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Report to the Subcommittee on Environment, Technology, and Standards, Committee on Science, House of Representatives

September 2004

POLAR-ORBITING ENVIRONMENTAL SATELLITES

Information on Program Cost and Schedule Changes

G A O

Accountability ★ Integrity ★ Reliability

GAO-04-1054

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GAO Accountability•Integrity•Reliability

Highlights

Highlights of GAO-04-1054, a report to Subcommittee on Environment, Technology, and Standards, Committee on Science, House of Representatives

Why GAO Did This Study

Our nation's current operational polar-orbiting environmental satellite program is a complex infrastructure that includes two satellite systems, supporting ground stations, and four central data processing centers. In the future, the National Polar-orbiting Operational Environmental Satellite System (NPOESS) is to combine the two current satellite systems into a single state-of-the-art environment monitoring satellite system. This new satellite system is considered critical to the United States' ability to maintain the continuity of data required for weather forecasting and global climate monitoring through the year 2020. Because of changes in funding levels after the contract was awarded, the program office recently developed a new cost and schedule baseline for NPOESS.

GAO was asked to provide an interim update to (1) identify any cost or schedule changes as a result of the revised baseline and determine what contributed to these changes and (2) identify factors that could affect the program baseline in the future.

In commenting on a draft of this report, DOD, NOAA, and NASA officials generally agreed with the report and offered technical corrections, which we incorporated where appropriate.

www.gao.gov/cgi-bin/getrpt?GAO-04-1054.

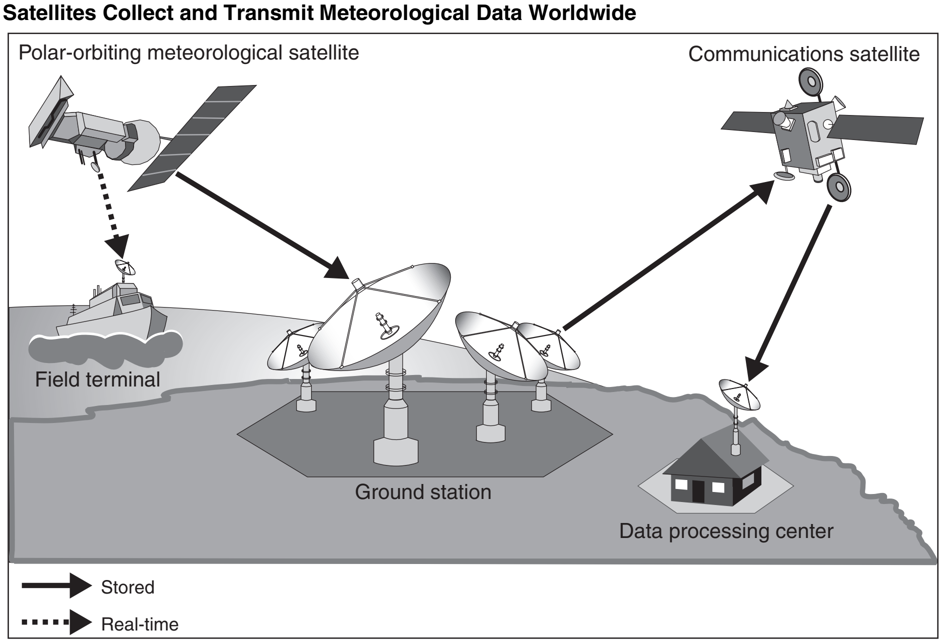
To view the full product, including the scope and methodology, click on the link above. For more information, contact David Powner at (202) 512-9286 or pownerd@gao.gov.

What GAO Found

The program office has increased the NPOESS cost estimate by $1.2 billion, from $6.9 to $8.1 billion, and delayed key milestones, including the availability of the first NPOESS satellite—which was delayed by 20 months. The cost increases reflect changes to the NPOESS contract as well as increased program management costs. The contract changes include extension of the development schedule to accommodate changes in the NPOESS funding stream, increased sensor costs, and additional funds needed for mitigating risks. Increased program management funds were added for non-contract costs and management reserves. The schedule delays were the result of stretching out the development schedule to accommodate a change in the NPOESS funding stream.

Other factors could further affect the revised cost and schedule estimates. First, the contractor is not meeting expected cost and schedule targets of the new baseline because of technical issues in the development of key sensors. Based on its performance to date, GAO estimates that the contractor will most likely overrun its contract at completion in September 2011 by at least $500 million. Second, the risks associated with the development of the critical sensors, integrated data processing system, and algorithms could also contribute to increased cost and schedule slips.

Satellites Collect and Transmit Meteorological Data Worldwide



Source: GAO, based on NPOESS Integrated Program Office data.

Contents

Abbreviations

CMIS	conical-scanned microwave imager/sounder
CrIS	cross-track infrared sounder
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
POES	Polar-orbiting Operational Environmental Satellites
VIIRS	visible/infrared imager radiometer suite

United States Government Accountability Office
Washington, D.C. 20548

September 30, 2004

The Honorable Vernon J. Ehlers
Chairman
The Honorable Mark Udall
Ranking Member
Subcommittee on Environment, Technology, and Standards
Committee on Science
House of Representatives

Our nation's operational polar-orbiting environmental satellite program is a complex infrastructure encompassing two satellite systems, the Polar-orbiting Operational Environmental Satellites (POES) and the Defense Meteorological Satellite Program (DMSP), as well as supporting ground stations and four central data processing centers. The program provides general weather information and specialized environmental products to a variety of users, including weather forecasters, military strategists, and the public. A tri-agency Integrated Program Office—comprised of officials from the Department of Defense (DOD), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA)—is working to combine the two current satellite systems into a single state-of-the-art environment monitoring satellite system called the National Polar-orbiting Operational Environmental Satellite System (NPOESS). This new satellite system is considered critical to the United States' ability to maintain the continuity of data required for weather forecasting and global climate monitoring through the year 2020.

When we testified on the NPOESS program in July 2003,[1] we reported that the program office was working to address changes in funding levels after the contract was awarded, and planned to develop a new cost and schedule baseline. Concerned with these cost and schedule changes, you asked us to provide an interim update on the revised baseline. Specifically, our objectives were to (1) identify any cost or schedule changes as a result of the revised baseline and determine what contributed to these changes, and (2) identify factors that could affect the program baseline in the future.

[1]GAO, *Polar-orbiting Environmental Satellites: Project Risks Could Affect Weather Data Needed by Civilian and Military Users*, GAO-03-987T (Washington, D.C.: July 15, 2003).

To address these objectives, we reviewed the new NPOESS cost and schedule baseline and compared it to the old baseline. Then we identified the factors that contributed to any cost increases or schedule delays. We also analyzed program cost estimates and project management reports and interviewed officials from the NPOESS Integrated Program Office, DOD, NOAA, and NASA. In addition, this review builds on other work we have done on environmental satellite programs over the last several years.[2] As agreed with your staff members, we plan to continue our oversight of this program.

We conducted our work at NOAA, DOD, and NASA headquarters in the Washington, D.C., metropolitan area between November 2003 and August 2004, in accordance with generally accepted government auditing standards. Appendix I contains further details on our objectives, scope, and methodology.

Results in Brief

The program office has increased the NPOESS cost estimate by $1.2 billion, from $6.9 to $8.1 billion, and delayed key milestones, including the expected availability of the first NPOESS satellite—which was delayed by 20 months. The cost increases reflect changes to the NPOESS contract as well as increased program management funds. According to the program office, contract changes include extension of the development schedule, increased sensor costs, and additional funds needed for mitigating risks. Increased program management funds were added for non-contract costs and management reserves. The schedule delays were the result of stretching out the development schedule to accommodate a change in the NPOESS funding stream.

Other factors could further affect the revised cost and schedule estimates. Specifically, the contractor is not meeting expected cost and schedule targets of the new baseline because of technical issues in the development of key sensors. Based on its performance to date, we estimate that the

[2] GAO, *Polar-orbiting Environmental Satellites: Project Risks Could Affect Weather Data Needed by Civilian and Military Users*, *GAO-03-987T (Washington, D.C.: July 15, 2003); Polar-orbiting Environmental Satellites: Status, Plans, and Future Data Management Challenges*, GAO-02-684T (Washington, D.C.: July 24, 2002); *National Oceanic and Atmospheric Administration: National Weather Service Modernization and Weather Satellite Program*, GAO/T-AIMD-00-86 (Washington, D.C.: Mar. 29, 2000); and *Weather Satellites: Planning for the Geostationary Satellite Program Needs More Attention*, GAO-AIMD-97-37 (Washington, D.C.: Mar. 13, 1997).

contractor will most likely overrun its contract at completion in September 2011 by $500 million. In addition, risks associated with the development of the critical sensors, integrated data processing system, and algorithms, among other things, could also contribute to increased cost and schedule slips.

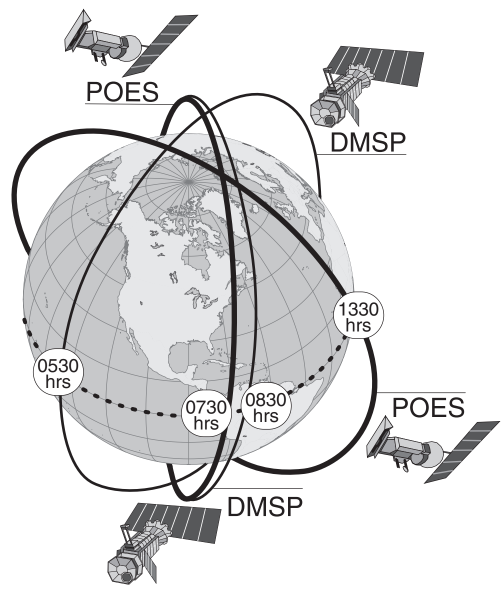
In commenting on a draft of this report, DOD, NASA, and NOAA officials generally agreed with the report and offered technical corrections, which we incorporated where appropriate.

Background

Since the 1960s, the United States has operated two separate operational polar-orbiting meteorological satellite systems: POES, managed by NESDIS of NOAA and DMSP, managed by DOD. The satellites obtain environmental data that are processed to provide graphical weather images and specialized weather products and are the predominant input to numerical weather prediction models. These images, products, and models are all used by weather forecasters, the military, and the public. Polar satellites also provide data used to monitor environmental phenomena, such as ozone depletion and drought conditions, as well as data sets that are used by researchers for a variety of studies, such as climate monitoring.

Unlike geostationary satellites, which maintain a fixed position above the earth, polar-orbiting satellites constantly circle the earth in an almost north-south orbit, providing global coverage of conditions that affect the weather and climate. Each satellite makes about 14 orbits a day. As the earth rotates beneath it, each satellite views the entire earth's surface twice a day. Today, there are two operational POES satellites and two operational DMSP satellites that are positioned so that they can observe the earth in early morning, mid morning, and early afternoon polar orbits. Together, they ensure that for any region of the earth, the data provided to users are generally no more than 6 hours old. Figure 1 illustrates the current operational polar satellite configuration. Besides the four operational satellites, six older satellites are in orbit that still collect some data and are available to provide some limited backup to the operational satellites should they degrade or fail. In the future, both NOAA and DOD plan to continue to launch additional POES and DMSP satellites every few years, with final launches scheduled for 2008 and 2011, respectively.

Figure 1: Configuration of Operational Polar Satellites



Source: GAO, based on NPOESS Integrated Program Office data.

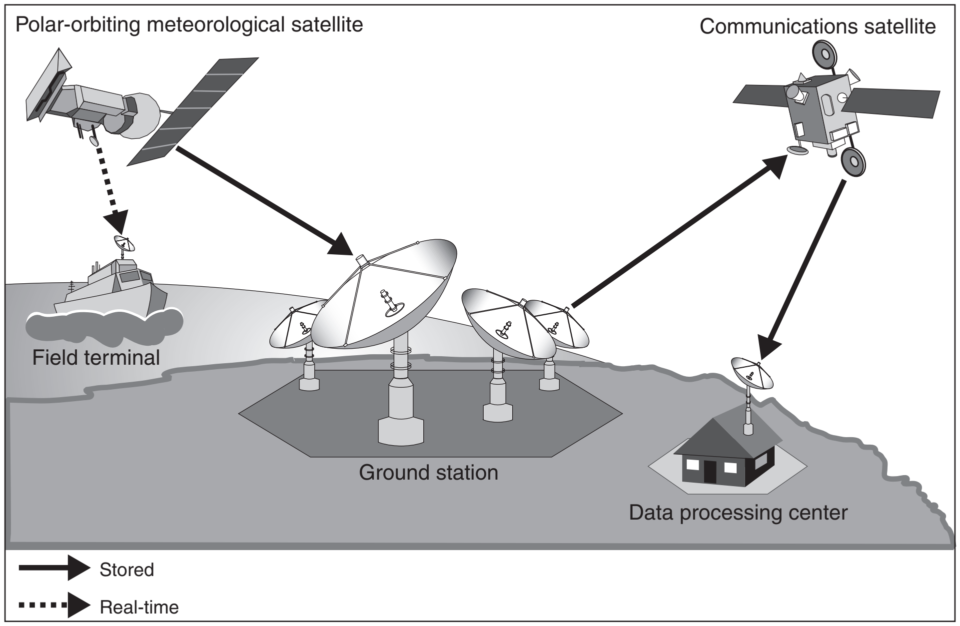
Each of the polar satellites carries a suite of sensors designed to detect environmental data that is either reflected or emitted from the earth, the atmosphere, and space. The satellites store these data and then transmit them to NOAA and Air Force ground stations when the satellites pass overhead. The ground stations then relay the data via communications satellites to the appropriate meteorological centers for processing. The satellites also broadcast a subset of these data in real time to tactical receivers all over the world.

Under a shared processing agreement among the four processing centers—NESDIS, the Air Force Weather Agency, Navy's Fleet Numerical Meteorology and Oceanography Center, and the Naval Oceanographic Office—different centers are responsible for producing and distributing via a shared network different environmental data sets, specialized weather and oceanographic products, and weather prediction model outputs.[3] Each of the four processing centers is also responsible for distributing the data to its respective users. For the DOD centers, the users include regional meteorology and oceanography centers, as well as meteorology and oceanography staff on military bases. NESDIS forwards the data to NOAA's National Weather Service for distribution and use by government and commercial forecasters. The processing centers also use the Internet to distribute data to the general public. NESDIS is responsible for the long-term archiving of data and derived products from POES and DMSP.

In addition to the infrastructure supporting satellite data processing noted above, properly equipped field terminals that are within a direct line of sight of the satellites can receive real-time data directly from the polar-orbiting satellites. There are an estimated 150 such field terminals operated by U.S. and foreign governments, academia, and many are operated by DOD. Field terminals can be taken into areas with little or no data communications infrastructure—such as on a battlefield or a ship—and enable the receipt of weather data directly from the polar-orbiting satellites. These terminals have their own software and processing capability to decode and display a subset of the satellite data to the user. Figure 2 depicts a generic data relay pattern from the polar-orbiting satellites to the data processing centers and field terminals.

[3]These environmental data sets, specialized weather and oceanographic products, and weather prediction model outputs are produced through algorithmic processing. An algorithm is a precise set of procedures that enable a desired end result, such as a measurement of natural phenomena.

Figure 2: Generic Data Relay Pattern for the Polar Meteorological Satellite System



Source: GAO, based on NPOESS Integrated Program Office data.

NPOESS Overview

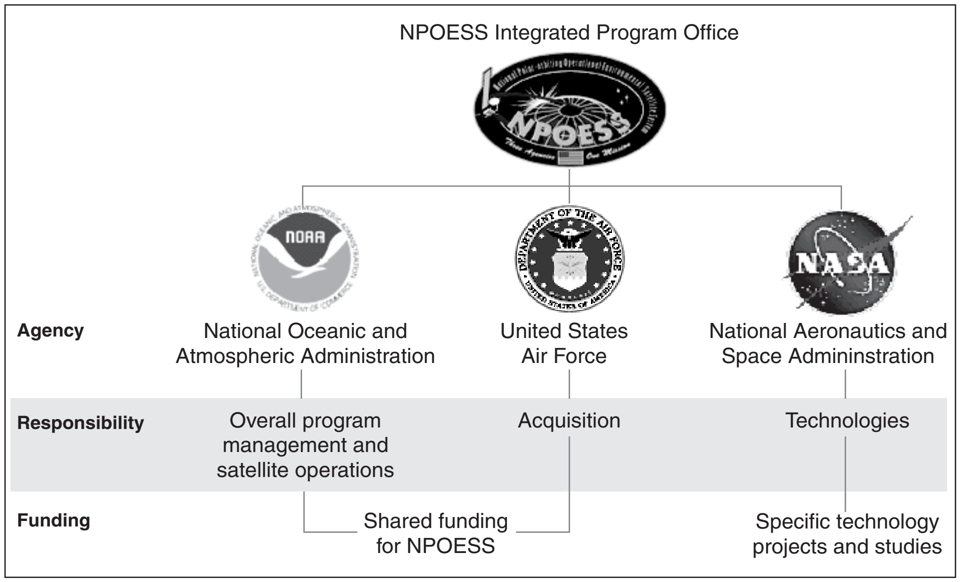
Given the expectation that combining the POES and DMSP programs would reduce duplication and result in sizable cost savings, a May 1994 Presidential Decision Directive[4] required NOAA and DOD to converge the two satellite programs into a single satellite program capable of satisfying both civilian and military requirements. The converged program, NPOESS, is considered critical to the United States' ability to maintain the continuity of data required for weather forecasting and global climate monitoring. To manage this program, DOD, NOAA, and NASA formed a tri-agency Integrated Program Office located within NOAA.

Within the program office, each agency has the lead on certain activities. NOAA has overall program management responsibility for the converged system, as well as satellite operations; DOD has the lead on the acquisition; and NASA has primary responsibility for facilitating the development and incorporation of new technologies into the converged system. NOAA and

[4]NSTC-2, May 5, 1994.

DOD share the costs of funding NPOESS, while NASA funds specific technology projects and studies. Figure 3 depicts the organizations coordinated by the Integrated Program Office and their responsibilities.

Figure 3: Organizations Coordinated by the NPOESS Integrated Program Office



Source: GAO, based on NPOESS Integrated Program Office data.

Program acquisition plans call for the procurement and launch of six NPOESS satellites over the life of the program, as well as the integration of 13 instruments, consisting of 11 environmental systems and 2 subsystems. Together, the sensors are to receive and transmit data on atmospheric, cloud cover, environmental, climate, oceanographic, and solar-geophysical observations. The subsystems are to support nonenvironmental search and rescue efforts and environmental data collection activities. According to the program office, 7 of the 13 planned NPOESS instruments involve new technology development, whereas 6 others are based on existing technologies. In addition, the program office considers 4 of the sensors involving new technologies critical because they provide data for key weather products; these sensors are shown in bold in table 1, which presents the planned instruments and the state of technology on each.

Table 1: Expected NPOESS Instruments (critical sensors in bold), as of August 31, 2004

Instrument name	Description	State of technology
Advanced technology microwave sounder	Measures microwave energy released and scattered by the atmosphere and is to be used with infrared sounding data from NPOESS' cross-track infrared sounder to produce daily global atmospheric temperature, humidity, and pressure profiles.	New
Aerosol polarimetry sensor	Retrieves specific measurements of clouds and aerosols (liquid droplets or solid particles suspended in the atmosphere, such as sea spray, smog, and smoke).	New
Conical-scanned microwave imager/sounder	Collects microwave images and data needed to measure rain rate, ocean surface wind speed and direction, amount of water in the clouds, and soil moisture, as well as temperature and humidity at different atmospheric levels.	New
Cross-track infrared sounder	Collects measurements of the earth's radiation to determine the vertical distribution of temperature, moisture, and pressure in the atmosphere.	New
Data collection system	Collects environmental data from platforms around the world and delivers them to users worldwide.	Existing
Earth radiation budget sensor	Measures solar short-wave radiation and long-wave radiation released by the earth back into space on a worldwide scale to enhance long-term climate studies.	Existing
Ozone mapper/profiler suite	Collects data needed to measure the amount and distribution of ozone in the earth's atmosphere.	New
Radar altimeter	Measures variances in sea surface height/topography and ocean surface roughness, which are used to determine sea surface height, significant wave height, and ocean surface wind speed and to provide critical inputs to ocean forecasting and climate prediction models.	Existing
Search and rescue satellite aided tracking system	Detects and locates aviators, mariners, and land-based users in distress.	Existing
Space environmental sensor suite	Collects data to identify, reduce, and predict the effects of space weather on technological systems, including satellites and radio links.	New
Survivability sensor	Monitors for attacks on the satellite and notifies other instruments in case of an attack.	Existing
Total solar irradiance sensor	Monitors and captures total and spectral solar irradiance data.	Existing
Visible/infrared imager radiometer suite	Collects images and radiometric data used to provide information on the earth's clouds, atmosphere, ocean, and land surfaces.	New

Source: GAO, based on NPOESS Integrated Program Office data.

In addition, the NPOESS Preparatory Project (NPP), which is being developed as a major risk reduction initiative, is a planned demonstration satellite to be launched in 2006, several years before the first NPOESS satellite launch in 2009. It is scheduled to host three of the four critical NPOESS sensors (the visible/infrared imager radiometer suite, the cross-track infrared sounder, and the advanced technology microwave sounder), as well as one other noncritical sensor (the ozone mapper/profiler suite). NPP will provide the program office and the processing centers an early opportunity to work with the sensors, ground control, and data processing systems. Specifically, this satellite is expected to demonstrate the validity of about half of the NPOESS environmental data records[5] and about 93 percent of its data processing load.

NPOESS Acquisition Strategy

When the NPOESS development contract was awarded, program office officials identified an anticipated schedule and funding stream for the program. The schedule for launching the satellites was driven by a requirement that the satellites be available to back up the final POES and DMSP satellites should anything go wrong during the planned launches of these satellites. In general, program officials anticipate that roughly 1 out of every 10 satellites will fail either during launch or during early operations after launch.

Key program milestones included (1) launching NPP by May 2006, (2) having the first NPOESS satellite available to back up the final POES satellite launch in March 2008, and (3) having the second NPOESS satellite available to back up the final DMSP satellite launch in October 2009. If the NPOESS satellites were not needed to back up the final predecessor satellites, their anticipated launch dates would have been April 2009 and June 2011, respectively.

These schedules were changed as a result of changes in the NPOESS funding stream. A DOD program official reported that between 2001 and 2002 the agency experienced delays in launching a DMSP satellite, causing delays in the expected launch dates of another DMSP satellite. In late 2002, DOD shifted the expected launch date for the final DMSP satellite from 2009 to 2010. As a result, DOD reduced funding for NPOESS by about $65 million between fiscal years 2004 and 2007. According to NPOESS program officials, because NOAA is required to provide no more funding than DOD provides, this change triggered a corresponding reduction in funding by NOAA for those years. As a result of the reduced funding, program officials were forced to make difficult decisions about what to focus on first. The program office decided to keep NPP as close to its original schedule as possible because of its importance to the eventual NPOESS development and to shift some of the NPOESS deliverables to later years. This shift

[5]Environmental data records are weather products derived from sensor data records and temperature data records.

affected the NPOESS deployment schedule. To plan for this shift, the program office developed a new program cost and schedule baseline.

NPOESS Costs Have Increased, and Schedules Have Been Delayed

The program office has increased the NPOESS life cycle cost estimate by $1.2 billion, from $6.9 to $8.1 billion, and delayed key milestones—including the expected availability of the first NPOESS satellite, which was delayed by 20 months. The cost increases reflect changes to the NPOESS contract as well as increased program management funds. The contract changes include extension of the development schedule, increased sensor costs, and additional funds needed for mitigating risks. Increased program management funds were added for non-contract costs and management reserves. The schedule delays were the result of stretching out the development schedule to accommodate the change in the NPOESS funding stream. In addition, the delayed launch dates of the NPOESS satellites have extended the maintenance and operation of the satellite system from 2018 to 2020.

When we testified on the NPOESS program in July 2003, we reported that the program office was working to develop a new cost and schedule baseline due to a change in the NPOESS funding stream. The program office completed its efforts to revise the NPOESS cost and schedule baseline in December 2003.

As a result of the revised baseline, the program office increased the NPOESS cost estimate by $638 million, from $6.9 to $7.5 billion. The program office attributed the $638 million cost increase to extending the development schedule to accommodate the changing funding stream, increased sensor costs, and additional funds needed for mitigating risks. The program office has since increased funds for non-contract costs and management reserves, which raised its estimate by an additional $562 million to bring the NPOESS life cycle cost estimate to $8.1 billion. According to program officials, non-contract costs included oversight expenses for the prime contract and sensor subcontracts. Management reserves, which are a part of the total program budget and should be used to fund undefined but anticipated work, are expected to last through 2020.[6] Table 2 shows a breakdown of the cost increases resulting from the revised plan.

[6] The prime contract provides options available to the program office that would enable the contractor to support the NPOESS system through 2020.

Table 2: Cost Increases Resulting from the Revised Plan (dollars in millions)

Effort	Amount
NPOESS cost estimate before revised plan	$6,950
Changes to the NPOESS Contract	
Inflationary impacts of delays to accommodate funding cuts	112
Impact of slowed start and contract extension resulting from delaying the first NPOESS satellite and stretching out several sensor deliveries	406
Additional tasks related to sensors	64
Preparation cost of the revised plan effort	13
Additional funds required for risk mitigation	43
Total revised plan costs	638
Changes to Program Management Costs	
Additional non-contract costs and management reserves	536
Increase in program office costs	26
NPOESS cost estimate after revised plan	**$8,150**

Source: NPOESS Integrated Program Office data.

Recently, program officials reported that a new life cycle cost estimate would be developed by the contractor and program office. The program office expects to brief its executive oversight committee on the results of its cost estimate analysis by December 2004. The new cost estimate will be used to help develop the NPOESS fiscal year 2007 budget request. Officials reported that the new estimate is necessary in order to ensure that the program will be adequately funded through its life.

In addition to increasing the cost estimate, the program office has delayed key milestones, including the expected availability of the first satellite, which was delayed by 20 months. The program office attributed the schedule delays to stretching out the development schedule to accommodate the changing funding stream. Table 3 shows program schedule changes for key milestones.

Table 3: Program Schedule Changes

Milestones	As of August 2002 contract award	As of February 2004 after the revised plan	Change from contract award to the revised plan
NPP launch	May 2006	October 2006	5-month delay
Final POES launch [a]	March 2008	March 2008	
First NPOESS satellite available for launch	March 2008	November 2009	20-month delay [b]
First NPOESS satellite planned for launch	April 2009	November 2009[c]	7-month delay
Final DMSP launch [a]	October 2009	May 2010[d]	
Second NPOESS satellite available for launch	October 2009	June 2011	20-month delay
Second NPOESS satellite planned for launch	June 2011	June 2011	No change
Third NPOESS satellite available for launch	March 2011	May 2013	26-month delay
Third NPOESS satellite planned for launch	May 2013	June 2013	1-month delay
Fourth NPOESS satellite available for launch	June 2012	May 2014	23-month delay
Fourth NPOESS satellite planned for launch	November 2015	November 2015	No change
End of operations and maintenance	2018	2020	2-year extension

Source: GAO analysis, based on NPOESS Integrated Program Office data.

[a]POES and DMSP are not part of the NPOESS program. Their launch dates are provided because of their relevance to the NPOESS satellite schedules.

[b]In our July 2003 testimony (GAO-03-987T), we reported a 21-month delay with launch availability in December 2009. However, since then, the program office has accelerated this date.

[c]A program official reported that if the first NPOESS satellite is needed to back up the final POES satellite, the contractor will prepare the satellite to be launched in a different orbit with a different suite of sensors. These factors will prevent launch from taking place until February 2010.

[d]In commenting on a draft of this report, DOD officials noted that the current launch date is October 2011.

A result of the program office extension of several critical milestone schedules is that less slack is built into the schedules for managing development and production issues. For example, the first NPOESS satellite was originally scheduled to be available for launch by March 2008 and to launch by April 2009. This enabled the program office to have 13 months to resolve any potential problems with the satellite before its expected launch. Currently, the first NPOESS satellite is scheduled to be available for launch by November 2009 and to launch the same month. This will allow the program office less than one month to resolve any problems. The program office has little room for error, and should something go wrong in development or production, the program office would have to delay the launch further.

NPOESS Could Experience Further Cost and Schedule Increases

NPOESS costs and schedules could continue to increase in the future. The contractor's continued slippage of expected cost and schedule targets indicates that the NPOESS contract[7] will most likely be overrun by $500 million at contract completion in September 2011. Program risks, particularly with the development of critical sensors to be demonstrated on the NPP satellite, could also increase costs and delay schedules for NPOESS.

Current Shortfalls in Cost and Schedule Targets Could Require Additional Funds to Meet Launch Deadlines

To be effective, project managers need information on project deliverables and on a contractor's progress in meeting those deliverables. One method that can help project managers track progress on deliverables is earned value management. This method, used by DOD for several decades, compares the value of work accomplished during a given period with that of the work expected in that period. Differences from expectations are measured in both cost and schedule variances.

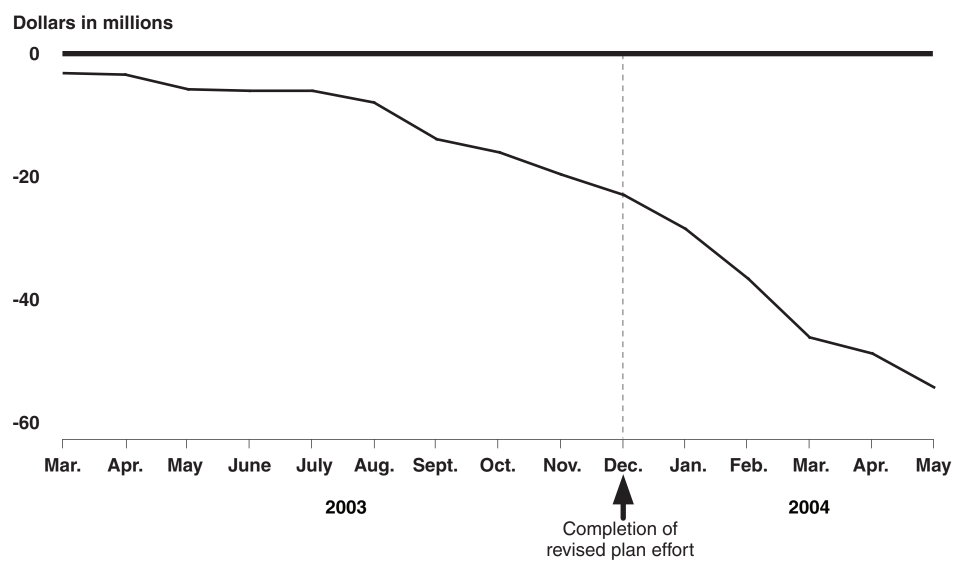
Cost variances compare the earned value of the completed work with the actual cost of the work performed. For example, if a contractor completed $5 million worth of work and the work actually cost $6.7 million, there would be a –$1.7 million cost variance. Schedule variances are also measured in dollars, but they compare the earned value of the work completed to the value of work that was expected to be completed. For example, if a contractor completed $5 million worth of work at the end of the month, but was budgeted to complete $10 million worth of work, there would be a –$5 million schedule variance. Positive variances indicate that activities are costing less or are completed ahead of schedule. Negative variances indicate activities are costing more or are falling behind

[7] The prime contract includes the development of the first two NPOESS satellites as well as instruments and support for NPP. It is worth about $3.4 billion. The contract also includes options to procure four more satellites and operate the NPOESS system through 2020, which would bring the total value of the contract up to $4.5 billion. The program cost estimate of $8.1 billion includes this contract, its options, program office costs, sensor developments prior to contract award, and satellite operations and maintenance.

schedule. These cost and schedule variances can then be used in estimating the cost and time needed to complete the program.

Using contractor-provided data, our analysis indicates that NPOESS cost performance was experiencing negative variances before the revised plan was implemented in December 2003, and continued to deteriorate after the implementation of the revised plan. Figure 4 shows the 15-month cumulative cost variance for the NPOESS contract. From March 2003 to November 2003, the contractor exceeded its cost target by $16.1 million, which is about 4.5 percent of the contractor's budget for that time period. From December 2003 to May 2004, the contractor exceeded its cost target by $33.6 million, or about 5.7 percent of the contractor's budget. The contractor has incurred a total cost overrun of about $55 million with NPOESS development less than 20 percent complete. This information is useful because trends tend to continue and can be difficult to reverse. Studies have shown that, once programs are 15 percent complete, the performance indicators are indicative of the final outcome.

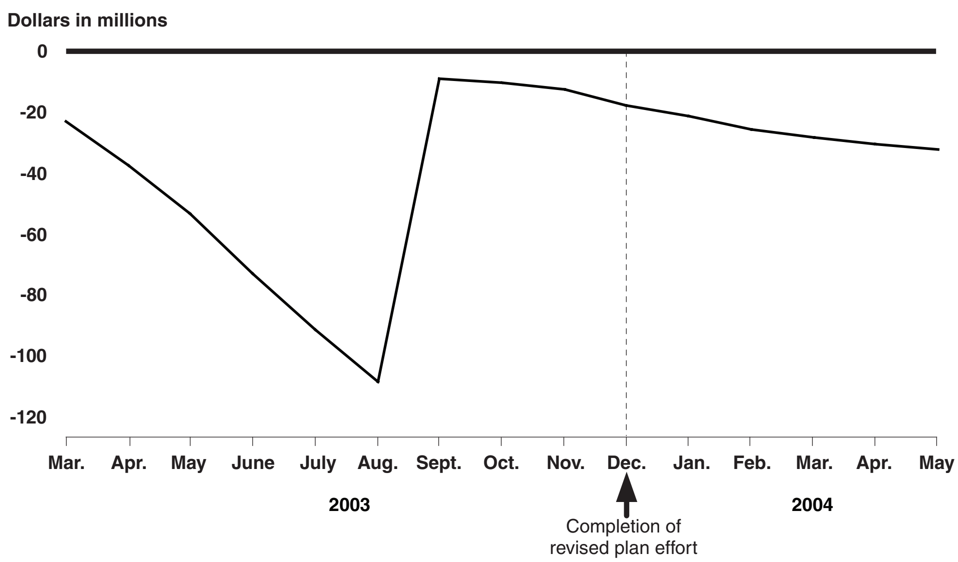
Figure 4: Cumulative Cost Variance of the NPOESS Program over a 15-Month Period



Source: GAO analysis, based on NPOESS Integrated Program Office data.

Our analysis also indicates that the program is showing a negative schedule variance. Figure 5 shows the 15-month cumulative schedule variance of NPOESS. From March 2003 to November 2003, the contractor recovered almost $11 million worth of planned work in the schedule. Program officials reported that within this time period, the program office ordered the contractor to stop some work until the new baseline was established. This work stoppage contributed to schedule degradation between March 2003 and August 2003. In September 2003, the program office implemented portions of the revised plan, which resulted in an improvement in schedule performance. The revised plan alleviated some of the cumulative schedule overrun by delaying the deadline for first unit availability by 20 months. However, based on our analysis, the cumulative schedule variance indicates slippage in the new schedule. Since December 2003, the contractor has been unable to complete approximately $19.7 million worth of scheduled work. The current inability to meet contract schedule performance could be a predictor of future rising costs, as more spending is often necessary to resolve schedule overruns.

Figure 5: Cumulative Schedule Variance of the NPOESS Program over a 15-Month Period



Source: GAO analysis, based on NPOESS Integrated Program Office data.

According to program office documents, cost and schedule overruns that occurred before December 2003 were caused by planning activities related to the revised plan, as well as by technical issues related to the development of the critical sensors and the spacecraft communications software. Since the completion of the revised plan, the program's ability to meet the new performance goals continues to be hampered by technical issues with the design complexity, testing, and integration, among other things, of the critical sensors. These technical issues could cause further cost and schedule shortfalls.

Based on contractor performance from December 2003 to May 2004, we estimate that the current NPOESS contract—which ends in September 2011 and is worth approximately $3.4 billion—will overrun its budget by between $372 million and $891 million. Our projection of the most likely cost overrun will be about $534 million, or about 16 percent of the contract. The contractor, in contrast, estimates about a $130 million overrun at completion of the NPOESS contract.

Risks Could Further Affect NPOESS Cost and Schedule

Risk management is a leading management practice that is widely recognized as a key component of a sound system development approach. An effective risk management approach typically includes identifying, prioritizing, resolving, and monitoring project risks.

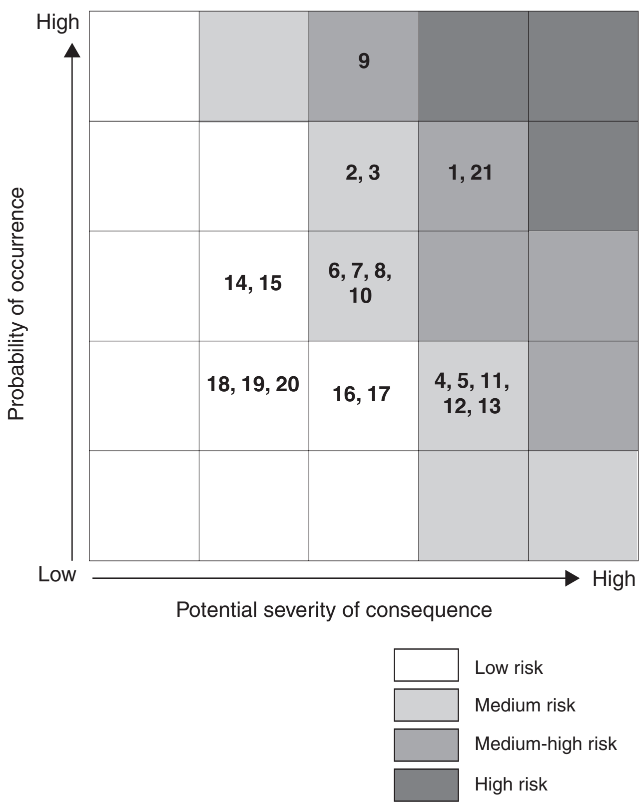
Program officials reported that they recognize several risks with the overall program and critical sensors that, if not mitigated, could further increase costs and delay the schedule. In accordance with leading management practices, the program office developed a NPOESS risk management program that requires assigning a severity rating to risks that bear particular attention, placing these risks in a database, planning response strategies for each risk in the database, and reviewing and evaluating risks in the database during monthly program risk management board meetings.

The program office identifies risks in two categories: program risks, which affect the whole NPOESS program and are managed at the program office level, and segment risks, which affect only individual segments[8] and are managed at the integrated product team level. The program office has identified 21 program risks, including 14 medium to medium-high risks. Some of these risks include the development of three critical sensors (the visible/infrared imager radiometer suite (VIIRS), the cross-track infrared sounder (CrIS), and the conical-scanned microwave imager/sounder (CMIS)) and the integrated data processing system; the uncertainty that

[8]These segments are identified as (1) overall system integration, (2) the launch segment, (3) the space segment, (4) the interface data processing segment, and (5) the command, control, and communications segment.

algorithms will meet system performance requirements; and the effort to obtain a security certification and accreditation. Figure 6 includes the 21 program risks and their assigned levels of risk.

Figure 6: Key Program Risks as Identified by the NPOESS Program Office, as of February 2004



1. VIIRS delivery and ease of integration for NPP
2. Algorithm performance
3. Integrated Data Processing System delivery for NPP
4. CrIS delivery and ease of integration for NPP
5. Delivery and integration of first CMIS instrument
6. Security accreditation
7. Calibration and validation readiness
8. Subcontract management performance
9. NESDIS facility readiness
10. Air Force Weather Agency facility readiness
11. NPP mission integration and readiness support
12. Software development
13. Software capability
14. Field terminal segment interface definition
15. Environmental Data Record quality
16. Instrument and payload interface development
17. Frequency registration
18. Satellite Electrical Ground Support Equipment readiness
19. Landing rights
20. System interoperability
21. Ozone Mapper/Profiler Suite delivery for NPP

Source: NPOESS Integrated Program Office.

Managing the risks associated with the development of VIIRS and CrIS, the integrated data processing system, and algorithm performance is of particular importance because these are to be demonstrated on the NPP satellite currently scheduled for launch in October 2006. Any delay in the NPP launch date could affect the overall NPOESS program because the success of the program depends on the lessons learned in data processing and system integration from the NPP satellite.

At present, the program office considers the three critical sensors—VIIRS, CMIS, and CrIS—to be key program risks because of technical challenges that each is facing. VIIRS's most severe technical issue, relating to flight-quality integrated circuits, was recently resolved; however, the program office continues to consider the schedule for the VIIRS sensor acquisition to be high risk. The prime contractor's analysis of the current schedule indicated that the present schedule is unlikely to be achieved, considering the technical risks, the optimistically planned integration and test phase, and the limited slack in the schedule at this stage of the program. VIIRS is experiencing ongoing technical issues on major subcontracts related to the motors, rotating telescope, and power supply. As a result of the numerous ongoing issues—many of which affect system performance—significantly more modeling, budget allocation work, and performance reviews have been required than were originally planned. Until the current technical issues are resolved, delays in the VIIRS delivery and integration onto the NPP satellite remain a potential threat to the expected launch date of the NPP.

The CMIS and CrIS sensor acquisitions are experiencing schedule overruns that may threaten their respective expected delivery dates. CMIS technical challenges include unplanned redesigns for receiver and antenna components, system reliability issues, and thermal issues. A significant amount of CrIS's developmental progress has been impeded by efforts to address a signal processor redesign, vibration issues in an optical instrument, and the late subcontract deliveries of some parts.

To the program office's credit, it is aware of these risks and is using its risk management plans to help mitigate them. We plan to further evaluate the risk mitigation strategies of the Integrated Program Office in a follow-on review.

Conclusions

The next generation polar-orbiting environmental satellite program, NPOESS, recently underwent a replanning effort that increased the NPOESS cost estimate by $1.2 billion, from $6.9 to $8.1 billion and delayed key milestones, including the expected availability of the first satellite by 20 months.

Other factors could further affect the revised cost and schedule estimates. Specifically, the current shortfalls in performance targets indicate that the NPOESS contract will most likely be overrun by $500 million at completion in September 2011 and program risks could contribute to additional cost and schedule slips. The program office is planning to develop new cost estimates but has not yet determined the impact of these risks.

Given the history of large cost increases and the factors that could further affect NPOESS costs and schedules, continued oversight is more critical than ever. Accordingly, we plan to continue our review of this program.

Agency Comments

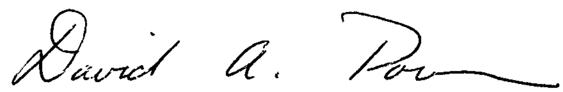
We provided a draft of this report to the Secretary of Commerce, Secretary of Defense, and the Administrator of NASA for review and comment. The departments generally agreed with the report and provided written and oral technical corrections, which have been incorporated as appropriate.

NOAA, Integrated Program Office, DOD officials, including the System Program Director of the NPOESS Integrated Program Office and the Assistant for Environmental Monitoring from the Office of the Assistant Secretary of Defense, noted that changes in funding levels, triggered after the contract was awarded, were the primary reason for rebaselining the program's costs and schedules. These funding level changes caused them to delay the development of the NPOESS system and led them to renegotiate the NPOESS contract. We revised our report to clarify the factors leading up to revising the baseline.

Additionally, NOAA officials commented that the Integrated Program Office continues to aggressively manage the NPOESS program to ensure it is completed within cost, schedule, and performance. In regard to our estimate that the contract will overrun by at least $500 million, NOAA officials reported that the agency will manage the contract to ensure that any cost overrun is identified and addressed. To this end, NOAA has asked the contractor to develop a new life cycle cost estimate.

NOAA and DOD officials also noted that in August 2004, the President directed the Departments of Defense, the Interior, Commerce, and NASA to place a LANDSAT-like imagery capability on the NPOESS platform. This new capability will collect imagery data of the earth's surface similar to the current LANDSAT series of satellites, which are managed by the Department of Interior's U.S. Geological Survey, and are reaching the end of their lifespans. Officials expect that this new sensor will be funded separately and will not affect the NPOESS program's cost or schedule. Accordingly, while this recent event is important to the NPOESS program, it does not change the results of our report.

We are sending copies of this report to the Secretary of Commerce, the Secretary of Defense, and the Administrator of NASA. In addition, copies will be available at no charge on the GAO Web site at http://www.gao.gov. Should you have any questions about this report, please contact me at (202) 512-9286 or Colleen Phillips, Assistant Director, at (202) 512-6326. We can also be reached by e-mail at pownerd@gao.gov and phillipsc@gao.gov, respectively. Other key contributors to this report included Carol Cha, Barbara Collier, John Dale, Neil Doherty, Karen Richey, and Eric Winter.



David A. Powner
Director, Information Technology Management Issues

Objectives, Scope, and Methodology

Our objectives were to (1) identify any cost or schedule changes as a result of the revised baseline and determine what contributed to these changes and (2) identify factors that could affect the program baseline in the future. To accomplish these objectives, we focused our review on the Integrated Program Office, the organization responsible for the overall National Polar-orbiting Operational Environmental Satellite System (NPOESS) program.

To identify any cost or schedule changes as a result of the revised baseline, we reviewed the new NPOESS cost and schedule baseline and compared it to the old acquisition baseline, as reported in our July 2003 testimony.[1] To determine the factors that contributed to the cost and schedule changes in the new baseline, we reviewed program office plans and management reports. We also interviewed IPO officials to discuss these contributing factors.

To identify factors that could affect the program baseline in the future, we assessed the prime contractor's performance related to cost and schedule. To make these assessments, we applied earned value analysis techniques[2] to data captured in contractor cost performance reports. We compared the cost of work completed with the budgeted costs for scheduled work for a 15-month period, from March 2003 to May 2004, to show trends in cost and schedule performance. We also used data from the reports to estimate the likely costs at the completion of the prime contract through established earned value formulas. This resulted in three different values, with the middle value being the most likely. We used the base contract without options for our earned value assessments. We reviewed these cost reports and program risk management documents and interviewed program officials to determine the key risks that negatively affect NPOESS's ability to maintain the current schedule and cost estimates. We reviewed independent cost estimates performed by the Air Force Cost Analysis Agency and compared them with the program office cost estimates in order to determine possible areas for cost growth. To assess the potential effect of the NOAA-N Prime satellite incident on the current program baseline, we reviewed documentation related to the POES accident and alternatives for

[1]GAO, *Polar-orbiting Environmental Satellites: Project Risks Could Affect Weather Data Needed by Civilian and Military Users*, GAO-03-987T *(Washington, D.C.: July 15, 2003).*

[2]The earned value concept is applied as a means of placing a dollar value on project status. It is a technique that compares budget vs. actual costs vs. project status in dollar amounts. For our analysis, we used standard earned value formulas to calculate cost and schedule variance and forecast the range of cost overrun at contract completion.

moving forward and interviewed officials from the National Aeronautics and Space Administration (NASA) and NOAA's National Environmental Satellite, Data, and Information Service.

We obtained comments on a draft of this report from officials at the Department of Defense (DOD), NOAA, and NASA, and incorporated these comments as appropriate.

We performed our work at the Integrated Program Office, DOD, NASA, and NOAA in the Washington, D.C., metropolitan area between November 2003 and August 2004 in accordance with generally accepted government auditing standards.

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