

April 2007

# MISSILE DEFENSE

## Actions Needed to Improve Information for Supporting Future Key Decisions for Boost and Ascent Phase Elements





Highlights of [GAO-07-430](#), a report to congressional committees

## Why GAO Did This Study

The Department of Defense (DOD) has spent about \$107 billion since the mid-1980s to develop a capability to destroy incoming ballistic missiles. DOD has set key decision points for deciding whether to further invest in capabilities to destroy missiles during the initial phases after launch. In March 2006, DOD issued a report on these capabilities in response to two mandates. To satisfy a direction from the House Appropriations Committee, GAO agreed to review the report.

To assist Congress in evaluating DOD's report and preparing for future decisions, GAO studied the extent to which DOD (1) analyzed technical and operational issues and (2) presented complete cost information. To do so, GAO assessed the report's methodology, explanation of assumptions and their effects on results, and whether DOD followed key principles for developing life-cycle costs.

## What GAO Recommends

To support future decisions, DOD should include key stakeholders in assessing operational issues, report on technical progress, and update and verify life-cycle cost estimates in accordance with key principles for developing life-cycle costs. In comments on a draft of this report, DOD agreed to include stakeholders and assess technical progress but did not agree to prepare or report life-cycle costs in accordance with key principles.

[www.gao.gov/cgi-bin/getrpt?GAO-07-430](http://www.gao.gov/cgi-bin/getrpt?GAO-07-430).  
To view the full product, including the scope and methodology, click on the link above. For more information, contact Janet A. St. Laurent at (202) 512-4402 or [stlaurentj@gao.gov](mailto:stlaurentj@gao.gov); or Paul Francis at (202) 512-2811 or [francisp@gao.gov](mailto:francisp@gao.gov).

# MISSILE DEFENSE

## Actions Needed to Improve Information for Supporting Future Key Decisions for Boost and Ascent Phase Elements

### What GAO Found

The report DOD's Missile Defense Agency (MDA) submitted to Congress in March 2006 included some useful technical and operational information on boost and ascent phase capabilities by describing these elements, listing upcoming decision points, and discussing geographic areas where boost and ascent elements could intercept missiles shortly after launch. However, the information in the report has several limitations because the analysis did not involve key DOD stakeholders such as the services and combatant commands in preparing the report and did not clearly explain modeling assumptions and their effects on results as required by relevant research standards. MDA's report states that, at this time, some data is limited, and operational concepts that discuss operations from forward locations have not been fully vetted with the services and combatant commands. However, the report did not explain how each element's performance may change if developing technologies do not perform as expected. Also, it did not address the challenges in establishing bases at the locations cited or provide information on the quantity of each element required for various deployment periods. Moving forward, DOD has an opportunity to involve stakeholders in analyzing operational and technical issues so that senior DOD and congressional leaders will have more complete information on which to base upcoming program decisions following key tests in 2008 and 2009 for the Kinetic Energy Interceptor and Airborne Laser boost and ascent phase programs.

MDA's report provided some cost estimates for developing and fielding boost and ascent phase capabilities, but these estimates have several limitations and will require refinement before they can serve as a basis for DOD and congressional decision makers to compare life-cycle costs for the elements. MDA's report states that there is uncertainty in estimating life-cycle costs because the elements are early in development. However, based on a comparison of the estimates in the report with key principles for developing life-cycle cost estimates, GAO found that MDA's estimates did not include all cost categories, including costs to establish and sustain operations at U.S. bases and at forward overseas operating locations. Also, MDA's estimates did not calculate costs based on realistic quantities of each element the combatant commanders or services would need to conduct the mission. Finally, MDA did not conduct a sensitivity analysis to assess the effect of key cost drivers on total costs. MDA officials stated that further analysis of the costs for each element along with measures to assess their confidence would help to better inform DOD and congressional decision makers in making investment decisions following key tests in 2008 and 2009.

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# Contents

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<b>Letter</b>		1
	Results in Brief	4
	Background	7
	MDA's March 2006 Report Includes Some Useful Information but Has Several Limitations	10
	DOD Can Significantly Improve Life-Cycle Cost Estimates to Support Future Investment and Budget Decisions for Boost and Ascent Phase Capabilities	14
	Conclusions	18
	Recommendations for Executive Action	19
	Agency Comments and Our Evaluation	20
<b>Appendix I</b>	<b>Scope and Methodology</b>	25
<b>Appendix II</b>	<b>Comments from the Department of Defense</b>	28
<b>Appendix III</b>	<b>GAO Contacts and Staff Acknowledgments</b>	32
<b>Related GAO Products</b>		33
<b>Table</b>		
	Table 1: Ballistic Missile Defense Boost and Ascent Phase Elements, Key Decision Points, and Their Planned Capability Dates	8

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## Abbreviations

ABL	Airborne Laser
BMDS	Ballistic Missile Defense System
DOD	Department of Defense
FYDP	Future Years Defense Program
KEI	Kinetic Energy Interceptor
MDA	Missile Defense Agency

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United States Government Accountability Office  
Washington, DC 20548

April 17, 2007

Congressional Committees:

The new security environment includes some states, such as North Korea, that are aggressively pursuing development of long-range missiles and weapons of mass destruction. In 2002, President Bush directed that the Department of Defense (DOD) proceed with plans to develop and put in place an initial set of ballistic missile defense capabilities beginning in 2004. DOD has spent about \$107 billion since the mid-1980s to develop a capability to destroy incoming ballistic missiles in all phases of their flight, including the initial phases after launch, called the boost and ascent phases.<sup>1</sup> The purpose of boost and ascent phase elements of a ballistic missile defense system (BMDS) is to engage incoming missiles before release of warheads or countermeasures. DOD is developing three BMDS boost and ascent phase capabilities: Airborne Laser (boost phase only), Kinetic Energy Interceptor (boost and ascent phase), and the Aegis Ballistic Missile Defense element that will fire the Standard Missile-3 block 2A<sup>2</sup> (ascent phase) from BMDS-capable Aegis surface combatants. According to the Missile Defense Agency (MDA), the agency responsible for developing an integrated ballistic missile defense system, DOD plans to spend \$1.6 billion for the Airborne Laser; \$800 million for the Kinetic Energy Interceptor; and \$200 million for the Aegis Standard Missile-3 Block 2A during fiscal years 2006–08. The long-term costs for these elements will be much greater if DOD continues their development and fielding. DOD projects the initial boost and ascent phase capabilities will not be available until about 2014 through 2020. Congress has raised questions about the affordability of pursuing both the Airborne Laser and Kinetic Energy Interceptor programs.

Over the next few years, DOD and Congress will be asked to make important program and investment decisions on boost and ascent phase capabilities—at a time when the federal government is facing a large and

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<sup>1</sup>The boost phase is the period immediately after launch when the missile's booster stages are still thrusting. Next is the ascent phase which ends when the ballistic missile completes deployment of reentry vehicles and possible decoys.

<sup>2</sup>Other versions of the Standard Missile-3 are being developed to intercept threat missiles in their midcourse phase.

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growing fiscal imbalance.<sup>3</sup> Further, we have identified the competing demands of investing in transformational capabilities while continuing to invest in legacy systems as one of the most significant national defense challenges for the 21st century.<sup>4</sup> MDA has established key decision points at which it will decide whether to continue to invest in certain elements of the integrated system. For example, one key decision point is the booster flight test for the Kinetic Energy Interceptor element, scheduled for 2008, at which time a decision will be made on the program's future. A key decision point for the Airborne Laser is the lethal shutdown demonstration scheduled for 2009.<sup>5</sup> Finally, in 2009, MDA plans a motor test for the Standard Missile-3 block 2A.

In March 2006, MDA issued a report on boost and ascent phase capabilities in response to two mandates—one in the House Appropriations Committee Report on the Defense Appropriations Bill for Fiscal Year 2006 and one in the National Defense Authorization Act for Fiscal Year 2006. The House Appropriations Committee directed the Secretary of Defense to conduct a study on boost and ascent phase intercepts including an assessment of operational capabilities, quantities of operational assets required for various deployment periods, basing options, and an assessment of life-cycle costs.<sup>6</sup> Life-cycle costs are the total cost to the government for a program over its full life, consisting of research and development, production, operations, maintenance, and disposal costs and are helpful in assessing whether a system's cost is affordable. The Department of Defense Authorization Act for Fiscal Year 2006 required the Secretary of Defense to conduct an assessment of U.S. missile defense programs that are designed to provide capability against threat ballistic missiles in the boost/ascent phase. The purpose of the assessment was to compare and contrast capabilities, asset requirements, and the costs for making the boost and ascent phase programs operational.<sup>7</sup> MDA, on behalf

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<sup>3</sup>GAO, *Budget Process: Long-term Focus Is Critical*, [GAO-04-585T](#) (Washington, D.C.: Mar. 23, 2004).

<sup>4</sup>GAO, *21st Century Challenges: Reexamining the Base of the Federal Government*, [GAO-05-325SP](#) (Washington, D.C.: February 2005).

<sup>5</sup>Although there are other interim decision points leading up to the lethal shutdown demonstration, MDA officials stated that the 2009 key decision point is one where decisions may be made about the future of the Airborne Laser program.

<sup>6</sup>H.R. Rep. No. 109-119 (2005).

<sup>7</sup>Pub.L. No. 109-163, § 231 (2005).

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of DOD, prepared one report to satisfy both requirements and sent the report to all four defense committees on March 30, 2006. According to MDA officials, that report was prepared specifically to satisfy the congressional requirements, not for use at any key decision point.

To satisfy a direction from the House Appropriations Committee report, we agreed to review the DOD report including assessing the report's methodologies, assumptions, completeness, and results.<sup>8</sup> This report is our assessment of the March 2006 MDA report and how DOD can build on this information to support future key decision points. Accordingly, we assessed the extent to which (1) information reported by DOD includes analysis of technical and operational issues and whether any additional information is needed to support future decision making and (2) DOD presented cost information to Congress that is complete and transparent. To assess the technical and operational information, we analyzed the extent to which the MDA report clearly explained technical maturity, modeling assumptions and their effect on results, and involved stakeholders in analyses of operational issues—steps which contribute to a sound and complete quality study and are embodied in relevant generally accepted research standards.<sup>9</sup> To assess the cost information in the March 2006 report, we compared MDA's cost data with key principles compiled from various DOD and GAO sources that describe how to develop accurate and reliable life-cycle cost estimates which are to include development, production, and all direct and indirect operating and support costs. We discussed the data and results of this comparison with DOD officials and identified some limitations, which we discuss in this report. We conducted our work between June 2006 and February 2007 in accordance with generally accepted government auditing standards. See appendix I for a more complete description of our scope and methodology.

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<sup>8</sup>While the House Appropriations Committee report originally directed us to conduct a joint study with DOD, we agreed with the Defense Subcommittee, House Appropriations Committee that, in lieu of a joint study, we would assess the Missile Defense Agency's March 2006 report on boost and ascent phase capabilities.

<sup>9</sup>In a September 2006 report, GAO identified frequently occurring, generally accepted research standards that are relevant for defense studies and define a sound and complete study. GAO, *Defense Transportation: Study Limitations Raise Questions about the Adequacy and Completeness of the Mobility Capabilities Study and Report*, [GAO-06-938](#) (Washington, D.C.: Sept. 20, 2006). Also, see app. I for a more complete description of our scope and methodology.

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This report is one in a series we have issued on ballistic missile defense (see the list of related GAO products at the end of this report). Some of these reports have focused on assessments of program goals and progress in developing each element. For example, our March 2006 report found that MDA made progress in the development and fielding of some elements but that time pressures caused MDA to stray from a knowledge-based acquisition strategy.<sup>10</sup> This is significant because straying from a knowledge-based approach opens the door to greater cost and performance risks by not having the right information available for decision makers at the right time.<sup>11</sup> Another report focused on DOD's planning to operate BMDS. We reported in May 2006 that DOD has not established criteria that would have to be met before declaring BMDS operational and that the Future Years Defense Program (FYDP), a major source of budget information, does not provide complete and transparent data on ballistic missile defense operational costs.<sup>12</sup>

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## Results in Brief

MDA's 2006 report to Congress included some useful technical and operational information on boost and ascent phase capabilities but the information in the report has several limitations. Specifically, MDA's report provided some key information on potential boost and ascent phase capabilities by describing these elements, listing upcoming decision points, and discussing geographic areas where these elements could intercept missiles shortly after launch. However, the analysis did not involve DOD stakeholders such as the services and combatant commands, which will have a key role in operating the elements, and did not clearly explain modeling assumptions and their effects on results as identified by relevant research standards. For example, the report assumed that each element would perform as desired and that the elements could be deployed at optimum locations, but it did not explain how each element's performance would change if developing technologies do not perform as expected. In addition, the report did not address the challenges in establishing bases at the locations cited or provide information on the

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<sup>10</sup>GAO, *Defense Acquisitions: Missile Defense Agency Fields Initial Capability but Falls Short of Original Goals*, [GAO-06-327](#) (Washington, D.C.: Mar. 15, 2006).

<sup>11</sup>GAO, *Missile Defense: Knowledge-Based Practices Are Being Adopted, but Risks Remain*, [GAO-03-441](#) (Washington, D.C.: Apr. 30, 2003).

<sup>12</sup>GAO, *Defense Management: Actions Needed to Improve Operational Planning and Visibility of Costs for Ballistic Missile Defense*, [GAO-06-473](#) (Washington, D.C.: May 31, 2006).



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quantity of each element required for various deployment periods. Two key reasons for these limitations, which the report acknowledges, are that some data on the elements are limited at this time, and operational concepts that discuss operations from forward locations have not been fully vetted with the services and combatant commands. However, moving forward, DOD has an opportunity to involve stakeholders in analyzing operational and technical issues to provide more complete data that senior DOD and congressional leaders can use to make informed program decisions following key tests in 2008 and 2009 for the Kinetic Energy Interceptor and Airborne Laser programs. To provide decision makers with information to support boost and ascent phase program decisions at future key decision points, we are recommending that DOD include all DOD stakeholders in developing and analyzing operational issues regarding what is needed to support operations at U.S. bases and potential forward locations, provide specific information on the technical progress of each element, and use the results of these analyses at each key decision point.

The Missile Defense Agency provided some cost estimates for developing and fielding each of the boost and ascent phase capabilities in its March 2006 report to Congress; however, these estimates have several limitations and will require refinement before they can serve as a basis for DOD and congressional decision makers to compare the costs of boost and ascent phase alternatives. We compared the report's cost estimates with various DOD and GAO sources that describe key principles for developing accurate and reliable life-cycle cost estimates. Based on our analysis, we found that the estimates provided in the report did not include all cost categories, including costs to establish and sustain operations at U.S. bases and at forward locations. Also, MDA did not calculate costs based on quantities the warfighter would need to conduct the mission, or conduct a sensitivity analysis identifying the effects of cost drivers. Although the report acknowledges that, at this time, there is uncertainty in estimating life-cycle costs for these elements, it did not fully disclose the limitations of the cost estimates. DOD can significantly improve the completeness of and confidence in its cost estimates for boost and ascent phase capabilities as it prepares for future investment and budget decisions. For example, although MDA did not have the cost estimates in its March 2006 report independently verified because doing so would have required several months, MDA officials agree that independent verification, which is another key principle of reliable cost estimates, will be critical to support major decision points. We are recommending that DOD prepare, periodically update, and independently verify life-cycle cost estimates for boost and ascent phase elements in accordance with key

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principles for developing accurate and reliable life-cycle cost estimates and that these verified estimates be used for making investment decisions and be reported with budget requests.

In commenting on a draft of this report, DOD agreed with our recommendations regarding the need for analysis of technical progress and operational issues to support key boost and ascent phase element decision points. DOD also partially concurred that an independent life-cycle cost estimate may be needed to inform some key decision points but said that they may not be needed at others. However, DOD did not agree to prepare and periodically update full life-cycle cost estimates for each boost and ascent phase element to support key decision points, and report independently verified life cycle cost estimates with budget requests and FYDP funding plans. In its comments, DOD stated that it will direct an independent evaluation of life-cycle costs if circumstances warrant or the Director of MDA declares an element mature enough to provide a militarily useful capability. However, if, as DOD's comments suggest, such costs are not assessed until circumstances warrant or MDA's Director makes such a declaration, these costs may not be available early enough to help shape important program and investment decisions and consider trade-offs among elements. We continue to believe our recommendation has merit because the development of life-cycle cost estimates that include potential operations and support costs would improve the information available to decision makers and increase accountability for key decisions that could involve billions of dollars at a time when DOD will likely face competing demands for resources. Finally, DOD did not agree to report independently verified life-cycle cost estimates along with budget requests and FYDP funding plans since the development of total life-cycle cost estimates for operationalized BMDS capabilities require agreement between MDA and the lead military department on the roles and responsibilities for fielded missile defense capabilities. However, independent verification allows decision makers to gauge whether the program is executable. Also, DOD procedures specify that when cost estimates are presented to the Office of the Secretary of Defense's Cost Analysis Improvement Group, life-cycle cost estimates should be compared with the FYDP and differences explained. Therefore, we continue to believe that our recommendation has merit because, without an independent cost estimate that can be compared to budget requests and FYDP funding plans, congressional decision makers may not have all the necessary information to assess the full extent of future resource requirements if the boost and ascent phase capabilities go forward, or assess the completeness of budget requests and FYDP funding plans.

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## Background

In 2002, the Secretary of Defense created MDA to develop an integrated system that would have the ability to intercept incoming missiles in all phases of their flight.<sup>13</sup> In developing BMDS, MDA is using an incremental approach to field militarily useful capabilities as they become available. MDA plans to field capabilities in 2-year blocks. The configuration of a given block is intended to build on the work completed in previous blocks. For example, Block 2006 is intended to build on capabilities developed in Block 2004, and is scheduled to field capabilities during calendar years 2006–07.

The integrated BMDS is comprised of various elements, three of which are intended to intercept threat missiles in their boost or ascent phase. Table 1 below describes each of these elements and shows the MDA projected dates for key decision points, initial capability, and tested operational capability.

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<sup>13</sup>The boost phase is the period immediately after launch when the missile's booster stages are still thrusting and typically lasts 3–5 minutes for intercontinental ballistic missiles. The ascent phase is when the booster stages have stopped thrusting and dropped away leaving a warhead and possible decoys. The midcourse phase, lasting for about 20 minutes, begins after the missile has stopped accelerating and the warhead travels through space on a predictable path. The final or terminal phase begins when the warhead reenters the atmosphere and lasts approximately a minute or less.

**Table 1: Ballistic Missile Defense Boost and Ascent Phase Elements, Key Decision Points, and Their Planned Capability Dates**

<b>Boost/ascent phase element</b>	<b>Description</b>	<b>Key decision points</b>	<b>Initial capability</b>	<b>Tested capability</b>
Standard Missile-3, block 2A <sup>a</sup>	Aegis Ballistic Missile Defense, which employs the Standard Missile, is a ship-based system designed to destroy medium, intermediate, and certain intercontinental ballistic missiles in the ascent and midcourse phases.	2009—motor test for the 21-inch diameter missile	Block 2012	Block 2014
Kinetic Energy Interceptor (KEI)—land-based	KEI is being designed to destroy medium, intermediate, and intercontinental ballistic missiles during the boost, ascent, and midcourse phases of flight. A land-based unit may consist of 5 launchers, 10 missiles, and fire control and communications equipment.	2008—booster flight test	Block 2014	Block to be decided
Kinetic Energy Interceptor—sea-based	KEI is being designed to destroy medium, intermediate, and intercontinental ballistic missiles during the boost, ascent, and midcourse phases of flight. DOD is currently studying sea-based platform alternatives including surface combatants, submarines, or a new platform.	2007—platform selection 2008—booster flight test	Block to be decided	Block to be decided
Airborne Laser (ABL)	ABL is an air-based missile defense system designed to destroy all classes of ballistic missiles during the boost phase. ABL also has onboard sensor capability designed to detect, track, and transmit targeting data.	2009—lethal shutdown demonstration	Block 2016	Block 2018

Source: GAO summary of DOD information.

<sup>a</sup>The Standard Missile is intended to be used on BMDS upgraded Aegis cruisers and destroyers. Other versions of the Standard Missile-3 are being developed to intercept threat missiles in their midcourse phase.

During the past year, Congress requested additional information and analyses on the boost and ascent phase elements from DOD. Specifically, House Report 109-119 on the Department of Defense Appropriations Bill for Fiscal Year 2006 directed the Secretary of Defense to conduct a study to review the early engagement of ballistic missiles to include boost and

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ascent phase intercepts and submit the report to the congressional defense committees.<sup>14</sup> The report was to include, but not be limited to

- an assessment of the operational capabilities of systems against ballistic missiles launched from North Korea or a location in the Middle East against the continental United States, Alaska, or Hawaii;
- an assessment of the quantity of operational assets required for deployment periods of 7 days, 30 days, 90 days, and 1 year;
- basing options; and
- an assessment of life-cycle costs<sup>15</sup> to include research and development efforts, procurement, deployment, operating, and infrastructure costs.

In addition, the National Defense Authorization Act for Fiscal Year 2006 required the Secretary of Defense to assess missile defense programs designed to provide capability against threat ballistic missiles in the boost/ascent phase of flight. The purpose of this assessment was to compare and contrast

- capabilities of those programs (if operational) to defeat ballistic missiles from North Korea or a location in the Middle East against the continental United States, Alaska, or Hawaii; and
- asset requirements and costs for those programs to become operational with the capabilities referred to above.

MDA, on behalf of DOD, prepared one report to satisfy both of the above requirements and sent the report to all four defense committees on March 30, 2006. The report included technical, operational, and cost information for each of the three boost and ascent phase BMDS elements. The remainder of this report discusses our assessment of the MDA report and how DOD can build on this information to support future key decision points.

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<sup>14</sup>H.R. Rep. No. 109-119 (2005).

<sup>15</sup>For most major acquisition programs, DOD prepares a life-cycle cost estimate that is independently verified for major program reviews. A life-cycle cost includes all costs associated with a weapon system's research and development, investment, which includes military construction, operations and support, and disposal.

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## MDA's March 2006 Report Includes Some Useful Information but Has Several Limitations

MDA's March 2006 report to Congress included some useful technical and operational information on boost and ascent phase capabilities. However, the information in the report has several limitations—such as not including stakeholders in the analysis or explaining how assumptions affect results. Moving forward, DOD can enhance its ability to make informed decisions at future key decision points by including stakeholders DOD-wide in conducting analyses to provide complete technical and operational information. Otherwise, senior DOD and congressional decision makers may be limited in their ability to effectively assess the technical progress and operational effects of proceeding with one or more boost and ascent phase element.

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## Report Provided Some Basic Information about Boost and Ascent Phase Elements

The March 2006 report to Congress contained some useful technical and operational information for Congress. For example, the report included a detailed description of the three boost and ascent phase elements, which could be useful for those unfamiliar with these elements. Additionally, the report listed upcoming knowledge points where DOD will review the progress MDA has made toward developing each of the boost and ascent phase elements. Further, the report discussed geographic areas where boost and ascent phase elements could intercept missiles shortly after launch based on desired technical capabilities. Also, MDA used a model<sup>16</sup> to assess the desired capabilities of each BMDS element for the March 2006 report to Congress. Further, the modeling environment was used for several past BMDS analyses and the results were benchmarked against other models. Finally, MDA performed a sensitivity analysis that compared how the results in the modeling changed when different assumptions for targets' propellants, ascent times, hardness levels, and burn times were used. To provide context, the report explained that the boost and ascent phase elements are in the early stages of development and that the operational concepts are not yet mature.

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## MDA's Analyses Have Limitations but DOD Can Improve Information to Support Future Decisions

The information in the March 2006 report has several limitations because the analyses did not involve stakeholders and did not clearly explain modeling assumptions and their effects on results as identified by relevant research standards. The relevant research standards and our prior work have shown that coordination with stakeholders from study design

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<sup>16</sup>The model, called WILMA, supports quantitative evaluation of ballistic missile defense system performance in terms of probabilities of success.

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through reporting, and clearly explained assumptions and their effects on results, can enable DOD officials to make fully informed program decisions. As a result, the March 2006 report presents an incomplete picture of technical capabilities, such as development challenges to be overcome in order to achieve desired performance, and it does not clearly explain the effects of operational assumptions, such as basing locations, asset quantities, and base support requirements. As a step in the right direction, MDA stated that it plans to develop criteria to assess the boost/ascent phase elements at major decision points in a process involving the combatant commands. Although MDA officials told us that they consult stakeholders in a variety of forums other than the March 2006 report, they did not clearly state whether or how the services or other DOD stakeholders would be involved in developing criteria for key decision points or the extent to which their analyses would include information on technical and operational issues.

Data Collection and Analysis  
for the March 2006 Report Did  
Not Involve Key DOD  
Stakeholders

MDA's analyses did not involve soliciting or using information from key DOD stakeholders such as the services, combatant commands, and joint staff from study design through reporting. For example, officials from the Office of the Secretary of Defense for Program Analysis and Evaluation and the Defense Intelligence Agency stated there were areas where additional information would have improved the fidelity of the results. First, the officials stated that there is uncertainty that the boost and ascent phase elements would achieve their desired capabilities within the timeframe stated in the report. Second, officials from both organizations stated that the report could have been enhanced by presenting different views of the type and capability of threats the United States could face and when these threats could realistically be expected to be used by adversaries. Third, officials from the Office of the Secretary of Defense for Program Analysis and Evaluation said that the MDA report did not distinguish between countermeasures that could be used in the near term and countermeasures that may be more difficult to implement. MDA officials said that they worked with the Office of the Secretary of Defense for Program Analysis and Evaluation in conducting analyses before they began work on the March 2006 report. MDA also stated that it discussed the draft March 2006 report with Office of the Secretary of Defense for Program Analysis and Evaluation officials and included some of their comments in the report's final version. However, without communication with stakeholders from study design through reporting, MDA may not have had all potential inputs that could have affected how the type, capability, and likelihood of countermeasures to the boost and ascent phase elements were presented in its report.

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Additionally, MDA did not solicit information from the services, combatant commands, or Joint Staff regarding operational issues that could have affected information about basing and the quantities of elements that could be required to support operations. Although the elements have to be located in close proximity to their intended targets, and the report discusses placing the elements at specific forward overseas locations, the report does not include a basing analysis explaining what would need to be done to support operations at these locations. Specifically, the report did not include any discussion of the infrastructure or security/force protection that will be needed for the BMDS elements. Although the report mentions some support requirements—such as the Airborne Laser’s need for unique maintenance and support equipment and skilled personnel to maintain the laser—the report did not fully explain how these support requirements would be determined, who would provide or fund them, or explain the operational effect if this support is not provided. For instance, without an adequate forward operating location, the boost and ascent phase elements would have to operate from much further away which would significantly limit the time an element is in close proximity to potential targets. Developing such information with the services, Joint Staff, and combatant commands could provide a much more complete explanation of operational issues and challenges. The services typically perform site analyses to ascertain what support is needed for a new weapon system at either a U.S. or overseas location. This comprehensive analysis examines a range of issues from fire protection to security, to infrastructure, to roads and airfields. In addition, U.S. Strategic Command and service officials told us that this type of support must be planned for in advance when adding a new system to any base, either in the United States or a forward location.

MDA also did not involve stakeholders in assessing the quantities of each element for deployment periods of 7 days, 30 days, 90 days, and 1 year. The report stated that limited data exist at this time for a full assessment of this issue, and service, Joint Staff, and MDA officials acknowledged that the quantities of each element used in the report are MDA assumed quantities. Service, Joint Staff, and U.S. Strategic Command officials stated that they have not completed analyses to assess quantities the warfighters may require. We understand that operational concepts will continue to evolve and could affect required quantities. However, stakeholders such as the services, Joint Staff, or combatant commands could have assisted MDA in assessing potential quantities required for various deployment periods. In addition, MDA did not solicit information from the services, Joint Staff, or combatant commands to determine if those organizations were conducting force structure analyses for the boost and ascent phase



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elements. We learned that the Navy had done a preliminary analysis in July 2005 and that the Joint Staff has begun a capabilities mix study and both include, in part, an analysis of quantities. Thus, in preparing for future decision points, MDA's analysis could be strengthened by including stakeholders to leverage other analyses. For example, MDA could have presented a range of scenarios to show how the quantities required to intercept adversary missiles could vary depending upon the number of sites covered and whether continuous, near-continuous, or sporadic coverage is provided.

**Assumptions and Their Effects on Data Presented in the MDA Report Were Not Clearly Explained**

The March 2006 report to Congress did not clearly explain the assumptions used in the modeling of the BMDS elements' capabilities and did not explain the effects those assumptions may have had on the results. First, the model inputs for the technical analysis assumed desired rather than demonstrated performance, and the report does not fully explain challenges in maturing technologies or how these performance predictions could change if the technologies are not developed as desired or assumed. For example, although the model MDA used is capable of showing different results based on different performance assumptions, the report did not explain how the number of successful intercepts may change if less than 100 percent of the desired technical capabilities are developed as envisioned. Thus the results represent the best expected outcome. Second, the report does not explain the current status of technical development or the challenges in maturing each element's critical technologies as desired or assumed in the report. DOD best practices define Technology Readiness Levels on a scale of 1-9, and state which level should be reached to progress past specific program decision points.<sup>17</sup> However, the March 2006 report does not explain the current Technology Readiness Level for any of the boost and ascent phase elements' critical technologies or the extent to which the technology has to mature to attain the performance assumed in the report. For example, the report does not explain that some of the technologies for the Airborne Laser have to improve between 60 percent and 80 percent and the report does not discuss any of the challenges MDA faces in doing so.

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<sup>17</sup>Technology Readiness Levels are measured on a scale of 1-9, beginning with paper studies of a technology's feasibility (level 1) and culminating with a technology fully integrated into a completed product (level 9).

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## DOD Can Significantly Improve Life-Cycle Cost Estimates to Support Future Investment and Budget Decisions for Boost and Ascent Phase Capabilities

The March 2006 report to Congress provides cost estimates for each of the boost and ascent phase capabilities; however, the cost estimates in the report have several limitations that raise questions about their usefulness. We compared the report's cost estimates with various DOD and GAO sources that describe key principles for developing accurate and reliable life-cycle cost estimates.<sup>18</sup> Based on our analysis, we found that MDA did not include all cost categories, calculate costs based on warfighter quantities, and did not conduct a sensitivity analysis to assess the effects of cost drivers. Moreover, although MDA's report acknowledges uncertainty in the cost estimates, the report does not fully disclose the limitations of the cost estimates. DOD can significantly improve the completeness of and confidence in cost estimates for boost and ascent phase capabilities as it prepares for future investment and budget decisions. For example, although DOD did not have its cost estimate for its March 2006 report independently verified because doing so would have taken several months, MDA officials agreed that independently verified cost estimates will be critical to support major decision points for boost and ascent phase capabilities.<sup>19</sup> In addition, as these capabilities mature, MDA officials agreed that showing cost estimates over time and conducting uncertainty analyses will be needed to support key program and investment decisions.

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## Cost Estimates Did Not Include All Cost Categories

The cost estimates provided in the MDA report included some development, production, and operations/support costs for each boost and ascent phase element but were not fully developed or verified according to key principles for developing life-cycle cost estimates. Life-cycle costs are the total cost to the government for a program over its full life, including

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<sup>18</sup>The criteria for developing accurate and reliable life-cycle cost estimates were compiled from several sources including the DOD Manual 5000.4-M *Cost Analysis Guidance and Procedures*, the *Defense Acquisition Guidebook*, and an exposure draft of *GAO's Cost Assessment Guide*. See app. I for a more complete description of our scope and methodology.

<sup>19</sup>As we reported in [GAO-05-817](#), independent cost estimates are normally first required for Milestone B, the decision to enter system development and demonstration. GAO, *Defense Acquisitions: Actions needed to Ensure Adequate Funding for Operation and Sustainment of the Ballistic Missile Defense System*, [GAO-05-817](#) (Washington, D.C.: Sept. 6, 2005). However, because BMDS elements do not enter DOD's acquisition cycle until Milestone C, the requirements under Section 2434 of Title 10 may not be applied to the BMDS until the transition phase that leads to the transfer to a military service. However, developing cost estimates using the key principles that we describe for developing accurate and reliable life-cycle cost estimates would provide useful information to DOD decision makers and Congress.

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the costs of research and development, investment, operating and support, and disposal.

Based on our comparison of the life-cycle cost estimates in the report with key principles for developing life-cycle cost estimates, we found that the estimates were incomplete in several ways. First, the cost estimates did not include all cost categories, such as costs to establish and sustain operations at U.S. bases. Instead, MDA assumed that the elements would be placed at existing bases with sufficient base support, infrastructure and security; however, some of these costs such as infrastructure could be significant. For example, an MDA planning document cited about \$87 million for infrastructure costs to support a ground-based BMDS element (Terminal High Altitude Area Defense). Army officials confirmed that training facilities, missile storage buildings, and a motor pool were built at a U.S. base specifically to support this element and it is likely that similar infrastructure would be needed to support the land-based Kinetic Energy Interceptor. Additionally, MDA's cost estimates did not include costs to establish and sustain operations at forward overseas locations, even though the report states that the elements will have to be located in close proximity to their targets, and the operational concepts for Kinetic Energy Interceptor and Airborne Laser, although in early development, state that these elements will be operated from forward locations. Again, these are important factors to consider—the Airborne Laser operational concept and the MDA report acknowledge that unique support will be required to support operations at any forward location for the Airborne Laser such as chemical facilities, unique ground support equipment, and maintenance. Service, Joint Staff, and U.S. Strategic Command officials also said that these elements would have to be located forward and could be used as a strategic deterrent in peacetime.

Second, the production and operating cost estimates were not based on warfighter quantities, that is, quantities of each element that the services and combatant commands may require to provide needed coverage of potential targets. MDA assumed a certain quantity of each element. For example, MDA officials told us that they assumed 96 Standard Missile-3 block 2A missiles because, at the time MDA prepared the report, they planned to buy 96 block 1A missiles developed to intercept short-range ballistic missiles. However, MDA did not solicit input from the services, Joint Staff, or combatant commands on whether they had done or begun analyses to determine element quantities.

Third, MDA did not conduct a sensitivity analysis to identify the effects of cost drivers. A sensitivity analysis is a way to identify risk by

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demonstrating how the cost estimates would change in response to different values for specific cost drivers. Therefore, a sensitivity analysis should be performed when developing cost estimates, and the results should be documented and reported to decision makers. This means, for example, that MDA could have computed costs with and without significant categories of costs such as forward bases to identify the effect that adding forward bases would have on operating costs. The House Armed Services Committee report on the National Defense Authorization Bill for Fiscal Year 2006 recognized that operational capabilities and costs must be taken into account when making decisions on future funding support. Finally, the cost estimates did not estimate costs over time—a process known as time phasing—which can assist decision makers with budgetary decisions. The MDA report showed an annual cost estimate but did not state for how many years the development, production, and operating costs may be incurred. Although MDA officials stated they did not prepare time-phased cost estimates in order to prepare the report to Congress in a timely manner, they agreed that showing cost estimates over time would be important information to support investment decisions at key decision points.

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**Cost Estimates Were Not Assessed or Independently Verified for MDA's 2006 Report but MDA Officials See Need to Do So for Key Decision Points**

Key principles for developing life-cycle cost estimates also include two steps for assessing the confidence of cost estimates. However, MDA did not take these steps to assess the confidence of the estimates reported in March 2006. First, the Missile Defense Agency did not conduct a risk analysis to assess the level of uncertainty for most of the cost estimates in the MDA report. Risk and uncertainty refer to the fact that, because a cost estimate is a prediction of the future, it is likely that the estimated cost will differ from the actual cost. It is useful to perform a risk analysis to quantify the degree of uncertainty in the estimates. By using standard computer simulation techniques, an overall level of uncertainty can be developed for cost estimates. In contrast, MDA officials told us that they could only provide a judgmental confidence level for the most of the cost estimates. Second, MDA did not have the cost estimates in the report verified by an independent organization such as DOD's Cost Analysis Improvement Group because doing so would have taken several months. However, MDA officials agreed that independent verification of cost estimates would be important information to support investment decisions at key decision points. According to the key principles that we have identified, all life-cycle cost estimates should be independently verified to

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assure accuracy, completeness, and reliability.<sup>20</sup> MDA has recognized the value in independently developed cost estimates. In 2003, MDA and the Cost Analysis Improvement Group developed a memorandum of understanding that said, in part, the Cost Analysis Improvement Group would develop independent cost estimates for the approved BMDS and its elements as appropriate during development in anticipation of transition to production, but MDA officials said that little work was completed under this agreement, which has expired.

Developing complete cost estimates in which decision makers can have confidence is important since life-cycle cost estimates usually form the basis for investment decisions and annual budget requests. Specifically, life-cycle cost estimates that include all cost categories, show costs over time, include warfighter quantities, include an assessment of cost drivers, and are independently verified are important because accurate life-cycle cost estimates can be used in formulating funding requests contained in the President's Budget and DOD's future funding plan, the Future Years Defense Program (FYDP) submitted to Congress. Therefore, there is a need for DOD to provide transparent budget and cost planning information to Congress. In May 2006, GAO reported that the FYDP, a major source of budget and future funding plans, does not provide complete and transparent data on ballistic missile defense operational costs because the FYDP's structure does not provide a way to identify and aggregate these costs. It is important that Congress has confidence in boost and ascent phase estimates because Congress has indicated that it is concerned with the affordability of pursuing both the Airborne Laser and Kinetic Energy Interceptor programs in parallel through 2008.

As we reported in 2003, DOD assumes increased investment risk by not having information available for decision makers at the right time, and the level of anticipated spending magnifies this risk.<sup>21</sup> Otherwise, senior DOD and congressional decision makers may be limited in their ability to assess

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<sup>20</sup>As we reported in [GAO-05-817](#), independent cost estimates are normally first required for Milestone B, the decision to enter system development and demonstration. However, because BMDS elements do not enter DOD's acquisition cycle until Milestone C, the requirements under Section 2434 of Title 10 may not be applied to the BMDS until the transition phase that leads to the transfer to a military service. However, developing cost estimates using the key principles that we describe for developing accurate and reliable life-cycle cost estimates would provide useful information to DOD decision makers and Congress.

<sup>21</sup>[GAO-03-441](#).

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the relative cost of the elements if all cost categories are not included and cost drivers are not identified. Considering competing demands, this could also limit Congress's ability to consider investment decisions or evaluate whether continued expenditures are warranted. MDA officials stated that, in developing the cost estimates for the March 2006 report, they decided not to follow some of the key principles for developing life-cycle cost estimates such as time phasing and independent verification of the cost estimates in order to complete the report in a timely manner. However, the officials also agreed that these key principles are important in developing complete, accurate, and reliable life-cycle cost estimates for supporting investment decisions at key decision points. Therefore, in the future, when preparing cost estimates to be used in support of key decision points, MDA could provide decision makers with more complete, accurate, and reliable cost estimates by better adhering to key principles for developing life-cycle cost estimates.

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## Conclusions

Our review of MDA's March 2006 report on boost and ascent phase elements identified a number limitations but helps to illuminate the kind of information that DOD and congressional decision makers will need following upcoming tests for boost and ascent phase elements. We recognize that the March 2006 report was prepared in response to congressional direction rather than to support program decisions. We also recognize that, at the time of MDA's report, these elements were early in their development and information was incomplete and changing. Thus, the focus of our analysis was to identify additional information that could enhance future program and investment decisions.

In particular, the House Armed Services Committee has raised questions about the affordability of pursuing both the Kinetic Energy Interceptor and the Airborne Laser in parallel through the projected knowledge point demonstrations,<sup>22</sup> which are now scheduled for 2008 and 2009 respectively. It is important that these decisions be both well-informed and transparent because of the long-term funding consequences. DOD and congressional decision makers' ability to assess which elements can be fully developed, integrated, and operated relative to the others will be enhanced if they have the benefit of information based on more rigorous analysis than that contained in MDA's March 2006 report. Looking forward, as DOD strengthens its analyses to support future key decisions, DOD and

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<sup>22</sup>H.R. Rep. No. 109-452 (2006).

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congressional decision makers will be able to use more complete information to assess force structure, basing, support, and infrastructure requirements, as well as technical maturity, budget requests, and FYDP spending plans, in deciding whether or not to continue developing one, two, or all three boost and ascent phase elements and in what quantities.

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## Recommendations for Executive Action

To provide decision makers with information that enables them to clearly understand the technical progress and operational implications of each boost and ascent phase element and make fully informed, fact-based, program decisions at future key decision points, we recommend that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to take the following actions to support key decision points for the BMDS boost and ascent phase elements:

- Include all DOD stakeholders (including services, combatant commands, Joint Staff) in developing and analyzing operational issues regarding what is needed to support operations at U.S. bases and potential forward locations, including basing assessments, force structure and quantity requirements, infrastructure, security/force protection, maintenance, and personnel.
- Provide specific information on the technical progress of each element. Specifically, the analysis should explain current technical maturity versus desired technical maturity and capabilities of all major components and subsystems, reasonable model inputs on element performance, and provide a clear explanation of assumptions and their effect on results.
- Use the results of these analyses at each key decision point.

To provide decision makers with complete and reliable data on the costs of each boost/ascent phase BMDS element to enhance investment and budget decisions, we recommend that the Secretary of Defense take the following actions:

- Direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to require MDA to prepare and—to support key decision points—periodically update a full life-cycle cost estimate for each boost/ascent phase element, in accordance with key principles for developing accurate and reliable life-cycle cost estimates, that includes all operational costs, including costs to establish and sustain operations at U.S. bases and forward locations, and that is based on warfighter quantities, includes sensitivity analyses, and reflects time phasing.

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- Direct an independent group, such as the Cost Analysis Improvement Group, to prepare an independent life-cycle cost estimate for each capability at each key decision point.
  - Direct MDA and services to report independently verified life-cycle cost estimates along with budget requests and FYDP funding plans for each boost/ascent phase element.

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## Agency Comments and Our Evaluation

In written comments on a draft of this report, DOD agreed with our recommendations regarding the need for analysis of technical progress and operational issues to support key boost and ascent phase element decision points. DOD also agreed that an independent life-cycle cost estimate may be needed to inform some key decision points while they may not be needed at other decision points. However, DOD did not agree to prepare and periodically update full life-cycle cost estimates for each boost and ascent phase element to support key decision points, and report independently verified life cycle cost estimates with budget requests and FYDP funding plans. As discussed below, we continue to believe our recommendations have merit and that DOD should take the additional actions we have recommended to provide a rigorous analytical basis for future decisions, enhance the transparency of its analyses, and increase accountability for key decisions that could involve billions of dollars. The department's comments are reprinted in their entirety in appendix II.

DOD agreed with our recommendations that all DOD stakeholders be included in developing and analyzing operational issues, that specific information on technical progress be provided to explain current versus desired capabilities, and that the results of both analyses be used at key decision points. DOD stated in its comments that officials from MDA, the military departments, the combatant commanders, and other organizations are collaborating to develop an operational BMDS. Moreover, the annual *BMDS Transition and Transfer Plan* is coordinated with the service secretaries and other stakeholders and serves as a repository for plans, agreements, responsibilities, authorities, and issues. DOD also stated that key program decisions are and will continue to be informed by detailed technical analysis, including assessment of element technical maturity. However, DOD did not clearly explain how future decision making will be enhanced or how analyses of operational issues will be conducted if, as in the case of the Kinetic Energy Interceptor, DOD has not assigned a service responsibility for operating the element once it is developed. We continue to believe that DOD and congressional decision makers will need more complete information on support requirements at upcoming decision points as well as a clear comparison of current versus desired technical



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capabilities in deciding whether or not to continue developing one, two, or all three boost and ascent phase elements.

Regarding our recommendations to improve cost estimates used to support key investment decisions, DOD partially concurred that independent life-cycle cost estimates may be required to inform some key decision points but stated that other key decision points may not. However, DOD did not agree that it should routinely prepare and periodically update a full life-cycle cost estimate for each boost and ascent phase element. DOD said that it continuously assesses all aspects of its development efforts and will direct an independent evaluation of life-cycle costs for boost and ascent phase elements if circumstances warrant or if MDA's Director declares an element mature enough to provide a militarily useful capability. However, if, as DOD's comments suggest, such costs are not assessed until circumstances warrant or MDA's Director declares an element mature enough to provide a militarily useful capability, these costs may not be available early enough to help shape important program and investment decisions and consider trade-offs among elements. Moreover, DOD's *Operating and Support Cost Estimating Guide*, published by the Cost Analysis Improvement Group, states that when the Cost Analysis Improvement Group assists the Office of the Secretary of Defense components in their review of program costs, one purpose is to determine whether a new system will be affordable to operate and support.<sup>23</sup> Therefore, such analysis must be done early enough to provide cost data that will be considered in making a decision to field, produce, or transition an element. We continue to believe our recommendation has merit because the development of life-cycle cost estimates that include potential operations and support costs would improve the information available to decision makers and increase accountability for key decisions that could involve billions of dollars at a time when DOD will likely face competing demands for resources.

Finally, DOD did not agree to report independently verified life-cycle cost estimates along with budget requests and FYDP funding plans for each boost and ascent phase element. DOD stated that operations and support segments of the budget are organized by functional area rather than by weapon system and are dependent on operations and support concepts of the employing military department. DOD further stated that development

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<sup>23</sup>DOD, Office of the Secretary of Defense Cost Analysis Improvement Group, *Operating and Support Cost Estimating Guide* (May 1992).

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of total life-cycle cost estimates for operational BMDS capabilities requires agreement between MDA and the lead military department on roles and responsibilities for fielded BMDS capabilities that transcend the annual transition planning cycle but serve as a basis for budget submittals. We recently reported that MDA enjoys flexibility in developing BMDS but this flexibility comes at the cost of transparency and accountability.<sup>24</sup> One purpose of cost estimates is to support the budget process by providing estimates of the funding required to efficiently execute a program. Also, independent verification of cost estimates allows decision makers to gauge whether the program is executable. Thus, cost estimating is the basis for establishing and defending budgets and is at the heart of the affordability issue. This principle is stated in DOD procedures which specify that when cost results are presented to the Office of the Secretary of Defense Cost Analysis Improvement Group, the program office-developed life-cycle cost estimate should be compared with the FYDP and differences explained.<sup>25</sup> Therefore, we continue to believe that our recommendation has merit because, without an independent cost estimate that can be compared to budget requests and FYDP funding plans, congressional decision makers may not have all the necessary information to assess the full extent of future resource requirements if the boost and ascent phase capabilities go forward, or assess the completeness of the cost estimates that are in the budget request and FYDP funding plans.

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We are sending copies of this report to the Secretary of Defense; the Commander, U.S. Strategic Command; the Director, Missile Defense Agency; Chairman, the Joint Chiefs of Staff; and the Chiefs of Staff of the Army, Navy, and Air Force. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

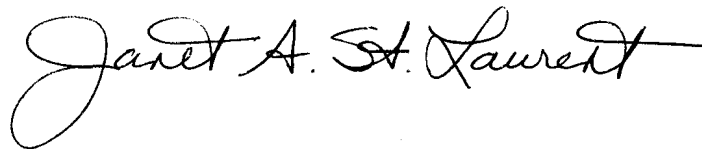
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<sup>24</sup>GAO, *Defense Acquisitions: Missile Defense Acquisition Strategy Generates Results but Delivers Less at a Higher Cost*, [GAO-07-387](#) (Washington, D.C.: Mar. 15, 2007).

<sup>25</sup>DOD, Assistant Secretary of Defense (Program Analysis and Evaluation), *Cost Analysis Guidance and Procedures*, DOD 5000.4-M (December 1992).

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If you or your staff have any questions, please call either Janet St. Laurent on (202) 512-4402 or Paul Francis on (202) 512-2811. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Staff members who made key contributions to this report are listed in appendix III.



Janet A. St. Laurent  
Director,  
Defense Capabilities and Management



Paul L. Francis  
Director,  
Acquisition, Sourcing, and Management

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*List of Committees*

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

The Honorable Daniel K. Inouye  
Chairman  
The Honorable Ted Stevens  
Ranking Minority Member  
Subcommittee on Defense  
Committee on Appropriations  
United States Senate

The Honorable Ike Skelton  
Chairman  
The Honorable Duncan L. Hunter  
Ranking Minority Member  
Committee on Armed Services  
House of Representatives

The Honorable John P. Murtha  
Chairman  
The Honorable C. W. Bill Young  
Ranking Minority Member  
Subcommittee on Defense  
Committee on Appropriations  
House of Representatives

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# Appendix I: Scope and Methodology

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During this review, we focused on assessing the analytical approach the Missile Defense Agency (MDA) used to develop its March 2006 report to Congress, as well as the methodology for developing the cost estimates for each of the three Ballistic Missile Defense System (BMDS) boost and ascent phase elements.

To assess the extent to which the Department of Defense (DOD) is developing technical and operational information useful for oversight and that will support decision making at key points, we compared the analytical approach DOD used to develop its March 2006 report with generally accepted research standards that are relevant for defense studies such as this, that define a sound and complete study, and that cover all phases of a study—design, execution, and presentation of results. The following were our sources for these standards:

- GAO, Government Auditing Standards: 2003 Revision, [GAO-03-673G](#) (Washington, D.C.: June 2003);
- GAO, Designing Evaluations, [GAO/PEMD-10.1.4](#) (Washington, D.C.: March 1991);
- GAO, Dimensions of Quality, [GAO/QTm-94-1](#) (Washington, D.C.: February 2004);
- RAND Corporation, RAND Standards for High-Quality Research and Analysis (Santa Monica, Calif.: June 2004);
- Air Force, Office of Aerospace Studies, Analysts Handbook: On Understanding the Nature of Analysis (January 2000);
- Air Force, Office of Aerospace Studies, Air Force Analysis Handbook, A Guide for Performing Analysis Studies: For Analysis of Alternatives or Functional Solution Analysis (July 2004);
- Department of Defense, DOD Modeling and Simulation (M&S) Verification, Validation, Accreditation (VV&A), Instruction 5000.61 (Washington, D.C.: May 2003);
- Department of Defense, Data Collection, Development, and Management in Support of Strategic Analysis, Directive 8260.1 (Washington, D.C.: Dec. 2, 2003); and
- Department of Defense, Implementation of Data Collection, Development, and Management for Strategic Analyses, Instruction 8260.2 (Washington, D.C.: Jan. 21, 2003).

For a more complete description of these standards and how we identified them, see [GAO-06-938](#), appendix I.<sup>1</sup> In applying these standards, we focused on the extent to which stakeholders were involved in study design and analysis as well as the extent to which assumptions were reasonable and their effects on results were clearly explained. We assessed MDA briefings that explained the modeling used for the technical analysis projecting the elements' capabilities. To assess the basis for the assumed performance parameters used to model each element's performance, we traced and verified a nonprobability sample of these parameters to their source documentation and concluded that they were generally supported. To evaluate the DOD report's characterization of threats, we reviewed Defense Intelligence Agency documents and discussed the type and capability of threats and expected BMDS capabilities with officials from the Office of the Secretary of Defense for Program Analysis and Evaluation and the Defense Intelligence Agency. In addition, to gain an understanding of the extent to which DOD has assessed warfighter quantities for the boost and ascent phase elements, the development of operational concepts, and operational implications of employing the boost and ascent phase elements at forward locations, we evaluated DOD and service guidance on assessing sites and support for new weapon systems and discussed these issues with officials from the Joint Staff; U.S. Army Headquarters and Space and Missile Defense Command; U.S. Strategic Command; the office of the Chief of Naval Operations Surface Warfare Directorate, Ballistic Missile Defense Division; Air Combat Command; and the office of the Secretary of the Air Force for Acquisition, Global Power Directorate. Finally, we discussed the results of all our analyses with officials in the Joint Staff; U.S. Strategic Command; the Army's Space and Missile Defense Command; Office of the Secretary of Defense for Acquisition, Technology, and Logistics; Missile Defense Agency; the office of the Chief of Naval Operations Surface Warfare Directorate, Ballistic Missile Defense Division; the office of the Secretary of the Air Force for Acquisition Global Power Directorate; and Air Combat Command.

To assess the extent to which DOD presented cost information to Congress that is complete and transparent, we first assessed how MDA developed its estimates and then compared the method by which those estimates were prepared to key principles compiled from various DOD and

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<sup>1</sup>GAO, *Defense Transportation: Study Limitations Raise Questions about the Adequacy and Completeness of the Mobility Capabilities Study and Report*, [GAO-06-938](#) (Washington, D.C.: Sept. 20, 2006).

GAO sources that describe how to develop accurate and reliable life-cycle cost estimates to determine their completeness and the extent to which DOD took steps to assess confidence in the estimates. The following were our sources for compiling the cost criteria:

- Department of Defense, Assistant Secretary of Defense (Program Analysis and Evaluation), Cost Analysis Guidance and Procedures, DOD Manual 5000.4-M (December 1992);
- Department of Defense, Office of the Secretary of Defense Cost Analysis Improvement Group, Operating and Support Cost Estimating Guide (May 1992);
- Department of Defense, Defense Acquisition University, Defense Acquisition Guidebook (online at <http://akss.dau.mil/dag>);
- Department of Defense, Defense Acquisition University, Introduction to Cost Analysis (April 2006);
- Air Force, Office of Aerospace Studies, Air Force Analysis Handbook: A Guide for Performing Analysis Studies for Analysis of Alternatives or Functional Solution Analysis (July 2004);
- Air Force, Base Support and Expeditionary Site Planning, Air Force Instruction 10-404 (March 2004); and
- GAO, GAO Cost Assessment Guide (currently under development).

In addition, we met with DOD officials from MDA, U.S. Strategic Command, the Joint Staff, Army, Navy and Air Force to determine the extent to which they were involved in developing the cost estimates for the DOD report. Finally, we corroborated our methodology and results with officials from the Office of the Under Secretary of Defense, Program, Analysis and Evaluation (Cost Analysis Improvement Group) and the Office of the Under Secretary of Defense (Comptroller) and they agreed that our methodology for examining the report's cost estimates was reasonable and consistent with key principles for developing accurate and reliable life-cycle cost estimates. We identified some data limitations with the cost estimates which we discuss in this report.

We provided a draft of this report to DOD for its review and incorporated its comments where appropriate. Our review was conducted between June 2006 and February 2007 in accordance with generally accepted government auditing standards.

# Appendix II: Comments from the Department of Defense



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

ACQUISITION,  
TECHNOLOGY  
AND LOGISTICS

MAR 28 2007

Ms. Janet St. Laurent  
Director, Defense Capabilities and Management  
U. S. Government Accountability Office  
441 G Street, N.W.  
Washington, DC 20548


Dear Ms. St. Laurent:

This is the Department of Defense (DoD) response to the GAO Draft Report GAO-07-430, "MISSILE DEFENSE: Actions Needed to Improve Information for Supporting Future Key Decisions for Boost and Ascent Phase Elements," dated February 28, 2007 (GAO Code 350861).

The DoD concurs with three, partially concurs with one, and non-concurs with two of the draft report's recommendations. The rationale for our position is included in the enclosure.

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

Sincerely,

  
for Dave G. Ahern  
Director  
Portfolio Systems Acquisition

Enclosure:  
As stated





**GAO DRAFT REPORT - DATED FEBRUARY 28, 2007**  
**GAO CODE 350861/GAO-07-430**

**“MISSILE DEFENSE: Actions Needed to Improve Information  
for Supporting Future Key Decisions for Boost and Ascent Phase Elements”**

**DEPARTMENT OF DEFENSE COMMENTS  
TO THE RECOMMENDATION**

**RECOMMENDATION 1:** The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to include all DoD stakeholders (including services, combatant commands, Joint Staff) in developing and analyzing operational issues regarding what is needed to support operations at U.S. bases and potential forward locations, including basing assessments, force structure and quantity requirements, infrastructure, security/force protection; maintenance, and personnel, for the Ballistic Missile Defense System (BMDS) boost and ascent phase elements. (Page 21/GAO Draft Report)

**DoD RESPONSE:** Concur. As reported in the DoD Report to Congress on Transition of Ballistic Missile Defense Programs to the Military Departments for 2007, the DoD has made significant progress in planning for the transition of operating and support responsibilities and authorities for elements of the BMDS to the Military Departments. Members of the Missile Defense Agency (MDA), the Military Departments, the Combatant Commands, the Joint Staff, and the Office of the Secretary of Defense are collaborating by way of an Integrated Product Team (IPT) to operationalize the BMDS. This Transition and Transfer IPT produces an annual DoD document referred to as the BMDS Transition and Transfer Plan (T&TP) that serves as a repository for plans, agreements, responsibilities, authorities, and issues. The T&TP is submitted by MDA to USD(AT&L) annually on March 1, and then coordinated with Service Secretaries and other stakeholders, and, with regards to operationalizing the BMDS, serves as the basis for MDA and Service budget formulation.

**RECOMMENDATION 2:** The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to provide specific information on the technical progress of each BMDS boost and ascent phase element to support key decision points. Specifically, the analysis should explain current technical maturity of all major components and subsystems in comparison to desired technical maturity, reasonable model inputs on element performance, and a clear explanation of assumptions and their effect on results. (Page 21/GAO Draft Report)

**DoD RESPONSE:** Concur. Key program decisions are and will continue to be informed by detailed technical analysis, including assessments of element technical maturity, and any sensitivity of element performance estimates to the models and simulations used.

**RECOMMENDATION 3:** The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to use the results of these analyses at each key decision point for the BMDS boost and ascent phase elements. (Page 21/GAO Draft Report)

**DoD RESPONSE:** Concur. Key program decisions are and will continue to be informed by detailed technical analysis, including assessments of element technical maturity, and any sensitivity of element performance estimates to the models and simulations used.

**RECOMMENDATION 4:** The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to require the Missile Defense Agency (MDA) to prepare and periodically update a full life cycle cost estimate for each boost/ascent phase element, in accordance with key principles for developing accurate and reliable life cycle cost estimates, that includes all operational costs, including costs to establish and sustain operations at U.S. bases and forward locations, is based on warfighter quantities, includes sensitivity analyses, and reflects time phasing. (Pages 21-22/GAO Draft Report)

**DoD RESPONSE:** Non-concur. As noted in the DoD Report to Congress on Transition of Ballistic Missile Defense Programs to the Military Departments for 2007, DoD guidance directs that BMDS elements be managed in three phases: development; transition, and procurement and operations. The Director, MDA is to manage the BMDS through the development and transition phases, baseline the capability and configuration of each element and capability block, and define interoperability standards. The Military Departments provide forces, as needed, to support fielding of early and or contingency capability. During early fielding and the transition phase, responsibilities are shared by MDA and the Military Departments; specific responsibilities and authorities are documented in the T&TP, agreed to by MDA and the Military Departments, and subsequently programmed for by the applicable Department or Agency. Beyond early fielding and or transition, and after an appropriate milestone decision, the Military Departments will provide resources to procure and support the transitioned elements as programs in their own right and as reflected by the planned force structure. DoD continuously assesses all aspects of its developments and will direct an independent evaluation of life cycle costs for boost and ascent phase elements if circumstances warrant or the Director, MDA declares an element mature enough to provide a militarily useful capability. In making this declaration, the Director, MDA will rely on all data available, including available cost estimates. These estimates will be refined in conjunction with designated lead Military Departments as part of the Transition and Transfer IPT and documented in the T&TP plan.

**RECOMMENDATION 5:** The GAO recommended that the Secretary of Defense direct an independent group, such as the Cost Analysis Improvement Group, to prepare an independent Life Cycle Cost Estimate for each capability at each key decision point. (Pages 21-22/GAO Draft Report)

**DoD RESPONSE:** Partially concur. While some of the key decision points may require independent life cycle cost estimates, others may not. As noted in the DoD Response to Recommendation 4 above, the Director, MDA may declare an element mature enough to provide a militarily useful capability. Based upon this recommendation, DoD will determine if that capability is ready to begin early fielding or proceed to a milestone review. DoD stakeholders will rely on independent life cycle cost estimates to inform these and other key decisions as applicable.

**RECOMMENDATION 6:** The GAO recommended that the Secretary of Defense direct MDA and the Military Services to report independently verified life cycle cost estimates along with budget requests and Future Years Defense Plan (FYDP) funding plans for each boost/ascent phase element. (Pages 21-22/GAO Draft Report)

**DoD RESPONSE:** Non-concur. Operations and support segments of the budget are organized by functional area rather than by weapon system. The functional areas are characterized by personnel, unit-level consumption, various levels of maintenance, sustaining support, and indirect support costs. Although the costs of certain elements (such as personnel) can often be identified explicitly, other elements may be common to more than one weapon system and are dependent on operations and support concepts of the employing Military Department. The cost of these latter elements may be allocated among respective systems and support organizations. Development of total life cycle cost estimates for operationalized BMDS capabilities requires agreement between MDA and lead Military Departments on roles and responsibilities for fielded missile defense capabilities. The T&TP, updated annually or as significant changes warrant, constitutes a “snapshot” of a work-in-progress intended to capture current BMDS capability transition status, roles, responsibilities, and future transition plans for the components and elements of the BMDS. The annual snapshot is taken with the intention of clarifying roles and responsibilities and documenting agreements between the Military Departments and MDA. These agreements cover responsibilities, deliverables, funding, and schedules that transcend the annual BMDS transition plan cycle. The T&TP is submitted early enough in the Programming Planning and Budgeting Cycle so that it can be used by MDA and the Services as a basis for their BMDS budget submittals and to provide needed insights into estimated life cycle costs of BMDS capabilities.

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# Appendix III: GAO Contacts and Staff Acknowledgments

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## GAO Contacts

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