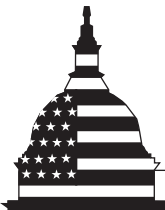


March 2011

# MISSILE DEFENSE

## Actions Needed to Improve Transparency and Accountability



G A O

Accountability \* Integrity \* Reliability

## Why GAO Did This Study

Since 2002, Congress has directed GAO to assess the Missile Defense Agency's (MDA) annual fiscal year cost, schedule, testing, and performance progress in developing the Ballistic Missile Defense System (BMDS). This year's report specifically assesses MDA's progress in (1) delivering missile defense assets as scheduled (2) improving accountability and transparency over the past year (3) implementing the European Phased Adaptive Approach (4) implementing changes to the Ground-based Midcourse Defense program (5) implementing the targets revised acquisition strategy identified in 2009, and (6) testing the BMDS and developing its modeling and simulations to assess performance. To accomplish this, GAO reviewed MDA's progress reports to the Congress, pertinent Department of Defense (DOD) policies and reports including a DOD assessment and plan related to the Ground-based Midcourse Defense system.

## What GAO Recommends

GAO makes 10 recommendations for MDA to strengthen its resource, schedule and test baselines, facilitate baseline reviews, and further improve transparency and accountability. GAO is also making a recommendation to improve MDA's ability to carry out its test plan. In response, DOD fully concurred with 7 recommendations. It partially concurred with 3, contending that its current actions are sufficient and that the test recommendation is also not affordable. GAO continues to believe that additional action is needed.

View [GAO-11-372](#) or key components. For more information, contact Cristina Chaplain at (202) 512-4841

## MISSILE DEFENSE:

### Actions Needed to Improve Transparency and Accountability

#### What GAO Found

In 2010, MDA made progress in delivering assets as well as increasing transparency and accountability. While many significant, positive steps were taken, GAO also found issues limiting the extent to which cost, schedule, and system performance can be tracked. Stabilizing the new acquisition approach, improving execution and increasing transparency are key steps for DOD.

#### Asset Delivery

In 2010, MDA was able to meet or exceed its delivery goals for several MDA activities, such as missile defense upgrades to Aegis ships. However, the agency was unable to meet all of its goals for Terminal High Altitude Area Defense, a system used to defend against targets in their last phases of flight.

#### Transparency and Accountability

MDA finalized a new process in which detailed baselines were set for several missile defense systems. As a result of the new process, its 2010 progress report to the Congress is more comprehensive than it was in 2009. Although the information in MDA's progress reports to the Congress increased, GAO found its unit and life-cycle cost baselines had unexplained inconsistencies and documentation for six baselines had insufficient evidence to be a high-quality cost estimate. As a result, GAO could not evaluate cost progress.

#### European Phased Adaptive Approach for Missile Defense

The September 2009 shift in focus for European missile defense represents a significant change in U.S. policy and a substantial investment for DOD. However, DOD has not fully implemented a management process that synchronizes European missile defense acquisition activities and ensures transparency and accountability. Without key management and oversight processes, there is a limited basis for oversight, and there is a risk that key components will start production before demonstrating system performance. In the past, similar deficiencies in missile defense acquisition oversight have led to rework, cost increases, delays, and doubts about delivered capabilities.

#### Ground-based Midcourse Defense (GMD)

While the GMD system—which is primarily designed to engage longer-range targets in the midcourse range of flight—has demonstrated a limited capability, DOD has not yet determined the system's full capabilities and limitations. In January and December 2010, GMD experienced two flight test failures. In addition, GMD is just beginning to take actions necessary to sustain the capability through 2032.

#### Targets Acquisition, Testing, and Performance

MDA made a targets acquisition decision in 2010 in response to a target failure. This decision was not consistent with its 2009 acquisition plan which envisioned competitive contract awards that would reduce reliance on its prime contractor. The cost of this action remains unknown. Also, as in previous years, failures and delays in testing have continued to delay validation of models and simulations used to assess BMDS performance.

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# Contents

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<b>Letter</b>		<b>1</b>
	Background	6
	MDA Met Most of Its Fiscal Year 2010 Asset Delivery Goals	11
	MDA Undertook Steps to Improve Transparency and Accountability	12
	Acquisitions Supporting European PAA Face Synchronization, Transparency, and Accountability Challenges	23
	New GMD Strategy Curtails Planned Operational Quantities, and It May Take Years to Understand Capabilities, Limitations, and Sustainability	26
	Decisions on Acquisition of Targets in Fiscal Year 2010	28
	Overall Performance of the BMDS Still Cannot Be Assessed Due to Models and Simulations Challenges and Shortfalls in Testing	30
	Conclusions	32
	Recommendations for Executive Action	33
	Agency Comments and Our Evaluation	34
<b>Appendix I</b>	<b>Comments from the Department of Defense</b>	<b>39</b>
<b>Appendix II</b>	<b>Assessment of MDA Resource Baselines</b>	<b>43</b>
<b>Appendix III</b>	<b>Aegis Ballistic Missile Defense (Aegis BMD) with Standard Missile-3 Interceptor</b>	<b>57</b>
<b>Appendix IV</b>	<b>Aegis Ashore with Standard Missile-3 Block IB (European PAA Phase II)</b>	<b>61</b>
<b>Appendix V</b>	<b>Airborne Infrared (ABIR)</b>	<b>66</b>
<b>Appendix VI</b>	<b>Airborne Laser Test Bed (ALTB)</b>	<b>70</b>

---

<b>Appendix VII</b>	<b>BMDS Sensors</b>	<b>72</b>
<b>Appendix VIII</b>	<b>Command and Control, Battle Management and Communications (C2BMC)</b>	<b>77</b>
<b>Appendix IX</b>	<b>Ground-based Midcourse Defense (GMD)</b>	<b>80</b>
<b>Appendix X</b>	<b>Precision Tracking Space System (PTSS)</b>	<b>90</b>
<b>Appendix XI</b>	<b>Space Tracking and Surveillance System (STSS)</b>	<b>95</b>
<b>Appendix XII</b>	<b>Targets and Countermeasures</b>	<b>100</b>
<b>Appendix XIII</b>	<b>Terminal High Altitude Area Defense (THAAD)</b>	<b>106</b>
<b>Appendix XIV</b>	<b>Scope and Methodology</b>	<b>112</b>
<b>Appendix XV</b>	<b>GAO Contact and Staff Acknowledgments</b>	<b>117</b>

---

## Tables

Table 1: Description of MDA's BMDS Elements and Supporting Efforts	8
Table 2: September 2009 Presidential Policy for European Phased Adaptive Approach	10
Table 3: BMDS Fiscal Year 2010 Asset Deliveries	11
Table 4: Some System Development Risks Exacerbated by European PAA Schedule Compression	25

---

Table 5: Status of Activities Needed to Inform GMD Sustainment Efforts	28
Table 6: Operation and Sustainment Costs as a Percentage of Total Costs Reported in the 2010 BAR	48
Table 7: Unreported APUC Variances from MDA's 2009 BAR (Dollars in Millions)	50
Table 8: Current Delivery Plans for AN/TPY-2	74
Table 9: The Number of Ground-Based Interceptors Needed through 2032 Lacks Analysis	88
Table 10: Key MDA Target Acquisition Decisions in Fiscal Year 2011	104
Table 11: THAAD's Knowledge Point Objectives by Test Before and After the FTT-11 Failure in December 2009	111

---

## Figures

Figure 1: GAO Analysis of MDA Cost Estimates against the Four Characteristics of High-Quality and Reliable Cost Estimates	18
Figure 2: GAO Analysis of MDA Cost Estimates against the Four Characteristics of High-Quality and Reliable Cost Estimates	54
Figure 3: February 2010 and February 2011 Plans for Aegis Ashore Flight Test Events	65

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## Abbreviations

ABIR	Airborne Infrared
Aegis BMD	Aegis Ballistic Missile Defense
AIRS	Airborne Infrared Surveillance
AN/TPY-2	Army Navy/Transportable Radar Surveillance - Model 2

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ALTB	Airborne Laser Test Bed
APUC	Average Procurement Unit Cost
AT&L	Acquisition, Technology and Logistics
BAR	BMDs Accountability Report
BMDR	Ballistic Missile Defense Review
BMDs	Ballistic Missile Defense System
C2BMC	Command, Control, Battle Management, and Communications
CAPE	Cost Assessment and Program Evaluation
CE-I	Capability Enhancement-I
CE-II	Capability Enhancement-II
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
EKV	Exoatmospheric Kill Vehicle
EVM	Earned Value Management
FTF	Flexible Target Family
GBI	Ground-based Interceptor
GMD	Ground-based Midcourse Defense
ICBM	Intercontinental Ballistic Missile
IMTP	Integrated Master Test Plan
MBIT	Maintenance Built-In Test
MDA	Missile Defense Agency
MDEB	Missile Defense Executive Board
OTA	Operational Test Agency
PAA	Phase Adaptive Approach
PAUC	Program Acquisition Unit Cost
PTSS	Precision Tracking Space System
RAM	Reliability, Availability and Maintainability
SBIRS	Space-Based Infrared System
SBX	Sea-Based X-Band
SM-3	Standard Missile-3
STSS	Space Tracking and Surveillance System
TDACS	Throttleable Divert and Attitude Control System
THAAD	Terminal High Altitude Area Defense
TIVS	Thermally Initiated Venting System
UAS	Unmanned Aircraft System
UEWR	Upgraded Early Warning Radar
VLS	Vertical Launch System

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United States Government Accountability Office  
Washington, DC 20548

March 24, 2011

### Congressional Committees

The Missile Defense Agency's (MDA) mission is to develop an integrated and layered Ballistic Missile Defense System (BMDS) to defend the United States, its deployed forces, allies, and friends. In order to meet this mission, MDA is developing a highly complex system of systems—land, sea-, and space-based sensors, interceptors and battle management. Since its initiation in 2002, MDA has been given a significant amount of flexibility in executing the development and fielding of the BMDS. To enable MDA to field and enhance a missile defense system quickly, the Secretary of Defense in 2002 delayed the entry of the BMDS program into the Department of Defense's (DOD) traditional acquisition process until a mature capability was ready to be handed over to a military service for production and operation. To meet a presidential directive to deliver an initial capability by 2004, the program has concurrently developed and fielded assets. While this approach helped MDA rapidly deploy an initial capability, it has also meant that MDA has fielded some assets whose capability is uncertain. Moreover, we have reported that MDA's approach has limited transparency and accountability for DOD's largest single acquisition program—spending from approximately \$7 billion to \$9.5 billion per year.<sup>1</sup> More specifically, there has been limited understanding about baseline costs, schedules, requirements, and system effectiveness.

Last year, we reported that MDA was in the process of transitioning to new leadership, a new acquisition strategy, a new test strategy, and a shift in emphasis toward early intercept capabilities. Given the breadth and scope of these changes, we concluded that the agency had an opportunity to chart a course that enables transparency and accountability while retaining its desired flexibility, and it appeared that MDA was committed to doing so. Importantly, the Director of MDA had begun new initiatives in accordance with guiding principles of DOD's acquisition policies, which already embrace knowledge-based practices and sound management

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<sup>1</sup> GAO, *Defense Acquisitions: Missile Defense Transition Provides Opportunity to Strengthen Acquisition Approach*, [GAO-10-311](#) (Washington, D.C. Feb.25, 2010).

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controls.<sup>2</sup> The Director of MDA intended to apply these new policies to each element or appropriate portions of the elements, as is currently done across DOD, in order to provide a better foundation for Congress and others to assess progress and hold senior leadership accountable for outcomes.<sup>3</sup>

Since 2002, Congress has directed GAO to assess MDA's annual fiscal year cost, schedule, testing, and performance progress in developing the BMDS.<sup>4</sup> We have delivered assessments of MDA's progress covering fiscal years 2003 through 2009 and are currently mandated to continue our assessments through fiscal year 2013.<sup>5</sup> According to this mandate, we are required to assess MDA's fiscal year progress against the annual goals it is required to report to Congress each February in the BMDS Accountability

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<sup>2</sup> Knowledge-based acquisition practices are used by successful developers to get quality products to customers as quickly and cost effectively as possible. As a part of meeting this goal, developers focus their technology programs on maturing technologies that have the realistic potential for being incorporated into the product under consideration. Accordingly, successful developers spend time to mature technology in a technology setting, where costs are typically not as great, and they do not move forward with product development until essential technologies are sufficiently mature.

<sup>3</sup> An element of the BMDS is essentially a program that, together with other BMDS elements or programs, comprises a complex system of defense. MDA intends for each element to play an important role in a system intended to defend against hostile missiles in any phase of flight. An element may consist of several components.

<sup>4</sup> 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.

<sup>5</sup> We did not assess MDA's progress in fiscal year 2002 as the agency did not establish goals for that fiscal year. We delivered the following reports for fiscal years 2003 through 2007: GAO, *Missile Defense: Actions Are Needed to Enhance Testing and Accountability*, [GAO-04-409](#) (Washington, D.C.: Apr. 23, 2004); *Defense Acquisitions: Status of Ballistic Missile Defense Program in 2004*, [GAO-05-243](#) (Washington, D.C.: Mar. 31, 2005); *Defense Acquisitions: Missile Defense Agency Fields Initial Capability but Falls Short of Original Goals*, [GAO-06-327](#) (Washington, D.C.: Mar. 15, 2006); *Defense Acquisitions: Missile Defense Acquisition Strategy Generates Results but Delivers Less at a Higher Cost*, [GAO-07-387](#) (Washington, D.C.: Mar. 15, 2007); *Defense Acquisitions: Progress Made in Fielding Missile Defense, but Program Is Short of Meeting Goals*, [GAO-08-448](#) (Washington, D.C.: Mar. 14, 2008); *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); and [GAO-10-311](#).



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Report (BAR).<sup>6</sup> This year's report specifically assesses MDA's progress in (1) delivering missile defense assets as scheduled (2) improving accountability and transparency over the past year (3) implementing the European Phased Adaptive Approach (PAA) (4) implementing changes to the Ground-based Midcourse Defense (GMD) program (5) implementing the targets revised acquisition strategy identified in 2009, and (6) testing the BMDS and developing its modeling and simulations to assess performance.

To assess all six areas of MDA's progress, we examined the accomplishments of nine BMDS elements and supporting efforts that MDA is currently developing and fielding: the Aegis Ballistic Missile Defense (Aegis BMD); Aegis Ashore; BMDS Sensors; Command, Control, Battle Management, and Communications (C2BMC); GMD; Precision Tracking and Surveillance System (PTSS); Space Tracking and Surveillance System (STSS); Targets and Countermeasures; and Terminal High Altitude Area Defense (THAAD). We reviewed individual element responses to GAO data collection instruments, which detailed key accomplishments for fiscal year 2010. The results of these reviews are presented in detail in appendixes to this report and are also integrated as appropriate in our findings related to progress in delivering assets and implementing new initiatives. We also sought to examine MDA's Baseline Execution Reviews of each element's progress, but were unable to assess the supporting backup materials as they were not made available to us until February 2011—the very end of the audit.

To assess whether MDA elements delivered assets as scheduled, we examined the 2009 BAR and compared it to the 2010 version, looking for similarities and differences between the two. We also reviewed responses to GAO data collection instruments, which detailed key accomplishments for fiscal year 2010, including some asset deliveries, as well as any delayed asset deliveries

To follow up on the progress MDA made to improve transparency and accountability, we reviewed pertinent DOD policies to compare MDA's

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<sup>6</sup> MDA reports its goals in the annual BAR. The agency did not issue its 2010 goals report until June 2010—4 months later than required. The National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107 § 232(c) required DOD to establish cost, schedule, testing and performance goals for the BMDS and to submit a statement of these goals to the congressional defense committees by February 1, each year. The BAR currently is used to meet this requirement.

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current level of accountability with that of other DOD programs. We also assessed the cost, schedule, and test baselines included in the 2010 BAR.<sup>7</sup> In addition, we held discussions with officials in MDA's Operations Directorate to discuss the new phased adaptive approach. Lastly, we met with officials in MDA's Acquisition Directorate to discuss how the agency is establishing and managing against its internal baselines.

For our assessment regarding the implementation of the management process to synchronize acquisitions for the European PAA, we synthesized management and oversight principles from the Office of Management and Budget, DOD, MDA, and GAO best acquisition practices for large acquisition efforts similar to European PAA.<sup>8</sup> We then compared European PAA acquisition efforts to these principles. We also reviewed DOD and MDA documentation related to European PAA. We also requested the European PAA cost estimate that was completed in fall of 2009.<sup>9</sup> However, we did not receive the cost estimate until February 2011—the very end of our audit—and therefore we could not assess it for this report. We met with MDA and Office of the Secretary of Defense officials. We visited the U.S. European Command and U.S. Strategic Command. We met with officials from MDA directorates and element program offices as well as the Offices of the Under Secretary of Defense for Policy and the Under Secretary of Defense for Acquisition, Technology and Logistics and visited contractor facilities.

In addition, we are including the acquisition-related parts of our final analysis performed in response to a congressional mandate that we review

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<sup>7</sup> 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, derived from the users' best estimates of cost, schedule, and performance requirements, provides decision makers with the program's total cost for an increment of work, average unit costs for assets to be delivered, key dates associated with a capability, and the weapon's intended performance parameters

<sup>8</sup> GAO, *Missile Defense: European Phased Adaptive Approach Acquisitions Face Synchronization, Transparency, and Accountability Challenges*, [GAO-11-179R](#) (Washington, D.C.: Dec. 21, 2010).

<sup>9</sup> According to MDA, the European PAA cost estimate was not a formal cost estimate, but an interim work product to provide a sense of budget requirements for European PAA considerations. The agency also noted that the Office of the Secretary of Defense's Cost Analysis and Program Evaluation does not endorse the estimate because of the insufficient definition of mission requirements and technical requirements, as well as a lack of validated, projected technical capabilities that MDA states will be accomplished through its test program.

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a DOD assessment and plan related to the GMD system, that included issues related to acquisition, sustainment and refurbishment.<sup>10</sup> For DOD's Assessment and Plan for the GMD program, we reviewed the reports provided by DOD; analyzed sustainment, refurbishment and test plans and program schedules; and assessed budget documents and program reviews. We interviewed officials from MDA, U.S. Strategic Command, U.S. Northern Command, and the Army.

To assess BMDS testing and target development progress, we reviewed technical baselines in the BAR, MDA's Integrated Master Test Plans, the target business case analysis, target contracts, and other documents related to target planning and acquisitions. We also interviewed officials within program offices and within MDA functional directorates, such as the Directorates for Engineering and Testing. In addition, we discussed the elements' test programs and test results with the BMDS Operational Test Agency and DOD's Office of the Director, Operational Test and Evaluation. We held discussions with the BMDS Operational Test Agency to follow up on BMDS models and simulations. Our scope and methodology for each of the six objectives is discussed further in appendix XIV.

As we agreed to with your staff, we do not include an analysis of MDA's earned value management (EVM) reporting this year. In prior years, in the absence of full cost baselines for elements, we assessed the EVM progress of individual contracts. We issued our findings on MDA's EVM progress during fiscal year 2009 in July 2010 and found data reliability issues with 2 of the 14 contracts.<sup>11</sup> Because of these issues with the GMD and Targets and Countermeasures programs' EVM data, we were unable to report cost progress for these two contracts which amounted to half of the total budgeted contract costs for MDA prime contracts we reviewed. We plan to assess EVM data on MDA prime contracts in the future once MDA has had time to address our recommendations to improve data reliability. In our July report, MDA stated that it intended to take a key step in addressing our recommendations by conducting a major review of the GMD

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<sup>10</sup> DOD was mandated in the National Defense Authorization Act for Fiscal Year 2010 Pub. L. No. 111-84, § 232 (2009) to conduct an assessment of the GMD element and establish a plan for GMD to cover period of the future years defense program. Additionally, the Comptroller General was mandated to review the plan and assessment and provide our assessment, which we did in a briefing on October 15, 2010 to all four defense committees. We have included the key acquisition related material in appendix IX.

<sup>11</sup> GAO, *Defense Acquisitions: Missile Defense Program Instability Affects Reliability of Earned Value Management Data*, [GAO-10-676](#) (Washington, D.C.: July 14, 2010).

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program's EVM data by the end of September 2010. Because MDA provided documentation of its actions at the end of our audit—in February 2011—leaving no time for review, we will assess whether the steps MDA has taken sufficiently address GMD's data reliability issues in next year's report.

We conducted this performance audit from March 2010 to March 2011 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.

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## Background

MDA's BMDS is being designed to counter ballistic missiles of all ranges—short, medium, intermediate, and long. Since ballistic missiles have different ranges, speeds, sizes, and performance characteristics, MDA is employing an integrated and layered architecture to provide multiple opportunities to destroy ballistic missiles before they can reach their targets. The system's architecture includes space-based and airborne sensors as well as ground- and sea-based radars; ground- and sea-based interceptor missiles; and a command and control, battle management, and communications system to provide the warfighter with the necessary communication links to the sensors and interceptor missiles.

A typical engagement scenario to defend against an intercontinental ballistic missile would occur as follows:

- Infrared sensors aboard early-warning satellites detect the hot plume of a missile launch and alert the command authority of a possible attack.
- Upon receiving the alert, land- or sea-based radars are directed to track the various objects released from the missile and, if so designed, to identify the warhead from among spent rocket motors, decoys, and debris.
- When the trajectory of the missile's warhead has been adequately established, an interceptor—consisting of a kill vehicle mounted atop a booster—is launched to engage the threat. The interceptor boosts itself toward a predicted intercept point and releases the kill vehicle.
- The kill vehicle uses its onboard sensors and divert thrusters to detect, identify, and steer itself into the warhead. With a combined closing speed of up to 10 kilometers per second (22,000 miles per

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hour), the warhead is destroyed above the atmosphere through a “hit to kill” collision with the kill vehicle.

- Some interceptors use sensors to steer themselves into the inbound ballistic missile. Inside the atmosphere, these systems kill the ballistic missile using a range of mechanisms such as direct collision between the missile and the inbound ballistic missile or killing it with the combined effects of a blast fragmentation warhead (heat, pressure, and grains/shrapnel) in cases where a direct hit does not occur.

Table 1 provides a brief description of nine BMDS elements and supporting efforts currently under development by MDA.

**Table 1: Description of MDA’s BMDS Elements and Supporting Efforts**

BMDS element/supporting effort <sup>a</sup>	Description
Aegis Ballistic Missile Defense (Aegis BMD)	Aegis BMD is a sea-based missile defense system being developed in incremental, capability-based blocks to defend against ballistic missiles of all ranges. Key components include the shipboard SPY-1 radar, Standard Missile-3 (SM-3) missiles, and command and control systems. It will also be used as a forward-deployed sensor for surveillance and tracking of ballistic missiles. The SM-3 missile has multiple versions in development or production: Blocks IA, IB, and IIA.
Aegis Ashore	Aegis Ashore is a future land-based variant of the ship-based Aegis BMD. It is expected to track and intercept ballistic missiles in their midcourse phase of flight using SM-3 interceptor variants as they come available. Key components include the Aegis SPY-1 radar, command and control system, and vertical launching system; and removable enclosures for the systems to facilitate worldwide deployment. DOD plans to deploy the first Aegis Ashore with SM-3 Block IB in 2015 as part of the European Phased Adaptive Approach.
BMDS Sensors	MDA is developing various sensors for fielding. These include forward-based sensors; mobile, sea-based, space-based and airborne sensors; as well as upgrades to existing early warning radars. The BMDS uses these sensors to identify and continuously track ballistic missiles in all phases of flight.
Command, Control, Battle Management, and Communications (C2BMC)	C2BMC is the integrating element of the BMDS. Its role is to provide deliberate planning, situational awareness, sensor management, and battle management for the integrated BMDS.
Ground-based Midcourse Defense (GMD)	GMD is a ground-based missile defense system designed to destroy intermediate and intercontinental ballistic missiles during the midcourse phase of their flight. Its mission is to protect the U.S. homeland against ballistic missile attacks from North Korea and the Middle East.
Precision Tracking and Space System (PTSS)	PTSS is being developed as an operational component of the BMDS designed to support early intercept of regional medium- and intermediate-range ballistic missile threats to the United States and its allies in Europe. PTSS will track large missile raid sizes early after launch, which could enable earlier intercepts.
Space Tracking and Surveillance System (STSS)	STSS is a space-based infrared sensor program with two demonstration satellites that launched on September 25, 2009. The purpose of the program is to provide risk reduction for the future PTSS.
Targets and Countermeasures	MDA maintains a series of targets used in BMDS flight tests to present realistic threat scenarios. The targets are designed to encompass the full spectrum of threat missile ranges and capabilities.
Terminal High Altitude Area Defense (THAAD)	THAAD is a ground-based missile defense system designed to destroy short- and medium-range ballistic missiles during the late-midcourse and terminal phases of flight. Its mission is to defend deployed U.S. forces and friendly foreign population centers.

Source: MDA data.

<sup>a</sup>The Airborne Laser Test Bed (ALTB), formerly the Airborne Laser program, is being developed as an advanced platform for DOD’s directed energy research program. As a test bed, the ALTB is currently not under development as a BMDS element.

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## Acquisition Strategy for Missile Defense

MDA has employed varied strategies to acquire and deploy missile defense systems. From its inception in 2002 through 2007, MDA developed missile defense capability in biennial increments, known as blocks. These 2-year blocks were each built on preceding blocks and enhanced the development and capability of the BMDS. However, there was little visibility into baseline costs and schedules associated with systems that comprised the blocks or how the blocks addressed particular threats. In response to recommendations from GAO, in December 2007, MDA announced a new block structure that was intended to improve the program's transparency, accountability, and oversight. The new blocks were not based on biennial time periods, but instead focused on fielding capabilities that address particular threats. Because the new block structure was not aligned to regular time periods, multiple blocks were under way concurrently. The capabilities-based five-block approach included several positive changes, including the commitment by DOD to establish total acquisition costs and unit costs for selected block assets, including in a block only those elements or components of elements that would be fielded during the block and abandoning the practice of deferring work from one block to another.

MDA was still transitioning to this new capabilities-based block approach when the MDA Director terminated it in June 2009—a year and a half after it was created. According to MDA, the agency terminated the capability-based block structure to address congressional concerns. The agency then began to manage the BMDS as a single integrated program but planned to report on cost, schedule, and performance issues by each element within the program. At the time of our 2010 report, MDA was in the process of determining how it would implement changes to its acquisition management strategy.

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## Shift in Approach to European Missile Defense

Another significant change that took place in 2009 was the new administration's shift in its approach to European missile defense. DOD altered its approach to European defense, which originally focused on ground-based interceptors (GBI) from the GMD element and a large fixed radar as well as transportable X-Band radars, in order to provide defenses against long-range threats to the United States and short-, medium-, and intermediate-range Iranian threats to Europe. The new European PAA consists primarily of Aegis BMD sea-based and land-based systems and interceptors, as well as various sensors to be deployed over time as the various capabilities are matured. According to DOD, this new approach offers a number of improvements over the previous architecture, such as providing missile defenses sooner with greater flexibility to meet evolving

threats, providing more opportunities to involve close allies, and delivering greater capability to defend against a large number of threat missiles. In essence, the new policy marks a fundamental change from an emphasis on a global integrated system to a policy that bundles capability and tailors it for different regions—the PAA—with the European PAA being the first of these regional approaches. According to DOD, it intends to use the department’s existing processes for managing missile defense acquisitions and the existing BMDS element-based acquisition approach for missile defense system elements—not one specific to each PAA—to approve system acquisitions for each PAA.

The European PAA policy announced by the President articulates a schedule for delivering four phases of capability to defend Europe and augment current protection of the U.S. homeland in the following timeframes: Phase 1 in 2011, Phase 2 in 2015, Phase 3 in 2018, and Phase 4 in 2020. DOD’s phased schedule for the European PAA comprises multiple elements and interceptors to provide increasingly integrated ballistic missile defense capability. The policy is structured around the phased deployment of increasingly capable variants of the SM-3 interceptor, together with sensors, command and control, and other capabilities. It is projected that each successive phase will deliver additional capability with respect to both threat missile range and raid size.

Table 2 outlines the plans and estimated delivery timeframes associated with each European PAA phase.

**Table 2: September 2009 Presidential Policy for European Phased Adaptive Approach**

European PAA phase	Plans	Estimated delivery time frame
Phase I	Deploy current and proven missile defense systems available in the next 2 years, including the sea-based Aegis Weapon System, the SM-3 interceptor (Block IA) and sensors such as the Army/Navy Transportable Radar Surveillance system to address regional ballistic missile threats to Europe and deployed U.S. personnel and their families.	2011
Phase II	After appropriate testing, deploy a more capable version of the SM-3 interceptor (Block IB) in both sea- and land-based configurations and more advanced sensors, to expand the defended area against short- and medium-range missile threats.	2015
Phase III	After development and testing are complete, deploy the more advanced SM-3 Block IIA variant currently under development to counter short-, medium-, and intermediate-range threats.	2018
Phase IV	After development and testing are complete, deploy the SM-3 Block IIB to help better cope with medium- and intermediate-range missiles and the potential future intercontinental range ballistic missile threat to the United States.	2020

Source: President's September 17, 2009 policy announcement.



However, many aspects of the European PAA have not yet been determined. DOD has thus far committed to using two land-based Aegis Ashore facilities and at least one Army Navy/ Transportable Radar Surveillance—Model 2 (AN/TPY-2) radar. Additionally, each European PAA phase could have as many as three Aegis BMD ship patrol areas, but DOD has not yet committed to a specific number of ships or SM-3 interceptors for each phase. DOD also has not yet committed to the specific type or number of the other elements and interceptors that will be part of the European PAA phases.

## MDA Met Most of Its Fiscal Year 2010 Asset Delivery Goals

MDA increased inventories for Aegis, GMD, Sensors, and THAAD in fiscal year 2010. The Aegis, GMD, and Sensors elements all either met or exceeded their delivery goals, but THAAD was unable to meet all of its 2010 delivery goals. Table 3 shows the asset deliveries that we were able to track and record based on the agency’s 2009 BAR and other information we obtained directly from each program element.

**Table 3: BMDs Fiscal Year 2010 Asset Deliveries**

BMDs element	Fiscal year 2010 delivery goals	Assets delivered in fiscal year 2010
Aegis	2 Aegis BMD cruisers (ships) 17 SM-3 missiles	2 Aegis BMD cruisers (ships) 26 SM-3 missiles
GMD	3 ground-based interceptors	6 ground-based interceptors <sup>a</sup>
BMDs Sensors	1 AN/TPY-2 radar	1 AN/TPY-2 radar
THAAD	1 THAAD battery <sup>b</sup>	1 partial THAAD battery <sup>c</sup>

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

<sup>a</sup>Although the GMD program delivered six GBIs in fiscal year 2010, two of the interceptors were delayed from fiscal year 2009 and another one was a test asset.

<sup>b</sup>A THAAD battery includes interceptor missiles, launchers, an X-band radar, and a fire control and communications system.

<sup>c</sup>THAAD delivered all of the first battery except for the interceptor missiles and launchers.

In fiscal year 2010, Aegis BMD planned to deliver two additional ships to the fleet with the Aegis Weapons System software as well as 17 SM-3 missiles. The program reported that it met its goal of delivering two additional ships with the Aegis Weapon System software as planned, which completed the 20-ship fleet. In addition, the program delivered 26 SM-3 Block IA missiles in fiscal year 2010—9 more than originally planned.

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Furthermore, MDA redelivered 2 missiles that resolved quality problems discovered in 2009.<sup>12</sup>

Meanwhile, GMD met its delivery goals, delivering three interceptors as planned. The program also delivered two additional interceptors in fiscal year 2010 that were originally scheduled to be delivered in fiscal year 2009. The program also delivered an interceptor that was used during a fiscal year 2010 flight test.<sup>13</sup> Lastly, the BMDS Sensors program successfully delivered one AN/TPY-2 radar to THAAD as planned.

The THAAD program partially met its goal to deliver its first battery in fiscal year 2010. While some assets of its first battery were delivered, which included an X-band radar, a fire control and communications system, and some ground support equipment, none of the battery's 24 interceptors or 3 launchers were delivered as planned. The interceptors are experiencing delays because of production issues stemming from design and qualification issues related to a safety system in the interceptor. The launchers are experiencing delays to completing the government acceptance process because of issues during production associated with manufacturing challenges, parts obsolescence, design changes, and manufacturing defects. Late qualification and design changes have also delayed the acceptance process further. THAAD plans to complete the interceptors by the end of the fourth quarter of fiscal year 2011. The government acceptance process for the launchers should be complete by the third quarter of fiscal year 2011.

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## MDA Undertook Steps to Improve Transparency and Accountability

Throughout 2010, MDA continued to make significant changes to its key acquisition processes in order to increase transparency and accountability and reflect acquisition best practices. Specifically, MDA assessed each program to determine its acquisition phase (technology development, product development, or production), and for the first time, developed and reported detailed baselines for each element, including resource baselines outlining key costs for several BMDS components. While the steps taken are significant and positive, our analysis identified shortcomings in cost,

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<sup>12</sup> 7 of these missiles were redelivered in 2009, and the remaining 6 were redelivered in 2011.

<sup>13</sup> The GBI used during the fiscal year 2010 flight test was a two-stage variant. The remaining 2010 GBI deliveries were the three-stage variant, which are designed for operational use.

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schedule, and testing baselines that limit the extent to which cost and schedule growth as well as system performance can be tracked.

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## New Review Process Results in More Detailed Baselines, but Gaps Remain

In our last report, we recommended that in addition to procurement unit costs, the unit costs for BMDS assets reported in the 2010 BAR be broadened to include development costs so that all costs were included in its unit costs.<sup>14</sup> We also recommended that MDA develop and report to Congress a measure for schedule baseline goals that incorporates delivering integrated capabilities to the warfighter and the dates at which performance baselines will be achieved. In addition, we recommended that top-level test goals for each element, or appropriate portions thereof, be reported to Congress in the 2010 BAR. A final recommendation called for MDA to report variances against all established baselines. DOD concurred with all of these recommendations.

In 2010, MDA made progress in implementing these recommendations by finalizing a new baseline phase review process in which the agency set detailed baselines for several BMDS elements, or portions of elements, for the first time. Specifically, MDA established resource, schedule, test, operational capacity,<sup>15</sup> technical,<sup>16</sup> and contract<sup>17</sup> baselines for several BMDS components. It reported these to Congress in its June 2010 BAR. MDA identified three phases of development where baselines are approved—technology development, product development, and initial production phases—and specified the key knowledge that is needed at each phase. MDA officials stated that they expect that aligning the

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<sup>14</sup> GAO-10-311.

<sup>15</sup> The operational capacity baseline, as defined in the 2010 BAR, is a detailed timeline and set of steps required to certify that BMDS capabilities are ready for operational use, including steps needed for obtaining compliance with information assurance requirements, documenting capabilities and limitations, and completing warfighter training requirements. However, in commenting on a draft of this report, DOD stated that an operational capacity baseline identifies elements and approved hardware and software configuration available for operational use by the combatant commanders.

<sup>16</sup> The technical baseline is a detailed technical description of the capability being developed and planned improvements over time. The description reflects system requirements and describes how particular capabilities satisfy the combatant commanders' prioritized capabilities and the key knowledge points that must be achieved for continued program development.

<sup>17</sup> The contract baseline is a timeline for a set of MDA contracts designed to deliver integrated BMDS capabilities. The timeline highlights the steps in the contracting process from request for proposals through proposal receipt, negotiations, and contract award.

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development efforts with the phases will help to ensure that the appropriate level of knowledge is obtained before the acquisitions move from one phase to the next. In another key step, approval of the product development and initial production baselines will be jointly reviewed by the Director of MDA and the respective service acquisition executive, as a number of missile defense systems are expected to eventually transition to the military services for operation. In addition, in regard to these new phases, the agency established a process for approving baselines. As a result of MDA's new baseline phase review process, its 2010 BAR is more comprehensive than its 2009 BAR.

This year, we specifically assessed the new resource, schedule, and test baselines set by MDA. While the material reported was more comprehensive and provided more transparency into resources, schedule, and testing than in previous years, we identified shortcomings that limit the ability to track cost and schedule growth and performance.

## Resource Baseline

The resource baseline is the expected investment needed that leads to the delivery of a BMDS product. MDA presented unit cost baselines for specific assets of each element as well as baselines for cost components of the element including development costs, production and deployment costs, and military construction costs. As a result, there can be multiple baselines for each element. This was the first time that MDA reported program acquisition unit costs (which include development costs in its calculation) and baselines for portions of, and in some cases all, life-cycle costs derived from life cycle cost estimates.

- Unit cost is the cost divided by the quantity. It is usually reported in two ways: (1) average procurement unit cost—procurement cost divided by procurement quantity—and (2) program acquisition unit cost—acquisition cost (which includes both development and procurement) divided by total quantity.<sup>18</sup>
- MDA's baselines for life cycle costs are based on life cycle cost estimates. A life cycle cost estimate should encompass all past (or

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<sup>18</sup> 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.

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sunk), present, and future costs for every aspect of the program, regardless of funding source, and can be used to support budgetary decisions, key acquisition decision points, milestone reviews, and investment decisions. The elements of a program's life cycle cost include the costs of research, development, test, and evaluation; production and deployment; military construction; operation and sustainment; and disposal. MDA's life cycle cost baselines in many cases included sunk costs and costs from the future years defense plan through completion. In addition, MDA included a time-phased estimate of the costs including sunk costs, costs through the future years defense plan, and "to complete" costs.

MDA provided 12 cost baselines for elements' efforts under our review, including Aegis Ashore; Aegis BMD SM-3 Block IB missiles and associated software upgrades for ship sets; future Aegis BMD ship software upgrades; two capability deliveries for AN/TPY-2; C2BMC Spiral 6.4; GMD; two capability deliveries for the Sea Based X-band (SBX) radar; the current THAAD capability configuration; and the Targets and Countermeasures program short-range, medium-range, intermediate-range, and intercontinental ballistic missile target efforts.<sup>19</sup>

While the amount of information presented has increased, we found that the unit cost baselines and the baselines for portions of, and sometimes all, life cycle costs in the BAR did not provide clear, consistent, and complete information, which affected its usefulness for oversight.

- Parts of the 2010 resource baselines were unclear and inconsistent because MDA used particular terms that did not always appear to accurately describe the costs and baselines it was reporting. For example, MDA presented "life cycle costs" in several resource baselines but the use of this term is misleading because in some cases the reported totals appeared to only partially reflect all the main life cycle cost categories. Specifically, it is unclear if disposal costs and, in some cases, operation and sustainment costs were accounted for in all of the life cycle costs. No explanation is provided in the BAR to explain why some of the cost categories appear to be missing or to

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<sup>19</sup> The AN/TPY-2 and SBX radars are both managed by the Sensors program. See appendix VII for further details on these radars. In addition, there are multiple shipset software upgrades planned for Aegis BMD ships. Aegis BMD SM-3 Block IB missiles and associated software upgrades for shipsets refers to software version 4.0.1. Future Aegis BMD ship software upgrades refer to software version 5.0. See appendix IV for details on these software versions.

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describe how the use of the term life cycle cost is appropriate for what was reported.

- The resource baselines for three of the four Targets and Countermeasures resource baselines were incomplete because a large percentage of sunk costs were excluded. The BAR, however, does not disclose that the sunk costs were excluded nor does it explain why MDA decided to exclude them.
- MDA officials told us that they mistakenly baselined operation and sustainment costs in the 2010 BAR and intend to remove those baselines in the 2011 BAR. Choosing not to baseline these costs, in some cases, excludes a large portion of costs from the total cost baseline MDA is reporting. Further, officials also told us that they do not plan to report variances in future BARs for any of the remaining development, production and deployment, or military construction costs that are baselined. Reporting variances is important because deviations from the baseline plan provide valuable insight into program risk and its causes to decision makers. It is unclear why the agency will not report variances against these baselines.
- MDA was also unclear and incomplete in its reporting of operation and sustainment costs. In four of five cases, the operation and sustainment costs reported in the BAR are only those costs for which MDA is responsible and do not include the costs borne by the services.<sup>20</sup> MDA's BAR does not explain that the operation and sustainment costs represented are only a portion of those costs that will be required for the program.<sup>21</sup>
- Although MDA presented average procurement unit costs for 10 BMDS assets in its 2009 BAR, it only reported on 6 of the 10 in its 2010 BAR. MDA also did not identify variances for any of these unit costs or

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<sup>20</sup> MDA also reported operation and sustainment costs for a sixth element's effort, the C2BMC's Spiral 6.4, but the agency did not clarify if the costs represented were the total operation and sustainment costs necessary for the effort.

<sup>21</sup> We previously reported in GAO, *Missile Defense: Actions Needed to Improve Planning and Cost Estimates for Long-Term Support of Ballistic Missile Defense*, [GAO-08-1068](#) (Washington, D.C. Sept. 25, 2008) that DOD had not clearly identified BMDS operation and sustainment costs because the department has not required that these costs are to be developed, validated, and reviewed, and it has not specified when this should be done or who is responsible for doing this.

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explain why these variances were not provided, although it could have reported variances in 3 of the 6 cases.

- MDA was also unclear and inconsistent in how it reported target unit costs—by choosing not to report average procurement or program acquisition unit costs. Instead the program reported average unit costs and, separately, recurring costs without defining these costs or explaining their purpose the BAR. By reporting only the average unit costs for targets, MDA is not reporting the full unit costs to develop and procure targets that would normally be captured in program acquisition unit costs as it reported for other baselines.

Details on these inconsistencies, exclusions, and issues with clarity are outlined in appendix II.

Finally, we sought to determine whether the cost baselines reported in the BAR were supported by high-quality—that is, reliable—cost estimates. According to the *GAO Cost Estimating and Assessment Guide*, the cost estimate is part of a total systems analysis and is a critical element in any acquisition process to help decision makers evaluate resource requirements at milestones and other important decision points.<sup>22</sup> Cost estimates establish and defend budgets and drive affordability analysis. The guide identifies the 12 steps necessary for developing a high-quality cost estimate, which we used to assess MDA's life cycle cost estimates to determine whether they were (1) comprehensive, (2) well documented, (3) accurate, and (4) credible. According to MDA cost officials, they developed their cost estimates based on the methodology in our guide. Our methodology and the full details of our assessment are reported in appendix II.

While MDA was able to provide life cycle cost estimates for all 12 of the BAR life cycle cost baselines reported, we found that 6 of the estimates did not match the costs that were reported in the BAR—specifically those for Aegis Ashore, Aegis BMD SM-3 Block IB missile and associated software upgrades for ship sets, C2BMC Spiral 6.4, GMD, SBX capability deliveries,

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<sup>22</sup> GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

and current THAAD capability configuration estimates.<sup>23</sup> We did not assess those estimates further because they did not support the BAR baselines. For the remaining 6, we found that the documentation that MDA provided contained insufficient evidence to meet the characteristics of a high-quality cost estimate. Specifically, the estimates were not comprehensive, lacked documentation, were not completely accurate, or were not sufficiently credible. See figure 1 for the results of our review of the 6 estimates.

**Figure 1: GAO Analysis of MDA Cost Estimates against the Four Characteristics of High-Quality and Reliable Cost Estimates**

	Future Aegis BMD ship software upgrades <sup>a</sup>				AN/TPY-2 <sup>b</sup>				Short range ballistic missile target <sup>c</sup>				Medium range ballistic missile target <sup>c</sup>				Intermediate range ballistic missile target <sup>c</sup>				Intercontinental range ballistic missile target <sup>c</sup>			
	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible
Met																								
Substantially met																								
Partially met	X	X	X		X	X	X		X				X				X							
Minimally met				X				X	X	X	X		X	X	X		X	X	X	X	X	X		
Not met																								X

Source: MDA data; GAO analysis.

Note: The ratings we used in this analysis are as follows: “met” means that the program provided documentation that satisfied the criterion; “substantially met” means that the program provided the majority of the documentation to satisfy the criterion; “partially met” means that the program provided documentation satisfying part of the criterion; “minimally met” means that the program provided documentation satisfying a minor part of the criterion; and “not met” means that the program did not provide documentation that satisfied the criterion.

<sup>a</sup>Future Aegis BMD ship software upgrades refer to software version 5.0. See appendix III for details on this software version.

<sup>23</sup> The Aegis BMD program office provided the life cycle cost estimate that was the basis for the Aegis BMD SM-3 Block IB missile and associated software upgrades for ship sets resource baseline presented in the June 2010 BAR. The estimate did not directly match information presented in the BAR. The program office provided an updated resource baseline in September 2010, but did not provide the life cycle cost estimate that supported the updated baseline in time for us to include in our analysis. We therefore limited our analysis of resource baselines to only those presented in the June 2010 BAR.



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<sup>b</sup>The cost estimate was for a portion of the AN/TPY-2 element's costs related to two capability deliveries.

<sup>c</sup>The Targets and Countermeasures program manages the short-range, medium-range, intermediate-range, and intercontinental ballistic missile efforts.

The 6 estimates were not fully comprehensive because in some cases they did not provide enough detail to enable us to determine if all government and contractor costs had been included, or, in other cases, did not include the historical data necessary to back up given assumptions. The estimates were not well documented in some cases because the estimates lacked documentation necessary to recreate the estimate, or, in some instances, did not provide enough information on how cost factors were derived. None of the estimates met the standards for accuracy because, in some cases the estimates did not provide a confidence level making it impossible to determine if the estimate was unbiased and based on most likely costs, did not provide access to the detailed calculations used in the estimate, or discrepancies existed on costs among several of the documents provided. Finally, costs associated with the estimates lacked credibility because none of the 6 estimates performed a cost sensitivity analysis, provided evidence that cost driver cross checks were performed, or completed independent cost estimates.

As discussed above, one of the criteria for a credible cost estimate is having an independent cost assessment. Other DOD major defense acquisition programs are required to perform an independent cost estimate before advancing through major milestones.<sup>24</sup> Because of the flexibilities granted in 2002, MDA is not required to obtain independent cost estimates for its programs, and has not otherwise required their programs to do so.<sup>25</sup> The Office of the Director for Cost Assessment and Program Evaluation (CAPE) has performed independent cost estimates for the Aegis BMD program as well as portions of other MDA programs in the past including the STSS and GMD programs. More recently, the CAPE performed an independent cost estimate of THAAD procurement costs. MDA has committed to work with the CAPE to develop cost estimates for other MDA elements in the future. MDA's plans to work with the CAPE to

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<sup>24</sup> 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.

<sup>25</sup> Because MDA has not yet formally entered the DOD acquisition cycle, the requirement at 10 U.S.C. § 2434, which is triggered by the phases of the cycle, does not yet apply.

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develop cost estimates for more MDA elements will contribute to the credibility of its estimates.

Although MDA established life cycle cost baselines as part of its resource baseline for the first time in fiscal year 2010, cost progress cannot be independently evaluated until MDA reports baselines that are supported by reliable, high-quality cost estimates and addresses the issues noted in appendix II.

### Schedule Baseline

The schedule baseline, as presented in the 2010 BAR, is a timeline for key product development milestones and tasks, such as key decision points and product deliveries. For the first time, MDA reported detailed schedule baselines, including information about the program phase decision points and capability deliveries, element knowledge points, models and simulations, and product and capability development efforts. In addition, some schedule baselines also include scheduled flight and ground test information, as well as fielding and field support events. For example, the GMD schedule baseline shows fielding and field support deliveries, such as hardware deliveries, which includes new and refurbished GBI deliveries; facilities, such as silo construction; and software upgrades. However, the amount and type of information presented varies from element to element.

While the amount of information presented is a significant improvement over that in the 2009 BAR, we found that the asset delivery schedule reported in the 2010 BAR was not comparable to the asset delivery schedule in the 2009 BAR. The 2009 BAR included a comprehensive list of planned asset deliveries, as well as schedule delays and accelerations. However, the 2010 BAR did not include a comprehensive list of planned asset deliveries nor did it report variances against the delivery plans it set in 2009. As a result, we could not track and analyze the timing and number of asset deliveries using the BAR. Instead, we had to request detailed information from each program element. The lack of variance reporting on asset deliveries from 2009 to 2010, coupled with the absence of planned asset deliveries limits the usefulness of the BAR for oversight.

### Test Baseline

MDA's 2010 BAR includes a schedule of major flight tests, ground tests, key modeling and simulation events and the primary goals associated with those tests and events. The test events found in the BAR are further detailed and explained in MDA's test baseline known as the Integrated Master Test Plan (IMTP). The IMTP is the management tool that MDA uses to establish and document test requirements for the BMDS test program. We reported last year that MDA extensively revised the IMTP to address

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concerns that the plan was not effective for management and oversight because it was revised frequently, only extended through the following fiscal year and was not well integrated with other key aspects of testing such as target acquisitions.<sup>26</sup> While the new IMTP still represents a significant improvement in test planning and transparency for MDA, frequent revisions to the test baseline due to test failures and/or target availability, hinders external oversight of MDA's test baseline and the funding allocated for testing.

More specifically, the revised IMTP extended the test baseline through 2015 and better laid out MDA's test plan by establishing and documenting the test requirements for the BMDS with specific focus on collecting the data needed for verification, validation, and accreditation of the BMDS models and simulations. Also, under the new plan, each test was designed to test certain criteria, so that, according to MDA test officials, a failed test did not necessarily require alteration to the IMTP.

Despite the agency's effort to revamp its test plans, MDA's test plan remains success-oriented. For example, MDA officials told us that they do not plan for test failures when developing the test schedule and that there is no flexibility to absorb test failures. Despite experiencing several failures in recent years and conducting several retests, the agency does not build in contingencies for retests in its test plans. Moreover, according to program officials, there are no risk reduction flights planned for newly developed targets and MDA does not budget for extra flight test interceptors. Accordingly, having a sufficient schedule and funding margin to account for actual recent experience remains key to a more successful and stable test program.

Because the IMTP is success-oriented, any problems encountered with the plan necessitates a change in the plan and frequent changes to those plans make it difficult to maintain effective oversight of MDA's test program using the test baselines reported in the BAR. For example two intercept tests that were planned for the THAAD program in fiscal year 2010 did not take place because of a target failure in a previous flight test.<sup>27</sup> Additionally, MDA had to alter GMD's planned flight test schedule for fiscal years 2010 and 2011 in order to conduct a retest of a prior test—

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<sup>26</sup> [GAO-10-311](#)

<sup>27</sup> THAAD did accelerate and conduct FTT-14 in fiscal year 2010. For specifics regarding THAAD's fiscal year 2010 activity, see app. XIII.

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FTG-06—that failed January 2010. According to the Director, Operational Test and Evaluation, this retest will likely delay the previous flight test program by at least 6 months. Also, MDA canceled an additional future flight test in order to conduct the retest, thereby reducing the amount of intercept data that will be collected.

These frequent changes make it more difficult to track testing progress and system performance. Moreover, it is unclear what happens to funding planned for tests within a certain fiscal year when the test is canceled or moved to a subsequent fiscal year. Each year, as part of its budget request, MDA justifies its flight test funding request based on a planned set of specific tests. However, because MDA is unable to execute its test plan as presented in the BAR and the budget and does not identify test cost variances in the BAR or the budget, the connection between the justification for funds and the actual execution is broken. For example, MDA requested funding for a GMD flight test—FTG-09. According to the fiscal year 2010 budget request, this test was scheduled to be conducted in fiscal year 2011 as a salvo test.<sup>28</sup> However, because of the noted failure in FTG-06, this test was canceled. Consequently, reviewing budget documents and the BAR does not enable us to determine how much was spent on the FTG-09 test prior to its deletion. Until MDA establishes or reports a test baseline that is both relatively stable and synchronized with other key BMDS management documents, such as the budget, as well as identifies test cost variances, decision-makers will continue to make decisions based on unstable data that are not effective for oversight or useful for timely decisions.

Lastly, as in prior years, target availability also continued to affect MDA's test plans in fiscal year 2010. Since 2006, we have reported that target availability has delayed and prompted modifications to planned test objectives. This trend continued in 2010. For example, because of target availability, five tests scheduled for fiscal year 2010 were canceled because of a moratorium on air launches of targets. Additionally, target shortfalls have contributed to delays in flight tests, reduced the number of flight tests, and altered test objectives. According to MDA officials, targets were the main driver of the revisions of the test schedule in the latest IMTP. For additional information regarding target issues and their effect on BMDS testing, see appendix XII.

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<sup>28</sup> A salvo launch includes the firing of two interceptors at one target.

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Congress established new requirements for Missile Defense baselines, in December 2010, in the National Defense Authorization Act for Fiscal Year 2011.<sup>29</sup> Several of the shortcomings in the 2010 BAR we discuss above are addressed in the law as MDA is now required to submit annual reports on acquisition baselines—to include schedules, cost estimates, and test baselines—starting February 15, 2011. MDA’s 2010 BAR was approved prior to this law. However, we plan to assess the agency’s 2011 BAR against the law’s criteria in our 2012 report.

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## Acquisitions Supporting European PAA Face Synchronization, Transparency, and Accountability Challenges

The shift in focus for European missile defense represents the most comprehensive shift in U.S. Ballistic Missile Defense policy since 2002 when the Secretary of Defense created MDA and the President directed the fielding of an initial set of missile defense capabilities by 2004. To assist Congress in its review of this policy shift and its implications, we were asked to assess DOD’s efforts to implement the phased adaptive approach for Ballistic Missile Defense in Europe. In December 2010, we issued a correspondence on acquisition management and near-term development risks related to the European PAA.<sup>30</sup> In January 2011, we reported on (1) the extent to which DOD has developed guidance and addressed management of cost and schedule in the planning and implementation of the European PAA and (2) the extent to which DOD planning for the European PAA is informed by operational performance data.

In our January report on the European PAA, we recommended actions to enable effective oversight of the European PAA, including establishment of a life cycle cost estimate to help assess affordability and an integrated schedule to help identify European PAA implementation risks.<sup>31</sup> With

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<sup>29</sup> The Ike Skelton National Defense Authorization Act for Fiscal Year 2011, Pub. L. No. 111-383, § 225 (2010) required the Secretary of Defense to ensure that MDA establishes and maintains an acquisition baseline for each program element of the BMDS. This law detailed specific requirements for the contents of the acquisition baseline, including a comprehensive schedule, a detailed technical description, a cost estimate (including life cycle cost estimate), and a test baseline. Annually, MDA is to submit a report on the baselines to the congressional defense committees. After the first such report, each subsequent report shall identify the significant changes or variances, if any, in any baseline from any earlier report.

<sup>30</sup> [GAO-11-179R](#).

<sup>31</sup> 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).

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respect to acquisition management for the European PAA, our December 2010 report found that DOD has not fully implemented a management process that synchronizes European PAA acquisition activities and ensures transparency and accountability. At the time of our review, DOD had made progress in acquisition planning for technology development and systems engineering and testing and partial progress in defining requirements and identifying stakeholders but had not yet developed a European PAA acquisition decision schedule or an overall European PAA investment cost. We found that the limited visibility into the costs and schedule for the European PAA and the lack of some key acquisition management processes reflect the oversight challenges with the acquisition of missile defense capabilities that we have previously reported. The consequences of these issues have included limited means of independently assessing progress and a limited basis for oversight and the department entering into production before fully demonstrating system performance, leading to rework, cost increases, delays, and uncertainties about delivered capabilities. We concluded that for the European PAA, the flexibility desired by DOD is not incompatible with appropriate visibility into key aspects of acquisition management. As DOD proceeds with the European PAA acquisition activities, it is important for Congress and the President to have assurance that the European PAA policy is working as intended and that acquisition activities are cost-effective.

In response to our December 2010 report, DOD stated that it disagreed with GAO's approach to assess the European PAA as what it termed a "near-distinct" element of the BMDS, rather than DOD's decision to employ the department's existing processes. As we have consistently reported, the department's existing processes for developing and acquiring missile defense have transparency and accountability issues that limit oversight and preclude assessing overall progress and limit opportunities for constructive action to put programs in a better position to succeed. The principles we used to assess the European PAA are embedded in the department's acquisition guidance as well as the Office of Management and Budget's guidance for capital programming across federal agencies, particularly as it relates to bringing together and synchronizing multiple development efforts. Although we understand that the European PAA is a policy approach, not an acquisition program, it nonetheless represents an arrangement of significant investments, it requires a high degree of coordination and technical integration, and the progress implementing the European PAA continues to be of congressional interest. Thus, we reported that we continue to believe these acquisition management principles serve as a useful, appropriate and beneficial standard by which

to assess the department’s approach to managing European PAA acquisitions.

**European PAA Acquisition Schedules Are Highly Optimistic**

We have consistently reported that a sound, executable acquisition has firm requirements, mature technologies, and a strategy that provides sufficient time and money for design activities before making the decision to start system development and demonstration or to transition to production. The administration’s European PAA policy committed DOD to a schedule before the scope of system development effort was fully understood. DOD is working to develop plans for implementation within the constraints of policy time frames; however, system schedules are highly optimistic in technology development, testing, production, and integration, leaving little room for potential delays. As efforts to meet near-term commitments unfold, the schedule for delivering capabilities may be difficult to achieve and resources needed may grow. (See table 4.)

**Table 4: Some System Development Risks Exacerbated by European PAA Schedule Compression**

BMDS element/area	Issues/risks
Command, Control, Battle Management, and Communication (C2BMC)	The C2BMC element, which is designed to integrate the BMDS capabilities and provide planning, situational awareness, sensor management, and battle management, may present an incorrect picture of the battle space because it may not accurately group threat missile tracks to reduce multiple cues from sensors about the tracks.
Aegis Ashore	<p>The Aegis BMD weapon system currently in service on ships will require modifications for use on land as Aegis Ashore.</p> <p>The contract for Aegis Ashore’s new deckhouse was awarded prior to key design reviews for Aegis Ashore and we have reported that such sequencing can lead to costly modifications later in the process.</p> <p>Aegis Ashore developmental flight test intercept events have been reduced from five to two, the first intercept test is delayed more than a year, and testing is not timed to inform production commitments.</p>
Aegis Ballistic Missile Defense (Aegis BMD) SM-3 IB	<p>Target availability delayed a key flight test expected to demonstrate performance of Aegis BMD 3.6.1 with Standard Missile-3 Block IA for European PAA Phase I.</p> <p>Progress of Aegis 4.0.1 with SM-3 Block IB is limited by delay in development of Throttleable Divert Attitude Control System (TDACS), an interceptor component.</p> <p>Aegis BMD 5.0 features highly integrated hardware and software and is a key dependency of the new Aegis Ashore program.</p>
Terminal High Altitude Area Defense (THAAD)	Some production risks for THAAD batteries including an incomplete system and some component qualification, potential design changes, and demonstrated production rates for interceptor components not supporting production needs, have caused a more than a 6-month delay in production.

BMDS element/area	Issues/risks
Interoperability and Assessment of Integrated System Performance	<p>As a system of systems, the BMDS is expected to perform as a whole, not just the sum of its individual parts; thus technical interoperability and integration among individual systems is key to whole system performance.</p> <p>Ability of testing and assessment plans to fully demonstrate BMDS capabilities in regional context is constrained by existing limitations in models and simulations. These limitations include incorrect representations of how BMDS elements are linked in the real world and can result in overstating integrated system performance.</p> <p>Interoperability with friends and allies is uncertain. Who will contribute, how, and the degree of technical feasibility and investment to interoperate with other nations has yet to be determined.</p>

Source: GAO analysis of DOD data.

## New GMD Strategy Curtails Planned Operational Quantities, and It May Take Years to Understand Capabilities, Limitations, and Sustainability

Another significant change made for 2010 included a reduction in the number of planned emplaced GBIs from 44 to 30. In making this reduction, the Secretary of Defense stated that 30 GBIs provide an adequate near-term defensive capability for the United States, while allowing for testing and resolution of problems with interceptor technology.<sup>32</sup> According to the Ballistic Missile Defense Review, over the past few years, MDA accelerated development of the homeland defense by simultaneously developing and fielding assets. This step was taken largely in order to facilitate the deployment of GBIs in time to coincide with the expected deployment of intercontinental ballistic missiles by North Korea. That projected intercontinental ballistic missile deployment has not yet occurred and consequently, DOD concluded that it is unnecessary to continue to accept the same level of programmatic risk in the GMD program going forward. Rather, the department plans to focus homeland defense on maintaining the current level of capability and developing future, proven capabilities to enhance homeland defense should a new threat emerge while still maintaining current GMD capabilities.

We were mandated by the Congress in 2009 to examine a DOD assessment and plan related to the GMD system, that included issues related to acquisition, sustainment and refurbishment. We found that while the GMD system has demonstrated a limited capability, DOD has not yet determined the system's full capabilities and limitations. According to the Director of Operational Test and Evaluation's fiscal year 2010 assessment, ground tests support characterization of GMD performance and test results

<sup>32</sup> Although the number of planned emplacements was reduced, funding continued to achieve a total inventory of 52 GBIs; 30 are planned for operational interceptors with an additional 22 for testing and spares.



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suggest that GMD provides a capability to defend the United States against limited, uncomplicated, long-range ballistic missile threats. However, lack of sufficient data for comprehensive model and simulation validation and accreditation continues to preclude a full performance evaluation of GMD. Even though GMD continued to further develop its capability in fiscal year 2010, the GMD program has been unable to successfully achieve all of its testing objectives since 2005. Testing shortfalls continued in fiscal year 2010 when GMD failed to achieve an intercept during Flight Test Ground-based Interceptor (FTG)-06. As we previously reported, FTG-06 was planned as the first test of GMD's enhanced version of the kill vehicle called the Capability Enhancement II (CE-II). Additionally, we noted that MDA stated that the CE-II interceptors would not be declared operational until the satisfactory completion of FTG-06. As a result of the failure in FTG-06, MDA inserted<sup>33</sup> FTG-06a, which also failed to achieve an intercept in December 2010.<sup>34</sup>

Despite testing delays, shortfalls, and failures, MDA has continued to deliver assets. For example, neither the Capability Enhancement I (CE-I) or CE-II Exoatmospheric Kill Vehicle (EKV) has verified its capability against countermeasures—a capability it expected to demonstrate for the CE-I in 2008. Failures in both the target and the interceptors over several years have prevented collecting this information. Moreover, the CE-II EKV has not successfully intercepted a target. Despite these shortfalls all CE-I EKVs have been delivered and the manufacturing and emplacements of the CE-II EKV continued in 2010. According to the Director, MDA, based on the issues that arose in FTG-06a, he directed the agency to stop taking deliveries of any more completed CE-II EKVs. MDA officials stated that the agency is allowing the contractor to continue to work on those components of the EKV that would not be factors in the FTG-06a flight test anomaly in order to keep the production line moving and to allow a rapid recovery of deliveries once the failure investigation team determines likely cause or causes and develops either design changes or mitigations. However, based on our assessment of the GMD developmental flight test plan that was scheduled to continue until 2021, even with this delay, most CE-II EKVs will be manufactured and delivered prior to completing the developmental flight tests and validating their capability.

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<sup>33</sup> GMD canceled GMD flight test FTG-07 in order to conduct FTG-06a.

<sup>34</sup> At the time of our review, MDA had initiated a failure review team to investigate the cause(s) of the failure.

Delays in collecting data to fully understand capabilities and limitations also hinder GMD's efforts to adequately plan sustainment efforts.<sup>35</sup> In fiscal year 2010, the Director of MDA stated that the GMD program is expected to be in service until 2032. However, in certain cases, the agency is just beginning to collect necessary sustainment data that would support the service life. In addition, the collection of this data is incomplete and, in many cases, will not be completed for many years. Table 5 lists several activities that are necessary to inform sustainment efforts and their status. Appendix IX provides additional details regarding GMD sustainment efforts.

**Table 5: Status of Activities Needed to Inform GMD Sustainment Efforts**

Activity necessary to inform sustainment effort	Status of activity
Stockpile Reliability Plan	<ul style="list-style-type: none"> <li>Finalized September 30, 2010</li> </ul>
Aging and Surveillance Test Program	<ul style="list-style-type: none"> <li>Began data collection in 2008 on certain components.</li> <li>Lack of spare parts hinders collection of key data.</li> <li>No specific CE-II EKV components are undergoing aging and surveillance testing.</li> <li>Planned completion: To be determined based on the quality of data gathered.</li> </ul>
Developmental Flight Test Program	<ul style="list-style-type: none"> <li>Expected completion: 2021</li> </ul>
Reliability, Availability, Maintainability, and Testability	<ul style="list-style-type: none"> <li>Reliability, availability, and maintainability was not designed into certain GMD components.</li> <li>Started gathering limited data in 2007.</li> <li>Planned completion: To be determined.</li> </ul>

Source: MDA data.

## Decisions on Acquisition of Targets in Fiscal Year 2010

MDA initiated a new targets acquisition plan in 2009 which called for separate contract awards for different classes of targets, including medium-range, intermediate-range, and intercontinental targets. This plan was undertaken in response to GAO findings regarding cost, schedule and performance problems with the previous targets acquisition approach.<sup>36</sup>

<sup>35</sup> GMD's sustainment program is comprised of multiple activities to maintain and support an effective defensive system, to meet warfighter requirements over the expected 20-year lifecycle, and to support a service life extension decision in 2027.

<sup>36</sup> GAO, *Defense Acquisitions: Sound Business Case Needed to Implement Missile Defense Agency's Targets Program*, [GAO-08-1113](#) (Washington, D.C.: Sept. 26, 2008).

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MDA conducted a business case analysis in order to identify a new acquisition plan that could address these problems. This new approach was to seek separate, competitive contract awards for different classes of targets, allowing MDA to benefit from greater opportunities for competition and reducing the role of the prime contractor. In fiscal year 2010, as part of this strategy, MDA issued two solicitations: one for medium-range targets, and another for intermediate-range targets. However, the agency canceled the solicitation for medium-range targets after receiving proposals. According to MDA officials, the proposals received were more expensive than anticipated. MDA officials cited higher-than-expected costs for the proposals received on the medium-range solicitation as the primary reason it was canceled, but the information they provided did not show detailed analysis of the effect of the cancellation on the cost and schedule assumptions of the business case. The cost effects of this change remain unknown. According to targets program officials, they may issue a new competitive solicitation for medium-range targets, but they have not yet done so. MDA also issued a draft solicitation for intercontinental-range targets in September 2010, but canceled the solicitation in February 2011 before it was finalized.<sup>37</sup>

Separately, MDA also issued a new undefinitized contract action in the second quarter of fiscal year 2010, which asked the incumbent prime contractor to build five new medium-range air-launched targets.<sup>38</sup> MDA officials stated that this action was in response to the target failure in the FTT-11 flight test, and was not related to the cancellation of the medium-range solicitation. Undefinitized contract actions authorize contractors to begin work before reaching a final agreement on contract terms. The current “not-to-exceed” level for the contract action is \$496 million. MDA has allowed this undefinitized contract action to continue for an extended

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<sup>37</sup> According to the notice posted by MDA on the FedBizOpps Web site, the solicitation was canceled due to reprioritization of planned tests, and the agency plans to compete intercontinental-range target requirements in the future at a time to be determined.

<sup>38</sup> To meet urgent needs, DOD can issue undefinitized contract actions, which authorize contractors to begin work before reaching a final agreement on contract terms. Undefinitized contract action means any contract action for which the contract terms, specifications, or price are not agreed upon before performance is begun under the action. Defense Federal Acquisition Regulation Supplement (DFARS) 217.7401(d).

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period—over 290 days as of January 2011.<sup>39</sup> According to MDA officials, the delay in definitization is due to changes in its requirements for the targets, and they anticipate definitization in July 2011, by which time the contract action will have remained undefinitized for about 450 days. The extended use of undefinitized contract actions has previously been identified by GAO and others as risky for the government. Because contracting officers normally reimburse contractors for all allowable costs they incur before definitization, contractors bear less risk and have little incentive to control costs during this period. The government also risks incurring unnecessary costs as requirements may change before the contract is definitized. According to MDA officials, acquiring these new medium-range air-launched targets through an undefinitized action was necessary in order to meet the testing schedule. Documentation provided by the agency showed only limited analysis prior to the decision to award the undefinitized contract action. Officials recognized that this approach would add to the cost of targets compared to the Air Force contract vehicle they had previously used, but because the action remains undefinitized, the agency does not yet know the final price of these targets. For more detailed information regarding targets during fiscal year 2010, see appendix XII.

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## Overall Performance of the BMDS Still Cannot Be Assessed Due to Models and Simulations Challenges and Shortfalls in Testing

For the eighth year, we are unable to report on the overall performance of the BMDS because MDA models and simulations have not matured sufficiently and may not be fully mature until 2017. Because the potential combinations of BMDS configurations, intercept scenarios, and missile threats are too numerous for ground and flight testing, assessing overall BMDS performance depends upon the use of models and simulations to understand the capabilities and limitations of the system. Such an end-to-end system-level simulation brings together the capabilities of various element models in order to analyze how the BMDS integrated and fielded radars, communication systems, and interceptors perform during scenarios. To work effectively, these models and simulations need to be anchored to data from ground and flight tests and validated by independent evaluators—the BMDS Operational Test Agency (OTA)—in

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<sup>39</sup> Under DFARS, undefinitized contract actions are to contain definitization schedules that provide for definitization by the earlier of 180 days after issuance of the action or the date on which the amount of funds obligated under the action is equal to more than 50 percent of the not to exceed price. The 180 days threshold may be extended, but may not exceed the date that is 180 days after the contractor submits a qualifying proposal. DFARS 217.7404-3(a) (1) and (2) and 216.603-2(c)(5).

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order to have confidence in their results. Moreover, the system-level simulation itself is expected to change over time as additional models become available to represent the evolving BMDS configuration. Until models and simulations are accredited and validated, BMDS performance cannot be fully assessed.

In fiscal year 2010, MDA began execution of its revamped IMTP to collect the data needed to accredit the models and simulations used for assessing BMDS performance. The agency was able to conduct several BMDS element tests that generated data needed to accredit models and simulations as well as assess performance for individual BMDS elements. For example, in June 2010 during a GMD booster verification test, C2BMC was able to collect data for accreditation of its models and simulations while demonstrating command and control of a key BMDS radar. In addition, in August 2010, MDA and the BMDS OTA conducted a ground test referred to as Ground Test Integrated-04b (GTI-04b), to demonstrate functionality, interoperability, and performance of the BMDS and to characterize BMDS element capabilities. According to the Director of Operational Test and Evaluation, this test provided the most accurate representation to date of the BMDS including GMD for characterization of performance as well as insight into GMD functionality, interoperability, and performance within the BMDS. Test results suggested that GMD provides a capability to defend the United States against limited long-range ballistic missiles with uncomplicated, emerging threat reentry vehicles.

While some individual BMDS elements' models and simulations provided insight into their interoperability and performance within the BMDS, BMDS OTA officials told us that current BMDS system-level modeling and infrastructure are inadequate to assess the overall performance of the BMDS. BMDS OTA officials told us that the current IMTP focuses on data needed to accredit element-level models, but it does not address system-level integrated performance. In an August 2009 memorandum to MDA, the BMDS OTA and the Joint Functional Component Command for Integrated Missile Defense, referred to as the Warfighter, identified testing requirements that are needed to assess BMDS performance. More importantly, in this memorandum both the BMDS OTA and the Warfighter alerted MDA that there were a number of system-level model, infrastructure, and stimuli limitations that adversely affected the OTA's ability to assess BMDS performance. The Warfighter and the BMDS OTA require testing to reflect realistic representations of strategic and regional/theater defense designs with the full complement of fielded BMDS assets. The BMDS OTA and the Warfighter noted that as the BMDS

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matures and fielded assets increase, modeling and simulation capabilities and laboratory representations of BMDS assets must keep pace to maintain operational realism. However, they stated that current laboratory and model and simulation limitations prevent full asset representation and fail to test the loading that would occur on the communication links as well as the complexity of a full regional/theater conflict on command and control nodes. This limitation severely affects event execution and the ability of the Warfighter to make informed decisions relative to the operational readiness and capability of BMDS elements.

In addition, as with previous years, failures and delays in testing have continued to delay the validation of the models and simulations used to assess the overall performance of the BMDS. GMD, Sensors and THAAD were able to conduct several key flight tests demonstrating element performance; however, each also failed to achieve all planned fiscal year objectives. Additionally, the C2BMC element successfully participated in multiple element tests and completed some ground tests needed to declare a new software configuration operational. Aegis BMD and STSS were unable to conduct either of their planned developmental flight tests for fiscal year 2010. For specific details regarding each element's annual testing accomplishments, delays, and failures, see the individual element appendixes.

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## Conclusions

Last year we noted that as MDA transitioned to new leadership, a new acquisition strategy, a new test strategy, and a shift in emphasis toward early intercept capabilities, the agency had an opportunity to chart a course that enables transparency and accountability as well as flexibility. We also noted that the Director of MDA had begun new initiatives in accordance with guiding principles of DOD's acquisition policies, which already embrace knowledge-based practices and sound management controls. This year we began to see the fruit of those efforts as MDA applied these new policies and began to provide a better foundation for Congress and others to assess progress and hold senior leadership accountable for outcomes. However, while it is undoubtable that some progress has been made in terms of implementing new acquisition reviews and reporting detailed baselines, there remain critical gaps in both the material reported and particularly the quality of the underlying cost estimates needed to establish baselines.

In addition, the department has undertaken another series of significant changes to the acquisition focus of MDA. The decision in 2010 to shift the focus of acquisitions from strategic to regional missile defense brings with

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it a host of significant challenges for MDA and the department. Ensuring that these changes are properly analyzed, efforts are properly synchronized and the resulting decisions are communicated and justified will require significant attention from top departmental leaders.

Lastly, fundamental to accountability and oversight is being able to establish a sound plan and to track actual performance against that plan. For a variety of reasons, including a lack of baselines and changing goals and methods for tracking progress, we have not been able to report with any confidence or consistency on how the missile defense program has performed against its plans or expectations these past 8 years. Thus, it is imperative that the latest policy initiatives be sustained in a way that provides consistent, complete and reliable reporting of progress and variances against those baselines from year to year. The baseline structure MDA established in 2010 is a good start and represents a reasonable basis for reporting progress and variances in the future, and thus should be safeguarded for several years.

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## Recommendations for Executive Action

We recommend that the Secretary of Defense direct MDA to undertake the following 10 actions to strengthen its baselines, facilitate external and independent reviews of those baselines, ensure effective oversight of the BMDS, and further improve transparency and accountability of its efforts. Several of these recommendations relate to how DOD may meet the new statutory requirements to establish and report baselines under the Ike Skelton National Defense Authorization Act for Fiscal Year 2011.

To improve clarity, consistency, and completeness of the baselines reported to Congress, the Secretary of Defense should ensure that MDA takes the following actions:

1. For resource baselines:
  - a) Provide more detailed explanations and definitions of information included in resource baselines; particularly operations and support costs and unit cost calculations.
  - b) Label cost estimates to appropriately reflect the content reported and explain any exclusions.
  - c) Include all sunk costs in all of its cost estimates and baselines.
  - d) Obtain independent cost estimates for each baseline.
  - e) 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.

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2. For schedule baselines:
    - a) In meeting new statutory requirements to report on an acquisition baseline including a comprehensive schedule, include a comprehensive list of actual versus planned quantities of assets that are or were to be delivered each fiscal year.
    - b) In meeting new requirements to report variances on acquisition baselines, report on variances of these quantities by fiscal year and the reasons for these differences.
  3. For test baselines:
    - a) In meeting new statutory requirements to report variances between reported acquisition baselines, also report variances between the test plan as presented in the previous acquisition baseline and the test plan as executed that explain the reason for any changes.
    - b) Report the cost effects of those test changes in either the BAR or the budget justification documentation.

In order to stabilize the test plan and ensure the test baseline can absorb test failures and test delays and remains executable, the Secretary of Defense should ensure that the Missile Defense Agency:

4. Includes sufficient schedule and resource margin, including spare test assets and targets, based on recent test experience and forecasted testing demands.

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## Agency Comments and Our Evaluation

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

DOD fully concurred with 7 of our 10 recommendations, including our recommendations to take steps to ensure its cost estimates are high-quality, reliable cost estimates that are documented to facilitate external review. In response to this recommendation, DOD stated that MDA will follow the *GAO Cost Estimating and Assessment Guide* for each program reported in the BAR. In doing so, MDA Cost Estimating and Analysis Directorate plans to form a cost assessment group to formally assess each cost estimate to ensure they are well documented, comprehensive, accurate, and credible. DOD also fully concurred with our recommendation to report the cost effects of its test changes in either the BAR or budget justification documentation, stating that MDA will provide the cost effects as part of the individual program resource baselines starting in the 2012 BAR.



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DOD partially concurred with our recommendation that the Secretary of Defense direct MDA to include all sunk costs in all of its cost estimates and baselines. DOD stated that MDA will continue to report sunk costs in most of its acquisition programs except targets, where it will continue to report unit costs in the same manner as the 2010 and 2011 BARs.

According to DOD, because each target is inherently a test article and no two are identical, there are always variable non-recurring costs associated with each article. Also, due to the extensive reuse of previous strategic missile components in the targets program, including all sunk costs does not reflect MDA program costs accurately. Accordingly, MDA will use the costs incurred/planned during the future years defense plan to calculate unit costs. These unit costs will not include any sunk costs. We continue to believe that all costs, including all sunk costs incurred for individual target efforts, should be reported to the maximum extent possible, regardless of the agency or service that originally incurred those costs. To the extent that a sunk cost, such as the original cost of previous strategic missile components, can not be calculated, that fact should be explained when the costs are reported. Moreover, DOD's method of reporting and baselining target unit costs will not reflect even MDA program costs accurately because it excludes MDA-incurred sunk costs. Excluding these costs, which can run into the hundreds of millions of dollars, precludes understanding of the full investment required to develop and procure targets, as well as limiting insight into developmental progress. In addition, the incomplete costs reported will be changed every two years because, as DOD noted, MDA uses only the costs for the future years defense plan to calculate the target unit cost baselines. The future years defense plan covers a six year period of time, but changes every two years to a new six year period of time. Calculating unit costs this way provides neither the full cost nor the full quantities of targets as it removes any costs or quantities prior to fiscal year 2010. We therefore continue to believe that including these costs will aid departmental and congressional decision makers as they make difficult choices of where to invest limited resources.

DOD also partially concurred with our recommendation that the Secretary of Defense direct MDA to report, in its annual reports on acquisition baselines, variances in quantities of assets by fiscal year that are or were to be delivered each fiscal year and the reasons for these differences. DOD stated that a change in an asset quantity in a fiscal year may drive a reportable BMDS schedule variance and noted that any changes in asset quantities would also be reflected in unit costs and in the technical baseline. In a separate response, DOD stated that in meeting new statutory requirements, MDA will report a comprehensive list of actual versus planned assets that are or will be delivered each fiscal year. MDA, in its

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2009 BAR, included a comprehensive list of actual versus planned quantities of assets that were to be delivered each fiscal year as its schedule baseline, identified the criteria for reporting schedule variances, and also planned to provide the rationale for any variances. MDA is now statutorily required to establish an acquisition baseline for each element that includes a comprehensive schedule, including delivery and fielding schedules. In addition, because DOD has stated that they will include actual versus planned quantities when meeting annual baseline reporting requirements, we continue to believe that additionally reporting the rationale for these variances, as MDA had previously committed to, would benefit departmental and congressional decision makers as they meet their obligations to manage and oversee this effort.

DOD also partially concurred with our recommendation that the Secretary of Defense direct MDA to include sufficient schedule and resource margin, including spare test assets and targets, based on recent test experience and forecasted testing demands. DOD responded that maintaining cost/schedule margins and additional targets is not cost effective. Instead, DOD stated that MDA will conduct an event-oriented test and acquisition decision-based program and update the test plan frequently to reflect the status of test execution. In addition, DOD noted that MDA will use a “rolling spare” approach to targets. We remain concerned about MDA’s inability to successfully execute those plans. MDA changed its approach to testing 2 years ago, after struggling for years to successfully execute the test plan, instituting a more rigorous planning effort. However, despite increased attention to defining and resourcing its test plan, it has been unable to stabilize and execute the plan successfully. Without a change in its approach, MDA is almost certain to continue to set and reset test plans that are immediately unexecutable soon after they are reset. This approach incurs significant hidden or unplanned costs as testing is delayed and test plans are restructured. As we testified February 25, 2009, the success of MDA’s test planning hinges on properly resourcing the tests with sufficient time, funding and reliable targets.<sup>40</sup> Our current recommendation, based on the experience of the last 2 years, is designed to help stabilize the test plan and reduce the frequency and effort required to reset the test plan while gathering the knowledge MDA has decided it needs as efficiently as possible. Until MDA adds sufficient cost and schedule margin, including additional interceptors and targets, it will

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<sup>40</sup> GAO, *Defense Acquisitions: Charting a Course for Improved Missile Defense Testing*, GAO-09-403T (Washington, D.C.: Feb. 25, 2009).

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continue to achieve less testing, at a greater cost than planned. We therefore continue to believe that the department and Congress would benefit if test plans incorporate reasonable cost and schedule margins.

Lastly, DOD identified 35 "factual errors" in its technical comments. However, upon review we found that 7 of the 35 were not errors of fact, but rather different conclusions; 6 we determined were errors in DOD's official comments, 12 required additional substantiation that was not provided or were material previously requested but could not be assessed during this review because the extensive delay left no time for analysis; and lastly 10 we determined were actual errors of facts and we therefore made the appropriate changes in those cases.

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We are sending copies of this report to the Secretary of Defense and to the Director of MDA. The report also is available at no charge on the GAO Web site 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](mailto:chaplainc@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Major contributors to this report are listed in appendix XV.



Cristina Chaplain  
Director  
Acquisition and Sourcing Management

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*List of Committees*

The Honorable Carl Levin  
Chairman  
The Honorable John McCain  
Ranking Member  
Committee on Armed Services  
United States Senate

The Honorable Daniel K. Inouye  
Chairman  
The Honorable Thad Cochran  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
United States Senate

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

The Honorable C.W. Bill Young  
Chairman  
The Honorable Norman D. Dicks  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
House of Representatives

# Appendix I: Comments from the Department of Defense



ACQUISITION,  
TECHNOLOGY  
AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE  
3000 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3000

MAR 15 2011

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

Dear Ms. Chaplain:

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-11-372, "MISSILE DEFENSE: Actions Needed to Improve Transparency and Accountability," dated February 25, 2011 (GAO Code 120904).

The DoD concurs with seven of the draft report's recommendations and partially-concurs with three. The rationale for our position is included in the enclosure. I submitted separately a list of technical and factual errors for your consideration.

We appreciate the opportunity to comment on the draft report. My point of contact for this effort is Mr. David Crim, [David.Crim@osd.mil](mailto:David.Crim@osd.mil), 703-697-5385.

Sincerely,

A handwritten signature in black ink, appearing to read "David G. Ahern".

David G. Ahern  
Deputy Assistant Secretary of Defense  
Portfolio Systems Acquisition

Enclosure:  
As stated

**GAO DRAFT REPORT DATED FEBRUARY 25, 2011  
GAO-11-372 (GAO CODE 120904)**

**“MISSILE DEFENSE: ACTIONS NEEDED TO IMPROVE TRANSPARENCY AND  
ACCOUNTABILITY”**

**DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS**

**RECOMMENDATION 1:** The GAO recommends that the Secretary of Defense direct Missile Defense Agency (MDA) to:

- a) Provide more detailed explanations and definitions of information included in resource baselines; particularly operations and support costs and unit cost calculations.
- b) Label cost estimates to appropriately reflect the content reported and explain any exclusions.
- c) Include all sunk costs in all of its cost estimates and baselines.
- d) Obtain independent cost estimates for each baseline.
- e) 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.

**DOD RESPONSE:**

- 1a) DoD concurs with the recommendation.
- 1b) DoD concurs with the recommendation.
- 1c) Partially Concur. MDA will continue to report sunk costs in most of its acquisition programs except targets. Specifically, MDA will continue to report unit costs for their targets in the same manner as the 2010 and 2011 Ballistic Missile Defense System (BMDS) Accountability Reports (BARs). Because each target is inherently a test article and no two are identical, there are always variable non-recurring costs associated with each article. Due to the extensive reuse of previous strategic missile components in our targets program, including all sunk costs does not reflect MDA program costs accurately. Accordingly, MDA will use the costs incurred/planned during the FYDP to calculate unit costs. These unit costs will not include any sunk costs.
- 1d) DoD concurs with the recommendation. The Department is using Cost Assessment and Program Evaluation Independent Cost Estimates (ICEs) for MDA programs.
- 1e) DoD concurs with the recommendation. MDA will ensure it has a high quality, reliable cost estimate, completed and documented in accordance with the GAO Cost Estimating and Analysis

Guide for each program reported in the BAR. To help ensure this, MDA Cost Estimating and Analysis Directorate plans to form a cost assessment group to formally assess each cost estimate to ensure they are well documented, comprehensive, accurate, and credible.

**RECOMMENDATION 2:** The GAO recommends that the Secretary of Defense direct Missile Defense Agency to:

a) In meeting new statutory requirements to report on an acquisition baseline including a comprehensive schedule, include a comprehensive list of actual versus planned quantities of assets that are or were to be delivered each fiscal year.

b) In meeting new requirements to report variances on acquisition baselines, report variance of these quantities by fiscal year and the reasons for these differences.

**DOD RESPONSE:**

2a) Concur. MDA will meet statutory requirements on acquisition baseline reporting, including comprehensive schedules, and will include a comprehensive list of actual versus planned quantities of assets that are or will be delivered each fiscal year.

2b) Partially Concur. A change in an asset quantity in a fiscal year may or may not drive a BMDS schedule variance. Changes in asset quantities are likely to affect Unit Cost (resource baseline). Changes in asset delivery schedule may affect BMDS performance (technical baseline). Changes to each baseline are reported. Each baseline has thresholds defining when changes become variances.

**RECOMMENDATION 3:** The GAO recommends that the Secretary of Defense direct Missile Defense Agency to:

a) In meeting new statutory requirements to report variances between reported acquisition baselines, also report variances between the test plan as presented in the previous acquisition baseline and the test plan as executed that explain the reason for any change.

b) Report the cost effects of those test changes in either the BMDS Accountability Report (BAR) or budget justification documentation.

**DOD RESPONSE:**

3a) DoD concurs with the recommendation.

3b) DoD concurs with the recommendation. MDA will provide the cost effects of test changes as part of the individual program resource baselines starting in the 2012 BAR.

**RECOMMENDATION 4:** The GAO recommends that the Secretary of Defense direct Missile Defense Agency to include sufficient schedule and resource margin, including spare test assets and targets, based on recent test experience and forecasted testing demand.

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**Appendix I: Comments from the Department  
of Defense**

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**DOD RESPONSE:** Partially Concur. Maintaining cost/schedule margins and additional targets is not cost effective. Instead, MDA will conduct an event-oriented test and acquisition decision based program and update the Integrated Master Test Plan frequently to reflect status of test execution. MDA will use a “rolling spare” approach to targets.



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# Appendix II: Assessment of MDA Resource Baselines

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We reviewed 12 resource baselines for Ballistic Missile Defense System (BMDS) elements' efforts as presented in the June 2010 BMDS Accountability Report (BAR) including:

- Aegis Ashore;
- Aegis Ballistic Missile Defense (BMD) Standard Missile 3 (SM-3) Block IB missiles and associated software upgrades for ship sets;
- future Aegis BMD ship software upgrades;
- two capability deliveries for Army Navy/Transportable Radar Surveillance (AN/TPY-2);
- Command and Control, Battle Management, and Communications (C2BMC) Spiral 6.4;
- Ground-based Midcourse Defense (GMD);
- two capability deliveries for the Sea Based X-Band (SBX) Radar;
- current Terminal High Altitude Area Defense (THAAD) capability configuration; and
- Targets and Countermeasures program short-range ballistic missile;
- Targets and Countermeasures program medium-range ballistic missile;
- Targets and Countermeasures program intermediate-range ballistic missile; and
- Targets and Countermeasures program intercontinental ballistic missile target efforts.<sup>1</sup>

The Missile Defense Agency (MDA) presented baselines for both unit costs and portions of, and in some cases all, life cycle costs in the 2010 BAR. MDA presented unit cost baselines for specific assets of each element as well as baselines for cost components of the element including development, production and deployment, and military construction costs. As a result, there can be multiple baselines for each element. MDA expressed the majority of its unit costs as program acquisition unit cost (PAUC) or average procurement unit cost (APUC). The APUC is the total procurement funds divided by the fielded quantity, and was included as part of MDA's unit cost baselines for the first time in the 2009 BAR.<sup>2</sup> The

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<sup>1</sup> The AN/TPY-2 and SBX radars are both managed by the Sensors program. See appendix VII for further details on these radars. In addition, there are multiple ship set software upgrades planned for Aegis BMD ships. Aegis BMD SM-3 Block IB missiles and associated software upgrades for ship sets refers to software version 4.0.1. Future Aegis BMD ship software upgrades refer to software version 5.0. See appendix IV for details on these software versions.

<sup>2</sup> 10 U.S.C. § 2432, with respect to major defense acquisition programs, defines the 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.

PAUC is the total cost for the development and procurement of the acquisition program divided by the total quantity, and was included for most of the elements for the first time in the 2010 BAR in response to GAO recommendations.<sup>3</sup> MDA's 2010 BAR also presented, for the first time, a baseline for portions of, and in some cases all, life cycle costs based on life cycle cost estimates for several BMDS components.

Other major defense acquisition programs<sup>4</sup> are required by statute to describe program goals in an acquisition program baseline that, as implemented by the Department of Defense (DOD), has been approved by a higher-level DOD official prior to the program's initiation.<sup>5</sup> The baseline, derived from the best estimates of cost, schedule, and performance requirements, provides decision makers with the program's total cost for an increment of work, unit costs for assets to be delivered, the date that an initial operational capability will be fielded, and the weapon's intended performance parameters. The baseline, according to DOD acquisition guidance, includes cost parameters that should reflect realistic cost estimates of the total program and/or increment, and should contain cost parameters for major elements of program life-cycle cost.<sup>6</sup> The elements of a program's life-cycle cost include research, development, test, and evaluation; production and deployment; military construction; operation and sustainment; and disposal costs. Once approved, major defense acquisition programs are required to measure their program against the baseline. The threshold application of these laws and policies related to baselines are typically triggered by a program's entry into engineering and manufacturing development (formerly system development and

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<sup>3</sup> 10 U.S.C. § 2432, with respect of major defense acquisition programs, defines the program acquisition unit cost 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.

<sup>4</sup> 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 instruction and guidance commonly referred to as 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 of more than \$365 million in fiscal year 2000 constant dollars or, for procurement, of more than \$2.190 billion in fiscal year 2000 constant dollars.

<sup>5</sup> 10 U.S.C. § 2435 requires a baseline description for major defense acquisition programs.

<sup>6</sup> Department of Defense, Chapter 2.1.1, "The Acquisition Program Baseline," of *Defense Acquisition Guidebook* (2009).

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The Resource Baselines  
Reported in the BAR Do Not  
Provide Clear, Consistent and  
Complete Information

demonstration)—a phase in the DOD acquisition cycle during which the weapon system is designed and then demonstrated in tests. The BMDS has not formally entered into the DOD acquisition cycle, therefore this requirement does not yet apply.<sup>7</sup>

Parts of the 2010 resource baselines were unclear because MDA used particular terms that did not always appear to accurately describe the costs and baselines it was reporting. For example, MDA presented “life cycle costs” in several resource baselines but it was unclear in the BAR whether these costs cover the full range of cost categories or cost components normally included in a life cycle cost estimate. In addition, although MDA presented baselines for some of the costs, and, in other cases, all of the costs included in its life cycle costs, program officials told us that they mistakenly baselined operation and sustainment costs in the 2010 BAR and intend to remove those baselines in the 2011 BAR. Officials also told us that they do not plan to report variances in future BARs for any of the remaining development and production costs that are baselined. The operation and sustainment costs that MDA did report in the BAR were incomplete and unclear because, except in one case, they did not include the costs borne by the services and there was no explanation in the BAR for these exclusions. The resource baselines also included many inconsistencies that were unexplained in the BAR. For example, MDA did

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<sup>7</sup> Though 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. The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Pub. L. No. 108-375, § 234(e) (2004), required the Director, MDA, to establish and report annually to Congress a cost, schedule, and performance baseline for each block configuration being fielded. MDA has since terminated its block approach. In addition, the National Defense Authorization Act for Fiscal Year 2008, Pub. L. No. 110-181, § 223(g) required that no later than the submittal of the budget for fiscal year 2009, MDA shall “establish acquisition cost, schedule and performance baselines” for BMDS elements that have entered the equivalent of system development and demonstration or are being produced and acquired for operational fielding. Most recently, the Ike Skelton National Defense Authorization Act for Fiscal Year 2011, Pub. L. No. 111-383, § 225 (2010) required the Secretary of Defense to ensure that MDA establishes and maintains an acquisition baseline for each program element of the BMDS. This law detailed specific requirements for the contents of the acquisition baseline, including a comprehensive schedule, a detailed technical description, a cost estimate, and a test baseline. The cost estimate is to include a life cycle cost estimate, PAUC, APUC, and identify when the program joint cost analysis requirements description document is scheduled to be approved. Annually, MDA is to submit a report on the baselines to the congressional defense committees. After the first such report, each subsequent report shall identify the significant changes or variances, if any, in any baseline from any earlier report. As this law was passed in December 2010, we do not yet know its impact on the problems discussed here.

not report unit cost variances that could have been reported and MDA presented alternate versions of unit costs without explaining how these unit costs were constructed. There also appeared to be instances of underestimating life cycle costs when we compared the time-phased estimate to the life cycle cost baseline. It was unclear why these inconsistencies existed for the life cycle cost baselines because MDA did not explain in the BAR how any portions of the life cycle costs were baselined.

Although MDA termed one section of its resource baseline “life cycle costs,” the use of the term is misleading because in some cases the reported totals appeared to only partially reflect all the main life cycle cost categories. These categories normally include research and development, production and deployment, operation and sustainment, and disposal costs. Life cycle should be thought of as a “cradle to grave” approach to managing a program throughout its useful life. This usually entails identifying all cost elements that pertain to the program from initial concept all the way through operations, support, and disposal. For some of the elements, not all of these cost categories were identifiable in the figures reported and as a result it appears that the totals reported were mislabeled as life cycle costs. Specifically, it appeared that the Aegis Ashore and future Aegis BMD ship software upgrades elements may not have included operation and sustainment costs. It also appeared that none of the 12 baselines reported disposal costs. No explanation was given in the BAR for the exclusion of either of these cost categories or why the term life cycle cost is appropriate for what was reported.

In another instance, the information reported in three of the four Targets and Countermeasures resource baselines was not complete because sunk costs were excluded from the life cycle cost baselines.<sup>8</sup> The short-range ballistic missile effort excluded more than \$400 million in sunk costs from its baseline, to leave less than 43 percent of its total estimated costs baselined. The intermediate-range ballistic missile effort also removed more than \$900 million in sunk costs from its baselined development costs, choosing to baseline less than half of the total estimated costs. MDA did note in the BAR that costs beyond fiscal year 2015 were excluded from the Targets and Countermeasures baselines because the quantities of targets were uncertain in the years beyond 2015. The BAR, however, does not inform the reader that the sunk costs were excluded nor does it

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<sup>8</sup> Sunk costs are costs incurred prior to the time at which the life cycle cost analysis occurs.

explain why MDA decided to exclude them. Agency officials told us that sunk costs were excluded from the development baseline because sunk costs did not fit the definition of average unit cost for the targets. However, this response still does not explain why these costs were excluded from the life cycle cost baselines. Excluding these costs in the baseline means that the full costs through 2015 for these efforts are underestimated and, therefore, are not transparent to decision makers external to the agency.

MDA officials told us that they mistakenly reported operation and sustainment costs as baselined for several elements and stated that they do not intend to report variances for the remaining baselined portions of life cycle costs, despite indications in the 2010 resource baselines that variances would be reported in the future. For the current THAAD capability configuration and the Aegis BMD SM-3 Block IB missiles and associated software upgrades for shipsets, agency officials said that reporting the operation and sustainment costs associated with these elements as a baseline was an error. Although the agency intends to continue to report operation and sustainment costs, they do not consider those costs baselined and will not report them as part of the baseline in the future. Choosing not to baseline these costs, in some cases, removes a large portion of costs from the total cost baseline MDA is reporting. See table 6 for details on the operation and sustainment costs as a percentage of total costs MDA will not baseline in the future.

**Table 6: Operation and Sustainment Costs as a Percentage of Total Costs Reported in the 2010 BAR**

Dollars in millions

	Operation and sustainment costs	Operation and sustainment as a percentage of total reported costs
Aegis BMD SM-3 Block IB missiles and associated software upgrades for shipsets <sup>a</sup>	\$591	9.0 percent
Two capability deliveries for AN/TPY-2	\$5,586	64.7 percent
C2BMC Spiral 6.4	\$387	31.1 percent
GMD <sup>b</sup>	\$12,871	38.6 percent
Two capability deliveries for SBX	\$2,550	63.4 percent
Current THAAD capability configuration	\$4,162	23.9 percent

Source: MDA (date); GAO (analysis)

Note: The operation and sustainment costs reported above only include those costs for which MDA is responsible and excludes those costs borne by the services except for the two capability deliveries for SBX which include both the costs borne by MDA and the service. MDA did not clarify if the operation and sustainment costs shown for C2BMC's Spiral 6.4 were the total operation and sustainment costs necessary for the effort.

<sup>a</sup>The Aegis BMD SM-3 Block IB missiles and associated software upgrades for shipsets effort provided a corrected version of the resource baseline after the June 2010 BAR was released. The updated version, dated September 2010, shows operation and sustainment costs of \$591 million as 7.4 percent of the total reported costs.

<sup>b</sup>In technical comments to our draft report, we learned that according to MDA, the GMD operation and sustainment costs are only for one capability delivery and are not representative of the entire program. The BAR did not explain that these costs only reflected a portion of the program.

Further, the operation and sustainment costs that MDA reported in the BAR were incomplete and unclear because, except in one case, they did not include the costs borne by the services and there was no explanation in the BAR for these exclusions. By excluding the services' portion of these costs, the operation and sustainment costs reported in the BAR for four out of five of the elements' efforts are underestimated since they only include those costs that MDA will be responsible for paying.<sup>9</sup> Only the operation and sustainment costs reported for the two capability deliveries for the SBX Radar included both the costs borne by MDA and the service.

<sup>9</sup> MDA also reported operation and sustainment costs for a sixth element's effort, the C2BMC's Spiral 6.4, but the agency did not clarify if the costs represented were the total operation and sustainment costs necessary for the effort.

The BAR does not explain these differences or exclusions in reporting its operation and sustainment costs.

In addition, MDA officials stated that although MDA will continue to report development, production and deployment, and military construction costs as baselined, none of these baselines will report variances. They stated that the resource baselines are represented solely by unit cost baselines—not by any baselines for life cycle costs. Officials told us that there is no technical reason that prevents MDA from reporting variances for development, production and deployment, or military construction costs. It is also unclear why the agency will not report baselines and variances for operation and sustainment costs. Reporting variances is important because deviations from the baseline plan give management at all levels information about where corrective actions are needed to bring the program back on track. While variances are often perceived as something bad, they provide valuable insight into program risk and its causes and can empower management to make decisions about how to best handle risks.

Although MDA presented APUC unit costs in its 2009 BAR, it only reported on six of the ten APUCs presented in last year's BAR. In addition, it did not present variances for any of these unit costs or explain why these variances were not provided. Of these six, MDA could have reported variances on three according to the agency's own definition of a variance—a cost increase of 10 percent or more when compared to the original resource baseline for a BMDS product. In the case of the THAAD fire control, the unit cost increased by more than 20 percent. According to MDA, the agency did not report on APUC unit costs for four of the assets presenting APUCs in the 2009 BAR because it considered these programs to be complete and the 2009 BAR to be a final report. However, one of the four assets not reporting an APUC in the 2010 BAR is the Aegis BMD SM-3 Block IA missile for which, during fiscal year 2010, the agency delivered an additional 26 missiles. It is unclear why the agency did not provide an updated APUC for this asset in the 2010 BAR since it was not complete before fiscal year 2010. In addition, the 2010 BAR did not explain MDA's decision to stop reporting these four assets. MDA officials also stated that no variances were reported because the agency considers the 2010 BAR resource baselines to be the first established unit cost baselines. However, the agency first reported APUC costs in 2009, and the 2009 BAR explicitly refers to these as "unit cost baselines." Further, the 2009 BAR states that the agency would report any variances to these APUC baselines in the 2010 BAR. See table 7 for a comparison of the 2009 BAR APUC unit costs to the 2010 BAR APUC unit costs and associated unreported variances.

**Table 7: Unreported APUC Variances from MDA’s 2009 BAR (Dollars in Millions)**

	2009 BAR APUC	2010 BAR APUC	Percentage change	Unreported variance
Aegis BMD Block I missiles	\$18	Not reported		
Aegis BMD Block IA missiles	11	Not reported		
Aegis BMD shipset software upgrades <sup>a</sup>	45	\$36	-20.0%	Not applicable
AN/TPY-2 <sup>b</sup>	208	177	-14.9%	Not applicable
Fylingdales upgraded early warning radar <sup>b</sup>	197	Not reported		
GMD ground based interceptors	62	71	14.5%	✓
THAAD interceptors	11	11	0.0%	Not applicable
THAAD fire control system	13	16	23.1%	✓
THAAD launchers	9	10	11.1%	✓
Thule upgraded early warning radar <sup>b</sup>	216	Not reported		

Source: August 2009 BAR and June 2010 BAR. GAO analysis.

Note: MDA’s definition of a variance is a cost increase of 10 percent or more when compared to the original resource baseline for a BMDS product. MDA does not consider cost decreases of 10 percent or more as variances for reporting purposes.

<sup>a</sup>Aegis BMD shipset software upgrades refers to software version 4.0.1. See appendix III for further details on this software version.

<sup>b</sup>The AN/TPY-2, Thule upgraded early warning radar, and Fylingdales upgraded early warning radar are all managed by the Sensors program office. For more details on these radars, see appendix VII.

MDA was also unclear and inconsistent in how it reported target unit costs and did not define or explain these inconsistencies in the BAR. While MDA reported APUC and PAUC for most of its unit cost baselines, it chose to instead report average unit costs for its 4 Targets and Countermeasures program efforts presented in the BAR—short-range, medium-range, intermediate-range, and intercontinental ballistic missile targets. It also separately reported the non-recurring costs to develop these targets. There was no explanation in the BAR as to how the targets’ average unit costs were constructed or why the targets required a different reporting method from the rest of the BMDS element assets. MDA officials told us that since Targets and Countermeasures is procuring targets and is not a developmental acquisition program, that reporting APUC and PAUC was not the best method for reporting unit costs for targets. However, MDA is investing significant amounts to develop the targets it needs. MDA reported in the 2010 BAR that it is planning to invest \$2.4 billion to develop and procure targets between fiscal years 2010 and 2015.

By reporting only the average unit costs for targets, which officials told us was the same as the average recurring costs, MDA is not reporting the full unit costs to develop and procure targets. In analyzing the information in



the 2010 BAR, we determined that in only 4 of the 12 separate target unit costs reported did the BAR provide enough information to calculate PAUC costs. For example, while MDA reported that the new extended medium range ballistic missile average unit cost was \$29 million, if it had included all reported development costs, it could have reported a PAUC of \$60 million for these targets. In addition, the planned new intermediate range ballistic missile reported an average unit cost of \$40 million, but had it included all reported development costs, it could have reported a PAUC of \$109 million. For 8 of the 12 targets presenting average unit costs, including the LV-2 intermediate range target, insufficient information was presented in the BAR to calculate a PAUC.

The 2010 BAR's life cycle cost baselines also lacked clarity and consistency in how some costs were accounted for, giving the appearance that some of the baselines were underestimated. MDA presented both a time-phased estimate in then-year dollars and a life cycle cost baseline in base year dollars, without providing any details in the BAR on how these costs were converted.<sup>10</sup> For example, sunk costs presented in the time-phased estimates were sometimes converted to base year dollars in the life cycle cost baseline and other times not converted. Four of the life cycle costs baselines contained sunk costs that were not converted. Not converting these costs to base year dollars means these costs were underestimated in the life cycle cost baseline. However, it is not possible to assess by how much these costs are underestimated since, in some cases, life cycle cost estimates did not include details on the span of years included in sunk costs. Without knowing which years are covered or being able to account for the costs per year, we were unable to verify the estimates for sunk costs.

### Life Cycle Cost Baselines Are Not Based on High-Quality Cost Estimates

We assessed MDA's life cycle cost estimates using the *GAO Cost Estimating and Assessment Guide* that is based on best practices in cost estimating and which identifies key criteria for establishing high quality cost estimates.<sup>11</sup> Our analysis of the 12 life cycle cost estimates that formed the basis of the 12 life cycle cost baselines in the 2010 BAR found that only 6 of these estimates matched the costs that were reported in the

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<sup>10</sup> Base year dollars are created by converting projected future annual budgets into a single base year by removing the projected effects of inflation. In addition, one can convert prior years budgets (sunk costs) into a single base year by adding inflation.

<sup>11</sup> GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

BAR. The 6 estimates that did not match the BAR baselines—Aegis Ashore, Aegis BMD SM-3 Block IB missile and associated software upgrades for shipsets, C2BMC Spiral 6.4, GMD, SBX capability deliveries, and current THAAD capability configuration—were therefore excluded from further analysis.<sup>12</sup> Of the remaining 6 life cycle cost estimates, none fully met the 4 characteristics of high-quality cost estimates as established by the *GAO Cost Estimating and Assessment Guide*.

According to the *GAO Cost Estimating and Assessment Guide*, the cost estimate is part of a total systems analysis and is a critical element in any acquisition process to help decision makers evaluate resource requirements at milestones and other important decision points. Cost estimates establish and defend budgets and drive affordability analysis. The guide identifies 12 steps necessary for developing a high-quality cost estimate.<sup>13</sup> According to the guide, documentation is a pervasive requirement throughout the 12 steps needed to establish a reliable cost estimate. The detailed documentation called for in the guide addresses the purpose of the estimate, the program background and system description, its schedule, the scope of the estimate (in terms of time and what is and is not included), the ground rules and assumptions, all data sources, estimating methodology and rationale, the results of the risk analysis, and a conclusion about whether the cost estimate is reasonable. A cost estimate is much more than just a single number. It is a compilation of many lower-level cost element estimates that span several years, based on the program schedule. Therefore, a good cost estimate—while taking the form of a single number—is supported by detailed documentation that describes how it was derived and how the expected funding will be spent in order to achieve a given objective. This documentation should include

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<sup>12</sup> The Aegis BMD program office provided the life cycle cost estimate that was the basis for the Aegis BMD SM-3 Block IB missile and associated software upgrades for shipsets resource baseline presented in the June 2010 BAR. The estimate did not directly match information presented in the BAR. The program office provided an updated resource baseline in September 2010, but did not provide the life cycle cost estimate that supported the updated baseline in time for us to include in our analysis. We therefore limited our analysis of resource baselines to only those presented in the June 2010 BAR.

<sup>13</sup> The 12 steps for developing credible cost estimates are (1) defining the project's purpose, (2) developing the estimating plan, (3) defining the project's characteristics, (4) determining the estimating approach, (5) identifying ground rules and assumptions, (6) obtaining data, (7) developing the point estimate, (8) conducting sensitivity analysis, (9) performing a risk or uncertainty analysis, (10) documenting the estimate, (11) presenting the estimate to management for approval, and (12) updating the estimate to reflect actual costs and changes.

enough detail that a cost analyst unfamiliar with the program could recreate it quickly with the same result.

Our research has identified a number of best practices that are the basis of effective program cost estimating and should result in reliable and valid cost estimates that management and key decision makers can use for making informed decisions. These four characteristics of a high-quality and reliable cost estimate are comprehensive, well documented, accurate, and credible. A cost estimate is considered:

- Comprehensive: when it accounts for all possible costs associated with a project, details all cost-influencing ground rules and assumptions, is technically reasonable, is structured in sufficient detail to ensure that costs are neither omitted nor double-counted, and the estimating teams' composition is commensurate with the assignment;
- Well-documented: when supporting documentation for the estimate is accompanied by a narrative explaining the process, sources, and methods used to create the estimate and contains the underlying data used to develop the estimate;
- Accurate: when the estimate is not overly conservative or too optimistic and is based on an assessment of the costs most likely to be incurred; and
- Credible: when the estimate has been cross-checked with independent cost estimates, the level of confidence associated with the point estimate has been identified, and a sensitivity analysis has been conducted—that is, the project has examined the effect of changing one assumption related to each project activity while holding all other variables constant in order to identify which variable most affects the cost estimate.<sup>14</sup>

Although MDA cost officials stated that MDA followed the *GAO Cost Estimating and Assessment Guide* for building cost estimates and baselines, the documentation that MDA provided for the 6 life cycle cost estimates contained insufficient evidence to meet the characteristics of a high-quality cost estimate. In our analysis, we used ratings to describe how much of the criteria the documentation met toward being comprehensive, well-documented, accurate, and credible. The ratings we used were as

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<sup>14</sup> A point estimate is the best guess or most likely value for the cost estimate, given the underlying data. The level of confidence for the point estimate is the probability that the point estimate will actually be met. For example, if the confidence level for a point estimate is 80 percent, there is an 80 percent chance that the final cost will be at or below the point estimate and a 20 percent chance that costs will exceed the point estimate.

follows: “Met” means that the program provided documentation that satisfied the criterion; “Substantially met” means that the program provided the majority of the documentation to satisfy the criterion; “Partially met” means that the program provided documentation satisfying part of the criterion; “Minimally met” means that the program provided documentation satisfying a minor part of the criterion; and “Not met” means that the program did not provide documentation that satisfied the criterion. See figure 2 for the results of our review of the 6 estimates.

Figure 2: GAO Analysis of MDA Cost Estimates against the Four Characteristics of High-Quality and Reliable Cost Estimates

	Future Aegis BMD ship software upgrades <sup>a</sup>				AN/TPY-2 <sup>b</sup>				Short range ballistic missile target <sup>c</sup>				Medium range ballistic missile target <sup>c</sup>				Intermediate range ballistic missile target <sup>c</sup>				Intercontinental range ballistic missile target <sup>c</sup>			
	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible	Comprehensive	Well documented	Accurate	Credible
Met																								
Substantially met																								
Partially met	X	X	X		X	X	X		X				X				X							
Minimally met				X				X	X	X			X	X	X		X	X	X	X	X	X		
Not met																								X

Source: MDA data; GAO analysis.

<sup>a</sup>Future Aegis BMD ship software upgrades refer to software version 5.0. See appendix III for details on this software version.

<sup>b</sup>The cost estimate was for a portion of the AN/TPY-2 element’s costs related to two capability deliveries.

<sup>c</sup>The Targets and Countermeasures program manages the short-range, medium-range, intermediate-range, and intercontinental ballistic missile efforts.

The 6 estimates were not fully comprehensive because they did not provide enough detail to enable us to determine if all government and contractor costs had been included, and it was unclear if the cost estimate was derived from a detailed work breakdown structure allowing us to check if all of the life cycle costs were fully accounted for. In addition, 4 of the estimates did not include the historical data necessary to back up given assumptions. The estimates were not well documented in 5 cases because the estimates lacked documentation necessary to be able to recreate the estimates, and further did not include an electronic cost

model to provide the information necessary to understand how each estimate was created. The remaining estimate was not considered well documented because, in some instances, it did not provide enough information on how cost factors were derived, and cited methodology but did not include the backup analysis to support it. None of the estimates met the standards for accuracy. For example, four of the estimates did not provide a confidence level in the estimate making it impossible to determine if the estimate was unbiased and based on most likely costs, did not provide access to the detailed calculations used in the estimate, or did not provide the historical data to allow us to check the reliability of the sources or how data is verified for accuracy. The other two cost estimates lacked accuracy because discrepancies existed on costs among several of the documents provided or the costs did not match the summary estimates reported in the BAR. Finally, costs associated with the estimates lacked credibility because none of the six estimates performed a cost sensitivity analysis, provided evidence that cost driver cross checks were performed, or completed independent cost estimates. In addition, MDA performed a cost and risk uncertainty analysis on only one of the six estimates, without which the estimate lacks the level of confidence associated with achieving the cost estimate.

As discussed above, one of the criteria for a credible cost estimate is having an independent cost assessment. Other DOD major defense acquisition programs are required to perform an independent cost estimate before advancing through major milestones.<sup>15</sup> Because of the flexibilities granted in 2002, MDA is not required to obtain independent cost estimates for its programs, and has not otherwise required their programs to do so.<sup>16</sup> The Office of the Director for Cost Assessment and Program Evaluation (CAPE) has performed independent cost estimates for the Aegis BMD program as well as portions of other MDA programs in the past including the STSS and GMD programs. More recently, the CAPE performed an independent cost estimate of THAAD procurement costs. MDA has committed to work with the CAPE to develop cost estimates for other MDA elements in the future. MDA's plans to work with the CAPE to

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<sup>15</sup> 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.

<sup>16</sup> Because MDA has not yet formally entered the DOD acquisition cycle, the requirement at 10 U.S.C. § 2434, which is triggered by the phases of the cycle, does not yet apply.

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develop cost estimates for more MDA elements will contribute to the credibility of its estimates.

# Appendix III: Aegis Ballistic Missile Defense (Aegis BMD) with Standard Missile-3 Interceptor

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"> <li>• Activities in fiscal year 2010—including the new European PAA—brought new challenges to the Aegis BMD portfolio.</li> <li>• MDA restructured Aegis BMD into a program executive office with four programs, including Aegis BMD 4.0.1/SM-3 IB, Aegis Ashore, and Aegis BMD 5.1/ SM-3 IIA.</li> <li>• MDA requested \$2.16 billion for fiscal year 2011, an 18 percent increase from last year’s request.</li> <li>• MDA added BMD 3.6.1 capability to two ships. DOD established Aegis Ashore, which will be based on Aegis 5.0 and the SM-3 IB interceptor.</li> <li>• MDA held several program reviews for Aegis BMD 4.0.1, Aegis Ashore, and Aegis 5.0.</li> </ul>	<ul style="list-style-type: none"> <li>➢ Comprising about 26 percent of MDA’s total fiscal year 2011 budget request, Aegis BMD is poised to be MDA’s largest single investment in a BMDS element.</li> <li>➢ Target availability delayed a key flight test expected to demonstrate performance of Aegis BMD 3.6.1 with SM-3 Block IA for European PAA Phase I.</li> <li>➢ Progress of Aegis 4.0.1 with SM-3 Block IB is limited by delay in development of the Throttleable Divert Attitude Control System (TDACS), an interceptor component.</li> <li>➢ Aegis BMD 5.0 features highly integrated hardware and software and is a key dependency of the new Aegis Ashore program.</li> </ul>

## Background and Overview

Aegis BMD is a sea-based missile defense system being developed in incremental, capability-based blocks to defend against enemy ballistic missiles of all ranges. Components include the shipboard SPY-1 radar, command and control systems, and Standard Missile 3 (SM-3). MDA continues to develop Aegis BMD in spirals for the weapon system and variants of the SM-3 interceptor. Following the shift in DOD’s strategy for the defense of Europe from one that relied on the Ground-based Midcourse Defense interceptors in Poland and the Czech Republic, Aegis BMD became the centerpiece of DOD’s new European PAA. Successive variants of Aegis with the SM-3 interceptor are designed to improve performance against increased threat missile range, type, and raid size. The currently deployed system is Aegis BMD 3.6.1 with SM-3 IA, which is designed to hit short- to medium-range threat missiles. The next generation version is Aegis BMD 4.0.1 with SM-3 IB which features an improved (two-color) target seeker, an advanced signal processor, and an improved divert/attitude control system for adjusting its course. Aegis BMD 5.0, scheduled for certification in 2014, does not add new functionality, but is designed to integrate Aegis BMD 4.0.1 with the Navy’s open architecture system, which would enable any Aegis ship to perform the BMD mission. A new land-based version—Aegis Ashore—will have its first configuration as Aegis BMD 5.0 with SM-3 IB, scheduled to become operational in fiscal year 2015 (see appendix IV).

Aegis BMD did not conduct any developmental intercept flight tests in fiscal year 2010, although it did participate in several other BMDS flight and ground tests to assess BMD functionality and interoperability with the

BMDS.<sup>1</sup> During fiscal year 2010, MDA expected to conduct FTM-15 to demonstrate Aegis 3.6's ability to launch the SM-3 IA interceptor using data from a remote sensor against an intermediate-range ballistic missile target. However, the flight test has been delayed due to target availability. This had a ripple effect on other scheduled events, resulting in a delay in demonstrating key capabilities of Aegis 3.6.1 with SM-3 IA and Aegis 4.0.1 with SM-3 IB. The FTM-15 is key to demonstrating capability of the IA interceptor to engage threat missiles in the range expected for European PAA Phase I, planned for deployment by December 2011. In other testing, a Japanese Aegis BMD destroyer conducted a successful intercept of a separating target using an SM-3 IA interceptor.

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**Progress of Aegis 4.0.1  
with SM-3 Block IB  
Limited by Delay in  
Development of TDACS,  
an Interceptor Component**

Aegis 4.0.1 with SM-3 IB has executed more slowly than expected in fiscal year 2010. At the last execution review of the fiscal year, progress toward verifying the SM-3 IB engagement capability required action, and 6 of the 14 development phase exit criteria tracking program execution were assessed as not on track, including those related to requirements, affordability, design, manufacturing, and weapon system safety. The slower pace primarily reflects delays in SM-3 IB interceptor development.

Aegis 4.0.1, with the SM-3 IB interceptor, is expected to have increased discrimination, engagement coordination, threat missile range capability and raid capacity. Technology development of the interceptor's Throttleable Divert Attitude Control System (TDACS) is following a high-risk path due to continuing resolution of issues discovered during sub-assembly hazard testing. The TDACS issues relate to the operational suitability and expected lifetime of the interceptor. The first intercept flight test, FTM-16, was moved into the third quarter fiscal year 2011 to allow time to investigate and resolve the issues. FTM-16 is critical to demonstrating the interceptor performance, as well as being required to certify the Aegis combat system. According to the Director, MDA, the flight test was rescheduled to allow time to complete qualification tests. Design verification and qualification tests validate component performance, reliability and producibility. MDA has since determined the root cause of the TDACS problem and identified two design improvements. However, due to continuing delays redesigned TDACS components will not be included in the interceptor manufactured for FTM-

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<sup>1</sup> Japanese flight tests help understand performance but because they are not US assets, they are not considered developmental flight tests from a programmatic perspective.



16; instead, it will be manufactured using a new process control to partially mitigate the issue. Further, MDA has since decided to conduct the flight test in the fourth quarter of fiscal year 2011 without completing the qualification tests as originally planned. The TDACS qualifications and verifications leading up to the FTM-16 intercept test will be limited to the environmental conditions expected during the FTM-16 event. Following FTM-16, the design changes to the TDACS will require the full set of design and qualification testing.

We reported in February 2010 that planned interceptor production would precede knowledge of interceptor performance, and recommended that MDA delay a decision to produce interceptors to follow successful completion of developmental testing, a flight test, and manufacturing readiness review. We reported again in December that the SM-3 IB test schedule was not synchronized with planned production and financial commitments. This schedule had become even more compressed as a result of TDACS redesign, and planned requalification. As a result, MDA recently deferred planned interceptor production decisions to follow redesign efforts, the manufacturing readiness review, and an additional flight test; steps that could better inform those production decisions.

While MDA characterized the first 30 interceptors as being test rounds, half remain unassigned to a specific test. Furthermore, of those interceptors assigned to a test, some may be produced earlier than necessary since they deliver 1 to 2 years prior to the scheduled test. Program officials note the unassigned “test” rounds will provide information on reliability, maintainability, and supportability, and verify cost estimates and production processes.

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### **Aegis BMD 5.0 Features Highly Integrated Hardware and Software and Is a Key Dependency of the New Aegis Ashore Program**

Aegis BMD 5.0 will not provide new mission capability; instead it will leverage the Navy’s Aegis modernization effort, which transitions the cruisers’ and destroyers’ computers and displays from military standard to commercial-off-the-shelf components. The modernization effort will increase the number of cruisers and destroyers that have the potential to be BMD capable from 27 to 84, and the installation of Aegis 5.0 in conjunction with the modernization will add the BMD capability. Once Aegis 5.0 is available, Aegis ships with version 3.6.1 may be upgraded directly to 5.0, instead of undergoing an interim installation of 4.0.1 (estimated at \$52 million per ship). Although it does not add new mission capability, the migration into an open architecture environment requires significant modification and testing of 8 of 10 major components of the Aegis weapons system. Execution reviews already show signs of schedule

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**Appendix III: Aegis Ballistic Missile Defense  
(Aegis BMD) with Standard Missile-3  
Interceptor**

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compression and interdependencies of multiple efforts increase schedule risk. As the European PAA's new Aegis Ashore program is highly dependent on the scheduled delivery of Aegis 5.0, delays could have significant consequences for providing European BMD capability as planned (see appendix IV).

# Appendix IV: Aegis Ashore with Standard Missile-3 Block IB (European PAA Phase II)

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"> <li>• MDA established the Aegis Ashore program office in early fiscal year 2010.</li> <li>• MDA held developmental baseline and baseline execution reviews for Aegis Ashore.</li> <li>• MDA prepared two program cost estimates; although the planned, independent cost estimate was not completed.</li> <li>• DOD selected the first two land-based sites for fielding the European Phased Adaptive Approach (Romania in 2015 and Poland in 2018).</li> <li>• MDA awarded the contract to design new Aegis Ashore system components, including deckhouse and enclosures for component systems.</li> <li>• DOD began expansion of the Pacific Missile Range Facility to support testing and development for the European PAA.</li> </ul>	<ul style="list-style-type: none"> <li>➢ Aegis Ashore was announced in September 2009 as part of the European PAA.</li> <li>➢ Technical analysis supporting the selection of Aegis Ashore for the European PAA is unclear.</li> <li>➢ Highly concurrent acquisition activity results in significant cost, schedule, and performance risk.</li> <li>➢ Development uncertainties remain and various Aegis components require modification for a land-based configuration.</li> <li>➢ Deckhouse and vertical launching system (VLS) enclosures design are not complete.</li> <li>➢ Flight tests reduced from previous plan, not timed to inform production commitments.</li> </ul>

## Background and Overview

Aegis Ashore is MDA’s future land-based variant of the ship-based Aegis BMD. It is expected to track and intercept ballistic missiles in their midcourse phase of flight using Standard Missile-3 (SM-3) interceptor variants as they come available. Key components include the Aegis SPY-1 radar, command and control system, vertical launching system (VLS), SM-3 missiles and removable enclosures for the systems to facilitate worldwide deployment. DOD expects to deploy the first Aegis Ashore with the SM-3 block IB in fiscal year 2015 as part of the European Phased Adaptive Approach (PAA).

## Technical Analysis Supporting Selection of Aegis Ashore for European PAA Is Unclear

According to the Director of MDA, the idea of Aegis Ashore preceded the new European PAA policy. Earlier in 2008 and 2009 MDA had been studying alternatives to the Arrow 3 program—a joint US-Israeli program designed for Israeli self-defense against short-range ballistic missiles. MDA’s analysis had considered several land-based SM-3 options, and had concluded that an Aegis with SM-3 was the preferred option. It is unclear how assumptions and analysis related to Arrow-3 supported—and what if any additional technical analysis was conducted to support—the selection of Aegis Ashore for the European PAA.

While MDA does not yet follow DOD’s standard acquisition processes, a robust consideration of alternatives is a key first step in that process and is intended to assess the operational effectiveness, costs, and risks of alternative weapon system solutions for addressing a validated warfighting

need. We reported in September 2009 that DOD often did not effectively consider a broad range of alternatives for addressing a warfighting need or assess technical and other risks associated with each alternative.<sup>1</sup> Without a sufficient comparison of alternatives and focus on technical and other risks, reviews of alternatives 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 found that programs that had a limited assessment of alternatives tended to have poorer outcomes than those that had more robust assessments. The Office of Cost Assessment and Program Evaluation is studying alternatives to Aegis Ashore.<sup>2</sup>

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Highly Concurrent  
Acquisition Activity and  
Development  
Uncertainties Result in  
Significant Cost, Schedule  
and Performance Risk

A knowledge-based acquisition approach is a cumulative process in which certain knowledge is acquired by key decision points before proceeding. In other words, demonstrating technology maturity is a prerequisite for moving forward into system development, during which the focus should be on design and integration. The President's announcement of the European PAA on September 17, 2009 officially began Aegis Ashore, and MDA placed Aegis Ashore directly into the third acquisition development phase—product development. MDA officials note that this decision was due to the understanding that Aegis Ashore would be a modification of proven Aegis BMD capabilities. Yet Aegis Ashore has not yet completed some of the activities MDA outlines for its first two development phases (materiel solutions analysis and technology development), and is executing others concurrently with activities in the third development phase (product development). For example, although MDA's acquisition oversight process identifies the following top-level tenets for phase review entry/entrance criteria prior to entering the Product Development phase, Aegis Ashore had not: obtained an independent cost estimate, prepared a life cycle cost estimate, demonstrated critical technologies in the operational environment (land), or ensured interoperability and integration with the larger BMDS. MDA's knowledge points—typically identified during the first MDA acquisition phase—identify information

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<sup>1</sup> GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, [GAO-09-665](#) (Washington, D.C.: Sep. 24, 2009).

<sup>2</sup> The Office of the Secretary of Defense, Office of Cost Assessment and Program Evaluation provides independent analytic advice to the Secretary of Defense on all aspects of the Defense program, including alternative weapon systems and force structures, the development and evaluation of defense program alternatives, and the cost-effectiveness of defense systems.

required to make key decisions (e.g. program funding decisions, technology selections, capability declarations, program continuation, or the selection of an alternative course of action) and manage program risk. MDA's knowledge points for Aegis Ashore were completely redefined less than 3 months after being established.

DOD's commitment to field Aegis Ashore by 2015 has resulted in significant schedule compression for the program, even as MDA discovered issues that broadened the scope of development and design, placing the program at increased risk of cost growth and schedule delay. According to the Director, MDA, Aegis Ashore development is not a high risk because it is based on the existing Aegis BMD system. However, while Aegis BMD has demonstrated performance at sea, these demonstrations used the currently fielded 3.6.1 version of Aegis BMD with the SM-3 IA interceptor, not the newer variant of the Aegis operating system and new interceptor that Aegis Ashore will use. Aegis Ashore is dependent on next-generation versions of Aegis systems—Aegis 4.0.1 and Aegis 5.0—as well as the new SM-3 IB interceptor, all of which are currently under development (see appendix III). Moreover, a series of changes are required to further modify these new variants of Aegis BMD for use on land with Aegis Ashore. These modifications include changes to the VLS; suppression or disabling of certain features used at sea; design, integration, and fabrication of a new deckhouse enclosure for the radar, and potential changes to the SM-3 IB interceptor. Changes to those existing Aegis BMD components that will be reused for Aegis Ashore may reduce their maturity in the context of the new Aegis Ashore program, and new features will require testing and assessment to demonstrate their performance. MDA plans to conduct both ground and flight tests prior to deployment, however these tests will not occur prior to making production decisions.

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### Various Aegis Components Require Modification for a Land-Based Configuration

Aegis Ashore expects to leverage the existing shipboard Aegis Combat System—comprised of 32 sensors, communications, weapons, and countermeasures. However only 11 of these will be reused for Aegis Ashore; the remaining 21 will need to be suppressed or otherwise disabled, including the software that accounts for a ship's pitch and yaw. While officials note that current land-based testing processes for portions of the Aegis Combat System involve similar suppression, the Aegis Ashore land-based configuration is unique and must still be demonstrated through operational testing.

The program office assessed both the SPY-1 radar and the VLS as flight proven through successful mission conditions, reflecting the assessment of the radar and VLS currently at sea. However, these systems will operate on land, and it is unclear whether the radar's spectrum supportability is fully understood or accounted for. Also, the VLS will be modified to address the differing protection, safety, and environmental requirements of its new land-based environment. Finally, MDA may modify the SM-3 Block IB for Aegis Ashore; the extent of these changes remains unknown.

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**Deckhouse and VLS  
Enclosures Design Not  
Complete**

Both the radar and the VLS will be configured in removable enclosures that have not yet been designed or tested. Also, Aegis Ashore's new deckhouse—instead of being integrated on a ship deck with the VLS and the ship's hull, mechanical, and electrical systems—will be configured apart from the VLS and these will require standalone power generation. The deckhouse design also requires that it be removable in order to facilitate shipment. However not all requirements are fully known, and although neither the deckhouse requirements or design are stable, the contract for Aegis Ashore deckhouse fabrication and integration was awarded prior to preliminary or critical design reviews for the overall Aegis Ashore system. The potential for rework because design starts before requirements are complete was noted as a continuing risk in the last program review of the fiscal year, and we have previously reported that starting fabrication prior to achieving design stability can lead to costly modifications later in the process due to rework.

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**Aegis Ashore Flight Tests  
Reduced from Previous  
Plan, Not Timed to Inform  
Production Commitments**

The number of planned developmental flight test events has been reduced since the Aegis Ashore program began and they are not timed to inform production decisions. In MDA's February 2010 test plan Aegis Ashore was scheduled to participate in 7 developmental flight test events, 5 of which were intercept events. The current plan is for 4 test events, 2 of which are intercepts. The first intercept is now scheduled more than a year later than previously planned (see figure 3).

**Appendix IV: Aegis Ashore with Standard  
Missile-3 Block IB (European PAA Phase II)**

**Figure 3: February 2010 and February 2011 Plans for Aegis Ashore Flight Test Events**

Test Plan	Fiscal year 2013				Fiscal year 2014				Fiscal year 2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Ver. 10.1 Feb. 2010	AA CTV-01	AA FTM-01				AA FTM-02	AA FTM-03			AA FTM-04 (2 intercepts)		AA FTX-01
Ver. 11.1 Feb. 2011				AA CTV-01 E1 AA CTV-01 E2			AA FTM-01 E1 AA FTM-01 E2					
	<b>Total</b>	AA non-intercept events		AA intercept events								
Ver. 10.1 Feb. 2010	7	2		5								
Ver. 11.1 Feb. 2011	4	2		2								

AA = Aegis Ashore  
AA CTV = Aegis Ashore Controlled Test Vehicle  
AA FTM = Aegis Ashore Flight Test Missile (interceptor)  
AA FTX = Aegis Ashore Flight Test Other (simulated intercept)

Source: GAO analysis of MDA data.

MDA officials indicate that the current plan is sufficient to collect data on critical variables and to evaluate weapon system performance in the Aegis Ashore configuration. We have previously reported that repetition of intercept-related objectives is important to build confidence in intercept capability. MDA plans to make production commitments for the first operational Aegis Ashore and its interceptors by early fiscal year 2012. The first intercept flight test with a target is planned for the second half of fiscal year 2014, at which point the design will have been finalized, the Aegis Ashore deckhouse and components built, and Aegis Ashore construction and interceptor production will be well under way.

# Appendix V: Airborne Infrared (ABIR)

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• The ABIR program demonstrated the ability of infrared sensors aboard Unmanned Aerial System (UAS) to observe ballistic missiles in flight at long distances and improved sensor performance.</li><li>• The ABIR program completed alternatives analysis and selected Multi-Spectral Target System-class infrared sensor and MQ-9 Reaper ABIR experiments and demonstration efforts.</li><li>• The ABIR program partnered with Air Force, Navy, and combatant commanders to develop risk reduction tests and preliminary operational concept.</li><li>• The program participated in five ABIR tests demonstrating missile-tracking accuracy.</li></ul>	<ul style="list-style-type: none"><li>➢ The ABIR acquisition approach focuses on exploring the use of currently available technology.</li><li>➢ MDA delayed fielding ABIR from fiscal year 2015 to fiscal year 2019.</li><li>➢ MDA faces significant challenges in developing an operational system.</li><li>➢ Delays in fielding ABIR prolong sensor coverage gaps in early intercept capabilities.</li><li>➢ MDA's plan to field ABIR in fiscal year 2019 is inconsistent with justification for developing the program.</li></ul>

## Background and Overview

ABIR is being designed to track enemy ballistic missile raids soon after launch with airborne sensors forward in the theater in order to enable early intercept attempts. MDA began exploring a similar concept of an operational unmanned aerial system (UAS) infrared missile detection system with the Airborne Infrared System (AIRS) in fiscal year 2002. In fiscal year 2009, MDA began assessing new platform and sensor alternatives and decided to conduct ABIR experiments and demonstration efforts to determine the usefulness of UASs to perform missile defense missions. In addition, MDA plans to have an operational ABIR program fielded by fiscal year 2019 as part of Phase III of the Phased Adaptive Approach (PAA) for the defense of Europe and the United States.

## The ABIR Acquisition Approach Focuses on Exploring the Use of Currently Available Technology

MDA is following a different acquisition approach for ABIR than it has with some of its other acquisition development programs, according to program officials. Rather than developing a system from the ground up, MDA is using existing technology to demonstrate the usefulness of UAS infrared sensors to perform early missile tracking. ABIR experiments and demonstrations will inform the requirements for an operational system. To facilitate this process, MDA will utilize experiments and demonstrations to meet dedicated knowledge points, such as verifying the infrared sensor's performance, assessing missile raid size handling, and launching an interceptor on ABIR sensor tracks. For the experiments and demonstration efforts, MDA and the Air Force jointly conducted an analysis of alternatives to select the infrared sensor and decided on the



Multi-Spectral Target System-class sensor, an infrared sensor with built-in integration to UASs that was used in earlier risk-reduction activities for ABIR. Program officials stated that MDA collaborated with the Air Force and determined that the MQ-9 Reaper, a medium-to-high altitude, long endurance UAS, best fit both MDA's and the Air Force's needs. While ABIR will use the Multi-Spectral Target System-class sensor and the MQ-9 Reaper, according to program officials, the operational system will be selected through industry competition. To that end, program officials stated they are developing the prototypes so that they are not necessarily tied to a specific UAS or sensor platform to enhance future competition.

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### MDA Delayed Planned Fielding of ABIR from Fiscal Year 2015 to Fiscal Year 2019

MDA decided to delay fielding ABIR to fiscal year 2019 in order to further explore the usefulness of forward based airborne sensors to the BMDS, follow a more knowledge-based acquisition approach, and alleviate funding constraints. MDA initially planned to deliver six ABIR platforms by fiscal year 2015 and participate in Phase II of the PAA. However, MDA decided to delay fielding to fiscal year 2019 and participate in Phase III of the PAA to allow MDA more time to experiment and demonstrate the usefulness of forward-based UASs for early intercept missile tracking. Technical development challenges exist, such as achieving a three dimensional track of boosting missiles within a tactically significant timeframe and operationally realistic setting as well as tracking mass raid sizes. Officials from the Office of the Under Secretary of Acquisition, Technology and Logistics have stated concerns about the Precision Tracking Space System's (PTSS) planned capability to accomplish similar objectives. MDA plans to conduct experiments and progressively demonstrate key knowledge points in order to determine the usefulness of ABIR to the BMDS.

In addition, although DOD has defined an initial operational concept for ABIR, DOD has identified challenges in determining a concept of operations for ABIR. DOD's initial operational concept is based on persistent coverage of a threat area by ABIR platforms for a limited duration, also referred to as a surge role. The intent is to maintain non-stop pre-determined orbits during periods of heightened tension, and thereby provide missile launch coverage. According to MDA officials, MDA does not plan to acquire UASs specifically for ABIR. Instead, MDA plans on adding missile-tracking capabilities to pre-existing UASs. The UASs that serve the ABIR role will be able to perform normal assignments and tasks when not being used for the BMDS mission. Program officials also stated that they are exploring the potential of using a detachable sensor pod or sensor processing "kit" to enhance the flexibility of the ABIR

operational system. However, DOD officials have identified operational challenges, such as operating UASs in controlled airspaces, developing a sensor that can interface with multiple UASs, and matching availability of UASs to meet operational needs of an effective ABIR system.

By allowing more time for ABIR experiments and demonstrations, MDA is following a more knowledge-based acquisition approach. Program officials stated that in order to meet timelines in the initial fiscal year 2015 schedule, the program schedule included a lot of concurrency where production decisions would occur before adequate testing had been conducted. As a result, MDA decided, in part, to delay fielding ABIR until fiscal year 2019 to ensure operationally realistic testing occurs before new capabilities are deployed—a key tenet of the 2010 Ballistic Missile Defense Review. For years, we have reported that MDA has allowed concurrent development, testing and fielding of BMDS elements at the expense of cost and performance. By delaying ABIR fielding to allow time to experiment and demonstrate planned capabilities, MDA is following a more knowledge-based acquisition approach.

In addition, MDA recognized budgetary constraints as a challenge to fielding an operational ABIR system by fiscal year 2015. According to MDA, accelerating ABIR and integrating the capability into Phase II of the PAA in fiscal year 2015 would have required significant funding and put the program on a high-risk path. MDA stated that the current 2018 capability delivery allows more time for sensor technology development, integration and testing of sensor capabilities on an unmanned aircraft, and integrating ABIR into the PAA Phase III architecture.

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### Delays in Fielding ABIR Prolong Sensor Coverage Gaps for Additional Early Intercept Capabilities

Delays in fielding ABIR prolong sensor coverage gaps to track missiles early after launch and delay plans for additional early intercept capabilities. MDA discovered there were sensor coverage gaps in its ability to acquire and track large ballistic missile raid sizes, intercept ballistic missiles earlier in its trajectory, assess intercept attempts in real-time, and launch additional interceptors if necessary. Currently, the sensor systems of the BMDS consist of radar sensors, such as Sea Based X-band Radar (SBX) and Army-Navy/Transportable Radar Surveillance (AN/TPY-2). ABIR is being designed to fill these sensor coverage gaps by tracking large missile raid sizes soon after launch to enable earlier intercepts.

Although MDA plans to deploy a forward-based AN/TPY-2 radar that can perform early missile tracking in southern Europe by fiscal year 2011, the radar has limitations in providing early intercept capabilities. The radar

has limitations in its ability to search for missile launches while simultaneously tracking missiles already in flight. According to program officials, one of the primary benefits of ABIR is its ability to free the AN/TPY-2 radar from its search roles, which substantially increases AN/TPY-2's tracking capabilities. Utilizing additional sensors, such as ABIR and PTSS, will increase capabilities for sensor coverage for early missile intercepts.

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**MDA's Plan to Field ABIR by Fiscal Year 2019 Is Inconsistent with Justification for Developing the Program**

ABIR will not be fielded sooner than PTSS, which is inconsistent with a major justification for developing the program. MDA has stated that a major reason for the ABIR program is that it could provide infrared tracking sooner than fielding a space-based infrared system. Infrared tracking is a necessary capability, according to MDA, because it can fill gaps in sensor coverage that currently exist in the BMDS. In 2002, the Senate Armed Services Committee recognized that MDA had no near-term plans to provide infrared tracking to missile defense systems. Plans to develop a space-based infrared system had been delayed so the committee urged MDA to aggressively pursue an airborne infrared program, the AIRS program, to fill sensor coverage gaps. According to program officials, MDA conducted some airborne data collection activities under the AIRS program but did not test infrared sensors with UASs until fiscal year 2010 under the ABIR program. MDA currently plans to field an operational ABIR system by fiscal year 2019, near the same time PTSS will be fielded. Since developing ABIR to fill the sensor coverage gaps until an operational space-based sensor could be fielded is a major justification for the program, MDA's current plan to field both systems at the same time is inconsistent with that justification. MDA officials noted that while both ABIR and PTSS are infrared systems, they are not duplicative systems because they provide different capabilities. For example, ABIR is capable of acquiring and tracking ballistic missiles earlier than PTSS and has the flexibility to deploy to multiple combat theaters to help meet combatant commander needs.

# Appendix VI: Airborne Laser Test Bed (ALTB)

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• After nearly 14 years of development and more than \$5 billion, the airborne laser successfully conducted its first lethal destruction of a target in February 2010.</li><li>• A subsequent attempt at lethal demonstration was conducted in September 2010, but was unsuccessful due to corrupted beam control software.</li></ul>	<ul style="list-style-type: none"><li>➢ Continuing cost, schedule, and technology challenges led to changing the program to a test bed.</li><li>➢ Technical issues continued to affect the test bed's experiments throughout fiscal year 2010 and into early fiscal year 2011.</li><li>➢ MDA is working with the Director of Defense Research and Engineering and High Energy Laser Joint Technology Office to shape the future of the ALTB.</li></ul>

## Background and Overview

The Airborne Laser program has faced many challenges to demonstrating that all of its leading technologies work. Since its inception in 1996, the program has also faced many schedule delays and cost increases, totaling approximately 7-½ years and approximately \$4 billion dollars. Consequently, affordability and technical problems as well as concerns about the Airborne Laser's long-term operational role prompted DOD to designate the program as a test bed. As a test bed, the ALTB does not have an operational mission and is not equipped to be an operational asset. The primary goal of the ALTB is to demonstrate the potential of using directed energy as a viable technology against ballistic missiles. The decision to change the role of airborne laser came after spending more than \$5 billion on its development.

## Test Bed's First Lethal Demonstration Was Successful

In February 2010, MDA demonstrated that the ALTB could successfully destroy a short-range threat-representative ballistic missile during the boost phase. This test marked the first directed energy intercept demonstration against a liquid-fueled boosting missile target from an airborne platform. The entire engagement occurred within 2 minutes of the target missile launch, while the target's rocket motors were still thrusting.

Less than 1 hour later, a solid-fuel missile was launched, but the system did not destroy the target because the laser shut down prematurely. During this engagement, the system detected increased laser light levels, which prompted the system to abort the test. Historically, these types of aborts are due to scattering of laser light which could prevent the system from successfully destroying the target missile.

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## Subsequent Flight Tests Were Unsuccessful

In September 2010, after overcoming a number of technical problems during ground and flight test preparations, MDA attempted to destroy another target using the ALT B, but failed to destroy the target. The ALT B successfully detected and tracked the target, but corrupted beam control software steered the high energy laser slightly off center. The ALT B safety system detected this shift and shut down the high energy laser.

MDA conducted another flight test in October 2010 against a solid-fuel missile. However, while the system seems to have successfully acquired and tracked the plume or rocket exhaust of the target, it never transitioned to active tracking. As a result, the laser was not fired. The laser incorrectly reported that it was not ready and the safety default aborted the engagement. The program's failure review board determined that the cause of the failure was a single micro-switch on a valve that incorrectly reported that the valve was closed. Neither the program's failure review board nor the contractor working with the valve and micro-switch component vendors was able to determine the root cause of the part failure. The board noted that it would take an extensive test program to attempt to determine the root cause and/or design a replacement micro-switch to determine or eliminate the root cause. However, it recommended corrective actions which were implemented by the program. According to program officials, the valves were replaced and new software procedures were implemented to ensure that this type of problem would not cause a system abort in the future.

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## The Future of the ALT B

MDA is working with the Director of Defense Research and Engineering and High Energy Laser Joint Technology Office to shape the future of the ALT B. The Secretary of Defense directed a joint study of the ALT B that was to be completed in June 2010. However, as of February 2011, the report was not available. Agency officials also told us that MDA has commissioned a Scientific Review Committee and an Executive Steering Group to develop a science and technology plan for the ALT B. The committee and steering group, consist of subject matter experts from the Air Force Research Laboratory, the High Energy Laser Joint Technology Office, and the Director of Defense Research and Engineering.

The Director of Defense Research and Engineering has also been tasked with annually assessing the ALT B for high power laser research and development. MDA will maintain the airborne laser aircraft as a potential test bed for ground and flight tests to characterize high energy laser research pending the results of the Director of Defense Research and Engineering study.

# Appendix VII: BMDS Sensors

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• MDA completed first version of common software development qualification which increases the flexibility and interchangeability of the AN/TPY-2 radar for forward-based and terminal-based modes.</li><li>• BMDS Sensors participated in ground and flight tests with other elements, including GMD and THAAD.</li><li>• Joint Chiefs of Staff made the decision to deploy an AN/TPY-2 radar to U.S. Central Command in fiscal year 2011.</li><li>• Transition of Thule Upgraded Early Warning Radar (UEWR) sustainment to the Air Force was completed in fiscal year 2011.</li></ul>	<ul style="list-style-type: none"><li>➢ AN/TPY-2 is a major component of Phases I and II of the Phased, Adaptive Approach.</li><li>➢ Although AN/TPY-2 will provide early intercept capabilities, additional sensors may be needed to enhance early intercept capabilities.</li><li>➢ MDA is on track to deliver 13 operational AN/TPY-2 radars by fiscal year 2017.</li><li>➢ MDA plans to hand over operational control of Sea-based X-band Radar (SBX) to the Navy in fiscal year 2012.</li><li>➢ The SBX program experienced a significant failure during FTG-06 and attempted to demonstrate a correction in FTG-06a.</li><li>➢ DOD has not yet made a decision to upgrade Cobra Dane, an important part of the BMDS sensor suite.</li></ul>

## Background and Overview

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

- **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 (FBM) is capable of detecting missiles early after launch to support Aegis Ballistic Missile Defense (BMD) and GMD engagements. AN/TPY-2 in the terminal mode (TM) can track missiles in the later stages of flight to support THAAD.
- **SBX** is a radar capable of tracking, discriminating, and assessing the flight characteristics of ballistic missiles. SBX primarily supports GMD for homeland defense and can guide interceptor missiles while in flight.
- **Upgraded Early Warning Radars (UEWR)** are U.S. Air Force early warning radars that are upgraded and, when integrated into the BMDS, provide sensor coverage for critical early warning, tracking, object classification, and cueing data. UEWRs are located in Beale, California; Fylingdales, United Kingdom; and Thule, Greenland. MDA also plans to upgrade the early warning radar in Clear, Alaska.
- **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.

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**AN/TPY-2 Is a Major Component in Phases I and II of the Phased Adaptive Approach**

MDA currently plans to deploy an AN/TPY-2 (forward-based mode) radar in southern Europe in 2011 as part of Phase I of the Phased, Adaptive Approach (PAA). The addition of the radar will significantly increase the size of the area that can be defended with Aegis BMD. Radar tracks from AN/TPY-2 will be used to provide early tracking information to enhance homeland defense assets. MDA will deploy AN/TPY-2 to southern Europe as part of the PAA to give the BMDS a continuous tracking and discrimination capability with more opportunities to engage the target, when coupled with other sensors, resulting in a greater probability for a successful intercept.

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**Although AN/TPY-2 Will Provide Early Intercept Capabilities, Additional Sensors May Be Needed to Enhance Early Intercept Capabilities**

Although AN/TPY-2 will provide missile coverage that will provide early intercept capabilities, the radar also has limitations in its capabilities. The AN/TPY-2 radar, like most other radars, is susceptible to adverse weather conditions. In addition, X-band radars can become overwhelmed due to their high detection sensitivity as exhibited by AN/TPY-2 during a 2009 event. In addition, forward-basing AN/TPY-2 radars come with diplomatic challenges to develop host nation agreements, have significant operation and sustainment costs, and need multi-layered force protection. Lastly, the radar has inherent capability limitations that necessitate the need for additional sensors.

AN/TPY-2 capability limitations can be mitigated, according to MDA officials, by utilizing additional infrared sensor systems, such as the future PTSS and ABIR programs. MDA is developing PTSS, a space-based infrared sensor satellite constellation, and ABIR, infrared sensors used aboard unmanned aircraft systems, to detect and track missile launches. Infrared sensors can help provide early missile launch acquisition and tracking while avoiding many of the limitations of radars. For example, according to MDA budget documentation, a small constellation of PTSS satellites can provide coverage equivalent to 50 AN/TPY-2 radars or 20 SBX radars. MDA plans to field a PTSS constellation by fiscal year 2018 and ABIR system by fiscal year 2019. Any delays in fielding additional infrared sensors to augment the AN/TPY-2 in southern Europe could significantly affect the planned capability to defend the United States and Europe from ballistic missile attack.

**MDA Is on Track to Deliver 13 Operational AN/TPY-2 Radars by Fiscal Year 2017 for European Missile Defense, Forward-Based Missions, and THAAD Deployment**

MDA plans to produce 14 radars by fiscal year 2017, the first of which is developmental, and the other 13 of which will be operational. MDA has currently delivered 4 AN/TPY-2 radars, all of which were delivered on schedule. Table 8 describes MDA’s current plans to deliver AN/TPY-2 radars.

**Table 8: Current Delivery Plans for AN/TPY-2**

<b>AN/TPY-2 ID</b>	<b>Planned assignment</b>	<b>Date of delivery to user</b>
#1	Development	N/A
#2	Japan	2006
#3	Israel	2007
#4	Southern Europe (location TBD)	2012
#5	THAAD Battery #1 (location TBD)	2009
#6	Central Command	2011
#7	THAAD Battery #2 (location TBD)	2010
#8	THAAD Battery #3 (location TBD)	2013
#9	THAAD Battery #4 (location TBD)	2014
#10	THAAD Battery #5 (location TBD)	2015
#11	THAAD Battery #6 (location TBD)	2016
#12	THAAD Battery #7 (location TBD)	2016
#13	THAAD Battery #8 (location TBD)	2017
#14	THAAD Battery #9 (location TBD)	2017

Source: MDA data.

Legend: TBD= to be determined.

Notes: Years are stated in fiscal years. Data is current as of October 21, 2010.

MDA recently decided to speed up production of radar #8 to be fielded with THAAD Battery #3 to help meet warfighter demands. Although DOD has not determined where THAAD batteries will be deployed, MDA has stated that future THAAD batteries may be deployed to Europe to defend critical assets against ballistic missile threats on a contingency basis. In addition, although the remaining radars to be produced (radars #8-14) are designated for THAAD batteries, MDA officials stated that if the need for an additional forward-based AN/TPY-2 arose, these radars may be redesignated for forward-based use.



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### MDA Plans to Hand over Operational Control of SBX to the Navy in Fiscal Year 2012

MDA made progress toward fielding SBX and plans to hand over operational control of SBX to the Navy in fiscal year 2012. During fiscal year 2010, MDA completed a critical Navy inspection and certification necessary to hand over operational control of SBX. Planned operational areas include positions in the northern, western, and middle Pacific Ocean. According to MDA, the Missile Defense Executive Board approved a recommendation from the Navy to utilize a more flexible approach allowing SBX to port at multiple locations rather than establishing a dedicated port for SBX. U.S. Strategic Command will exercise combatant commander authority of SBX and delegate operational control to the Navy via Pacific Command. Although the Navy will operate SBX, MDA will maintain the development responsibility for improving radar capabilities.

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### The SBX Program Experienced a Significant Failure during FTG-06 and Attempted to Demonstrate a Correction in FTG-06a

During the GMD flight test FTG-06 in January 2010, SBX experienced a significant failure. According to program officials, as the primary sensor for the flight test, SBX's task was to track the missile target, an intermediate-range missile, and provide a qualified track on the target to GMD. During the flight test, SBX initially performed as expected but then experienced a failure which prevented it from establishing a reportable track on the target. According to MDA, high sensitivity coupled with a large number of presented objects could cause the SBX processor to become overwhelmed as exhibited in FTG-06. MDA also states that software changes were incorporated into SBX to mitigate this problem. Currently, computer models cannot replicate the situation SBX experienced during FTG-06 but can replicate the effect SBX experienced.

To address the failure in FTG-06, program officials developed iterative software corrections. The first software correction, Spiral 1, has already been developed by the program office and was tested during four targets of opportunity. During three of the tests, computer simulators mimicked the effects experienced during FTG-06 to test the software corrections. According to program officials, these tests, in addition to other ground tests, served as risk reduction leading up to a re-test of SBX objectives in FTG-06a.

MDA tested those software corrections in FTG-06a, which was conducted in December 2010. This test was deemed a failure by MDA because GMD was unable to intercept the target. However, the performance of SBX during the flight test is unknown at this time because the test report for this event was unavailable during our audit. SBX served as an inline sensor for the test and was tasked to track the target over the horizon, discriminate the warhead, and send a missile track of the target to GMD.

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**Transition of Thule UEWR Sustainment to the Air Force Was Completed in Fiscal Year 2011**

In fiscal year 2011, MDA transitioned Thule to the Air Force after successfully transitioning sustainment of both Beale and Fylingdales to the Air Force in 2009. According to program officials, transitioning the UEWRs is a process during which MDA gradually hands over control of the UEWRs to the Air Force. The official transfer of the UEWRs will occur in fiscal year 2012 when all software upgrades are completed. The most recent software build to add information assurance upgrades that is currently under development will be deployed in fiscal year 2011. According to MDA officials, once certified for missile defense, the addition of Thule UEWR to the BMDS reduces sensor coverage gaps and provides larger defended areas for homeland defense.

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**DOD Has Not Yet Made a Decision to Upgrade Cobra Dane, an Important Part of the BMDS Sensor Suite**

MDA and the Director, Operational Test and Evaluation believe that both Clear and Cobra Dane are vital sensors for GMD. Both radars provide data to GMD to enable ballistic missile intercepts. However, Cobra Dane will soon be in need of large-scale hardware upgrades to continue to operate, according to program officials. Although MDA has upgraded UEWRs in the past for BMDS functions, those upgrades involved small hardware and software processing additions to the radars. MDA currently plans to upgrade Clear to bring it up to the current configuration of the other UEWRs in order to efficiently manage all the UEWRs. According to an official in the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, a decision to upgrade Cobra Dane will be a departmental decision, which will be made after consultation with interagency partners.

DOT&E officials have emphasized the importance of keeping Cobra Dane a part of the BMDS sensor suite. According to DOT&E officials, Clear will not provide all necessary sensor coverage to take the place of Cobra Dane. For GMD to have the necessary sensor coverage, it must rely on both Clear and SBX to be available. However, since SBX may be unavailable for missile tracking at times, GMD would also need Cobra Dane in order to have robust sensor coverage. DOT&E officials stated Cobra Dane is also an advantageous sensor for GMD because of its unique geographic location to detect a launch from North Korea.

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# Appendix VIII: Command and Control, Battle Management and Communications (C2BMC)

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Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• The C2BMC program demonstrates control of multiple AN/TPY-2 radars during ground tests.</li><li>• C2BMC participates in several elements' flight tests including THAAD, GMD, and BMDS Sensors.</li></ul>	<ul style="list-style-type: none"><li>➢ Spiral 6.4 adds the capability to control more than one radar in one region and better communicate and manage BMDS capabilities.</li><li>➢ Spiral 6.4 has experienced multiple delays and adjustments to content since fiscal year 2008.</li><li>➢ C2BMC completed all ground testing in fiscal year 2010 to make progress toward declaring Spiral 6.4 operational</li><li>➢ C2BMC plans for new server at U.S. Central Command in fiscal year 2011.</li></ul>

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## Background and Overview

C2BMC is a global network that links and integrates individual missile defense elements. C2BMC also enables the U.S. President, Secretary of Defense and combatant commanders at the strategic, regional, and operational levels to systematically plan ballistic missile defense operations, to collectively see the battle develop, and to dynamically manage designated networked sensors and weapons systems to achieve global and regional mission objectives. The network includes software, as well as some hardware including high-end workstations, servers and network equipment. The program delivers the software capabilities in spirals—the current operational spiral is Spiral 6.2, which became operational in December 2007. These software spiral deliveries are first tested and then declared operational at servers located at combatant commands, which are connected to each other as well as to other strategic locations.

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## Spiral 6.4 Adds Capability to Control More Than One Radar in One Region and Better Communicate and Manage BMDS Capabilities

The next upgrade is Spiral 6.4, which is planned for operational use in the third quarter of fiscal year 2011. Spiral 6.4 is the first release of upgraded software since Spiral 6.2 became operational in December 2007. Spiral 6.4 offers several upgrades to Spiral 6.2 including the Global Engagement Management, which will add the capability to manage multiple AN/TPY-2 radars in a region to acquire and discriminate threat tracks, then forward the best track to BMDS weapon system fire controls. Spiral 6.4 will also improve C2BMC's capability to send situational awareness data to European Command in addition to the tri-node server which includes U.S. Strategic Command, Northern Command, and Pacific Command. The program intends to declare Spiral 6.4 operational for the tri-node in the third quarter of fiscal year 2011. Concurrent with Spiral 6.4 fielding, the

program is preparing for the release of its next planned spiral capability release, Spiral 8.2, in fiscal year 2015.

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### Spiral 6.4 Has Experienced Multiple Delays and Adjustments to Content since Fiscal Year 2008

The plan for Spiral 6.4 has changed significantly from when MDA expected to release a single configuration for the tri-node in fiscal year 2008. Since then, MDA has modified its releases to break-up Spiral 6.4 into smaller increments of capabilities and for other combatant commands. During fiscal year 2009, the program was replanned to accelerate capabilities from Spiral 8.2 to Spiral 6.4 adding the capability for C2BMC to manage multiple radars and to enhance the BMDS' ability to perform early intercept.<sup>1</sup> The following year, in February 2010, the program decided to release its Spiral 6.4 multi-radar configuration in two separate releases—one for the tri-node and then later for European Command. MDA added European Command to address requirements for the European phased adaptive approach. In addition, the program intended to later deliver a separate upgrade to enhance the BMDS' ability to perform early intercept to both the tri-node and European Command as well. Just 4 months later, MDA decided to delay this early intercept capability until Spiral 8.2.

The C2BMC has experienced multiple delays in declaring Spiral 6.4 operational. It was originally planned to go operational in fiscal year 2008. However, in 2008, the program delayed it to the first quarter of fiscal year 2010 due to technical issues in both the current operational capability, Spiral 6.2, and the developing capability, Spiral 6.4. These delays were necessary because throughout fiscal year 2008, Spiral 6.2 required more fixes than anticipated for warfighter-identified deficiencies. In order to fix the deficiencies the contractor delayed Spiral 6.4 work so that it could apply those resources to the Spiral 6.2 problems. Specifically, experience with testing the AN/TPY-2 with Spiral 6.2 identified the need to improve radar track processing in Spiral 6.4. This, along with changes that needed to be incorporated to meet new information assurance requirements pushed Spiral 6.4 operational fielding to the first quarter of fiscal year 2010. Then during fiscal year 2009, the program added another year of development, delaying Spiral 6.4 to the first quarter of fiscal year 2011 when it accelerated Spiral 8.2's capabilities to control multiple radars, support early intercept, and support deployment of Spiral 6.2 capability to European Command. In June 2010, the program again delayed the tri-node

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<sup>1</sup> Early intercept is the interception of threat missiles early enough in their flight to allow for a shoot-look-shoot tactic.

server release of Spiral 6.4 another 6 months to the third quarter of fiscal year 2011 because changes to the BMDS-level testing plan delayed the ground testing necessary to declare the spiral operational.

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**C2BMC Completed All Ground Testing in Fiscal Year 2010 to Make Progress toward Declaring Spiral 6.4 Operational**

During fiscal year 2010, the C2BMC program was able to successfully complete ground testing as part of the series needed to declare Spiral 6.4 operational. MDA completed its first test of the initial C2BMC Global Engagement Management capabilities during the second quarter of fiscal year 2010. It was the first in a series of ground tests necessary to declare Spiral 6.4 operational. This test successfully demonstrated the capability of Global Engagement Manager to manage operations of multiple AN/TPY-2 radars. This was the first major system-level event using Spiral 6.4.

In addition, MDA completed a second ground test in the series during the fourth quarter of fiscal year 2010. This integrated ground test demonstrated system track forwarding between C2BMC and Aegis BMD as well as supported C2BMC element-level verification. It also tested mission functionality with GMD, AN/TPY-2, THAAD, Aegis, and Patriot. Full analysis results of this testing are expected in fiscal year 2011.

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**C2BMC Plans for New Server at Central Command in Fiscal Year 2011**

During fiscal year 2010, MDA made the decision to install an operational Spiral 6.2 server at Central Command during the second quarter of fiscal year 2011. Program officials told us that this capability was urgently needed in Central Command, so the agency made Spiral 6.2 operational immediately rather than waiting until Spiral 6.4 was available.

# Appendix IX: Ground-based Midcourse Defense (GMD)

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"> <li>• The program completed the planned fielding of 30 GBIs.</li> <li>• The GMD element continued the manufacturing and delivery of the enhanced version of the kill vehicle known as the Capability Enhancement II (CE-II) EKV's.</li> <li>• The program failed to successfully intercept a target during its only intercept test in fiscal year 2010. This was the first test designed to assess the capability of the enhanced CE-II variant.</li> <li>• The GMD element conducted a non-intercept flight test of its two-stage GBI, which was originally designed for a European site.</li> </ul>	<ul style="list-style-type: none"> <li>&gt; GMD's expected service life is until 2032.</li> <li>&gt; To date, DOD has spent over \$35 billion on this system and is planning on spending approximately another \$6 billion over the future years defense plan.</li> <li>&gt; In response to the President's 2002 directive to deploy an initial set of missile defense capabilities by 2004, MDA accelerated GMD developmental activities and emplaced five Ground-based interceptors (GBIs) by 2004.</li> <li>&gt; To date, GMD has fielded 30 GBIs: 20 with the original kill vehicle known as the Capability Enhancement I (CE-I) and 10 with the enhanced kill vehicle known as the Capability Enhancement II (CE-II).</li> <li>&gt; GMD has only successfully conducted 3 intercepts with the operationally configured GBI.</li> <li>&gt; The CE-II EKV has failed in both flight test attempts to intercept a target.</li> <li>&gt; GMD is expected to award a new development and sustainment contract in fiscal year 2011, expected value of \$600 million per year, not to exceed 10 years.</li> </ul>

## Background and Overview

The GMD element is a ground-based defense system designed to provide combatant commanders the capability to defend the homeland against a limited attack from intermediate-, and intercontinental-range ballistic missiles from regional actors like North Korea and Middle Eastern countries during the midcourse phased of flight. According to the Director, MDA, the GMD program is expected to be in service until 2032

The GMD element consists of a ground-based interceptor (GBI)—a booster with an Exoatmospheric Kill Vehicle (EKV) on top—and a fire control system that receives target information from BMDS sensors in order to formulate a battle plan. GMD's planned acquisition cycle was streamlined in response to the President's 2002 directive to deploy an initial set of missile defense capabilities by 2004. To do so, the GMD element concurrently matured technology, designed the element, tested the design and produced and fielded a system. Additionally, reliability and sustainability efforts normally addressed early in development were deferred. Testing delays and cancellations have also resulted in less knowledge than planned about the capabilities and limitations of the system under development. For example, according to MDA, with the focus on rapid development, there was not always adequate opportunity to

fully ground test the system prior to each flight test attempt. Corrective actions focused, instead, on fixing the problem at hand. According to officials from DOD, however, with this approach, GMD was rapidly fielded for the limited defense of the United States and its allies while development continued.

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## 2010 Congressionally Mandated Reports

The National Defense Authorization Act for Fiscal Year 2010<sup>1</sup> mandated the Secretary of Defense to (1) conduct an assessment of the Ground-based Midcourse Defense element and future options for GMD and (2) establish a plan for the GMD element to cover the period of the future years defense program. Additionally, the act mandated the Comptroller General to review the assessment and plan and provide the results to Congress. We briefed the Congress in October 2010 and agreed to include the acquisition-related findings in this report. Those findings are included below.

The two DOD reports were issued in May 2010 and covered numerous topics including, but not limited to the following key areas:

- The capabilities as of the date of the assessment and any planned capabilities.
- The plan to maintain the operational effectiveness of the GMD element over the course of its service life, including sustainment efforts.
- The plan for flight testing the GMD element, including aging and surveillance tests to demonstrate the continuing effectiveness for the system over its service life.
- The number of GBI missiles necessary for operational assets, test assets, and spare missiles.

The following sections reflect GAO's findings on each of these topics.

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<sup>1</sup>The National Defense Authorization Act for Fiscal Year 2010, Pub. L. No. 111-84 § 232 (2009).

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## GMD Fielded a Limited Defensive Capability in 2004

The integrated capabilities of the GMD element are expressed as performance baselines with associated performance metrics reported in the BAR; however, DOD lacks the information needed to validate them. DOD established performance metrics such as the Probability of Engagement Success, Launch Area Denied, and Defended Area.<sup>2</sup> To be credible, these metrics must to be informed by models that are anchored by flight and ground test data, but test delays and failures have provided less data than is needed for evaluation. For example, at the end of fiscal year 2009, the data necessary for validation, verification, and accreditation of GMD models was only 8 percent complete. Moreover, U. S. Northern Command officials stated that they do not have confidence in the values provided by MDA for the official metric of effectiveness (Probability of Engagement Success) due to the low number of tests and the use of specification data rather than test data.

Although uncertainties remain about the performance of GMD's capabilities, a 2010 annual review of BMDS capability conducted by U.S. Strategic Command highlighted an increasing confidence in GMD. Additionally, the Director, Operational Test and Evaluation recently concluded in its annual assessment that test results suggested GMD provides a capability against limited, emerging, uncomplicated threats. However, the lack of sufficient data for comprehensive model and simulation validation and accreditation continues to preclude a full evaluation of GMD performance.

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## DOD's Sustainment Program Critical to Ensure Effectiveness of the GMD System through 2032

GMD's sustainment program is expected to maintain and support an effective defensive system over the expected 20-year lifecycle, through 2032; however the decision to defer reliability and sustainment efforts coupled with delays in collecting data has hindered GMD's efforts to adequately plan sustainment efforts. Although the program has been fielding interceptors since 2004, the Director, MDA stated that the decision to maintain the GMD system until 2032 is based on the fact that the expected lifespan for the interceptors is 20 years and the last GBI is planned to be fielded in 2012 resulting in the 2032 timeframe.

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<sup>2</sup> The Probability of Engagement Success is the probability that the BMDS will prevent an adversary warhead from carrying out its mission. Launch Area Denied is the geographic area that is defended by the BMDS. Defended area is the geographic area that the BMDS is capable of defending against adversary ballistic missiles.



The GMD sustainment program is comprised of multiple efforts. Key among them is the Stockpile Reliability Program Plan, which is intended to monitor the health of fielded interceptors, identify reliability degraders, and mitigate obsolescence issues.<sup>3</sup> The Stockpile Reliability Program Plan was not finalized by GMD until September 30, 2010<sup>4</sup> and still requires additional data in order for it to be fully implemented. For example, the reports states that the “overall approach to accomplishing the GBI surveillance and stockpile reliability program is to analyze data from GBI development, sustainment, and flight testing activities throughout the lifecycle of the deployed interceptor fleet.” However, developmental testing to get that data will not be completed until at least 2021.<sup>5</sup> GMD intercept tests conducted to date have already led to major hardware or software changes to the GBIs—not all of which have been verified through flight testing.

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Formal Aging and  
Surveillance Testing<sup>6</sup>  
Beginning; Data  
Incomplete

Aging and surveillance data, a key part of the Stockpile Reliability Program Plan, for a certain limited set of GBI components are being gathered by GMD contractors and other government organizations including the Crane Division of the Naval Surface Warfare Center and the U.S. Army Aviation & Missile Research, Development & Engineering Center. However, testing will not be completed for many years. Although Crane has been testing since 2008, a completion date has not been determined because it is based on the sufficiency of data received from ongoing component testing and funding. In addition, according to Crane officials, the Aging and Surveillance Test Program does not cover all Capability Enhancement-I (CE-I) component parts and there are no

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<sup>3</sup> The Stockpile Reliability Program Plan includes, but is not limited to the following activities: Aging and Surveillance Test Program, Maintenance Built-in Test, GBI Refurbishment Strategy, Flight Test Rotation Strategy, GBI Sustainment Program, and the Service Life Extension Plan.

<sup>4</sup> According to GMD program officials, the GMD program expected it to be finalized in June 2010. However, the original plan was directed to undergo significant revisions. This delayed the release of the Stock Reliability Program Plan until September 2010.

<sup>5</sup> According to MDA, however, results from developmental testing are being incorporated incrementally as test results are analyzed and sufficient conclusions can be drawn from all test data.

<sup>6</sup> The Aging and Surveillance test program is a subcomponent to the Stockpile Reliability Program Plan and is designed to examine aged hardware to determine natural degradation characteristics and to understand performance changes.

current efforts to test any Capability Enhancement-II (CE-II) specific components.

Comprehensive aging and surveillance testing is hampered by limited availability of spare components for the booster and the EKV. For example, according to Crane officials, they have had to obtain components for testing from engineering units or returns. In addition, artificially aged testing has not been conducted on the Inertial Measurement Unit because there are insufficient numbers of components available for testing.<sup>7</sup> However, according to the DOD, natural aging of the inertial measurement unit is being assessed.

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**Valuable, but Limited Data  
Provided by Current  
Maintenance Built-in Test**

Maintenance Built-in Test (MBIT)<sup>8</sup> testing provides trend data for the status of the interceptor and determines the interceptor's health, although the assessment is primarily pass/fail. According to program officials, MBIT testing is conducted quarterly on emplaced interceptors in the silos. However, an April 2007 report,<sup>9</sup> developed by a team that included the prime contractor, warned that a lack of improvements to the MBIT may compromise GMD's ability to make refurbishment decisions over the service life of fielded GBIs.

GMD has developed enhanced MBIT testing to provide a better insight into the health of the GBIs. For example, enhanced MBIT enables program officials to gather more extensive and higher fidelity telemetry data for components of the interceptor and develop detailed graphical trends in the health and status for GBIs. According to contractor officials, enhanced MBIT would add value to monitoring the GBI fleet. However, currently only one silo is equipped with the enhanced MBIT capability and according to MDA officials, there are no plans to upgrade existing silos or to incorporate enhanced MBIT capability in new silos being constructed.

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<sup>7</sup> The inertial measurement unit is designed to aid the kill vehicle in its flight location and has undergone several significant design changes and alterations.

<sup>8</sup> The MBIT is the primary method for determining and monitoring the health and status of the fielded interceptor. In addition, the MBIT verifies the readiness of stored interceptors.

<sup>9</sup> Task Assignment-23 Interceptor Refurbishment Plan (April 2007).

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### Lack of Spare Component Parts Makes Planning for Refurbishments, Repairs, and Unexpected Failures Difficult

MDA lacks sufficient spare parts for EKV refurbishments and repairs. According to MDA officials, besides the initial refurbishment kits that were on contract, there were no other spare component parts ordered for CE-I and CE-II EKVs. Consequently, there are no spare components for CE-I refurbishments and only minimal spares for the CE-II EKVs. Certain EKV components are specifically fitted for either the CE-I or CE-II configuration, therefore these components are not interchangeable. The lack of spare components could lead to difficult choices if components that are no longer available fail. For example, contractor officials stated that EKVs might need to be used as a source for parts resulting in a reduction in available inventory.

MDA plans to purchase a specific amount of kits for scheduled refurbishments, but GMD officials stated that the amount of additional spare parts needed for unexpected failures and repairs has not been determined. It is planned that as part of the development and sustainment contract, which MDA expects to award in fiscal year 2011, the contractor will define repair and spare hardware requirements for each GBI. However, it is unclear when that will occur and at what cost.

Lower-tier GBI suppliers began completing delivery followed by a break in production starting in 2007. All remaining third- and fourth-tier GBI suppliers are expected to complete their deliveries in fiscal year 2010 with two exceptions—Aerojet and Rockwell Collins. Future GBI procurements—five additional GBIs plus additional hardware to support GBI scheduled maintenance activities—will require funding to restart manufacturing lines. However, the full cost to restart and requalify vendors is unknown. Although estimates for fiscal year 2010 and 2011 funding were provided, MDA has not yet developed a comprehensive cost estimate for restart and requalification activities for all vendors involved in GBI production beyond fiscal year 2011. Under the current plan, any additional GBI purchases beyond that year will likely incur redesign and development costs due to parts obsolescence and GBI purchases after fiscal year 2013 will incur manufacturing line restart costs for third- and fourth-tier GBI suppliers.

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### Reliability, Availability, and Maintainability Is Key for Developing and Fielding Weapon Systems

Reliability, Availability, and Maintainability (RAM) analysis provides the probability that an item will perform its required function under stated conditions for a specified period of time, measures failure rates, sets corrective and preventative maintenance requirements, and determines maintenance conditions and procedures. According to DOD's *Guide for Achieving Reliability, Availability, and Maintainability*, during system

development, the most important RAM activity is to identify potential failure mechanisms and to make design changes to remove them. Achieving specified levels of RAM for a system is important for many reasons; specifically because of the effect RAM has on readiness, system safety, and mission success. Additionally, RAM problems slow the development and fielding of systems, drive up total cost, and degrade operational readiness and mission accomplishment. However, according to a June 2010 MDA briefing on GMD's RAM program, RAM was not designed into components nor were complete data collected to inform RAM prior to 2007. Additionally, a comprehensive RAM program was not developed until 2008.

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### Difficulty in Conducting GMD Flight Testing Delays Planned Knowledge

Although MDA altered the GMD flight test tempo to one intercept per year, it is unclear if it can still be executed successfully. Since 2004, we have continually reported that GMD has experienced difficulty in conducting its annual flight test plan, a difficulty that continued in 2010 as well. According to MDA's fiscal year 2010 budget request, the GMD program expected to conduct two tests utilizing its two-stage booster in fiscal year 2010. However, the program modified this plan to include one intercept test (FTG-06) that utilized the enhanced kill vehicle known as the CE-II EKV and one booster verification test for the two-stage design.<sup>10</sup> As we previously reported, FTG-06 was important because it was planned as the first intercept test of this version of the EKV,<sup>11</sup> and because it was designed to demonstrate a long-flight time for the GBI and GMD's capability against countermeasures. MDA officials told us that they will not add the CE-II EKV to the operational baseline until after the successful completion of an intercept test. One such test, FTG-06, was conducted in January 2010, but was unsuccessful: the CE-II EKV failed to achieve an intercept of the target. MDA chartered a failure investigation team to investigate and determine the root cause of the failure.<sup>12</sup> In light of the failure, the GMD program attempted to conduct a similar test in December

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<sup>10</sup> According to MDA, the two-stage design is an alternative for the PAA and the test was utilized as a risk reduction for future tests. However, there are no current plans to produce two-stage GBIs for operational use.

<sup>11</sup> GAO, *Defense Acquisitions: Missile Defense Transition Provides Opportunity to Strengthen Acquisition Approach*, GAO-10-311 (Washington, D.C.: Feb. 25, 2010).

<sup>12</sup> The failure investigation team concluded that the failure was caused by a quality control event. Corrective actions include design enhancements to improve vehicle processing, which according to MDA, mitigates the risk of reoccurrence.

2010—FTG-06a—but that test was also unsuccessful due to a failure with the CE-II EKV.<sup>13</sup>

The costs to conduct each GMD flight test are in the hundreds of millions. For example, as we previously reported, MDA projected, prior to FTG-06, that the test would cost over \$236 million while the Defense Contract Management Agency estimated that the cost was likely to exceed \$310 million. These costs were likely understated because they did not include all of the cost increases of delaying the test first to September 2009, nor did they include any cost increases of further delaying the test to fiscal year 2010 or for investigating the failure. Additionally, as noted above because FTG-06 failed MDA inserted FTG-06a which was structured to capture the same objectives. It is therefore likely that the cost to conduct the FTG-06a test was similarly expensive.

It should be noted that although the program failed to successfully complete its intercept tests in fiscal year 2010, MDA was able to conduct a non-intercept flight test of its two-stage GBI (designated BVT-01) in June 2010. Although all flight test objectives were achieved, an EKV anomaly was experienced that might affect system performance.

GMD testing delays and shortfalls have had three major consequences for the program. First, delays in validating capability results in a reduce level of knowledge needed to inform GMD models. Second the production and fielding of the CE-II EKVs has gotten ahead of testing. Currently, even though the CE-II has failed both intercept attempts, 12 of the 23 CE-II GBIs have already been delivered. Additionally, according to the March 2010 plan, all CE-IIs under contract are expected to be delivered prior to fully validating its capability.<sup>14</sup> Third, GMD's current flight test plan assumes success and any flight test failures could require difficult decisions, such as a reduction in planned developmental flight tests or the use of an interceptor designated as an operational spares or for stockpile reliability testing. For example, FTG-09, a salvo test planned for fiscal year 2011, was canceled in order to re-conduct FTG-06. Although the flight test objectives were moved to FTG-06a and FTG-08, this removes an opportunity to collect performance data needed to develop GMD models and to assess

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<sup>13</sup> At the time of our review, MDA had initiated a Failure Review Team to investigate the cause(s) of failure.

<sup>14</sup> According to the Director, MDA, based on the issues that arose in FTG-06a, he directed the agency to stop taking deliveries of any more completed CE-II EKVs.

the capability of the EKV. Additionally, as we previously reported, the repetition of intercept-related objectives is important to build confidence in the intercept capability.<sup>15</sup> Consequently, the delays in validating capability results in a reduced level of knowledge needed to inform the GMD program leaving a significant amount of data still needing to be gathered to fully assess GMD capability. For example, the CE-I and CE-II capability against countermeasures still is not validated, although MDA has been attempting to obtain it since 2008 and EKV performance against its main threat class—an intercontinental ballistic missile—will not occur until at least 2014.

**Planned Inventory of 52 GBIs Needed through 2032 Lacks Analysis**

In 2009, the Secretary of Defense reduced the number of planned emplaced GBIs from 44 to 30, reducing the number of operational GBIs needed. The reduced inventory includes 30 operational interceptors and an additional 22 for testing and spares. Although officials from U.S. Northern Command agree that 30 operational GBIs is currently sufficient, as table 9 shows, the planned inventory lacks analysis:

**Table 9: The Number of Ground-Based Interceptors Needed through 2032 Lacks Analysis**

GBIs	GMD analysis/justification for GBIs	Limitations
<b>30 Operational GBIs</b>	<ul style="list-style-type: none"> <li>The number of operational GBIs was a policy decision based on the calculation of threat missiles.</li> </ul>	<ul style="list-style-type: none"> <li>Sufficiency of operational GBI numbers is based on various assumptions including the reliability of the interceptor. However, the reliability of the interceptor is not fully known.</li> <li>MDA has not completed analysis to determine whether the 2032 timeframe for GBI lifespan is achievable.</li> </ul>
<b>16 flight test GBIs</b>	<ul style="list-style-type: none"> <li>According to DOD's Assessment, the number of necessary flight test GBIs was dictated by the Integrated Master Test Plan.</li> </ul>	<ul style="list-style-type: none"> <li>MDA's analysis for the number of GBIs necessary to conduct flight testing assumes success: flight test failures could require an adjustment to the remaining GBI inventory that supports operational spares, stockpile reliability testing and flight testing.</li> </ul>

<sup>15</sup> GAO-09-338.

**Appendix IX: Ground-based Midcourse  
Defense (GMD)**

<b>GBIs</b>	<b>GMD analysis/justification for GBIs</b>	<b>Limitations</b>
<b>6 Operational Spares and Stockpile Reliability Program Testing GBIs</b>	<ul style="list-style-type: none"> <li>According to DOD's Assessment, the number of spare missiles needed for spare requirements and Stockpile Reliability Program testing was determined through reliability, availability, maintainability, and testability analysis.</li> </ul>	<ul style="list-style-type: none"> <li>We could not determine based on the RAM-T analytical materials provided by MDA how it determined the number of GBIs needed for operational spares and Stockpile Reliability Program testing.</li> <li>RAM was not designed into the components.</li> <li>Only limited RAM data are available; RAM quality data were not collected prior to 2007.</li> <li>No GBIs are dedicated to aging and surveillance testing.</li> </ul>

Source: GAO analysis of MDA data.

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# Appendix X: Precision Tracking Space System (PTSS)

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Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• MDA conducted architecture studies and system engineering, including developing system concepts and determining capability needs.</li></ul>	<ul style="list-style-type: none"><li>&gt; Many aspects of the PTSS acquisition approach are consistent with GAO-recommended best practices.</li><li>&gt; However, MDA has developed an optimistic schedule to field an operational constellation by fiscal year 2018.</li><li>&gt; MDA faces significant design challenges in developing PTSS but has mitigation plans in place to address them.</li><li>&gt; Delays in fielding PTSS would significantly affect U.S. and European missile defense.</li></ul>

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**Background and Overview** PTSS is being designed to detect and track large ballistic missile raid sizes beginning shortly after launch and throughout their trajectories. Tracking ballistic missiles earlier in flight enables earlier interceptor launches and the potential to shoot another interceptor if necessary. Earlier intercept attempts improve ballistic missile defensive capabilities and reduce the need for terrestrial sensors and the size of deployable missile defense systems.

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**Many Aspects of PTSS's Acquisition Approach Are Consistent with GAO Best Practices** In alignment with GAO best practices, MDA plans to build two prototype satellites to define the system performance and focus on cost-effective production in an industrial environment. The prototype design and operation will be heavily informed by the on-orbit STSS demonstration satellites. Past GAO work identified Department of Defense (DOD) programs that did not regularly test production-representative prototypes before committing to production which led to cost growth and schedule delays. We have recommended that DOD develop fully-capable prototypes to demonstrate that the system can be built efficiently and production and postproduction costs are minimized.

Also consistent with GAO best practices, MDA plans to separate technology discovery from technology development by ensuring critical technologies are matured before large-scale acquisition begins. In the past, we have reported that some programs have attempted to satisfy all requirements in a single step, regardless of the design challenge or the maturity of technologies necessary to achieve the full capability. We have recommended that DOD separate technology discovery from acquisition and follow an incremental path toward meeting user needs. MDA plans to utilize systems and components for the PTSS design that are currently



used in commercial satellite sensors without significantly altering form, fit or function. In addition, the Director, MDA stated that a key hallmark of the PTSS satellites will be their relatively small size and simplistic design. For example, rather than including a dedicated acquisition sensor to identify ballistic missile launches, PTSS will rely on other existing DOD infrared sensors to establish a ballistic missile launch, thus removing the need for an acquisition sensor and simplifying the overall design of the satellite.

MDA also plans to follow an incremental path toward meeting user needs by using currently available technology to deliver near-term capabilities while maintaining the flexibility to add capabilities later. For example, combatant commanders identified a need for global coverage of missile threats to the homeland. To address the need, PTSS will initially be able to track regional medium- and intermediate-range ballistic missile threats, with the potential to handle future intercontinental ballistic missile threats to the United States. MDA officials stated that they also have the flexibility to increase the total constellation size by building and emplacing additional satellites to further add to system capabilities, such as increasing raid handling size. MDA plans to confine PTSS's program objectives to track missile launches for the BMDS and exclude additional program objectives to ensure that the design remains relatively simple. For example, the program currently plans to exclude observation of space objects, also known as space situational awareness, as a program objective as it could complicate the design and scope of the program. MDA officials stated that PTSS could potentially serve other functions, such as space situational awareness, during times when the satellite is not actively being used to serve the BMDS.

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### MDA Has Developed an Optimistic PTSS Schedule

MDA has developed an optimistic PTSS acquisition approach to field an operational constellation by fiscal year 2018. MDA plans to conduct prototyping efforts beginning in fiscal year 2011 and launch two prototype satellites in fiscal year 2015. MDA also plans to launch a minimum of seven additional satellites by fiscal year 2018. According to program officials, the two prototype satellites will become part of the operational system forming a minimum nine-satellite constellation in fiscal year 2018. Other DOD space programs have experienced long development times to launch initial satellites. For example, Space Based Infrared System (SBIRS) High, a program that will potentially supply ballistic missile launch cues to PTSS, began development in fiscal year 1997 and plans to deliver the first of six satellites in fiscal year 2011, totaling approximately 15 years. Another example is the MDA-developed Space Tracking and Surveillance

System (STSS), a program that will heavily inform PTSS. After years of research and development efforts by the Air Force, MDA began refurbishing and developing two demonstration STSS satellites in 2002 and launched the satellites in fiscal year 2009, totaling about 8 years. PTSS intends to develop and launch two prototype satellites in approximately 5 years. MDA stated that it has conducted three studies in recent years and concluded that using current technologies for the payload design may enable a rapid PTSS acquisition approach. However, it should be noted that the program is not yet far enough along in development to determine whether MDA's current acquisition plans will enable it to develop and deploy the operational constellation faster than other DOD space programs.

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### MDA Faces Significant PTSS Design Challenges but Has Mitigation Plans in Place to Address Them

Although MDA plans to follow many GAO-recommended best practices to use mature technologies, MDA faces significant design challenges. Officials in the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) have identified key technical design challenges to PTSS that will benefit from long lead analysis and prototyping activities, including payload design and characterization. Key design risks include developing sufficient sensitivity to detect and track post boost ballistic missiles, tracking large raids of ballistic missiles, and mass-producing payloads. According to AT&L officials, the program plans to address these design challenges through the use of computer modeling and simulations and refining payload design models. Modeling and simulation is verified and validated by on-orbit test and activities of STSS. Although the STSS program has experienced delays in obtaining this data, MDA officials stated that they are confident that STSS will collect the data in time to sufficiently inform PTSS.

MDA also faces significant design challenges integrating missile launch cues from other DOD infrared sensors into the BMDS in order to cue PTSS to track the detected missile launch. Since missile defense applications run on a timescale of seconds to minutes, the overriding challenges for receiving launch cues are obtaining on-demand tasking priority for DOD infrared sensors and processing the cues on highly compressed early intercept timelines. For example, to address challenges with integrating launch cues, MDA is pursuing a developmental initiative dedicated to incorporating DOD infrared sensor cues within the BMDS. To obtain priority for DOD infrared sensors, AT&L officials state that the main risk reduction effort is to develop a joint concept of operations for their use.

MDA also faces challenges integrating C2BMC with PTSS, including processing multiple PTSS missile tracks with other sensor tracks simultaneously and filtering out false alarms without significant processing delays. MDA plans to mitigate challenges by measuring and planning for processing delays and simulating PTSS and C2BMC interactions.

In addition, STSS, a program that heavily informs PTSS, has encountered significant problems operating in a high radiation environment in space. This environment is similar to the environment PTSS will operate in. During fiscal year 2010, a radiation particle collided with the STSS spacecraft processor while program officials were conducting efforts to fully calibrate the STSS satellites. Although program officials fully restored the affected processor, the event delayed the STSS satellites reaching full operating capability. MDA plans to mitigate environmental radiation issues by incorporating lessons learned from STSS radiation issues into the PTSS program. For example, PTSS program officials participated in STSS review meetings to determine root causes and solutions for radiation issues that arose during satellite calibration. In addition, MDA officials stated that the radiation environment will be considered as a key factor during the selection of PTSS satellite parts. PTSS also plans to use newer satellite processors than STSS that have improved capabilities to shield against radiation.

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### Delays in Fielding PTSS Would Significantly Affect U.S. and European Missile Defense

Delays in fielding a PTSS constellation in fiscal year 2018 would significantly affect the implementation of the Phased Adaptive Approach (PAA) to defend Europe and the United States against regional ballistic missile attacks. MDA discovered that there were sensor coverage gaps in its ability to acquire and track large ballistic missile raid sizes, intercept ballistic missiles earlier in their trajectories, assess intercept attempts in real time, and launch additional interceptors if necessary. Currently, the sensor systems of the BMDs consist of radar sensors, such as SBX and AN/TPY-2. According to MDA, infrared satellites such as PTSS would have advantages over terrestrial radars because they can limit the affect of weather conditions, eliminate the need for host nation agreements, and observe ballistic missile launches occurring in remote locations. In addition PTSS is being designed to track large missile raid sizes soon after launch to enable earlier intercepts. Such capabilities would alleviate sensor coverage gaps and reduce the need for terrestrial sensors. For example, according to MDA budget documentation, a small constellation of PTSS satellites can provide coverage equivalent to approximately 50 AN/TPY-2 radars or 20 SBX radars. MDA plans to deploy a forward-based

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AN/TPY-2 radar to southern Europe for Phase I of the PAA for the defense of Europe and the United States. Although the AN/TPY-2 radar can perform early missile tracking, the radar has inherent capability limitations. It is therefore necessary to have additional sensors in order to enhance early launch missile tracking capabilities. Delays in the PTSS programs would prolong robust early intercept capabilities, resulting in increased vulnerability to ballistic missile attacks.

# Appendix XI: Space Tracking and Surveillance System (STSS)

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"> <li>• Demonstration satellites progressed towards full capability performance.</li> <li>• STSS successfully tracked six missile targets.</li> <li>• STSS performed two-dimensional and three-dimensional acquisition sensor missile tracks.</li> <li>• STSS performed a track of an intercontinental ballistic missile.</li> </ul>	<ul style="list-style-type: none"> <li>➢ STSS has experienced several on-orbit issues following launch.</li> <li>➢ MDA's decision to develop PTSS extended STSS's on-orbit activities three years beyond its planned mission life.</li> <li>➢ On-orbit issues and aggressive scheduling have led to significant schedule delays.</li> <li>➢ The program is at risk of not completing all data collections to inform PTSS.</li> <li>➢ Despite on-orbit issues, STSS has overcome significant challenges and has reached full capability performance.</li> </ul>

## Background and Overview

MDA is pursuing the STSS program as a space-based sensor component of the BMDS. Over the past two decades, DOD has initiated several programs and spent several billion dollars trying to develop a system to track missiles from space. In 2002, MDA began refurbishing two demonstration satellites from the Air Force SBIRS Low program that was halted in 1999. MDA launched the demonstration satellites in September 2009 and fully calibrated the satellites in November 2010. Prior to launch of the satellites, MDA officials stated the program experienced 2 years of delays because of development challenges which resulted in over \$400 million in cost growth. In addition, following launch of the satellites, MDA encountered several on-orbit issues resulting in an 11-month delay in fully calibrating the satellites. MDA initially planned to begin fielding a follow-on operational STSS system in fiscal year 2011, however, MDA later decided against fielding an operational STSS system, according to the Director, MDA, in favor of developing a different satellite system, the PTSS. STSS will support the future PTSS program by collecting critical risk reduction data during flight tests to help inform PTSS design. MDA plans to launch two PTSS prototypes in fiscal year 2015 and have a nine-satellite PTSS constellation in place by fiscal year 2018.

## MDA's Decision to Develop PTSS Extended STSS's On-Orbit Activities 3 Years beyond Its Planned Mission Life

MDA's decision to develop PTSS significantly affected planned STSS on-orbit activities. MDA developed on-orbit activities for the demonstration satellites to help support and inform an operational STSS system. Because of the decision to develop PTSS, MDA significantly altered STSS's planned on-orbit activities almost 4 months after launch of the satellites. MDA decided to cancel the dedicated flight tests for STSS because of language in the explanatory statement related to the Defense Appropriations Act, 2010, that suggested a reduction in funding. A report by the Senate

Committee on Appropriations related to a 2010 Defense Appropriation bill stated that the demonstration satellites were built with payloads that would demonstrate capabilities required under the former SBIRS-Low program and that the PTSS constellation MDA is pursuing is very different from the original SBIRS-Low concept and the STSS demonstration satellites. The committee stated that while dedicated flight tests for STSS could provide useful data to MDA, there was sufficient funding in the budget request to demonstrate the STSS capability for which they were built.

STSS's revised on-orbit activities are planned to continue 3 years past the satellites' planned mission life. As a result of MDA's decision to cancel dedicated flight tests, program officials altered their planned on-orbit activities for STSS to support PTSS by collecting risk reduction data during BMDS test flights and targets of opportunity. In fiscal year 2010, STSS successfully tracked six missile targets over the last year producing very significant risk reduction data for PTSS, according to program officials. Although MDA has developed a plan to collect a majority of risk reduction data by fiscal year 2013, the satellites will not complete the PTSS risk reduction data collections until fiscal year 2016—3 years after the satellites' planned mission life ends.

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### STSS has Experienced Several On-Orbit Issues Following Launch

Since launch of the demonstration satellites in September 2009, STSS has experienced over twenty-two on-orbit issues.<sup>1</sup> For example, shortly after launch, one of the satellites was unable to autonomously stabilize itself during launch deployment. The operations team had to manually rotate the satellite to a safe sun pointing configuration. An anomaly review indicated that one of the satellite alignment numerical matrices was missing a “comma,” causing the satellite to fire its stabilization thrusters inaccurately—a potentially catastrophic failure. According to program officials, good launch preparation enabled the team to successfully mitigate the situation. Program officials stated that prior to launch, they had practiced several contingency circumstances including the exact scenario which occurred. According to program officials, whereas most satellite programs only set up a few, if any, mobile command sites, the STSS program set up multiple mobile command sites to monitor and control the satellites throughout post-launch operations. Had the team been unable to control the satellite, program officials said it was possible that they could have lost the satellite entirely.

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<sup>1</sup> Data is current as of October 20, 2010.

The most significant on-orbit issue STSS experienced delayed the program by over 3 months. Less than 2 weeks after launch, program officials discovered problems with the Attitude Determination and Control System when one of the satellites lost lock on its alignment stars. The satellite was conducting a system bake-out, a 3-week process in which the satellite heats up so any remaining moisture in the satellite evaporates, when the error occurred, forcing the satellite to exit the system bake-out and rotate to a safe-sun pointing position. Program officials uploaded corrective software updates to the demonstration satellites about 5 months after the problem was identified. Since the corrective software was uploaded, program officials stated they have not experienced any additional problems with the Attitude Determination and Control System.

The satellites have also experienced challenges operating in a high radiation environment. About 11 months after launch, one of the demonstration satellite's processors was struck by an atomic particle resulting in a temporary memory issue. According to program officials, they have fully restored the affected processor but anticipate that such radiation events will happen approximately 4 times per year. Although the program took measures to protect the satellites from radiation damage, inherent risks remain while the satellites continue to operate in a high radiation environment.

Program officials are also investigating the root cause of telemetry problems with one of the demonstration satellites. While conducting a payload software upgrade, the satellite experienced an anomaly that prevented telemetry reporting of the cryocoolers, a system that ensures the sensors are kept at an appropriately cool temperature range. The lack of telemetry reporting prevented the sensor from operating, resulting in over a 2-week delay. Program officials made the decision to use backup hardware while they investigated the root cause and now believe they have a better understanding of the problem.

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### On-Orbit Issues and Aggressive Scheduling Led to Significant Schedule Delays

Program officials stated that at launch, the program had an aggressive, no schedule margin plan that was ultimately delayed by approximately 11 months. Following launch of the demonstration satellites, program officials planned to conduct initial satellite check-out and sensors calibration to achieve full capability performance of the satellites within 4 months. At that point, the satellites would then begin collecting critical risk reduction data to inform PTSS. However, due to on-orbit issues and aggressive scheduling, the satellites did not reach full capability performance until December 2010, approximately 15 months after launch.

STSS on-orbit issues resulted in significant delays in the program's schedule. Half of the 22 on-orbit issues the program has experienced to date resulted in schedule delays, ultimately delaying the satellites from reaching full capability performance.<sup>2</sup> Because of on-orbit issues, MDA revised their test program and test schedule to focus on achieving fully calibrated performance and participating in interim BMDS-level flight tests.

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**The Program Is at Risk of Not Completing All Data Collections to Inform PTSS**

The program is at risk of not completing all data collections before the satellites' mission life is over, although the majority of data collection will occur by fiscal year 2013. The STSS program expects to fulfill all risk reduction data collection with the conclusion of flight test FTG-17 in fiscal year 2016, resulting in a 7-year mission life for the demonstration satellites. The STSS demonstration satellites were designed to have a 4-year mission life and are therefore at risk of not completing all data collections before the satellites go inoperable. Program officials anticipate collecting a large majority of risk reduction data by fiscal year 2013, within the satellites' planned mission life.

STSS faces challenges coordinating flight tests to be able to collect data when targets will be able to fly within the satellites' viewing window. According to program officials, in order for STSS to view a target during a flight test, the test has to be coordinated among STSS program officials and testing officials when the STSS satellites will be in a position to view the target. However, competing requirements of other participating elements may require some tests to be conducted without STSS's participation. For example, STSS was unable to collect data in flight tests FTG-06, FTL-01, and FTG-06a because the target did not fly within the satellite's view. Delays in collecting full risk reduction data necessary for PTSS could result if STSS is unable to collect data during planned flight tests.

In addition, program officials have identified insufficient funding as a major risk to the program completing all data collections to inform PTSS, a critical mission for the program. The STSS will support the future PTSS program by collecting risk reduction data during flight tests. As such, STSS is currently a mandatory asset for all BMDS-level flight tests. Although the program has experienced almost 3 years in schedule delays and over \$400

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<sup>2</sup> Data is current as of October 20, 2010.



million in cost overruns, program officials assert that insufficient funding due to several years of budget cuts may prevent the STSS program from collecting all the data required for PTSS risk reduction.

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**Despite On-Orbit Issues, STSS Has Overcome Significant Challenges and Reached Full Capability Performance**

Although the STSS demonstration satellites have encountered several on-orbit issues, the STSS program has minimized the affect of these issues and reached full capability performance in November 2010. Program officials stated that both demonstration satellites have healthy hardware and the remaining issues are understood by the program office. Program officials stated that the satellites are incrementally improving through testing and operations and are currently exceeding sensor measurement requirements as well. Although the satellites were delayed in reaching full capability performance in fiscal year 2010, that capability has now been achieved and both satellites routinely participate in BMDS flight tests and PTSS data collection events. The satellites have been successfully participating in flight tests and achieved several important accomplishments including establishing a three-dimensional track of a ballistic missile, tracking an intercontinental ballistic missile, and tracking a medium-range missile early after launch through the midcourse phase. Program officials are confident that on-orbit issues have not disrupted risk reduction data collection to inform PTSS and that, the majority of necessary data for PTSS will be collected by fiscal year 2013 according to the program's current schedule.

# Appendix XII: Targets and Countermeasures

Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• Thirteen targets delivered and launched.</li><li>• There was one failure of a target, on the FTT-11 flight test.</li><li>• There were successful first launches of three new target types: LV-2, JUNO, and ARAV-C.</li><li>• Solicitations for medium- and intermediate-range targets were issued.</li><li>• Medium-range solicitation was canceled after bids were received; no contract was awarded.</li><li>• An undefinitized contract action with the prime contractor for medium-range targets was issued.</li></ul>	<ul style="list-style-type: none"><li>➢ Targets remain a source of delays in BMDS testing</li><li>➢ Target failure in the FTT-11 flight test resulted in additional costs and delays</li><li>➢ A key MDA decision was not consistent with a targets acquisition goal set in 2009</li><li>➢ Reliance on the prime contractor may increase costs, and use of an undefinitized contract action may increase the risk of further cost growth</li><li>➢ MDA will make more key acquisition decisions in fiscal year 2011, which will have an impact on the extent of competition and the targets industrial base</li></ul>

## Background and Overview

The Targets and Countermeasures program provides ballistic missiles to serve as targets in the MDA flight test program. The targets program involves multiple acquisitions—including a variety of existing and new missiles and countermeasures.

In response to cost and schedule problems, MDA initiated a new targets acquisition strategy in 2009. Previously, MDA had relied on its prime contractor, Lockheed Martin, for much of its target needs. However, we found that this contracting approach had contributed to increased costs because of higher labor costs and management fees imposed by the prime contractor. In addition, the prime contractor's development of new targets experienced recurring cost and schedule overruns, contributing to delays in MDA's testing program. This Flexible Target Family (FTF) approach, followed at the time, sought to design a group of new targets with closely-related designs that could meet a range of MDA needs for short, medium, and long-range targets. However, because of the continuing cost and schedule problems, MDA suspended development of the 52-inch FTF target in 2008, leaving only the 72-inch FTF target, which experienced cost and schedule overruns of its own.

In response to congressional concern about these problems and our recommendations, MDA conducted a business case analysis that led in 2009 to a new approach to target acquisitions. This new approach was to seek separate, competitive contract awards for different classes of targets, allowing MDA to benefit from greater opportunities for competition and reducing the role of the prime contractor.

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### MDA Had a Number of Successful Target Flights in Fiscal Year 2010, Including New Targets

In fiscal year 2010, MDA delivered 13 targets. The targets launched during the year supported tests of several different BMDS elements, including the THAAD, GMD, and Patriot systems. Three of the targets launched were new developments.

MDA made important progress in target development during fiscal year 2010, launching three new targets. After a series of delays and cost increases, the long-range 72-inch FTF target, referred to as the LV-2, was launched for the first time in January 2010. According to MDA officials, the target performed properly, although the interception by the GMD system was unsuccessful. Two short-range targets, the JUNO and the ARAV-C, were also successfully flown for the first time, in tests of the Patriot system and Aegis BMD radar, respectively.

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### FTT-11 Failure Caused Delays and Cost Increases

A target failure in the THAAD FTT-11 test resulted in additional costs, delayed some other launches, and led to changes in MDA's acquisition approach for air-launched targets. That short-range air-launched target was the only unsuccessful launch in fiscal year 2010. The target failed to initiate after it was dropped from the aircraft, falling into the ocean, and as a result, FTT-11 was aborted. A subsequent failure review board investigation identified the rigging of cables to the missile in the aircraft as the immediate cause of the failure. These cables are attached to the target while it remains inside the aircraft, and are detached as the target is dropped from the aircraft. However, the investigation identified shortcomings in internal processes at the contractor as the underlying cause.

The agency took several actions in response to the failure and the review board's findings. Through the Air Force Space and Missile Systems Center, the holder of the underlying contract, it issued a cure notice requiring the contractor to complete specific steps by certain dates. If the contractor fails to do so, MDA may terminate or descope the delivery orders. In addition, the government told the contractor that it would halt further obligations of funding until the first step called for in the cure notice—personnel and organizational changes—was taken. MDA is in the process of a joint review and "return to flight" process with the Space and Missile Systems Center. According to MDA, the agency also incurred a total of \$96.4 million in costs because of the failure, including the loss of the target itself and associated logistics (\$38.5 million), the "return to flight" test and related activities (\$29 million), delays to other flight tests (\$19.8 million), and increased mission assurance work (\$9.1 million).

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## Targets Remained a Source of Delays for BMDS Testing

Targets continued to be a source of delays for MDA's BMDS testing program. We have previously reported that problems with the availability and reliability of targets have caused delays in MDA's testing of BMDS elements, and they continued to cause delays in fiscal year 2010.<sup>1</sup> According to MDA, 8 additional tests that had been planned during fiscal year 2010 were delayed past the end of the year or canceled. Five of these delayed tests were a result of the air launch moratorium put in place after the failure of FTT-11. The remaining 3 delays and cancellations were caused by factors outside the targets program, such as congressional action modifying BMDS elements.

In addition, MDA has changed its planned schedule of BMDS tests in response to target availability. According to MDA officials, target availability was a driving factor in determining the testing schedule for the new version 10.2 of its Integrated Master Test Plan (IMTP). In this revision, the agency delayed 11 tests compared to IMTP 10.1; 5 of those tests were delayed for more than a year. MDA also accelerated 10 tests, 6 of which were accelerated by one fiscal year quarter.<sup>2</sup> In addition, MDA stated that the test program has been restructured and the IMTP revised in support of the PAA.

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## Decisions on Acquisition of Targets Made in Fiscal Year 2010

MDA issued a new competitive solicitation for medium-range targets in the first quarter of 2010, as part of the new acquisition plan it initiated in 2009. However, it canceled this solicitation in June 2010, after receiving proposals. According to MDA officials, the bids received were more expensive than anticipated. The agency is presently considering options for procuring medium-range targets. Officials said that this includes the possibility of issuing a second medium-range solicitation, but they have not yet done so. MDA additionally released a draft solicitation for

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<sup>1</sup> GAO, *Defense Acquisitions: Missile Defense Transition Provides Opportunity to Strengthen Acquisition Approach*, [GAO-10-311](#) (Washington, D.C.: Feb. 25, 2010); *Defense Acquisitions: Charting a Course for Improved Missile Defense Testing*, [GAO-09-403T](#) (Washington, D.C.: Feb. 25, 2009); and *Defense Acquisitions: Sound Business Case Needed to Implement Missile Defense Agency's Targets Program*, [GAO-08-1113](#) (Washington, D.C.: Sept. 26, 2008).

<sup>2</sup> In addition, 9 tests were added in IMTP 10.2 and 14 were removed.

intercontinental-range targets in September 2010, also as part of its 2009 acquisition plan, but it was later canceled as well.<sup>3</sup>

Separately, MDA awarded a new undefinitized contract action to its incumbent prime targets contractor.<sup>4</sup> This action, signed in April 2010, asked the prime contractor to build a new type of medium-range air-launched target. The contract action initially included three targets; the quantity was then increased to five targets in September 2010. MDA officials stated that this new acquisition was to obtain a second procurement source for air-launched targets following the FTT-11 failure and was not in response to the cancellation of the medium-range solicitation.

According to MDA officials, pursuing new air-launched targets through an undefinitized action was necessary to meet the test schedule. The extended use of undefinitized contract actions has previously been identified by GAO and others as risky for the government. Because contracting officers normally reimburse contractors for all allowable costs they incur before definitization, contractors bear less risk and have little incentive to control costs during this period. The government also risks incurring unnecessary costs as requirements may change before the contract is definitized.

The purchase of air-launched targets through this undefinitized contract action is not consistent with the acquisition plan that MDA established in 2009, which envisioned competitive contract awards that would reduce the agency's reliance on its prime contractor.<sup>5</sup> This purchase of air-launched targets increased MDA's reliance on the prime contractor. We

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<sup>3</sup> The draft intercontinental solicitation was canceled in February 2011, prior to being finalized. According to the notice posted by MDA on the FedBizOpps Web site, the solicitation was canceled due to reprioritization of planned tests, and the agency plans to compete intercontinental-range target requirements in the future at a time to be determined.

<sup>4</sup> To meet urgent needs, DOD can issue undefinitized contract actions, which authorize contractors to begin work before reaching a final agreement on contract terms. Undefinitized contract action means any contract action for which the contract terms, specifications, or price are not agreed upon before performance is begun under the action. DFARS 217.7401(d).

<sup>5</sup> To the extent MDA has experienced circumstances that warrant a departure from its 2009 acquisition plan, section 7.104 of the FAR requires planners to review at key dates specified in the plan or whenever significant changes occur, and no less often than annually, acquisition plans and, if appropriate, revise them.

previously reported that conducting work through the prime contractor had increased target costs. Likewise, in comparing the prime contractor to other options prior to awarding the contract action, MDA estimated that the prime contractor’s management and fees would add about \$9 million per target compared to the Air Force contract vehicle they had previously used. MDA still does not know what the total cost will be for these targets—as of January 2010, the contract action had remained undefinitized for over 290 days, despite regulations that require such contract actions to provide for definitization within 180 days.<sup>6</sup> The current not-to-exceed amount for this contract action is \$496 million. According to MDA officials, the delay in definitization is due to changes in its requirements for the targets, and they anticipate definitization in July 2011, by which time the contract action will have remained undefinitized for about 450 days.

**Key Targets Acquisition Decisions in Fiscal Year 2011 Will Shape Program Outcomes**

The Targets and Countermeasures program will make several key acquisition decisions in fiscal year 2011 that will shape outcomes several years into the future, as well as decisions related to contractor return to flight activities in the wake of the FTT-11 failure. (See table 10.)

**Table 10: Key MDA Target Acquisition Decisions in Fiscal Year 2011**

Target class	Key fiscal year 2011 decisions	Anticipated date in fiscal year 2011
Intercontinental	Release solicitation	Canceled February 16
Intermediate-range	Award contract	Second quarter
Medium-range	Definitize contract action	July
	Identify acquisition approach for additional targets	No set timetable

Source: GAO analysis of MDA information.

Officials stated that now that proposals have been received for the intermediate-range target, they are in the process of evaluating the proposals, and anticipate a contract award in the second quarter of fiscal

<sup>6</sup> DFARS 217.7404-3 states that UCAs shall provide for definitization by the earlier of either, 180 days after issuance of the action or the date on which more than 50% of the not-to-exceed price has been obligated. The 180 day threshold may be extended but may not exceed the date that is 180 days after the contractor submits a qualifying proposal. If a contractor submits a qualifying proposal before the 50 percent threshold has been reached, then the limitation on obligations may be increased to no more than 75 percent.

year 2011. A goal of this contract is to build an inventory of targets that can be used to meet testing needs as they arise.

Likewise, MDA may also make a decision on its strategy for procuring medium-range targets. Following the cancellation of the solicitation in 2010, MDA officials reported that they are considering options for procurement of future medium-range targets. The agency cited both a new solicitation and the use of existing contracts as options they are considering. Use of existing contracts—as MDA has already done for five targets under the undefinitized contract action with its prime contractor—would reduce planned opportunities for competition and not be consistent with the acquisition approach the targets program initiated in 2009.

Finally, the return to flight process for MDA's air-launch contractor will also take place during fiscal year 2011. Following the December 2009 failure of FTT-11 and the subsequent failure review board report, MDA halted flight tests that use the contractor's systems or components, and has been working with the firm to address problems. The results of the "return to flight" test, a target launch that is presently scheduled for the third quarter of fiscal year 2011, will inform MDA decisions regarding targets currently on contract with the firm, as well as potential future contract awards.

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# Appendix XIII: Terminal High Altitude Area Defense (THAAD)

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Fiscal Year 2010 Events	What You Need To Know
<ul style="list-style-type: none"><li>• FTT-11 was declared a no-test due to a target failure.</li><li>• The program successfully conducted FTT-14 to prove out objective software for THAAD batteries.</li><li>• The program completed ground component deliveries for THAAD Battery 1 and 2.</li><li>• The program successfully completed qualification on interceptor ignition safety system.</li></ul>	<ul style="list-style-type: none"><li>➢ THAAD interceptor design and qualification issues delay delivery of the first two batteries.</li><li>➢ The THAAD program is currently mitigating production issues.</li><li>➢ Conditional release of THAAD Batteries to the Army is delayed 6 months.</li><li>➢ Successful THAAD flight test proves out objective software for batteries during fiscal year 2010.</li><li>➢ Targets issues continued to delay test schedule and achievement of knowledge points.</li></ul>

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## Background and Overview

The THAAD element is a rapidly-deployable ground-based system able to defend against short- and medium-range ballistic missile attacks during their late midcourse and terminal stages. A THAAD battery consists of interceptor missiles, three to six launchers, an X-band radar, and a fire control and communications system. The THAAD program is producing assets for initial operational use, but it is still qualifying components, conducting flight tests, and having issues with targets.

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## THAAD Interceptor Design and Qualification Issues Have Delayed Delivery of the First Two Batteries

Delivery of the first two THAAD batteries has been delayed by interceptor design and qualification issues. MDA's first THAAD battery was originally to be delivered in the fourth quarter of fiscal year 2010 but due to design and qualification issues with an ignition safety system on the interceptors, the 24 interceptors for the first battery won't be completed until the fourth quarter of fiscal year 2011. The full 48 interceptors necessary for both batteries won't be delivered until the second quarter of fiscal year 2012, three quarters later than originally intended. All of the remaining radars, fire controls, and other ground support equipment have been delivered for the first two batteries except for the launchers for Battery 1 and Battery 2 which are experiencing a 2-year delay in completing the government acceptance process. The launchers were originally planned to complete this process by the third quarter of fiscal year 2009, but now the program does not expect this process to be completed until the third quarter of fiscal year 2011. These delays stem from production issues associated with manufacturing challenges, parts obsolescence, design changes, and manufacturing defects. The government acceptance process was also contingent upon launcher qualification which, due to an ongoing development effort and changing designs, did not occur until February



2011. In addition, discoveries during a recent ground test have led to further design changes which are not expected to be completed until the second or third quarter of fiscal year 2011.

MDA's delays in incorporating the requirement for the optical block, an ignition safety system to prevent inadvertent launches, led to the design and qualification issues. In 2003, an Army safety review board identified the requirement to install an optical block on the THAAD interceptor's initiation system. However, MDA did not modify the development contract to include this requirement until 2006. In addition, MDA awarded a production contract in December 2006 before a design for the optical block was selected. To date, 7 years after the optical block requirement was identified, program and contractor officials told us that full recurring costs have not been determined and the requirement has not been defined on the production contract. Although the safety switch itself had been qualified, the program's first qualification of the integrated design in early fiscal year 2010 failed due to contamination. After making changes to the manufacturing process, the part was able to pass qualification in September 2010.

Although the program recently completed efforts to requalify the optical block component, failures during recent in-processing testing on the integrated design have again led the program to make minor design changes and delayed production of the first interceptor for a THAAD battery another quarter. The program was on-track to produce the first interceptor for THAAD Battery #1 in the first quarter of fiscal year 2011, but due to corrective actions to a circuit in the integrated design, the program won't be able to produce its first interceptor for a THAAD battery until the second quarter of fiscal year 2011. This extra quarter is in addition to the more than a year delay from the original planned date. According to program officials, the program plans to develop another design of the optical block that is more producible for use on THAAD battery interceptors in the future.

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### The THAAD Program Is Currently Mitigating Production Issues

In addition to completing its optical block design qualification, the THAAD program office is pursuing mitigation plans on other production risks including production rates and production gaps.

The THAAD program has a plan in place to ensure the interceptors can be produced at the necessary rate of four per month to meet planned delivery dates. One of the parts that has yet to demonstrate the required rate is the flight sequencing assembly, which houses the optical block. Currently, the

program has only demonstrated producing one flight sequencing assembly every 2 months. A variety of issues have prevented the subcontractor from demonstrating the necessary production rate including design changes and producibility issues associated with the optical block as well as availability of optical block parts from the contractor that produces it. However, according to the program office, the main issue that led to such a low level of production was a time-consuming testing procedure during the production process of the flight sequencing assembly. A new process has been devised to significantly speed up this testing and program officials are projecting that, with this process in place, production rates will increase to one per week—meeting the four per month required rates. The program hopes to demonstrate this new production rate as production resumes.

The THAAD program also faces a production gap that poses cost and schedule risks to retrain workers and recertify and requalify production processes. The contract award for Battery 3 interceptors was delayed by approximately 6 months to the end of fiscal year 2010 which contributed to a 1-year production gap for some interceptor components. Program officials told us that the cost to restart production for the subcontractors would be rolled up into the contract during the negotiation process. In addition, the contract for THAAD Battery 3 and 4 ground components and Battery 4 interceptors was not awarded as planned in the first quarter of fiscal year 2011, adding to the production gap of up to 3 years for some ground components. Program officials told us that delays to the contract award are because of ongoing contract negotiations. MDA is negotiating a contract which will include sections priced on a fixed-price incentive (firm target) basis for ground equipment and interceptors.<sup>1</sup> The contract is expected to be awarded in the second quarter of fiscal year 2011. Because there are fewer ground components than interceptors to produce, the program anticipated these gaps but could do nothing to prevent them. The

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<sup>1</sup> According to FAR 16.403-1, a fixed-price incentive (firm target) contract specifies a target cost, a target profit, a price ceiling (but not a profit ceiling or floor), and a profit adjustment formula. These elements are all negotiated at the outset. The price ceiling is the maximum that may be paid to the contractor, except for any adjustment under other contract clauses. When the contractor completes performance, the parties negotiate the final cost, and the final price is established by applying the formula. When the final cost is less than the target cost, application of the formula results in a final profit greater than the target profit. When final cost is more than target cost, application of the formula results in a final profit less than the target profit, or even a net loss. If the final negotiated cost exceeds the price ceiling, the contractor absorbs the difference as a loss.

program plans to negotiate these costs with the future contract but the effect of these gaps on cost is not yet known.

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### Conditional Release of THAAD Batteries to the Army Is Delayed 6 Months

The THAAD program has delayed its conditional release of batteries to the Army from September 2010 until April 2011 because of ongoing safety issues with interceptor components. For the release to occur, the Army must certify that the batteries are safe, suitable, and logistically supported. According to program officials, the Army Safety Review Board will perform safety testing on the integrated design of the optical block to be completed in February 2011. These results are needed before the release board can make its decision. However, the review board would need to perform repeat testing on 21 integrated designs of the optical block in order to achieve full materiel release, so THAAD will continue with conditional materiel release after passing Army safety testing on 3 units of the integrated designs.

In addition, program officials told us that THAAD is also accepting conditional materiel release because of its inability to incorporate another safety feature into the initial production units. This safety feature, called a thermally initiated venting system (TIVS) prevents explosion of the boost motor in the event that the canister holding the interceptor heats up to a certain temperature. The THAAD program provided an authorization to proceed on the requirement for TIVS in June 2007—more than 6 months after the production contract was signed. The scope of the work for TIVS on the production contract has yet to be authorized by the THAAD program. A developmental test of the early TIVS design resulted in a test failure. The program has planned corrective actions which will be tested during an upcoming verification test in the second quarter of fiscal year 2011. The THAAD program will not be able to start producing interceptors with this safety feature until it has produced more than half of its production quantity for the first two batteries. Because it cannot deliver interceptors with this safety feature to meet the requirement for full materiel release up front, according to program officials, the Army will accept conditional material release of THAAD and the THAAD program will cut-in the TIVS design in the production process during the fourth quarter of fiscal year 2011.

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### Successful THAAD Flight Test Proves Out Objective Software for Batteries during Fiscal Year 2010

Despite test delays over the past 2 years due to targets issues, the THAAD program was able to conduct a flight test in June 2010 that successfully demonstrated the complete objective software for the THAAD battery. After reorganizing its testing schedule due to address issues with air-launched targets, the program was able to accelerate the next test that did not use the air-launched targets, FTT-14, from the second quarter of fiscal year 2012 to the third quarter of fiscal year 2010. The program changed FTT-14's objectives to demonstrate component objective software for the THAAD battery in order to meet an important knowledge point for the program. Also during the test, the program was able to successfully demonstrate THAAD's performance against a simulated mass raid scenario.

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### Targets Issues Continued to Delay Test Schedule and Achievement of Knowledge Points

Since 2009, the THAAD program has experienced multiple delays and test restructures that have affected the program's ability to achieve knowledge points. The THAAD program was unable to conduct planned tests FTT-11 and FTT-12 in fiscal year 2009 due to target availability issues and an agency-wide restructuring of its testing schedule. Both of these tests were slated to meet key knowledge points to demonstrate the AN/TPY-2 (THAAD mode) radar's advanced discrimination capabilities and to demonstrate the component objective software for the THAAD battery, respectively. These tests were delayed into fiscal year 2010. However, in December 2009, FTT-11 resulted in a "no test" due to a target failure related to air-launched targets. This target failure led MDA to suspend all tests involving air-launched targets (see appendix XII for a detailed discussion of target issues). The THAAD program then had to reorganize its testing plans delaying FTT-12 and FTT-13, accelerating FTT-14, and changing its test objectives to meet the knowledge point originally planned for FTT-12 to prove out THAAD battery objective software. Although the program was able to successfully demonstrate this knowledge point, it won't be able to demonstrate the AN/TPY-2 (THAAD mode) radar's advanced discrimination capability until the fourth quarter of fiscal year 2011, nearly 2 years after it was originally planned. The third knowledge point to demonstrate a flight test intercept against a medium-range ballistic missile target to be met during FTT-13, has been delayed from the second quarter of fiscal year 2011 until the third quarter of fiscal year 2012 because of the lack of availability of a medium range air-launched target. See table 11 for how THAAD's flight test objectives have changed.

**Appendix XIII: Terminal High Altitude Area  
Defense (THAAD)**

**Table 11: THAAD’s Knowledge Point Objectives by Test Before and After the FTT-11 Failure in December 2009**

<b>Knowledge points to achieve intercept versus medium-range target</b>	<b>Before FTT-11 failure</b>		<b>After FTT-11 failure</b>	
	<b>Flight test</b>	<b>Date</b>	<b>Flight test</b>	<b>Date</b>
Demonstrate AN/TPY-2 (terminal mode) radar advanced discrimination	FTT-11	First quarter fiscal year 2010	FTT-12	Fourth quarter fiscal year 2011
Demonstrate complete component objective software for THAAD batteries	FTT-12	Second quarter fiscal year 2010	FTT-14	Third quarter fiscal year 2010
Demonstrate flight test intercept against a medium range ballistic missile target	FTT-13	Second quarter fiscal year 2011	FTT-13	Third quarter fiscal year 2012

Source: MDA (data); GAO (analysis)

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# Appendix XIV: Scope and Methodology

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To assess all six areas of MDA’s progress, we examined the accomplishments of nine BMDS elements that MDA is currently developing and fielding: the Aegis Ballistic Missile Defense (Aegis BMD); Aegis Ashore; BMDS Sensors; Command, Control, Battle Management, and Communications (C2BMC); Ground-based Midcourse Defense (GMD); Precision Tracking and Surveillance System (PTSS); Space Tracking and Surveillance System (STSS); Targets and Countermeasures; and Terminal High Altitude Area Defense (THAAD). We developed data collection instruments that were completed by most elements’ program offices<sup>1</sup> and reviewed the individual element responses. These instruments collected detailed information on prime contracts, test schedules and results, element performance, noteworthy progress, lessons learned, and challenges facing the elements during the fiscal year. We also performed detailed reviews of the progress made within selected Missile Defense systems, or elements. The results of these reviews are presented in detail in appendixes to this report and are also integrated as appropriate in our findings related to progress in delivering assets and implementing new initiatives. We also examined the cost/resource, schedule and test baselines as presented in the BMDS Accountability Report (BAR), test plans and reports, and production plans. We sought to examine MDA’s Baseline Execution Reviews of each element’s progress, but were unable to assess the supporting backup materials as they were not made available to us until February 2011—the very end of the audit.

To assess whether MDA elements delivered assets as scheduled, we examined the 2009 BMDS Accountability Report, and compared it to the 2010 version, looking for similarities and differences between the two. We also reviewed responses to GAO data collection instruments, which detailed key accomplishments for fiscal year 2010, to include some asset deliveries, as well as any delayed asset deliveries.

To follow up on the progress MDA made to improve transparency and accountability, we held discussions with officials in MDA’s Operations Directorate to discuss the new phased adaptive approach as well as the status of transparency and accountability issues the agency initiated in early 2010. In addition, we reviewed pertinent DOD policies to compare MDA’s current level of accountability with that of other DOD programs.

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<sup>1</sup> Instead of requesting data collection instrument information from the GMD element, we relied on the information that had already been collected for the GMD briefing to Congress, “DOD’s Assessment and Plan for the GMD Program.”

We interviewed officials from the Office of the Under Secretary of Defense for Acquisition Technology and Logistics to discuss the oversight role of the Missile Defense Executive Board. We also met with officials in MDA's Acquisition Directorate to discuss how the agency is establishing and managing its internal baselines. We also reviewed various MDA statements and documents related to MDA's new phased adaptive approach. We reviewed DOD acquisition system policy and various DOD directives to gain insight into other DOD systems' accountability and oversight mechanisms. We also analyzed MDA's acquisition directives and Missile Defense Executive Board briefings to examine MDA's current level of oversight. In addition, we reviewed MDA's Fiscal Year 2010 BMDS Accountability Report, Integrated Master Test Plans, MDA budget estimate submission justifications, the Ballistic Missile Defense Master Plan, and prior reports that outlined the agency's baselines and goals.

To assess the management process to synchronize acquisitions for the European Phased Adaptive Approach, we synthesized management and oversight principles from the Office of Management and Budget, DOD, the Missile Defense Agency (MDA), and GAO best acquisition practices for large acquisition efforts similar to EPAA. We then compared EPAA acquisition efforts to these principles. To determine the status of those efforts, we reviewed DOD and MDA documentation related to EPAA, including the Ballistic Missile Defense Review (BMDR) Report and MDA's BMDS Accountability Report (BAR). We also requested the European PAA cost estimate that was completed in fall of 2009. However, we did not receive the cost estimate until near the end of our review and therefore we could not perform and include the related analysis in our review. We met with MDA and Office of the Secretary of Defense officials. We also visited the U.S. European Command and U.S. Strategic Command. In addition, to identify near-term development risks, we reviewed MDA's BMDS acquisition documentation, including the integrated master test plan and budget documents. We met with officials from MDA directorates and element program offices as well as the Offices of the Under Secretary of Defense for Policy and the Under Secretary of Defense for Acquisition, Technology, and Logistics and visited contractor facilities. We also used prior GAO work regarding best acquisition practices to assess those risks.

We included the acquisition parts of our final analysis performed in response to a congressional mandate that we review a DOD assessment and plan related to the GMD system that included issues related to acquisition, sustainment and refurbishment. To assess DOD's Assessment and Plan for the GMD program, we reviewed the reports provided by DOD. We sought the analysis and assumptions behind the statements in the

reports; however, in certain cases MDA was unable to provide supporting documentation or the documentation provided was determined to be insufficient to assess. Specifically, we analyzed sustainment, refurbishment and test plans and program schedules. We also assessed budget documents, and program reviews. We interviewed officials from MDA, U.S. Strategic Command, U.S. Northern Command, and the Army. We also interviewed officials from DOD's Office of the Director, Test and Evaluation, and the Space and Missile Defense Command. We met with GMD contractors, Boeing and Raytheon, and met with officials from the Naval Warfare Center, Crane Division to discuss aging and surveillance testing. Our analysis covered data ranging from January 2002 through September 2010.

We assessed MDA's testing and target development progress by reviewing the technical baselines in the BAR, MDA's Integrated Master Test Plans, the target business case analysis, target contracts, and other documents related to target planning and acquisitions. In addition, we met with officials in the Targets and Countermeasures Program Office to obtain information on the target acquisition strategy including plans for cost, schedule, and testing as well as to discuss the progress, challenges, and lessons learned during fiscal year 2010 testing. We also interviewed officials within program offices and within MDA functional directorates, such as the Directorates for Engineering and Testing. In addition, we discussed the elements' test programs and test results with the BMDS Operational Test Agency and DOD's Office of the Director, Operational Test and Evaluation. We held discussions with the BMDS Operational Test Agency to follow up on BMDS models and simulations.

As we agreed to with your staff, we do not include an analysis of MDA's earned value management reporting this year. In prior years, in the absence of full cost baselines for elements, we assessed the earned value management progress of individual contracts. We issued our findings on MDA's earned value progress during fiscal year 2009 in July 2010 and found data reliability issues with two of the 14 contracts.<sup>2</sup> Because of these issues with the GMD and Targets and Countermeasures programs' earned value management data, we were unable to report cost progress for these two contracts which amounted to more than half of the total budgeted contract costs for MDA prime contracts we reviewed. We plan to re-assess earned value management data on MDA prime contracts in the

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<sup>2</sup> [GAO-10-676](#).



future once MDA has had time to address our recommendations to improve data reliability. In our July report, MDA stated that it intended to take a key step in addressing our recommendations by conducting a major review of the GMD program's EVM data by the end of September 2010. Because MDA provided documentation of its actions at the end of our audit—in February 2011—leaving no time for review, we will assess whether the steps MDA has taken sufficiently address GMD's data reliability issues in next year's report.

As noted above, during the course this audit, we experienced significant delays in obtaining information from MDA. During the audit, MDA did not always provide GAO staff with expeditious access to requested documents and articles of information, which delayed some audit analysis and contributed to extra staff hours. Notwithstanding these delays, we were able to obtain the information needed to satisfy our objectives in accordance with generally accepted government auditing standards. However, we were not given access until Late February 2011 to the September 2009 European Phased Adaptive Approach cost estimate, the backup material for the Baseline Execution Reviews, or the actions MDA took to respond to our previous recommendations on Earned Value Management. As a result, we were unable to assess this material as part of this year's annual review. We intend to review this material as part of our next mandated annual assessment.

Our work was performed at MDA headquarters in Arlington, Virginia, in Dahlgren, Virginia, at various program offices and contractor facilities located in Huntsville, Courtland, and Troy, Alabama, and at contractor facilities in Orlando, Florida. In Arlington we met with officials from the Airborne Laser Testbed Program Office; Command, Control, Battle Management, and Communications (C2BMC) Program Office; MDA's Operations Directorate; DOD's Office of the Director, Operational Test and Evaluation; and the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. In Dahlgren we met with officials from the Aegis Ballistic Missile Defense Program Office. In Huntsville, Alabama we interviewed officials from the Ground-based Midcourse Defense (GMD) Program Office, the Sensors Program Office, the Space Tracking and Surveillance System Office, the Terminal High Altitude Area Defense Project Office, the Targets and Countermeasures Program Office, the Advanced Technology Directorate, and Test Directorate. We also met with Lockheed Martin officials in Huntsville and Courtland, Alabama to discuss their role on the MDA Targets and Countermeasures prime contract, and production of intermediate-range targets. In addition, we met with Orbital Sciences officials to discuss their role as a contractor and

subcontractor providing medium-range targets. We also met with Coleman Aerospace officials in Orlando, Florida to discuss their work on short-range targets and the actions they are taking in response to a December 2009 target failure. We met with Lockheed Martin official in Troy, Alabama to discuss their role in developing THAAD interceptors.

We conducted this performance audit from March 2010 to March 2011 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.

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# Appendix XV: GAO Contact and Staff Acknowledgments

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## GAO Contact

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

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## Acknowledgments

In addition to the contact named above, David Best, Assistant Director; LaTonya Miller; Ivy Hübler; Teague Lyons; Steven Stern; Gwyneth Woolwine; Meredith Allen Kimmett; Brian Tittle; Letisha Antone; Kenneth E. Patton; Karen Richey; Hai Tran; Robert Swierczek; Nicolaas Cornelisse; Matthew S. Spiers; Rebecca Guerrero; and Alyssa Weir made key contributions to this report.

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