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Major Management Challenges and Program Risks

National Aeronautics and Space Administration

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Accountability * Integrity * Reliability

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Comptroller General
of the United States

United States General Accounting Office
Washington, D.C. 20548

January 2001

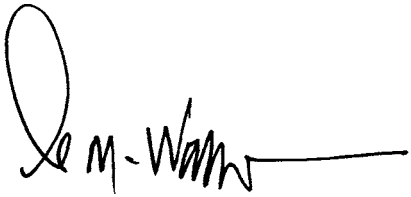
The President of the Senate
The Speaker of the House of Representatives

This report addresses the major performance and accountability challenges facing the National Aeronautics and Space Administration (NASA) as it seeks to advance human exploration and development of space, advance and communicate scientific knowledge, and research and develop aeronautics and space technologies. It includes a summary of actions that NASA has taken and that are under way to address these challenges. It also outlines further actions that GAO believes are needed. This analysis should help the new Congress and administration carry out their responsibilities and improve government for the benefit of the American people.

This report is part of a special series, first issued in January 1999, entitled the *Performance and Accountability Series: Major Management Challenges and Program Risks*. In that series, GAO advised Congress that it planned to reassess the methodologies and criteria used to determine which federal government operations and functions should be highlighted and which should be designated as "high risk." GAO completed the assessment, considered comments provided on a publicly available exposure draft, and published its guidance document, *Determining Performance and Accountability Challenges and High Risks* (GAO-01-159SP), in November 2000.

The full 2001 *Performance and Accountability Series* contains separate reports on 21 agencies—covering each cabinet department, most major independent

agencies, and the U.S. Postal Service. The series also includes a governmentwide perspective on performance and management challenges across the federal government. As a companion volume to this series, GAO is issuing an update on those government operations and programs that its work identified as "high risk" because of either their greater vulnerabilities to waste, fraud, abuse, and mismanagement or major challenges associated with their economy, efficiency, or effectiveness.



David M. Walker
Comptroller General
of the United States

Overview

The National Aeronautics and Space Administration's (NASA) mission encompasses human exploration and development of space, the advancement and communication of scientific knowledge, and research and development of aeronautics and space technologies. Its activities span a broad range of complex and technical endeavors—from investigating the composition, evaluation, and resources of Mars; to working with its international partners to complete and operate the International Space Station; to providing satellite and aircraft observations of Earth for scientific and weather forecasting purposes; to developing new technologies designed to improve air flight safety. Overall, NASA spends more than $12 billion annually for goods and services supporting these and other activities, mostly on contracts with businesses and other organizations.

Since 1990, we have identified a number of major management challenges at NASA. Currently, four challenges warrant increased NASA attention, including one area—contract management—that we are continuing to categorize as high risk. As highlighted in this overview, NASA has made substantial progress in addressing these challenges. Nevertheless, key steps remain.

Contract Management

Much of NASA's success depends on the work of its contractors—on which it spends the greatest part of its funds. As such, it is exceedingly important for NASA to have accurate and reliable information on contract spending and to exercise effective contract oversight. In 1990, however, we identified NASA's contract management function as an area at high risk due to its ineffective systems and processes for overseeing contractor activities. At that time, there was little emphasis on end results, product performance, and cost control; the acquisition process itself was cumbersome and time-consuming; and NASA found itself procuring expensive hardware that did not work properly.

NASA has made progress in developing systems to correct some weaknesses—notably by strengthening performance measurement and introducing widely accepted standards for managing procurement activities. However, until its integrated financial management system, which is central to providing effective management and oversight over its

procurement dollars, is operational, performance assessments relying on cost data may be incomplete, and full costing will be only partially implemented. Therefore, the agency's contract management function remains a high-risk area.

We have also reported that NASA is continuing to rely on undefinitized change orders—that is, contract changes initiating new work before NASA and the contractor agree on a final estimated cost and fee—to complete work on its largest space station contract. This is a risky way of doing business because it increases the potential for unforeseen cost increases and scheduling delays.

Space Station Costs

The International Space Station is characterized as one of the most challenging engineering feats ever attempted. When assembly is completed, the space station will be a football field-sized laboratory manned by up to seven crewmembers. However, until the space station is completed, NASA will continue to face challenges in controlling the cost and schedule of the program. Initially, the prime contract for the space station was expected to cost over $5.2 billion, and the assembly of the station was expected to be completed in June 2002. By October 2000, the prime contractor's cost had grown to about $9 billion, of which $986 million was for cost overruns. Moreover, the prime contractor has advised NASA of its intent to submit additional claims totaling between $200 million and $300 million. The assembly sequence is now expected to be completed by April 2006. NASA's Office of Inspector General reported the same cost overrun increase of $986 million in a February 2000 audit report on performance management of the International Space Station. The Inspector General stated that the prime contractor attributed part of this increase to contractor reorganization activities.

In response to the Inspector General's recommendations, NASA agreed to take several actions, including discussing the prime contractor's cost performance at regularly scheduled meetings and preparing monthly written reports to senior management on the overrun status. NASA's continued ability to meet space station schedules will dictate whether previously experienced station cost growth will be mitigated. We have reported that space station cost growth stemmed in many cases from schedule delays—particularly with Russian and U.S.-built components.

Faster-Better-Cheaper

NASA faces the challenge of exploring numerous planets and other distant bodies in a low-cost way. To meet this challenge, NASA has embarked on an approach that emphasizes less complex designs that can be assembled quickly and launched at lower cost. However, the recent failure of two faster-better-cheaper Mars probes shows that there are limits to this approach. NASA-sponsored investigative boards recently found that opportunities to identify and resolve problems prior to launch were missed due to poor communications, budget pressures, and poor management and engineering practices. Also, senior management officials were not aware of how much trouble the programs were in. NASA also faces significant challenges as it attempts to create highly reliable missions and faster more open communications under the budget constraints of its faster-better-cheaper space exploration strategy.

Until NASA resolves these problems and finds an effective way to capture and disseminate lessons learned on an agencywide basis, space exploration programs using this approach may not achieve their objectives, and NASA's financial resources will remain vulnerable to ineffective use.

Human Capital

The space shuttle is the world's first reusable space transportation system. Since it is the nation's only launch system capable of carrying people to and from space, its viability is critical to other space programs such as the International Space Station. Nevertheless, since 1995, the shuttle workforce has decreased by more than one-third. Several internal NASA studies have shown that the shuttle program's workforce has been affected negatively by such downsizing. In particular, the shuttle program has identified many key areas that are not sufficiently staffed by qualified workers, and the remaining workforce shows signs of overwork and fatigue. Moreover, the program's demographic shape and skill mix jeopardize the program's ability to "hand off" leadership roles to the next generation and achieve a higher flight rate to support assembly of the International Space Station.

NASA has begun taking actions to address workforce problems. For example, it has discontinued its downsizing plans and has hired 114 full-time personnel to support current shuttle program operations requirements and shuttle program upgrades. It has also undertaken a joint review with the Office of Management and Budget to address personnel issues that will enable it to identify its overall future workforce needs. At the outset, NASA used a draft human capital self-assessment checklist we published as a guide in discussions with the Office of Management and Budget. A final version of the checklist was published in September 2000. Continued NASA management emphasis on human capital planning will be critical to continued safe shuttle operations in an environment of increasing shuttle flights.

Major Performance and Accountability Challenges

Correcting Weaknesses in Contract Management

NASA spends more than $12 billion annually for goods and services—ranging from procurements of expensive space hardware to contracts for research and development-related services. As such, much of NASA's success hinges on its contractors. Moreover, with most of its funds going to outside businesses and other organizations, it is exceedingly important that NASA have good control and oversight over its procurement dollars.

In 1990, we began a special effort to review and report on federal program areas that our work had identified as high risk because of vulnerabilities to waste, fraud, abuse, and mismanagement. We identified NASA's contract management as an area at high risk because it lacked effective systems and processes for overseeing contractor activities. Specifically, little emphasis was being placed on end results and on controlling costs. Procurement processes themselves were cumbersome and time-consuming. In 1992, we reported that the agency still had ineffective systems and processes for overseeing contractors' activities and that NASA field centers had failed to comply with contract management requirements.

Since then, NASA has made progress in addressing its contract management challenges. In July 1998, for example, we reported that NASA was developing systems to provide oversight and information needed to improve contract management and that it had made progress evaluating its field centers' procurement activities on the basis of international quality standards and its own procurement surveys. In January 1999, we found that NASA was implementing its new system for measuring procurement-related activities and had made progress in evaluating procurement functions at its field centers.

Nevertheless, as discussed below, key issues remain. For example, in 1998 and again in 1999, we reported that NASA had delayed implementation of its integrated financial management system—which was central to producing accurate and reliable information needed to support contract management. Moreover, in 2000, we reported that NASA needed to rely less on the use of undefinitized contract actions—that is, unnegotiated contract changes—as a way of doing business since this practice could result in contract cost overruns and cost growth in the International Space Station program.

NASA Delayed Implementation of Integrated Financial Management System

Modernizing NASA's financial management systems is key to providing better oversight over contract management activities. However, according to NASA, the agency's financial management environment is comprised of decentralized, nonintegrated systems with policies, procedures, and practices that are unique to its field centers. For the most part, data formats are not standardized, automated systems are not interfaced, and on-line financial information is not readily available to program managers. Thus, it is difficult to ensure contracts are being efficiently and effectively implemented and budgets are executed as planned. In addition, NASA has pointed out that the cost to maintain these systems has been high, since both data and software are replicated at each field center.

To correct these problems, on September 18, 1997, NASA awarded a fixed-price contract, valued at $186 million, to provide a NASA-wide integrated financial management system primarily based on commercial off-the-shelf software. The contract required that the integrated financial management project be implemented at all NASA centers by July 1, 1999. From its inception, the project experienced significant development and implementation problems. Work was stopped on the contract in March 2000. On October 13, 2000, a settlement agreement was reached

between NASA and the contractor to terminate the contract for the convenience of the government. NASA's total cost for the unsuccessful attempt to implement the integrated financial management project was $131 million.

NASA is undertaking its third attempt to implement the integrated financial management project. Its approach focuses on learning from other organizations' successes in implementing similar projects, as opposed to revisiting its own failures. NASA has also abandoned the single product approach that the two prior attempts had as their basic architecture. Instead, the project will be broken down into implementable modules on the basis of the availability of proven software products. Specifically, NASA has segmented implementation of the integrated financial management project into 14 modules, with estimated completion scheduled in fiscal year 2007. The first project scheduled for completion is the core financial project for acquiring and implementing financial software to serve as the backbone for all the other projects. However, NASA has established only tentative planning dates for full implementation.

Until the core financial project is operational, NASA has devised an interim approach, which it believes will achieve certain benefits associated with full-cost accounting practices. The concept of full-cost accounting ties all agency costs (including civil service personnel costs) to major activities. NASA officials expect this approach to provide complete cost information to management for more fully informed decision-making. In September 1999, NASA's Chief Financial Officer directed that (1) the centers initiate full-cost accounting activities in fiscal year 2000; (2) the focus in the immediate future be on providing full cost reports to center project managers; and (3) NASA not plan to spend significant amounts on enhancing existing systems on the basis of current plans to replace many of

these systems, if not all, in the future. NASA plans to follow this interim approach until the core financial project is operational at all centers (estimated in 2003).

NASA Has Implemented Its New System for Measuring Procurement-Related Activities

In response to our March 1997 report on NASA's contract management and our observation on the agency's need to produce accurate and reliable procurement-related information, NASA implemented a revised system of procurement metrics in fiscal year 1999. This revised system involves the development of measurable performance metrics, benchmarking these metrics, and the development of both NASA headquarters and agencywide procurement customer satisfaction surveys for timeliness, quality, and service. According to a NASA official, the purpose of the initiative is to help procurement managers measure and improve the performance of their organizations.

NASA conducted a customer satisfaction survey in 1999. It showed that most participants were satisfied with procurement services quality, timeliness, and customer service. A second survey, now being analyzed, will further assess satisfaction in communication, customer service, meeting mission goals, and procurement knowledge and skills.

NASA Has Made Progress in Evaluating Procurement at Its Field Centers

To strengthen contract management across the agency, NASA now requires a management system that, at a minimum, complies with the International Organization for Standardization (ISO) 9000[1] series of standards, which includes a standard for purchasing. The ISO 9000 series consists, in part, of 20 quality management and assurance standards. The general purchasing standard

[1] ISO is a worldwide federation of national standards bodies from some 130 countries. ISO 9000 standards provide a framework for quality management and quality assurance.

states that the supplier (for example, NASA's field centers' procurement offices) shall establish and maintain documented procedures to ensure that purchased products conform to specified requirements.

In April 1998, NASA's procurement officers agreed that a combination of ISO 9000 external and internal audits and procurement surveys should provide sufficient confidence in the soundness of NASA's procurement system. A NASA procurement official stated that NASA survey teams are currently conducting self-assessments and extensive audits of center operations on a 3-year schedule. Furthermore, NASA headquarters and all centers were certified as ISO 9000 compliant by authorized independent accreditation organizations as of the end of fiscal year 1999.

NASA Continues to Use Undefinitized Contract Actions

NASA officials can authorize work to begin on a contract change before NASA and the contractor agree on a final estimated cost and fee. Such changes are referred to as undefinitized contract actions—that is, unnegotiated contract changes. Relying on unnegotiated changes as a way of doing business is risky because it increases the potential for additional unanticipated cost growth. This, in turn, may force an agency to divert scarce budget resources intended for other important programs. In view of this risk, the Federal Acquisition Regulation and current NASA policy state that work on contract changes that have not been negotiated should occur on an exception basis and be limited to urgent requirements.

Both NASA's Office of the Inspector General and we have reported our concerns about NASA's frequent use of undefinitized contract changes. In May 2000, we reported that NASA authorized 593 changes to the space station prime contract in fiscal years 1998 and 1999. The cost of these changes amounted to $897.7 million. Of the 593 changes, 280 added capability or revised initial

designs. Added capabilities were to increase the station's operational performance, especially in meeting research needs. Revisions of initial designs included changes to (1) correct operability and design deficiencies and (2) reduce cost, schedule, and technical risks. The total estimated cost of changes made to add capabilities and revise initial designs was $368.1 million.

NASA officials have stated that because the space station program is complex and is nearing completion of the design, development, test, and evaluation stage of the program, the agency expects many urgent changes in the future. While they recognize that beginning work on contract changes that have not been negotiated is not the preferred way of doing business, NASA officials believe that such changes are necessary in order to avoid delaying the space station program schedule, modify ongoing work, or reduce the cost of a change by taking advantage of other ongoing work.

Our recent review of space station prime contract changes, however, showed that unnegotiated change orders accounted for more than one-half of all authorized changes and 98 percent of the cost of changes whereas the Federal Acquisition Regulation limits the use of such change orders to an exception basis. Moreover, the practice puts NASA at risk to unanticipated cost increases that may require funding reallocations and negatively impact other critical NASA programs.

Contract Management Remains a High-Risk Area

While NASA has made progress in correcting some weaknesses in contract management, it has not yet established a financial management system or integrated it with full-cost accounting practices. NASA is starting its third attempt on this effort by segmenting implementation of the project into 14 modules, with completion tentatively scheduled in fiscal year 2007. This effort will require continued management attention

to correct problems and keep projects on schedule. NASA included an objective in its fiscal year 2000 strategic plan to continue to develop a new integrated financial management system. The strategic plan notes that the integrated financial management project and other initiatives, such as full-cost accounting, will improve NASA's financial resource management. Until the system is operational, performance assessments relying on cost data may be incomplete and full costing will be only partially implemented.

In NASA's view, with the exception of an integrated financial management system, significant progress has been made resolving those contract management challenges related to the procurement function, notably, measuring procurement-related activities and evaluating procurement activities at its field centers. Therefore, NASA officials believe designating contract management as a major management challenge and high-risk area is no longer warranted.

While these actions are steps in the right direction, more actions are required to provide for effective oversight and management of the entire contract implementation process. Principally, NASA still needs an effective and efficient integrated financial management system as well as cost controls, particularly for the International Space Station program. Moreover, NASA's Inspector General and we have repeatedly reported on the need to limit the use of undefinitized contract change orders to prevent further unanticipated cost increases and scheduling delays. Therefore, we are retaining contract management as a major management challenge and a high-risk area.

Controlling International Space Station Development and Support Costs

NASA and its international partners—Japan, Canada, the European Space Agency, and Russia—are building a space station as a permanently orbiting laboratory to conduct research on materials and life sciences, to observe the earth, and to provide commercial services under nearly weightless conditions. In December 1998, NASA successfully coupled the first two elements of the space station in orbit. Since then, several other missions have been successfully launched, including the Russian-provided Service Module in July 2000. However, cost estimates continue to increase substantially.

Prime Contract and Nonprime Activity Costs Continue to Increase

Initially, the prime contract for the space station was expected to cost over $5.2 billion, and the assembly of the station was expected to be completed in June 2002. In September 1997, we reported that the cost and schedule performance of the space station's prime contractor, which showed signs of deterioration in 1996, had continued to worsen steadily and that program financial reserves for contingencies had deteriorated, principally because of program uncertainties and cost overruns. At that time, we also reported that NASA had questioned the accuracy of the prime contractor's reported estimate of the cost overrun at completion. On the basis of an internal review, the prime contractor more than doubled its estimate of the total cost growth at contract completion, from $278 million to $600 million. We also reported that NASA had become concerned with Russia's ability to meet its commitments.

As shown in table 1, costs for the station have continued to escalate since our 1997 report—leading to funding shortfalls and subsequent delays in assembly of the station.

Table 1: Space Station Cost Escalation

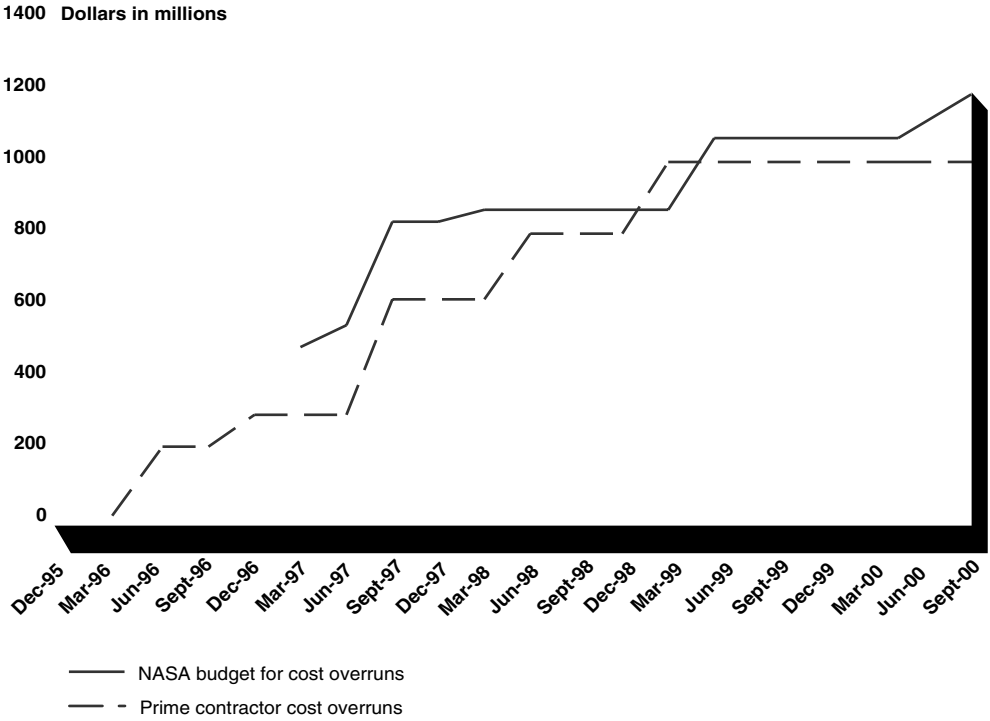
May 1998	• We reported that the life-cycle cost estimate to develop, operate, and decommission the station had increased by about $2 billion since 1995, to about $95.6 billion. The increase in development cost was offset by a dramatic reduction in NASA's estimate of the shuttle support costs for the station. • Also, the final assembly date of the station slipped from June 2002 to December 2003 and a number of potential program changes, including additional schedule delays and the need for more shuttle launches, threatened to further increase costs. Moreover, financial reserves appeared inadequate, considering that development was still about 6 years from completion.
January 1999	• We reported that the program was still facing cost and schedule challenges. NASA continued to identify cost growth and limited reserves as major program concerns and gave added attention to problems with nonprime contractors. The prime contractor's latest estimate of cost overruns at completion increased from $600 million to over $780 million. • We reported that cost increases had negatively impacted the program. In October 1998, NASA and its partners revised the official assembly sequence, adding additional shuttle flights and extending the assembly date of the station to July 2004.
August 1999	• We reported that the estimated development costs for the station were between $24 billion and $26 billion primarily due to further schedule slippage and Russian manufacturing delays. The prime contractor's estimate of cost overruns at assembly completion increased from $783 million to $986 million. • We also reported that one mechanism that could help managers deal with cost growth risks was a thorough risk management plan. Such a plan could force managers to identify and cost out all major program risks and develop effective strategies for mitigating risks. We recommended that NASA finalize the overall space station plan before the launch of the Service Module, an important component.
February 2000	• NASA's Office of Inspector General reported on the station's cost overrun of $986 million on the basis of its review of performance management of the space station contract and stated that the prime contractor attributed part of the cost overrun to unexpected cost increases due to contractor reorganization activities.[a] The Inspector General made 14 recommendations aimed at strengthening space station performance management and minimizing or eliminating the cost impact to NASA of contractor restructuring activities.
September 2000	• NASA officials stated that on the basis of the agency's review of the cost estimate at completion in June 2000, the prime contractor was still estimating cost overruns at $986 million.[b] Moreover, the prime contractor advised NASA of its intent to submit claims totaling between $200 million and $300 million. NASA indicated that it could not comment on the validity of the claims since they had not yet been submitted for adjudication. • NASA's own projections predicted a cost overrun at assembly completion of about $1.2 billion, due to additional costs to rework flight hardware and software to resolve problems relating to integration, parts quality, and pre-launch testing. NASA officials indicated that the agency was taking steps to increase its vehicle development budget reserves to cover the potential impact of the prime contractor's claims. NASA's most recent station assembly sequence showed a final assembly date of April 2006.

[a] *Review Report: Performance Management of the International Space Station Contract* (IG-00-007; Feb. 16, 2000).

[b] In December 2000, NASA officials stated that by October 2000, the prime contract cost had grown to about $9 billion, of which $986 million was for cost overruns.

Figure 1 shows the trend of estimated cost overruns for the prime contract and NASA's budget for overruns.

Figure 1: Estimates of Prime Contract Cost Overruns at Completion



Source: NASA

In the past, we reported that NASA had initiated a number of actions to mitigate the impact of cost increases and delays that affected the assembly completion milestones. These actions included (1) negotiating with partners to provide hardware

associated with the U.S. commitment in return for launch services or other considerations; (2) dropping components from the design; (3) transferring funds from other NASA programs, notably science funding; and (4) deferring activities, such as the procurement of spare parts, until later fiscal years.

We also reported in August 1999 that the costs of the nonprime portion of the program's development budget—activities related to science facilities and ground and vehicle operations—had increased from $8.5 billion in 1994 to over $12.4 billion by early 1999. The increase was due largely to added scope and schedule slippage. NASA began undertaking initiatives to improve its oversight of nonprime contract activities, including requiring periodic evaluations and increasing visibility through high-level reviews. In September 2000, NASA officials told us that although numerous minor changes had been made to the content of the nonprime budget, the overall budget outlook had remained constant since our August 1999 report. NASA provided information that indicated that nonprime costs totaled approximately $12.5 billion, slightly higher than the $12.4 billion in our August 1999 report. According to NASA officials, the agency is continuing to undertake initiatives to improve the oversight of nonprime contract activities.

Overall Contingency Plan Not Yet Approved

We reported in August 1999 that because of Russia's continuing funding problems, NASA had developed a multifaceted contingency plan to mitigate the risk of further delays in the Russian Service Module and the possibility that the Russians may not provide reboost capability for the station. The contingency plan provided for financial assistance to the Russian Space Agency and development of additional U.S. hardware. We further stated in our August 1999 report that while NASA had a plan to deal with Russian nonperformance, it did not have an approved overall contingency plan to address

space station development issues involving all partners. NASA identified the lack of such a plan as a program risk and, in response, drafted a plan to address issues such as late delivery or loss of critical hardware. However, the plan lacked an estimate of the potential cost of all contingencies. According to program officials, the higher priority items included in the overall contingency plan would ultimately be costed. We recommended that the NASA Administrator direct the station program manager to finalize the overall contingency plan before the Russian Service Module was launched to minimize the potential of further schedule disruptions and related cost increases. As of September 2000, the plan was still a draft and had not been approved by all station partners. Also, the potential cost of all contingencies in the plan had not been estimated. We continue to believe that completion of such a plan is critical if potential disruptions and related cost increases are to be minimized.

Space Station Cost Control and Contingency Planning Are Not Adequately Addressed

NASA's fiscal year 2000 and 2001 performance plans do not include performance measures that directly address space station cost control issues or risk mitigation activities and contingency planning. These plans include an objective to deploy and use the space station to advance scientific, exploration, engineering, and commercial objectives. However, we reported in June 2000 that the objective would be strengthened if performance measures that clearly addressed space station cost control and risk mitigation issues were established. Also, in addressing factors that could influence NASA's ability to achieve its goals and objectives, NASA's 2000 strategic plan states that NASA has developed alternate courses of action in the event an International Space Station partner is unable to meet a commitment. The value of this statement would be strengthened if the plan went a step further and briefly described some of the actions NASA had developed or referenced a separate plan that included such actions.

We will continue to monitor NASA's annual performance and strategic plans to determine the progress the agency is making in addressing cost control issues and risk mitigation activities and contingency planning.

Effectively Implementing the Faster-Better-Cheaper Approach to Space Exploration

To meet the challenge of exploring space in a low cost-way, NASA began following a faster-better-cheaper management philosophy in 1992. The approach focuses on building less expensive space probes much quicker than in the past. It is intended to stimulate innovative development and application of technology, streamline policies and practices, and energize and challenge a workforce to continue to safely and successfully undertake bold new missions in an era of diminishing resources. Specifically, NASA is emphasizing the following with this new approach:

- Distribution of risk by moving from single high-cost, long development time missions to multiple low-cost, shorter development time missions.
- Accountability and responsibility for success placed with the implementing teams at NASA's centers, as well as within industry and academia.
- Efficiency in process and methodology and exploitation of new, yet mature, technology to enable and enhance new and challenging science and technology programs and projects consistent with short development cycles.

Since NASA has introduced this approach, it has launched 158 missions valued at a total of $18.9 billion. All but 10 missions were successful. However, as a result of two recent failed missions to Mars, at a cost of about $300 million, the approach has come under increased scrutiny.

The Mars Climate Orbiter, which was intended to observe Mars' seasonal climate and daily weather from a

low orbit around the planet, was lost on September 23, 1999. Then on December 3, 1999, the Mars Polar Lander, a robotic spacecraft intended to land near the South Pole of Mars for a planned 90-day mission to study the planet's layered polar terrain, was also lost.

NASA sponsored investigative boards to determine the causes of the failed Mars missions. For example, NASA's Mars Program Independent Assessment Team found that a combination of mission design and execution factors had caused the failures. Further, opportunities to identify and resolve problems were missed due to poor communications, budget pressures, and poor management and engineering practices. Also, upper management officials were not aware of the extent of the programs' problems.

In March 2000, NASA's Administrator delegated authority to NASA's chief engineer to define an integrated plan to address the recommendations of NASA-sponsored investigative boards in response to the two failed Mars missions, shuttle wiring problems, and a generic assessment of NASA's approach to executing faster-better-cheaper projects. NASA's chief engineer chartered a NASA-wide senior team, the NASA Integrated Action Team, which concluded that the faster-better-cheaper principles are valid if properly applied. However, the team found that agency guidance associated with the application of faster-better-cheaper principles to actual situations was not sufficiently articulated. Moreover, the report recommended that NASA improve its approach to applying the principles with safety and prudent risk as key criteria. Furthermore, the report concluded that one of the critical elements for success in the faster-better-cheaper approach is the project manager's ability to understand and control risk.

NASA still faces significant challenges as it attempts to create highly reliable missions and foster open communications under the budget constraints of the agency's faster- better-cheaper space exploration strategy. In addition, real success will require a comprehensive integration of lessons learned from failures on an agencywide basis. Until NASA resolves these problems, its financial resources are vulnerable to inefficient use. We will continue to monitor NASA's future progress in refining its faster-better-cheaper strategy.

Integrating Human Capital Approach Into NASA's Workforce Management Strategies

The space shuttle is the world's first reusable space transportation system. Since it is the nation's only launch system capable of carrying people to and from space, its viability is critical to other space programs such as the International Space Station. In August 2000, we reported that, according to internal NASA studies, workforce reductions were affecting NASA's ability to safely support the shuttle's planned flight rate. Recognizing that in-house workforce reductions had gone too far, NASA discontinued its downsizing and began addressing critical staffing needs. However, the agency still faces several human capital challenges, including attracting and retaining employees with critical skills.

Recent Studies and NASA's Actions Highlight Shuttle Workforce Problems

In August 2000, we reported that several internal NASA studies had shown that the agency's space shuttle program's workforce had been affected negatively by NASA's downsizing, much of which occurred after 1995. Since 1995, the shuttle workforce has decreased by more than one-third, to about 1,800 full-time equivalent employees.[2] The studies found that stress levels had

[2] Full-time equivalent is a measure of staff hours equal to those of an employee who works 40 hours per week in 1 year.

reached the point of creating an "unhealthy" workforce. According to NASA's Associate Administrator for the Office of Space Flight, the agency faced significant safety and mission success risks as a result of the downsizing. NASA's Aerospace Safety Advisory Panel concluded that workforce problems could potentially impact flight safety, as the shuttle launch rate increased to meet International Space Station's demands.

In addition, NASA concluded that the shuttle program's workforce was showing signs of overwork and fatigue as a result of downsizing. For example, indicators on forfeited leave, absences from training courses, and stress-related employee assistance visits were all on the rise. Moreover, the program's demographic shape and skill mix jeopardized the program's ability to hand off leadership roles to the next generation, achieve a higher flight rate to support assembly of the International Space Station, and safely support the shuttle's planned flight rate. For example, throughout the Office of Space Flight, which includes the shuttle program, there were more than twice as many workers over 60 years old than under 30 years old.

NASA has identified many key areas in which the shuttle program is experiencing critical skill shortages. These areas include avionics, mechanical engineering, computer systems, and software assurance engineering. One internal NASA study has concluded that NASA should determine the size of the workforce, skill levels, and experience needed to maintain and operate the shuttle at the anticipated higher flight rates. The shuttle program flew four flights each in fiscal year 1998 and 1999. However, the number of flights is projected to increase substantially over the next 5 years. For example, NASA plans nine flights in fiscal year 2001.

NASA Has Begun Taking Actions to Address Shuttle Workforce Problems

We reported in August 2000 that NASA had begun taking actions to address its shuttle workforce problems. It discontinued downsizing plans and was expecting to add 95 full-time equivalent employees to the shuttle program in fiscal year 2000 to address many critical skill shortages. Data obtained from NASA since our August 2000 report show that of the 873 total personnel gains at all NASA centers, 778 are new hires to the agency, and 95 are transfers from other centers. NASA's Office of Space Flight has gained a total of 405 personnel, including 370 new hires and 35 transfers. The three space flight centers have hired 114 full-time personnel in the shuttle program. The Kennedy Space Center has hired 55 full-time personnel, the Marshall Space Flight Center has hired 31, and the Johnson Space Center has hired 28. These new hires have been staffed to support current shuttle program operation requirements and upgrades. In addition to these new hires, the centers have reallocated personnel from other activities to the space shuttle program. According to NASA officials, the combination of new hires and realignment of experienced personnel has helped the shuttle program infuse new talent to meet current program requirements. In its fiscal year 2001 budget request, NASA sought authority to add another 278 full-time equivalent employees to the shuttle workforce.

In addition, NASA has undertaken a joint review with the Office of Management and Budget with the goal of identifying overall future workforce needs. This review will assess potential tools for and approaches to overall agency personnel management. NASA and the Office of Management and Budget plan to complete the study in time for consideration during the fiscal year 2002 budget process.

The President made human capital management a priority management objective in the fiscal year 2001 budget and in June 2000, he directed the heads of all

executive branch federal agencies to integrate human resource management into planning, budgeting, and mission evaluation processes. The directive requires each agency to include specific human resource management goals and objectives in its strategic and annual performance plans beginning October 1, 2000. NASA human resource officials told us that the agency is using a draft human capital self-assessment checklist we published as a guide in ongoing workforce planning and discussions with the Office of Management and Budget. A final version of the checklist, which was published in September 2000, follows a five-part framework that comprises strategic planning, organizational alignment, leadership, talent, and performance culture. For example, NASA has developed a draft Human Resources and Education Functional Leadership Plan that establishes the human resource management and development strategies and flexibilities necessary to achieve the agency's missions and goals. In addition, NASA's Office of Human Resources and Education is working collaboratively with NASA's chief engineer in developing the agency's next strategic capability review. This review will assist NASA in developing future strategic capabilities and in identifying and addressing current and future skill gaps.

NASA included a broad objective in its fiscal year 2000 strategic plan to invest in the agency's use of human capital, developing and drawing upon the talents of all its employees. The objective states that NASA must align the management of its employees to best achieve its strategic goals and objectives. In reviewing NASA's fiscal year 2000 annual performance plan, we found that the plan did not adequately describe how the agency's strategies and human capital resources would help achieve performance goals. NASA's fiscal year 2001 performance plan addressed at least some human capital issues in that it included an objective to improve workforce health monitoring. However, addressing other relevant human capital issues, such as skill mix

and staffing levels, would be beneficial to the agency and provide a better link to the human capital objective in the strategic plan. NASA has an opportunity to include in its future annual performance plans specific performance measures for achieving its strategic human capital objective. We will continue to monitor NASA's annual performance plans and reports to determine the progress the agency is making in integrating human resource management into its performance planning and in establishing results-oriented human capital performance measures for the space shuttle and other programs.

To ensure that a proper skill mix and staffing level for the shuttle program are achieved and maintained, continued NASA management emphasis on human capital planning is critical, especially for continued safe shuttle operations in an environment of increasing flight rates. In dealing with its workforce issues, NASA shuttle program officials will have to deal with a number of complicating challenges. These include (1) meeting increased training needs deriving from higher workforce levels, (2) ensuring adequate staffing levels for its safety upgrade program, (3) attracting and retaining employees with critical skills, and (4) achieving a higher projected flight rate in support of the International Space Station compared with rates of recent years.

NASA's human capital problems can be seen as part of a broader pattern of human capital shortcomings that have eroded mission capabilities across the federal government. See our *High-Risk Series Update: An Update* (GAO-01-263) for a discussion of human capital as a newly designated governmentwide high-risk area.

Key Contact

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