, D.C.: Mar. 13, 2009).

[28]GAO-02-701.

continue to be present in many of the elements' acquisition strategies. For example, as we reported last year, MDA's production problems were magnified by high levels of overlap—or concurrency—between product development and production.[29] Although the stated rationale for this overlap is to introduce systems in a timelier manner and to maintain an efficient industrial development and production workforce, MDA's Aegis BMD, GMD, and THAAD interceptor production have been significantly disrupted during the past few years due to this concurrency, delaying planned deliveries to the warfighter, raising costs, and disrupting the industrial base. Program plans for the Aegis Ashore and PTSS also include high acquisition risks due to planned premature commitments to production. In addition, we reported in April 2012 that risk reduction flight tests are conducted the first time a system is tested in order to confirm that it works before adding other test objectives and that MDA's flight test program had been disrupted by the lack of those risk reduction flight tests. Looking forward, the risks for an upcoming complex test involving multiple MDA systems are elevated because MDA is planning to use a new type of target for the first time in this critical operational test.

MDA Increased Its Understanding of BMDS Performance by Successfully Conducting Several Key Flight Tests

MDA conducted the largest integrated air and missile defense flight test to date, achieving near simultaneous intercepts of multiple targets by various BMDS interceptors. Flight Test Integrated-01, conducted October 2012, was a combined developmental and operational flight test that for the first time utilized warfighters from multiple combatant commands and employed multiple missile defense systems including THAAD, Aegis BMD, and the Patriot Advanced Capability-3.[30] All five targets, three of which were ballistic missiles and two of which were cruise missiles, were launched and performed as expected during this test. This is a significant achievement because, as we have reported in the past, troubles with target performance in prior years have hindered MDA's ability to conduct flight testing and achieve planned objectives. In addition, during this test, THAAD achieved its objectives by intercepting a medium-range target for the first time and an Aegis ship conducted another successful standard

[29]GAO, *Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency*, GAO-12-486 (Washington, D.C.: Apr. 20, 2012).

[30]Patriot Advanced Capability-3 is a missile designed to destroy its target in the terminal phase, however, this report does not contain an assessment of the Patriot Advanced Capability-3 because its initial development is complete and it has been transferred to the Army for production, operation, and sustainment.

missile-2 engagement against a cruise missile.[31] The SM-3 Block IA failed to intercept its target during the BMD portion of the event. This test also provided valuable data to evaluate interoperability and integration between THAAD, Aegis BMD, Patriot Advanced Capability-3, C2BMC, and various sensors during a live engagement.

In May and June 2012, the Aegis BMD program successfully completed intercepts using the new SM-3 Block IB missile which demonstrated increased capability for some of the system's components. In May 2012, the program intercepted a short-range target with its Block IB missile for the first time. The test demonstrated, among other things, the missile's improved capability to track and identify objects in space. In June 2012, the Aegis BMD SM-3 Block IB program completed another successful intercept test. During this test the missile intercepted a separating target and provided more insight into the missile's enhanced ability to discriminate the target from other objects during an engagement.

THAAD successfully conducted its first operational flight test in October 2011 before entering full-rate production.[32] This was also the first time Army and DOD test and evaluation organizations were involved to confirm that the test and the test results were representative of the fielded system. During the test, the THAAD system fired two interceptors and successfully—and nearly simultaneously—intercepted two short-range targets. The test demonstrated THAAD's ability to perform under operationally realistic conditions (within the constraints of test range safety), from initial stages of mission planning through the completion of the engagement. Additionally, this test incorporated fixes to a required safety device and supported the resumption of interceptor manufacturing. The Army also used this test as support for accepting the first two THAAD batteries for use by the warfighter.

[31]During the test, Aegis was able to successfully intercept a cruise missile with its standard missile-2 Block IIIA interceptor. The standard missile-2 Block IIIA interceptor is designed to intercept short-range ballistic missiles in the end part of their flight.

[32]Pursuant to MDA's acquisition flexibilities, once an element enters the production and deployment phase, the element enters the formal DOD acquisition system. Consequently, 10 U.S.C. § 2366 requires completion of realistic survivability testing of a weapon system before a program can begin full-rate production.

MDA Reduced the Acquisition Risk in the Aegis BMD SM-3 Block IIA and Block IIB Programs

MDA has taken steps to reduce acquisition risk by decreasing the overlap between technology development and product development for two of its programs—the Aegis BMD SM-3 Block IIA and the SM-3 Block IIB programs. Reconciling gaps between requirements and available resources before product development begins makes it more likely that a program will meet cost, schedule, and performance targets.

- The Aegis BMD SM-3 Block IIA program added time and money to the program to extend development. Following significant technology development problems with four components, MDA delayed the system preliminary design review—during which a program demonstrates that the technologies and resources available are aligned with requirements—for more than 1 year, thereby reducing its acquisition risk.[33] As a result, in March 2012, following additional development of the four components, the program was able to successfully complete the review.

- The Aegis BMD SM-3 Block IIB program responded to our April 2012 recommendation to reduce acquisition concurrency by delaying the start of product development until after its preliminary design review was complete.[34] By delaying the start of product development, the program increased the amount of technical knowledge it plans to achieve prior to committing to development. Additionally, the program is leveraging competition among contractors during the technology development phase, which we reported in April 2012 increases technical innovation.[35] Program management officials stated they have already seen benefits from this competition. For example, they stated they have a better understanding of the program's progress, performance possibilities for the missile, and risks associated with those possibilities.

[33]GAO-12-486.

[34]GAO-12-486.

[35]GAO-12-486.

MDA Continues Risky Acquisition Strategies for Six Other Programs, Some Already Resulting in Cost and Schedule Disruptions

Despite significant cost and schedule disruptions resulting from elevated acquisition risks in the Aegis BMD SM-3 Block IB, GMD, and THAAD programs, MDA continues to follow high risk acquisition strategies for its Aegis Ashore, PTSS, and Targets and Countermeasures programs. We reported in April 2012 that the Aegis BMD SM-3 Block IB, GMD, and THAAD programs discovered problems during developmental testing—and after production had begun—which delayed planned deliveries to the warfighter, increased costs, and affected MDA's supplier base.[36] In addition, for the Aegis BMD SM-3 Block IB and GMD programs, these issues also affected the performance of delivered missiles and created pressure to keep producing to avoid work stoppages even when problems were discovered in testing. In fiscal year 2012, the SM-3 Block IB and GMD programs continued to work on the issues that disrupted their production, but the THAAD program was able to overcome most of its issues. The Aegis Ashore and PTSS programs are also undertaking high risk acquisition strategies that include premature commitments to production that could result in schedule delays, cost increases, and performance shortfalls. Additionally, the Targets and Countermeasures acquisition strategy is adding risk to an upcoming major operational flight test because it is planning to use undemonstrated targets in this complex and costly test involving multiple MDA systems.

Aegis BMD SM-3 Block IB's Premature Commitment to Production Continues to Disrupt the Schedule

In 2012, the Aegis BMD SM-3 Block IB was able to partially overcome the production and testing issues exacerbated by its concurrent development and production strategy. MDA prematurely began purchasing SM-3 Block IB missiles beyond the number needed for developmental testing in 2010. In 2011, developmental issues arose when the program experienced a failure in its first developmental flight test and an anomaly in a separate SM-3 Block IA flight test, in a component common with the SM-3 Block IB. As a result, production was disrupted when MDA slowed production of the SM-3 Block IB interceptors and reduced planned quantities from 46 to 14. In 2012, the program was able to successfully conduct two flight tests which allowed the program to address some of the production issues by demonstrating a fix made to address one of the 2011 flight test issues. However, development issues continue to delay the program's fiscal year 2012 schedule and production. For example, MDA experienced further difficulties completing testing of a new maneuvering component—contributing to delays for a third flight test needed to validate the SM-3

[36] GAO-12-486.

Block IB capability and also subsequently delaying a production decision for certain components from December 2012 to February 2013.

In order to avoid further disruptions to the production line, the program plans to award the next production contract for some missile components needed for the next order of 29 SM-3 Block IB missiles in February 2013—before the third flight test can verify the most recent software modifications. The program then plans to award the contract to complete this order upon conducting a successful flight test planned for the third quarter of fiscal year 2013.The program is at risk for costly retrofits, additional delays and further production disruptions if issues are discovered during this flight test.

GMD Continues to Work to Overcome Developmental Issues, Restart Production, and Develop a Path Forward to Fix Already Manufactured Missiles

The GMD program continues to have production delays and cost increases intensified by its concurrent development and production strategy. In order to meet a presidential directive to field a limited capability to defend the United States, MDA simultaneously developed, produced and fielded the GMD system. In 2004, the agency fielded five GMD interceptors configured with the program's initial kill vehicle design referred to as the Capability Enhancement-I (CE-I) prior to completing development and testing. Although MDA had not yet fully completed development or demonstrated the full capability of these initial interceptors, in 2004 it committed to another highly concurrent acquisition strategy to develop, produce, and field additional interceptors with an upgraded kill vehicle known as the Capability Enhancement-II (CE-II). MDA proceeded to concurrently develop, manufacture and deliver 12 of these interceptors before halting manufacturing and delivery of interceptors due to a second flight test failure in December 2010.[37] To address the causes of the failure, the program redesigned a component in the kill vehicle's guidance system and is also planning to implement some changes to the firmware associated with it.[38] MDA planned to conduct two flight tests in 2012 to demonstrate the new design and resume manufacturing the interceptors. While the program was unable to conduct either test as planned, MDA conducted the first resolution test in January 2013, a non-intercept test, known as Control Test Vehicle-01.

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[37]MDA's first flight test with the CE-II configuration failed in January 2010 because of an assembly process quality issue.

[38]Firmware is software that is permanently placed on a hardware device.

While initial indications are that all components worked as intended, at the time of this review, analysis was ongoing.

We reported in April 2012 that the discovery of the design problem while production was already under way increased MDA costs to demonstrate and fix CE-II capability from approximately $236 million to over $1.2 billion.[39] This cost increase was due to the added costs of additional flight tests including the costs of the target and test-range, investigating the failure, developing failure resolutions, and fixing the already delivered CE-II missiles. Costs continue to grow because MDA has had to further delay the next CE-II intercept test originally planned for fiscal year 2012. Moreover, at the time of this review, the next CE-II intercept test date is yet to be determined as MDA is considering various options, including adding another flight test.

THAAD Overcame Past Production Issues after Extensive Delays and Increased Costs

As we reported in April 2012, problems encountered while THAAD was concurrently designing and producing interceptors led to slower delivery rates of interceptors for the first and second THAAD batteries. During fiscal year 2011 after several years' delay, 11 of the expected 50 operational interceptors were delivered. In fiscal year 2012, after a 15-month delay and increased costs, the program was able to deliver the remainder of the interceptors needed for the first two batteries after completing necessary testing of a safety device.

Aegis Ashore, PTSS, and Targets and Countermeasures Are Pursuing Acquisition Strategies with High Levels of Risk

The Aegis Ashore program, as we reported in April 2012, initiated product development and established cost, schedule, and performance baselines prior to completing the preliminary design review.[40] Further, we reported that this sequencing increased technical risks and the possibility of cost growth by committing to product development with less technical knowledge than recommended by acquisition best practices and without ensuring that requirements were defined, feasible, and achievable within cost and schedule constraints. In addition, the program committed to buy components necessary for manufacturing prior to conducting flight tests to confirm the system worked as intended. As a result, any design modifications identified through testing would need to be retrofitted to produced items at additional cost. However, the MDA Director stated in March 2012 that the Aegis Ashore development is low risk because of its

[39] GAO-12-486.

[40] GAO-12-486.

similarity to the sea-based Aegis BMD.[41] Nonetheless, this concurrent acquisition plan means that knowledge gained from flight tests cannot be used to guide the construction of Aegis Ashore installations or the procurement of components for operational use.

The PTSS program approved its third acquisition strategy in October 2012, and continues to include several important aspects of sound acquisition practices, such as competition and short development time frames. However, it also contains overlap between development and production. The PTSS program plans to finalize the satellite design, select a manufacturer, and commit to producing components for the next two operational satellites—all while a laboratory team develops and manufactures the first two satellites. This approach will not enable decision makers to fully benefit from the knowledge about the design to be gained from on-orbit testing of the laboratory-built satellites before committing to the next industry-built satellites. Also, these first four satellites will be operational satellites, forming part of the operational nine satellite constellation until they are replaced between 2025 and 2027. As a result, if on-orbit testing reveals the need for hardware changes, the program may face cost increases to implement changes, and the operational constellation may face performance shortfalls as it will not fully benefit from those changes until the initial four satellites are replaced.

MDA’s first use of a new target in its upcoming major operational flight test is adding risk to that test. This flight test, called Flight Test Operational-01, is planned to be one of the most complex tests MDA has attempted. This test will demonstrate the ability of multiple BMDS elements to defeat a raid of up to five near-simultaneous regional threats including two new air-launched extended medium-range ballistic missile targets, a short-range ballistic missile target, and two cruise missiles. The risk of this test is higher than it would otherwise be because MDA is using newly designed medium-range targets for the first time instead of first demonstrating them in a less complex and expensive scenario. Using these new targets puts this major test at risk of not being able to obtain key information should the targets not perform as expected. Developmental issues with this new medium-range target as well as

[41]In March 2012, the MDA Director was Lieutenant General Patrick O’Reilly. At the present time, the MDA Director is Vice Admiral James Syring.

identification of new software requirements have already contributed to delaying the test, which was originally planned for the fourth quarter of fiscal year 2012 and is now planned for the fourth quarter of fiscal year 2013.

Challenge: Ensure Program Baselines Support Oversight

While MDA made substantial improvements to the clarity of its reported cost and schedule baselines in fiscal year 2012, the information underlying these baselines is not yet sufficiently reliable. In addition, MDA's estimates are not comprehensive because they do not include costs from military services in reported life cycle costs for its programs. Instability in the form of MDA's frequent adjustments to its acquisition baselines makes assessing progress over time extremely difficult and, in many cases, impossible. Since we began annual reporting on missile defense in 2004, we have made a number of recommendations—and Congress has passed a number of laws—directing MDA to establish baselines for the expected cost, schedule, and performance of the BMDS and report deviations from the baseline as the programs progress. These recommendations and laws have offered a number of approaches to provide necessary information while preserving the MDA Director's acquisition flexibility. However, despite some positive steps forward since 2004, issues remain that limit the ability to meaningfully assess BMDS cost and schedule progress.

Although MDA Improved the Clarity of Its Reported Baselines, They Are Not Sufficiently Reliable or Comprehensive to Support Oversight

Most major defense acquisition programs are required to establish baselines prior to beginning product development. These baselines, as implemented by DOD, include key performance, cost, and schedule goals. Decision makers can compare the current estimates for performance, cost, and schedule goals against a baseline in order to measure and monitor progress. Identifying and reporting deviations from the baseline in cost, schedule, or performance as a program proceeds provides valuable information for oversight by identifying areas of program risk and its causes to decision makers. Baselines also help ensure that the full financial commitment is considered before embarking on major development efforts.

MDA, in response to statutory requirements, reported detailed baselines for several BMDS program elements, or portions of those program elements, for the first time in its June 2010 BMDS Accountability Report

(BAR).[42] These baselines are not like the baselines reported for other major defense acquisition programs. MDA established resource, schedule, test, operational capacity, technical, and contract baselines.[43] They were established for BMDS elements that, according to MDA, have entered product development but are not yet mature enough to enter the formal DOD acquisition cycle for full-rate production and deployment. MDA's baselines reported in the BAR are updated annually. Only the resource and schedule baselines have measureable goals and separately report and explain when the current program cost and schedule estimates have deviated to a certain extent from the baseline set in the prior year's BAR. For that reason, we focus our assessment on these two baselines.

The baselines reported in the 2012 BAR are for BMDS elements or major portions of those elements. For example, a major portion of an element may include an individual software version of the C2BMC element or an initial capability for GMD homeland defense. The 2012 BAR resource and schedule baselines we reviewed are

- Aegis BMD SM-3 Block IB with second generation weapon system software;
- Aegis BMD modernized weapon system software;
- Aegis Ashore;
- AN/TPY-2 increment 1—enables multiple radars to be managed and provides improved track accuracy, among other improvements;
- GMD initial homeland defense for a fundamental capability against intermediate- and long-range ballistic missile threats;
- THAAD 1.0 for a fundamental capability against short- and medium-range ballistic missiles; and

[42]Pub. L. No. 110-181, § 223(g) (2008).

[43]The operational capacity baselines, as defined in the 2012 BAR, present information on the fielding plans, capabilities and limitations, and supporting activities for operational capability deliveries. The technical baseline presented in the BAR is comprised of a list of capability needs derived from the warfighters' prioritized capabilities, enduring capabilities, current and future capabilities, and knowledge points which together define the way points the program must achieve to proceed successfully through development. The contract baseline presented in the BAR is a timeline for a set of MDA contracts designed to deliver integrated BMDS capabilities from request for proposals through proposal receipt, negotiations complete, contract award, and contract execution.

- Targets and Countermeasures intermediate-, medium-, and short-range ballistic missiles.[44]

MDA's 2012 resource baselines report costs for all the categories of the life-cycle—research and development, procurement, military construction, operations and support, and disposal costs.[45] The 2012 BAR also reports unit costs, which are usually reported in two ways:

(1) average procurement unit cost—the average cost to produce one unit, and

(2) program acquisition unit cost—the average cost to develop and produce one unit.[46]

According to the 2012 BAR, MDA separately reported and explained unit costs that increased by more than 5 percent from the prior year's baseline.

The schedule baseline includes key milestones and tasks, such as important decision points, significant increases in performance knowledge, modeling and simulation events, and development efforts. Some schedule baselines also show time frames for flight and ground tests, as well as for fielding and events to support fielding. According to

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[44]MDA established new baselines for common components for re-entry vehicles and associated objects for its different targets classes which are not covered in our assessment. In addition, MDA reported baselines for its command, control, battle management, and communications program as well as for other systems it is developing for Israeli programs which are not covered in this report.

[45]Research and development costs include development and design costs for system engineering and design, test and evaluation, and other costs for system design features. Procurement costs include total production and deployment costs (e.g., site activation, training) of the prime system and its related support equipment and facilities. Military construction costs include costs for major construction such as bases and buildings. Operations and support costs include costs of operating and supporting the fielded system, including all direct and indirect costs incurred in using the system, (e.g., personnel, maintenance, and sustaining investment). Disposal, or inactivation, costs include the costs of disposing of the prime equipment after its useful life.

[46]10 U.S.C. § 2432 defines, with respect to a major defense acquisition program, procurement unit cost as the amount equal to (1) the total of all funds programmed to be available for obligation for procurement for the program divided by (2) the number of fully configured end items to be procured. In addition, program acquisition unit cost is defined as the amount equal to (1) the total cost for development and procurement of, and system-specific military construction for, the acquisition program divided by (2) the number of fully configured end items to be produced for the acquisition program.

the 2012 BAR, MDA also separately reported and explained events delayed three months or more from the prior year baseline.

MDA Improved the Clarity of Its Reported Cost and Schedule Baselines in Fiscal Year 2012

In its 2012 BAR, MDA made several useful changes to its reported resource and schedule baselines in response to our concerns and congressional direction. We reported in March 2011 that MDA's schedule and resource baselines had several issues with clarity that limited their usefulness for oversight such as only reporting portions of life cycle costs.[47] In that report, we recommended that MDA provide more detailed explanations and definitions of information included in the resource baselines, label cost estimates to reflect the content reported and explain any exclusions, and include all sunk costs in all of its cost estimates and baselines. MDA concurred with two of these recommendations but stated that it did not intend to include sunk costs into its unit costs for Targets and Countermeasures because, based on the extensive reuse of previous missile components in the targets program, including all sunk costs would not reflect MDA program costs accurately. Congress, in the National Defense Authorization Act for Fiscal Year 2012, added more detailed requirements for the contents of MDA's acquisition baselines.

MDA addressed many issues affecting the clarity, consistency, and completeness of information reported in its BAR baselines by

- reporting the full range of life cycle costs borne by MDA in the 2012 BAR resource baselines;
- defining more clearly what costs are presented in the resource baselines and also noting and explaining when costs were excluded from the estimates; and
- including costs already incurred in the unit cost for Targets and Countermeasures so they were more complete.

In its 2012 BAR, MDA also addressed issues with its schedule baseline identified in our March 2011 report. For example, we found the BAR lacked a comprehensive list of planned deliveries and did not report major changes in planned dates for deliveries. Further, we recommended that the Secretary of Defense should ensure that MDA, as part of its acquisition baseline, include (1) a comprehensive list of actual versus planned quantities of assets that are or were to be delivered each fiscal

[47] GAO, *Missile Defense; Actions Needed to Improve Transparency and Accountability,* GAO-11-372, (Washington, D.C.: March 24, 2011).

year and (2) a report on variances of these quantities by fiscal year and the reasons for these differences.[48] As a new addition to its 2012 BAR, MDA addressed this first recommendation by adding a separate delivery table that provides more detailed information on deliveries and inventories. However, we are not yet able to assess significant changes to all of the planned delivery dates reported in the 2012 BAR because this was the first year that the information was reported in this format.

To provide further insight into its reported baselines, MDA also added a list of significant decisions made or events that occurred in the past year—either internal or external to the program—that affected program progress or baseline reporting. The agency also explained how these decisions or events affected each program. For example, DOD reduced AN/TPY-2 radar quantities which shortened the time to complete radar deliveries. These changes are reflected in the schedule baseline and the increase in unit costs. Understanding the effect of these decisions and events provides a valuable source of information for understanding why current estimates for unit costs or scheduled activities may differ from those reported either in the original or prior year's baseline.

Resource and Schedule Baselines Are Insufficiently Reliable or Comprehensive to Gauge Progress

While MDA has made some progress improving the clarity of its baseline reports, the agency has not yet addressed the underlying reliability issues with the cost estimates and schedules used to develop these baselines. One of the issues with the reliability of these estimates is that they are not comprehensive because they do not include costs from military services in reported life cycle costs for its programs. Until MDA's baselines are based on reliable information and are comprehensive, they will not be useful for decision makers to understand progress.

GAO-11-372

We recommended that the Secretary of Defense, to improve clarity, consistency, and completeness of the baselines reported to Congress, should ensure that MDA, in meeting new statutory requirements to include a cost estimate in each acquisition baseline for a program element, take steps to ensure these cost estimates are high quality, reliable cost estimates that are documented to facilitate external review.

Although MDA has plans in place, it has made little progress improving the quality of its cost estimates that support its resource baseline since we made a recommendation to improve these estimates in our March 2011 report. In that report, we assessed MDA's life cycle cost estimates using the *GAO Cost Estimating and Assessment Guide*. This guide is based on best practices in cost estimating and identifies key criteria for establishing high quality cost estimates. Our review found that the estimates we assessed were not comprehensive, lacked documentation, were not completely accurate, or were not sufficiently credible. For

[48] GAO-11-372.

example, the MDA documentation lacked sufficient evidence to be considered a high-quality cost estimate.

In June 2012, MDA completed an internal Cost Estimating Handbook, largely based on our guide, which, if implemented, could help address nearly all the shortfalls we identified in 2011. According to MDA's Director of Operations, the agency is also assembling an independent cost group to carry out the processes outlined in its handbook. Because the handbook was only recently completed, it is too early to assess whether the quality of MDA's cost estimates has improved.

According to our guide, completing and documenting an independent cost assessment is a key criteria for establishing reliable cost estimates. While DOD major defense acquisition programs must obtain an independent cost estimate before advancing through certain major milestones,[49] MDA has been exempted from these requirements. Nevertheless, DOD has conducted independent cost estimates for early versions of the Aegis BMD program, and for portions of the Space Tracking and Surveillance System, GMD, and THAAD programs. In addition, the Office of the Director for Cost Assessment and Program Evaluation is currently completing an independent cost estimate for PTSS that is planned to be released in the spring of 2013. According to officials from the Office of the Director for Cost Assessment and Program Evaluation, assessments have also been completed for the Aegis BMD program elements as part of a cost estimate for U.S. missile defense in Europe that has not yet been released. Once these estimates are released, we will review the Cost Assessment and Program Evaluation Office's findings related to them. Independent cost estimates for additional MDA elements will further improve the credibility of MDA's estimates.

In addition, according to our guide, the cost estimate should be comprehensive. Comprehensive estimates include both government and contractor costs of the program over its full life cycle, from inception of the program through design, development, deployment, and operation and support to retirement. The agency made improvements to its resource

[49] 10 U.S.C. § 2434 requires an independent cost estimate of the full life-cycle cost of the program before a major defense acquisition program can advance into system development and demonstration (now known as engineering and manufacturing development) or production and deployment. The full life-cycle cost must be provided to the decision maker for consideration.

baselines to include all of the life cycle costs funded by MDA from development through retirement of the program. However, the baselines do not include the operation and support costs funded by the individual military services. MDA officials told us in 2011 that they do not consider military service operation and sustainment funds to be part of a baseline because the services—not MDA—execute the funds. We recognize that the services execute these funds; however, they are part of the program's life cycle costs. It is unclear what percentage these costs are in the case of MDA elements because these estimates have not been reported, however for other programs outside of MDA they can be significant. By not including military service costs, the life cycle costs for some MDA programs could be significantly understated.

GAO-12-720R

To improve the transparency and needed accountability over the BMDS over the near and long term, we recommend the Director of MDA, for the long term, develop a plan, …, to ensure that best practices are applied to those schedules as outlined in GAO's Schedule Assessment Guide.

Similarly, in our July 2012 report, we used our Schedule Assessment Guide to assess five MDA program element schedules that support the baselines. We reported that none fully met the best practices identified in the guide.[50] Some schedules had major deficiencies. While our analysis of these five programs cannot be generalized to apply to all MDA programs, these results are nevertheless significant because a reliable schedule is one key factor that indicates a program is likely to achieve its planned outcomes. The Department of Defense concurred with our recommendations and MDA programs have taken some actions to improve their schedules. However, MDA has not yet had time to fully address our recommendations. We plan to continue to monitor their progress because establishing sound and reliable schedules is fundamental to creating realistic schedule and cost baselines.

Instability in the Content of Reported Baselines Makes Assessing Progress Difficult or Impossible

In order for baselines to be useful for managing and overseeing a program, they need to be stable over time so progress can be measured and so that decision makers can determine how best to allocate limited resources.[51] However, MDA only reports annual progress by comparing its current estimates for unit cost and scheduled activities against the prior year's estimates. As a result, MDA's baseline reports are not useful for tracking longer term progress. In contrast, DOD reports longer term

[50]GAO, *Schedule Best Practices Provide Opportunity to Enhance Missile Defense Agency Accountability and Program Execution,* GAO-12-720R (Washington, D.C.: July 19, 2012).

[51]GAO, *GAO Cost Estimating and Assessment Guide*, GAO-09-3SP (Washington, D.C.: March 2009).

progress for its other major defense acquisition programs. When we sought to make a longer-term comparison of the latest 2012 unit cost and schedule estimates against the original baselines set in 2010, we found that such a calculation could not be made in many instances because the content of the baselines had been adjusted from year to year in such a way that the baselines were no longer comparable. For example, a substantial amount of new program activities and costs were added to the reported baseline or work activities and costs were moved out of the cost or schedule baseline and placed into other baselines. In addition, there were instances where calculating a one-year change provided no insight into program progress because of these baseline adjustments. Specifics follow on Aegis Ashore, GMD, and Targets and Countermeasures.

Aegis Ashore

As we reported in April 2012, the instability of content in the Aegis Ashore program's resource baseline obscures our assessment of the program's progress.[52] MDA prematurely set the baseline before program requirements were understood and before the acquisition strategy was firm. The program established its baseline for product development for the Romania and Hawaii facilities in June 2010 with a total cost estimate of $813 million. However 3 days later, when the program submitted this baseline to Congress in the 2010 BAR, it increased the total cost estimate by 19 percent, to $966 million. Since that time, the program has added a significant amount of content to the resource baseline to respond to acquisition strategy changes and requirements that were added after the baseline was set. Because of these adjustments, from the time the total estimated cost for Aegis Ashore in Romania and Hawaii was first approved in June 2010 at $813 million, it has nearly doubled to its estimate of $1.6 billion reported in the February 2012 BAR. These major adjustments in program content made it impossible to understand annual or longer-term program progress.

These adjustments also affected the schedule baseline for Aegis Ashore. For example, many new activities were added to the baseline in 2012. In addition, comparing the estimated dates for scheduled activities listed in the 2012 BAR to the dates baselined in the 2010 BAR is impossible in some cases because activities from the 2010 BAR were split into multiple events, renamed, or eliminated all together in the 2012 BAR. MDA also redistributed planned activities from the Aegis Ashore schedule baselines

[52] GAO-12-486.

into several other Aegis BMD schedule baselines. For example, activities related to software for Aegis Ashore were moved from the Aegis Ashore baseline and were split up and added to two other baselines for the second generation and modernized Aegis weapon systems software. Rearranging content made tracking the progress of these activities against the prior year and original baseline very difficult and in some cases impossible. As a result, appendix III contains a limited schedule assessment of near-term and long-term progress based on activities we were able to track in the BAR.

GMD

GMD is moving activities and costs from a currently reported baseline to one that will be reported in the future, thereby obscuring cost growth. The GMD program's current baseline represents activities and associated costs needed to achieve an initial defense of the United States. Although the program planned to report a new baseline in the 2013 BAR for its next set of capabilities, it has delayed reporting this baseline by at least one year.

Despite significant technical problems, production disruptions and the addition of previously unplanned and costly work in its current efforts, the GMD total cost estimate as reported in the resource baseline has decreased from 2010 to 2012. We reported last year that GMD had a flight test failure in 2010 which revealed design problems, halted production, and increased costs to demonstrate the CE-II from $236 million to about $1.2 billion. This cost increase includes retrofit costs to already-delivered CE-II interceptors. Instead of increasing, the total costs reported in the BAR resource baseline have decreased because the program moved activities from out of its reported baseline. By moving these activities, MDA used the funds that were freed up for failure resolution efforts instead.[53] In addition, because the baseline for its next set of capabilities will be defined after these activities have already been added to it, the additional cost for these activities will not be identifiable. The full extent of actual cost growth may never be determined or visible for decision makers for either baseline because of this adjustment.

Targets and Countermeasures

MDA removed activities and costs from its Targets and Countermeasures resource baselines, making it impossible to assess longer term progress.

[53]The GMD program deferred activities for addressing obsolescence in GMD's ground systems, upgrading communication infrastructure at Fort Greely, Alaska, and performing CE-I interceptor upgrades and flight tests through fiscal year 2017.

For example, costs for common target components, such as re-entry vehicles and associated objects, which were previously included in the baselines for medium-range and intermediate-range targets, were removed and redirected into a separate, newly created baseline for common components. In addition, the agency also changed the way it calculated its targets baselines by removing support costs and adding costs incurred in previous years. While the agency adjusted the accounting rules retroactively for the 2011 BAR to enable direct cost comparisons with the 2012 BAR, it is not possible to compare the 2012 BAR baselines with the original baselines set in the 2010 BAR for any of the targets.

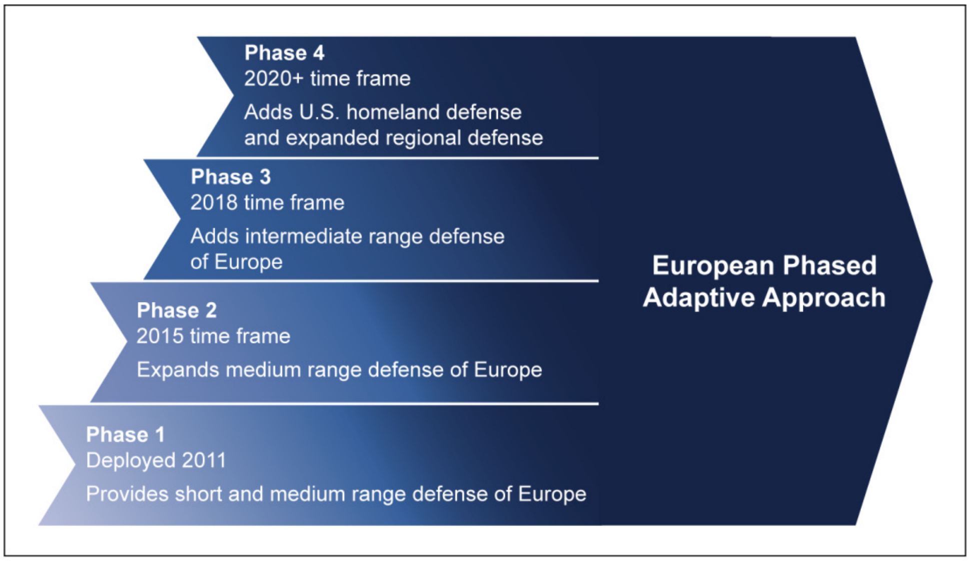
Challenge: Developing and Deploying U.S. Missile Defense in Europe

Developing and deploying new missile defense systems in Europe to aid in defense of Europe and the United States is a highly complex effort. We reported last year that several of the individual systems that comprise the current U.S. approach to missile defense in Europe—called the European Phased Adaptive Approach—have schedules that are highly concurrent. Concurrency entails proceeding into product development before technologies are mature or into production before a significant amount of independent testing has confirmed that the product works as intended. Such schedules can lead to premature purchases of systems that impair operational readiness and may result in problems that require extensive retrofits, redesigns, and cost increases. A key challenge, therefore, facing DOD is managing individual system acquisitions to keep them synchronized with the planned time frames of the overall U.S. missile defense capability planned in Europe. MDA still needs to deliver some of the capability planned for the first phase of the U.S. missile defense in Europe and is grappling with delays to some systems and/or capabilities planned in each of the next three major deployments. MDA also is challenged by the need to develop the tools, the models and simulations, to understand the capabilities and limitations of the individual systems before they are deployed. Because of technical limitations in the current approach to modeling missile defense performance, MDA recently chose to undertake a major new effort that it expects will overcome these limitations. However, MDA and the warfighters will not benefit from this new approach until at least half of the four planned phases have deployed.

Towards the end of our audit work, in March 2013, the Secretary of Defense altered the plans for developing and deploying missile defense systems in Europe and the United States for the protection of the United States. Specifically, the announcement canceled Phase 4 which planned to use Aegis BMD SM-3 Block IIB interceptors, and announced several other plans, including deploying additional ground based interceptors in Fort Greely, Alaska, and deploying a second AN/TPY-2 radar in Japan. In April 2013, DOD proposed canceling the PTSS and Aegis BMD SM-3 Block IIB programs in the Fiscal Year 2014 President's Budget Submission. Because the proposed cancellations occurred in the last few weeks of our audit, we were not able to assess the effects and incorporate this information into our report.

U.S. missile defense in Europe is a four-phase effort that relies on increasingly capable missiles, sensors, and command and control systems to defend Europe and the United States. The presidential announcement in September 2009 associated each phase with a specific time frame as shown in figure 2.

Figure 2: Time Frames and Defensive Capabilities for the U.S. Missile Defense in Europe



Source: GAO analysis of President's September 17, 2009, policy announcement and MDA and DOD data.

The first phase became operational in December 2011 and provides defense of Europe against short- and some medium-range ballistic missiles. MDA identified both the systems and the capabilities that the systems should have to enable defense of Europe against these threats. For example, C2BMC is needed and should be able to transmit data at a certain rate to an Aegis BMD ship during an engagement. The second phase plans a more robust defense against short- and medium-range ballistic missiles with the development of SM-3 Block IB missiles, and upgraded Aegis Weapons System software both at sea on Aegis BMD ships and on land at an Aegis Ashore site in Romania. The third phase is intended to add defense against intermediate -range ballistic missiles using the SM-3 Block IIA and an Aegis Ashore site in Poland. The fourth phase is expected to add an additional layer for defense of the United States against some intercontinental ballistic missiles using the SM-3 Block IIB as well as expand regional defense.

Capability Delays

As we reported in December 2010, the U.S. missile defense approach in Europe commits MDA to delivering systems and associated capabilities on a schedule that requires concurrency among technology, design, testing, and other development activities.[54] We reported in April 2012 that deployment dates were a key factor in the elevated levels of schedule concurrency for several programs. We also reported at that time that concurrent acquisition strategies can affect the operational readiness of our forces and risk delays and cost increases.[55]

GAO-12-486

We recommended that the Secretary of Defense Direct the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics to review and report to the Secretary of Defense the extent to which capability delivery dates announced by the President in 2009 are contributing to concurrency in missile defense acquisitions and recommend schedule adjustments where significant benefits can be obtained by reducing concurrency.

DOD declared Phase 1 operational in December 2011, but the systems delivered do not yet provide the full capability planned for the phase. MDA deployed, and the warfighter accepted, Phase 1 with the delivery of an AN/TPY-2 radar, an Aegis BMD ship with SM-3 Block IA missiles, an upgrade to C2BMC, and the existing space-based sensors. Given the limited time between the September 2009 announcement of the U.S. missile defense in Europe and the planned deployment of the first phase in 2011, that first phase was largely defined by existing systems that could be quickly deployed. MDA planned to deploy the first phase in two stages—the systems described above by December 2011 and upgrades to those systems in 2014. Although the agency originally planned to deliver the remaining capabilities of the first phase in 2014, an MDA official told us that MDA now considers these capabilities to be part of the second phase and these capabilities may not be available until 2015.

In addition, independent organizations determined that some of the capabilities that were delivered did not work as intended. For example,

[54]GAO, *Missile Defense: European Phased Adaptive Approach Acquisitions Face Synchronization, Transparency, and Accountability Challenges,* GAO-11-179R (Washington, D.C.: Dec. 21, 2010).

[55]GAO-12-486.

the Director, Operational Test and Evaluation reported that there were some interoperability and command and control deficiencies. This organization also reported that MDA is currently investigating these deficiencies.

According to MDA documentation, systems and associated capabilities for the next phases are facing delays, either in development or in integration and testing.

- For Phase 2, some capabilities, such as an Aegis weapon system software upgrade, may not be available. MDA officials stated they are working to resolve this issue.
- For Phase 3, some battle management and Aegis capabilities are currently projected to be delayed and the initial launch of a planned satellite sensor system—PTSS—is delayed.
- For Phase 4, deployment of the SM-3 Block IIB missile is delayed from 2020 to 2022, and full operational capability of PTSS is delayed to no sooner than 2023.

Modeling and Simulation Limitations

A key challenge for both the Director of MDA and the warfighter is understanding the capabilities and the limitations of the systems MDA is deploying before they are deployed, particularly given the rapid pace of development. A critical step in this effort is to have the tools—which are the models and simulations—to perform these integrated and complex assessments.[56] According to MDA's Fiscal Year 2012 President's Budget Submission, models and simulations are critical to understanding BMDS operational performance because assessing performance through flight tests alone is prohibitively expensive and can be affected by safety and test range constraints. Models and simulations, on the other hand, can be much less costly and are inherently not subject to the same safety and test range constraints. However, we have previously reported that MDA has struggled to develop these tools.

[56]A model is a representation of an actual system that involves computer simulations that can be used to predict how the system might perform or survive under various conditions or in a range of hostile environments. A simulation is a method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behavior of the system modeled under selected conditions or of evaluating various strategies for the operation of the system within the limits imposed by developmental or operational criteria. Simulation may include the use of digital devices, laboratory models, or “test bed” sites.

In August 2009, U.S. Strategic Command and the BMDS Operational Test Agency jointly informed MDA of a number of system-level limitations in MDA's modeling and simulation program that adversely affected their ability to assess BMDS performance. Since that time, we have reported that MDA has had difficulty developing its models and simulations to the point where it can assess operational performance. Over the past few years, the agency adopted different approaches to try to resolve issues with its modeling and simulation.

MDA continues to have difficulty credibly assessing operational performance using models and simulations. MDA declared the first phase of U.S. missile defense in Europe operational in December 2011, but did so without the benefit of all planned supporting data because of problems with a key modeling and simulation event. MDA officials and officials from the Operational Test Agency determined that there were too many issues with the models and simulations in the event for it to be useful for determining operational effectiveness for the planned configuration.[57]

More broadly, in their independent 2012 assessments, both the Director, Operational Test and Evaluation and the BMDS Operational Test Agency reported a lack of confidence in MDA's ability to completely and credibly model BMDS performance using existing models. Once a model or simulation is deemed credible, it can be used to explore the various operational conditions and reveal both the capabilities and limitations of the actual system. Without a full understanding of the capabilities and limitations of the first phase of U.S. missile defense in Europe, it is difficult for the warfighter and MDA to understand how the system will work in a real event or to develop solutions to problems that may arise with the systems and capabilities that have been delivered.

MDA recently committed to a new approach in its modeling and simulation program that officials stated could put them on a path to credibly model individual programs and system-level BMDS performance by 2017. To accomplish this, MDA is replacing the two existing simulation frameworks used for ground testing and performance assessments with one framework. By using one framework, the agency anticipates data quality improvements through consistent representations of the threat, the

[57] Phase I declaration was supported by several ground tests conducted prior to the modeling and simulation event.

environment, and communications at the system level. Without implementing these changes, MDA officials told us their ability to credibly model BMDS performance by the 2017 time frame, in time to assess the third phase of U.S. missile defense in Europe, is not possible.

MDA program officials told us that the next major assessment of U.S. missile defense in Europe for the 2015 deployment will continue to have many of the existing shortfalls. As a result, MDA is pursuing initiatives to improve confidence in the realism of its models in the near term. One of the agency's new initiatives involves identifying more areas in the models where credibility can be certified by the BMDS Operational Test Agency. A second initiative is focused on resolving the limitations identified jointly by the Operational Test Agency and U.S. Strategic Command. Lastly, MDA officials told us they are refining the process used to digitally recreate system-level flight tests in order to increase confidence in the models.

Conclusions

The new MDA Director faces long-standing acquisition management challenges that hamper the agency's ability to make wise investment choices, to develop and deliver cutting edge, integrated technologies within budget and time constraints, and to meet the President's goals for U.S. missile defense in Europe. At the same time, for over a decade, MDA has provided Congress with very limited insight into cost and schedule growth for individual elements. While baseline reporting is more complete and comprehensive, the fact remains there is no way to track cost and schedule growth over time using those baselines. This makes it difficult for Congress to hold MDA accountable and to consider the wisdom of continuing high risk efforts. Since its inception, MDA has been operating in an environment of working under tight time frames for delivering capabilities—first with a presidential directive in 2002 and then with a presidential announcement in 2009 on U.S. missile defense in Europe. Although pressure remains to develop and field systems to meet set time frames and increased threats, we have also reached a critical juncture in our nation's ability to afford spending limited funds to fix problems created by a high risk acquisition strategy.

GAO has made recommendations over the years aimed at addressing many of these challenges. We have noted several in this report that have not yet been acted on. As the new MDA Director works to address the challenges we have identified, fully implementing two prior recommendations in particular could prove beneficial. First, our 2009 recommendation to reconsider the testing and validation schedules of ballistic missile defense systems and ensure they are synchronized with the development, manufacturing and fielding schedules so that items are not manufactured for fielding before their performance has been validated through testing could help reduce the risk of production disruptions. Second, our 2012 recommendation to make adjustments to acquisition schedules to reduce concurrency could help reduce the acquisition risks in the U.S. missile defense in Europe.

Going forward, as Congress and DOD decide in which new missile defense programs to invest, they may lack a full understanding of the cost, technical feasibility, and operational requirements for those proposed new programs. Performing a robust analysis of alternatives, while not required of MDA, could be a proactive and beneficial step to laying a sound basis for determining which systems to pursue. Similarly, as MDA delivers increasingly complex missile defense systems, it is critical that it successfully conduct upcoming complex operational flight tests and gather necessary performance data. Reducing the risks tied to the first use of new types of targets in less critical tests before they are used in a major test could help put these programs on a better path to succeed. Finally, until MDA's baselines have comprehensive cost information and are stabilized, the progress of MDA's individual acquisitions cannot be assessed.

Recommendations for Executive Action

In order to strengthen investment decisions, place the chosen investments on a sound acquisition footing, provide a better means of tracking investment progress, and improve the management and transparency of the U.S. missile defense approach in Europe, we recommend that the Secretary of Defense direct MDA's new Director to take the following four actions:

1. Undertake robust alternatives analyses for new major missile defense efforts currently underway, including the SM-3 Block IIB, and before embarking on any other major new missile defense programs. In particular, such analyses should consider a broad range of alternatives.
2. Add risk reduction non-intercept flight tests for each new type of target missiles developed.
3. Include in its resource baseline cost estimates all life cycle costs, specifically the operations and support costs, from the military services in order to provide decision makers with the full costs of ballistic missile defense systems.

4. Stabilize the acquisition baselines, so that meaningful comparisons can be made over time that support oversight of those acquisitions.

Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. These comments are reprinted in appendix XI. DOD also provided technical comments, which were incorporated as appropriate.

DOD concurred with two of our four recommendations and partially concurred with the remaining two. DOD concurred with our first recommendation to undertake robust alternatives analyses for new major missile defense efforts currently underway and before embarking on any other major new missile defense programs. However, in its response, DOD stated that MDA currently performs studies and reviews that provide outcomes similar to analyses of alternatives formally conducted by other agencies. While we recognize in our report that MDA performed some limited analyses that considered alternatives for its newer programs, we also found that these reviews cannot be considered robust analyses of alternatives, in part, because the range of alternatives considered were too narrow. Without a sufficient comparison of alternatives and focus on technical and other risks, alternatives analyses may identify solutions that are not feasible and decision makers may approve programs based on limited knowledge. While many factors can affect cost and schedule outcomes, we reported in September 2009 that programs that had a limited assessment of alternatives tended to have poorer outcomes than those that had more robust analyses of alternatives.[58] A robust analysis of alternatives can also help ensure that key DOD and congressional decision makers understand why the chosen system was selected in order to prioritize limited investment dollars to achieve a balanced BMDS portfolio. As MDA conducts additional alternatives analyses for new programs, it is important that they be robust, comparing the costs, performance, effectiveness, and risks of a broad range of alternatives.

DOD partially concurred with our second recommendation to conduct risk reduction non-intercept flight tests for each new type of target missile developed. In its response, DOD agreed that non-intercept flight tests may be conducted for each new type of target--but not necessarily on each individual target developed. DOD stated that the decision to perform a non-intercept target test must be balanced against cost, schedule, and

[58] GAO-09-665.

programmatic impacts. In addition, DOD stated that MDA's qualification tests for key target components and proven quality control processes gave the confidence necessary for the agency to plan for and launch targets for the first time as part of a system-level flight test. However, while there may be exceptions that would need to occur when there is a critical warfighter need, in general, we remain concerned about the use of undemonstrated targets during complex, expensive tests. These tests remain critical to both MDA's development efforts and to independent assessors of missile defense performance because they are needed to demonstrate critical BMDS functions. Whenever possible, we believe MDA should avoid using undemonstrated targets, particularly for costly and complex major operational tests, because they add significant risks to those tests.

DOD partially concurred with our third recommendation for MDA to include in its BMDS Accountability Report baselines the full program life cycle costs, including operations and support costs from military services. While DOD agreed that decision makers should have insight into the full life cycle costs of DOD programs, it did not identify how the full life-cycle costs could be reported to decision makers. DOD further stated that the BMDS Accountability Report should only include content for which MDA is responsible and that it did not consider the BMDS Accountability Report an appropriate forum for including military services operation and support costs for BMDS elements. However, good budgeting requires that the full costs of a project be considered when making decisions to provide resources and, therefore, both DOD and Congress would benefit from a comprehensive understanding of the full costs of MDA's acquisition programs. DOD has reported full operation and support costs to Congress for major defense acquisition programs where one military service is leading the development of an acquisition planned to be operated by many military services. Limiting the baseline reporting for MDA acquisition programs to only MDA reported costs therefore precludes a full understanding of DOD's acquisition commitments, particularly the resource demands on the military services that will operate and maintain the planned missile defense weapon systems. Because MDA already reports the estimated acquisition costs and some of the operation and support costs for the acquisitions in the annual BMDS Accountability Report, we believe that annual document to be the most appropriate way to report the full costs to Congress. We also continue to believe that including these costs in that report will aid both departmental and congressional decision makers as they make difficult choices of where to invest limited resources.

DOD also concurred with our fourth recommendation to stabilize MDA's acquisition baselines so that meaningful comparisons can be made over time. DOD stated in its response that MDA's 2013 BMDS Accountability Report would contain both a one-year comparison between the current program baselines and the previously reported baselines as well as provide a longer-term comparison to the initial program baselines, when appropriate. DOD further stated that it is necessary to recognize that BMDS baselines change to respond to evolving requirements provided by other organizations and leaders, from the warfighters to the President, to counter changing threats. Finally, DOD stated that the MDA Director has authority to make these adjustments, within departmental guidelines. Our recommendation is not designed to limit the authority of the MDA Director to adjust baselines or prevent adjusting baselines when appropriate. As we reported in March 2005, a new baseline serves an important management control purpose when program goals are no longer achievable, because it presents an important perspective on the programs current status and acquisition strategy.[59] Our recommendation to stabilize acquisition baselines is designed to address the issues we found that are within MDA's control, such as prematurely setting baselines and decisions to move reported content between various program baselines. In order for MDA to effectively report longer-term progress of its acquisitions and provide necessary transparency to Congress, it will be critical for MDA to address these issues.

We are sending copies of this report to the Secretary of Defense and to the Director of MDA. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on

[59]GAO, *Defense Acquisitions: Information for Congress on Performance of Major Programs Can Be More Complete, Timely, and Accessible,* GAO-05-182 (Washington D.C.: Mar 28, 2005).

the last page of this report. GAO staff who made key contributions to this report are listed in appendix XII.

Cristina Chaplain
Director
Acquisition and Sourcing Management

List of Committees

The Honorable Carl Levin
Chairman
The Honorable James Inhofe
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Richard Durbin
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The Honorable Thad Cochran
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Howard McKeon
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The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable C.W. Bill Young
Chairman
The Honorable Pete Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Scope and Methodology

To assess any progress and any remaining challenges of selecting new Ballistic Missile Defense System (BMDS) programs in which to invest, we identified two Missile defense Agency (MDA) programs that were in the initial acquisition stages, the Precision Tracking and Space System (PTSS) and the SM-3 Block IIB. For these programs, we reviewed documentation of Missile Defense Agency (MDA) and Department of Defense (DOD) reviews that program management officials considered similar to an analysis of alternatives, and compared this documentation to acquisition best practices for analysis of alternatives and DOD acquisition guidance.[1] In addition, we examined recent legislation about a statutorily directed assessment of the PTSS and compared criteria written in the legislation to acquisition best practices for an analysis of alternatives.[2] Finally, we interviewed MDA and DOD officials about any reviews conducted that were relevant to an analysis of alternatives.[3]

To assess any progress and any remaining challenges MDA faces in putting missile defense acquisitions on a sound development path, we reviewed MDA element acquisition strategies and compared them to our best practice criteria.[4] To assess the extent to which MDA achieved stated acquisition goals and objectives, we reviewed the accomplishments for several Ballistic Missile Defense System elements and supporting efforts that MDA is currently developing and fielding: the Aegis Ballistic Missile Defense (Aegis BMD) with Standard Missile-3 (SM-3) Block IB; Aegis Ashore; Aegis BMD SM-3 Block IIA; Aegis BMD SM-3 Block IIB; BMDS Sensors; Ground-based Midcourse Defense (GMD); PTSS; Targets and Countermeasures; and Terminal High Altitude Area Defense (THAAD). We reviewed data collection instruments that we submitted to several elements' program offices. These instruments collected detailed information on schedule, cost, contracts, testing and

[1]GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, GAO-09-665 (Washington, D.C.: September 2009); and *Homeland Security: DHS Requires More Disciplined Investment Management to Help Meet Mission Needs*, GAO-12-833 (Washington, D.C.: Sept. 18, 2012).

[2]Pub. L. No. 112-239, § 224. Also see GAO-09-665 and GAO-12-833.

[3]We did not assess the reviews beyond whether they included information relevant for an analysis of alternatives.

[4]GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-12-400SP (Washington, D.C.: Mar. 29, 2012); and *Best Practices: Using a Knowledge-Based Approach to Improve Weapon Acquisition*, GAO-04-386SP (Washington, D.C.: January 2004).

performance, and noteworthy progress during the fiscal year. In addition, we examined Baseline and Program Execution Reviews, test schedules and reports, and production plans, where appropriate. We also discussed element- and BMDS-level testing plans and progress by meeting with officials within element program offices and MDA functional directorates, such as the Directorates for Engineering and Testing. We also examined the agency's Integrated Master Test Plan and discussed the elements' test programs and test results with the BMDS Operational Test Agency and DOD's Office of the Director of Operational Test and Evaluation.

To assess the progress made as well as any remaining challenges MDA faces in establishing program baselines that support oversight, we examined MDA's reported baselines in the 2010, 2011, and 2012 BMDS Accountability Reports (BAR). We interviewed officials in MDA's Acquisitions Directorate about how the agency is establishing and managing its internal baselines. We also met with MDA officials in the Operations Directorate to discuss their progress in adopting cost estimating best practices based on our Cost Guide.[5] We reviewed findings from our July 2012 report, which compared MDA program schedules to best practices in schedule development.[6] In addition, we examined DOD acquisition policy to discern how other major defense acquisition programs are required to report baselines and measure program progress. To gauge MDA element cost and schedule progress, we compared the resource and schedule baselines as presented in the 2012 BAR to the 2010 baselines presented in the June 2010 BAR. In order to present consistent cost comparisons for unit costs calculated in different years, there were instances where it was necessary to convert unit costs from base year 2010 dollars to base year 2011 dollars.[7] We performed these conversions using indexes published by the Office of the Secretary of Defense (Comptroller) in the National Defense Budget Estimates for Fiscal Year 2011, commonly referred to as the "Green Book." The results of our reviews are presented in detail in the element appendixes of this report and are also integrated into our findings, as appropriate. We did not present BAR schedule and cost analysis for the

[5]GAO-09-3SP.

[6]GAO-12-720R and GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-12-120G (Washington, D.C.: May 2012).

[7]By comparing costs presented in the same base year, we were able to ensure that cost changes in these dollar amounts were not due to inflation.

Aegis BMD SM-3 Block IIA, Aegis BMD SM-3 Block IIB, or PTSS programs because these programs have not yet begun MDA's product development phase and, subsequently, do not yet present baselines in the BAR. In addition, we narrowed our assessment of the Targets and Countermeasures baselines down to two medium-range targets, the extended medium-range ballistic missile and the extended long-range air-launched target because they were originally planned to be launched for the first time in 2012.

To assess any acquisition progress and any remaining challenges developing and deploying ballistic missile defense systems for the European Phased Adaptive Approach, we reviewed relevant policy and acquisition documents. In addition, we examined MDA's Integrated Master Assessment Plan; Integrated Master Test Plan; and Master Integration Plan to determine how MDA intended to test and assess its progress in developing and fielding BMDS capabilities. We also interviewed officials within MDA's System Assessment Office to discuss how the agency planned to assess BMDS capabilities once they had completed development. We reviewed ground and flight test reports to determine the extent to which those capabilities were meeting performance expectations. Additionally, we examined Combatant Command, BMDS Operational Test Agency, and Office of the Director, Operational Test and Evaluation assessments of the first phase of U.S. missile defense in Europe. We also interviewed officials with U.S. Strategic Command's Joint Functional Component Command for Integrated Missile Defense and U.S. Northern Command as well as MDA program offices and MDA functional directorates about MDA's progress in developing and deploying ballistic missile defense systems needed for the defense of Europe and the United States. We also discussed BMDS capabilities demonstrated through testing with officials in the BMDS Operational Test Agency and Office of the Director, Operational Test and Evaluation.

To assess any progress and any remaining challenges in developing its models and simulations, we reviewed MDA's Modeling and Simulation Master Plan as well as system-level verification and validation plan. We also met with MDA officials at the Missile Defense Integration and Operations Center as well as officials with the BMDS Operational Test Agency to understand the status of MDA's modeling and simulation program, progress in resolving past issues, and future plans.

Towards the end of our audit work, in March 2013, the Secretary of Defense altered the existing plans for developing and deploying missile defense systems in Europe and the United States for the protection of the United States. Specifically, the announcement canceled Phase 4 which planned to use Aegis BMD SM-3 Block IIB interceptors, and announced several other plans, including deploying additional ground based interceptors in Fort Greely, Alaska, and deploying a second AN/TPY-2 radar in Japan. In April 2013, DOD proposed canceling the PTSS and Aegis BMD SM-3 Block IIB programs in the Fiscal Year 2014 President's Budget Submission. Because the proposed cancellations and the release of the president's budget occurred in the last few weeks of our audit, we were not able to assess and incorporate either the proposed cancellations or the latest budget information into our report.

Our work was performed at MDA locations including their headquarters in Fort Belvoir, Virginia; various program offices in Dahlgren, Virginia, Falls Church, Virginia, and Huntsville, Alabama; the GMD element in Ft. Greely, Alaska; and MDA's Integration and Operations center in Colorado Springs, Colorado. In Fort Belvoir, Virginia, we met with officials from MDA's System Engineering Assessment Directorate. In Dahlgren, Virginia, we spoke with officials from the Aegis BMD program office, the Aegis Ashore program office, and the Aegis SM-3 Block IIA program office. In Falls Church, Virginia, we met with officials from the PTSS program office. In Huntsville, we interviewed program officials for the BMDS Sensors, GMD; Global Deployment, THAAD; and the Targets and Countermeasures program office. At that location, we also met with officials in MDA's Acquisition, Engineering, Test, and Cost Directorates as well as with officials in MDA's Advanced Technology Directorate who manage the Aegis BMD SM-3 Block IIB program.

We visited contractor facilities that we determined, based on MDA acquisition documentation, were working to address technical issues. These facilities are located in Huntsville, Alabama; Tucson, Arizona; Moorestown, New Jersey; and Salt Lake City, Utah. We discussed the latest GMD program test plans following flight test failures with Boeing officials in Huntsville. In addition, we met with Raytheon and Defense Contract Management Agency officials in Tucson to discuss the manufacturing of the Exoatmospheric Kill Vehicle and schedule issues for GMD, respectively. We also interviewed Raytheon officials in Tucson about various topics concerning the SM-3 Block IA, Block IB, and Block IIA programs. In Moorestown, we met with officials from Lockheed Martin to discuss the Aegis Ashore element with its SPY-1 radar. In Salt Lake City, we met with officials from Northrop Grumman to discuss their progress in addressing GMD flight test failures and their development of the new guidance system design.

We also met with Combatant Commands and independent testing agencies in Colorado Springs, Colorado; Huntsville, Alabama; and Alexandria, Virginia. In Colorado Springs, we spoke with officials from U.S. Northern Command and the U.S. Strategic Command's Joint Functional Component Command for Integrated Missile Defense. We interviewed officials from the BMDS Operational Test Agency in Huntsville to discuss MDA's performance assessment, as well as its models and simulations. In Alexandria, Virginia, we met with the Director, Operational Test and Evaluation to discuss MDA's test plans and results from recent testing.

We conducted this performance audit from March 2012 to April 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Aegis Ballistic Missile Defense (BMD) with Standard Missile-3 (SM-3) Block IB and Second Generation Weapon System Software

Recent Events	Overview
• First successful flight test intercept in May 2012. • Demonstrated improved discrimination capability in a June 2012 flight test. • Initial production decision delayed about two years to September 2013. • DOD approved upgrading Aegis ships to the second generation of aegis BMD weapon system software in March 2012. • Completion of maneuvering component qualification further delayed from third quarter fiscal year 2011 to the second quarter of fiscal year 2013.	➢ MDA rectified many issues discovered during 2011 flight tests. ➢ Concurrency continues to disrupt production and flight tests. ➢ The program is planning improvements to software and missiles to counter more advanced threats. ➢ Changes in funding, quantities as well as test issues affected cost and schedule baselines for the missile. ➢ Second generation weapon system software: costs increased but schedule activities completed as planned.

Background and Overview

Aegis BMD SM-3 Block IB with second generation Aegis weapon system software is a sea-based missile defense system designed to intercept ballistic missiles during the middle part of their flight. Key components include the Aegis Weapons System software, SPY-1 radar, battle management and command and control systems, and SM-3 missiles.[1] The Missile Defense Agency (MDA) is developing Aegis BMD in successive combinations of upgraded ship-based weapon system software and new versions of SM-3 missiles to improve defense against threat missiles with increased range and numbers. With the SM-3 Block IB and associated ship-based upgrades, the Navy anticipates expanding its defense capabilities against short-range ballistic missiles and medium-range ballistic missiles, as well as some intermediate-range ballistic missiles. MDA expects to operationally deploy the SM-3 Block IB in 2014 and make it available for use in defense of Europe in 2015.

The SM-3 Block IB missile features improvements over the Block IA with additional capabilities to identify, discriminate, and track objects during flight through an enhanced seeker and attitude control system for adjusting course. For example, the SM-3 Block IB seeker—a device used in missiles that locates a target by detecting light, heat, or other radiation

[1]Aegis BMD SM-3 Block IB missiles will also be deployed on land as part of the Aegis Ashore in the 2015 time frame for phase two of the European Phased Adaptive Approach.

waves—senses information in two distinct types of radiation waves instead of one, improving its ability to identify multiple objects associated with a ballistic missile that are close together. The SM-3 Block IB also incorporates a new maneuver component, the Throttleable Divert and Attitude Control System (TDACS). The TDACS improves the ability of the missile to maneuver to its target. The Aegis BMD second generation weapon system software more accurately locates, discriminates, and tracks the threat objects and sends more refined data to the SM-3 Block IB in real time compared to the first generation weapon system software.

MDA Rectified Many Issues Discovered During 2011 Flight Tests

MDA slowed production of its SM-3 Block IA and Block IB in order to redesign components and incorporate fixes to address both a failure in the program's first developmental flight test in September 2011 and a separate flight test anomaly in April 2011. In June 2012, the program executed the second of three intercept flight tests planned for fiscal your 2012, that are needed to validate SM-3 Block IB capability. In October 2012, the program was able to resume accepting deliveries. Some of the fixes to the issues from the September 2011 failed test are planned to be demonstrated in the next flight test planned during fiscal year 2013.

In the past year, the program identified the root cause of the September 2011 flight test failure and incorporated fixes. The failure review team traced the cause of the failure to an abnormal performance of the third stage rocket motor during thrust pulses, which control the final maneuvers of the missile. To address this issue, the program developed a new version of the second generation Aegis weapons system to control the amount of time between the pulses. According to the Aegis program office, these changes will have minimal consequences on missile performance and ship operations. Although the program successfully re-conducted the failed flight test in May 2012, it did so prior to implementing the software modifications and altered the scenario to avoid the malfunction. The program tested the modification in a February 2013 flight test. While the intercept was successful, a thorough assessment of the test has not yet been issued.

The program also determined the root cause of the anomaly in the April 2011 SM-3 Block IA flight test. MDA determined that it was caused by a component of the third stage rocket motor that is common to both the SM-3 Block IA and SM-3 Block IB missiles. After performing a redesign of the component that caused the anomaly, the program was able to successfully flight test this new design in June 2012.

In addition to verifying these fixes, the program demonstrated important new capabilities during its two successful fiscal year 2012 SM-3 Block IB flight tests. Its May 2012 flight test was the first intercept of a short-range ballistic missile target by the SM-3 Block IB with the second-generation Aegis BMD weapon system software. The test successfully demonstrated the capability to assess the success or failure of the intercept in real time, and gave the program additional insight into the improved capability of the missile to track and identify objects in space. During its June 2012 test, the missile intercepted a separating target when surrounded by debris. This test provided more insight into the missile's enhanced ability to distinguish the lethal object from other objects.

Concurrency Continues to Disrupt Production and Flight Tests

GAO-10-311

We recommended that the Secretary of Defense direct MDA to delay the manufacturing decision for SM-3 Block IB missiles intended for delivery to the fleet as operational assets until after (1) the critical technologies have completed developmental testing, (2) a successful first flight test demonstrates that the system works as intended, and (3) the successful conclusion of the manufacturing readiness review.

The program's continuing concurrency has disrupted production and testing over the past 3 years. The concurrency arose because MDA prematurely ordered more SM-3 Block IB missiles than needed for development before completing developmental qualification of a key component and before confirming the missile worked as intended in flight testing. Qualification is a step in development in which a component's performance is tested in a variety of expected conditions it may operationally encounter. Qualification of components is normally completed prior to conducting developmental flight tests and before beginning production of missiles beyond the number needed for developmental testing. We made a recommendation in our February 2010 report intended to address this concurrency risk.

Since that report, as developmental issues arose, MDA had to restructure both its production and test plans. For example, MDA was forced to reduce planned SM-3 Block IB quantities from 34 to 25 in fiscal year 2011, to free up funding needed to redesign the TDACS. Then, following the failure of the first SM-3 Block IB flight test in 2011, MDA established a new program baseline, and requested an additional $149 million, in part to investigate the failure, and to implement and assess necessary modifications. MDA also reduced the 2012 procurement from 46 to 14 missiles, delayed key production milestones by a year or more, and slowed delivery of SM-3 Block IB missiles already in production, accepting only missiles necessary for testing until modifications were validated. While this decision reduced the effects of the ongoing development issues, MDA's premature commitment to quantities beyond those needed for testing had other consequences. Slowing down the acceptance of SM-3 Block IB deliveries and reducing near-term production resulted in the need for additional investments to sustain suppliers of various SM-3 Block IB components. Additionally, once again the agency needed to extend the production of SM-3 Block IA missiles by purchasing 14 additional SM-3 Block IAs (a missile that shares many components with the SM-3 Block IB). MDA originally planned to end the production of SM-3 Block IAs in 2009 as production of the SM-3 Block IB began. However, it has needed to extend production three times in 2010, 2011 and 2012 in order to bridge the production gaps. To date, MDA has contracted for 55 more SM-3 Block IA missiles than originally planned.

The TDACS qualification was completed in February 2013 after many delays and additional cost. As we reported in April 2012, MDA only partially completed qualification testing of this component before conducting the first unsuccessful SM-3 Block IB developmental flight test in September 2011. During 2012, the program experienced multiple issues completing TDACS qualification tests, including a failure in October. MDA is still determining the cause of the failure. According to program documentation, this investigation is expected to cost $27.5 million. Although completion of qualification testing had previously been delayed over a year to the fourth quarter of fiscal year 2012, the recent issues further delayed the completion to February 2013.

These qualification issues are contributing to further cost growth, delays to the third flight test and preventing completion of the manufacturing readiness review. After the 2011 flight test failure occurred, MDA originally committed to completing three flight tests and a manufacturing readiness review prior to making a long lead production decision. The long lead decision begins the purchase of materials and components that must be procured earlier in order to maintain a planned production schedule. While the agency successfully completed two of those flight tests in 2012, it postponed the third, called FTM-19, to the third quarter of fiscal year 2013. The program estimates that this delay will cost the program an additional $16.7 million. MDA also held its manufacturing readiness review for the next procurement request in May 2012. This review demonstrated that the manufacturing processes were mature for most of the SM-3 Block IB components and demonstrated readiness for a manufacturing rate of two missiles per month. However, the program could not complete the review due to delays with the TDACS qualification. TDACS qualification issues have also contributed to delays for a long lead materiel production decision from December 2012 to February 2013, at an additional $19 million.

In order to avoid further disruptions to the production line, MDA plans to award the next production contract for some components of 29 additional missiles in February 2013—before the third flight test can verify the most recent software modifications. According to program documentation, delaying this decision further until after the next flight test—currently slated for the third quarter of fiscal year 2013—could result in a production gap, requiring additional funding to maintain the industrial line. The program plans to award the contract for up to 29 whole missiles after the successful performance in the third quarter of fiscal year 2013 flight test. The program is at risk for costly retrofits, additional delays and further production disruptions if issues are discovered during this flight test.

The Program Is Planning Improvements to Software and Missiles to Counter More Advanced Threats

The Aegis program officials are planning to make further improvements to the second generation Aegis weapon system software and to develop an enhanced capability SM-3 Block IB (upgraded SM-3 Block IB) to counter advanced threats expected after 2015. The program plans to complete the necessary software and firmware upgrades in July 2014, flight test it in fiscal year 2014, and field it by the 2015 time frame. Program officials project the effort to cost an estimated $86.6 million over the course of five years.

Changes in Funding, Quantities As Well As Test Issues Affected Cost and Schedule Baselines for the Missile

MDA's Director approved a new baseline for the Aegis BMD SM-3 Block IB program in June 2011 and reported it in the 2012 BMDS Accountability Report (BAR). The new baseline addresses changes caused by the design modification of the TDACS.

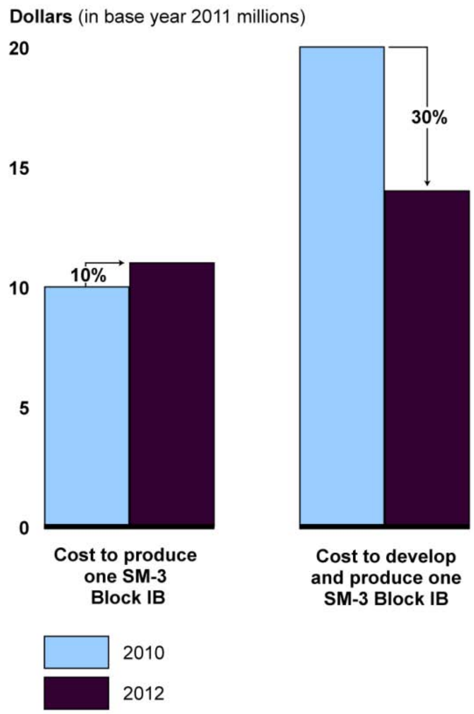
Funding Changes and Increased Quantities Affected Aegis BMD SM-3 Block IB Unit Costs

MDA reported that the average cost to produce one Aegis BMD SM-3 Block IB missile increased by 10 percent from the 2010 to the 2012 BAR because the program changed the way it funded initial spares. The program began funding initial spares and production engineering with procurement funds instead of development money. Because procurement funds are used for the production of operational assets, this accounting change increased the reported unit cost. Although this change was above the 5 percent reporting threshold that MDA established in its 2012 BAR, the $1 million dollar change in the average cost to produce a missile was not separately reported because the agency attributed this increase to an accounting change and not to real cost growth.

The 2012 reported average cost to develop and produce one Aegis BMD SM-3 Block IB missile decreased by approximately 30 percent from the 2010 baseline because the total number of missiles planned increased by

219 percent. The cost decreased because of efficiencies gained by producing more each year. Figure 3 shows the unit costs as reported in the 2010 and 2012 BMDS Accountability Reports.

Figure 3: Comparison of 2010 and 2012 BAR Reported SM-3 Block IB Unit Costs

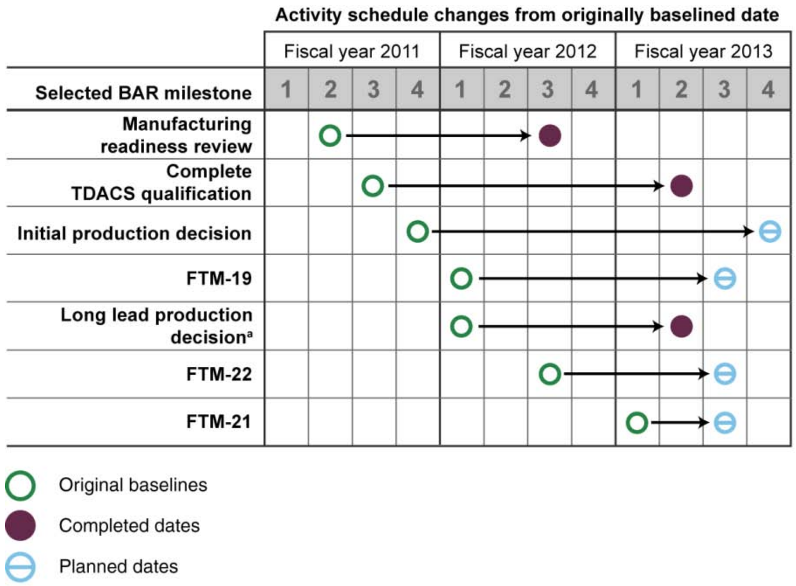


Source: GAO analysis of MDA data.

Test Issues Are Causing Schedule Delays

The Aegis BMD SM-3 Block IB had a number of schedule delays caused by issues discovered in 2011 flight tests and issues discovered during qualification tests in 2012. The 2011 issues (1) contributed to delays to the program's manufacturing readiness review and (2) affected the flight test schedule by adding one flight test in 2012 and delaying two others. Additionally, the missile's maneuvering component failed a qualification test in 2012, which delayed the completion of its qualification program. The qualification delays coupled with the 2011 flight test issues have delayed the next flight test and the long lead production decision by over a year and delayed the initial production by two years. Figure 4 shows schedule changes made.

Figure 4: Schedule Assessment for Selected Aegis BMD SM-3 Block IB Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

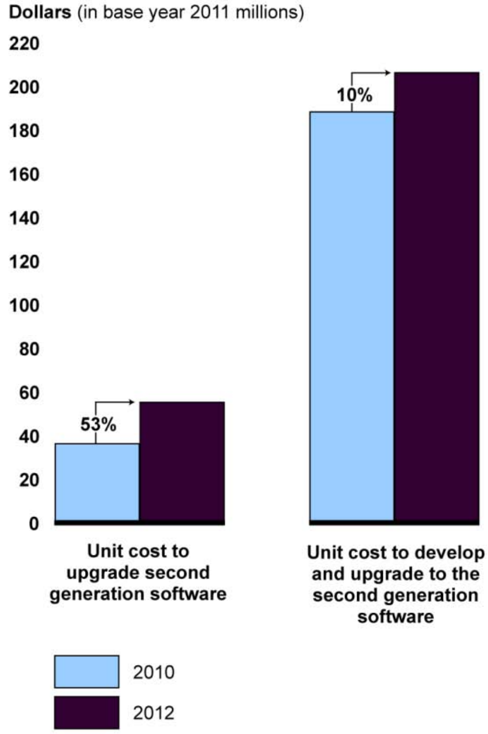
Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Originally baselined in 2011 BAR.

Second Generation Weapon System Software: Costs Increased but Scheduled Activities Completed As Planned.

Unit costs increased for the Aegis BMD second generation weapon system software because of decreased quantities and the inclusion of costs previously excluded. According to program officials, unit costs to upgrade to this new version of the software include installation of the software as well as hardware, such as computers and displays, to Aegis ships. The reported unit cost to upgrade to the Aegis BMD second generation weapon system software increased by over 50 percent from the originally anticipated unit cost reported in the 2010 BAR. In addition, the unit cost to both develop and upgrade to the second generation weapon system software increased by 10 percent from the reported 2010 BAR cost. The majority of these cost increases occurred between 2010 and 2011. MDA explained in 2011 that the increases to these unit costs were due to government costs, which were erroneously excluded from the 2010 unit cost calculations but were included in the 2011 BAR unit costs. In addition, the unit cost to both develop and upgrade to the second generation software increased in part because of a decrease in the number of ships receiving the installations. Figure 5 shows the unit costs as reported in the 2010 and 2012 BMDS Accountability Reports.

Figure 5: Comparison of 2010 and 2012 BAR Reported Aegis BMD Second Generation Weapon System Software Unit Costs



Source: GAO analysis of MDA data.

MDA began installing the second generation Aegis Weapons System software as planned for two ships in fiscal year 2012 with only a minor schedule slip in the planned installation for a third Aegis BMD ship. After installations are complete, there will be four second generation Aegis capable ships in the fleet.

Appendix III: Aegis Ashore with Modernized Weapon System Software

Recent Events	Overview
• Awarded deckhouse construction contract. • Started construction of Romania facility. • Completed system critical design review. • Established baseline for the Poland Aegis Ashore facility. • Requested radio-frequency spectrum allocation for the Romania Aegis Ashore facility.	➢ Aegis Ashore made design and construction progress in fiscal year 2012. ➢ Aegis Ashore schedule remains challenging. ➢ Concurrent development and production has increased. ➢ Aegis Ashore faces continued challenges related to radio-frequency spectrum. ➢ Total estimated costs have increased from $813 million to $1.6 billion, but progress cannot be assessed because of baseline instability. ➢ MDA established new baselines for its Poland site. ➢ Large adjustments to schedule baseline limited insight into program progress.

Background and Overview

Aegis Ashore is planned to be a land-based, or ashore, version of the ship-based Aegis BMD. Aegis Ashore is to track and intercept ballistic missiles in the middle of their flight using SM-3 interceptors. Key components include a vertical launching system with SM-3 missiles and an enclosure, referred to as a deckhouse, that contains the SPY-1 radar and command and control system. Aegis Ashore will share many components with the sea-based Aegis BMD and will use future versions of the Aegis weapon system that are still in development. MDA plans to equip Aegis Ashore with a modified version of the Aegis weapon system software developed jointly with the Navy as part of its modernization program. The new software is to integrate Aegis ship anti-air defense with ballistic missile defense, expanding the number of Aegis ships that are capable of ballistic missile defense. The modified version of the Aegis weapon system software that is planned for Aegis Ashore is to retain the ballistic missile defense capabilities being developed and suppress or otherwise disable the other capabilities. DOD plans to deploy Aegis Ashore in Romania with the SM-3 Block IB in the 2015 time frame and in Poland in the 2018 time frame.

A total of three Aegis Ashore facilities are planned. The program is currently constructing two of these facilities—an operational facility planned for Romania and a second facility for developmental testing in Hawaii. The Romanian facility is to be constructed and undergo Aegis radar testing in New Jersey before being shipped to Romania. The Hawaiian test facility is to begin construction after the Romanian operational deckhouse construction is underway. The construction plans for the Poland Aegis Ashore site have not been finalized, but the construction could potentially begin in fiscal year 2015.

Included in this appendix are analyses of the cost and schedule baselines for the Aegis weapon system modernization effort, which, while it will be used by Aegis Ashore, will also be used by Aegis BMD ships.

Aegis Ashore Made Design and Construction Progress in Fiscal Year 2012

Aegis Ashore completed key engineering design reviews in fiscal year 2012, determining that the design meets program requirements as well as cost, schedule, and reliability targets. The program successfully completed its system critical design review in December 2011. In addition, the deckhouse design was 100 percent completed in February 2012 indicating that the design may be stable and could meet requirements.

In fiscal year 2012, the program began construction in New Jersey for the Romanian Aegis Ashore facility. The program had to design the facility so that it could be reconstituted—or disassembled and ready for transport to another location within 120 days. As a result, the program is using skids—which are flat surfaces on which deckhouse equipment is secured and slid into place. During fiscal year 2012, the program built the skids and started loading the equipment. Officials for the contractor told us that as of October 2012, the majority of the skids had been completed. In addition, in early fiscal year 2013 the program received congressional authorization to exchange equipment originally planned for one of the Navy's Aegis BMD destroyers with equipment planned for Romania. Without this approval, the equipment needed for the Romanian facility would not have been ready in time.

The program also awarded a contract for the Hawaiian test site in June 2012 and began site preparation and construction.

Aegis Ashore Schedule Remains Challenging

While the program made significant progress in fiscal year 2012, its schedule is difficult because of extremely limited time between events. Further, according to program documentation the greatest risk to the program is meeting the established schedule particularly (1) integration testing in Hawaii and New Jersey, (2) potential shipping or transportation delays, and (3) construction delays for the operational and test facilities.

Program management officials stated they are confident that they will meet the commitment to field the Romania facility by 2015. In addition, officials for the contractor stated that while they previously had concerns about the schedule, the progress made during fiscal year 2012 and the current pace of the work underway had relieved these concerns.

However, there were delays in fiscal year 2012 that may affect the schedule. There was a delay in the contract award for deckhouse construction that postponed the first risk reduction flight test by one quarter to the third quarter of fiscal year 2014. The Aegis Ashore schedule contains more risk before this flight test and less risk between that test and the planned fielding in Romania. Program management officials told us they organized the schedule in this way to increase the amount of time to resolve any issues that emerge from the flight test. With the delay in the test flight, the time available to resolve issues, however, has been reduced.

Concurrent Development and Production Has Increased

The Aegis Ashore program continues to follow a concurrent acquisition strategy with elevated levels of acquisition risk. We reported in April 2012 that given the plan to field Aegis Ashore by the 2015 time frame, the program's schedule contains a high level of concurrency—buying weapon systems before they demonstrate, through testing, that they perform as required.[1] Further, under such a strategy, problems are more likely to be discovered in production, when it is too late or very costly to correct them. The MDA Director stated in March 2012 that Aegis Ashore development is low risk because of its similarity to the sea-based Aegis BMD.[2] However, we reported in April 2012 that the short amount of time for integrating and fielding Aegis Ashore could magnify the effects of any problems that arise.[3]

MDA recently increased the concurrency for the remaining effort. We reported in April 2012 that the first intercept test would not occur until the second half of fiscal year 2014, at which point two of the three deckhouses would already be completed, and Aegis Ashore site

[1]GAO-12-486.

[2]In March 2012, the MDA Director was Lieutenant General Patrick O'Reilly. At the present time, the MDA Director is Vice Admiral James Syring.

[3]GAO-12-486.

construction and interceptor production well under way.[4] MDA now plans to order long-lead materials for the final Aegis Ashore site in Poland in January 2014—prior to conducting any of the developmental flight tests. Although the program is to procure materiel already used by the sea-based Aegis, committing to all three planned Aegis Ashore facilities prior to demonstrating that the system works as intended puts the program at risk for costly rework should issues be discovered during testing.

Aegis Ashore Faces Continued Challenges Related to Radio-Frequency Spectrum

Radio-frequency spectrum is used to operate both the SPY-1 radar used by Aegis BMD, as well as provide an array of wireless communication services to the civilian community, such as mobile voice and data services, radio and television broadcasting, and satellite-based services. According to guidance on spectrum management from the International Telecommunication Union, because of the potential overlap and interference between these different uses, radio-frequency is regulated by countries.[5] In particular, given that it is a shared resource, national governments monitor and manage frequencies to prevent and eliminate harmful interference. According to the guidance, in the European Union, national standards reflect European standards and national policy is to implement European policy. In March 2011 and April 2012, we raised that Aegis Ashore faces two issues related to radio-frequency spectrum: (1) the possibility that the SPY-1 radar might interfere with host nation wireless usage; and (2) the program and the relevant host nation authorities must work together to ensure that host nations approve use of the operating frequency needed for the SPY-1 radar.

Program management officials told us that they are analyzing whether or not the SPY-1 radar's frequency usage would interfere with wireless usage in Romania. They expect to conclude this analysis in 2013. Although program management officials stated that the program could address potential frequency interference, they also stated that some potential adjustments could be costly and would have unknown effects on the radar's operational capability. In addition, a program management

[4] GAO-12-486.

[5] The International Telecommunication Union is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services. The guidance mentioned is International Telecommunication Union Report ITU-R SM.2093-1 (09/2010) Guidance on the Regulatory Framework for National Spectrum Management.

official stated a preference to not make changes to Aegis Ashore or its operating frequency, both because of the cost of such changes and a desire to ensure limited differences between Aegis Ashore and Aegis BMD ships.

The program has requested the use of the SPY-1 operating frequency in Romania. The program has identified this request as a top issue for Aegis Ashore.

Total Estimated Costs Have Increased from $813 million to $1.6 billion, but Progress Cannot Be Assessed Because of Baseline Instability

Instability in the Aegis Ashore program's resource baseline makes it impossible to understand annual or longer-term progress by comparing the latest reported estimates to the prior year baseline or the original baseline. In order for baselines to be useful for managing and overseeing a program, they need to be stable over time so progress can be measured and so that decision makers can determine how best to allocate limited resources. The total estimated costs for an Aegis Ashore in Romania and Hawaii have increased from $813 million to $1.6 billion from the time the program first established baselines to the estimate reported in the February 2012 BMDS Accountability Report (BAR).

As we reported in April 2012, MDA prematurely set the Aegis Ashore baseline in 2010 before program requirements were understood and before the acquisition strategy was firm.[6] The program established its baseline for product development in June 2010 with a total cost estimate of $813 million. However 3 days later, when the program submitted this baseline to Congress in the 2010 BAR, it increased the total cost estimate by 19 percent to $966 million. The program attributed these changes to refined program requirements and a review of earlier estimates.

Since that time, the program has repeatedly added and moved a significant amount of content to both its resource and schedule baselines to respond to acquisition strategy changes and requirements that were added after the baseline was set. For example, in the 2012 BAR, the cost to complete these efforts increased to $1.6 billion because the program added costs that were previously accounted for under another program and added costs that were a part of the program but had not been included in prior BAR baselines. In addition, the program's unit cost

[6] GAO-12-486.

baselines were significantly affected by new requirements for the program to pay for its deckhouse construction costs with development money instead of military construction funds. However, despite these changes, the resource baseline still does not include all costs associated with Aegis Ashore—such as for the Aegis Ashore adjustments needed to the Aegis BMD modernized weapon system software.

The Aegis Ashore program rebaselined its estimates for the Romania and Hawaii facilities in June 2012, which resulted in a minor increase to its total cost estimate. A program management official stated that program costs will continue to change as future contracts, most of which are Navy contracts outside of the control of the program, are negotiated. However, the official stated that the 2013 BAR should report more concrete costs as more contracts will have been negotiated.

MDA Established New Baselines for Its Poland Site

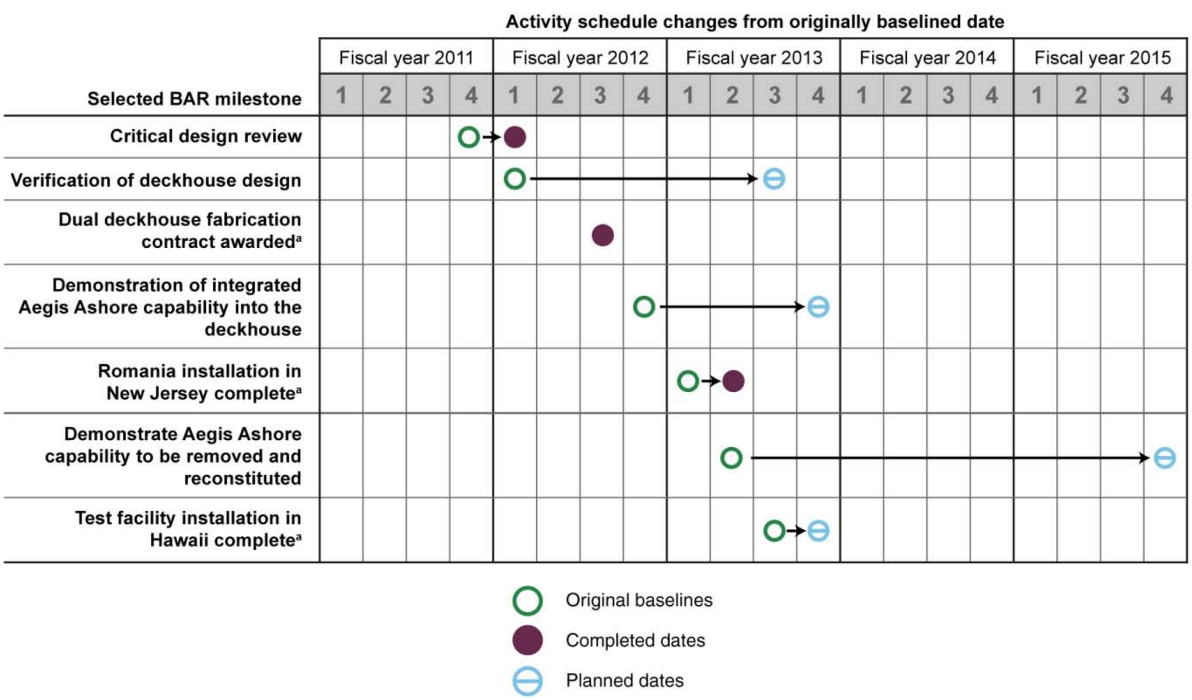
In July 2012, MDA established a resource baseline for the Poland Aegis Ashore facility. The Poland baseline, with a total estimated cost to develop and procure the facility of $746 million, includes MDA operations and support, disposal, global deployment, military construction, and production and deployment costs. Based on these new baselines, the MDA reported costs of all three Aegis Ashore facilities is $2.3 billion. It remains unclear what if any costs would be borne by other DOD organizations, such as the Navy, to operate and maintain these facilities over time.

Large Adjustments to Schedule Baseline Limited Insight into Program Progress

MDA's many adjustments to the Aegis Ashore schedule baseline content affected our ability to assess progress. Many new activities were added in 2012. In addition, comparing the estimated dates for scheduled activities listed in the 2012 BAR to the dates baselined in the 2010 BAR is impossible in some cases because activities from the 2010 BAR were split into multiple events, renamed, or eliminated all together in the 2012 BAR. MDA also redistributed planned activities from the Aegis Ashore schedule baselines into several other Aegis BMD schedule baselines. For example, activities related to software for Aegis Ashore were moved from the Aegis Ashore baseline and were split up and added to two other baselines for the Aegis second generation and modernized weapon system software. Rearranging content made it impossible to track the progress of some of these activities against the prior year and original baselines. While we were not able to track all of the scheduled events from prior years, there were a selected number of activities we were able to track, for which we provide an assessment below.

Due to schedule pressures experienced in 2011, the program adopted a new deckhouse acquisition strategy in fiscal year 2011, in which the test deckhouse and first operational deckhouse are constructed concurrently, that changed the previous schedule for many activities. While the program was able to hold the system-level critical design review with only a quarter slip, many of the key events that were planned in fiscal years 2012 and 2013 were delayed a year or more. For example, confirmation of the deckhouse design was delayed by a year and a half to the third quarter of fiscal year 2013, and demonstrating the Aegis Ashore capability integrated in the deckhouse slipped one year to the fourth quarter of fiscal year 2013. In addition, the planned date to demonstrate Aegis Ashore's ability to be moved to a new location and reconstituted has been delayed approximately 2.5 years to the fourth quarter of fiscal year 2015 as seen in figure 6.

Figure 6: Schedule Assessment for Selected Aegis Ashore Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Originally baselined in 2012 BAR.

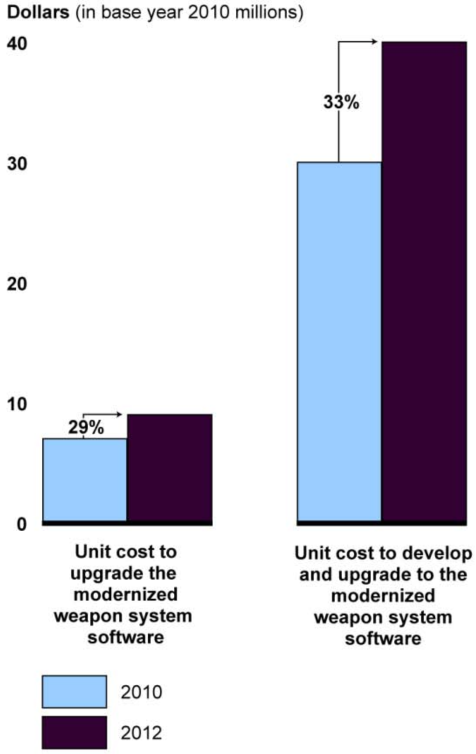
Addition of Activities for Aegis Ashore and New Software Version Increased Unit Costs for Modernized Weapon System Software and Rearranged Schedule Baselines

The Navy and MDA are developing a modernized version of the Aegis weapon system software for fleet wide use and use with Aegis Ashore. The Aegis modernized weapon system software is being developed in two versions: the first integrates the Aegis BMD second generation weapon system software with Aegis ship anti-air defense capabilities, while the second contains a Capability Upgrade to improve on the types and the numbers of ballistic missiles this system can engage. The Capability Upgrade version of the software was added to the baseline for the first time in the February 2012 BAR. Aegis Ashore is planned to initially be deployed with the Capability Upgrade version.

Unit Costs Increased after Adding a New Software Version and Activities to Adapt It to Aegis Ashore

Between the 2010 and 2012 BAR, the reported unit costs for the modernized weapon system software increased significantly, as seen in figure 7, because the estimates now include additional funds for a new software version and other efforts needed to adapt it for the Aegis Ashore. For example, the unit cost to upgrade to the modernized software increased by 29 percent and the unit cost to develop and upgrade to the modernized software increased by 33 percent from the baselines originally reported in the 2010 BAR. These unit costs increased because the total estimated development costs for the Aegis BMD modernized weapon system software increased by 30 percent to include costs for an Aegis Ashore computer program as well as the new Capability Upgrade version of the software. Although these unit cost changes were above the 5 percent reporting threshold that MDA established, they were not separately reported because the agency attributed these increases to expanded program content and not to real cost growth.

Figure 7: Comparison of 2010 and 2012 BAR Reported Aegis BMD Modernized Weapon System Software Unit Costs



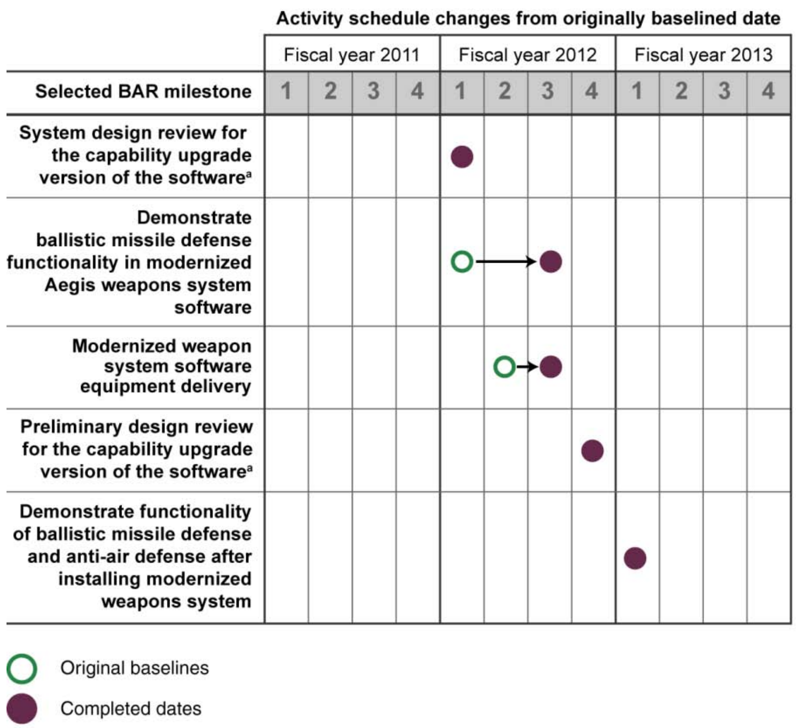
Source: GAO analysis of MDA data.

Consolidating Existing Schedules with New Efforts Obscures Schedule Progress

In 2012, MDA consolidated the existing baseline for modernized Aegis software with activities required to adapt it to operate on land in Aegis Ashore. In addition, the original baseline was expanded to include activities for the development of the capability upgrade version of the software. Because of these changes, it was impossible to track the progress for all previously baselined activities. Selected activities we were able to track are discussed below.

The modernized Aegis weapon system software program met many of its schedule goals in fiscal year 2012 and early 2013, with only small delays. For example, the program delivered the modernized weapon system software for installation on a Navy destroyer in the third quarter of fiscal year 2012, after a minor delay. The most significant delay was in the demonstration of ballistic missile defense capabilities for the system software which was delayed by almost two fiscal quarters. Specifically, the program encountered challenges with integrating the multi-mission signal processor—a key component responsible for integrating ballistic missile defense and anti-air defense capabilities so they can be executed simultaneously. The program demonstrated a full system integration of anti-air defense and ballistic missile defense capability in the first quarter of fiscal year 2013, as seen in figure 8.

Figure 8: Schedule Assessment for Selected Modernized Aegis Weapon System Software Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Originally baselined in 2012 BAR.

Appendix IV: Aegis BMD SM-3 Block IIA with Third Generation Aegis Weapons System Software

Recent Events	Overview
• Completed a key engineering review—the system-level preliminary design review. • Signed a contract for the remainder of the cooperative development program. • Started component critical design reviews.	➢ Program successfully completed its preliminary design review. ➢ Program faces technology development challenges. ➢ Program faces key decisions on plans for the SM-3 Block IIA following the completion of the cooperative development program.

Background and Overview

The SM-3 Block IIA is the third SM-3 version to be developed for use with the sea-based and future land-based Aegis BMD. Most of the SM-3 Block IIA components will differ from the versions used in the SM-3 Block IB, so technology has to be developed for the majority of the SM-3 Block IIA components. The SM-3 Block IIA will be configured with a kill vehicle on top of three stages of rocket motors. The first two rocket motors will propel the missile and then the third stage rocket motor will lift the missile out of the atmosphere and direct the kinetic kill vehicle into its intended target. The kill vehicle will have a throttleable divert and attitude control system that is used to adjust its course as it nears the threat. The kill vehicle will also be enclosed by a nosecone covering the top of the missile. This missile is planned to have increased range compared to earlier SM-3s. The SM-3 Block IIA is also planned to have more sensitive seeker technology and an advanced kill vehicle compared to the SM-3 Block IB. The SM-3 Block IIA is expected to defend against medium- and intermediate-range ballistic missiles.

Initiated in 2006 as a cooperative development program with Japan, the SM-3 Block IIA is planned to be fielded with the third generation Aegis weapon system software by the 2018 time frame as part of the third phase of the U.S. missile defense in Europe. Because the program is in the technology development phase, the SM-3 Block IIA does not have cost, schedule, or performance baselines.

Program Successfully Completed Its System Preliminary Design Review

In March 2012, the program held and successfully completed the system preliminary design review, meaning the program was able to demonstrate that the technologies and resources available for the SM-3 Block IIA could result in a product that matched its requirements. The program completed this review after delaying it for more than one year to address technology development problems with four of its components. Although adjustments made in 2011 to recover from issues with these components increased estimated program development costs by $296 million, we reported in April 2012 that these adjustments may reduce future cost growth and reduce acquisition risk.[1]

Program Faces Technology Development Challenges

Because the SM-3 Block IIA program is currently in MDA's technology development phase, its efforts are primarily focused on developing and maturing its technology. During the program's preliminary design review, several important technical issues were identified that may affect program progress and those issues increased in significance after the review. These technology challenges could lead to delays to the program's critical design review schedule. They affect key components such as the nosecone and second and third stage rocket motors. For these issues, the program has either identified the cause, redesigned some components which it will need to test to ensure they work as intended, or determined the path to resolve the issue.

In addition, the program experienced some problems in fiscal year 2012 developing the new throttleable divert and attitude control system, which has historically been a challenge for SM-3 development—particularly for the SM-3 Block IB. During fiscal year 2012, the program experienced delays obtaining a part needed for this system from one of its suppliers. Because the part has no substitute or alternate supplier, concerns were raised about the delays affecting the program schedule. However, the contractor and program are working to ensure the throttleable divert and attitude control system and its components do not affect the program schedule. Program management officials told us they are applying SM-3 Block IB program lessons learned.

Program Faces Key Decisions on Plans for the SM-3 Block IIA Following the Completion of the Cooperative Development Program

SM-3 Block IIA program is preparing for key decisions on integration, testing, and production after the initial cooperative development project is completed, currently scheduled for fiscal year 2017. Any decisions it makes will affect the overall program cost and timing. For example, program officials have stated that the program has not yet determined the number of development and production rounds to be produced after the first 22 development and 12 initial production rounds have been delivered. In addition, any decisions on future production plans will

[1] GAO-12-486.

require negotiations with Japan since many key components on the missile are developed there.

Appendix V: Aegis BMD SM-3 Block IIB with Third Generation Aegis Weapons System Software

Recent Events	Overview
• In April 2013, the Department of Defense (DOD) proposed canceling the Aegis BMD SM-3 Block IIB program. • MDA redirected some fiscal year 2012 funds to the program to address a significant fiscal year 2012 funding reduction. • Navy approved the consideration of liquid propellants for the SM-3 Block IIB during early program stages.	➢ MDA revised the schedule due to fiscal year 2012 budget reductions. ➢ Program plans to reduce concurrency and is benefiting from competition. ➢ Navy decision to consider liquid propellants enables MDA to consider missile design options with varying capabilities and risks. ➢ Program did not conduct an analysis of alternatives—a key step to ensuring a sound basis for a new program.

Background and Overview

The SM-3 Block IIB is a planned Aegis BMD interceptor intended to contribute to the defense of the United States by providing the first tier of a layered defense against some intercontinental ballistic missiles. It is also expected to contribute to regional defense against medium- and intermediate-range ballistic missiles. The SM-3 Block IIB program began in June 2010 and entered the technology development phase in July 2011. Given its early stage of development, the SM-3 Block IIB does not have cost, schedule or performance baselines and is not managed within the Aegis BMD program office. Instead, this program has a tentative schedule and is being managed within MDA's Advanced Technology office. It is gradually transitioning management to the Aegis BMD program office, a transfer that is planned to be completed by fiscal year 2015. The SM-3 Block IIB is planned to be fielded by 2022 at the earliest as part of the fourth phase of U.S. missile defense in Europe.

The SM-3 Block IIB plans to use a third generation version of the Aegis Weapon System software that is still in development.

Towards the end of our audit work, DOD proposed canceling of the Aegis BMD SM-3 Block IIB program in April 2013, in the Fiscal Year 2014 President's Budget Submission. Because the proposed cancellation occurred in the last few weeks of our audit, we were not able to assess the effects of the program's proposed cancellation and incorporate this information into our report.

MDA Revised the Schedule Due To Fiscal Year 2012 Budget Reductions

The fiscal year 2012 budget reduced SM-3 Block IIB funding by nearly 90 percent, from $123 million to $13 million. DOD reduced the budget in response to congressional concerns about concurrency in the program's schedule and other concerns about the mission of the program. In order to maintain some program activities, including the work of three contractors that are developing possible concepts for the missile, the agency redirected $15 million in funds originally intended for other programs. However, to manage the program within the new budget, the program revised its schedule to delay key events—most notably, the planned initial capability of the SM-3 Block IIB, which slipped from 2020 to 2021. Program management officials stated that the initial capability has been delayed further—to 2022—due to the continuing resolution enacted in fiscal year 2012.

Program Plans to Reduce Concurrency and Is Benefitting from Competition

GAO-12-486

We recommended that the Secretary of Defense direct MDA to ensure that the SM-3 Block IIB requirements are defined and feasible and that the proposed design can meet those requirements within cost, schedule, and other system constraints by delaying the commitment to product development until the program completes a successful preliminary design review.

In fiscal year 2012, the program planned to reduce concurrency by delaying product development until after a key design review is held. We reported in April 2012 that the program planned to award the contract for product development prior to holding its preliminary design review.[1] This sequence would have committed the program to developing a product with less technical knowledge than our prior work on acquisition best practices has shown is needed, and without fully ensuring that requirements are defined, feasible, and achievable within cost, schedule, and other system constraints. DOD concurred with a recommendation we made in our April 2012 report to address this concurrency risk. The program does not yet have a final acquisition strategy, but, based on its current tentative plans, the concurrency in the program schedule has decreased. MDA adjusted the program's tentative schedule to delay the start of product development until after the preliminary design review, a sequencing that will increase technical knowledge prior to committing to development. Further, the revised tentative schedule postpones the start of product development until fiscal year 2017, which allows the program additional time to mature key technologies.

In addition, the program continues risk reduction activities—although it has had to limit its efforts to focus on key components because of fiscal year 2012 funding limitations. We reported last year that the program was using risk reduction contracts to develop technologies that could cut across versions of the SM-3. During fiscal year 2012 the program reported several significant developments related to risk reduction for the focal plane array, which is a component that helps the missile identify targets, as well as the divert and attitude control system, which maneuvers the warhead toward the target. For example, the program

[1] GAO-12-486.

completed development, fabrication, and testing of the first focal plane arrays. In addition, it completed a design prototype for a third stage rocket motor that meets key SM-3 Block IIB requirements.[2] We reported in April 2012 that these risk-reduction efforts may improve performance across the SM-3 variants.[3]

In fiscal year 2012, the program also reported benefits from competition among contractors through a better understanding of the program's progress, possibilities for the missile, and risks associated with those possibilities. The program continues to utilize three contractors to develop concepts during the technology development phase. In April 2012, we reported on the benefits of competition among contractors, particularly the increase in technical innovation.[4]

Navy Decision to Consider Liquid Propellants Enables MDA to Consider Missile Design Options with Varying Capabilities and Risks

The SM-3 Block IIB is being designed for deployment on both Aegis BMD ships and on land. The SM-3 Block IIB program has been considering missile concepts with two options for the diameter of the interceptors—either 27 or 22 inches—and two options for propellants for a maneuvering component—either liquid or solid. To be ship compatible means that the program must consider Navy needs and requirements when developing the specifications of the SM-3 Block IIB. While recent Navy decisions have allowed the program to consider a variety of options for the SM-3 Block IIB, there are associated cost and schedule risks associated with each of these missile configurations.

In 2012, the Navy decided that the program could consider liquid propellants. The Navy banned the use of liquid propellants on ships in 1988 due to the potential for substantial ship damage, crew injury and loss of life from unintended explosive incidents with liquid propellants. In the summer of 2012 the Navy reaffirmed this position in regards to the SM-3 Block IIB. However, in October 2012 the Navy determined it would allow the program to develop concepts for the SM-3 Block IIB that use liquid propellants. While the Navy memo allowed these concepts to be explored in the early stages of the program, the memo was not a final

[2]The third stage rocket motor is used to lift the missile out of the atmosphere and direct the kinetic warhead to the target.

[3]GAO-12-486.

[4]GAO-12-486.

decision to allow the use of liquid propellants on ships. Liquid propellants can provide performance increases, more speed and range, compared to solid propellants but at a greater safety risk. However, the Navy also stated in its summer 2012 memo, that if the program decided to use liquid propellants on a ship, an expensive and lengthy development effort would be needed to reduce the safety risks of having liquid propellants on a ship to an acceptable level. In addition, because of the technology issues associated with undertaking this effort, there would be no assurance the outcome would be successful. Further, many ship modifications will be required across multiple ship classes.

In addition, the October memo stated that the Navy was open to accepting modifications to its vertical launch system, which is a missile launching system that is already installed on Aegis ships and will be used at Aegis Ashore facilities. The 27-inch diameter missile would provide more capabilities over the 22-inch diameter missile. However, it would require at least some modifications to the vertical launch system, because of its larger diameter than other missiles used by the system, which could increase costs. A smaller, 22-inch diameter missile would not require such modifications.

Concept and technology development are still ongoing, and the program has not decided the diameter or type of propellant. Although the smaller 22-inch diameter missile with solid propellant would likely be a lower risk and cost option, both the Navy and MDA have noted that the capability limitations are significant. However, pursuing a larger, 27-inch diameter missile with liquid propellant, while it could provide many of the needed capabilities, might also introduce significant cost and schedule risks for the program, in part due to the safety risks associated with liquid propellants on ships. The program tentatively plans to select a configuration for its SM-3 Block IIB in fiscal year 2015.

Program Did Not Conduct an Analysis of Alternatives—a Key Step to Ensuring a Sound Basis for a New Program

We have previously reported that the SM-3 Block IIB program did not conduct a formal analysis of alternatives (AOA) prior to beginning technology development. We were requested in 2012 to assess the extent to which an AOA was conducted for the program.[5] AOAs provide insight into the technical feasibility and costs of alternatives by determining if a concept can be developed and produced within existing resources. Although MDA is not required to do an AOA for its programs because of its acquisition flexibilities, we have previously reported that an AOA can be a key step to ensure that new programs have a sound acquisition basis.[6]

While program management officials identified two reviews that they consider similar to an AOA, the reviews were not intended to be AOAs, and they did not address all of the key questions that would normally be included as part of an AOA. For example, the reviews did not consider the life-cycle costs for each alternative or the programmatic risks of the alternatives. Further, while the reviews did consider alternatives that could provide validated capabilities, the range of alternatives considered did not include non-Aegis missile options that could provide an additional layer defense of the United States. This narrow range of alternatives is particularly problematic because it limits the quality of the answers that can be provided for other key questions.

As the program has progressed, additional analysis has led to changes in the initial program assumptions and results that suggest additional development and investment will be needed by the program to defend the U.S. homeland. MDA initially assumed that SM-3 Block IIB interceptors would be based on land at host nation facilities in Romania and Poland.[7] However, subsequent MDA analyses demonstrated that

- the Romania site was not a good location from a flight path standpoint for defending the United States with the SM-3 Block IIB; and

[5]GAO, *Standard Missile-3 Block IIB Analysis of Alternatives*, GAO-13-382R (Washington, D.C.: Feb. 11, 2013).

[6]GAO-09-665.

[7]These locations are planned to provide both regional and U.S. homeland defense. We did not assess these locations for regional defense purposes.

- the Poland site may require the development of the ability to launch the interceptor earlier—during the boost phase of the threat missile—to be useful for defense of the United States.[8]

MDA technical analysis in 2012 concluded that a ship-based SM-3 Block IIB in the North Sea is a better location for U.S. homeland defense and it does not require launch during boost capabilities.[9] While MDA's initial assumption was the missile was to be land-based, the program is now requiring the SM-3 Block IIB to be ship and land compatible.

To some extent, this progression has been driven by the early decision to narrow solutions to an Aegis-based missile without the benefit of a robust analysis of other alternatives. While this does not mean the SM-3 Block IIB is not a viable choice, we have previously reported that without fully exploring alternatives, programs may not achieve an optimal concept for the war fighter, are at risk for cost increases, and can face schedule delays or technology maturity challenges.[10]

[8]With launch during boost, the missile launches during the boost phase of the threat missile. It intercepts the threat after the boost phase.

[9]According to DOD, additional operational analysis of this location would be needed.

[10] GAO-09-665.

Appendix VI: BMDS Sensors

Recent Events	Overview
• An Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) radar was delivered to U.S. Central Command in fiscal year 2012. • Awarded contract to upgrade Early Warning Radars at Clear, Alaska and Cape Cod, Massachusetts. • BMDS Sensors participated in ground and flight tests with other elements, including Aegis Ballistic Missile Defense (BMD) and MDA's first system-level integrated flight test.	➢ MDA downgraded the Sea-Based X-Band radar to a limited test support status primarily due to budget concerns. ➢ DOD faces challenges addressing Cobra Dane sustainability concerns as well as confirming new capabilities. ➢ Despite high demand for AN/TPY-2 radars, MDA is procuring fewer than previously planned. ➢ AN/TPY-2 Cost Baselines Are Relatively Stable and Progress Against Schedule Baselines Is Mixed.

Background and Overview

The current generation of Ballistic Missile Defense System (BMDS) sensors includes the following:

Sea Based X-Band (SBX) is a sea-based radar capable of tracking, discriminating, and assessing the flight of ballistic missiles. SBX primarily supports the Ground-based Midcourse Defense (GMD) system for defense of the U.S. and is considered a critical sensor for GMD, in part because it is able to provide tracking information to the GMD interceptor as it targets an incoming threat missile. SBX is docked near Hawaii when not in testing or operational status.

Upgraded Early Warning Radars are U.S. Air Force early warning radars that are upgraded and integrated into the BMDS to provide sensor coverage for critical early warning, tracking, object classification, and cueing data. Upgraded Early Warning Radars are located in Beale, California; Fylingdales, United Kingdom; and Thule, Greenland. MDA awarded a contract to upgrade the early warning radars in Clear, Alaska and at Cape Cod, Massachusetts. The upgrades to the Clear and Cape Cod Early Warning Radar sites are joint MDA / Air Force projects. Both organizations are contributing funding to these sites.

Cobra Dane radar is a U.S. Air Force radar located in Shemya, Alaska that has been upgraded and integrated into the BMDS to provide missile acquisition, tracking, object classification, and cueing data. Cobra Dane supports GMD for homeland defense.

AN/TPY-2 is a transportable X-band high resolution radar that is capable of tracking all classes of ballistic missiles. AN/TPY-2 in the forward-based mode is capable of detecting and tracking missiles in all stages of flight to support Aegis BMD and GMD engagements and provides threat missile data to C2BMC. AN/TPY-2 in the terminal mode can track missiles in the later stages of flight to support THAAD engagements. Four AN/TPY-2 radars for use in forward-based mode are deployed to support regional defense with two in U.S. European Command, one in U.S. Pacific Command, and one in U.S. Central Command.

MDA Downgraded the SBX Radar to a Limited Test Support Status Primarily Due to Budget Concerns

MDA removed the SBX radar from operational status and placed it into a limited test support status beginning in 2012 due to budget concerns. Limited test support status means SBX will support BMDS flight and ground tests as appropriate, but can be recalled to active, operational status when warnings indicate a need to do so. MDA officials stated that cuts by the Office of the Secretary of Defense to MDA's fiscal year 2013 budget required the agency to find approximately $2 billion in overall reductions. By transitioning SBX to a limited test support status, MDA officials expect to save almost $670 million in operation and maintenance costs for fiscal years 2013 through 2018.

Because SBX is primarily used to support GMD's defense of the United States, removing SBX from operational status also changes how the BMDS operates. However, MDA officials told us that SBX was developed to assist in countering a threat that has not yet manifested and therefore, from an operational standpoint, the radar is not currently needed. An official with U.S. Northern Command, which is concerned with defense of the United States, told us that the command has developed alternatives for conducting engagements without the SBX. However, U.S. Northern Command's 2011 assessment of the BMDS notes there is a difference in how the BMDS operates without SBX, the details of which are classified.

DOD Faces Challenges Addressing Cobra Dane Sustainability Concerns, as well as Confirming New Capabilities

According to MDA officials, to continue operating Cobra Dane beyond 2015, when sustainment funding is schedule to end, the Air Force, with input from MDA, will need to determine whether to proceed with a service life extension plan to address sustainability concerns.[1] Cobra Dane is a vital sensor for GMD—especially with the limited availability of SBX. MDA officials stated the Air Force and MDA would likely share the cost of this extension. However, they told us that it is unclear how many years it would extend the service life of Cobra Dane and that the agency is exploring other long-term solutions. One option is to replace Cobra Dane with a new radar although doing so is likely to be costly. One contractor-funded study estimated the life-cycle cost of a Cobra Dane replacement at approximately $1 billion. MDA officials told us for BMDS purposes, their preferred long-term solution is to replace the functions currently performed by the Cobra Dane radar with the Precision Tracking Space System (PTSS) which the agency currently expects to become fully operational in 2023.

Although DOD has upgraded the Cobra Dane radar in the past, it has not yet confirmed those upgrades work in an intercept flight test. The radar's capabilities were last demonstrated during a fly-by flight test in September 2005. The Director, Operational Test & Evaluation has reported that, due to Cobra Dane's location and field-of view, the upgrades have been constrained to ground testing using models and simulations, and these tests were limited by the continuing lack of credibility that the models used accurately portray BMDS performance. The Director, Operational Test and Evaluation further stated that MDA would conduct a flight test in Cobra Dane's field of view to confirm that the upgrades work as intended. MDA had originally played to complete this flight test in late fiscal year 2010, but has delayed it until fiscal year 2015.

[1] In addition to providing ballistic missile defense capability, Cobra Dane is also used by the Air Force for space surveillance.

Despite High Demand for AN/TPY-2 Radars, MDA Is Buying Fewer than Previously Planned

MDA is planning to procure fewer AN/TPY-2 radars than previously planned even though the recent increased focus on regional—in addition to homeland—defense makes them in high demand from various combatant commands.[2] MDA reduced the number of AN/TPY-2 radars from 18 planned in the fiscal year 2012 budget down to 11 in the fiscal year 2013 budget. The agency decided to procure 7 fewer AN/TPY-2 radars because fewer THAAD batteries that utilize the radars are being procured, and because of budget cuts in its fiscal year 2013 budget.

Currently, the last AN/TPY-2 procurement is scheduled for fiscal year 2013 and production will end in fiscal year 2015. Officials told us, however, that the agency may have some opportunities for the U.S. to procure additional AN/TPY-2 radars if additional radars are produced for sales to foreign governments in the interim.

AN/TPY-2 Cost Baselines Are Relatively Stable and Progress against Schedule Baselines Is Mixed

The only baselines reported for BMDS Sensors in the 2012 BMDS Accountability Report (BAR) are for the AN/TPY-2.

Reported Unit Costs for AN/TPY-2 Have Remained Relatively Stable Since 2010

Since the 2010 BAR baselines were established, the AN/TPY-2 program entered the initial production phase for its ninth and tenth radars and established a new baseline. However, the AN/TPY-2 reported unit costs have increased by less than 5 percent from the 2010 BAR to the 2012 BAR. The reported average cost in the 2012 BAR for MDA to produce one AN/TPY-2 is $187 million and the reported average cost to develop and produce one AN/TPY-2 is $226 million.[3] According to its 2012 BAR, MDA did not separately report or explain cost increases that were less than the agency's established threshold of 5 percent since the prior year reported unit cost.

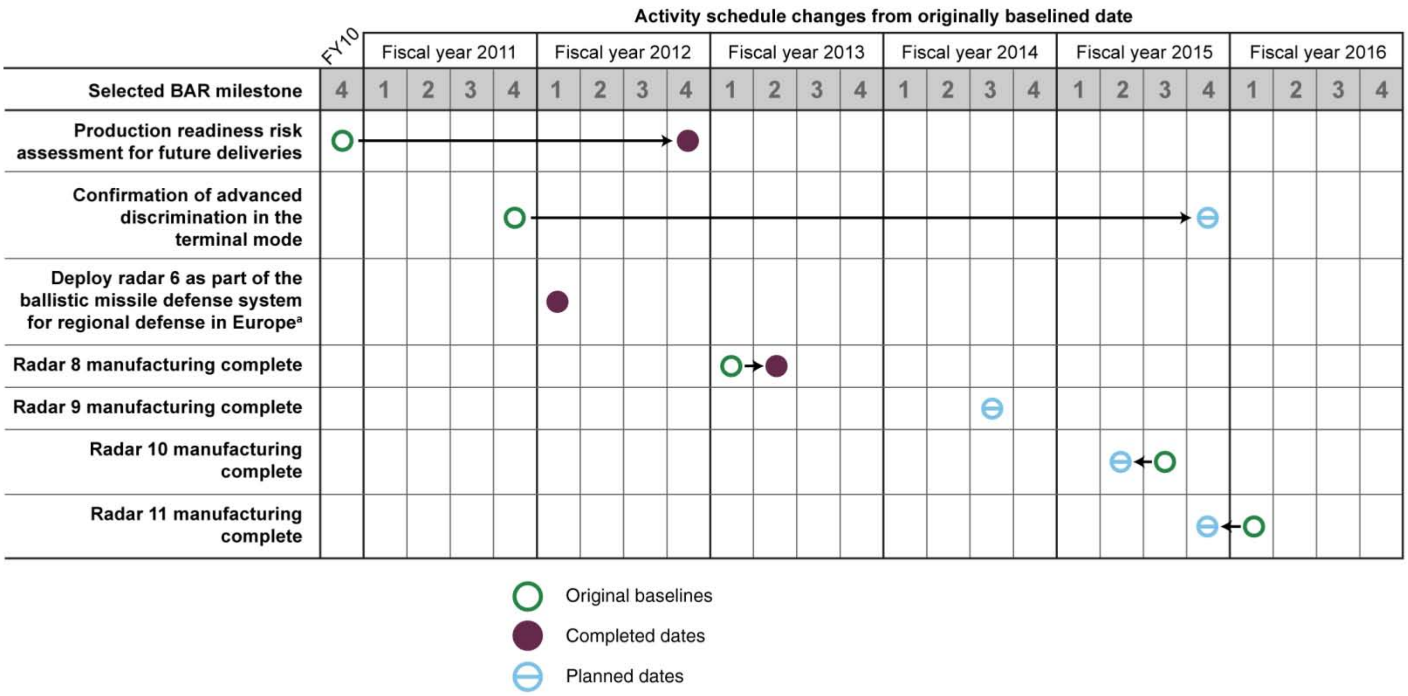
[2] Regional defense is focused on protecting deployed forces and allies against regional threats. Homeland defense focuses on protecting the United States from intercontinental ballistic missile threats.

[3] These unit costs are in base year 2011 dollars. Expressing estimates in base year dollars eliminates the effects of inflation when analyzing cost changes.

Mixed Schedule Progress for AN/TPY-2 Program

The AN/TPY-2 radar had some success in meeting 2012 BAR schedule goals, however, some milestones—including the assessment of a key capability—were delayed. Specifically, confirming the radar's advanced capability to distinguish incoming threats while in terminal mode was delayed until the fourth quarter of fiscal year 2015, about four years later than originally planned. The delay was driven by revisions to MDA's ground and flight test program and a slip of a key THAAD test designed to assess the capability in an operational environment. In addition, the program delayed Production Readiness Risk Assessments—formal assessments used to determine if production commitments can be made without incurring unacceptable risks to schedule, performance, cost, or other established criteria—for future deliveries of AN/TPY-2 radars by 2 years. The delay was due to an obsolete radar processor and difficulty in establishing a replacement for it. During fiscal year 2012, the program successfully deployed a radar to Turkey as part of the BMDS for regional defense in Europe. Also during the fiscal year, MDA reduced the total number of AN/TPY-2 radars being procured. In response to this reduction, the program accelerated the delivery schedule for two of the three AN/TPY-2 radars already in production. MDA delivered its eighth radar after a short delay and projected the next three radars to be delivered on time or ahead of schedule as seen in figure 9.

Figure 9: Schedule Assessment for Selected BMDS Sensor Program's AN/TPY-2 Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Originally baselined in 2012 BAR.

Appendix VII: Ground-based Midcourse Defense

Recent Events	Overview
• The program continued its extensive effort to resolve the CE-II flight test failure. • GMD was unable to conduct either of its planned flight tests in fiscal year 2012. • The program continued to refurbish and retrofit fielded CE-I interceptors. • The program completed the construction of a second missile field at Fort Greely, Alaska. • In January 2013, MDA conducted a flight test designed to gather performance data in a flight environment. • In March 2013, the Secretary of Defense announced the deployment of additional ground-based interceptors to enhance the protection of the United States.	➢ GMD's failure resolution effort is rigorous. ➢ Concurrency disruptions to interceptor production continued in 2012. ➢ The costs to demonstrate and fix the CE-II continue to increase. ➢ Instability of GMD resource baselines prevents insight into cost progress. ➢ Return to intercept activities are causing schedule delays.

Background and Overview

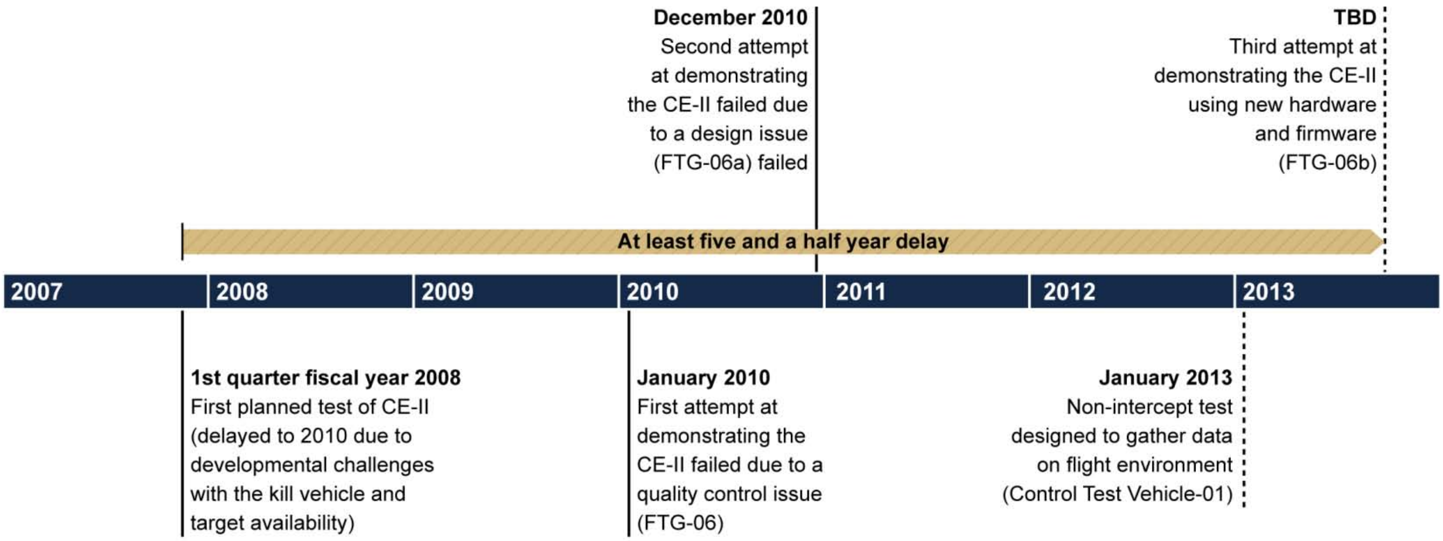
The Ground-based Midcourse Defense (GMD) enables combatant commanders from the U.S. Northern Command to defend the United States against a limited attack from intermediate- and intercontinental-range ballistic missiles during the middle part of their flight. Through fiscal year 2012, about $36.5 billion has been spent on GMD and MDA is planning on spending another $4.5 billion between fiscal years 2013-2017. GMD is expected to remain in service until at least 2032.

GMD consists of a ground-based interceptor—a booster with an exoatmospheric kill vehicle on top—and a fire control system that uses information from Ballistic Missile Defense System sensors to formulate a battle plan. The kill vehicle is designed to hit an enemy's missile warhead while it is above the atmosphere. DOD has emplaced two versions of the kill vehicle and has fielded its entire planned inventory. Development, however, continues.

- The first version of the kill vehicle, fielded since 2004, is known as the Capability Enhancement I (CE-I), and
- The second version of the kill vehicle, currently in development and production, is called the Capability Enhancement II (CE-II).

The CE-II has not yet been demonstrated to work as intended through flight testing, failing in its only two attempts to intercept a target. MDA originally planned to confirm the CE-II design worked as intended in an intercept test in fiscal year 2008. However, as a consequence of developmental challenges, flight test failures, failure review boards, and return to intercept activities, confirmation that the design works as intended has been delayed by at least five and a half years as shown in figure 10 below.[1]

Figure 10: Planned Demonstration of CE-II Capability Delayed at Least Five and a Half Years



FTG = Flight Test Ground (GMD)
Firmware: software permanently placed on a hardware device

Source: GAO analysis of MDA data.

The first intercept attempt in January 2010 failed due to a quality control issue[2] and the second intercept attempt failed in December 2010 due to the effects of vibration on the kill vehicle's guidance system. The December 2010 failure had serious consequences for GMD. For example, MDA halted the final integration and deliveries of the remaining CE-II kill vehicles until the failure investigation was completed and testing

[1] As we reported in 2009, MDA had originally planned to assess CE-II capability in fiscal year 2008. However, early ground test failures in the inertial measurement unit caused delivery delays and resulted in a redesign of the component. Consequently, the program had to delay the test. See GAO-09-338.

[2] The failure review investigation concluded that the failure was due to a quality control issue. Corrective actions include design enhancements to improve vehicle processing, which according to MDA, mitigates the risk of a reoccurrence.

demonstrates that a resolution to the issue has been confirmed. MDAs plan to return the program to flight testing involved:

(1) Determining the cause of the failure,

(2) Developing hardware and software solutions,

(3) Demonstrating the new hardware and software have resolved the cause of the failure in a non-intercept flight test, and

(4) Confirming the new design works as intended by successfully conducting an intercept flight test.

The two planned flight tests, known as Control Test Vehicle-01 and Flight Test Ground-06b (FTG-06b), were originally planned to occur in the fourth quarter of fiscal year 2011 and the third quarter of fiscal year 2012 respectively.

Towards the end of our audit work, in March 2013, the Secretary of Defense announced a significant adjustment to existing plans for the protection of the United States including deploying additional ground based interceptors in Fort Greely, Alaska. Because this announcement occurred late in our audit, we were not able to assess the effects and incorporate this information into our report.

GMD's Failure Resolution Effort is Rigorous

The GMD program's failure investigation and return to intercept effort has been rigorous. MDA convened a failure review board composed of independent experts to conduct an extensive investigation into the cause of the failure and perform modeling and testing to confirm the failure conditions. During the investigation, a series of ground tests were conducted to recreate and confirm the cause of failure, characterize the environment, and test materials, components and systems. According to a GMD program official, the program conducted over 50 component and subcomponent failure investigation and resolution tests. These tests focused on two primary areas of the kill vehicle—the thrusters and the guidance system. While initial ground testing could not replicate the environment in which the kill vehicle operates, the program did develop new test equipment that provided conditions similar to flight and recreated and confirmed the failure. In August 2011, the investigation attributed the failure to a guidance system fault that happened while in space that caused the kill vehicle to fail in the final seconds of the test. The investigation concluded that the guidance system required redesign and further development.

Concurrency Disruptions to Interceptor Production Continued in 2012

The program's continuing concurrent acquisition practices have disrupted development, testing, and production since 2010, thus delaying deliveries to the warfighter. Simultaneous with the failure investigation, MDA and its contractors undertook an effort to develop hardware and firmware solutions to return the program to intercept flight tests. [3] These solutions were then planned to be assessed in two flight tests to determine whether they successfully addressed the shocks and vibrations the kill vehicle experiences during flight. Because the initial design solutions were developed concurrently and prior to the full understanding of the cause of failure, when developmental issues then arose, the flight tests had to be delayed and their objectives modified. As originally planned, the first non-intercept flight test was designed to demonstrate the effectiveness of the resolution efforts by testing both the new hardware and firmware in order to support a decision to resume manufacturing of kill vehicles.[4] The test was originally scheduled for the fourth quarter of fiscal year 2011, but was not conducted until January 2013. This delay was due to difficulties developing the new firmware and concerns about the device that detonates in order to release the kill vehicle from the booster. MDA chose to modify the objectives of this test in order to prevent further delays. For example, the kill vehicle tested the new guidance system, but did not have the new firmware as originally planned. Additionally, the test was no longer designed to demonstrate that the CE-II works as intended in order to resume manufacturing. However, the test was a significant diagnostic flight test to gather data on the operational environment not achievable in ground tests. According to MDA officials, the test also included certain other components that have undergone design changes to address issues discovered in prior flight tests. MDA's final evaluation of the January 2013 test was not available in time for our review for this report.

The next planned CE-II intercept test, designed to demonstrate its capability, has been delayed from the third quarter of fiscal year 2012 by development issues. At the conclusion of our review, the exact timing and

[3]Firmware is software that is permanently placed on a hardware device.

[4]GAO recommended in 2012 that the Secretary of Defense direct the MDA to demonstrate that the CE-II design works as intended through a successful intercept flight test in the operational environment—FTG-06b—prior to making the commitment to restart integration and production efforts. DOD concurred with our recommendation and in response, DOD stated that the program plans to restart CE-II manufacturing upon successful completion of the FTG-06b flight test.

sequence of further GMD flight tests is to be determined because the flight test schedule continues to change.[5]

The December 2010 failure also delayed MDA's broader GMD developmental flight testing. Because MDA inserted two flight tests to show that the causes of failure had been resolved, MDA had to reschedule its test plan, moving a flight test from fiscal year 2013 to 2016, and delaying a planned operational test from fiscal year 2015 until 2016. MDA also delayed completing developmental flight testing from 2021 to at least the fourth quarter of fiscal year 2022, well after the scheduled completion of CE-II manufacturing.

In continuing to follow a concurrent acquisition strategy, DOD is accepting the risk that later flight tests may find issues requiring costly design changes and retrofit programs to resolve. Prior to the December 2010 flight test failure, MDA planned to complete delivery of the CE-II interceptors by the fourth quarter of fiscal year 2012. However, due to the delay in conducting the intercept test necessary to resume deliveries, the completion date has not yet been determined but, as of May 2012, they had expected to complete deliveries by 2015. According to the GMD program manager, the program will resume integration of certain kill vehicle components they have determined are not related to the failure prior to the next intercept test.

GMD's recent program disruptions are tied to the initial adoption of concurrent acquisition practices and the continuation of these practices as developmental problems occurred. In 2004, MDA committed to a highly concurrent development, production, and fielding strategy for the new interceptor,[6] approving production before completing development of the prior version or completing development or flight testing of the new components.[7] MDA proceeded to concurrently develop, manufacture, and deliver, starting in 2008, 12 of these interceptors even though they had

[5] MDA has inserted a Capability Enhancement I intercept test in fiscal year 2013 to validate reliability improvements made over the last several years.

[6] GAO-12-386.

[7] The CE-II kill vehicle was not originally a reliability upgrade or a performance upgrade program. Its initial priority was replacing obsolete components. However, updating certain components is expected to result in increased performance.

not yet been successfully tested, ultimately resulting in significant delays and cost growth.

The Costs to Demonstrate and Fix the CE-II Continue to Increase

The cost to demonstrate the new CE-II kill vehicle through flight testing and fix the CE-IIs already produced continues to increase. MDA planned to demonstrate the CE-II capability in January 2010 for approximately $236 million with one flight test. In April 2012 we reported that the cost had increased to $1.2 billion According to MDA, the cost growth was, in part, due to reconducting flight tests (which includes the cost of planning, test execution and range support, the target, and post-test analysis), as well as conducting failure investigations and fixing already delivered CE-II interceptors as noted in table 3.

Table 3: Estimated Costs to Demonstrate and Fix CE-II Capability

Dollars in millions

Activity	Cost
FTG-06	$236.3
FTG-06a	238.9
Control Test Vehicle-01 Costs as of August 2012	171.5
FTG-06b Costs as of August 2012	227.9
FTG-06a Failure Review as of August 2012	119.3
CE-II Retrofit as of August 2012[a]	180.0
Total as of August 2012	**$1,173.9**

Source: MDA (data); GAO presentation.

[a]10 CE-II interceptors will have to be retrofit at an estimated total cost of $18 million per interceptor for a total cost of $180.0 million.

This estimate does not include the costs already expended during development of the interceptor and the target. For example, the costs of the flight tests do not include nonrecurring development costs, such as those for systems engineering and test and evaluation, among others. Often these costs were incurred many years before flight tests are conducted. Consequently, including nonrecurring development costs for both the CE-II and the targets would substantially increase the costs by hundreds of millions of dollars for each flight test and increase the overall cost outlined in table 3.

The cost to demonstrate the new CE-II kill vehicle continues to grow due to the delays in conducting the next intercept test. According to the GMD program manager, although the total cost is not determined, delays in conducting the intercept test are estimated to cost about $3 million per month.

According to the Department of Defense's Report to Congress on Ground-based Midcourse Defense December 2010 Flight Test Failure and Correction Plan, MDA will fund the resolution efforts within the existing budget appropriations. The significant costs of the flight tests needed to demonstrate the failure resolution, according to this report, will be offset in large part by realigning the resources already allocated to planned testing that has not occurred. MDA will also delay new interceptor manufacturing and interceptor upgrades that were dependent on the redesigned CE-II kill vehicle.

Instability of GMD Resource Baseline Prevents Insight into Cost Progress

The GMD program's reported baseline in the 2012 BMDS Accountability Report (BAR) represents activities and associated costs needed to achieve an initial defense of the United States. Although the program planned to report a new baseline in the 2013 BAR for other activities and associated costs needed for its next set of capabilities, it recently delayed this effort.

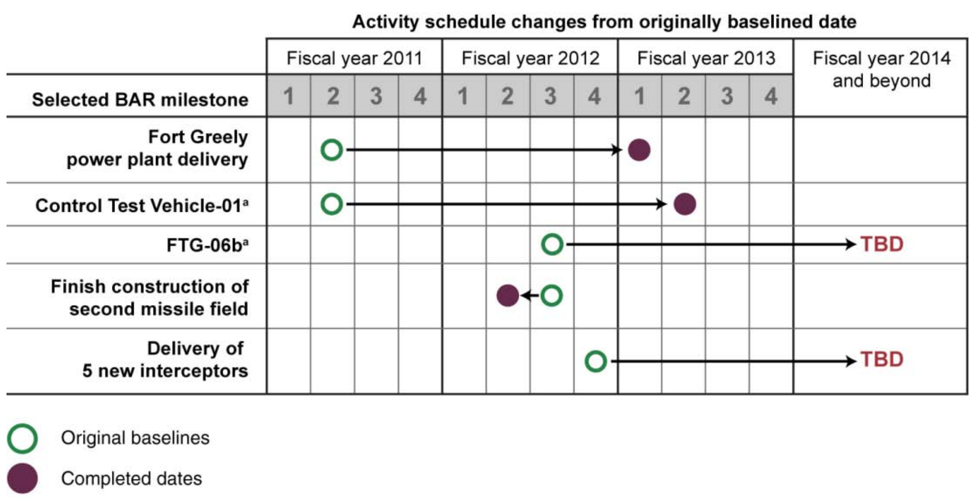
Adjustments to the content of the GMD program's resource baseline in 2012 have obscured cost progress to the extent that we are unable to assess longer-term or near-term progress. Although we have reported over the past few years that the program has experienced (1) significant technical problems, (2) production disruptions and (3) the addition of previously unplanned and costly work, the GMD total cost estimate as reported in the resource baseline has decreased from 2010 to 2012. The reported costs have decreased because the program moved activities from its initial baseline to its next undefined effort to enhance defense of the United States. By moving these activities, MDA used the funds that were freed up for failure resolution efforts instead.[8] In addition, because the next baseline won't be defined until after these activities have already been added to it, the additional cost for conducting these activities in the next baseline will not be identifiable. The full extent of actual cost growth may never be determined or visible for decision makers for either baseline because of these adjustments.

[8]The GMD program deferred activities for addressing obsolescence in GMD's ground systems, upgrading communication infrastructure at Fort Greely Alaska, and performing CE-I interceptor upgrades and flight tests through fiscal year 2017.

Return to Intercept Activities Are Causing Schedule Delays

While GMD has been able to complete some of it schedule and delivery goals, the program continued to experience challenges with its return to intercept activities, which delayed key developmental events and planned interceptor deliveries. For example, in the first quarter of fiscal year 2013, MDA completed the construction of a new power plant in Fort Greely, Alaska as seen in figure 11. The delivery was completed following a nearly two year schedule delay driven by failures identified during contractor integration testing which necessitated corrective action and additional testing. This power plant is important as it will provide an independent power source to the GMD missile fields at Fort Greely.

Figure 11: Schedule Assessment for Selected GMD Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Originally baselined in 2011 BAR.

Appendix VIII: Precision Tracking Space System (PTSS)

Recent Events	Overview
• DOD proposed canceling the PTSS program in April 2013. • Launch of the first two developmental satellites delayed from September 2017 to March 2018 because of the fiscal year 2013 continuing resolution. • Completed a major review to begin the technology development phase in September 2012, still awaiting final approval. • In February 2013, the Aegis BMD successfully intercepted a target using data from the Space Tracking and Surveillance System, a program that is informing PTSS development.	➢ In 2012, MDA determined that PTSS requires nine satellites on orbit at the same time, full cost has not been determined. ➢ MDA has not conducted a robust Analysis of Alternatives; Congress is requiring DOD to evaluate PTSS alternatives. ➢ PTSS program faces technical and operational challenges, primarily from high radiation environment. ➢ PTSS program revised its acquisition strategy but elevated acquisition risks remain..

Background and Overview

PTSS is a space-based infrared sensor system designed to track ballistic missiles after boost and through the middle part of their flight. The operational satellite system will include a constellation of nine satellites in orbit at the same time around the earth's equator. These satellites communicate with one another and a ground station to provide intercept-quality tracks of enemy missiles to other BMDS elements for engagement. The system is expected to expand the BMDS's ability to track ballistic missiles by providing persistent coverage of approximately 70 percent of the earth's surface while handling more advanced missiles and larger raid sizes than current ground and sea-based radar sensors. The PTSS program is preceded by a prior MDA demonstration effort for space-based missile tracking, the Space Tracking and Surveillance System, which continues to inform PTSS development. Since the PTSS program is in the very early stages, it does not have cost, schedule or performance baselines. The program will set baselines when it begins product development, which is scheduled for fiscal year 2014.

The PTSS program is designing the acquisition to allow future adjustments, such as an increase to constellation size or changes to how the satellites communicate with the rest of the BMDS. This flexibility would permit the system to adjust to changes in the threat. The program also plans to upgrade its capabilities from tracking objects to discriminating among the objects it tracks.

DOD proposed canceling the PTSS program in April 2013 in the Fiscal Year 2014 President's Budget Submission. Because the proposed cancellation occurred in the last few weeks of our audit, we were not able to assess the effects of the program's proposed cancellation and incorporate this information into our report.

In 2012, MDA Determined That PTSS Requires Nine Satellites on Orbit at the Same Time, Full Cost Has Not Been Determined

In August 2012, MDA formally defined the PTSS operational constellation as 9 satellites in orbit at the same time and established the planned launch schedule for the life of the program. The program plans to launch two laboratory-built developmental satellites in March 2018, then four industry-built satellites to achieve an initial operational capability of 6 satellites in December 2021, and finally achieve full operational capability with a 9-satellite constellation in December 2023. As part of this plan, the program expects the two laboratory-built developmental satellites to be part of the operational constellation until December 2025 when it will begin launching replacement satellites. From initial launch in 2018 to the program's projected completion in 2040, the program plans to procure a total of 26 satellites.

A recent study by the National Academy of Sciences estimated the PTSS life-cycle cost to range between $18.2 billion and $37 billion based on configurations for a 9-satellite and 12-satellite constellation.[1] DOD's Cost Assessment and Program Evaluation office is currently conducting an independent cost estimate for PTSS and plans to finish the assessment in April 2013. It is unclear if the independent cost estimate will include costs for additional upgrades the program could add in the future, such as improving the satellite's discrimination capabilities or optimizing the program for observation of space objects.

MDA Has Not Conducted a Robust Analysis of Alternatives; Congress Is Requiring DOD to Evaluate PTSS Alternatives

An Analysis of Alternatives (AOA) is an analytical study that compares the operational effectiveness, cost and risks of alternative potential solutions to address valid needs and shortfalls in operational capability. We previously reported that a robust AOA addresses some key questions, such as determining which alternatives provide validated capabilities, assessing the technical, operational, and programmatic risks for each

[1] National Research Council, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives*, National Research Council of the National Academies, (Washington, D.C.: 2012).

alternative, determining the life-cycle cost for each alternative, and comparing the alternatives to one another.[2]

Although MDA is not required to complete an AOA for its programs because of its acquisition flexibilities, it has conducted a number of studies in the past related to PTSS to compare alternatives. None of these studies can be considered robust AOAs primarily because the studies considered too narrow a range of alternatives. For example, in October 2011, the U.S. Strategic Command, at the direction of the Under Secretary of Defense for Acquisition, Technology, and Logistics, conducted an assessment that compared the expected operational performance of PTSS against two other MDA sensors—the operational AN/TPY-2 radar and the developmental Airborne Infrared.[3] While this review could be a useful source of information for a more robust AOA, the study cannot be considered a robust AOA because it assessed too narrow a range of alternatives and did not fully assess programmatic and technical risks, both of which are important aspects of a robust AOA.[4] Although MDA has also conducted a number of studies in the past that mostly focused on follow-on concepts for MDA's Space Tracking and Surveillance System demonstration program, none of the completed studies considered a broad range of alternatives.

Partially in response to concerns raised by the National Academy of Sciences last year about the costs and benefits of the PTSS program,[5] in January 2013, Congress required DOD to evaluate PTSS alternatives.[6] DOD's Cost Assessment and Program Evaluation office is currently conducting a comprehensive review of the PTSS program in response.

[2]GAO-09-665.

[3]The Airborne Infrared was a program designed to track ballistic missiles shortly after launch by utilizing infrared sensors onboard select unmanned aircraft systems. DOD canceled the program in 2012 based on Congress' recommendation in the conference report to the Consolidated Appropriations Act 2012 to reduce the program's funding in its entirety. H.R. No. 112-331, at 719 (2011) (Conf. Rep.).

[4]Criteria for robust analyses of alternatives can be found in GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, GAO-09-665 (Washington, D.C.: Sept. 24, 2009).

[5]National Research Council, *Making Sense of Ballistic Missile Defense*.

[6]Pub. L. No. 112-239, § 224.

Because the study is ongoing at the time of this review, it was not available for our review. DOD plans to complete the study in April 2013.

The Program Faces Technical and Operational Challenges, Primarily from High Radiation Environment

The PTSS program faces significant technical challenges to achieving a fully operational constellation by 2023. Some of PTSS's major components require significant development to function in the high radiation environment in which the satellites will operate. If that development is not successful, the satellite performance could be less than currently planned and the expected life of the satellites could be reduced. In addition, the program expects some level of performance reduction of the satellites on orbit because it plans to operate the satellites past their planned mission life. Although the program is developing the satellites to achieve a fully operational, nine-satellite constellation no sooner than 2023, its strategy leaves little margin for error. If these technical risks are realized, the operational performance of the constellation could be reduced, development costs could grow, and the cost to maintain the planned nine-satellite constellation could grow significantly if more frequent replacement is required.

The high radiation environment in which the PTSS satellites plan to operate in is more intense than that experienced by other satellite systems and could result in reduced performance. The PTSS satellites are designed to view ballistic missiles as they fly above the earth's horizon. To accomplish this, the satellites will orbit the earth at an altitude of approximately 930 miles above the earth's surface. Consequently, the satellites will pass within the region of one of the earth's radiation belts where fast moving protons and electrons can penetrate and damage sensitive satellite equipment. The Space Tracking and Surveillance System demonstration satellites currently operate in a similarly high radiation environment at an altitude of approximately 840 miles and, as we have previously reported, have experienced multiple problems as a result.[7] Although program officials anticipate these problems to occasionally occur and have successfully recovered from all prior incidents, radiation events have affected the Space Tracking and Surveillance System satellites' availability and contributed to an 11-month delay completing initial check-out for the satellites to reach full capability

[7]GAO, *Missile Defense: Actions Needed to Improve Transparency and Accountability*, GAO-11-372 (Washington, D.C.: Mar. 24, 2011).

after launch. Recently, the National Aeronautics and Space Administration launched the Van Allen Probes, a space program led by the same laboratory leading the PTSS design efforts, to explore the Earth's radiation belts. These probes may collect data that could help design PTSS components to protect them against radiation damage.[8] The Van Allen Probes recently discovered a previously unknown, additional radiation belt, indicating a more dynamic radiation environment than previously thought.

Recognizing the high radiation challenge, the PTSS program is seeking to develop ways to minimize the effects of radiation damage to components. While most of PTSS's technologies are mature, some of the technologies with less maturity are major components of the satellite's design. These technologies have low levels of maturity, in part, because they require radiation protection at levels that have not yet been demonstrated for those specific technologies. The program has added the development of these critical technologies to its high risk list, such as the star tracker, a component of the guidance and control system that uses stars to track its orientation, and the focal plane array, a component of the optical payload that locates and tracks enemy missiles. While some of these technologies are in early development, the program has undertaken risk reduction plans to focus development of these technologies. Because these technologies are critical, if they require additional development for radiation protection beyond what is already planned, the program could experience delays, a reduction in system performance, or a reduction in the satellites' planned mission life.

The program expects that over time, the satellites will have some reduction to their initial performance because it plans to operate satellites longer than their planned 5-year mission life. During the mission life, the PTSS satellites are expected to perform the designed functions to effectively meet the system's performance requirements. After that 5-year period, there will be a growing likelihood that operational performance will be reduced. The program plans to launch the final satellites needed to achieve an operational nine-satellite constellation in 2023.[9] However, it won't launch replacement satellites for the first two satellites until 2025—

[8]This program was formerly known as the Radiation Belt Storm Probes.

[9]The program currently plans to utilize a launch vehicle that will carry 2 PTSS satellites per launch, resulting in an initial 10-satellite constellation in 2023.

nearly 8 years after they were put in orbit. In fact, all of the satellites in the constellation will be operated beyond their planned mission life with an average 8 years in orbit and in some cases, as long as 9.5 years. Historically, several DOD space systems have continued to operate several years beyond their planned mission life. For example, the Global Positioning System Block IIA satellites were designed to last an average 7.5 years but have actually lasted about twice as long. This is largely because satellites are typically designed with high levels of redundancy and other reliability measures that ensure performance over a period of time.

For PTSS, employing a strategy of leaving satellites in orbit for 8 years rather than only 5 years will, in the long term, mean that MDA will purchase, produce, and launch about 16 fewer satellites through 2040 at a cost savings of several billion dollars. However, it also adds performance risk for the warfighter. Although other DOD space programs have planned for satellites to operate past their planned mission life, they usually wait until they have some on-orbit performance data from demonstration or similar previous satellites. The PTSS strategy, however, is based solely on pre-launch engineering and design analysis with assumptions that may or may not prove to be accurate. For example, the program estimates satellite reliability to gradually decrease over time assuming that random failures may occur, but components are not likely to prematurely wear out. However, if radiation risks do materialize, satellite components are much more likely to prematurely wear out. Also, program officials stated they plan to include fewer redundant measures than prior space systems to reduce cost, weight, power consumption, and design complexity. However, this may increase the likelihood the satellites will not effectively perform beyond their planned mission life.

PTSS Program Revised Its Acquisition Strategy but Elevated Acquisition Risks Remain

In April 2012, we reported the program’s acquisition strategy incorporated several important aspects of sound acquisition practices, such as competition and short development time frames.[10] However, we also found that there were elevated acquisition risks tied to the concurrency—the overlap—between the development of the laboratory-built satellites and industry-built satellites. Under the previous strategy, the program planned to select a manufacturer, conduct a major review to finalize the

[10]GAO-12-486.

satellite design, and authorize production of items that require a long lead time (more than 2 years) for satellites 3 and 4—all while the laboratory team develops and manufactures satellites 1 and 2. Because the industry-built satellites will be under contract before on-orbit testing of the lab-built satellites, we found that the strategy may not enable decision makers to fully benefit from the knowledge about the design to be gained from that on-orbit testing before making major commitments. In October 2012, the program approved its third acquisition strategy, revising it so that two manufacturers are initially selected rather than one. After the program has conducted the design review, the program will then select one of the manufacturers to produce satellites 3 and 4 and authorize production of long lead items.

Although the revised acquisition strategy may improve collaboration between the laboratory team and industry, the concurrency risks remain unchanged. The revised strategy may improve the opportunity for collaboration between industry and the laboratory teams because the two manufacturers will be able to coordinate with the laboratory team while they are finalizing the design. However, the same concurrent activities in the previous strategy—finalizing the design and committing to long lead production for satellites 3 and 4 while developing satellites 1 and 2—continue. This approach will not enable decision makers to fully benefit from the knowledge about the design to be gained from on-orbit testing of the laboratory-built satellites before committing to the next industry-built satellites. Also, these first four satellites will be operational satellites, forming part of the operational nine satellite constellation until they are replaced between 2025 and 2027. As a result, if on-orbit testing reveals the need for hardware changes, the operational constellation will not fully benefit from those changes until the initial four satellites are replaced.

Appendix IX: Targets and Countermeasures

Recent Events	Overview
• All eight targets launched in fiscal year 2012 were flown successfully. • Developmental issues with a new extended medium-range ballistic missile target contributed to delays for MDA's first system-level operational test. • Successful first flight of a new extended long-range air-launched target in October 2012. • Contract for medium-range ballistic missile target expected in April 2013.	➢ MDA's first use of new targets in complex and costly system-level tests is causing delays and unnecessary risk. ➢ Competitive contracts could offer opportunity for savings. ➢ New medium-range targets cost baseline adjustments prevent insight into long-term cost progress; schedule baseline reflects delivery delays..

Background and Overview

The Missile Defense Agency's (MDA) Targets and Countermeasures program designs, develops, produces, and procures missiles serving as targets for testing missile defense systems. The targets program acquires many types of targets covering the full spectrum of threat missile capabilities and ranges.[1] A typical target consists of a launch vehicle made up of

(1) one or more boosters,

(2) a control module that steers the vehicle after the booster stage separates,

(3) a payload module that can deploy countermeasures,[2] and

(4) a surrogate re-entry vehicle.

Some target types have been used by MDA's test program for years while others have been recently or are now being developed to represent more complex threats. As MDA's test effort has matured, its Targets and Countermeasures program has worked toward developing more complex targets to more closely represent current and future threats. Our

[1]Ballistic missiles are classified by range: short-range ballistic missiles have a range of less than 621 miles; medium-range ballistic missiles have a range from 621 to1,864 miles; intermediate-range ballistic missiles have a range from 1,864 to 3,418 miles; and intercontinental ballistic missiles have a range greater than 3,418 miles.

[2]Countermeasures are objects, released by a threat missile, that imitate the re-entry vehicle in an effort to confuse the intercepting missile and associated sensors.

assessment primarily focuses on two new medium-range air-launched targets that are being flown for the first time in fiscal years 2012 and 2013: (1) the extended medium-range ballistic missile target (eMRBM), and (2) the extended long-range air-launched target (E-LRALT).

MDA's First Use of New Targets in Complex and Costly System-Level Tests Is Causing Delays and Unnecessary Risk

MDA has chosen to demonstrate new targets for the first time during complex and costly system-level tests instead of first demonstrating them in less complex and expensive scenarios. System-level flight tests can involve multiple BMDS elements including land-, sea-, air-, and space-based sensors and one or more interceptors and can cost hundreds of millions of dollars. MDA launched a new target, its E-LRALT, for the first time as part of its first system-level integrated flight test, its most complex test to-date, in the first quarter of fiscal year 2013. MDA plans to launch two of its new eMRBMs for the first time during the agency's first operational system-level test in the fourth quarter of fiscal year 2013.

MDA's first system-level integrated flight test, Flight Test Integrated-01, was conducted in October 2012 and was the most complex test MDA has conducted. It coordinated multiple combatant commands and missile defense elements to intercept four of five targets launched. MDA added this test as a risk reduction exercise for its planned operational test. While the E-LRALT target performed successfully, the test experienced a minor delay from September to October 2012 when the new target was unable to meet the readiness reviews for the original test deadlines. This target needed additional time to complete a series of tests of the target's flight termination system – a safety system that terminates the booster motor's thrust if unsafe conditions develop during flight. These tests were delayed when workmanship and test set up issues required correction and further retesting, which delayed the integration of these components into the missile. Despite the additional risk, this target was successfully launched for the first time and performed as expected during the integrated test in October 2012.

MDA's first operational system-level test, Flight Test Operational-01, is currently planned for the fourth quarter of fiscal year 2013. During this test, the agency plans to use a total of five targets, three ballistic missiles and two cruise missiles, and a variety of coordinated missile defense elements to conduct a highly complex scenario. This test is a very important integrated flight test designed to demonstrate regional capabilities of U.S. missile defense. MDA plans to use its new eMRBM target for the first time for two of the five targets during this operational test rather than using it first in a simpler and less costly risk reduction flight test. Risk reduction flight tests are normally conducted the first time a system, such as a new target, is tested in order to confirm that it works before adding other test objectives. This operational flight test has experienced between a six and nine month delay caused by weapon system issues and developmental problems associated with the eMRBM target. MDA was on a tight schedule to meet the original test date before issues arose with the air-launched target's restraint system, which holds the target in cradles while it is launched from an aircraft cargo hold. The entire target restraint system had to be redesigned and was not finalized until August 2012. The delay in availability of this target contributed to MDA's decision to delay this test.

Competitive Contracts Could Offer Opportunity for Savings

MDA's contracting strategy has evolved from a single prime contractor strategy to more competitively awarded contracts for new target types. In 2003, MDA chose a single prime contractor, Lockheed Martin, to lead the acquisition of targets with what it called the Flexible Target Family approach, which used common components and shared inventory, and promised reduced acquisition time, cost savings, and increased capability. However, the approach soon proved more costly and more time-consuming than expected. Responding to congressional concern about these problems[3] and our 2008 recommendations, MDA revised its acquisition approach in 2009, seeking to increase competition by returning to a multiple contract strategy with as many as four prime contractors—one for each separate target class. Shortly after, attempts to competitively award the first contract were canceled because the bids received were more expensive than anticipated. MDA completed a competitive award for an intermediate-range target in 2011 but otherwise continued to rely heavily on Lockheed Martin for new target types. For example, in 2011, MDA awarded three new task orders to its prime contractor for eMRBM targets, a more specialized medium-range target that will be procured in fewer quantities, and for re-entry vehicles that are interchangeable among multiple targets.

MDA is now using parts of both approaches by using its prime contractor to keep some commonality among new targets it develops, and by issuing some competitive solicitations for other targets. It has recently begun to see some cost savings from the intermediate-range competition, reporting

[3] H.R Rep No. 110-477, at 823-24 (2007) (Conf. Rep.).

a cost of $103 million less than expected, compared to the independent government estimate it developed for that competition. In addition, MDA has continued to pursue additional competitive awards in fiscal years 2012 and 2013. MDA awarded a contract in October 2012 for the first two intercontinental ballistic missiles needed for future flight tests, and, according to a program official, also expects to award a contract for a new medium-range target in April 2013. These competitive contract decisions could offer more opportunities for cost efficiencies.

New Medium-Range Targets Cost Baseline Adjustments Prevent Insight into Long-Term Cost Progress; Schedule Baseline Reflects Delivery Delays

MDA's BMDS Accountability Report (BAR) reports baselines for cost and schedule. In the BAR, Targets and Countermeasures report detailed cost and schedule information for individual targets under three baselines for short-, medium-, and intermediate-range interceptors. In addition, MDA added new baselines in the 2012 BAR for common components, such as re-entry vehicles and associated objects. We focused our assessment on the new medium-range targets—the eMRBM and E-LRALT targets mentioned above.

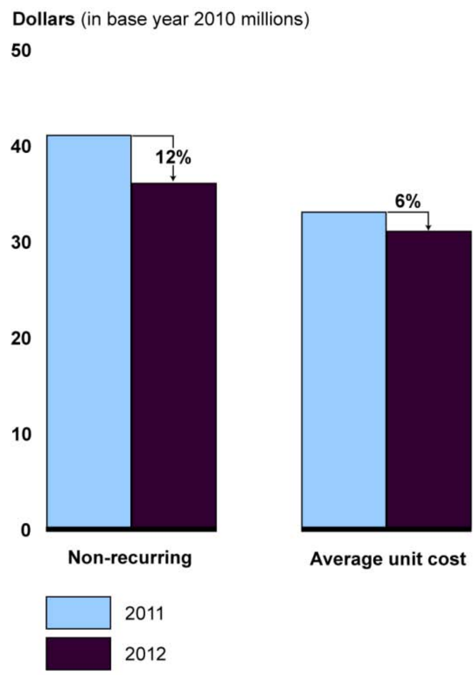
In its 2012 BAR resource baselines for Targets and Countermeasures, MDA reports an average unit cost and a non-recurring cost baseline. Non-recurring costs include the cost to design and develop a target configuration. Average unit cost is the sum of manufacturing costs for targets using research, development, test, and evaluation funding divided by the number of targets delivered. The agency reports that it uses these nonstandard unit costs because targets are modified to meet specific threat representations and are consumed in testing. In addition, no procurements funds are used to acquire targets.

Although Targets and Countermeasures have reported baselines since 2010, it is no longer possible to compare the 2012 BAR reported average unit cost or non-recurring cost baselines with the original baselines set in the 2010 BAR for any of the Targets—including the eMRBM and E-LRALT targets. Unit cost baselines were affected when costs for common target components, which were previously included in the target baselines, were removed and redirected into a separate, newly created baseline for common components. In addition, the agency also changed the way it calculated its unit cost estimates for the eMRBM by adding costs incurred in previous years. Non-recurring cost baselines were also affected by removing costs for common target components, adding costs incurred in previous years, and removing support costs.

One-Year Comparison Shows an E-LRALT Unit Cost Decrease Because of Less Than Anticipated Quality Control and Testing Costs

The agency applied these new accounting rules retroactively to the 2011 BAR and reported the revisions in the 2012 BAR which enabled a one-year comparison. Between the retroactively adjusted 2011 BAR and the 2012 BAR, the average unit cost and non-recurring costs decreased for the E-LRALT target by 6 and 12 percent, respectively, as seen in figure 12. According to program officials, this is because actual costs for quality control and testing requirements for this missile were lower than originally estimated.

Figure 12: Comparison of 2011 and 2012 BAR Reported E-LRALT Unit Costs



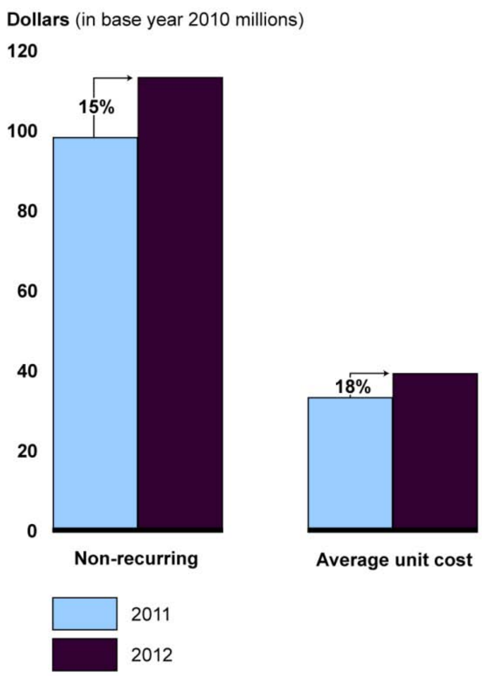
Source: GAO analysis of MDA data.

The E-LRALT is manufactured by the same contractor that manufactured the short-range air-launched target that failed during a THAAD flight test in 2009. Program officials explained that the estimates reported in the 2011 BAR assumed that the extensive quality control measures and testing requirements imposed by MDA would be more costly than they ultimately were.

One-Year Comparison Shows eMRBM Unit Cost Increase Because of Fewer Quantities and Higher Costs to Address Issues during Development

As seen in figure 13, non-recurring and average unit costs increased for the eMRBM targets between the retroactively adjusted 2011 BAR and the 2012 BAR by 15 and 18 percent, respectively, because of increased testing requirements and a reduction in the quantity. Non-recurring costs increased because design issues with the air launch system and additional testing requirements were added to the program after it experienced development issues. The average unit cost increased solely due to a reduction in the quantity which eliminated the opportunity to purchase them more efficiently. The quantity decreased from 11 to 5 targets between the 2011 and 2012 BARs because the latest agency testing plan increased the number of intermediate-range targets and reduced the number of medium-range targets. Although the average unit cost change was above the 5 percent reporting threshold that MDA established in its 2012 BAR, the $6 million dollar change in the average unit cost of the eMRBM target was not separately reported because the agency attributed this increase solely to a quantity change and not to real cost growth.

Figure 13: Comparison of 2011 and 2012 BAR Reported eMRBM Unit Costs

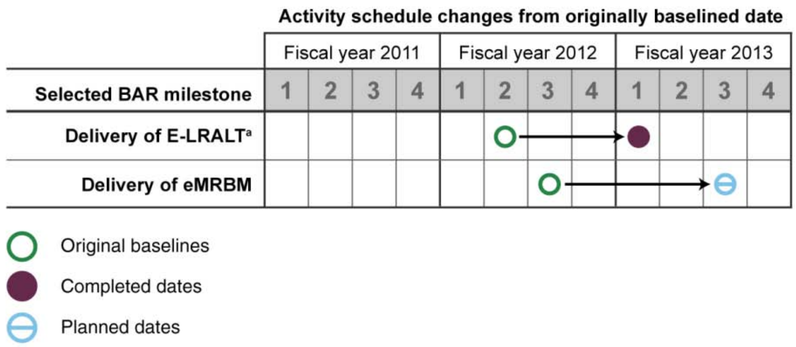


Source: GAO analysis of MDA data.

Developmental Challenges Cause Delays for eMRBM and E-LRALT Needed for System-Level Tests

The Targets and Countermeasures program met the majority of its schedule goals to support the test program in fiscal year 2012 by successfully flying eight targets. However, the program experienced delays in delivering an E-LRALT for Flight Test Integrated-01 and delays delivering eMRBM targets as previously discussed.

Figure 14: Schedule Assessment for Selected Targets and Countermeasures eMRBM and E-LRALT Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]The E-LRALT was originally planned for delivery in second quarter fiscal year 2012 to support FTT-13, which was canceled for budgetary reasons. The E-LRALT was then rescheduled for use in Flight Test Integrated-01, originally planned for the fourth quarter of fiscal year 2012.

Appendix X: Terminal High Altitude Area Defense (THAAD)

Recent Events	Overview
• First two THAAD batteries conditionally accepted for use by the Army. • Successfully conducted the first THAAD operational flight test. • First intercept of a medium-range ballistic missile.	➢ THAAD overcame past production issues exacerbated by concurrency and has plans to recover from a 2012 production issue. ➢ First two THAAD batteries conditionally accepted by the Army with full acceptance expected by 2017. ➢ THAAD completes first intercept of medium-range ballistic missile during a complex system-level flight test. ➢ THAAD was declared operationally effective in 2012, but test officials note several limitations. ➢ THAAD cost and schedule baselines reflect budget cut and the completion of previously scheduled activities..

Background and Overview

THAAD is a rapidly deployable ground-based system designed to defend against short- and medium-range ballistic missile attacks during the middle and end of their flight. A THAAD battery currently consists of 24 interceptor missiles, three launchers, a radar, a fire control and communications system, and other support equipment. Starting in fiscal year 2013, the program plans to increase each battery to 48 interceptors and six launchers. The first two batteries have been conditionally released to the Army for initial operational use. The program plans to continue production through fiscal year 2021, producing a total of 6 batteries, including 503 interceptors and 6 radars.[1]

THAAD Overcame Past Production Issues Exacerbated by Concurrency and Has Plans to Recover from a 2012 Production Issue

As we reported in April 2012, THAAD adopted a highly concurrent development, testing, and production strategy for its interceptors. Under this concurrent strategy, the program committed to production in 2006 before the requirements or design for a required safety device, called an optical block, were completed. An optical block is an ignition safety device designed to prevent accidental launches of the missile. Problems encountered while THAAD was concurrently designing and producing these interceptors led to slower delivery rates for the first and second THAAD batteries. While all other systems needed for the first two batteries were complete in 2010, only 11 out of the expected 50 interceptors were delivered during fiscal year 2011. Although the program

[1]The BMDS Sensors program manages the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) production and delivers the radars to THAAD.

still had not completed testing of the safety device for the interceptor or overcome its production issues, MDA continued its concurrent acquisition strategy by signing a production contract in early 2011 for two additional THAAD batteries.

In fiscal year 2012, after a 15-month delay, THAAD was able to overcome its production issues and deliver the remainder of the interceptors needed for the first two batteries. The program resumed production in the second quarter of fiscal year 2011 after completing testing for its optical block. MDA issued a contract in July 2012 for the continued production of THAAD batteries including procurement of additional interceptors as well as manufacturing and delivery of launchers and support equipment. The program is planning to award another production contract in fourth quarter fiscal year 2013 which will continue production for a total of 320 interceptors through fiscal year 2017.

After experiencing a minor delay to interceptor production during 2012, the THAAD program plans to continue interceptor deliveries as planned. The program was on track to meet the new interceptor production goals in mid 2012 when faulty memory devices were discovered on the mission computers of interceptors procured in 2010 and 2011. Though the defective parts were discovered while most interceptors were still at the contractor’s facility, the issue caused a production gap beginning in late fourth quarter fiscal year 2012. This gap put the interceptor production schedule four months behind. However, program officials have acquired and completed initial testing of the new parts and expect to recover the delays by increasing the average rate of production from three up to four interceptors per month. By making this change, they expect to be able to deliver the next set of 48 interceptors by December 2013 as scheduled. However, six interceptors with the faulty parts had already been delivered with the first two batteries and will have to be retrofitted.

First Two THAAD Batteries Conditionally Accepted by the Army with Full Acceptance Expected by 2017

The Army has declared the THAAD Weapon System as safe, suitable, and supportable for Army soldiers to operate, with conditions. A list of these conditions that must be satisfied before the Army approves full materiel release has been defined. Examples of which include additional flight testing, verification of safety systems, training, and reliability improvements. Also defined are the resolution plan, funding, and estimated schedules. The program expects the last conditions to be resolved by the end of fourth quarter fiscal year 2017.

One of the conditions that must be met to achieve full materiel release of THAAD to the Army is the incorporation of the required Thermally Initiated Venting System. The venting system is a safety feature of the interceptor that prevents the boost motor from starting or exploding in the event that the canister holding the interceptor heats up beyond a certain temperature. The program concurrently developed and tested this system while producing the fielded interceptors. After a redesign in 2011, the system is performing better in recent testing than it has in the past. Program officials say that this safety system may not meet all of the Army standards for full materiel release. However, military standards for the venting requirement are written for smaller scale systems and have never been incorporated into a system as large as THAAD. Although the program does not expect to complete all required testing of the safety system until late in the second quarter of fiscal year 2013, the program has already inserted the latest version into the interceptor production line for batteries three and four and plans to include it in all subsequent interceptors.

THAAD Completes First Intercept of Medium-Range Ballistic Missile during a Complex System-Level Flight Test

THAAD successfully demonstrated its capability to intercept a medium-range ballistic missile for the first time during a complex, integrated test (Flight Test Integrated-01) involving multiple BMDS elements and targets in October 2012. This test provided key data to DOD test organizations to demonstrate recent upgrades to THAAD hardware and software. The test was also used to evaluate how well THAAD and other missile defense elements such as Aegis Ballistic Missile Defense, Patriot, and Command, Control, Battle Management and Communications elements work together. THAAD was operated by Army soldiers during the test, even though the overall event was considered a combined developmental and operational test.

Although THAAD was able to achieve an important step by intercepting a medium-range target during the test, other capabilities have still not been demonstrated. One significant example is demonstrating the performance of the system using the radar advanced software against a complex target. The software has been implemented in the operational radar and ground tested, but will not be demonstrated in a flight test until fiscal year 2015. The THAAD program expects to have three batteries delivered to the Army before this test is complete. The program plans to deliver additional batteries while it continues conducting flight tests to verify the system's capabilities. If the program discovers issues that need to be corrected during these later tests, it could be very costly to resolve any issues and retrofit existing inventory.

THAAD Was Declared Operationally Effective in 2012, but Test Officials Note Several Limitations

Testing officials declared THAAD operationally effective in 2012 after it successfully conducted its first operational flight test in October 2011. We reported in April 2012 that THAAD successfully conducted this flight test and demonstrated its ability to perform, from planning through live operations, under operationally realistic conditions (within the constraints of test range safety).[2] A February 2012 evaluation of this test and prior flight test data by the Director, Operational Test and Evaluation, concluded that the system is operationally effective, suitable, and survivable against the threats and environments tested.[3] However, the evaluation also noted some suitability-related limitations and maintenance shortfalls as well as the need for improvements in its ability to be deployed, and its manpower and training, ease of using its software, and ability to connect and function with other systems. Army and BMDS test organizations provided data to the Army for evaluation of materiel release. Additional testing will be needed to further verify that these issues have been resolved.

While the system begins to release initial batteries to the Army, flight and ground testing of THAAD continues in order to further verify system performance and other ongoing modifications. For example, while all THAAD components used in the operational test were the final major hardware and software used in the first two batteries, additional software and hardware modifications are planned for subsequent batteries. As planned hardware and software modifications are made, additional testing demonstrations are required to verify that the new software and hardware work as intended.

THAAD Cost and Schedule Baselines Reflect Budget Cut and the Completion of Previously Scheduled Activities

Since the 2010 BAR baselines were reported, the THAAD program entered initial production and established a new baseline. Its resource baselines report separate unit costs for its interceptors, fire control system, and launchers.

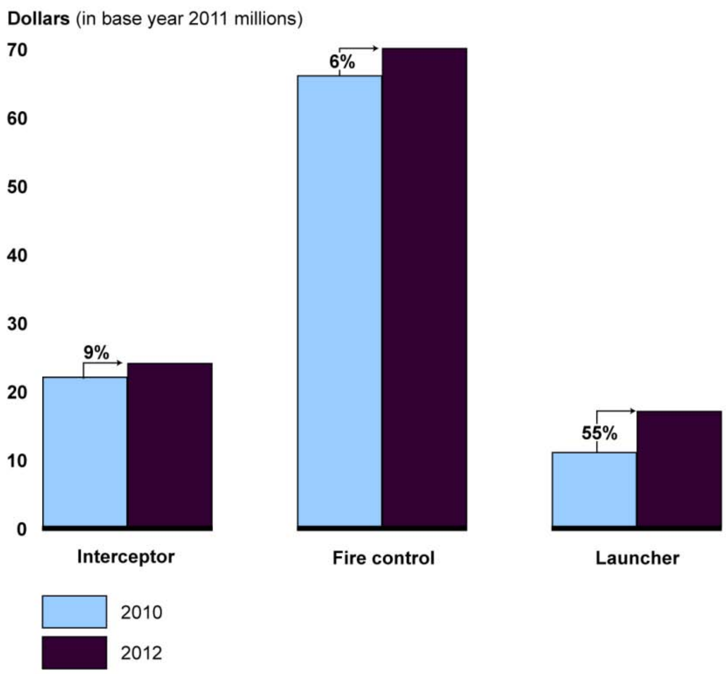
[2]GAO-12-486.

[3]Pursuant to MDA's acquisition flexibilities, once an element enters the production and deployment phase, the element enters the formal DOD acquisition system. Consequently, 10 U.S.C. § 2366 requires completion of realistic survivability testing of a weapon system before a program can begin full-rate production.

THAAD Unit Costs Have Grown Because of Quantity Reduction

During the fiscal year, MDA reduced the number of THAAD batteries to be procured from nine down to six because of budget constraints. This reduction in THAAD batteries subsequently caused an increase in the unit cost to develop and produce launchers and fire controls. The cost for each unit has increased between the 2010 and 2012 BARs primarily because the development costs are shared by fewer numbers of operational systems. Because of these reductions, the unit cost to develop and produce the fire control and the launcher increased by 6 percent and 55 percent, respectively as seen in figure 15. MDA did not separately report these increases, even though they are above the 5 percent threshold that MDA established in its 2012 BAR, because they are solely attributed to the quantity change.

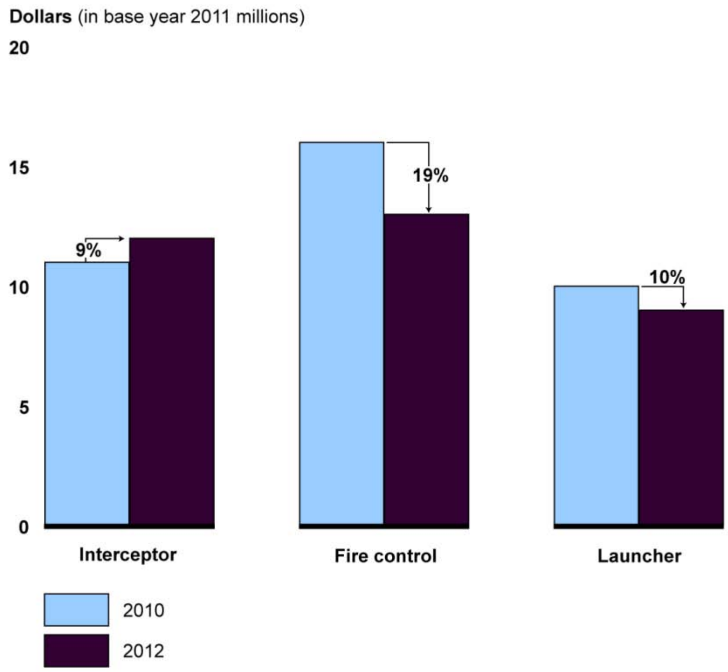
Figure 15: Comparison of 2010 and 2012 BAR Reported THAAD Unit Costs to Develop and Produce Items



Source: GAO analysis of MDA data.

Since its 2010 BAR reporting, the agency significantly reduced the planned rate of interceptor production from six down to three per month which led to a 9 percent increase in the average cost to develop and produce a THAAD interceptor as shown in figure 15. This rate change is also partly responsible for the increased average cost to produce one interceptor as seen in figure 16. MDA did not separately explain or report these increases, even though they are above the 5 percent threshold that MDA established in its 2012 BAR, because they are largely due to the rate change.

Figure 16: Comparison of 2010 and 2012 BAR Reported THAAD Unit Costs to Produce Items



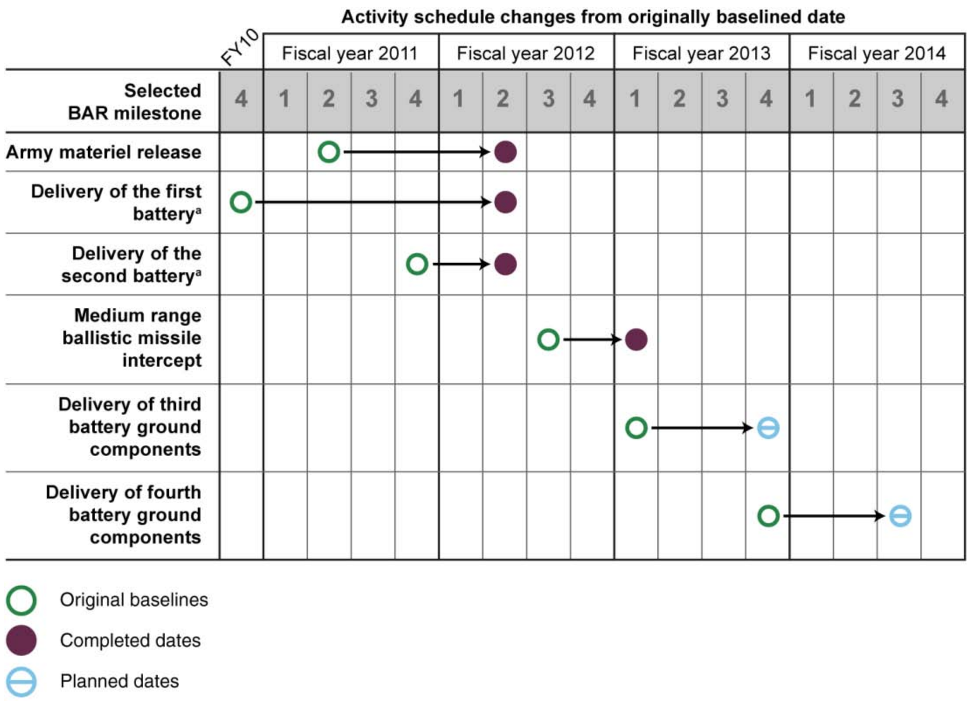
Source: GAO analysis of MDA data.

According to program officials, the reported unit cost to produce the fire control and launcher decreased significantly between the 2010 and 2012 BAR resource baselines largely due to a reallocation of common support costs after the total numbers of THAAD batteries were reduced but the total number of interceptors increased. A small portion of the decrease in the average costs to produce the fire control and launcher is attributable to favorable contract negotiations for the third and fourth battery. However, according to program officials, the majority of this cost decrease is due to how common support costs for the originally planned nine THAAD batteries were reallocated among the new quantity of six THAAD batteries. Officials explained that during this reallocation, a larger percentage of these common costs were allocated for the larger number of interceptors and a smaller percentage was allocated to the fewer number of fire control and launchers. This reallocation reduced the reported unit costs to produce the fire control and launchers and also increased the unit cost to produce the interceptor—although some portion of the interceptor cost increase is because of the slower production rate.

Many Previously Delayed Activities Completed

In fiscal year 2012 THAAD completed many of its previously delayed schedule goals. Following successful performance in an early fiscal year 2012 flight test, the program obtained a conditional materiel release from the Army in the second quarter of fiscal year 2012 after approximately a one year delay. After addressing production issues with its interceptors, the program was also able to deliver its first two THAAD batteries to the Service for operational use during the fiscal year. Prior to BAR baseline reporting, the first full battery was originally scheduled to be delivered in the fourth quarter of fiscal year 2010. It was delivered in the second quarter of fiscal year 2012 after approximately a year and a half delay. The second THAAD battery was also delivered in the second quarter of the fiscal year following a 6-month delay. THAAD is expecting delays to deliveries of the third and fourth THAAD battery ground components, as seen in figure 17, driven by a longer than expected time to negotiate and issue production contracts needed for these batteries. Additionally, the program successfully met its goal to intercept a Medium-Range Ballistic Missile for the first time in the first quarter of fiscal year 2013, following a 6-month delay, primarily driven by delays with a target delivery.

Figure 17: Schedule Assessment for Selected THAAD Activities in the BMDS Accountability Report



Source: GAO analysis of MDA data.

Note: All original dates for activities are based on baselines in the 2010 BAR unless noted otherwise.

[a]Prior to 2010 BAR, the first THAAD battery was originally scheduled to be delivered in the fourth quarter of fiscal year 2010. At the time of the June 2010 BAR, the battery had already been delayed and was, at that time, scheduled for delivery in the second quarter of fiscal year 2011.

Appendix XI: Comments from the Department of Defense

ASSISTANT SECRETARY OF DEFENSE
30150 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

ACQUISITION

041113

Ms. Cristina Chaplain
Director, Acquisition and Sourcing Management
U. S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Chaplain:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-13-432, "MISSILE DEFENSE: Opportunity to Refocus on Strengthening Acquisition Management," dated March 15, 2013 (GAO Code 121066). Detailed comments on the report recommendations as well as technical comments are enclosed. The DoD concurs with two of the draft report's recommendations and partially concurs with two of the recommendations.

We appreciate the opportunity to comment on the draft report. My point of contact for this effort is Lt Col Peter Jackson, 703-695-7328, Peter.Jackson@osd.mil.

Sincerely,

Katrina McFarland

Enclosures:
As stated

GAO Draft Report Dated March 15, 2013
GAO-13-432 (GAO CODE 121066)

"MISSILE DEFENSE: OPPORTUNITY TO REFOCUS ON STRENGTHENING ACQUISITION MANAGEMENT"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATIONS

In its report, GAO recommends that the Secretary of Defense direct the Missile Defense Agency's (MDA) new Director to take the following action to strengthen investment decisions, place the chosen investments on a sound acquisition footing, provide a better means of tracking investment progress, and improve the management and transparency of the U.S. missile defense approach in Europe. The GAO makes four recommendations:

RECOMMENDATION 1: Undertake robust alternatives analysis for new major missile defense efforts currently underway, including the SM-3 Block IIB, and before embarking on any other major new missile defense programs. In particular, such analyses should consider a broad range of alternatives.

DoD RESPONSE: Concur. For all new capabilities, MDA currently performs studies and reviews that provide outcomes similar to analysis of alternatives formally conducted by other agencies. The agency will undertake appropriate alternatives analysis prior to determining a materiel solution for any needs driven capability requirement.

RECOMMENDATION 2: Add risk reduction non-intercept flight tests for each new type of target missiles developed.

DoD RESPONSE: Partially Concur. Non-intercept flight tests may be conducted for "each new type of target" developed by MDA, depending on assessed risk, but not necessarily on each new target. The decision to perform a non-intercept target test to reduce risk and increase confidence must be balanced against cost, schedule, and programmatic impacts.

Qualification tests of key target components and a proven quality control process provide MDA the confidence necessary to plan for and launch targets for the first time as part of a system level flight test. A target development approach similar to the extended long range air launched target is being pursued for the extended medium-range ballistic missile targets. MDA remains committed to continuously monitoring and mitigating the risks related to target development to ensure successful flight test missions.

RECOMMENDATION 3: Include in its resource baseline cost estimates all life cycle costs, specifically the operations and support costs, from the military services in order to provide decision-makers with the full costs of ballistic missile defense systems.

DoD RESPONSE: Partially Concur. The Department agrees that decision-makers should have insight into the full life-cycle costs of DoD programs. MDA provides an annual update of its resource baselines in the Ballistic Missile Defense System (BMDS) Accountability Report (BAR). However, the BAR is not the appropriate forum for including military service Operations and Support (O&S) costs for BMDS elements. The MDA BAR should only include content for which MDA is responsible. MDA will provide to the GAO joint MDA-Service O&S cost estimates as they are completed. To date, MDA has established joint cost positions with the Army for Terminal High-Altitude Area Defense and Army Navy/Transportable Radar Surveillance – Model 2, and with the Navy for Sea-Based X-Band Radar. The Cost Assessment and Program Evaluation office will continue to produce independent cost estimates for each BMDS element.

RECOMMENDATION 4: Stabilize the acquisition baselines, so that meaningful comparisons can be made over time that supports oversight of those acquisitions.

DoD RESPONSE: Concur. As BMDS and its element development matures, including the approach to US missile defense in Europe, MDA strives to stabilize program baselines for its component programs. In 2010, MDA established initial baselines for all BMDS component programs in the product development phase or later and created a formal process to maintain configuration control of these baselines. MDA has reported these baselines annually to Congress in the BMDS Accountability Report (BAR). The 2013 BAR will contain comparisons between the current program and the previously reported baselines in the 2012 BAR. It will also contain comparisons to the initial program baselines when appropriate. The National Defense Authorization Act for Fiscal Year 2012 provided the MDA Director the authority to "adjust or revise" the acquisition baselines provided the Director notify Congress and provide justification.

It is necessary to recognize that BMDS component baselines respond to evolving requirements provided by external stakeholders (e.g., Missile Defense Executive Board, warfighters, Secretary of Defense direction, Presidential direction) to counter evolving and projected threats (e.g., Iran and North Korea). In response to direction, the MDA Director exercises his authority to realign MDA resources, within departmental guidelines, to adjust the evolving BMDS development and fielding program as necessary. MDA remains committed to providing transparency in reporting BMDS component program baselines.

Appendix XII: GAO Contact and Staff Acknowledgments

GAO Contact

Cristina Chaplain (202) 512-4841 or chaplainc@gao.gov

Acknowledgments

In addition to the contact named above, David Best, Assistant Director; Brent Burris, Ivy Hübler; Meredith Allen Kimmett; Wiktor Niewiadomski; Kenneth E. Patton; John H. Pendleton; Karen Richey; Ann F. Rivlin; Brian T. Smith; Steven Stern; Robert Swierczek; Brian Tittle; Hai V. Tran; and Alyssa Weir made key contributions to this report.

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