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Report to the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

October 2003

DEFENSE ACQUISITIONS

Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns

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GAO-04-48

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GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-04-48, a report to the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

In 1996, the Department of Defense (DOD) initiated the Space-Based Infrared System (SBIRS) to provide greater long-range ballistic missile detection capabilities than its current system. The initial SBIRS architecture included "High" and "Low" orbiting space-based components and ground processing segments.

SBIRS has been technically challenging, and in October 2001, SBIRS Low was transferred from the Air Force to the Missile Defense Agency. The Air Force expected to field SBIRS High by 2004, but numerous problems have led to schedule overruns. In the fall of 2001, DOD identified potential cost growth of $2 billion.

To determine the causes of the significant cost growth, DOD convened an Independent Review Team. In August 2002, the Air Force restructured the program to address the findings of the team's assessment. Our report (1) describes the key elements of the restructured program and (2) identifies problems and potential risks still facing the program.

What GAO Recommends

GAO is recommending that DOD convene a task force to assess the restructured program with an emphasis on providing concrete guidance for the program to address its underlying problems. DOD agrees that another review of the program is warranted.

www.gao.gov/cgi-bin/getrpt?GAO-04-48.

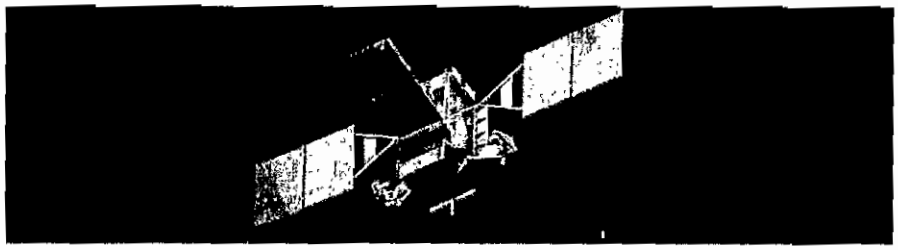
To view the full product, including the scope and methodology, click on the link above. For more information, contact Robert Levin at (202) 512-4841 or levinr@gao.gov.

What GAO Found

In an effort to get the SBIRS High program on track, the most recent program restructuring provided contractor incentives and oversight measures, as recommended by the Independent Review Team. Under the current contract, the prime contractor's award fees are now tied to the incremental delivery of specific system capabilities. DOD also modified the contract to prescribe tighter management controls, improve reporting of contractor information, and add formal review processes by DOD management. This increased oversight is intended, in part, to minimize further changes in requirements and improve management of software development, both of which have been particularly problematic. The restructuring also added funding and other resources to the program and extended the scheduled delivery of certain components. At the time of the restructuring, the Air Force believed the modified contract established an executable schedule, a realistic set of requirements, and adequate funding.

However, the restructuring did not fully address some long-standing problems identified by the Independent Review Team. As a result, the program continues to be at substantial risk of cost and schedule increases. Key among the problems is the program's history of moving forward without sufficient knowledge to ensure that the product design is stable and meets performance requirements and that adequate resources are available. For example, a year before the restructuring, the program passed its critical design review with only 50 percent of its design drawings completed, compared to 90 percent as recommended by best practices. Consequently, several design modifications were necessary, including 39 to the first of two infrared sensors to reduce excessive noise created by electromagnetic interference—a threat to the host satellite's functionality—delaying delivery of the sensor by 10 months or more. Software development underlies most of the top 10 program risks, according to the contractor and the SBIRS High Program Office. For example, testing of the first infrared sensor revealed several deficiencies in the flight software involving the sensor's ability to maintain earth coverage and track missiles while orbiting the earth. Program officials stated that they are coordinating the delivery of the first sensor with the delivery of the host satellite to mitigate any schedule impacts, but they agreed that these delays put the remaining SBIRS High schedule at risk.

Illustration of geosynchronous earth-orbiting satellite



Source: Lockheed Martin

Contents

Abbreviations

CMMI	Capability Maturity Model Integration
DCMA	Defense Contract Management Agency
DOD	Department of Defense
DSP	Defense Support Program
EMI	electromagnetic interference
EVMS	Earned Value Management System
GEO	geosynchronous earth orbit
HEO	highly elliptical orbit
IRT	Independent Review Team
ITW/AA	integrated tactical warning/attack assessment
LEO	low earth orbit
M3P	multimission mobile processor
MCS	mission control station
ORD	operational requirements document
OSD	Office of the Secretary of Defense
SBIRS	Space-Based Infrared System
TES	theater event system
TSPR	Total Systems Performance Responsibility
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics

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October 31, 2003

The Honorable Wayne Allard
Chairman
The Honorable Bill Nelson
Ranking Minority Member
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate

Since the early 1980s, the Department of Defense (DOD) has initiated several long-range ballistic missile detection programs aimed at providing greater capabilities than the Defense Support Program (DSP), the currently operating strategic-surveillance and early warning satellite system.[1] In 1996, DOD initiated the most recent of these efforts: the Space-Based Infrared System (SBIRS). SBIRS has proven to be a technically challenging program, intended to combine all military infrared surveillance requirements into a single, integrated system, or "system of systems," to provide accurate and timely warning and tracking of a ballistic missile attack. The initial SBIRS architecture included "High" and "Low" orbiting space-based components[2] and ground processing segments. In October 2001, the Low component was transferred from the Air Force to the Missile Defense Agency and in 2002 was renamed the Space Tracking and Surveillance System.[3] The Air Force continues to develop SBIRS High and its related ground segment—now one of DOD's highest priority space programs—as an upgrade and eventual replacement for DSP.

Originally, SBIRS High was expected to be fielded between 1999 and 2004, under a research and development contract with an estimated value of $1.8 billion. However, since the program began, it has encountered a

[1] The detection programs DOD initiated were the Advanced Warning System (early 1980s); the Boost Surveillance and Tracking System (late 1980s); the Follow-On Early Warning System (early 1990s); and the Alert, Locate, and Report Missiles System (mid-1990s).

[2] The High component has elements in highly elliptical orbit and geosynchronous earth orbit; the Low component has elements in low earth orbit.

[3] U.S. General Accounting Office, *Missile Defense: Alternate Approaches to Space Tracking and Surveillance System Need to Be Considered*, GAO-03-597 (Washington, D.C.: May 23, 2003).

number of problems, including immature technologies and changing requirements, that have resulted in cost and schedule overruns. In the fall of 2001, DOD identified cost growth of at least $2 billion, which, because it exceeded a statutory threshold, triggered a Nunn-McCurdy review and certification of the program as required by law.[4]

To determine the underlying causes of the significant cost growth, DOD convened an Independent Review Team (IRT), and in August 2002, the Air Force restructured the program to address the findings of the IRT assessment. Currently, the amount under contract for the SBIRS High program is $4.4 billion. Concerned that cost, schedule, and performance problems may persist, you asked us to (1) describe the key elements of the restructured program and (2) identify problems and potential risks still facing the program.

Results in Brief

In an effort to get the SBIRS High program on track, the most recent program restructuring provided additional resources, contractor incentives, and oversight measures. DOD modified its contract with Lockheed Martin Space Systems Company,[5] the prime contractor, to prescribe tighter management controls, improve reporting of contractor information, and add formal review processes by DOD management. This increased oversight is intended, in part, to minimize further changes in requirements and improve management of software development, both of which have been particularly problematic in the development of SBIRS High. Additionally, Lockheed Martin's award fees have been tied to the incremental delivery of specific system capabilities. At the time of the restructuring, the Air Force believed the contract, as modified, established an executable schedule, a realistic set of requirements, and adequate funding to address the underlying factors that led to the cost growth and Nunn-McCurdy review.

While the restructuring implemented a number of needed management changes, it did not fully address some long-standing problems in the development of SBIRS High identified by the IRT. As a result, the program continues to be at substantial risk of cost and schedule increases. Key among the problems is the program's history of moving forward with system development before requirements are set and sufficient knowledge

[4] 10 U.S.C. § 2433.

[5] An operating unit of the Lockheed Martin Corporation.

is gained. For example, a year before the restructuring, the program passed its critical design review with only 50 percent of its design drawings completed, compared to 90 percent as recommended by the best practices that we have found characterize successful programs. Consequently, several design modifications have been necessary, including 39 modifications to the first of two infrared sensors to reduce excessive noise created by electromagnetic interference—a threat to the host satellite's functionality—delaying delivery of the sensor by 10 months. Software development also remains problematic. For example, Defense Contract Management Agency (DCMA) officials report that testing of the first infrared sensor in May 2003 revealed several deficiencies in the flight software involving the sensor's ability to maintain earth coverage and track missiles while orbiting the earth. According to the contractor and SBIRS High Program Office, software development underlies most of the top 10 program risks. Moreover, delays in the development of the first sensor have had a cascading effect. For example, the continuing design and software development work on the first sensor is now competing for staff and other resources that were scheduled to be used for follow-on developmental tasks. Program officials stated that they are coordinating the delivery of the first sensor with the delivery of the host satellite to mitigate any schedule impacts, but they agreed that these delays put the remaining SBIRS High schedule at risk.

We are recommending that DOD reassess the SBIRS High program with the aim of making the best decisions for proceeding with the procurement of a system that meets this nation's need for strategic surveillance and early warning satellite data. DOD agrees that a thorough review of the SBIRS High program is warranted but would like the flexibility to consider other approaches before making a final decision on assigning responsibilities for conducting a review. (DOD's comments are reprinted in app. I.) We agreed and modified our recommendations accordingly.

Background

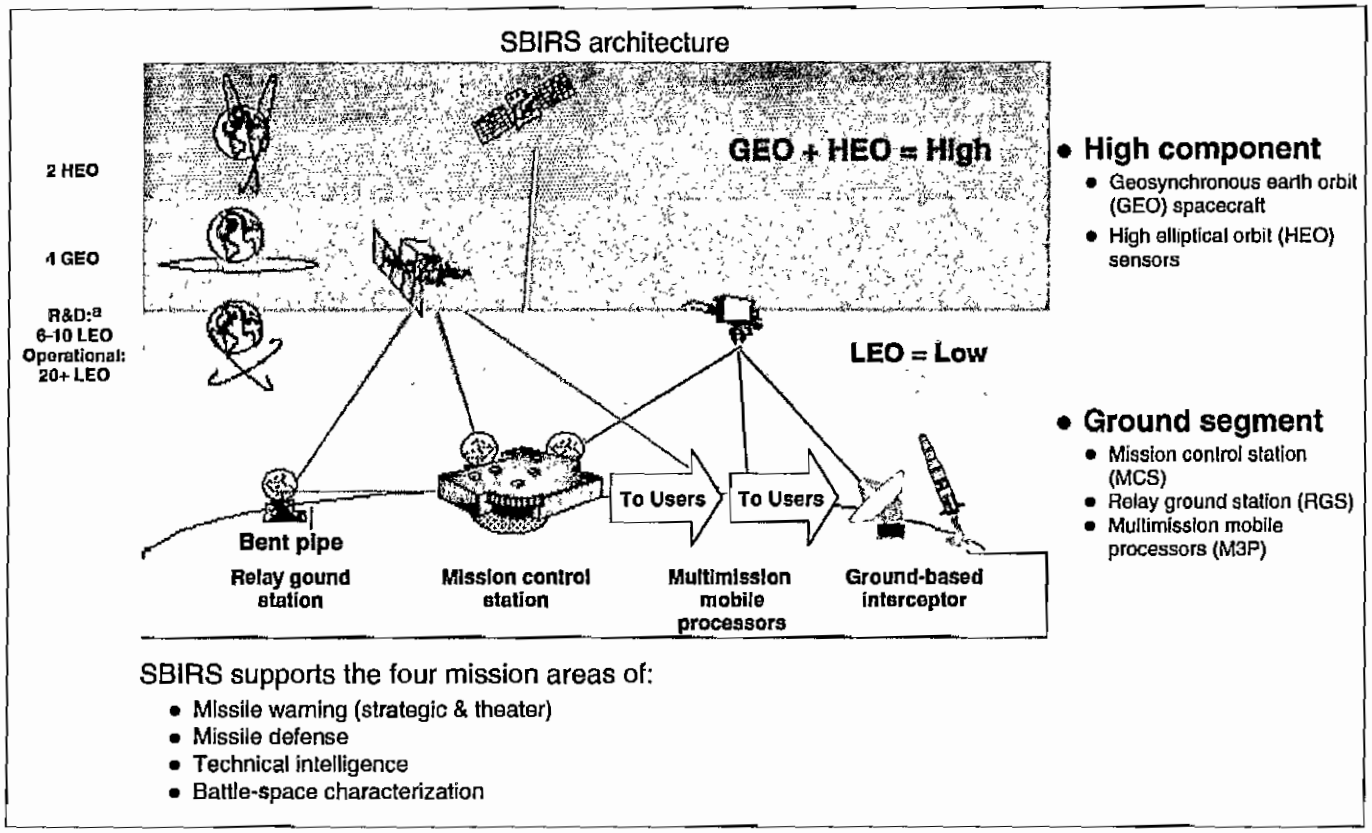
SBIRS High Program Description

SBIRS High is designed to contribute to four defense mission areas: missile warning, missile defense, technical intelligence, and battle-space characterization. (See app. II for a description of the program's contribution to each.) SBIRS High is intended to replace the DSP satellite constellation, which has provided early missile warning information for more than 30 years, and to provide better and more timely data to the Unified Combatant Commanders, U.S. deployed forces, U.S. military strategists, and U.S. allies.

As currently planned, SBIRS High will be comprised of four satellites in geosynchronous earth orbit (GEO), two infrared sensors that are to be placed on separate host satellites in highly elliptical orbit (HEO)[6]—known as "HEO sensors"—and a ground segment for mission processing and control. These elements are illustrated in figure 1. The Air Force plans to acquire a fifth GEO satellite to serve as a spare that would be launched when needed.

[6] A GEO satellite's revolution is synchronized with the earth's rotation giving it a seemingly stationary position above a fixed point on the equator. At an altitude of about 22,300 miles above the equator, three or four strategically spaced satellites can view the entire globe with the exception of the polar regions. HEO satellites, which linger over a designated area of the earth, can provide polar coverage.

Figure 1: Space-Based Infrared System Description



Source: U.S. Air Force.

[a] Once a product decision is made, the operational constellation will consist of 20 plus satellites for continuous coverage.

SBIRS High is intended to provide taskable sensors with improved sensitivity and revisit rate allowing them to see dimmer objects and provide more accurate estimates of missile launch and impact point than the sensors in the existing satellite constellation. SBIRS High sensors are also expected to view particular areas of interest and to revisit multiple areas of interest as directed by ground controllers. In addition to covering the shortwave infrared spectrum like their predecessor, SBIRS High

sensors are also expected to cover midwave infrared bands and see-to-the-ground bands[7] allowing them to perform a broad set of missions.

SBIRS High is being developed in two increments. Increment 1, which achieved initial operational capability in December 2001, consolidated DSP and Attack and Launch Early Reporting to Theater ground stations into a single mission control station, which is currently operating using DSP data. Through spiral development,[8] Increment 2 (now in the systems design and development phase) will develop the HEO sensors and first two GEO satellites and will upgrade Increment 1 hardware and software to operate and process data from the HEO and GEO elements. The remaining three GEO satellites are to be procured at some future date.

Past Problems

Since the SBIRS program's inception in 1996, it has been burdened by immature technologies, unclear requirements, unstable funding, underestimated software complexity, and other problems that have resulted in mounting cost overruns and delays. In addition, the program has been restructured several times. Most notably, in 1998, the SBIRS High Program Office had to restructure the program around an Air Force directive to delay the GEO satellite launches by 2 years in order to fund other DOD priorities. This contributed to program instability since the contractor had to stop and restart activities and devise interim solutions that would not otherwise have been required. In early 2001, there were growing cost and schedule variances and a related decrease in contractor management reserve funding. Primary drivers of these problems were technical issues with the HEO sensors and associated test failures.

In November 2001, the Assistant Secretary of the Air Force (Acquisition) and the Executive Vice President of Lockheed Martin Space Systems Company formed the IRT—comprised of various specialists in acquisition,

[7] Midwave infrared bands provide the below-the-horizon launch phase and missile tracking. See-to-the-ground bands provide below-the-horizon tracking of slow or static dim targets below 6.2 miles.

[8] Spiral development is an iterative process for developing defined capabilities within each increment (that is, a desired capability is identified, but the end-state requirements are not known at program initiation). This process provides the opportunity for interaction among the user, tester, and developer. The requirements are refined through experimentation and risk management; there is continuous feedback, and the user is provided the best possible capability within the increment. The requirements for future increments depend on feedback from users and technology maturation. Each increment may include a number of spirals.

operations, engineering, and business management from industry and the federal government—to conduct a comprehensive, independent review of the SBIRS High program. In February 2002, the IRT issued a candid and critical report identifying three primary causes that led to the significant cost growth:

- The program was too immature to enter the system design and development phase. Program activation was based on faulty and overly optimistic assumptions about software reuse and productivity levels, the benefits of commercial practices, management stability, and the level of understanding of requirements.
- The complexity of developing engineering solutions to meet system requirements was not well understood by program and contracting officials. The systems integration effort was significantly underestimated in terms of complexity and the associated impacts. In addition, the requirements refinement process was ad hoc, creating uncertainty on the status of program priorities and affecting cost and schedule.
- Breakdown in execution and management. Overly optimistic assumptions and unclear requirements eventually overwhelmed government and contractor management. The 2-year delay of the GEO satellite launches, which occurred in 1998, contributed to management instability and was a factor in the Program Office and the contractor having to spend 25 of the first 60 months of the contract on replanning activities.

The IRT also made a number of recommendations to address these problems. These included establishing accurate baselines for cost, schedule, and technology; revising the contract fee structure; and redefining Program Office and contractor management roles and responsibilities.

Nunn-McCurdy Breach and Certification

A preliminary effort to capture a realistic estimate of total program costs conducted in the fall of 2001 suggested potential cost growth in excess of $2 billion, or a 70-percent program acquisition unit cost increase. A major defense acquisition program that incurs a unit cost growth of at least 25 percent in the acquisition program baseline triggers a statutory requirement that the Secretary of Defense[0] certify to the Congress that four criteria have been met in order to continue the program—a process

[0] The Secretary of Defense delegated this responsibility to the Under Secretary of Defense for Acquisition, Technology, and Logistics.

known as Nunn-McCurdy.[10] See table 1 for a list of the criteria and the information DOD used to support certification for the SBIRS High program.

Table 1: Nunn-McCurdy Criteria and DOD's Supporting Information for SBIRS High Certification, May 2002

Criteria	DOD supporting information
System is essential to national security.	U.S. Strategic Command is required to maintain space and missile warning/defense resources and to provide the President and military leaders with missile warning and defense information; the Joint Requirements Oversight Council revalidated the SBIRS Operational Requirements Document in January 2002; SBIRS High is needed to replace DSP.
There are no alternatives that will provide equal or greater military capability at less cost.	Many alternatives were reviewed but none could provide equal or greater military capability at the same cost as SBIRS High. Additionally, all alternatives had greater technical and schedule risk.
New cost estimates are reasonable.	Cost estimates from various entities, including Lockheed Martin, the SBIRS High Program Office, and the Air Force Cost Analysis Agency, were close and the engineering manufacturing development estimate was mature, had high fidelity, and appeared reasonable.
Program management is adequate to manage and control costs.	The contractor has established an effective organization and instituted positive changes.

Source: U.S. Air Force.

Based on the information submitted to the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L)), the SBIRS High program was officially certified on May 2, 2002, with the contingencies that the Air Force fully fund the program to the cost estimate developed by the Office of the Secretary of Defense (OSD) and to reestablish a baseline to OSD's schedule for the GEO satellites. USD (AT&L) also directed that a revised acquisition strategy and program baseline be approved by the end of August 2002. These revisions and the new contract with Lockheed

[10] 10 U.S.C. § 2433. This unit cost reporting mechanism, which also applies to procurement unit cost for procurement programs, originated with the Nunn-McCurdy Amendment to the Department of Defense Authorization Act, 1982. The amendment, as revised, was made permanent law in the following year's authorization act. Known as Nunn-McCurdy "breaches," program unit cost increases of 15 percent or more trigger a requirement for detailed reporting to Congress about the program. Increases of 25 percent or more also trigger the requirement for Secretary of Defense certification.

Martin Space Systems Company represent the most recent program restructuring. (App. III provides a chronology of key events in the development of SBIRS High.)

Restructured Program Focused on Contract Management and Program Oversight

In August 2002, the SBIRS High program was restructured to address a number of the problems that led to the Nunn-McCurdy breach. In implementing changes, the Air Force relied heavily on the findings and recommendations of the IRT. The restructuring increased program oversight and provided additional resources as well as incentives intended to improve contractor performance.

As part of the program's recertification after the Nunn-McCurdy breach, USD (AT&L) directed the Air Force to reestablish a baseline for the program's cost and schedule estimates. The value of the restructured development contract increased by $2 billion to $4.4 billion. The first GEO satellite (GEO 1) launch was replanned from September 2004 to October 2006 and the GEO 2 launch from September 2005 to October 2007. The procurement start of GEO satellites 3 through 5 was replanned from fiscal year 2004 to fiscal year 2006. The SBIRS High budget for fiscal years 2006 and 2007 has identified funding for GEO satellites 3 through 5 totaling $1.3 billion—these satellites are not yet on contract. In addition to increased funding, the restructuring added 656 staff to the program—including increased staff for software development—bringing the total number of personnel to 2,305 by June 2003.

Under the restructuring, DOD's contract with Lockheed Martin was modified from a cost-plus-award fee structure to a cost-plus-award-and-incentive fee structure. The objective of this change was to encourage timely delivery of accepted capabilities by providing the incentive of the full potential profit or fee for the contractor. At the time of the restructuring, the Air Force believed the modified contract established an executable schedule, a realistic set of requirements, and adequate funding, and addressed the underlying factors that led to the Nunn-McCurdy breach.

The restructured contract was planned around 10 "effectivities"—milestones at which an incremental system capability is delivered by the developer and accepted by the operator as shown in table 2. Delivery of these effectivities is tied to the contractor's award and incentive fees. Lockheed Martin met the first effectivity and was awarded 100 percent of its fee (about $1.4 million).

Table 2: Effectivities and Their Utilities in Relation to SBIRS High Launch/Delivery Dates

Effectivity	Event	Milestone date	Operational and military utility
1	Interim mission control station (MCS) backup-1 system certification	Oct. 2002 (completed)	Provides an interim catastrophic peacetime backup capability for the Increment 1 MCS at another location.
	HEO 1 delivery	*Feb. 2003 (delayed)*	
2	Integrated training suite	Sept. 2003 (completed)	Provides the ability to train the integrated SBIRS High missions; provides better-trained crew members, crew coordination, and utilization of training resources.
	HEO 2 delivery	*Jan. 2004 (delayed)*	
3	HEO message certification	Nov. 2004 (delayed to Apr. 2005)	Provides an interim test center for HEO launch and early on-orbit testing operations; would signify interim operations of the HEO sensor; missile warning and missile tracking information would be reported to MCS; both real time and off-line technical intelligence data gathering would be performed.
4	DSP multimission mobile processor (M3P) theater event system (TES) certification	Apr. 2005	Improves maintainability and supportability; sustains theater performance.
	GEO 1 launch	*Oct. 2006*	
5	GEO message certification	Aug. 2007	Provides an interim test center for GEO launch and early on-orbit testing operations; GEO scanner-only mono-track event data released to MCS; increases capabilities to better meet the technical intelligence mission.
	GEO 2 launch	*Oct. 2007*	

Effectivity	Event	Milestone date	Operational and military utility
6	GEO Air Force M3P survivable/endurable integrated tactical warning/attack assessment (ITW/AA) system certification	Oct. 2008	Fuses available DSP, HEO sensor, and GEO satellite infrared data to detect events and generate reports; improves Increment 2 detection, reporting, and accuracy of missile events (where M3Ps are deployed) and battle-space characterization capability.
	GEO 3 launch	*Jan. 2009 (rescheduled to Sept. 2010)*	
7	Interim MCS backup-2 multisatellite system certification	Jan. 2009	First opportunity at a fixed site to provide multisatellite fusion capability for DSP, HEO, and GEO; improves tactical parameters, such as location of launch point, impact area, and state vector accuracy.
8	MCS-2 system certification	Oct. 2009	Fully integrates MCS operations; improves accuracy and detection of events for war-fighting operations.
	GEO 4 launch	*Jan. 2010 (rescheduled to Sept. 2011)*	
9	GEO Army M3P survivable/endurable ITWW/AA system and TES certification	Apr. 2010	Improves detection and reporting of infrared events; fuses DSP, HEO, and GEO track data relayed from MCS and the interim backup; improves tactical parameters from in-theater assets, such as launch point, impact area, and state vector accuracy.
10	Increment 2 complete	Apr. 2010	Concludes the Increment 2 development and deployment of the SBIRS High full constellation; additional follow-on GEO satellites provide multitheater/worldwide coverage.

Source: U.S. Air Force.

The restructured contract also prescribed tighter management controls, improved reporting of contractor information, and added formal review processes. For example, the modified contract removed Total Systems Performance Responsibility (TSPR)[11] from the contractor, transferring more oversight back to the government because, according to the IRT, this concept was not properly understood or implemented within the

[11] TSPR is a contract condition that obligates the prime contractor to assume total responsibility for the integration of an entire weapon system. This is to ensure that the government receives an integrated system that meets the performance requirements as defined in the system specifications.

SBIRS High program. This was evidenced by the numerous instances where the contractor was asked by program participants to accomplish work under TSPR guidelines without going through the appropriate management processes. In addition, since requirements were not prioritized or well-defined below the Operational Requirements Document (ORD) level, the contractor's refinement of requirements was ad hoc, creating uncertainty on the status of program priorities and impacting cost and schedule.

The restructuring also modified the program's use of DOD's Earned Value Management System (EVMS).[12] Specifically, Lockheed Martin and its subcontractors standardized EVMS procedures in an effort to provide more accurate and up-to-date reporting on the status of the program. In addition, an EVMS oversight team was established to focus on process improvements, and Lockheed Martin and its subcontractors developed a surveillance plan to review the EVMS data. The contractor is now monitoring EVMS data more closely through monthly meetings and reviews of specific cost accounts. Changes to the reporting of EMVS data also help identify risks more effectively.

The contractor and SBIRS High Program Office have also increased oversight and established a more formal risk management process within the restructuring. For example, the prime contractor placed three vice presidents in charge of the program as program director, deputy for ground segment development, and deputy for systems integration. In addition, the Air Force established a program management board consisting of high-level Air Force officials to prevent uncontrolled changes in the SBIRS High program. Risks are now monitored and reported during weekly risk management meetings. On a monthly basis, these risks are also discussed with government and contractor senior management.

Finally, program officials reported that Lockheed Martin has employed a more structured software development process that focuses on building the software in increments, thereby helping to spread out risks. A vice president is now overseeing the ground segment development, including software development. Further, Lockheed Martin has reorganized the ground software development group under its Management and Data Systems, which is known for its software expertise.

[12] EVMS is a tool used by the program manager to monitor the technical, schedule, and cost parameters of the contract.

This component of Lockheed Martin achieved a Capability Maturity Model Integration (CMMI) level 5—the highest rating—for its software management and procedures.[13] The ground software group does not have a formal CMMI rating—Lockheed Martin Management and Data Systems was brought in to help improve this group's processes.

Restructuring Did Not Address Long-Standing Problems That Put the Program at Risk

While the new oversight processes under the restructured program should help managers identify and address problems as they arise, the restructuring does not fully account for earlier program decisions made without sufficient systems engineering and design knowledge. As a result, the program continues to experience problems and risks related to changing requirements, design instability, and software development concerns. In particular, design problems have delayed the delivery of the first HEO sensor (HEO 1). Because development of the GEO satellites and possible additional HEO sensors are tied to the completion of HEO 1, the schedules for the subsequent components could slip, continuing to put the program at significant risk of cost and schedule overruns.

Requirements Modifications Continue

As we reported in June 2003, the majority of DOD satellite programs that GAO has reviewed over the past 2 decades, including SBIRS, have cost more than expected and have taken longer to develop and launch than planned because performance requirements were not adequately defined at the beginning of the program or were changed significantly once the program had already begun.[14] The numerous changes to the SBIRS High requirements contributed to the cost and schedule overruns early in the program. Although a more defined requirements management process is now in place, changes to both the operational requirements and the contract are being proposed that could impact the program's cost and schedule.

Before the restructuring, a total of 94 requirements changes were made to the SBIRS High program—16 of which were added after the critical design

[13] The CMMI rating standards, developed by the Software Engineering Institute at Carnegie Mellon University, range from 1 through 5. A CMMI rating of 1, called "performed," means that company's process is unpredictable, poorly controlled, and reactive. A CMMI rating of 5 indicates that the company's process is at the "optimizing" level, which focuses on continuous process improvement.

[14] U.S. General Accounting Office, *Military Space Operations: Common Problems and Their Effects on Satellite and Related Acquisitions*, GAO-03-825R (Washington, D.C.: June 2, 2003).

review in August 2001.[15] The effect that these changes may continue to have on the program was not addressed in the August 2002 restructuring efforts. Since restructuring, an Air Force program management board—which was established to oversee requirements changes and help ensure appropriate use of funds—has approved 34 actions that will require contract modifications. If funded, these changes, identified as "urgent and compelling,"[16] would total $203.8 million and come from the Program Manager's discretionary funds (also known as management reserve) or be paid by the user who needs the new capability. The majority of these dollars would be used to cover the following four changes

- earlier implementation of HEO mission processing in the mission control station at an estimated cost of $15 million,
- full implementation of the mission management component of HEO for the technical intelligence community at an estimated cost of $33 million,
- implementation and fielding of an operational mission control station backup to meet Increment 1 ITW/AA requirements in fiscal year 2006 at an estimated cost of $97 million, and
- the Army's implementation of a capability for DSP M3Ps to receive and process HEO tracking data at an estimated cost of $27 million.

In addition to these pending changes, the Air Force is considering acquiring a third and possibly a fourth HEO sensor and accelerating the procurement schedule for GEO satellites 3 through 5.[17] If procured together, the estimated cost (including integration and testing) is $283 million for the third HEO sensor and $238 million for the fourth HEO sensor. The funding for these sensors has yet to be determined. The potential acceleration of the acquisition of GEO satellites 3 through 5 is similarly placing added pressures on the program. Plans to accelerate the acquisition of these GEO satellites is in response to a recent concern by

[15] While the requirements in the SBIRS High ORD have not changed, the contractor has needed clarifications and refinements to understand what certain requirements entailed. According to Air Force officials, most of the changes earlier in the program can be attributed to weaknesses in earlier program management processes under the TSPR model of program management.

[16] Under the current restructuring, proposed program changes must be designated as "urgent and compelling"—that is, extremely important to mission needs and requiring near-term action to meet the need on time.

[17] The acquisition of additional HEO sensors comes as a result of delays with the Space Tracking and Surveillance System. See GAO-03-597.

the Senate Armed Services Committee[18] that an Air Force decision to delay the acquisition of satellites 3 through 5 would create a 3-year gap between the launch of the second and third satellites. As a result, the committee directed the Air Force to develop a plan to reduce the production gap in the SBIRS High program from 2 years to 1. The committee also directed the Air Force to assess the program's technical, schedule, and cost risks associated with a 2-year delay, compare the operational risk of a 1-year delay with a 2-year delay, and describe steps to mitigate the impact of a 1-year production gap.

In April 2002, a group comprised of DOD subject matter experts reviewed the SBIRS High requirements and concluded that four operational requirements will not fully be met by the current design under certain scenarios. While these requirements are only 4 of 140, they are important to the system's overall missile defense and warning capability:

- threat typing—the ability to identify a certain type of missile launched under certain scenarios;
- impact point prediction—the ability to predict where a particularly stressing theater-class missile will hit the earth;
- theater state vector velocity—the ability to track the path of a particularly stressing theater-class missile; and
- strategic raid count—the ability to count and discriminate the number of true incoming missiles for a certain scenario.

Program officials said that these four requirements were poorly written, defined, or described in the ORD and that efforts are underway to rewrite, seek waivers, or clarify them and negotiate deviations with users.

Design and System Integration Continue to Be Unstable

Achieving a stable design before entering product demonstration is critical to maintaining cost and schedule goals.[19] However, at the SBIRS High critical design review—1 year before the restructuring—only 50 percent of

[18]According to the Senate Armed Services Committee, a delay in acquiring GEO satellites 3 through 5 would (1) increase costs because production lines will have to close and reopen and subcontractors will have to be requalified, (2) increase technical risk due to a loss of key personnel and subcontractor base, and (3) increase operational risk due to the age of the current satellite constellation. See Senate Report 108-46 accompanying S. 1050, National Defense Authorization Act for Fiscal Year 2004, at 244-245 (May 13, 2003).

[19] U.S. General Accounting Office, *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002).

design drawings were complete, compared to 90 percent as recommended by best practices.[20] In addition, the IRT report found that the program did not invest enough time and resources in basic systems engineering analysis. Despite these problems, the program passed the critical design review. As a result, persistent problems with and changes to the design—especially of HEO 1—continue to impact the program's cost and schedule.

The HEO 1 sensor is the first major deliverable for Increment 2 and the only near-term deliverable to measure the program's progress. As a part of the restructuring, the delivery of this sensor to the host satellite was delayed from its original date in February 2002 to February 2003. At that time, program officials were confident of meeting the new delivery date. However, significant deficiencies were revealed during systems tests in November 2002 making it apparent that the February 2003 date would not be met, and delivery was postponed another 2 months. At this writing, the first HEO sensor has yet to be delivered. In May 2003, the Program Director reported that the delays were due to a series of design deficiencies. For example, the design to control the sensor's electromagnetic interference (EMI) was inadequate.[21] Specifically, Lockheed Martin identified 148 offending EMI frequencies that exceeded the tolerances established by the host satellite. These excessive frequencies could interfere with the operations of the host satellite and jeopardize its mission. Thirty-nine design modifications to the HEO sensor were made, which eliminated 80 percent of these noise conditions. However, the final EMI test, completed in early July 2003, identified seven remaining EMI frequencies that were not within tolerance—two of which appear to be attributable to the HEO sensor. Since the problems cannot be resolved and there is no expected impact on performance, the Program Director requested waivers for the offending frequencies to allow the sensor to be integrated onto the host satellite. According to a program official, the waivers have been approved and the first HEO sensor is now

[20] GAO reviews of best practices have found that successful commercial firms require a high level of knowledge at key junctures during a product's development and use this knowledge to make informed investment decisions. These firms place more importance on capturing specific technology, design, and manufacturing knowledge than on meeting milestones. Moreover, these firms identify and use specific criteria to ensure that the program has sufficient knowledge to move forward. For example, the release of 90 percent or more of the engineering drawings indicates that the product design is stable and meets performance requirements.

[21] Two other design problems encountered were associated with the outer tiles of the spacecraft and the Common Gyro Reference Assembly.

expected to be delivered on December 6, 2003, provided no additional testing is needed.

The Program Director reported that the HEO 1 design problems were attributable to weaknesses in earlier program management processes. Under these processes, the program tried to achieve efficiencies by cutting back on detailed design analyses and component testing. The exact costs associated with these weaknesses are unclear. Our independent estimate—using data from the contractor's June 2003 cost performance report—indicates that the development of HEO 1 will overrun the contract amount at completion by about $25 million to $54 million, and that additional costs associated with HEO 2 rework would be between $20 million and $80 million.[22] The Program Office is currently assessing estimates of total cost impact.

Since the critical design review in August 2001, the Air Force also determined that two late design changes to the GEO satellites were necessary to improve the program's chances of success. In January 2003, the Air Force directed the contractor to replace the 80 ampere-hour battery with a 100 ampere-hour battery to improve the satellites' operational reliability. Program officials estimate that the new battery will cost about $15 million, but the June 2003 cost performance report shows that the contractor is having difficulty assessing and establishing specifications for the battery, which has resulted in schedule delays and could result in even greater costs. The second design change to the GEO satellites is to resolve a power deficiency by modifying the solar cell panel. The expected cost of this change has not yet been determined.

In April 2002, 4 months before the restructuring, a report prepared by subject matter experts determined that while there were no significant technical barriers to eventually meeting the key requirements for SBIRS High, technology integration was a high risk owing to insufficient time. In restructuring the program, the Air Force implemented earlier integration and testing activities to mitigate this risk. However, we found that these mitigation measures may not be sufficient to avoid delays. For example, as of June 2003, the contractor has completed about 58 percent of the GEO

[22] Our analysis was based on the earned value statistics from the latest available cost performance report. The upper bound of the estimate is a worst case scenario cost based on the contractor's cost performance for that month.

sensor integration, assembly, test and checkout work, but it is still behind schedule with about $2 million of the planned work not yet accomplished.

Software Development Is Still High Risk

The development of software for the HEO sensors and GEO satellites (known as "flight" software) and the ground facility was a major factor that led to the Nunn-McCurdy breach. Despite the restructuring, the contractor and Program Office continue to report that software development underlies most of the top 10 program risks. Flight and ground software have already experienced difficulties, delaying delivery and putting program accomplishments at further risk.

Most of the software for SBIRS High is for the ground stations to operate and command the satellites, process and display missile warning data, and perform mission management functions. Additional flight software is being developed for the HEO sensors and GEO satellites to control the infrared sensors and optical telescope and to process infrared data onboard the satellite.[23] Another set of software elements will be used to test and simulate the performance of the SBIRS High system before it is put into operation. According to Lockheed Martin officials, the risks associated with the development of these software elements would be minimal because the majority of the software would be reused and modified.[24]

However, the risk associated with software development and reuse in Increment 1 was underestimated, which led to significant delays and cost overruns. This problem was not fully addressed by the restructuring and the time needed to develop the software continues to be underestimated. For example, in the current phase (Increment 2), delivery of the HEO flight software has been delayed because software item qualification testing—which was completed in May 2003 after a 3-month delay—revealed three deficiencies. One deficiency involved the HEO sensor's ability to maintain earth coverage and track missiles while orbiting the earth. Delivery of the HEO ground software has also been delayed, and according to a program official, did not meet a revised delivery date of August 2003 because several ground software issues must still be resolved. While the problems encountered with the development of the flight and

[23] Signal processing software is responsible for collecting and formatting infrared digital data which will be transmitted and further processed at the ground station.

[24] Software reuse involves previously developed software that is to be integrated with other new, modified or other reuse software.

ground software have only resulted in delays of a few months, the delays signal weaknesses that could put the program at further risk of cost and schedule overruns.

The remaining computer memory margin on the onboard satellites is also a concern. The SBIRS High program requirements mandate that the memory margin be at least 50 percent. This is to ensure there is sufficient remaining memory to accommodate future software code growth. However, inefficient coding for onboard satellite operations has resulted in an estimated current memory margin of 35 percent. Since rewriting the code would be too costly to the program, Lockheed Martin is requesting a waiver from this requirement to allow the 35-percent margin.

According to DCMA officials, the HEO software delays are the result of an overly aggressive software development schedule and a lack of management's understanding of the complexity of the software task. A program official stated the contractor's software productivity and efficiency metrics have recently begun to reflect a negative trend in the program due to the delays in software development and increases in software defects. These officials stated that the program suffered from a lack of skilled computer personnel with infrared space systems knowledge. After the August 2002 restructuring, DCMA officials stated that Lockheed Martin committed more personnel and approved overtime when necessary to achieve schedules and has been cooperative in making changes recommended by DCMA and the SBIRS High Program Office. Although these actions should improve the schedule status, they will have a negative cost impact because of the additional resources that will need to be committed to recover and meet the program's future schedule.

HEO Delays Affect the Total SBIRS High Program

Delays in the development and delivery of the HEO 1 sensor will likely have long-term consequences for the remainder of the program. According to DOD officials, until tasks leading to HEO message certification are complete, the program will not have "turned the corner" to achieving its objectives. However, some schedule milestones for these tasks have begun to slip due to problems in developing the HEO 1 sensor. As a result, the HEO message certification milestone, scheduled for November 2004, will slip 5 months or more.

Program officials stated that they are coordinating the delivery of HEO 1 and the host satellite to mitigate any schedule impacts, but they agreed that these delays put the remaining SBIRS High schedule at risk. For example, the continuing HEO 1 sensor and software work is now

competing for staff and other resources dedicated to HEO 2 and GEO tasks. As a result, the HEO 2 sensor and the first GEO satellite are unlikely to maintain their current development and launch schedules already revised under the restructuring. Program officials now estimate the HEO 2 sensor delivery will be delayed from February 2004 to June 2004—or as much as a year later—to implement more in-depth modifications to correct EMI problems, as recommended by a technical review team. According to program officials, the development schedule for the first GEO satellite has sufficient margin—approximately 300 days—to avoid delays in the first GEO launch. However, delivery and integration of the GEO flight software—a high-risk effort—did not begin in August 2003 as scheduled. While DCMA officials report that they are monitoring Lockheed Martin's progress to maintain the software development schedule, any delays will affect the entire GEO schedule and could jeopardize the delivery and launch of the first GEO satellite.

In an attempt to avoid delays, the program has compressed schedules and implemented work-around plans. However, in compressing original schedules, the program creates other risks because the time allotted to test and analyze the software and to train personnel to operate the SBIRS High ground processing system has been significantly reduced. In addition, work-around plans to overcome delays, even if feasible, would be difficult and costly to accomplish. At the same time, valuable on-orbit information of the HEO sensor's performance may not be available in a timely manner for the GEO development efforts. Since HEO and GEO have common components, including the infrared sensor subsystem, HEO on-orbit data would improve the knowledge base for GEO development.

Increased cost is also a risk. Although the contractor forecasts that the contract will be within cost at completion, significant cost overruns are likely. In analyzing data from the contractor's cost performance reports from February 2003 through June 2003, we found that the cumulative cost overrun increased by more than 800 percent, from approximately $3 million to approximately $31.7 million, due to the significant overtime worked over a number of months. Moreover, as the program works to accomplish the almost $40 million worth of planned work that is behind schedule, the negative cumulative cost variance of approximately $31.7 million will continue to grow. Specifically, we predict that at contract completion, the program will have a cost overrun ranging from roughly $80 million to $432 million. DCMA similarly predicts significant

cost overruns—officials reported an estimated overrun ranging from $34 million to $210 million at completion and gave an overall assessment of "red"[25] for the SBIRS High earned value management status.

Finally, as the program works to remedy problems—particularly those associated with the HEO sensors—management reserves are diminishing. For fiscal year 2003, reserves have been depleted, and Air Force and program officials are concerned that fiscal year 2004 reserves are insufficient to address contingencies. As a result, some planned development tasks may be delayed to fiscal year 2005.

The Program Director stated that the program is applying lessons learned from HEO 1 to the HEO 2 sensor, the first GEO satellite, and other parts of the program. The knowledge gained from correcting problems on HEO 1 will be necessary if the Air Force decides to procure additional HEO sensors and accelerate procurement of the third, fourth, and fifth GEO satellites. The Program Office is also assessing the overall program impacts from the HEO 1 delay but has yet to complete the analysis.

[25] A "red" rating is issued for any current negative cost or schedule variance that is greater than 10 percent.

Conclusions

DOD has invested billions of dollars in an effort to develop a system that will provide greater long-range detection capabilities than DSP, its current missile tracking system. Yet more than a year after the most recent restructuring, the SBIRS High program continues to experience problems that have existed since its inception: cost overruns, schedule delays, and performance limitations. While the Air Force has taken a number of actions as recommended by the IRT to improve program oversight, it has become increasingly evident that the underlying factors that led to the Nunn-McCurdy breach—particularly the lack of critical knowledge—continue to cause problems, and additional cost and schedule slips beyond the revised acquisition program baseline appear inevitable. Without sufficient knowledge to ensure that the product design is stable and meets performance requirements and that adequate resources are available, there is no assurance that technical problems—such as those experienced with the HEO 1 sensor—will not surface on other major program components once they go through systems integration and testing. Moreover, the inability of the Air Force and its contractor to deliver HEO 1 as scheduled has put into question whether the restructuring has provided the right mechanisms to achieve program objectives. If the Air Force continues to add new requirements and program content while prolonging efforts to resolve requirements that cannot be met, the program will remain at risk of not achieving within schedule its intended purpose—to provide an early warning and tracking system superior to that of DSP.

Recommendations for Executive Action

Given the considerable investment yet to come, the Congress and the Secretary of Defense would benefit from an assessment of whether the Program Office and contractor are doing everything necessary and feasible to achieve program objectives and to minimize future cost and schedule growth and address the underlying factors that are causing these problems. Therefore, we recommend that the Secretary of Defense reconvene the IRT or similar independent task force with substantial program knowledge to provide an assessment of the restructured program and concrete guidance for addressing the program's underlying problems. Such a review should include determining whether the

- SBIRS High development schedule is executable within current cost and schedule estimates in light of the recent HEO 1 delays and other risks (such as software development),
- program design is stable and sufficient to meet performance requirements,

- contractor's software development procedures and practices have reached at least a CMMI level 3[26] in relation to the Software Engineering Institute's standards,
- appropriate management mechanisms are in place to achieve intended program objectives, and
- pending requirements changes should be funded.

We further recommend that the Secretary of Defense put in place a mechanism for ensuring that the knowledge gained from the assessment is used to determine whether further programmatic changes are needed to strengthen oversight, adjust current cost and schedule estimates, modify contract mechanisms, and address requirements changes.

Agency Comments

In commenting on a draft of this report, DOD agreed that another thorough review of the SBIRS High program is warranted, and that the results of this review should be used to bring about needed program changes. However, DOD only partially agreed with our recommendations because it would like the option to consider other approaches for assigning responsibility for conducting a review. Given the complexity of this program, we agree that the Secretary of Defense should have this flexibility. We have modified our recommendations accordingly. DOD also provided technical comments, which we have incorporated as appropriate. DOD's written comments—provided by the Deputy Under Secretary of Defense for Policy, Requirements, and Resources within the Office of the Under Secretary of Defense for Intelligence—are reprinted in appendix I.

[26] A CMMI 3, called "defined," means the company's process is characterized for the organization and is defined.

Scope and Methodology

To identify the key elements of the restructured SBIRS High program, we reviewed the program's operational requirements document, acquisition program baseline, single acquisition management plan, cost analysis requirements description, technical reports, and status documents; the restructured contract with Lockheed Martin Space Systems Company; and Nunn-McCurdy certification documents. We discussed the restructured program with representatives from the SBIRS High Program Office, Space and Missile Systems Center, Los Angeles Air Force Base, El Segundo, California; Secretary of the Air Force, Space Force Enhancement, Washington, D.C.; Office of the Assistant Secretary of Defense, Networks and Information Integration, Washington, D.C.; Office of the Secretary of Defense, Director of Program Analysis and Evaluation, Washington, D.C.; Lockheed Martin Space Systems Company, Missile and Space Operations, Sunnyvale, California; and Lockheed Martin Management and Data Systems, Boulder, Colorado. We also discussed requirements and mission needs with officials from Air Force Space Command and U.S. Strategic Command (West), Peterson Air Force Base, Colorado Springs, Colorado and Air Force Headquarters, Directorate of Operational Capability Requirements, Space Capability, Arlington, Virginia.

To determine the problems and potential risks relating to cost, schedule, and performance that are still facing the SBIRS High program, we reviewed technical reports and program briefings and held discussions with program and contractor officials regarding ongoing challenges. To gain an understanding of these challenges, we reviewed monthly acquisition reports, Air Force Space Command's urgent and compelling needs lists, the contractor's top program risks lists, and recent congressional language concerning delivery schedules. To determine the program's ability to meet cost and schedule projections, we examined schedule and funding information for developing hardware and software. We compared information from the SBIRS High Program Office to other independent reports including those from the IRT, a commissioned technology review, and DCMA. We also reviewed the report from the Baseline Update-1, a formal program review, and other program assessment reports. In addition, we performed our own analysis of cost and schedule projections using Lockheed Martin's 2003 cost performance report data. We discussed all of these issues with representatives from the SBIRS High Program Office; Lockheed Martin Space Systems Company, Missile and Space Operations; Lockheed Martin Management and Data Systems; Office of the Secretary of Defense, Director of Operational Test and Evaluation, Alexandria, Virginia; and the Defense Contract Management Agency, Sunnyvale, California.

We performed our work from October 2002 through September 2003 in accordance with generally accepted government auditing standards.

We plan to provide copies of this report to the Secretary of Defense, the Secretary of the Air Force, and interested congressional committees. 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 or John Oppenheim at (202) 512-3111. Key contributors to this report are listed in appendix IV.

R E Levin

R. E. Levin
Director, Acquisition and Sourcing Management

Appendix I: Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
5000 DEFENSE PENTAGON
WASHINGTON, DC 20301-5000

October 7, 2003

INTELLIGENCE

Mr. Robert E. Levin
Director, Acquisition and Sourcing Management
U.S. General Accounting Office
441 G Street, N.W.
Washington DC 20548

Dear Mr. Levin:

This is the Department of Defense (DoD) response to the GAO report, DEFENSE ACQUISITIONS: Despite Program Restructuring, SBIRS High Remains at Risk of Cost and Schedule Overruns, dated September 4, 2003 (GAO Code 120177/GAO-04-48).

The Secretary of Defense will take under advisement the GAO recommendation that he direct an independent task force to conduct a review of the program, either by the Secretary of the Air Force as GAO recommends or through some other mechanism.

Detailed comments on the recommendations and the report are enclosed. If you have any additional questions, my point of contact for this report is Mr. Kevin Meiners, (703) 607-0455.

Letitia A. Long
Deputy Under Secretary of Defense
(Policy, Requirements & Resources)

Enclosure:
OSD Comments

cc:
USD(AT&L)
USD(C)
ASD(NII)

DDR&E
GC, DoD
DOT&E
USecAF
D, PA&E
JCS/J8

Note: Page numbers in the draft report may differ from those in this report.

GAO DRAFT REPORT – DATED SEPTEMBER 4, 2003
GAO CODE 120177/GAO-04-48

"DEFENSE ACQUISITIONS: Despite Program Restructuring, SBIRS High Remains at Risk of Cost and Schedule Overruns"

OSD COMMENTS
TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Secretary of the Air Force to reconvene the IRT or similar independent task force with substantial program knowledge to provide an assessment of the restructured program and concrete guidance for addressing the program's underlying problems. Such a review should include determining whether the:

- SBIRS High development schedule is executable within current cost and schedule estimates in light of the recent HEO 1 delays and other risks (such as software development);
- program design is stable and sufficient to meet performance requirements;
- contractor's software development procedures and practices have reached at least a CMMI level 3 in relation to the Software Engineering Institute's standards;
- the right management mechanisms are in place to achieve intended program objectives; and
- pending requirements changes should be funded. (p. 23/GAO Draft Report)

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense direct the Secretary of the Air Force to put in place a mechanism for ensuring that the knowledge gained from the assessment is used to determine whether further programmatic changes are needed to strengthen oversight, adjust current cost and schedule estimates, modify contract mechanisms, and address requirements changes. (p. 23/GAO Draft Report) .

OSD RESPONSE TO BOTH RECOMMENDATIONS: Partially Concurs. The department agrees that a thorough review of the SBIRS program is warranted, and agrees that a comprehensive program assessment will be conducted. The department also agrees that the results of the review will be used to determine what programmatic changes are needed and to implement these changes. Rather than following the specific recommendation to have the Secretary of the Air Force reconvene an independent task force, the Secretary of Defense will consider other approaches before a final decision is made on assigning responsibilities for conducting the review.

Appendix II: SBIRS High Performance in Mission Areas

- Missile Warning: SBIRS High is expected to provide reliable, unambiguous,[1] timely, and accurate missile warning information to the President of the United States, the Secretary of Defense, Unified Combatant Commanders, and other users. This mission includes both global and theater requirements to provide strategic and theater ballistic missile warning in support of passive defense and force posturing.
- Missile Defense: SBIRS High is expected to provide reliable, accurate, and timely information to defensive systems. This mission includes both strategic and theater functional requirements to enable active missile defense and attack operations against hostile forces.
- Technical Intelligence: SBIRS High is expected to provide reliable, accurate, and timely infrared target signature and threat performance data to warfighters, the intelligence community, weapon system developers, and other users. This data may be used for target classification and identification templates and algorithm development for SBIRS High operational missions. SBIRS High also monitors activities and provides information to policy makers and other users on observed military tactics, new foreign technology development, arms control compliance, and proliferation activities.
- Battle-space Characterization: SBIRS High provides reliable, accurate, and timely data to enhance situational awareness, non-ballistic missile threat warning, decision support, battle damage assessment and intelligence information (for land, sea, air, and space) for the Unified Combatant Commanders, Joint Task Force Commanders, and other users. Battle-space characterization applies the SBIRS High product to the immediate need of the warfighters.

[1] Unambiguous warning is a valid mission level requirement that, to date, has been accomplished primarily through dual phenomenology and human in-the-loop concepts of operations. SBIRS will contribute to but will not, by itself, provide unambiguous warning.

Appendix III: Key Events in the SBIRS High Program

Date		Key events
1994	September	• OSD issues the *Space-Based Warning Summer Study.*
	November	• SBIRS is named an Air Force lead program for acquisition reform.
1995	January	• U.S. Space Command SBIRS *Capstone Requirements Document* is validated by the Joint Requirements Oversight Council.
	February	• *SBIRS Single Acquisition Management Plan* is approved.
	August	• Air Force awards two pre-engineering and manufacturing development contracts to Hughes and Lockheed Martin teams.
1996	April	• Changes to the *SBIRS Capstone Requirements Document* are validated by the Joint Requirements Oversight Council.
	September	• *SBIRS System Threat Assessment Report* is validated.
	October	• SBIRS is authorized to proceed to milestone II.
	November	• Air Force awards one engineering and manufacturing development contract to Lockheed Martin.
1997	January	• Construction begins on the Mission Control Station at Buckley Air Force Base, Colorado.
	December	• SBIRS High preliminary design review is held.
1998	July	• *SBIRS System Threat Assessment Report* is revalidated.
	December	• DOD removes $150 million from the SBIRS High program to fund other DOD priorities and directs the delay of the GEO launches by 2 years.
1999	May	• Based on the DOD directive, a joint estimate team reviews the program to determine an attainable and affordable program restructure.
2000	June	• *SBIRS System Threat Assessment Report* is revalidated.
2001	August	• SBIRS critical design review is held.
	December	• SBIRS ground Increment 1 is certified.
		• Secretary of the Air Force notifies Congress of the Nunn-McCurdy breach.
	October	• SBIRS Low is transferred to Missile Defense Agency.
2002	January	• SBIRS ORD is revalidated by the Joint Requirements Oversight Council for the Nunn-McCurdy review.
	February	• IRT report is issued identifying the underlying causes for the cost growth that led to the Nunn-McCurdy breach.
	May	• *SBIRS High Acquisition Decision Memorandum* is signed, certifying the program after the Nunn-McCurdy breach.
	June	• Revised *SBIRS High Single Acquisition Management Plan* is approved.
		• Construction begins on the Mission Control Station Backup at Schriever Air Force Base, Colorado.
	August	• Revised SBIRS High contract with Lockheed Martin goes into effect.
	September	• *SBIRS High Acquisition Program Baseline* (restructuring) is approved.
	November	• Interim Mission Control Station Backup in Boulder, Colorado, is certified.

Date		Key events
2003	January	• Air Force Space Command identifies need for HEO 3 and possibly HEO 4.
		• DCMA reports HEO 1 schedule slip.
		• Air Force provides USD (AT&L) with SBIRS High program assessment.
	February	• Assistant Secretary of Defense for Command, Control, Communications, and Intelligence issues memorandum to Air Force calling for another review in November 2003.

Source: U.S. Air Force.

Appendix IV: GAO Contacts and Staff Acknowledgments

GAO Contacts

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John Oppenheim (202) 512-3111

Acknowledgments

In addition to those listed above, Maricela Cherveny, Steve Martinez, Karen A. Richey, Nancy Rothlisberger, Karen M. Sloan, Hai V. Tran, Dale M. Yuge, and Randolph S. Zounes made key contributions to this report.