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Report to Congressional Committees

March 2006

DEFENSE ACQUISITIONS

Missile Defense Agency Fields Initial Capability but Falls Short of Original Goals

GAO-06-327

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GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-06-327, a report to congressional committees

Why GAO Did This Study

The Department of Defense (DOD) has spent nearly $90 billion since 1985 to develop a Ballistic Missile Defense System (BMDS). In the next 6 years, the Missile Defense Agency (MDA), the developer, plans to invest about $58 billion more. MDA's overall goal is to produce a system that is capable of defeating enemy missiles launched from any range during any phase of their flight. MDA's approach is to field new capabilities in 2-year blocks. The first—Block 2004—was to provide some protection by December 2005 against attacks out of North Korea and the Middle East.

Congress requires GAO to assess MDA's progress annually. This year's report assesses (1) MDA's progress during fiscal year 2005 and (2) whether capabilities fielded under Block 2004 met goals. To the extent goals were not met, GAO identifies reasons for shortfalls and discusses corrective actions that should be taken.

What GAO Recommends

To better ensure the success of future development efforts, GAO recommends that MDA implement a knowledge-based acquisition strategy for future missile defense efforts, assess whether such a strategy is compatible with a 2-year block strategy, and adopt more transparent criteria for reporting significant departures from plans. DOD did not agree to take any of the actions we recommended.

www.gao.gov/cgi-bin/getrpt?GAO-06-327.

To view the full product, including the scope and methodology, click on the link above.
For more information, contact Paul L. Francis at (202) 512-4841 or francisp@gao.gov.

What GAO Found

MDA made good progress during fiscal year 2005 in the development and fielding of two of the seven elements reviewed. Most of the others encountered problems that slowed progress. Meanwhile, contractors for the seven elements exceeded their fiscal year budget by about $458 million, or about 14 percent, most of which was attributable to cost overruns in developing the Ground-based Midcourse Defense (GMD) element.

Accelerating Block 2004 allowed MDA to successfully field missile defense assets faster than planned. But, MDA delivered fewer quantities than planned and exceeded the cost goal of $6.7 billion by about $1 billion. The increased cost is primarily the added cost of sustaining fielded assets. However, the increase would have been greater if some development and other activities had not been deferred into Block 2006. Also, MDA has been unable to verify actual system performance because of flight test delays.

Block 2004 Goals, as of February 2003, Compared with Fielded Assets, as of December 2005

Activities	Planned	Fielded
Ground-based Midcourse Defense interceptors	20 interceptors	10 interceptors
Aegis missiles	Up to 20 missiles	9 missiles
Aegis destroyer upgrade	15 destroyers	10 destroyers
Aegis cruiser upgrade	3 cruisers	2 cruisers
Command, control, battle management, and communications software	Development and testing of upgrades	Testing of final upgrade incomplete

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

Time pressures caused MDA to stray from a knowledge-based acquisition strategy. Key aspects of product knowledge, such as technology maturity, are proven in a knowledge-based strategy before committing to more development. MDA followed a knowledge-based strategy with elements not being fielded, such as Airborne Laser and Kinetic Energy Interceptor. But it allowed the GMD program to concurrently mature technology, complete design activities, and produce and field assets before end-to-end testing of the system—all at the expense of cost, quantity, and performance goals. For example, the performance of some GMD interceptors is questionable because the program was inattentive to quality assurance. If the block approach continues to feature concurrency as a means of acceleration, MDA's approach may not be affordable for the considerable amount of capability that is yet to be developed and fielded. MDA has unusual flexibility to modify its strategies and goals, make trade-offs, and report on its progress. For example, MDA's Director may determine when cost variations are significant enough to report to Congress.

MDA is taking actions to strengthen quality control. These actions are notable, but they do not address the schedule-induced pressures of fielding or enhancing a capability in a 2-year time frame or the need to fully implement a knowledge-based acquisition approach.

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Abbreviations

ABL	Airborne Laser
ASIC	application-specific integrated circuit
BMDS	Ballistic Missile Defense System
CPR	Contract Performance Report
C2BMC	Command, Control, Battle Management, and Communications
DCMA	Defense Contract Management Agency
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
EKV	exoatmospheric kill vehicle
FBX-T	Forward-Based X-Band Transportable
FM	Flight Mission
FTM	Flight Test Mission
GMD	Ground-Based Midcourse Defense
ICBM	intercontinental ballistic missile
IFT	integrated flight test
KEI	Kinetic Energy Interceptor
MAIP	Mission Assurance Implementation Plan
MAP	Missile Defense System Assurance Provisions
MDA	Missile Defense System
NASA	National Aeronautics and Space Administration
NFIRE	Near Field Infrared Experiment
SAR	Selected Acquisition Report
SBX	Sea-Based X-Band
SDACS	Solid Divert and Attitude Control System
SM-3	Standard Missile-3
SBIRS	Space-Based Infrared System
STSS	Space tracking and Surveillance System
THAAD	Terminal High Altitude Area Defense

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For nearly 50 years, the Department of Defense (DOD) has been spending money to develop a missile defense system capable of protecting the U.S. homeland and U.S. deployed forces from ballistic missile attacks. Since 1985, DOD has spent almost $90 billion for this purpose, and it plans to invest an additional $58 billion, or about 14 percent of its research and development budget, over the next 6 years. The Ballistic Missile Defense System (BMDS) under development includes a diverse collection of land-, air-, sea-, and space-based assets located around the globe and founded on cutting-edge technology. The Missile Defense Agency (MDA)—the component within DOD responsible for managing the development of the various missile defense programs—originally focused on developing a test bed in which the design of the various BMDS assets could be matured and demonstrated. However, in 2002, the President directed MDA to begin fielding an initial BMDS capability in the 2004 and 2005 time frame.

MDA is currently developing eight BMDS elements: Ground-Based Midcourse Defense (GMD); Aegis Ballistic Missile Defense (Aegis BMD); Command, Control, Battle Management, and Communications (C2BMC); Airborne Laser (ABL); Kinetic Energy Interceptors (KEI); Space Tracking and Surveillance System (STSS); Terminal High Altitude Area Defense (THAAD); and BMDS Sensors.[1] MDA has adopted an evolutionary acquisition approach in which the BMDS will be developed and fielded in 2-year blocks. The first block, known as Block 2004, ended on December 31, 2005. The block fielded an initial capability that includes initial versions of GMD; Aegis BMD; Patriot Advanced Capability-3; and the Command, Control, Battle Management, and Communications elements. This capability is designed to provide limited protection of the United States from ballistic missile attacks out of North Korea and the Middle East and protection of U.S. forces and critical assets from short- and medium-range ballistic missiles. Future blocks are expected to enhance

[1]The BMDS also includes a ninth element, Patriot Advanced Capability-3 (PAC-3), which has been transferred to the Army for production, operation, and sustainment. This report does not evaluate PAC-3 because its initial development is complete and it is now being managed by the Army. In addition, the report does not separately evaluate the BMDS Sensors program; but with its assessment of GMD, the report includes an assessment of MDA's progress in developing and fielding the Forward-Based X-Band-Transportable (FBX-T) radar, the sensor being developed by the Sensors Program Office.

this capability. Over time, MDA expects its block approach to produce an overarching BMDS capable of protecting the United States, deployed forces, friends, and allies from ballistic missile attacks of all ranges.

To facilitate oversight of the ballistic missile defense program, the Defense Authorization Acts for fiscal years 2002 and 2005 mandated that we prepare annual assessments of MDA's ongoing progress.[2] To date, we have delivered assessments covering fiscal years 2003 and 2004 to Congress.[3] Because our assessment of MDA's fiscal year 2005 progress was ongoing when Block 2004 ended, we were also able to make observations about the outcome of the block. Specifically, this report

1. assesses the progress MDA made during fiscal year 2005 toward the fiscal year plans of work established by seven of the BMDS elements;

2. compares the fielded Block 2004 capability with the quantity, cost, and performance goals established for that capability;

3. identifies reasons why the fielded capability fell short of goals; and

4. discusses corrective actions being taken by MDA.

To address our objectives, we looked at the accomplishments of seven BMDS elements—GMD, Aegis BMD, C2BMC, ABL, KEI, STSS, and THAAD. These elements collectively account for about 73 percent of MDA's research and development budget. For each element, we examined documents such as System Element Reviews, test plans and reports, production plans, and Contract Performance Reports. We also interviewed officials within each element program office and within MDA functional offices, such as the Office of Safety, Quality, and Mission Assurance. In addition, we discussed each element's test program and the results of tests with DOD's Office of the Director, Operational Test and Evaluation (DOT&E). We performed our work from May 2005 to March 2006 in accordance with generally accepted government auditing standards.

[2]The act for 2002 is the National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107, section 232. The act for 2005 is the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Pub. L. No. 108-375, section 233.

[3]GAO, *Missile Defense: Actions Are Needed to Enhance Testing and Accountability*, GAO-04-409 (Washington, D.C.: Apr. 23, 2004); GAO, *Missile Defense: Status of Ballistic Missile Defense Program in 2004*, GAO-05-243 (Washington, D.C.: Mar. 31, 2005).

Additional details of our scope and methodology can be found in appendix VI.

Results in Brief

MDA made progress in fiscal year 2005 on seven elements of the BMDS program, but it did not complete all of the activities scheduled. By September 30, 2005, MDA planned to develop improved C2BMC software, field eight Aegis BMD missiles, upgrade seven Aegis destroyers and two Aegis cruisers for the missile defense mission, emplace 10 GMD interceptors, and conduct nine flight tests to demonstrate the performance of various components and elements of the BMDS. At the end of September, MDA had completed development, but not testing, of improvements to the C2BMC, delivered all eight Aegis BMD missiles, delivered 4 of 10 GMD interceptors, upgraded six of seven Aegis destroyers and two Aegis cruisers, and successfully completed two of nine flight tests. Two additional tests were completed by the end of calendar year 2005. Some activities that would have furthered the development of elements planned for later blocks, such as the THAAD element, slipped into fiscal year 2006, which could potentially delay the elements scheduled integration into the BMDS. Although MDA did not complete all work scheduled during the fiscal year, most of MDA's prime contractors reported that the accomplished work cost more than expected. Collectively, the contractors overran their fiscal year 2005 budgets by about $458 million, or about 14 percent, with the GMD contractor accounting for most—over $365 million—of the overrun. The GMD contractor alone overran its fiscal year budget by 25 percent.

By December 31, 2005, when Block 2004 officially ended, MDA had delivered an initial missile defense capability—composed of the GMD, Aegis BMD, C2BMC elements—to the field faster than it had originally planned. While it fielded assets, MDA did not meet its quantity, cost, or performance goals. Block 2004 delivered fewer components than planned, cost more than anticipated, and its performance is unverified. Compared to its original goals set in 2003, MDA fielded 10 fewer GMD interceptors than planned, two fewer radars, 11 fewer Aegis BMD missiles, and six fewer Aegis ships. Despite some work being deferred to Block 2006, MDA expected the cumulative cost of developing and fielding the components to be about $7.7 billion, or about $1 billion more than originally expected. The $7.7 billion cost represents the added cost of sustaining fielded assets as well as cost reductions from the deferral of some Block 2004 characterization and verification activities into Block 2006. Although it has successfully tested various functions of the BMDS engagement—such as launch detection, tracking, interceptor launch, and intercept—MDA cannot estimate the performance capability of the Block 2004 assets because it has not successfully completed an end-to-end test of the GMD element using production representative hardware. Doubts about the rigor of quality control procedures have also raised additional questions about the performance of fielded GMD interceptors.

Management compromises made to accelerate fielding prevented MDA from meeting its Block 2004 goals. In 2002, MDA adopted an acquisition strategy that includes many of the knowledge-based practices that enable leading commercial developers to field sophisticated products on time and within budget. Had MDA followed its original plan, the GMD program would have moved through a sequence of eight events that included assessing the maturity of critical technology, designing the element, and demonstrating the stability of the element's design in an end-to-end test using production-representative components—all before making a decision to produce and field the element. At the end of each block, MDA could have determined whether to continue development in the next block; transfer all or part of the capability to a military service for operation, production, and sustainment; or terminate the development effort completely. However, to place a capability in the field quickly, MDA allowed the GMD program to accept significant risk by condensing its acquisition cycle. GMD concurrently matured technology, designed the element, tested the design, and produced and fielded the system, even though the stability of the element's design had not been demonstrated in an end-to-end test and production processes were not mature. Quality control problems occurred when the program was accelerated. According to MDA's own audits, the interceptor's design requirements were unclear and sometimes incomplete, design changes were poorly controlled, and the interceptor's design resulted in uncertain reliability and service life. MDA does have unique flexibility to make changes to its strategy—including revising its goals or making trade-offs among the seven BMDS elements—without necessarily having to seek prior approval from a higher-level DOD acquisition executive, as most other major acquisition programs are required to do. DOD acquisition regulations have been effectively deferred for MDA, and although the Director confers with the warfighter to define the performance of the BMDS, MDA works with flexible performance, cost, and quantity goals that can be changed if they are not achievable with the time or money available. In addition, there are no criteria to identify which variances are significant enough to be reported to Congress or when they should be reported. For example, the Director, by statute, may decide whether a cost variation is significant enough to be reported to Congress.

MDA is taking several actions to address overall quality control weaknesses in the BMDS program. Some are simple, such as having the Director for Safety, Quality, and Mission Assurance report directly to MDA's Director and establishing toll-free telephone numbers to report problems. MDA is also taking actions to make contractors aware of the emphasis being placed on product quality. For example, contract award fees will be based, in part, on the contractor's implementation of good quality control procedures and industry best practices. Contracts are also being modified to implement mission assurance provisions that promote process improvements, which are expected to reduce costs, improve productivity, and enhance safety, quality, and mission assurance. MDA is also placing renewed emphasis on surveillance activities by placing MDA Safety, Quality, and Mission Assurance personnel in major contractors' facilities; giving the Office of Safety, Quality, and Mission Assurance unfettered access to all MDA contractor operations, activities, and documentation; and strengthening the quality assurance role of the Defense Contract Management Agency. In addition, MDA also examined the test strategy of the troubled GMD program and laid out an approach that increases the role of ground testing, progressively increases the complexity and realism of flight tests, and ensures that progress through the test process is based on having requisite knowledge.

While we believe that MDA is taking many of the actions needed to correct problems within the BMDS program, we believe that others are needed. We are making recommendations to the Secretary of Defense to ensure that all of the BMDS elements are put back on a knowledge-based path and to provide a more transparent basis for reporting changes from the plan. DOD partially concurred with our recommendations that MDA direct all of its programs to adapt a knowledge-based acquisition strategy and to assess whether the agency's plan to improve the BMDS in 2-year blocks is compatible with such a strategy. DOD stated that MDA's use of knowledge points remains consistent with DOD acquisition regulations while providing MDA's Director with the flexibility to determine the regulation's applicability to the BMDS block development concept. In its comments, DOD also stated that it believes that MDA's block goals are compatible with a knowledge-based strategy because knowledge points are used to establish block goals and make adjustments to the block when necessary. DOD did not concur with our third recommendation, that MDA adopt more transparent criteria for identifying and reporting significant changes in quantities, cost, or performance, because it believes that current reporting requirements and reviews offer an adequate level of oversight.

Background

A weapon system for ballistic missile defense, even a rudimentary one, requires the coordinated operation of a diverse collection of components. For example, the initial capability emplaced in 2004 employs early-warning satellites for launch detection, ground-based radars in California and Alaska, and sea-based Aegis radars in the Sea of Japan for surveillance and tracking of enemy missiles, interceptors at launch sites in Alaska and California to engage and destroy incoming warheads, and command and control nodes in Alaska and Colorado to orchestrate the mission.

A typical scenario to engage an intercontinental ballistic missile (ICBM) would unfold 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 on the order of 10 kilometers per second (22,000 miles per hour), the warhead is destroyed through a "hit-to-kill" collision with the kill vehicle above the atmosphere.

To develop a system capable of carrying out such an engagement, MDA is executing an evolutionary acquisition strategy in which the development of missile defense capabilities is organized in 2-year increments known as blocks. In 2001, when it adopted the block strategy, MDA planned to construct a test bed in which new sensors, weapon projects, and enhancements to existing capabilities could be matured. When assets were considered mature, MDA planned to integrate them into the BMDS to increase the system's capability to respond to the evolving threat. However, with the President's directive to begin fielding an initial BMDS capability beginning in 2004, MDA switched its emphasis from developing a test bed to developing and fielding an operational capability.

MDA is completing its Block 2004 program of work. The associated military capability of this block is primarily one for defending the United States against ICBM attacks from North Korea and the Middle East, although the block increases the United States' ability to engage short- and medium-range ballistic missiles.[4] Block 2004 is built around the GMD element, augmented by shipboard Aegis BMD radars and missiles, and integrated by the system-level C2BMC element. In addition, MDA attempted to accelerate the fielding of the Forward-Based X-Band-Transportable (FBX-T) radar into Block 2004. This radar, being developed by the Sensors Program Office, was originally intended for operation during Block 2006.

MDA is also carrying out an extensive research and development effort to expand its current operational capability into future blocks. During fiscal year 2005, MDA funded the development of four other major BMDS elements in addition to the four elements that were to be fielded as part of the Block 2004 BMDS. These elements are the ABL, KEI, STSS, and THAAD. MDA expects to field a limited THAAD capability during Block 2008. The other elements, which are primarily in technology development, will likely be fielded in later blocks. Table 1 provides a brief description of all elements being developed by MDA. More information about them is provided in appendix II.

[4]The Patriot Advanced Capability-3 system, which is managed by the Army, also provides a capability against short-range ballistic missiles.

Table 1: BMDS Elements

Element	Missile defense role
Ground-based Midcourse Defense	GMD is a ground-based missile defense system designed to destroy ICBMs 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. GMD is part of the initial capability fielded in 2004-2005 with an inventory of 10 interceptors. MDA plans to field 26 additional interceptors in Alaska and California through 2010.
Aegis Ballistic Missile Defense	Aegis BMD is a ship-based missile defense system designed to destroy short- and medium-range ballistic missiles during the midcourse phase of their flight. Its mission is twofold: to protect deployed U.S. forces, allies, and friends against ballistic missile attacks and to serve as a forward-deployed BMDS sensor, especially in support of the GMD mission. MDA has plans to deliver about 100 Aegis BMD missiles—the Standard Missile 3—and to upgrade 18 ships for the BMD mission by the end of 2011.
Command, Control, Battle Management, and Communications	C2BMC is the integrating and controlling element of the BMDS. During 2004-2005, C2BMC's role is to provide deliberate planning, situational awareness, sensor management and control of the Forward-Based X-Band-Transportable (FBX-T) radar, and network support for fire control and situational awareness.
BMDS Sensors	MDA is developing various stand-alone radars for fielding. In particular, MDA is leveraging the THAAD radar's hardware design and modifying existing software to develop the FBX-T. MDA expects to emplace the first FBX-T in Japan to augment existing BMD surveillance and tracking capabilities.
Airborne Laser	ABL is an air-based missile defense system designed to destroy all classes of ballistic missiles during their boost phase of flight. ABL employs a high-energy chemical laser to rupture a missile's motor casing, causing the missile to lose thrust or flight control. MDA plans to demonstrate proof of concept in a system demonstration no earlier than 2008. The fielding of a militarily useful ABL capability is not planned through 2011.
Kinetic Energy Interceptors	KEI is a land-based missile defense system designed to destroy medium, intermediate, and intercontinental ballistic missiles during the boost phase and all parts of the midcourse phase of their flight. The agency expects to demonstrate defensive capability through flight testing during 2012-2015. This capability could be expanded to sea-basing in subsequent blocks.
Space Tracking and Surveillance System	The Block 2006 STSS consists of a constellation of two demonstration satellites. MDA intends to use these satellites for testing missile warning and tracking capabilities in the 2007-2009 time frame. If the demonstration satellites perform successfully, MDA plans an operational capability of next-generation satellites that will be available in the next decade.
Terminal High Altitude Area Defense	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 population centers. MDA plans to field a fire unit, including 24 missiles, in 2009 and a second unit in 2010.

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

Note: The Patriot Advanced Capability-3 system is also part of the BMDS, but it is not included in the table because management responsibility for this element has been transferred to the Army.

Since 2002, missile defense has been seen as a national priority and has been funded nearly at requested levels. However, DOD's Program Budget Decision of December 2004 called for MDA to plan for a $5 billion reduction in funding over fiscal years 2006-2011. In addition, MDA will continue to compete with hundreds of existing and planned technology development and acquisition programs for research, development, and evaluation funding. Cost growth of existing weapon programs is also likely to affect MDA's share of future DOD budgets.

MDA Made Progress during Fiscal Year 2005, but Some Activities Were Not Completed as Planned

MDA made progress during fiscal year 2005 in carrying out the fiscal year plans of work established by the seven BMDS elements, but it was not able to field all planned components or conduct all scheduled tests. Also, some activities that would have furthered the development of elements planned for later blocks slipped into fiscal year 2006, possibly delaying the elements' scheduled integration into the BMDS. In addition, although MDA did not complete all work scheduled during the fiscal year, most of MDA's prime contractors reported that the work accomplished cost more than expected.

During fiscal year 2005, MDA intended to improve the C2BMC, field eight Standard Missile-3 (SM-3) missiles, make seven Aegis destroyers capable of performing long-range surveillance and tracking, upgrade two Aegis cruisers with a missile defense contingency engagement capability, upgrade two radars (Beale and Fylingdales early warning radars), and deliver and emplace 10 GMD interceptors. In addition, MDA planned a number of flight tests—six GMD flight tests, four of which Aegis BMD would participate in to detect and track ICBM targets, and three Aegis BMD intercept tests.

Good Progress Made in the C2BMC and Aegis Elements

The C2BMC program completed most activities required to provide situational awareness of the missile defense battle. The C2BMC element, whose development is in its early stages, is initially expected to monitor the operational status of each BMDS component and display threat information, such as missile trajectories and impact points. In 2005, the program installed C2BMC suites (communications software and hardware) at U.S. Strategic Command, U. S. Northern Command, and U.S. Pacific Command. The additions at U.S. Strategic Command and U.S. Northern Command provide redundant capability and more flexibility to test, exercise, and maintain the C2BMC. MDA also planned to install a Web browser in the United Kingdom, to provide situational awareness for the British government. However, the Web browser will not be operational until 2006 because DOD did not complete final policy agreements as scheduled.

Development of two C2BMC software upgrades was also completed during the fiscal year. The first upgrade gave C2BMC the ability to display GMD assets on the user's computer monitors, improved the user's ability to call up BMDS information, reduced the time to transfer force-level planning files, and installed the software and hardware necessary to provide an operational capability at U.S. Pacific Command. The final decision to make the U.S. Pacific Command suite operational has not yet been made, but a decision is expected in March 2006. Completion of the second upgrade was a little behind schedule, but it was completed by the first quarter of calendar year 2006. Development of the upgrade, known as Spiral 4.5, was completed by the end of September 2005, but all testing is not expected to be completed until the end of March 2006. Spiral 4.5 gives C2BMC the capability to receive, distribute, and display information developed by three new sensors—the FBX-T and Sea-Based X-Band (SBX) radars and the Fylingdales upgraded early warning radar. It also improves the consistency between the data displayed by the C2BMC and the GMD fire control monitors, both of which receive information directly from various sensors.

The Aegis BMD program made good progress in developing and delivering missiles and upgrading Aegis ships for the missile defense mission. To increase the United States' capability to defend against short- and medium-range ballistic missiles, the program produced and delivered eight Standard Missile-3s—the "bullet" for the Aegis BMD element. These missiles will be launched from Aegis cruisers, two of which were upgraded in fiscal year 2005 to enable them to perform their engagement and long-range surveillance and tracking missions. Six destroyers, whose ballistic missile defense mission is to provide long-range surveillance and tracking of ICBMs for the GMD element, were also upgraded in fiscal year 2005. The program was unable to upgrade a seventh destroyer during the fiscal year as scheduled—although assets required to proceed with the upgrade were in place—because the Navy had scheduled the ship for other activities. However, the destroyer was upgraded before the end of Block 2004.

GMD Program Makes Less Progress

Although the GMD program made progress during fiscal year 2005, it did not meet all expectations. The GMD program had planned to field 10 additional interceptors during the fiscal year, but actually fielded 4. Two additional GMD interceptors were delivered and fielded at Fort

Greely, Alaska, and the first 2 interceptors were emplaced at Vandenberg Air Force Base, California. The 2 interceptors installed at Vandenberg provide a redundant launch site and a better intercept trajectory against some ICBM threats. MDA also upgraded two early warning radars—one at Beale Air Force Base, California, and another at Fylingdales in the United Kingdom. In some scenarios, each of these radars will act as the primary fire control radar for the GMD element.

Interceptor production slowed as the year progressed primarily because technical problems were discovered, mostly in the interceptor's exoatmospheric kill vehicle (EKV). MDA officials explained that these problems were traced back to poor oversight of subcontractors, too few qualification tests, and other quality assurance issues. By the end of the fiscal year, the program had reduced its fiscal year plan for fielding interceptors from 10 to 6 so that additional interceptors could be made available for ground tests, but the contractor was only able to emplace the 2 interceptors at Fort Greely and the 2 at Vandenburg Air Force Base.

Two of Nine Flight Tests Successfully Completed

The GMD and Aegis BMD programs also planned to conduct a number of flight tests during the fiscal year. The GMD program planned three nonintercept and three intercept flight tests. However, the program was able to successfully complete only one of the nonintercept flight tests and none of the intercept tests. The successful nonintercept test demonstrated that the upgraded Cobra Dane radar could detect and track a target of opportunity. However, a second nonintercept flight test that would have examined upgrades to the Beale upgraded early warning radar was delayed, when GMD's test plan was restructured to make it less concurrent. Also, the other nonintercept test (integrated flight test [IFT]-13C) that was to demonstrate operational aspects of the fielded configuration of GMD's interceptor could not be completed because the interceptor failed to launch. Of the three planned intercept tests, the program conducted one (IFT-14). However, this test was also aborted when the interceptor failed to launch.[5] MDA planned two other intercept tests, but the tests did not take place because MDA restructured GMD's test plan after the interceptor failures to implement a less risky test strategy. The first test in the restructured plan—which was a nonintercept

[5]The launch failure was traced back to a quality assurance problem, which is discussed in more detail later in this report and in appendix IV.

test to assess the interceptor's operation in space—was successfully completed in December 2005.

The Aegis BMD Program Office planned to participate in four of the GMD tests during fiscal year 2005. Aegis BMD did not participate in any of these tests because weather conditions prevented the ship from participating in one test, the ship was unavailable during another, and GMD's test plan was restructured, causing two tests to be canceled.

In addition to participating in GMD tests, the Aegis BMD program planned three intercept tests during fiscal year 2005. However, only one test was conducted. The program delayed the two other tests because of budgetary constraints and technical problems. MDA completed one of the delayed tests in the first quarter of fiscal year 2006 and canceled the second delayed test because most of its objectives had been accomplished in the completed test. In the fiscal year 2006 test, an SM-3 missile successfully engaged a separating target, that is, a target whose warhead separates from its booster. In defeating this target, the program demonstrated that the Aegis BMD element has a capability against a more advanced threat than the nonseparating targets included in earlier tests.

Developmental Elements Progress but Experience Some Setbacks

MDA made progress in developing the four elements that are expected to enhance the BMDS during future blocks—THAAD, ABL, STSS, and KEI—but some planned activities fell behind schedule. The THAAD Program Office completed numerous ground and component qualification tests that led to a successful first flight test in the first quarter of fiscal year 2006. The program also worked to solve technical problems that could have affected the success of the first flight tests. The ABL program completed the first major milestones of its restructured program—First Flight and First Light, completed scheduled activities associated with a series of Beam Control/Fire Control low-power passive flight tests, and began integrating the full Beam Control/Fire Control with other laser systems aboard the aircraft.[6] The STSS program tested and integrated spacecraft components for the demonstration satellites that the program expects to launch and began testing the first satellite's payload. The KEI program completed the construction of a shelter to house prototype fire control and communications equipment and conducted several demonstrations during which the prototype equipment collected data from overhead nonimaging infrared satellites in a timeline that, according to program officials, proves a boost phase intercept is possible. In addition, the program completed studies of communications equipment—which uplinks information from KEI's fire control and communications component to its interceptor—that allowed the program to optimize the equipment's design to operate in a nuclear environment or against jamming threats.

However, all four programs experienced some setbacks. The THAAD program delayed the start of flight tests until the first quarter of fiscal year 2006. The ABL Program Office did not complete laboratory testing of the element's high-energy laser in September 2005, as planned, and the STSS Program Office rescheduled tests of the first satellite's payload until the second quarter of fiscal year 2006. The fourth element, KEI, also delayed some activities related to its Near Field Infrared Experiment (NFIRE), which is being conducted to gather data on the risk in identifying the body of a missile from the plume of hot exhaust gases that can obscure the body while the missile is boosting.

The THAAD Program Office expected to begin flight tests in June 2005. However, the first test was delayed until November 2005 because of unexpected integration problems. For example, one delay was caused by a tear in a filter in the missile's divert attitude control system. Program officials expect to recover the test schedule and conduct 14 flight tests before turning the first THAAD fire unit over to the Army in 2009 for operational use and testing. However, the test schedule is aggressive,

[6]First Flight was the first of a series of planned flight tests with the Beam Control/Fire Control segment that demonstrated the completion of all necessary design, safety, and verification activities to ensure flight worthiness. It also began the process of expanding the flight envelope—types and combinations of flight conditions—in which ABL can operate. First Light refers to the first ground test and demonstration of the integration of six individual laser modules that produced a single beam of laser energy. Passive flight tests are conducted without the use of the Beacon Illuminator Laser (BILL) or the Tracking Illuminator Laser (TILL). The BILL and TILL are part of the laser beam control system used to mitigate the effects of the atmosphere on beam quality and to focus the laser beam on the target. In contrast, active flight tests include the use of the illuminator lasers.

requiring as many as 5 tests in some years. To complete all tests as planned, the officials told us that there can be no test failures.

The Airborne Laser Program Office planned to complete tests of the element's high-energy laser by September 30, 2005. The laser is a component of the ABL prototype that will be used to demonstrate the element's lethality as early as the 2008 time frame. Prior to installing the laser on the prototype aircraft, the program tested the laser in its System Integration Laboratory at Edwards Air Force Base. Program officials expected the tests, which began in November 2004, to be completed by the end of fiscal year 2005. During this time frame, officials wanted to demonstrate that the laser could generate 100 percent of its design power and that it could repeatedly operate at that power for periods of about 10 seconds. As of October 2005, the laser had produced 83 percent of the power it is designed to generate and was able to operate for periods of about 5 ¼ seconds. After solving technical problems with the laser's abort system and completing the planned installation of an ammonia cooling system, the program was able, in December 2005, to extend the laser's operating time to more than 10 seconds. Although the laser has not reached 100 percent of its design power, officials told us that the 83 percent obtained thus far is sufficient to achieve 95 percent of maximum lethal range against all classes of ballistic missiles. The ABL Program Manager originally told us that he expected the laser to remain in the system integration laboratory until it produced 100 percent of its design power. Nonetheless, on December 9, 2005, MDA's Director gave the ABL program permission to disassemble the System Integration Laboratory and install the laser on the aircraft. Program officials told us that they would continue to test the laser, when the aircraft is on the ground, in an attempt to demonstrate that the laser can produce 100 percent of its design power.

During fiscal year 2005, the STSS program intended to integrate and test the spacecraft for two demonstration satellites and integrate and test the sensor payload, which includes surveillance and tracking sensors, for the first of the two satellites. The program is constructing the demonstration satellites from hardware developed by the Space-Based Infrared System-Low program before it was canceled in 1999 and plans to launch the satellites in fiscal year 2007, after all hardware has been integrated and tested. The program did not complete the payload integration and test activities in fiscal year 2005, as planned, because thermal vacuum testing is taking longer than expected.[7] Hardware issues have emerged as the payload is being tested in a vacuum and at cold temperatures for the first time. For example, in a vacuum, the sensors' optics did not cool to the desired temperature and the power supply to the acquisition sensor's signal processor failed. The program office believes that repairs will correct the problems, but program officials are in the process of deciding whether further tests must be completed after the repairs are made and before the sensor payload is placed aboard the satellite.

As part of its fiscal year 2005 activities, the KEI program intended to complete a number of tasks that would have enabled it to conduct the NFIRE experiment. The experiment places sensors aboard a satellite that will be launched into space, where the sensors will observe and collect infrared imagery of boosting intercontinental ballistic missiles. In fiscal year 2005, the KEI program expected to calibrate and deliver the sensor payload, complete the space vehicle integration and acceptance test, procure targets, and certify mission operation readiness. However, anomalies in the sensor payload delayed the delivery of the payload, in turn delaying the remaining activities. The day-to-day management of all NFIRE activities has since been transferred to the STSS program, which has extensive experience with the development of satellites. STSS officials told us that they do not expect the fiscal year 2005 delays to affect the experiment's launch date.

Completed Work Cost More than Expected

Although MDA was unable to complete all activities during fiscal year 2005 as planned, the completed work cost more than expected. Collectively, prime contractors for the various elements overran their budgets by about $458 million, or about 14 percent, with GMD accounting for approximately 80 percent of the collective overrun. Although the GMD contractor experienced the largest overrun, exceeding its fiscal year 2005 budget by approximately 25 percent, it is notable that the ABL contractor overran its fiscal year budget. The ABL contract had been restructured in 2004 to provide a more realistic cost estimate for the work planned. It is also noteworthy that continuing cost growth in the development of the THAAD missile caused the contractor to overrun its fiscal year budget for the first time since the contract was awarded.

[7] A thermal vacuum test verifies that the temperature control design will maintain the spacecraft and all its elements within allowable flight temperature ranges while operating over the environmental extremes expected for the mission.

Table 2 contains our analysis of the contractor's cost and schedule performance in fiscal year 2005 and the potential overrun or underrun of each contract at completion. All estimates of the contracts' costs at completion are based on the contractors' performance through fiscal year 2005. Collectively, the six contracts, for which data were available to estimate a cost at completion, could overrun their budgets by about $1.3 billion to $2.1 billion. It should be noted that the cost variance at completion projected for most of the contracts is based on more than one block of work. For example, the STSS contract covers the contractor's work on Block 2006 and Block 2010. Appendix III provides further details regarding the performance of the prime contractors for the seven elements shown in the table.

Table 2: Prime Contractor Fiscal Year 2005 and Cumulative Cost and Schedule Performance

BMDS Element	FY 05 cost variance	FY 05 schedule variance	Cumulative cost variance	Cumulative schedule variance	Percentage of contract completed	Estimated contract underrun/overrun
ABL	($29.6)	($22.0)	($23.1)	($23.6)	69%	Overrun: $43.8 to $231.7
GMD	($365.1)	($38.9)	($713.1)	($227.9)	75%	Overrun: $1,042 to $1,360
Aegis BMD (Weapon System)	$2.6	$2.0	$6.1	0	67%	Underrun: $7.1 to $12.5
Aegis BMD(SM-3)[a]	$10.9	($9.6)	$10.9	($9.6)	74%	Underrun: $11.5 to $17.8
THAAD	($19.0)	($4.6)	($15.0)	$10.1	72%	Overrun: $16.9 to $48.2
C2BMC	$1.0	$6.4	$1.7	($0.9)	87%	Underrun: $1.8 to $2.4
KEI	$3.0	($3.9)	$3.0	($5.9)	4%	[b]
STSS	($61.5)	$6.8	($96.9)	($20.3)	65%	Overrun: $248.3 to $479.4[c]

Source: Contractors (data); GAO (analysis).

Note: Negative variances are shown with parentheses around the dollar amounts.

[a]Contract performance reporting data for the Aegis BMD SM-3 element were not available prior to fiscal year 2005. Therefore, cumulative and fiscal year 2005 values are the same.

[b]We could not estimate the likely outcome of the KEI contract at completion because a trend cannot be predicted with only 4 percent of the contract complete.

[c]The overrun projected for STSS is based on the contractor's performance through fiscal year 2005 in carrying out both Block 2006 and Block 2010 work. The STSS Program Office noted that considering the contractor's performance on Block 2006 alone, a contract overrun of $80 million to $120 million is anticipated. In addition, program officials told us that the prime contractor's Block 2006 performance has been affected by the poor performance of a subcontractor whose work effort will be completed in fiscal year 2006. All remaining work will be performed by the prime contractor, whose performance has been significantly better.

About $240 million of the GMD overrun can be traced to the interceptor, with the EKV accounting for more than 42 percent, or $102 million, of that amount. The EKV's cost growth was caused by poor quality control procedures and technical problems during development, testing, and production. The interceptor's cost also grew when the contractor had to bring a new supplier online to produce the motors for the BV+ booster, one of the two boosters being developed to carry the EKV into space. A new supplier was needed because explosions at the old supplier's plant prevented it from delivering the motors.

As of September 30, 2005, the SBX radar, which is also being developed by the GMD program, had also overrun its fiscal year budget by about $55 million. The cost of developing this component increased when numerous unplanned changes were made to the platform that holds the radar, subcontractor costs could not be negotiated at the expected price, and additional efforts were required to ensure a functional radome.[8]

The ABL prime contractor also experienced cost growth during fiscal year 2005, even though the ABL contract had been restructured in 2004. This action provided a more realistic budget and schedule for remaining contract activities leading up to a 2008 ABL lethality demonstration. With the restructure, the contractor was no longer required to report past cost and schedule growth. However, in fiscal year 2005, the contractor once again reported that ABL's cost was growing and that some work had been delayed. Cost grew and schedules slipped as the contractor made software changes to address problems identified during tests of the Beam Control/Fire Control, modified the laser's abort system so that it would not shut down the operation of the laser prematurely, and reprioritized activities throughout the program. Other costs were attributable to problems with ABL's Active Ranger System and Beacon Illuminator Laser.[9] For example, the contractor's cost grew when it redesigned and replaced contaminated, damaged, and inefficient optics in the commercial off-the-shelf Active Ranger System. In addition, the contractor incurred additional cost because numerous faults in the power supply for the Beacon Illuminator Laser forced changes in circuit cards and circuit boards.

[8]The radome is a domelike shell transparent to radio-frequency radiation that is used to house a radar antenna.

[9]ABL's Active Ranger System is designed to estimate an enemy missile's launch and impact point. The Beacon Illuminator Laser measures atmospheric disturbance so that the high-energy beam can be shaped, preventing the atmosphere from scattering and weakening the beam's energy.

For the first time since the THAAD contract was awarded, in 2000, the cost of the work being performed in a given fiscal year was greater than the funds budgeted for that work. The THAAD Program Office attributed the contractor's overrun to unanticipated missile integration problems. For example, the Flight Termination Assembly, which is responsible for terminating a THAAD missile in flight, failed qualification tests that in turn delayed qualification of the next larger assembly. In another instance, work was delayed while engineers determined why telemetry equipment, which is placed aboard a test missile to report the missile's condition in flight, sent corrupted data to the test station. Program officials told us that the program solved all known problems that could have prevented a successful first flight test. However, the officials said that the missile still has telemetry problems that prevent the test station from collecting all of the data that will be generated in the third flight test. Program officials expect to find solutions for these problems prior to the third test.

Block 2004 Delivers Assets Faster, but with Unverified Performance

MDA succeeded in fielding an initial missile defense capability by the end of fiscal year 2004 and in improving that capability by December 31, 2005, when Block 2004 ended. However, the block included fewer components than planned, cost more than anticipated, and its performance is unverified. In February 2003, MDA forwarded to Congress the goals that it had established for the initial BMDS capability that it planned to develop and field during Block 2004. The goals included the quantity of components that would compose the block, the cost of developing and producing those components, and the performance that the initial BMDS capability was to deliver. However, over the course of the block, MDA progressively reduced the number of components that it expected to field and increased its cost goal, primarily to recognize the cost of sustaining fielded assets. Even with changes, MDA was unable to meet its quantity goals, and MDA is reporting that the cost of Block 2004 will be greater than expected because of additional sustainment costs. However, the Block 2004 cost being reported by MDA does not include the cost of some activities that must still be completed. MDA did not change its performance expectations for the block.

Significantly Fewer Block 2004 Assets Fielded than Planned

Between 2003 and mid-2005, MDA progressively decreased the number of components it planned to field as part of the Block 2004 capability. However, even with the reductions, MDA was unable to deliver all components planned. Table 3 illustrates the evolution of MDA's quantity goals and compares those goals with the number of assets fielded.

Table 3: Evolution of Block 2004 Quantity Goals versus Fielded Assets

BMDS Element	Goal as of Feb. 2003	Goal as of Feb. 2004	Goal as of Feb. 2005	Goal as of mid-2005	Assets available for operational use as of Dec. 31, 2005
GMD Interceptors	• Up to 20	• 20	• 18	• 14	• 10
Radars	• Cobra Dane • 2 Upgraded early warning radar (UEWR)[a] • Sea-Based X-Band Radar	• Cobra Dane • 2 UEWR	• Cobra Dane • 2 UEWR • Sea-Based X-Band Radar • Forward- Based X-Band-Transportable Radar[b]	• Cobra Dane • 2 UEWR • Sea-Based X-Band Radar • Forward-Based X-Band-Transportable Radar[b]	• Cobra Dane • 1 UEWR
Aegis BMD SM-3 Missiles	• Up to 20	• 9	• 8	• 8	• 9[c]
Aegis BMD ships	• 15 destroyers[d] • 3 cruisers	• 10 destroyers • 3 cruisers	• 10 destroyers • 2 cruisers	• 10 destroyers • 2 cruisers	• 10 destroyers • 2 cruisers

Sources: MDA (data); GAO (analysis).

[a]Upgraded early warning radars are located at Beale Air Force Base, California, and Fylingdales Air Base, United Kingdom.

[b]The FBX-T was originally planned as a Block 2006 asset, but MDA accelerated it to make it available in 2005.

[c]The Aegis BMD program planned to field eight SM-3 missiles even though more than eight missiles were to be produced. The program was able to field nine SM-3 missiles because one that was planned for testing was diverted to operational use when it was no longer needed for test purposes.

[d]The Aegis BMD Program Office told us that the goal of upgrading 15 destroyers was based on a capability-defined block, that is, a block that ended when the final ship was upgraded.

By mid-2005, MDA had reduced its February 2003 goal for operational GMD interceptors from 20 to 14. The first reduction occurred when MDA recognized that an explosion at a subcontractor's facility would reduce the number of boosters available for interceptors slated for fielding.[10] Although MDA was developing an alternate source for boosters, the second developer could not produce all of the boosters needed to field 20 interceptors. Therefore, MDA decided two interceptors would be

[10]The interceptor is composed of a booster that carries an EKV into space. MDA was developing two sources for boosters. One booster, known as the BV+, was being produced by Lockheed Martin, and the other by the Orbital Sciences Corporation (OSC). An explosion at the facility of a Lockheed Martin subcontractor responsible for producing motors for the BV+ booster stopped the booster's production until an alternate source for the motors could be found. The first BV+ booster is expected to be produced in calendar year 2006.

diverted for testing. One was used in ground testing, and the second, which will not be built until calendar year 2006, will be used in a flight test. In mid-2005, after two unsuccessful flight tests, the GMD Program Office reduced its goal for operational interceptors further—from 18 to 14—to set aside more interceptors for ground tests. The test missiles will be assembled in a later block.

Even with the reductions, MDA failed to meet its quantity goals. By the end of Block 2004, MDA had delivered 10 GMD interceptors. Production slowed as the program addressed technical issues and quality control problems discovered during testing and in quality control audits. Further, GMD program officials also told us that the SBX radar will not be operational until 2006 because funds that were to be used to integrate the radar into the BMDS were used to cover some of the cost of the restructured test program.

MDA was also unable to place the FBX-T radar and the Fylingdales upgraded early warning radar in operation before the end of the block. While MDA did not formally add the FBX-T to its Block 2004 Statement of Goals, agency officials told congressional committees that they were developing this radar and expected to have it fully operational by the end of the block. MDA was able to accelerate this capability by 1 full year and to ready the radar for deployment within Block 2004. However, negotiations with Japan, the host nation for the radar, were not completed by December 2005, and site preparation, which will commence once negotiations are complete, is expected to take 8 to 9 months. Full functionality of the Fylingdales upgraded early warning radar was also delayed. MDA used the funds that were needed to make the radar fully functional to cover part of the cost of the restructured GMD test program.

Over time, MDA also altered the number of SM-3 missiles that it planned to procure. MDA's goal of producing up to 20 missiles was never reached because of fiscal constraints and missile parts availability. MDA set aside funding for 11 SM-3 missiles, 9 of which were to be made available for operational use. Program officials told us that had MDA funded more than 11 missiles it would have been necessary to restart some component production lines, which had been closed. Reopening these lines would have caused the additional components to be expensive. Also, the production lines could not have produced the components in a time frame that would have allowed the Aegis BMD program to meet the President's directed fielding date. In December 2004, MDA further reduced its operational goal for SM-3 missiles from 9 to 8 in response to a DOD reduction in MDA's fiscal year 2005 budget request. However, by the end of 2005, MDA was able to make 9 missiles available for operational use because 1 missile that the Aegis BMD program expected to use for testing was not needed for that purpose.

MDA's February 2003 Statement of Goals also included the planned upgrade of 15 destroyers and three cruisers for the missile defense mission. However, the Aegis BMD Program Office told us that the established goals were based on a capability-defined block, that is, a block that ended when the final ship was upgraded. In February 2004, MDA corrected Aegis BMD goals to take into account the agency's definition of a block as a 2-year time period. In making this correction, MDA reduced the number of destroyers to be delivered during Block 2004 from 15 to 10. By February 2005, budgetary constraints also caused MDA to reduce its planned Block 2004 upgrade of cruisers from three to two.

Block 2004 Cost Is Understated

MDA is reporting that the cost of Block 2004 will exceed the cost goals established in 2003 and 2004, but the reported cost does not include the cost of Block 2004 activities that have been deferred until Block 2006. In February 2003, when it sent its Statement of Goals for Block 2004 to Congress, MDA estimated that in addition to the funds received in 2002, the agency would need $5.5 billion more, or a total of about $6.7 billion, to field this capability. Table 4 shows how MDA estimated those funds would be used. A year later, in 2004, the goal had increased to approximately $7 billion. However, the expected cost of the capability is now about $7.7 billion, or around $600 million more than the revised goal and $1 billion, or about 15 percent, more than the original Block 2004 goal. MDA primarily attributes Block 2004's increased cost to the sustainment of fielded assets, which officials told us they could not fully estimate until they prepared their fiscal year 2006 budget request. However, the $7.7 billion cost does not include some work planned for Block 2004, which the contractor could not complete before December 31, 2005. According to GMD officials, this work has been deferred until Block 2006 and its cost will be recognized as part of that block's cost.

Table 4: Composition of the Block 2004 Fielded Configuration Cost Goal, February 2003

Dollars in millions

Program element	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
C2BMC	$21	$80	$114	$79	0	**$294**
Hercules Block 2004 Joint Warfighter Support	0	0	$18	$27	0	**$45**
Test and Evaluation Block 2004	$47	$57	$37	$33	0	**$174**
Targets and Countermeasures	$75	$104	$197	$170	0	**$546**
GMD Test Bed Block 2004	$636	$452	$1,205	$868	0	**$3,161**
Aegis BMD Test Bed Block 2004	$413	$440	$648	$894	$98	**$2,493**
Total	**$1,192**	**$1,133**	**$2,219**	**$2,071**	**$98**	**$6,713**[a]

Source: MDA budget submission, February 2003.

[a]The total cost goal for Block 2004 includes MDA's actual costs for fiscal year 2002 and its cost goals for 2003 through the first quarter of fiscal year 2006, which corresponds to the end of Block 2004.

The Aegis BMD element was the only element of the BMDS program that estimated it would need funds during the first quarter of 2006 to complete Block 2004 fielding. GMD and C2BMC predicted that all work related to fielding the Block 2004 capability would be completed by September 30, 2005, when MDA expected to place a limited defensive operational capability on alert.

In February 2004, MDA revised its estimated cost for fielding a Block 2004 capability to a little over $7 billion, or about $332 million more than originally projected. Table 5 presents the changes in the composition of the goal.

Table 5: Composition of the Block 2004 Fielded Configuration Cost Goal, February 2004

Program element	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
C2BMC	$21	$71	$117	$154	0	**$363**
Hercules Block 2004 Joint Warfighter Support	0	0	$18	0	0	**$18**
Test and Evaluation Block 2004	$47	$46	$37	$39	0	**$169**
Targets and Countermeasures	$75	$95	$224	$233	0	**$627**
GMD Test Bed Block 2004	$636	$397	$1343	$861	0	**$3,237**
Aegis BMD Test Bed Block 2004	$413	$433	$641	$966	$178	**$2,631**
Total	**$1,192**	**$1,042**	**$2,380**	**$2,253**	**$178**	**$7,045**

Source: MDA Budget estimate submission, February 2004.

The cost of fielding the Block 2004 capability will be about $939 million more than the originally estimated cost of $6.7 billion and approximately $607 million more than the revised cost goal of $7 billion. Officials primarily attribute the increased cost to MDA's sustainment of fielded assets. However, the Block 2004 cost that MDA is reporting does not include work that the contractor was unable to complete within the block's time frame. Program officials told us that in fiscal year 2006 the contractor will conduct additional Block 2004 development and deployment efforts. This will be followed in fiscal year 2007 with work needed to characterize and verify the Block 2004 fielded elements. The officials said that Block 2006 funds will be used to pay for these activities.

Table 6 shows the actual cost incurred between October 1, 2002, and December 31, 2005, for the Block 2004 fielded capability and the sustainment cost expected to be incurred in fiscal years 2006 and 2007. It should be noted that this is not the full cost of the initial capability because DOD began to spend funds to develop the current missile defense capability in 1995, and as noted above, additional Block 2004 work will be completed and funded during Block 2006. [11]

[11]Although DOD began developing a missile defense capability as early as 1958, it was not until 1995 that it began development of the predecessors of the current BMDS elements. DOD launched development of the Theater Missile Defense system, the predecessor of Aegis BMD, in 1995; National Missile Defense System, GMD's predecessor, in 1996; and C2BMC in 2002. However, it should be noted that initial versions of C2BMC build on existing Air Force and GMD fire control software.

Table 6: Expected Cost of Block 2004 Fielded Capability, Including Initial Sustainment

Dollars in millions

Program element	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
C2BMC	$ 21	$ 80	$ 92	$ 154	$ 23	$ 16	**$ 386**
Hercules Block 2004 Joint Warfighter Support	0	0	$ 5	0	0	0	**$ 5**
Test and Evaluation Block 2004	$ 47	$ 57	$ 41	$ 143	0	0	**$ 288**
Targets and Countermeasures	$ 75	$ 104	$ 183	$ 176	0	0	**$ 538**
GMD	$ 636	$ 369	$1,357	$ 955	$279	$375	**$3,971**
Aegis BMD	$ 413	$ 386	$ 606	$ 943	$101	$15	**$2,464**
Total	**$1,192**	**$ 996**	**$2,284**	**$2,371**	**$404**	**$406**	**$7,652**

Source: MDA.

Note: According to MDA officials, all cost incurred in fiscal years 2006 and 2007 are for the sustainment of fielded assets.

BMDS Performance Is Unverified

Because test data are not available to anchor simulations that MDA uses to predict BMDS performance, the capability of Block 2004 cannot be verified. MDA has conducted a variety of tests that suggest Block 2004 offers some protection against ballistic missile attacks. However, MDA cannot be sure how well the BMDS will perform against ICBMs because tests needed to characterize the system's performance have not yet been conducted. Test officials have also suggested that to fully characterize the BMDS's ability to defeat short- and medium-range ballistic missile threats, more tests of Aegis BMD are needed. Additionally, the performance of emplaced GMD interceptors is uncertain because inadequate mission assurance/quality control procedures may have allowed less reliable or inappropriate parts to be incorporated into the manufacturing process.

In February 2003, MDA set performance goals[12] for Block 2004 that included a numerical goal for the probability of a successful BMDS engagement, a defined area from which the BMDS would prevent an enemy from launching a ballistic missile, and a defined area that the BMDS

[12] Unlike traditional DOD programs, MDA is not developing the BMDS to meet firm requirements established by the warfighter. Instead, MDA is using a capabilities-based approach that establishes goals or objectives that address a threat identified by the range of parameters within which a threat ballistic missile is likely to operate and that consider the capability that the U.S. defense industry can realistically build to address this threat.

would protect from ballistic missile attacks.[13] MDA did not alter Block 2004 performance goals, despite its actions on quantity and cost goals.

A combination of tests and simulations is necessary to demonstrate whether the Block 2004 capability can meet its performance goals. Because it does not always conduct a sufficient number of tests to compute statistical probabilities of performance, MDA uses models and simulations to measure the probability that the BMDS will perform as designed. By employing digital simulations, estimates of system effectiveness are obtained over a wide range of conditions, scenarios, and system architectures. However, to ensure that models underlying these simulations are reflective of real-world operation, the models must be anchored by data collected during both ground and flight tests.

MDA has completed simulations, ground tests, and flight tests that demonstrate various functions of the BMDS engagement, such as launch detection, tracking, interceptor launch, and intercept. However, it has not successfully completed an end-to-end flight test of the GMD element—the centerpiece of the BMDS—using production-representative components. In the absence of these data, MDA's assessment of GMD's Block 2004 performance is based on data derived from a number of sources, including design specifications, output from high-fidelity simulations, and integrated ground tests of various components. Officials in DOD's Office of Operational Test and Evaluation told us that MDA's computer-based assessments are appropriate for a developmental program but could present difficulties in interpreting results for operational considerations.

During fiscal year 2005, MDA planned four integrated flight tests to demonstrate the ability of the Block 2004 BMDS against ICBMs. Together these tests were to assess the ability of different radars to detect and track targets for the GMD element, the ability of GMD's fire control system to formulate a firing solution from each radar's data, and the interceptor's ability to hit and kill the target. Two of these tests were initiated. However, both tests were aborted because, in each, the GMD interceptor failed to launch. MDA postponed and has not rescheduled the third and fourth tests because, after the test failures, MDA decided to restructure its test program to make it less concurrent.

[13]The specifics of the performance goals are classified.

MDA's cancelation of the third flight test was particularly problematic because it prevented MDA from exercising Aegis BMD's long-range surveillance and tracking capability in a manner consistent with an actual defensive mission. The Aegis BMD Program Office told us that Aegis BMD can adequately perform detection and tracking for the GMD element because in one test Aegis BMD demonstrated the ability to track a real target and in another test the ability to communicate track data to GMD's fire control. However, DOT&E officials told us that having Aegis BMD perform long-range surveillance and tracking in real time would determine the degree to which errors are introduced when these activities are combined.

MDA also planned to have the third test fulfill a congressional mandate to test the Block 2004 configuration in an operationally realistic manner. For the first time, a test would have included production-representative GMD hardware and software operated by sailors and soldiers. All successful GMD intercepts, to date, have used surrogate and prototype components.

Test Officials Suggest Further Aegis BMD Characterization Tests Are Needed

DOT&E officials suggested that further tests are needed to fully characterize Aegis BMD's capability against ballistic missiles. The officials told us that Aegis BMD is making good progress in incorporating operational realism into its flight tests. Operational crews execute the intercept flight missions without advance notice of launch time. However, in early tests, ship position with respect to the target's trajectory is still controlled to increase the probability of intercept. In addition, the tests have been constrained by sea states, time of day, weather, target dynamics, and the need to baseline Aegis BMD's performance and concept of operations. The officials are recommending that in future tests Aegis BMD's tactical mission planner should dictate the ship's position and the sectors that its radar searches, rather than the program scripting the ship's locations and its radar's search sectors.

Aegis program officials explained that the need to baseline Aegis BMD's performance has indeed affected the ship's position during tests. An intercept attempt in February 2005, for example, that tested a specific burn sequence for the missile's booster required the ship be placed close to the target track. Yet another test, in November 2005, placed the ship relatively far from the target track. The officials emphasized that in both tests Aegis BMD performed successfully.

Quality Control Issues Raise Additional Performance Questions

Even if MDA had successfully completed flight tests needed to anchor the models and simulations used to predict the performance of the initial BMDS capability, the performance of some emplaced GMD interceptors would still be uncertain. GMD officials told us that before emplacing interceptors at Fort Greely and at Vandenberg Air Force Base for operational use, the interceptors undergo various tests. However, quality control procedures may not have been rigorous enough to ensure that unreliable parts or parts that were inappropriate for space applications would be removed from the manufacturing process. Two unsuccessful flight tests have been traced to poor quality control procedures. GMD officials have recommended that MDA remove the first nine interceptors emplaced at Fort Greely and Vandenberg Air Force Base, as the interceptors are scheduled for upgrades, so that any parts that tests have shown may not be adequately reliable or appropriate for use in space can be replaced.

One of the two test failures (IFT-10) occurred in December 2002 when the EKV could not separate from its booster. A team of engineers that investigated the test failure found that an open circuit occurred in one part of the interceptor's Laser Firing Unit, which disconnects the EKV from the booster. The open circuit was caused by a broken pin in an application-specific integrated circuit (ASIC) that controlled one aspect of the EKV/booster separation. The pin was fatigued during flight vibration. According to the test report, the ASIC's design did not allow for variations in the assembly process and the contractor did not lay out an adequate process to uniformly produce the part. Additionally, the contractor did not adequately test to identify the problem. In earlier tests, the board on which the ASIC was mounted was stabilized with a foam material so that the board was not as affected by the severe vibrations that occur at launch. However, to improve producibility and reliability, the foam was removed prior to IFT-8.

The second flight test (IFT-14) failure occurred in fiscal year 2005. The interceptor in this test failed to launch because two of the three arms that support the interceptor within its silo did not fully retract and lock. MDA's investigation into the test failure found that the arms could not retract because the surface of one part was significantly corroded, and crush blocks, which absorb the impact of the arms as they retract and lock into position, were an earlier design that required more force to crush. MDA's Deputy Director for Technology and Engineering pointed out that the corroded part was subjected to a more severe environment than it was designed to withstand. However, officials in the Office of Safety, Quality, and Mission Assurance told us that if simple quality assurance procedures had been in place, the corroded part would have been detected and the earlier design of the crush blocks would not have been installed.

The GMD program considered four options for dealing with the first nine interceptors emplaced for operational use (seven at Fort Greely and two at Vandenberg Air Force Base). The options included (1) leaving the interceptors in their silos and accepting them as is; (2) using the interceptors in reliability tests; (3) over time, returning the interceptors to the contractor's facility for disassembly and remanufacture; or (4) a combination of the other options. GMD program officials recently told us that their recommendation to MDA is to replace questionable parts when the interceptors are upgraded in fiscal year 2007. The officials said to replace the parts, the interceptors will be removed from their silos.

Schedule Pressures Caused Management to Stray from Knowledge-Based Practices

The problems encountered during Block 2004, which ultimately prevented MDA from achieving all of its goals for the block, were brought about by management compromises. Time pressures caused MDA to stray from a knowledge-based acquisition strategy, allowing the GMD program to condense its acquisition cycle at the expense of cost, quantity, and performance goals. DOD has given MDA the flexibility to make such changes.

GMD Program Sacrificed Knowledge-Based Approach to Accelerate Schedule

MDA programs follow a structured acquisition plan called the Integrated Management Plan that is meant to guide the development of elements and components, as well as their integration into the BMDS. If the plan, which includes eight events, is completed in an orderly manner, it will increase the likelihood that programs will attain knowledge at appropriate points in the acquisition cycle. Successful developers have found that attaining certain knowledge at specific points decreases the likelihood of cost growth, schedule slips, or degraded performance. However, because MDA's plan allows early deployment of a capability well before the eight events are completed, programs may gain knowledge too late in the process to prevent such problems. MDA officials told us that because the agency was directed to field a capability earlier than planned, it accepted additional risks. The risks were greatest in the GMD program that concurrently matured technology, designed the system, and produced and fielded operational assets as it attempted to meet its Block 2004 fielding dates.

A primary tenet of a knowledge-based approach to product development is to demonstrate the maturity of critical technologies before starting product development and to demonstrate design maturity and production process maturity before committing to production and fielding. MDA's Integrated Management Plan provided for this orderly progression through the acquisition cycle. At Event 1, an assessment of all technology critical to the system's design was to be completed. By the end of Event 2, design work was to be finished, and at the end of Event 4, the design was to be demonstrated in developmental tests. By the close of Event 5, an assessment of the element's operational capability would be complete and MDA would decide whether the element was ready to be handed over to a military service for production, operation, and sustainment or whether the element should be developed further.

However, the Integrated Management Plan also allows a program to depart from a knowledge-based acquisition strategy if a decision is made to field all or part of a capability early. At the end of each event from Event 3 on, MDA may elect to accelerate fielding of all or part of a capability by simultaneously completing all phases of the acquisition cycle. That is, a program can concurrently mature technology, design its system, and produce and field assets for operational use—which is contrary to a knowledge-based acquisition strategy. According to MDA officials, GMD was at Event 3—the point at which a pilot production line produced its first components and the components' functionality had been tested—when the presidential decision was made to deploy an early capability. MDA's Integrated Management Plan is presented in appendix IV.

Until the President's directive, the GMD program was focused on developing a test bed. If GMD had serially progressed through all eight events of the Integrated Management Plan, components would have been matured and demonstrated in the test bed. At the end of Block 2004, MDA could have (1) transferred GMD to a military service for production, operation, and sustainment; (2) developed GMD further in a subsequent block; or (3) terminated the program altogether. However, to field early, the GMD program condensed its Block 2004 acquisition cycle. The program attempted to simultaneously demonstrate technology, design an integrated GMD element, and produce and emplace assets for operational use—all within 2 years of the President's directive.

The GMD program fielded an initial capability in 2004 and 2005, as it was directed to do. However, there were consequences of the accelerated schedule. The fielding schedule for some GMD components slipped, and the program could not complete an end-to-end test needed to verify GMD's performance. Production and fielding of GMD interceptors was slowed by technical problems and the program's need to address quality control issues. To address these issues, the program restructured its test plan at a cost of about $115 million; but it funded the plan at the expense of making the Sea-Based X-Band and Fylingdales upgraded early warning radars operational. Block 2006 funds will now be used to complete these Block 2004 activities.

Other BMDS elements, whose fielding was not planned as part of Block 2004, are currently following a knowledge-based acquisition strategy. For example, the ABL program is concentrating on maturing technologies critical to the element's design by designing a prototype. If the prototype successfully demonstrates its lethality in a demonstration planned no earlier than 2008, it will become the basis for the design of an operational capability. Similar to ABL, the KEI program is also concentrating on demonstrating technologies critical to its design. If these demonstrations are successful, they could be incorporated into KEI's design.

GMD Management Became Inattentive to Quality Control Risks

GMD officials told us that in the process of accelerating GMD's schedule they became inattentive to weaknesses in the program's quality control procedures. The GMD program had realized for some time that its quality controls needed to be strengthened. However, the program's accelerated schedule left little time to address the problems. The extent of the weaknesses was documented in 2005 when MDA's Office of Safety, Quality, and Mission Assurance conducted audits of the contractor developing the interceptor's EKV and the Orbital Boost Vehicle.

In its audit of the EKV contractor, the MDA auditors found evidence that

- The prime contractor did not correctly communicate all essential EKV requirements to its subcontractor and the subcontractor did not communicate complete and correct requirements to its suppliers.
- The EKV subcontractor did not exercise good configuration control.
- The reliability of the EKV's design cannot be determined, and any estimates of its serviceable life are likely unsupportable.
- The contractor has no written policy involving qualification testing and does not require that its EKV subcontractor follow requirements established by industry, civilian, and military users of space and launch vehicles.

- The contractor's production processes are immature, and the contractor cannot build a consistent and reliable product.

More details on MDA's audit of the EKV contractor can be found in appendix IV.

Similarly, the auditors found that the contractor producing the Orbital Boost Vehicle needed to improve quality control processes and adherence to those processes. According to deficiency reports, the contractor did not always, among other things, flow down requirements properly; practice good configuration management to ensure that the booster met form, fit, and function requirements; implement effective environmental stress screening; or have an approved parts, material, and processes management plan.

Ironically, the pitfalls that result from an accelerated fielding had already been learned in the THAAD program. In 2000, we reported that pressure on the THAAD program to meet an early fielding date nearly resulted in the program's cancelation in 1998.[14] When flight testing began, in 1995, the THAAD missile experienced numerous problems. Eight of the first nine flight tests revealed problems with software errors, booster separation, seeker electronics, flight controls, electrical short circuits, foreign object damage, and loss of telemetry. According to several expert reviews from both inside and outside the Army, the causes of early THAAD flight test failures included inadequate ground testing, poor test planning, and shortcomings in preflight reviews. One study noted that failures were found in subsystems usually considered low-risk. Subsequently, the THAAD program manager adopted a knowledge-based strategy, which led to successes in later tests.

MDA Has Flexibility in Making and Reporting Program Changes

Compared with other DOD programs, MDA has greater latitude to make changes to the BMDS program without seeking the approval of high-level acquisition executives outside the program. In early 2002, DOD allowed MDA to effectively defer the application of DOD acquisition regulations to the BMDS program until a decision is made to transfer a BMDS capability to a military service for production, operation, and sustainment. This

[14] GAO, *Best Practices: : A More Constructive Test Approach Is Key to Better Weapon System Outcomes*, GAO/NSIAD-00-199 (Washington, D.C.: July 31, 2000).

allows MDA to make program changes without asking for prior approval.[15] For example, MDA has the flexibility to make trade-offs between BMDS elements. That is, the MDA Director can decide to accelerate one element while slowing another down. That is not to say that DOD and Congress are not kept informed of MDA's progress or changes, but that the MDA Director, by statute, has the discretion to determine which variations are significant enough to be reported. Accountability has thus become broadly applied as to mean delivering some capability within funding allocations.

Under DOD's acquisition regulations, each BMDS element would likely have met the definition of a major acquisition program. Major acquisition programs are required by statute (10 U.S.C. § 2435) to develop a program baseline when the program begins system development and demonstration. The baseline, which includes cost and schedule estimates and formal performance requirements developed by the warfighter, is considered the initial business case for the acquisition effort. Once a baseline is approved, major acquisition programs are required to operate within the baseline or to obtain approval from a high-level acquisition executive outside the program to make cost, schedule, or performance changes.[16] Changes in any of these baseline parameters would reflect a change in the program's business case. Approved programs also report program status measured against the baseline and any baseline changes to Congress in an annual Selected Acquisition Report (SAR). Congress has also established criteria to identify significant variations in a weapon system's cost or schedule and requires that those changes be reported more often, in a quarterly SAR.[17]

[15]MDA is subject to overall direction and guidance, however, from the Under Secretary of Defense for Acquisition, Technology, and Logistics, and the Senior Executive Council, chaired by the Deputy Secretary of Defense.

[16]For major defense acquisition programs, this executive, known as the Milestone Decision Authority, is typically the Under Secretary of Defense for Acquisition, Technology, and Logistics; the component head; or the component's acquisition executive.

[17]10 U.S.C. § 2432(b)(2); 10 U.S.C. § 2433(e)(1).

MDA is not yet required to have an approved program baseline as defined by 10 U.S.C. § 2435 for either the BMDS or its elements.[18] Instead MDA develops more flexible cost and quantity goals and capability-based performance objectives. MDA has a separate statutory requirement to establish and report cost, schedule, and performance baselines for block configurations of the BMDS being fielded.[19] But these baselines are more flexible than the rigid baselines required of other acquisition programs that DOD and Congress use in performing program oversight. While MDA reports its cost, quantity, and performance information to Congress in an annual Selected Acquisition Report, it is free to revise its goals and objectives, as it did during Block 2004, if they are not achievable with the time or funds available.[20] MDA is also required by statute to report significant variations from the baselines in its annual SAR.[21] However, there are no criteria to identify which variations are significant enough to report. Instead, MDA's Director, by statute, has the discretion to determine which variations will be reported. For example, the Director decides whether to report that activities that Congress funded in one block are being deferred to a later block and will be paid for with the latter block's funding.

MDA Is Taking Several Corrective Actions

MDA has begun to address the quality control weaknesses in the BMDS program. Some actions are as simple as revising reporting lines so that MDA's Chief of Safety, Quality, and Mission Assurance reports directly to MDA's Director and Deputy Director and establishing toll-free telephone numbers for the report of safety and quality issues. MDA is also

[18]The BMDS as a whole meets the definition of a major acquisition program and is treated as such. However, MDA does not divide research, development, test, and evaluation of the BMDS or its elements into the acquisition phases defined by DOD acquisition regulations, and thus neither the BMDS nor its elements will enter system development and demonstration. Accordingly, the baseline required by 10 U.S.C. § 2435 will not be required of the BMDS or its elements until they enter the formal DOD acquisition cycle (i.e., while being transferred to the warfighter for production and deployment).

[19]Section 234(e) of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (Pub. L. No. 108-375) established the requirement for MDA's cost, schedule, and performance baselines and the reporting of those baselines in the Selected Acquisition Report.

[20]However, MDA must report any modifications to its cost, schedule, and performance baselines to the congressional defense committees, with the rationale for the modification. Pub. L. No. 108-375 § 234(g).

[21]Pub. L. No. 108-375 § 234(f).

renegotiating some aspects of its prime contracts to revise the award fee determination process in an effort to place more emphasis on quality control and the implementation of industry best practices, and adding mission assurance provisions to contracts that promote process improvements, improve productivity, and enhance safety, quality, and mission assurance. Furthermore, MDA is placing more emphasis on the definition and correction of quality control weaknesses by conducting audits of major contractors and subcontractors. It has also renewed the emphasis on the role of the Defense Contract Management Agency in performing quality assurance functions in support of MDA programs. Finally, MDA has adopted a more conservative test approach for the GMD program that includes increased ground tests and an incremental approach to flight testing. However, the actions have not gone so far as to ensure that all BMDS programs implement knowledge-based practices or to ensure that the activities planned to develop, demonstrate, and produce the capabilities intended for future blocks are achievable within the block time frames without resorting to a concurrent schedule.

Contracts to Reflect the Importance of Good Quality Assurance Strategy

MDA plans to revise prime contracts to reflect the importance of good quality assurance procedures and the contractor's implementation of industry best practices. GMD officials told us that in fiscal year 2005 award fee on the GMD contract was partially based on a good quality control program. The officials said that of the $407 million award fee available for the period running from October 1, 2004, through September 30, 2005, $9 million was based on the contractor's implementation of good quality assurance and supplier management procedures. In November 2005, MDA awarded the contractor $2.1 million of the $9 million set aside for the implementation of quality assurance procedures. MDA officials also told us that in fiscal year 2006, the overarching criteria for the entire award fee pool of $302 million will be the contractor's implementation and adherence to industry standards and best practices.

MDA also expects to modify prime contracts to incorporate a document referred to as MDA Assurance Provisions (MAP). All prime contracts are to include MAP standards, but not all contracts have been modified because MDA and some contractors have not reached agreement on the cost of implementing the MAP. For example, the GMD prime contractor estimates that implementation costs will be somewhere around $280 million. However, officials in MDA's Office of Safety, Quality, and Mission Assurance told us that at least one contractor has agreed to implement the MAP at no additional cost.

The MAP provides a measurable, standardized set of safety, quality, and mission assurance requirements to be applied to developers for mission- and safety-critical items in support of evolutionary acquisition and deployment of MDA systems.[22] For example, the document includes standards regarding the collection and reporting of foreign object damage and debris incidents, a requirement for working-level peer reviews throughout design and development to identify and resolve technical issues and concerns prior to formal system-level reviews, and a requirement for ensuring that commercial off-the-shelf items meet all functional and interface requirements and are qualified to operate in their intended environment.

In addition to requiring contractors to abide by MAP standards, MDA also requires each BMDS element program office to compare its mission assurance plan with the MAP. As a result of the comparison, the program is expected to identify critical mission assurance needs that are not being met. The results are catalogued in a Mission Assurance Implementation Plan (MAIP), which element program directors are accountable for implementing. Each element is to continuously assess MAIP execution so that feedback can be used to improve both the MAP and the MAIP.

MDA Renews Emphasis on Contractor Surveillance

So that the quality assurance weaknesses in the BMDS program are accurately defined, the MDA Director also gave the Office of Safety, Quality, and Mission Assurance unfettered access to all MDA contractor operations, activities, and documentation. Under this authority, MDA quality personnel have been placed in each prime contractor facility to monitor the contractor's quality procedures, and the office is auditing major contracts to identify quality assurance deficiencies and areas where procedures can be improved. As of November 2005, the office had completed audits of the Aegis BMD SM-3, GMD EKV, and Orbital Sciences Corporation booster, and THAAD contracts.

MDA is also placing a renewed emphasis on the Defense Contract Management Agency's (DCMA) quality assurance role. In a May 2005 delegation letter, MDA directed DCMA to

[22] Mission- and safety-critical items are those items whose failure would directly affect system or personnel safety, mission success, or operational readiness.

- perform quality assurance surveillance activities in accordance with DCMA policies and directives;
- ensure that mandatory government inspections authorized by MDA are incorporated into the contractor's manufacturing process plans and/or critical suppliers' plans;
- report mandatory government inspection test results, missed inspections, and requests for permission to waive inspections to MDA's Office of Safety, Quality, and Mission Assurance for that office's approval; and
- support technical surveillance activities by carrying out such duties as participating in mission critical item and component Material Review Boards and providing insight and recommendations on engineering change proposals, requests for waivers, employee training, and the contractor's critical manufacturing processes.

MDA Restructures GMD's Test Plan

In 2005, the MDA Director established a new position—Director, Mission Readiness—whose primary focus during fiscal year 2005 was to examine the Ground-Based Midcourse Defense test program. To assist in this examination, a small, highly experienced Mission Readiness Task Force was established. The goals of the task force were to establish confidence in GMD's ability to reliably hit its target, establish credibility in setting and meeting test event dates, build increasing levels of operationally realistic test procedures and scenarios, raise confidence in successful outcomes of flight missions, and conduct the next flight test as soon as practical within acceptable risk bounds.

To meet these goals, the task force recommended a knowledge-based flight readiness process and flight test program. Before a test is held, the GMD program presents evidence that all components are ready for test. Program officials explained that senior executives from all key stakeholder organizations review the evidence and make a recommendation to the MDA Director as to whether the test event should proceed. GMD's test plan has also been restructured to place more emphasis on successful ground tests prior to each flight test. According to MDA program officials, part of the evidence for proceeding from one flight test to another is success in the preceding ground and flight tests.

The first flight tests have simple objectives. For example, flight test 1, conducted in December 2005, demonstrated the successful launch of the GMD interceptor and the separation of the EKV from its booster. By flight test 4, MDA expects to be ready to demonstrate that the GMD system is capable of hitting an operationally representative target. Tests that follow will become progressively more difficult.

Corrective Actions May Not Alleviate Pressures Associated with Schedule-Driven Block Approach

Although MDA is taking many actions to address quality assurance problems, it has not taken any steps to ensure that all elements follow a knowledge-based acquisition strategy or to ensure that the time is available to follow such a strategy. For example, a number of activities planned for the GMD element during Block 2004 have been deferred to Block 2006. Also, developmental efforts for other elements did not progress as planned, leaving more work to be completed during Block 2006 and, perhaps, later blocks.

Conclusions

Missile defense is one of the largest weapon system investments DOD is making. To date, around $90 billion has been spent, and over the next 6 years, DOD expects that it will need about $58 billion more to enhance the BMDS. Beyond that, more funding will be required if DOD is to reach its ultimate goal of developing a system capable of countering ballistic missile launches from any range during all phases of flight. By driving to a fielding date during Block 2004, MDA placed assets in the field faster than originally planned. However, in doing so, MDA strayed from the knowledge-based approach that allows successful developers to deliver, within budget, a product whose performance has been demonstrated. Instead, MDA fielded assets before their capability was known. In addition, the full cost of this capability is not transparent to decision makers because MDA has deferred the cost of some Block 2004 activities into the next block.

The fielding of the Block 2004 capability provides an opportunity for DOD to take stock of the approach it has taken thus far on missile defense and determine whether changes are warranted for its approach to future blocks. We believe they are. The concurrent development approach dictated by the directed fielding date and enabled by considerable flexibility to lower goals and defer capability has resulted in delivering fewer assets than planned. Accountability has been very broadly applied as to mean delivering some capability within funding allocations. While recognizing this approach did successfully accelerate fielding, to the extent it continues to feature concurrency as a means for acceleration, it may not be affordable for the considerable amount of capability that is yet to be developed and fielded. While the effects of this approach were perhaps most keenly felt with the Block 2004 capability, signs of its continuance can be seen in the developmental activities that were deferred during fiscal year 2005.

It is possible for MDA to return to a knowledge-based approach to development while still fielding capability in blocks. To its credit, MDA instituted its own audits and is heeding the results of those audits in taking a number of steps to correct the quality assurance and testing problems encountered thus far. Yet these corrective actions have not gone far enough to put all of the BMDS elements on a knowledge-based approach to development and fielding. MDA's experience during Block 2004 shows that it may not always be possible to deliver a capability in a 2-year time frame. Clearly, a block or stepped approach to fielding a new system is preferable to attempting a single step to full capability. However, a primary tenet of a knowledge-based acquisition strategy is that a program should be event- rather than schedule-driven. This philosophy is consistent with the evolutionary acquisition approach preferred by DOD in its acquisition regulations. It also provides a better basis for holding MDA accountable for what it can deliver within estimated resources.

Recommendations for Executive Action

To better ensure the success of future MDA development efforts, we recommend that the Secretary of Defense direct the Director, MDA, to take the following three actions.

- Direct all BMDS elements to implement a knowledge-based acquisition strategy that provides for demonstrating knowledge points for major events or steps leading up to those events. These knowledge points should be consistent with those called for in DOD's acquisition regulations. For example, markers could be established that would demonstrate that programs have the knowledge to meet design review standards and are ready to hold those reviews.

- Assess whether the current 2-year block strategy is compatible with the knowledge-based development strategy recommended above. If not, the Secretary should develop event-driven time frames for future blocks. Events could represent demonstrated increases in capability, such as the addition of software upgrades, stand-alone components, or elements.

- Adopt more transparent criteria for identifying and reporting on significant changes in each element's quantities, cost, or performance, such as those that are found in DOD's acquisition regulations. Coupled with a more knowledge-based acquisition strategy, such criteria would enable MDA to be more accountable for delivering promised capability within estimated resources.

Agency Comments and Our Evaluation

DOD's comments on our draft report are reprinted in appendix I. DOD partially concurred with our first recommendation. DOD stated that MDA has implemented a knowledge-based acquisition strategy that relies upon discrete activities to produce data that can be used to judge an element's progress. DOD noted that unlike the knowledge points discussed in DOD acquisition regulations, the knowledge points used by MDA are discrete points, not reviews. According to DOD, MDA's strategy is consistent with the principles of DOD acquisition regulations while providing MDA's Director with the flexibility to determine their applicability to the BMDS block development concept. We agree that knowledge is obtained through discrete events, such as a successful test or the completion of a cost/benefit analysis, but we define knowledge points as meaning more than discrete events. Rather, knowledge must be looked at in the aggregate. For example, the knowledge gained from a number of discrete events must be considered collectively to confirm that the design of a system is stable. It is these aggregations that we consider to be the knowledge points that should form the basis for investment decisions. For example, the GMD program's successful demonstration of various functions of the BMDS engagement may have been sufficient to continue funding of the element's development, but the discrete events were not sufficient to demonstrate that the element's design and production processes were sufficiently mature to begin production and fielding. We also note that the knowledge points discussed in DOD acquisition regulations do represent measurable, demonstrated knowledge, such as technology and design maturity, that then become the basis for reviews. They are not the reviews themselves, as reviews can take place regardless of the level of knowledge available.

DOD also partially concurred with our recommendation that MDA assess whether the 2-year block strategy is compatible with a knowledge-based acquisition strategy. DOD stated that MDA uses knowledge points to establish block goals and makes adjustments to those goals when necessary. DOD noted that the 2-year block strategy is compatible with this approach. We have not seen the decisions made on Block 2004 as being consistent with knowledge points. During Block 2004, MDA allowed the GMD program to complete all phases of the acquisition cycle—technology development, product design, production, and fielding—simultaneously to enable the program to field a capability within the 2-year time frame. If MDA is to be truly knowledge-based, it must be dedicated to taking the time to gather the knowledge needed to be successful in the next acquisition phase. Because MDA did not follow this strategy in Block 2004, we still believe that MDA should assess future blocks to determine whether those blocks can be developed within the 2-year time frame without resorting to a concurrent schedule.

DOD did not concur with our third recommendation to adopt more transparent criteria for identifying and reporting program changes. In responding to this recommendation, DOD responded that MDA in 2005, by statute, began submitting fielding baselines to Congress and must report significant cost, schedule, or performance variances to these baselines in future reports. DOD believes that these reports and the quarterly reviews conducted by DOD staff provide an adequate level of oversight. We agree that MDA is required to report significant variances to established baselines to Congress and that MDA keeps DOD informed about the Ballistic Missile Defense program. However, given the management flexibilities accorded MDA and the large amount of resources (more than $50 billion) that DOD currently plans for missile defense, more transparent criteria is needed for better program management and oversight.

DOD provided technical comments to our draft report, which we considered and incorporated as appropriate. In its technical comments, for example, DOD expressed concern that our draft report measured Block 2004 against goals established in February 2003 rather than the fielded baseline goals established in 2005. We chose the 2003 goals as a baseline because the goals were MDA's official notification to Congress of the agency's expectations for the block. In addition, goals are meant to be a result that an organization strives to achieve. If goals are changed over time to more closely reflect actual performance, they lose their validity. We have included in the report a discussion of the changes that MDA made in its Block 2004 goals from 2003 through 2005 and the reasons for those changes.

We are sending copies of this report to the Secretary of Defense and to the Director, MDA. 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.

If you, or your staff, have any questions concerning this report, please contact me at (202) 512-4841. Contact points for our offices of Congressional Relations and Public Affairs may be found on the last page of this report. The major contributors to this report are listed in appendix VII.

Paul L. Francis

Paul Francis
Director, Acquisition and Sourcing Management

List of Congressional Committees

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

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

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

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

Appendix I: Comments from the Department of Defense

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

ACQUISITION, TECHNOLOGY AND LOGISTICS

Mr. Paul Francis
Director, Acquisition and Sourcing Management
U. S. Government Accountability Office
441 G. Street, N.W.
Washington, DC 20548

Dear Mr. Francis:

This is the Department of Defense (DoD) response to the GAO Draft Report, "MISSILE DEFENSE: Missile Defense Agency Fields Initial Capability But Falls Short of Goals," dated February 2, 2006 (GAO Code 120442/GAO-06-327).

The DoD partially concurs with the draft report's recommendations. 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. For further questions concerning this report, please contact COL Fred Coppola, (703) 695-7329, fred.coppola@osd.mil.

Sincerely,

Mark D. Schaeffer
Acting Director
Defense Systems

Enclosure:
As stated

GAO DRAFT REPORT DATED FEBRUARY 2, 2006
GAO-06-327 (GAO CODE 120442)

"MISSILE DEFENSE: Missile Defense Agency Fields Initial Capability But Falls Short of Goals"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Director, MDA to direct all BMDS elements to implement a knowledge-based acquisition strategy that provides for demonstrating knowledge points for major events or steps leading up to those events. These knowledge points should be consistent with those called for in DOD's acquisition regulations. For example, markers could be established that would demonstrate that programs have the knowledge to meet design review standards and are ready to hold those reviews.

DOD RESPONSE: Partially concur. Consistent with DOD acquisition regulations, MDA has implemented a knowledge-based acquisition strategy to demonstrate knowledge points for major events. MDA establishes knowledge points for its programs. Unlike knowledge points discussed in DOD acquisition regulations, the knowledge points used by MDA are not reviews, but discrete activities that produce data on program progress. This approach is consistent with the MDA Charter that requires MDA to manage the BMDS consistent with the principles of DoD acquisition regulations, but provides the Director the flexibility to determine their applicability to the BMDS Block development concept. This approach is fundamental to how MDA executes its development program because it enables decisions to be made based on what we will and will not fund based upon the proven success of each program element. The Department sees no need for the Secretary to provide additional direction to the Director, MDA on the subject.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense direct the Director, MDA to assess whether the current 2-year block strategy is compatible with the knowledge-based development strategy recommended above. If not, the Secretary should develop event-driven timeframes for future blocks. Events could represent demonstrated increases in capability, such as the addition of software upgrades, stand-alone components, or elements.

DOD RESPONSE: Partially concur. MDA uses knowledge points to establish block goals and makes adjustments to these block goals when necessary. The 2-year block strategy is compatible with this approach. The Department sees no need for the Secretary to provide additional direction to MDA on the subject.

RECOMMENDATION 3: The GAO recommended that the Secretary of Defense direct the Director, MDA to adopt more transparent criteria for identifying and reporting on significant changes in each element's quantities, cost, or performance, such as those that are found in

DOD's acquisition regulations. Coupled with a more knowledge-based acquisition strategy, such criteria would enable MDA to be more accountable for delivering promised capability within estimated resources.

DOD RESPONSE: Non-concur. MDA in 2005, by statute, submitted fielding baselines to Congress and must now report significant cost, schedule, or performance variances in their Selected Acquisition Report and update Congress on baseline changes. In addition, the USD(AT&L) conducts quarterly formal reviews of the Ballistic Missile Defense program, along with other Office of the Secretary of Defense staff. The Department believes that these reviews are consistent with other defense programs and are sufficient to provide an adequate level of oversight on significant program changes.

Appendix II: Block 2004 Element Assessments

The Missile Defense Agency (MDA) developed and fielded in Block 2004 three Ballistic Missile Defense System (BMDS) elements for operational use in the event of an emergency. These elements are the Aegis Ballistic Missile Defense (Aegis BMD); Ground-Based Midcourse Defense (GMD); and the Command, Control, Battle Management, and Communications (C2BMC) elements. MDA also attempted to accelerate the fielding of the Forward-Based X-Band Transportable (FBX-T) radar being developed by the Sensors Program Office into Block 2004. Although the agency was able to complete the radar's development, DOD did not complete negotiations with Japan, the host nation, in time to make the FBX-T operational during the block.

During Block 2004, MDA also carried out development efforts for other elements that are expected to be incorporated into the BMDS during later blocks to enhance the system's capability. These elements include the Airborne Laser (ABL), Kinetic Energy Interceptor (KEI), Terminal High Altitude Area Defense (THAAD), and Space Tracking and Surveillance System (STSS). Development of the THAAD element, which is being designed to attack short- and medium-range ballistic missiles during the terminal stage of their flight, is further along than the other developmental elements, and MDA expects to make one THAAD fire unit available for operational use in fiscal year 2009. The other three developmental elements are at an early stage. The ABL element, which is to attack missiles during the boost phase of their flight, is developing a prototype to demonstrate technologies critical to the system's design. MDA expects to demonstrate the technologies no earlier than 2008, when the program will test the element's lethality against a short-range ballistic missile. Similarly, the KEI program's work during Block 2004 is focused on technology demonstration. MDA will assess KEI's progress in 2008 and decide the future of its effort to develop a mobile, multi-use system capable of intercepting ballistic missiles during the boost and midcourse phases of flight. During Block 2004, the STSS program readied demonstration satellite and sensor hardware for launch. MDA expects the STSS to provide surveillance and tracking of enemy ballistic missiles for other BMDS elements. If the two STSS satellites being launched in 2007 successfully demonstrate this function, a constellation of STSS satellites could be launched beginning in 2013.

Aegis BMD

The Aegis BMD element is a sea-based missile defense system designed to defeat short- and medium-range ballistic missiles in the midcourse phase of flight. Its mission is to protect deployed U.S. forces, allies, and friends from such attacks, and to employ its shipboard radar as a forward-deployed Ballistic Missile Defense System sensor to support intercontinental ballistic missile (ICBM) engagements.[1]

The Aegis BMD element builds upon the existing capabilities of Aegis-equipped Navy cruisers and destroyers. Planned hardware and software upgrades to these ships will enable them to carry out the missile defense mission in addition to their current role of protecting U.S. Navy ships from air, surface, and subsurface threats. The program is also developing the Standard Missile-3 (SM-3)—the system's "bullet"—which is designed to destroy enemy warheads through hit-to-kill collisions above the atmosphere. The SM-3 is composed of a kinetic warhead (kill vehicle) mounted atop a three-stage booster.

Program Accomplishes Fielding Plan

The program fielded Block 2004 assets mostly on schedule. Nine (Block I) SM-3 missiles were ready for operational use by December 2005, as planned. In addition, two Aegis BMD cruisers received system upgrades making them capable of launching missiles to engage ballistic missile targets. Ten Aegis BMD destroyers were equipped with long-range surveillance and tracking software during Block 2004.

Test Results Are Good, but Further Tests Are Needed

Aegis BMD conducted the most realistic tests of all the BMDS elements, but further tests are needed to fully characterize the element's missile defense performance. The program has successfully tested Aegis BMD's engagement capability in six intercept attempts since 1999 using variants of the SM-3 missile. One of these successful intercepts, Flight Test Mission (FTM) 04-1, was conducted in fiscal year 2005. Operational test officials reported that the test incorporated many operational characteristics. For example, the warfighter had no preknowledge of the target launch time, the target was representative of a real-world threat, and the fielded missile configuration was used. However, the officials said that in early tests, including FTM 04-1, ship position with respect to the target's trajectory was controlled to increase the probability of intercept. The officials are recommending that in future tests Aegis BMD's tactical mission planner should dictate the ship's position and the sectors that its radar searches, rather than the program scripting the ship's locations and its radar's search sectors.

[1]The terms "intercontinental ballistic missile" and "long-range ballistic missile" are used interchangeably. They are, by definition, ballistic missiles with ranges greater than 5,500 kilometers (3,400 miles).

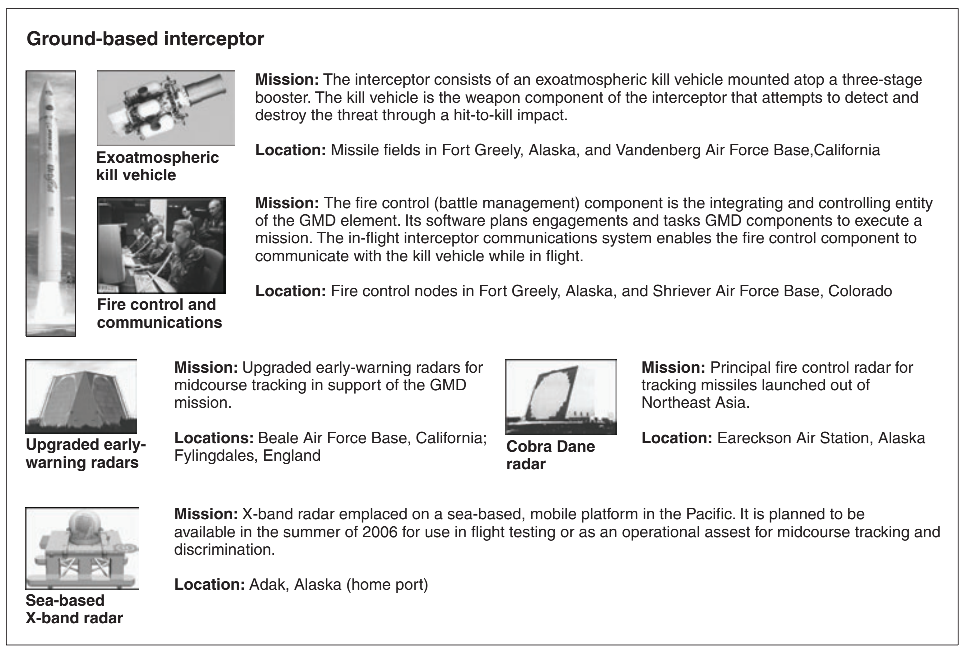
Additional tests are also needed to demonstrate that the program has resolved problems that limit the SM-3 missile's ability to divert to its target. Although the current configuration is adequate for the current threat, the missile will require more divert capability if it is to hit more complex targets and targets with more challenging trajectories than were seen in early tests. For example, the missile's Solid Divert and Attitude Control System (SDACS) needs to operate in a pulse mode, rather than its current sustain mode, to increase the missile's ability to maneuver toward its target. Performance problems with the SDACS's pulse mode of operation were first noticed in a June 2003 flight test, Flight Mission (FM)-5, and have remained a concern to the program. Program officials modified the SDACS's design in fiscal year 2005, and they believe that the root cause of the problem is understood. However, ground and flight tests, planned for fiscal year 2006, are needed to verify that the SDACS will perform as designed. If the tests are successful, the pulsed SDACS could be incorporated into the missile in fiscal year 2007. Although the earliest fielded missiles will not be capable of pulse mode operation, which will reduce their divert capability, program officials believe that these missiles will provide a credible defense against a large population of the threat. A test (FTM 04-2) successfully conducted in November 2005 against a "separating" target—a target whose warhead separates from its booster rocket—also showed that the SM-3 has some capability against a more advanced target than the nonseparating targets used in prior tests.

The program has also flight-tested Aegis BMD's long-range surveillance and tracking capability, but further verification of fielded system upgrades is needed. In fiscal year 2005, the program successfully used the system upgrade (Ballistic Missile Defense 3.0E) to track live ICBM targets of opportunity in two separate events. However, because GMD did not participate in these tests, track data developed from the live target were not used to formulate a task plan for a GMD interceptor, as it would need to do in an actual defensive mission. Although track data have been passed to the fire control unit in a separate event, this has not been demonstrated in real time. MDA expected to test Aegis BMD's long-range surveillance and tracking capability in several fiscal year 2005 flight tests, but it was unable to do so, mostly because of delays in the GMD test program. Aegis BMD was unable to participate in Integrated Flight Test (IFT)-13C because of weather conditions and in IFT-14 because of fleet scheduling conflicts. Other GMD tests were put on hold and later folded into a new test schedule to begin in fiscal year 2006. MDA has not yet rescheduled a GMD flight test that uses Aegis BMD in its long-range surveillance and tracking role.

Ground-Based Midcourse Defense

The GMD element is a missile defense system being developed to protect the United States against ICBM attacks launched from Northeast Asia and the Middle East. The GMD element relies on a broad array of components, including (1) space- and ground-based sensors to provide early warning of missile launches, (2) ground- and sea-based radars to track and identify threatening objects, (3) ground-based interceptors to destroy enemy missiles through hit-to-kill impacts above the atmosphere, and (4) fire control and communications nodes for battle management and execution of the GMD mission. Figure 1 illustrates the various GMD components, which are situated at several locations within and outside the United States.

Figure 1: Components of the GMD Element



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

Progress during Block Falls Short of Expectations

GMD's progress toward meeting Block 2004 goals was less than expected. Silos and other construction at GMD facilities were completed on schedule, but the program was unable to meet its fielding goals for ground-based interceptors. Most of the GMD radars are fielded and could be used for defensive operations if needed. However, some radar upgrades were delayed, and none of the radars have been tested in integrated flight tests. In addition, an operational flight test and other key tests needed to characterize GMD's performance were delayed into fiscal year 2006.

Program Did Not Meet Scheduled Deliveries

The infrastructure for the missile defense complex is complete, but MDA was unable to deliver almost half of the interceptors initially planned for the Block 2004 inventory. MDA completed, on schedule, construction of all facilities needed to place the GMD system on alert, including the construction of the first missile field at the missile defense complex at Fort Greely, Alaska. However, the GMD program emplaced only 10 of the 20 interceptors originally planned for Block 2004. In fiscal year 2004, the program designated 2 of the 20 interceptors as test assets after an explosion at a plant producing motors for the interceptor’s booster caused the interceptor’s delivery schedule to slip. In fiscal year 2005, the program diverted 4 more interceptors to the test program in response to a MDA task force recommendation for a revised test plan. According to GMD officials, delivery of five of the six test assets and the remaining four missiles for operational use were delayed beyond December 2005.

MDA has two radars ready for operation, Cobra Dane and the Beale upgraded early warning radar. However, tests have identified a Cobra Dane shortcoming, and neither radar’s capability has been verified in system-level flight tests. The Cobra Dane radar has been ready for limited defensive operations since September 2004. It has participated in ground tests and successfully tracked several targets of opportunity. Because the radar’s location prevents it from participating in integrated flight tests, an air-launched target was used in a September 2005 flight test (FT 04-5). The test was designed to assess the radar’s ability to transmit track data, in real time, to the missile defense fire control system. Cobra Dane performed as expected in these test events, but officials in the office of the Director, Operational Test and Evaluation (DOT&E) are concerned that the radar’s software, as currently written, could cause the GMD element to waste inventory. The Beale radar is also ready to conduct the missile defense mission, but software deficiencies and lack of testing are still a concern. While Beale radar hardware and communications upgrades are complete, software deficiencies caused software upgrades planned for Block 2004 to fall slightly behind schedule. The program planned to resolve the deficiencies, which could cause some degradation in the radar’s performance, in early 2006. However, officials consider Beale ready to perform its basic missile defense mission should the BMDS be placed on alert prior to the resolution of the deficiencies because the radar has successfully tracked several targets of opportunity. A test to certify all radar upgrades is currently scheduled for fiscal year 2006. In early fiscal year 2007, MDA also plans to test Beale’s operational capability as the fire control radar in an intercept attempt. In this test, for the first time, Beale will track a live target and provide track data to the GMD fire control component that will use the data to develop a weapon system task plan.

Full functionality of two additional early warning radars was delayed into later blocks. Fylingdales upgraded early warning radar was delayed slightly to cover some of the cost of additional flight tests added to the GMD program. Its missile defense capability will be available in early Block 2006, after a distributed ground test scheduled for the second quarter of fiscal year 2006. Full radar functionality, which will allow the radar to perform both its missile defense mission and its legacy Air Force mission, is expected in October 2006. Likewise, deployment of the Thule upgraded early warning radar, which MDA had planned to upgrade incrementally, was postponed to Block 2008 so that the radar could be fully upgraded before taking on its missile defense mission.

The Sea-Based X-Band radar (SBX) is also slightly behind schedule. Additional funding needs for new flight tests prevented the GMD program from integrating the Sea-Based X-Band radar into the BMDS by December 31, 2005, as planned. The radar is able to track targets but will not be able to pass track data to the fire control center until it is integrated with the GMD system during the distributed ground test scheduled for April 2006. The radar is expected to be transported to its home port at Adak, Alaska, by the third quarter of calendar year 2006 where it will be available in the event of an emergency. However, MDA does not plan to verify the performance of the radar in a system-level flight test until late in 2007.

GMD Unable to Carry Out Flight Test Plan

The GMD program was unable to demonstrate the Block 2004 GMD system in flight tests. The program attempted two integrated flight tests in fiscal year 2005, IFT-13C in December 2004 and IFT-14 in February 2005. In both tests, interceptors failed to launch from their silos. In IFT-13C, a timing problem with the interceptor's flight computer caused the interceptor to abort its launch. In IFT-14, the first intercept attempt since 2002, the interceptor was unable to lift off because the arms inside the silo failed to fully retract and lock out of the way. Program officials traced the root cause of this failure to poor quality control procedures.

In response to these test failures, MDA delayed upcoming plans for future tests and chartered the Mission Readiness Task Force to review the program and propose changes. The task force found that MDA's problems were primarily linked to inadequate quality assurance processes. An independent review team attributed these problems to the urgency of the fielding schedule, which drove decision making and program planning. The task force provided guidance for improving the test program by significantly restructuring the focus of upcoming test events. MDA adopted the recommended test strategy at an additional cost of $115 million.

Although early tests in the restructured plan have simple objectives, the tests get progressively more difficult, and DOT&E is concerned that MDA cannot meet its schedule to conduct the first four tests between November 2005 and November 2006. The first flight test (FT-1) was successfully conducted in December 2005, 1 month later than planned. The objective of the test was not to intercept a live target, but to verify that an interceptor, representative of the configuration being fielded, could be successfully launched and to evaluate its booster's delivery performance. The next intercept attempt, FT-4, is not scheduled until late calendar year 2006.

One consequence of restructuring the GMD test program was MDA's inability to fulfill the statutory mandate that required DOD to conduct an operationally realistic test of the BMDS by October 1, 2005. MDA had planned to conduct this test in the third quarter of fiscal year 2005. However, after the two flight test failures, the task force recommended that MDA spend additional time addressing mission readiness before attempting an operational test of the BMD system. FT-4, scheduled for November 2006, is the first test that has the potential to fulfill the mandated objectives. FT-4 is planned as an intercept attempt using the Beale radar as the fire control radar. This will be the GMD program's first intercept attempt to use a nonsurrogate fire control radar.

Program Proves GMD Concept, but Not Its Design

While the GMD program has proved the concept of destroying ICBMs during the midcourse of their flight, the program has not proved GMD's design will deliver the performance desired. The GMD program, the centerpiece of the BMDS Block 2004 defensive capability, has demonstrated its ability to intercept target warheads in flight tests since 1999. The program has conducted five successful intercept attempts, the last one in 2002. While the program maintains that each piece of the engagement sequence has been demonstrated by flight and ground tests, the program has been unable to verify that the integrated system, using production-representative components, will work in an end-to-end operation. Until further testing is done, MDA will not know for sure that the integrated system using operational interceptors and fire control radars will perform as expected, or that technical problems with the kill vehicle and its booster have been fixed.

Quality control weaknesses also raise concerns about the performance of GMD interceptors. Quality control procedures may not have been rigorous enough to ensure that unreliable parts, or parts that were inappropriate for space applications, would be removed from the manufacturing process. For example, a leak in an attitude control system regulator was traced to unauthorized rework. Although production has slowed as the program introduces initiatives to strengthen quality controls, interceptors are still being emplaced in silos before all initiatives are in place. Additionally, the first nine interceptors emplaced for operational use—seven at Fort Greely and two at Vandenberg Air Force Base—could include questionable parts that were not detected during the interceptor's acceptance tests. Program officials told us that they are recommending that such parts be replaced in 2007, when the interceptors are scheduled to be upgraded. Making the replacements will require that the interceptors be removed from their silos.

Command, Control, Battle Management, and Communications

The C2BMC element is being developed as the integrating and controlling entity of the BMDS. Leveraging existing infrastructure, it is initially designed to provide connectivity between the various BMDS components and in later blocks will manage their operations as part of an integrated, layered missile defense system. Over time, C2BMC will not only provide planning tools to assist the command structure in formulating defensive actions, it will also generate detailed instructions for executing various missile defense functions, such as tracking enemy missiles, discriminating the warhead from decoys and associated objects, and directing the launch of interceptors. It will also manage the exchange and dissemination of information necessary for carrying out the missile defense mission.

The Block 2004 C2BMC element provides situational awareness by monitoring the operational status of each BMDS component, and it displays threat information such as missile trajectories and impact points. When the FBX-T becomes operational, C2BMC will also provide sensor control, sensor tasking, and sensor monitoring of the radar and forward the data to GMD.

The incorporation of battle management capabilities into the C2BMC element begins with Block 2006. In the 2006-2007 time frame, the element is expected to track a ballistic missile threat throughout its entire trajectory and select the appropriate element to engage the threat. For example, the Block 2006 C2BMC configuration would be able to generate a single, precise track from multiple radars and transmit it to the other elements. This allows elements to launch interceptors earlier, providing more opportunity to engage incoming ballistic missiles.

Block 2006 is also expected to enhance C2BMC's communications with each BMDS component. C2BMC program officials will work to establish communications with all elements of the BMDS, overcome limitations of legacy satellite communications protocols, and establish redundant communications links to enhance robustness. Such upgrades will improve operational availability and situational awareness.

Most Block 2004 Activities Completed on Schedule

The C2BMC team executed all of its planned fiscal year 2005 activities as scheduled and nearly all of the activities needed to complete the Block 2004 capability. Program officials completed software development and testing, and integration activities, and enhanced the system's robustness. Additional suites were also installed at command centers to provide the warfighter with the capability to plan and monitor the missile defense mission. [2] A number of activities in preparation for Block 2006 were also completed during fiscal year 2005. For example, design and planning requirements for Block 2006 software upgrades (Spirals 6.1 and 6.2), along with a Block 2006 system requirements review, were completed in June and July of 2005 respectively.

During fiscal year 2005, program officials completed the development of the final two upgrades (Spirals 4.4 and 4.5) to Block 2004 C2BMC element software. The first upgrade (Spiral 4.4) added the ability to display GMD assets on users' computer monitors, improved the user's ability to call up BMDS information, and reduced the time to transfer force-level planning files. The second upgrade (Spiral 4.5) gave C2BMC the capability to receive, distribute, and display information developed by three new sensors—the Forward-Based X-Band and Sea-Based X-Band radars and the Fylingdales upgraded early warning radar. It also improved the consistency between the data displayed by the C2BMC and the GMD fire control monitor, which also receives information directly from various sensors.

The program office installed a suite at the U.S. Pacific Command during fiscal year 2005, and it is waiting on policy agreements to turn on a Web browser— providing summary screens of the unfolding battle—in the United Kingdom. Additionally, second suites were added at the U.S. Strategic Command (STRATCOM) and the U.S. Northern Command (NORTHCOM) to allow for concurrent operations and system upgrades as well as to make the C2BMC a more robust system.

The C2BMC program also completed most of the activities needed to verify its Block 2004 capability. In August 2005, the program completed

[2] The C2BMC element includes hardware, such as workstations and communications equipment.

testing that proved the readiness of Spiral 4.4 software for operations. The program also participated in demonstrations with other elements to practice transitioning the BMDS to alert. By the end of Block 2004, the final software upgrade (Spiral 4.5) was tested to verify that the C2BMC could interface with each BMDS element and that the improved software was ready for operational use. However, further testing is needed to verify that Spiral 4.5 can provide planning and situational awareness at U.S. Northern Command, U.S. Strategic Command, U.S. Pacific Command, and the Department of Defense's Cheyenne Mountain Operations Center. Program officials told us that they expect to complete the verification tests by the end of March 2006.

Performance Mostly on Track

The C2BMC program successfully demonstrated its ability to maintain situational awareness during several ground- and flight-testing activities. Program officials were able to monitor the operational status of BMDS components and display threat information, such as missile trajectories and impact points. However, during tests, program officials discovered three primary risk items that have the potential to affect C2BMC's performance. Table 7 identifies these risks, the possible impact on program performance, and the actions being taken to address each.

Table 7: C2BMC Risk Areas

Program risks	Impact of risk	Corrective actions
Track association from multiple new Block 2004 sensors	Significant risk[a]: If the sensor tracks are unidentified, the situational awareness displays are degraded by overstating or understating the number of lethal objects impacting in a certain region.	• Implemented improvements to algorithms to handle new Block 2004 sensors—initial testing results are meeting requirements. • Continue to participate in and analyze results of various live and simulated tests with the other MDA elements.
High-availability communications network equipment design	Extensive risk[b]: If high-availability design does not function properly, the reliability of the second set of communications network equipment at each controlling command and regional gateway is degraded.	• First network nodes have been upgraded with high-availability system—nodes have been tested and are operating as designed.
Integration of new Block 2004 interfaces (Ground-based Midcourse Fire Control and FBX-T)	Significant risk: If C2BMC cannot transmit or receive messages from GFC and FBX-T, then ability to control FBX-T radar, forward track messages from FBX-T to GFC, and display GFC sensor track data, engagement data, and health and status data is degraded.	• Developed interface documents to allocate functionality, define work, and clearly articulate interfaces. • Holding weekly technical interchange meetings to identify and resolve issues. • Completed pair-wise testing, as well as integration testing to identify and resolve problems quickly.

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

[a]Significant risk: can meet requirements with about a month's time or cost to develop work-arounds or alternatives.

[b]Extensive risk: severe issues and items that cause program officials to be unable to meet requirements without about a quarter of a year 's time or cost to develop alternatives.

Terminal High Altitude Area Defense

The THAAD element is being developed as a mobile, ground-based missile defense system to protect forward-deployed military forces, population centers, and civilian assets from short- and medium-range ballistic missile attacks. A THAAD unit consists of a THAAD fire control component for controlling and executing a defensive mission, truck-mounted launchers, ground-based radars, interceptor missiles, and ground support equipment. The THAAD missile is composed of a kill vehicle mounted atop a single-stage booster and is designed to destroy enemy warheads through hit-to-kill collisions.

Assessment of Element Progress

The THAAD program is not expected to deliver an initial capability until 2009, when a fire unit and 24 missiles will be handed over to the Army for concurrent test and operation. Fiscal year 2005 activities focused on developing and ground-testing THAAD components in preparation for the initiation of THAAD's flight test program. While several of these preparatory activities were completed on schedule, others were deferred, causing a further delay in the flight test program. According to program officials, unanticipated missile integration issues caused the delay.

Integration Problems Delay Flight Tests

During fiscal year 2005, the THAAD program accomplished several key activities in preparation for flight tests, but flight tests began later in the block than planned. Program officials successfully integrated software upgrades into the launcher and radar and completed missile qualification tests that lead to flight readiness certification. However, a flight test delay that we reported last year has lengthened. [3] Two explosions in the summer of 2003 at a subcontractor's propellant mixing facility delayed the start of flight testing from December 2004 to March 2005 and led to revisions of the program's flight test plan. However, because of unanticipated integration issues, the first flight test, which validated missile performance in a high endoatmospheric flight environment, was further delayed from March to November 2005.[4] The delay occurred because program officials found problems with THAAD's Laser Initiated Ordnance System and its

[3]GAO, *Defense Acquisitions: Status of Ballistic Missile Defense Program in 2004*, GAO-05-243 (Washington, D.C.: March 2005).

[4]MDA successfully completed the first THAAD flight test on November 22, 2005.

telemetry system during ground tests and assembly operations.[5] The discovery of these problems delayed other ground tests and the assembly of the THAAD missile being manufactured for the first THAAD flight test.

Tests identified two problems in the Laser Initiated Ordnance System. A design issue caused one subcomponent to fail during testing, delaying the Laser Initiated Ordnance System's qualification test. Also, during assembly operations, the program identified a change in the Laser Initiated Ordnance System's power output that required the program to improve the design robustness of a fiber optic cable assembly. Additional qualification testing was then required to obtain range safety approval. Both of these problems, which were discovered during ground and qualification tests, were solved, but not before they affected the flight test schedule.

The program also identified a problem with the missile's telemetry system, which transmits flight test data to ground stations for observation during testing. During integration testing, transmission errors occurred between the missile's telemetry system and the ground test station. Program officials told us that a solution was found that eliminated transmission errors in the first flight test. However, the telemetry system is not providing as much information as wanted in one mode of operation. According to the officials, this does not present a problem until flight test 3, which is scheduled for July 2006, and a solution is expected by that time.

The THAAD program also had to address a number of range safety requirements prior to the initiation of flight testing. In September, the officials told us that they had addressed all requirements related to the first flight test, which did not involve an intercept attempt, and the majority of the requirements related to the second flight test. Officials do not expect any range safety requirements to delay future flight tests.

THAAD program officials plan to conduct 14 more flight tests between April 2006 and December 2008. To complete these tests prior to handing the first THAAD fire unit over to the Army for concurrent operation and tests in 2009, the program will have to successfully conduct as many as 5 flight tests in each fiscal year. Program officials told us that if all tests

[5]The Laser Initiated Ordnance System initiates THAAD missile artillery events such as boost motor ignition, separation, and flight termination. THAAD's telemetry system transmits flight test data to ground stations for observation during tests.

are successful, they can meet this schedule. However, a failure will cause delays.

THAAD's Performance Remains Uncertain

THAAD's performance and effectiveness remain uncertain until the program conducts flight tests with updated hardware and software. Data from flight testing are needed to anchor simulations of THAAD's performance and to more confidently predict the element's effectiveness.

Airborne Laser

The ABL element is a missile defense system designed to shoot down enemy missiles during the boost phase of flight, the period after launch when the missile's rocket motors are thrusting. The concept involves the coordinated operation of a high-energy laser and a beam control system that focuses the laser on a target missile. By rupturing the missile's fuel or oxidizer tank, the laser causes the missile to lose thrust or flight control, and the missile cannot reach its intended target.

The ABL element consists of three major components integrated onboard a highly modified Boeing 747 aircraft—a high-energy chemical oxygen-iodine laser; a beam control/fire control component to focus the laser's energy on a targeted spot of the enemy missile; and a battle management/command control, computers, communications, and intelligence component to plan and execute the element's defensive engagements. In addition, the element includes ground support infrastructure for storing, mixing, and handling chemicals used in the laser.

Most Fiscal Year 2005 Activities Completed on Schedule

Commensurate with its fiscal year 2004 restructuring effort, the ABL program continued to focus on near-term milestones. By accomplishing its near-term goals, the program expects to increase confidence in its longer-term program objectives of demonstrating ABL's lethality against a short-range ballistic missile target.[6] During fiscal year 2005, the program focused its efforts on testing ABL's Beam Control/ Fire Control and its high-energy laser. Nearly all activities related to these milestones were completed on schedule. Program officials noted that the program's progress over the past 18 months caused Congress to appropriate an additional $7 million for ABL's fiscal year 2006 budget.

[6]In January 2004, MDA restructured the ABL program to focus on near-term milestones and to improve confidence in longer-term schedule and cost projections.

Both First Flight and First Light—the first major milestones of the restructured program—were achieved during the first quarter of fiscal year 2005.[7] First Flight was the first of a series of planned flight tests with the Beam Control/ Fire Control segment. The test demonstrated that all necessary design, safety, and verification activities to ensure flight worthiness had been completed. It also began the process of expanding the flight envelope—types and combinations of flight conditions—in which ABL can operate. The program also completed scheduled activities associated with a series of Beam Control/ Fire Control low-power passive flight tests.[8] The program is currently integrating the full Beam Control/ Fire Control with the Beacon Illuminator Laser, which helps mitigate the effects of the atmosphere on the laser beam's quality and with the Tracking Illuminator Laser, which helps focus the laser beam on its target. Once integration is complete, the program plans to conduct a series of active flight tests planned for summer 2006.[9]

First Light, which integrated six individual laser modules to demonstrate that the combined modules can produce a single beam of laser energy, was completed in November 2004. Further tests to extend the duration of the laser's operation were scheduled for completion in September 2005. However, the tests were not completed until fiscal year 2006.

The program plans to conduct its lethality demonstration—a flight test in which the ABL aircraft will attempt to shoot down a short-range ballistic missile—no earlier than 2008. If this test is successful, MDA believes it will prove the concept of using directed energy for missile defense.

Program Moves Forward with Testing

As previously noted, the ABL's fiscal year 2005 test program was centered on its Beam Control/ Fire Control passive flight test series and its high-energy laser ground tests. The flight test series included 28 tests that enabled the program to

[7]"First Light" refers to the first ground test and demonstration of the integration of six individual laser modules that produced a single beam of laser energy.

[8]Passive flight tests are conducted without the use of the Beacon Illuminator Laser (BILL) or the Tracking Illuminator Laser (TILL). The BILL and TILL are part of the laser-beam control system used to mitigate the effects of the atmosphere on beam quality and to focus the laser beam on the target. In contrast, active flight tests include the use of the illuminator lasers.

[9]Active flight tests include the use of a functioning BILL and TILL.

- demonstrate the performance of the aircraft's turret, laser optics, and initial integration of Beam Control/ Fire Control software;
- verify the structural performance of the Active Ranger System—a system that helps ABL predict a missile's launch point;
- complete flights under various combinations of flight conditions;
- collect data critical for readying the aircraft for laser installation; and
- demonstrate the performance of Link-16—a communications component that ABL uses to interact with other elements of the BMDS.

The demonstration of First Light proved that individual laser modules, which have the fit and function needed to be placed on the aircraft, could be successfully integrated to produce a single laser beam for a fraction of a second. The program planned a series of tests during fiscal year 2005 that would gradually increase the length and power of the laser's operation. However, problems encountered during testing limited the duration of lasing to less than 1 second and affected the program's ability to determine the laser's maximum power output. Program officials told us that two of the laser's individual laser modules experienced alignment issues that prompted the system to shut down prior to completing extended lase times. The alignment problem was rectified and the program was able to conduct additional tests at longer durations. Over the fiscal year, the program operated the high-energy laser 51 times for a total of 23.5 seconds, with the longest duration being 5.25 seconds. On December 6, 2005, the program conducted a longer-duration test of the high-energy laser and was able to sustain the beam for more than 10 seconds. The ABL also produced approximately 83 percent of its design power.

Although the ABL has not reached 100 percent of its design power, program officials told us that the 83 percent power is sufficient to achieve 95 percent of maximum lethal range against all classes of ballistic missiles. Prior to the longer-duration test, program officials told us that the laser would not be installed on the aircraft until it produced 100 percent of its specified power. However, on December 9, 2005, the Director, MDA, gave the program permission to disassemble the System Integration Laboratory and begin installation of the laser on the aircraft. Program officials said that the program will continue to test the laser when the aircraft is on the ground in an effort to demonstrate that the laser can produce 100 percent of its design power.

Jitter Continues to Threaten ABL Performance

The program continues to characterize jitter as a risk to the ABL system's overall performance. Jitter is a phenomenon pertaining to the technology of controlling and stabilizing the high-energy laser beam so that vibration unique to the aircraft does not degrade the laser's aim point. Jitter control is crucial to the operation of the laser because the laser beam must be stable enough to focus sufficient energy on a fixed spot of the target missile to rupture its fuel or oxidizer tank. Program officials told us that they will not be fully confident that jitter can be controlled until it is demonstrated in an operational environment during the lethality demonstration, but data on the two major components that cause jitter were collected in ABL's System Integration Laboratory. These data were fed into simulations and models that help the program understand the effects of jitter and how components can be designed to reduce jitter. According to program officials, data obtained during recent laser and flight tests increased the program's understanding of the phenomenon.

Kinetic Energy Interceptor

The KEI element is being designed as a mobile, multi-use land-based system designed to destroy medium, intermediate, and intercontinental ballistic missiles during boost and all midcourse phases of flight. MDA originally planned to develop KEI to defeat threat missiles during the boost phase of their flight. However, in 2005 MDA directed the KEI program to incorporate the capability to engage missiles during both the ascent and the descent portions of the midcourse phase of flight, as well as the boost phase.

The KEI program is currently focused on developing a mobile, land-based system that according to program officials is expected to be available in the Block 2014 time frame. The land-based system will be a deployable unit consisting of a fire control and communications unit, mobile launchers, and interceptors. The KEI element has no sensor component, such as radars, for detecting and tracking boosting missiles. Instead, it will rely on external ballistic missile defense system sensors, such as space-based infrared sensors and forward-deployed radars.

A sea-based capability is planned in subsequent blocks. Preliminary work will also begin on a space-based interceptor in fiscal year 2008. If MDA should decide to go forward with a space-based interceptor, it would not be deployed until the next decade.

KEI Progresses Slowly

Although the KEI program completed many planned activities on schedule, the program continued to progress slower than anticipated. KEI officials were forced to replan several activities and reduce the scope of others after both Congress and MDA reduced program funding.

The activities completed during the fiscal year included constructing a shelter to house prototype fire control and communications equipment and conducting several demonstrations. According to program officials, the demonstrations showed the prototype equipment could collect data from overhead nonimaging infrared satellites in a time frame that would make a boost phase intercept possible. In addition, the program completed studies that allowed it to optimize the design of communications equipment that uplinks information from KEI's fire control and communications component to its interceptor so that there is a decreased likelihood that communications will be jammed. The studies also allowed the program to optimize the equipment's design to operate in a nuclear environment.

Other activities scheduled to be completed during fiscal year 2004 were deferred into fiscal year 2005 and have now been further delayed. For example, the System Requirements Review, which documents mission objectives, identifies critical components, and establishes a program plan, was delayed from fiscal year 2004 to 2005 and then to fiscal year 2007. Program officials noted that funding shortfalls also forced the program to eliminate some of its initial risk reduction activities. For instance, the program originally planned to develop a two-color seeker, which would aid in plume-to-hardbody handover.[10] However, because of a reduced program budget, program officials now plan to take advantage of the Aegis Ballistic Missile Defense program's development of a two-color seeker and to work on a KEI-specific two-color seeker later in the program.

NFIRE Management Transferred To STSS

In fiscal year 2005, the KEI program office planned to continue work on its Near Field Infrared Experiment (NFIRE), an experimental satellite that will collect infrared imagery of boosting intercontinental ballistic missiles. In 2004, the KEI program office signed a memorandum of agreement and transitioned day-to-day management and execution of NFIRE to the Space Tracking and Surveillance System program. The STSS Program Office has experience with satellite development and can leverage its resources to manage the experiment. STSS expects to launch NFIRE in September 2006, the launch date established by the KEI Program Office.

[10]"Plume-to-hardbody" handover refers to the identification of the actual missile from among the plume of hot exhaust gas that obscures the body of the boosting missile.

Too Early to Assess KEI's Performance

At this early stage of element development, data are not available to evaluate element performance. However, the program office identified areas of high risk that could affect performance.[11] The interceptor's booster motors, which demand high performance for KEI engagements, and the algorithm enabling the kill vehicle to identify a target missile's body from its luminous exhaust plume, are high-risk technologies. Initially, program officials were focused on designing KEI and maturing these technologies concurrently. However, the program has adopted an approach that lets it proceed with less risk. KEI is now focused on maturing the high-risk technologies before integrating them into the land-based capability.

Contract Extended despite Uncertain Future

In 2008, KEI is scheduled to participate in its first booster flight test. According to program officials, at that time a decision will be made on the program's future. In spite of program uncertainties, program officials are working to extend the prime contract. Currently, KEI's contract, which was awarded in December 2003, has a term that extends through January 2012 (98 months). Program officials are now working to extend this period until September 2015 (143 months).

Space Tracking and Surveillance System

MDA is developing STSS as a space-based sensor element of the BMDS. It is currently working on the first increment of STSS, which is focused on the preparation and launch of two technology demonstration satellites partially built under the former Space-Based Infrared System-Low (SBIRS-Low) program.[12] Each satellite making up the program's "space segment" includes a space vehicle and a payload of two infrared sensors—an acquisition sensor to watch for the bright plumes (hot exhaust gas) of boosting missiles, and a tracking sensor to follow the missile through midcourse and reentry. The STSS element also has supporting ground infrastructure, known as the ground segment, which includes a ground station and mission software to support the processing and communication of data from the satellites to the BMDS.

[11] "High-risk" means that the program will not meet its objectives without priority management actions and risk reduction activities.

[12] The two technology demonstration satellites were called the Flight Demonstration System. The satellites are expected to assume low-earth orbits at an altitude much less than satellites in geosynchronous orbit.

MDA plans to launch these satellites in 2007, in tandem, in an effort to assess how well they perform surveillance and tracking functions. Using data collected by the satellites, MDA will determine what capabilities are needed and what goals should be set for the next generation of STSS satellites. The first operational constellation of satellites is expected to be available in the 2012 time frame.

Progress on Demonstration Satellites Slows

The STSS program accomplished many of the activities planned for completion in fiscal year 2005. Both spacecraft buses have been integrated and tested, the first of two ground software builds has successfully completed acceptance testing, and the second software build is progressing on schedule. However, one key activity, delivering the payload for the first satellite, was delayed because of problems in testing of the payload. By contract, the payload for the first satellite was supposed to be delivered in January 2005, but delivery has been delayed twice, with the last delaying delivery until early 2006. The delays are affecting scheduled work on the second satellite's payload, potentially delaying the satellites' launch date.

During our last assessment of STSS, the program office expected the satellites to be launched in February 2007, earlier than the contract date of July 2007. However, the more recent problems and delays may result in the launch being later than February 2007, but still before the required launch date of July 2007. The program office is so confident that it will launch on time that it has placed an order through the National Aeronautics and Space Administration (NASA) for the Delta II launch vehicle, with a requested launch date during the second quarter of fiscal year 2007.

Vacuum Tests Delay Delivery of Payload

The first satellite payload is being delayed because problems occurred during thermal vacuum testing. Hardware issues emerged when the payload was tested in a vacuum and at cold temperatures for the first time. Although the significance of the problems is not yet clear, repairs will have to be made. The program office and contractors plan to make the repairs and then decide if further testing is needed to ensure that all problems have been corrected. Several options for testing the payload are being considered. They include (1) retesting the payload in the thermal vacuum chamber without making repairs; (2) taking the payload out of the chamber, completing the repairs, and then retesting; (3) taking the payload out of the chamber and conducting tests at ambient (room) temperatures; or (4) shipping the payload as is to the prime contractor for retest at the contractor's facility. However, if the program decides to return the payload to the contractor's facility, the contractor could not test as specifically as could be done in the vacuum chamber, making it challenging to isolate problems. If further testing is completed before returning the payload to the prime contractor, several weeks will be added to the schedule because the payload will have to be removed from the vacuum chamber, disassembled, repaired, reassembled, and placed back in the chamber. The chamber will then have to be returned to the right vacuum and temperature conditions and the payload retested.

The program office is having an independent team review the situation with the first payload to determine how much more testing should be conducted. The program manager does not believe any of the thermal vacuum testing problems are mission assurance or performance issues.

In addition to the thermal vacuum issues, integration issues have been discovered as the subcontractor continues to integrate and test the payload at successively higher levels of integration. The payload ambient-level testing took nearly 3 months longer than expected to complete. This was due to the large number of software and hardware integration issues discovered when the flight hardware and software were tested together for the first time. Most software issues are due to the configuration differences between the pathfinder hardware that served as the test bed for the payload software and the actual flight hardware.

Program Continues to Address Quality Problems

The quality and workmanship problems with the payload subcontractor have continued to persist. These problems have been ongoing for the last 2 years and have contributed to a schedule delay in delivering the payload. According to program officials, the quality and workmanship problems are the result of the subcontractor's lack of experience. Examples of the quality and workmanship issues include the initial failure of the second satellite's track sensor during vibration testing. The failure occurred because fasteners were not tightened according to specifications and because payload cables were poorly manufactured by a third-tier vendor. Although neither of these issues resulted in damage to the flight hardware, both have taken substantial management attention and considerable effort to correct. In response to the quality and workmanship issues, quality control at the subcontractor's site has undergone significant restructuring. In addition, the prime contractor's on-site quality organization at the subcontractor's site stepped up its inspection and supervision of all processes and is providing mentoring. A reeducation effort was also undertaken to ensure that all personnel on the program knew and understood the program instructions.

The program office expects that the quality improvements the payload subcontractor has implemented will reduce the probability of additional quality-related issues in the future. According to the program office, the integration issues that have been discovered are not unusual for a first-time integration effort, but are taking more time than planned to work through. However, the second satellite's hardware is consistently moving through integration and testing much more efficiently than the first satellite's hardware.

Appendix III: An Assessment of BMDS Prime Contractors' Cost and Schedule Performance

Prime contractors typically receive most of the funds that MDA requests from Congress each fiscal year to develop elements of the BMDS. To determine if it is receiving a dollar of value for each dollar it spends, each BMDS program office requires its prime contractor to provide monthly reports detailing cost and schedule performance. In these reports, which are known as Contract Performance Reports (CPR), the prime contractor makes comparisons that inform the program as to whether the contractor is completing work at the cost budgeted and whether the work scheduled is being completed on time.[1] If the contractor does not spend all funds budgeted or completes more work than planned, the CPR shows positive cost and/or schedule variances. Similarly, if the contractor spends more than planned or cannot complete all of the work scheduled, the CPR shows negative cost and/or schedule variances. Using data from the CPR, a program manager can assess trends in cost and schedule performance, information that is useful because trends tend to persist. Studies have shown that once a contract is 15 percent complete, performance metrics are indicative of the contract's final outcome.

We used CPR data to assess the fiscal year 2005 cost and schedule performance of prime contractors for seven BMDS elements. When possible, we also predicted the likely cost of each prime contract at completion. Our predictions of final contract cost are based on the assumption that the contractor will continue to perform in the future as it has in the past. An assessment of each element is provided in this appendix.

Aegis BMD Contractors Deliver Good Performance

The Aegis BMD program has a prime contract for each of its two major components—the Aegis BMD Weapon System and the Standard Missile-3. During fiscal year 2005, both contractors completed most of their planned activities on time and at or less than budgeted costs. Based on the weapon system contractor's performance through fiscal year 2005, the contractor could underrun the budgeted cost of the contract by about $7.1 million to $12.5 million, while the SM-3 contractor could underrun its budgeted costs for the contract by about $11.5 million to $17.8 million.

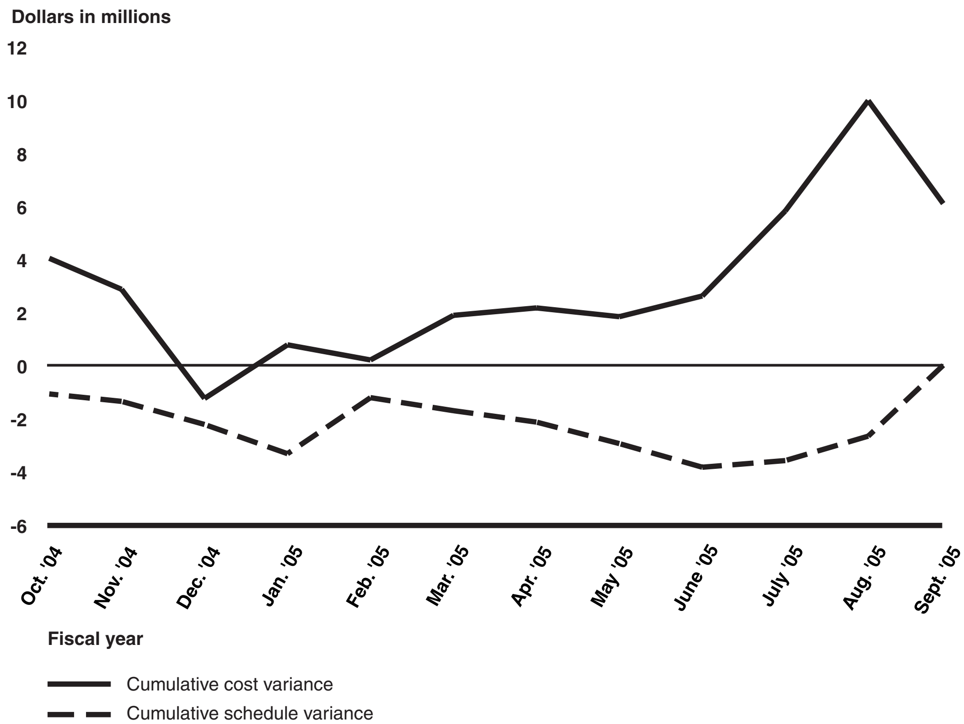
Aegis BMD Weapon System Contractor Mostly on Track

Weapon System CPRs show that the contractor underran its budgeted costs for the prime contract and was able to complete all of its planned

[1] In March 2005, DOD directed that CPRs be named Contract Performance Reports. Formerly, CPRs were known as Cost Performance Reports.

work on schedule. The weapon system contract's cumulative cost and schedule variances—variances that take into account all work completed on the contract since its award—are highlighted in figure 2.

Figure 2: Aegis BMD Weapon System Fiscal Year 2005 Cost and Schedule Performance



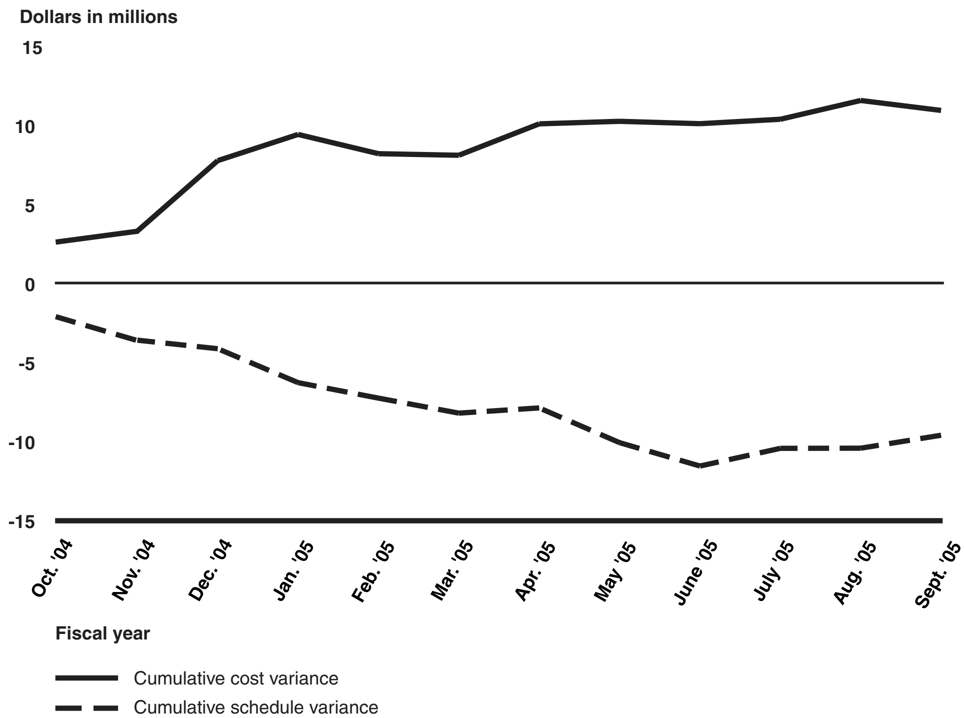
Source: Contractor (data); GAO (analysis).

According to program officials, the minimal schedule variance during the fiscal year was driven by ship availability and changing test event schedules. Additionally, the contractor incurred a $6 million positive cost variance as a result of underruns for Block 2004 and Block 2006 efforts. In September 2005, work tasks were replanned for the Block 2004 completion effort to reflect funding impacts.

Standard Missile-3 Contractor's Cost Performance Is Mostly Good

The prime contractor for the SM-3 missile component performed within its budgeted costs, but was slightly behind schedule. By the end of fiscal year 2005, the contractor reported a positive cost variance of $10.9 million and a negative schedule variance of $9.6 million. Figure 3 illustrates the cumulative cost and schedule performance for the SM-3 prime contractor.

Figure 3: Standard Missile 3 Fiscal Year 2005 Cost and Schedule Performance



Source: Contractor (data); GAO (analysis).

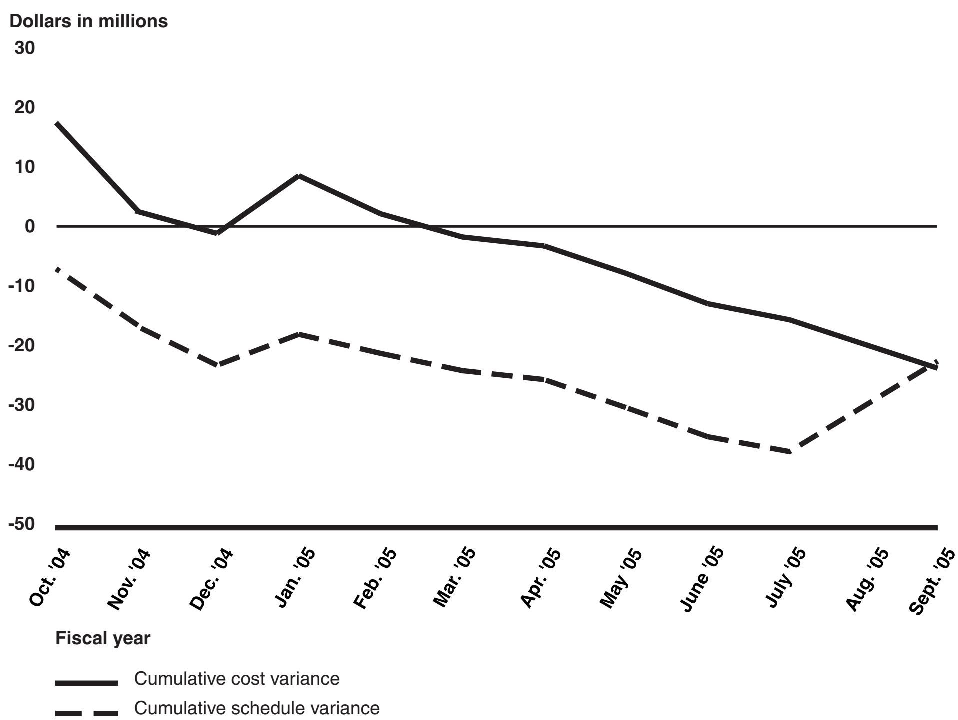
Our analysis of CPR data shows that the contractor spent less than budgeted because it did not need all staff originally planned to conduct test events; these events were delayed because of ship availability and fleet priorities. Program officials told us that the tests were rescheduled when the contractor was unable to meet the planned test dates. The funds budgeted for these tests will be used to conduct the tests at the rescheduled dates.

The delayed test events also caused the contractor to fall slightly behind schedule. In addition, the contractor could not complete some planned work because hardware deliveries were late, delaying related integration activities. Despite these delays, the program asserts that the contractor has met most of its contractual delivery dates thus far, and the program expects the contractor to meet future delivery obligations.

Despite Restructure, ABL Contractor Experiences Cost and Schedule Growth

Our analysis of ABL CPRs indicates that the prime contractor's cost and schedule performance declined during fiscal year 2005 despite the program's restructuring efforts in the spring of 2004. The program restructured the contract to give the contractor a more realistic budget and schedule to do work that is needed to get ready for and complete a lethality demonstration of the ABL element. Despite these adjustments, the contractor was unable to complete fiscal year 2005 activities within budget or on schedule. As illustrated in figure 4, the ABL contractor incurred a negative cost variance of $23.1 million and a negative schedule variance of $23.6 million during fiscal year 2005.

Figure 4: Airborne Laser Fiscal Year 2005 Cost and Schedule Performance



Source: Contractor (data); GAO (analysis).

Note: As agreed to by both the contractor and the ABL System Program Office, August 2005 CPR data included actual costs only. Therefore, the data point for August 2005 is not included.

The program planned to complete two major activities during fiscal year 2005—passive flight tests of ABL's Beam Control/Fire Control component and duration tests of the system's high-energy laser. [2] However, technical challenges associated with these activities increased costs and delayed scheduled work. Changes had to be made to Beam Control/Fire Control software, and additional work was needed on the Beam Control/Fire Control Hard Wire Abort System to support test activities. In addition, the program also reprioritized activities throughout the program. Furthermore, the contractor informed the ABL program office that negative cost variances caused by technical problems related to the element's Active Ranger System and Beacon Illuminator Laser components cannot be recovered.[3] These problems and their potential impact on the program are outlined in table 8.

Table 8: Airborne Laser Technical Issues and Their Potential Impact on Program

Component	Technical issue	Potential impact
Active Ranger System (ARS)	• Laser range receiver cannot consistently perform as expected • Contaminated, damaged, and inefficient optics must be redesigned and replaced • The ARS does not meet all design requirements	• Schedule delays—the program currently anticipates that the ARS will not be delivered until after ABL's lethal demonstration, which is scheduled to be completed no earlier than 2008. According to program officials, the ARS is not required for lethal demonstration. • Decrease in expected performance—without the ARS, the ABL has reduced ability to estimate missile launch and impact points. ABL's ability to respond to simultaneous missiles may also be reduced.
Beacon Illuminator Laser	• Rapid prototyping led to numerous faults in power supplies	• Delays in completing performance testing of the component

Source: MDA.

According to program officials, the late delivery of the Active Ranger System will not affect ABL's planned 2008 lethality demonstration because the test will not require ABL to estimate the target missile's launch or impact point. Neither will the test include more than one target. However, the delay could affect the contract's schedule and cost because planned work related to the Active Ranger System may not be completed and the

[2]The Beam Control/Fire Control component's primary function is to maintain the beam's quality as it travels through the aircraft and into the atmosphere. Passive flight tests of this component are tests conducted without ABL lasers that measure atmospheric disturbance and that track the target.

[3]The Active Ranger System is the laser that sits atop the aircraft and provides preliminary range and tracking of a target missile. The Beacon Illuminator Laser is the laser that bounces a beam off the target missile back to the aircraft and thus measures the amount of atmospheric disturbance between the aircraft and the target.

cost of unplanned work needed to resolve the technical problems was not included in the contractor's budget.

Despite program challenges, program officials noted that the contractor still believes it can complete the contract within the current contract ceiling. However, based on our analysis of the program's fiscal year 2005 performance, we estimate a contract overrun of between $43.8 million and $231.7 million.

Lack of Reporting Limits Knowledge of C2BMC Contractor's Performance

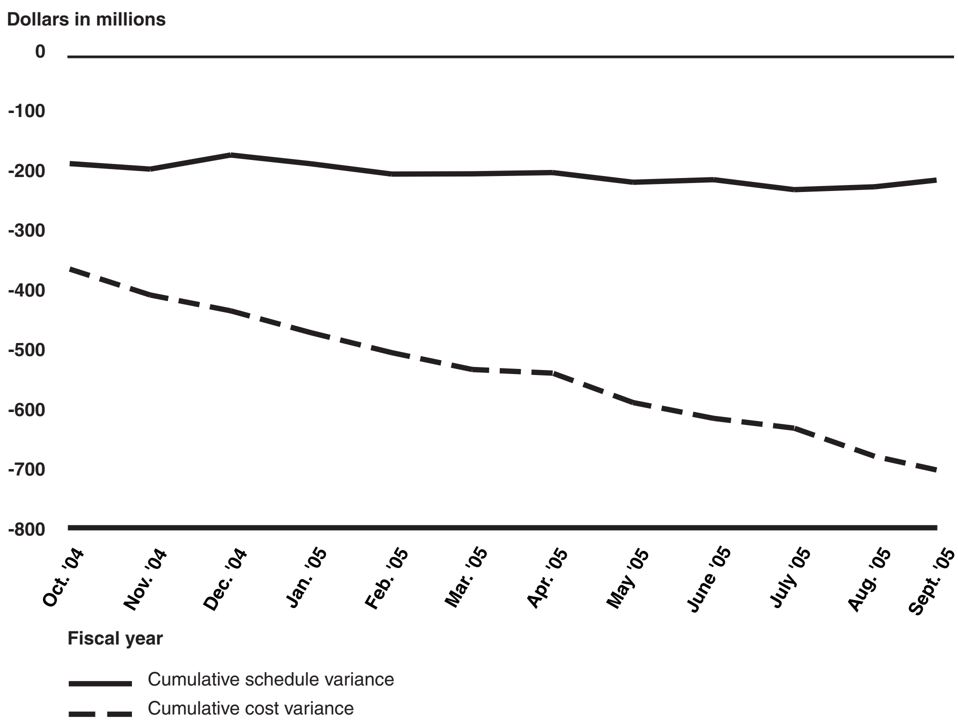
Our analysis of the performance of the contractor developing the C2BMC element was limited because the program did not deliver CPRs for 6 months during fiscal year 2005. Program officials cited the dynamics of the program as the primary reason for the suspension. In 2004, the C2BMC program office directed the contractor to add requirements to integrate a Forward-Based X-band—Transportable radar into the program's architecture, adjust its schedule to absorb funding reductions, and make several high-priority engineering changes. The contractor was unable to update its work plan and realign its budget quickly enough to reflect these changes. Without changes, CPRs would have compared the work under way with an outdated schedule and budget and would not have reflected the contractor's true performance. The contractor completed all activities needed to replan its work in May 2005 and began to deliver CPRs in June 2005. By the close of fiscal year 2005, the contractor reported that it was performing work within budget and slightly behind schedule. The cumulative cost and schedule variances for the contract were approximately positive $1.7 million and negative $ 0.9 million, respectively. Our analysis shows that based on its performance so far, the contractor should be able to complete all scheduled contract work within the contract's negotiated cost.

GMD Contractor's Performance Continues to Decline

The GMD prime contractor's cost and schedule performance continued to erode during fiscal year 2005. By September 2005, the cumulative cost of all work completed was $713 million more than expected, and the contractor had incurred a cumulative negative schedule variance of $228 million. In fiscal year 2005 alone, work cost about $365 million more than budgeted. Furthermore, CPRs show that the contractor incurred a negative schedule variance of approximately $39 million during the fiscal year. However, officials in MDA's Office of Business Management told us that the schedule variance does not capture some work planned for fiscal year 2005 that was deferred. The officials said that if the contractor deferred fiscal year 2005 work to another fiscal year before the work was begun, the CPR would not show that the contractor was behind schedule in completing that work.

Judging from the contractor's cost and schedule performance in fiscal year 2005, we estimate that at the contract's completion, the contractor will have overrun the budgeted cost of the contract by between $1.0 billion and $1.4 billion. Figure 5 shows the unfavorable trend in GMD fiscal year 2005 performance.

Figure 5: Ground-based Midcourse Defense Fiscal Year 2005 Cost and Schedule Performance



Source: Contractor (data); GAO (analysis).

Developmental issues with the interceptor continue to be the leading contributor to cost overruns and schedule slips for the GMD program. Interceptor-related work cost $240 million more than budgeted in fiscal year 2005, with the kill vehicle accounting for more than 42 percent of this overrun. Poor quality control has led to a number of technical problems with the kill vehicle—such as foreign object debris in wiring harnesses and leaks in thermal batteries—that have increased manpower and rework costs. Additionally, the contractor for the BV+ booster incurred increased costs as a result of inefficiencies related to its transition to a new supplier. New requirements and redesign efforts related to the BV+ booster also contributed to the prime contractor's negative cost performance.

The program's schedule variance grew as flight and ground tests were delayed. During fiscal year 2005, several flight tests were deferred after the interceptors in two flight tests failed to launch. The GMD program has restructured its test plan, and the first flight test was successfully conducted in December 2005. Program officials noted that the contractor expects to reduce its schedule variance in fiscal year 2006. However, the program's negative performance forced the program to restructure its future work efforts and extend its prime contract by 1 year.

Kinetic Energy Interceptors

In March 2005, we reported that plans to restructure the KEI contract prompted program office officials to suspend CPRs.[4] The contract has since been restructured, and the contractor began delivering CPRs in March 2005. As of September 2005, the KEI prime contractor had completed approximately 4 percent of its planned work and was performing within its budgeted costs, but slightly behind schedule. The program incurred a positive cost variance of $3.0 million and a negative schedule variance of $3.9 million during the fiscal year. Because the contractor has completed a small percentage of the work required by the contract, the contractor's performance to date cannot be used to estimate whether the contract can be completed within its estimated cost.

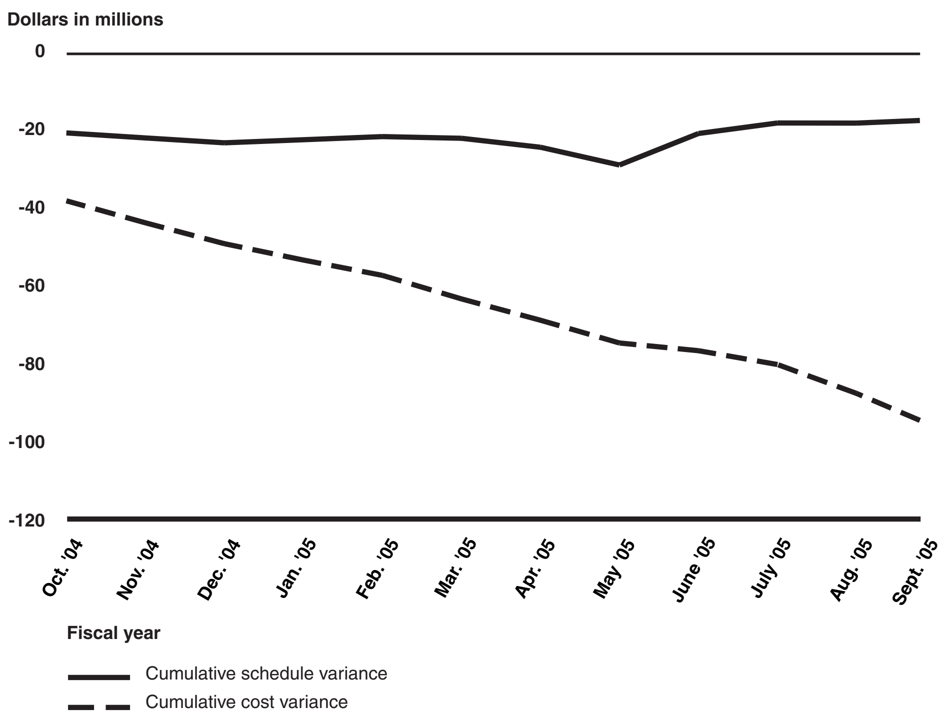
The KEI program is undergoing several contract modifications to address additional requirements. In July 2005, the program modified the contract to require that KEI be capable of intercepting enemy missiles in the midcourse of their flight. Consequently, the program plans to extend the prime contract to better align its cost and schedule objectives with the new work content. Future CPRs will compare the contractor's performance with the new cost and schedule objectives. Program officials plan to begin work on the midcourse capability in fiscal year 2008 and will continue to develop this capability through the end of the contract, which is expected to be September 2015.

[4]GAO, *Defense Acquisitions: Status of Ballistic Missile Defense Program in 2004*, GAO-05-243 (Washington, D.C.: Mar. 31, 2005).

STSS Contractor's Performance Declines

Our analysis of contractor performance reports shows that the STSS program continued to experience a decline in contractor performance during fiscal year 2005. As depicted in figure 6, the contractor incurred cumulative negative cost and schedule variances of $97 million and $20 million, respectively. If the contractor's performance continues to decline, we estimate that at its completion the contract will exceed budgeted cost by between $248 million and $479 million. However, program officials noted that more than 90 percent of the contractor's past performance can be attributed to a subcontractor whose work will be completed in fiscal year 2006.

Figure 6: Space Tracking and Surveillance System Fiscal Year 2005 Cost and Schedule Performance



Source: Contractor (data); GAO (analysis).

Quality issues with the subcontractor were the primary reason that the STSS prime contractor overran its fiscal year 2005 budget. For example, poor workmanship caused a satellite's sensor payload to fail a vibration test because fasteners—designed to hold the sensor steady—were not tightened according to specifications. Additionally, poor workmanship at a third-tier vendor led to difficulties in manufacturing payload cables.

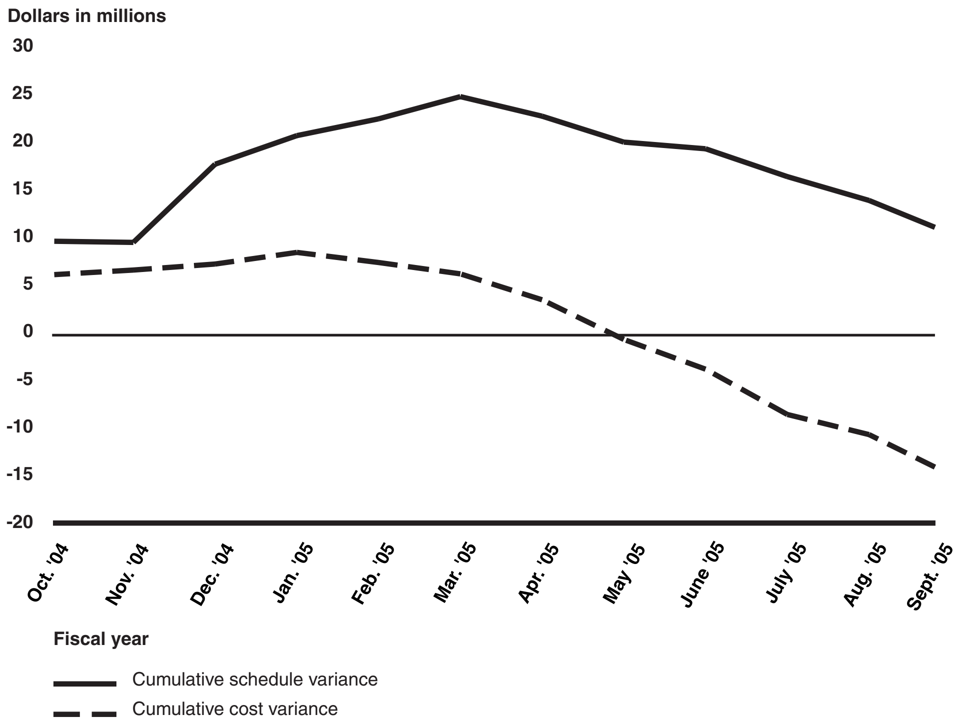
Program officials told us that the prime contractor had to direct management attention and considerable effort to rectify the effects of the subcontractor's poor quality control procedures. In addition to citing quality issues, program officials told us that they continue to encounter integration-related problems as the program progresses with testing the payload at successively higher levels of integration.

Program officials noted that the subcontractor has made some improvements to its quality control program that should minimize future quality-related problems. For example, the subcontractor instituted an on-site Quality Assurance Council to develop improvements to the quality process at all levels of the organization. Additionally, quality personnel increased the number of inspections and supervision of all processes to ensure quality control.

Overall Performance of THAAD Contractor Declines

During fiscal year 2005, the THAAD program incurred cumulative cost overruns on its prime contract. As of September 2005, the contractor was overrunning its budgeted costs for the fiscal year by approximately $19 million, but it was still ahead of schedule. Because the cost performance of the contractor prior to fiscal year 2005 was positive, the cumulative overrun through September 2005 was about $15 million. Figure 7 illustrates the cumulative cost and schedule variances incurred by the program during the fiscal year. Judging from the contractor's cost performance to date, we estimate that the contract could exceed its budgeted cost by about $48 million.

Figure 7: Terminal High Altitude Area Defense Fiscal Year 2005 Cost and Schedule Performance



Source: Contractor (data); GAO (analysis).

During fiscal year 2005, the missile component continued to be the lead cause of the contractor's negative performance. Major factors contributing to the missile's cost variance include delays in activating a test facility at the Air Force Research Laboratory, redesign of faulty valves, performance issues related to vibration and shock testing, and unplanned hardware fabrication, assembly, and support costs. Redesign, material growth, and integration issues related to the missile also contributed to the program's unfavorable cost performance.

Appendix IV: MDA'S Audit of GMD Interceptor Contractors

In 2005, MDA's Office of Safety, Quality, and Mission Assurance conducted audits of the contractor developing the interceptor's exoatmospheric kill vehicle and the Orbital Boost Vehicle. In its audit of the EKV contractor, a number of quality control weaknesses were documented. First, the MDA auditors found evidence that the prime contractor had not correctly communicated all essential EKV requirements to its subcontractor and the subcontractor had not communicated complete and correct requirements to its suppliers. For example, the prime contractor did not require the EKV contractor to use space-qualified parts—parts that have been proven to reliably withstand the harsh environment of space. Similarly, the auditors found that the subcontractor had not always provided its suppliers with correct parts, materials, and processes requirements. For example, the auditors found multiple incidents in which the subcontractor required one supplier to abide by incorrect or outdated compliance documents.

The audit also identified numerous instances in which the EKV subcontractor had not exercised good configuration control. In some cases, drawings did not reflect current changes. In others, assembly records did not agree with build records. For example, the assembly record for one component showed that it included a different part from the one recorded in its build record. In another, the assembly tag showed that a component was not built in the same configuration shown in the build record.

Auditors found that the reliability of the EKV's design cannot be determined and any estimates of its serviceable life are likely unsupportable. The audit team established that the results from a March 2004 failure modes effects and criticality analysis were not fully used to influence the design of the EKV and that the contractor has not planned or performed a reliability demonstration, a maintainability analysis or demonstration, and does not plan reliability growth testing. Additionally, major requirements waivers approved on the basis of a short-term, limited-life mission significantly limit service life and have not been fully vetted, accepted, and mitigated for longer-term operational use.

Further, auditors determined that the contractor has no written policy involving qualification testing and does not require that its EKV subcontractor follow requirements established by industry, civilian, and military users of space and launch vehicles. For this reason, tests of the EKV under thermal vacuum conditions representative of those found in space are not being conducted. The auditors also identified numerous issues with EKV shock and vibration testing and found that the contractor performs no formal qualification or acceptance tests on the EKV.

Finally, the audit showed that because the contractor's production processes are immature, the contractor cannot build a consistent and reliable product. For example, auditors found instances where work instructions were not followed and a number of deficiencies in the build books that lay out the plans and processes for manufacturing the EKV.

Similarly, the auditors found that the contractor producing the Orbital Boost Vehicle needed to improve quality control processes and adherence to those processes. According to deficiency reports, the contractor, did not always, among other things, flow down requirements properly; practice good configuration management to ensure that the booster met form, fit, and function requirements; implement effective environmental stress screening; or have an approved parts, material, and processes management plan.

Appendix V: Integrated Management Plan

Event 0 – Block Capability Alternative

- Block planning process completed
- Long lead targets, tests and exercises identified
- Affordability analysis completed
- Acquisition strategy approved
- Preliminary block plan approved

Event 1 – Preliminary block definition

- Block performance assessments updated
- Detailed cost estimates/estimates at completions (EAC) available
- Costs/benefit analysis updated
- Risks assessed and mitigation programs established
- Preliminary operational concept and operations architecture drafted
- Integration test objectives defined
- Preliminary designs for all elements/components/targets completed
- Required funding identified for development
- Integrated master schedule created
- Preliminary block definition approved

Event 2 – Final block definition

- Performance assessments updated
- Detailed cost estimates/EACs available
- Risks assessed and mitigation programs updated
- Military utility characterized and operational concept refined
- Preliminary integration test plan available
- Final design for all elements/components/targets completed
- Funding available for development
- Integrated master schedule updated
- Block activation plan available
- Block definition updated

Event 3 – First complete development article

- Detailed cost estimates/EACs available
- Operational concept defined and operations architecture available
- Test range and support planning completed
- Military utility assessment completed
- First development article/targets built and initial tests completed

Event 4 – Element/Component development complete

- Detailed cost estimates/EACs available
- Block integration test planning completed
- Element/component/targets development and testing complete
- Support systems defined
- Training systems defined
- Fielding readiness assessed (initial defensive operations)

Event 5 – Interim block integration and capability assessment

- Detailed cost estimates/EACs available
- Initial operational characterization completed
- Interim block capability performance assessment
- Initial transition planning completed

Event 6 – Fielding completed

- Detailed cost estimate/EACs available
- Transition plans completed and funded
- Operational characterization and certification completed
- System/element/component performance assessment completed
- Support systems planned, budgeted and approved
- Training systems planned, budgeted and approved
- Production plans available
- Updated block definition available
- Combatant commander and service memorandum of agreements coordinated
- MDA capability declaration

Event 7 – Block capability activation

- Combatant commander planning complete
- Equipment introduction and checkout
- Unit level training, qualification, and certification complete
- Integrated BMDS level training, qualification, and certification compete

Appendix VI: Scope and Methodology

To examine the progress MDA made in fiscal year 2005 toward its Block 2004 goals, we examined the efforts of individual programs that are developing BMDS elements under the management of MDA, such as the GMD program. The elements included in our review collectively accounted for 73 percent of MDA's fiscal year 2005 research and development budget requests. We compared each element's completed activities, test results, demonstrated performance, and actual cost achieved in fiscal year 2005 with those planned for fiscal year 2005. In making this comparison, we examined System Element Reviews, test schedules, test reports, and MDA briefing charts. To assess each element's progress toward its cost goals, we reviewed Contract Performance Reports and Defense Contract Management Agency's analyses of these reports (if available). We applied established earned value management techniques to data captured in Contract Performance Reports to determine trends and used established earned value management formulas to project the likely costs of prime contracts at completion. We also developed data collection instruments, which were submitted to MDA and each element program office, to gather detailed information on completed program activities, including tests, design reviews, prime contracts, and estimates of element performance. In addition, we discussed fiscal year 2005 progress with officials in MDA's Business Management Office and each element program office, as well as the office of DOD's Director, Operational Test and Evaluation.

To determine whether MDA achieved the quantity, cost, and performance goals it set for Block 2004 in February 2003, we examined fielding schedules, System Element Reviews, test reports, budget estimate submissions, and the U.S. Strategic Command's Military Utility Assessment. We also held discussions with the Aegis BMD, GMD, and C2BMC program offices; MDA's Office of Safety, Quality and Assurance; and the Office of the Director, Operational Test and Evaluation.

We determined the conditions that prevented MDA from achieving its Block 2004 goals by examining MDA's implementation of its Integrated Management Plan, the Secretary of Defense 2002 memo establishing the Ballistic Missile Defense Program, and audits conducted by MDA's Office of Safety, Quality, and Mission Assurance. We also held discussions with MDA's Offices of Business Management and Safety, Quality, and Mission Assurance and the GMD Program Office.

In determining the actions MDA is taking to address problems that affected the outcome of Block 2004, we reviewed MDA Assurance Provisions, recommendations of the Mission Return to Flight Task Force, memorandums of agreement between MDA and the Defense Contract Management Agency and MDA and the National Aeronautics and Space Administration, GMD award fee letters, and directives issued by MDA's Director. We also discussed MDA's plans with members of the Mission Readiness Task Force and officials in the agency's Office of Safety, Quality, and Mission Assurance.

To ensure that MDA-generated data used in our assessment are reliable, we evaluated the agency's management control processes. We discussed these processes extensively with MDA upper management. In addition, we confirmed the accuracy of MDA-generated data with multiple sources within MDA and, when possible, with independent experts. To assess the validity and reliability of prime contractors' earned value management systems and reports, we analyzed audit reports prepared by the Defense Contract Audit Agency. Finally, we assessed MDA's internal accounting and administrative management controls by reviewing MDA's Federal Manager's Financial Integrity Report for Fiscal Years 2003, 2004, and 2005.

Our work was performed primarily at MDA headquarters in Arlington, Virginia. At this location, we met with officials from the Kinetic Energy Interceptors Program Office; Aegis Ballistic Missile Defense Program Office; Airborne Laser Program Office; Command, Control, Battle Management, and Communications Program Office; Business Management Office; and Office of Safety, Quality, and Mission Assurance. In addition, we met with officials from the Space Tracking and Surveillance System Program Office, El Segundo, California; and the Ground-based Midcourse Defense Program Office and Terminal High Altitude Area Defense Project Office, Huntsville, Alabama. We also interviewed officials from the office of the Director, Operational Test and Evaluation, Arlington, Virginia.

We conducted our review from May 2005 through March 2006 in accordance with generally accepted government auditing standards.

Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

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