

March 2005

# SPACE SHUTTLE

## Actions Needed to Better Position NASA to Sustain Its Workforce through Retirement





Highlights of [GAO-05-230](#), a report to congressional requesters

## Why GAO Did This Study

The President's vision for space exploration (Vision) directs the National Aeronautics and Space Administration (NASA) to retire the space shuttle following completion of the International Space Station, planned for the end of the decade. The retirement process will last several years and impact thousands of critically skilled NASA civil service and contractor employees that support the program. Key to implementing the Vision is NASA's ability to sustain this workforce to support safe space shuttle operations through retirement.

Because of the potential workforce issues that could affect the safety and effectiveness of operations through the space shuttle's retirement, GAO was asked to identify (1) the progress of efforts to develop a strategy for sustaining the space shuttle workforce through retirement and (2) factors that may have impeded these efforts.

## What GAO Recommends

GAO is recommending that NASA take steps aimed at better positioning the agency to sustain a critically skilled space shuttle workforce through retirement. In particular, we are recommending that the Space Shuttle Program begin identifying its future workforce needs based upon various future scenarios the program could face. In commenting on a draft of this report, NASA concurred with our recommendation.

[www.gao.gov/cgi-bin/getrpt?GAO-05-230](http://www.gao.gov/cgi-bin/getrpt?GAO-05-230).

To view the full product, including the scope and methodology, click on the link above. For more information, contact Allen Li at (202) 512-4841 or [lia@gao.gov](mailto:lia@gao.gov).

## SPACE SHUTTLE

# Actions Needed to Better Position NASA to Sustain Its Workforce through Retirement

## What GAO Found

The Space Shuttle Program has made limited progress toward developing a detailed long-term strategy for sustaining its workforce through the space shuttle's retirement. The program has taken preliminary steps, including identifying the lessons learned from the retirement of programs comparable to the space shuttle, such as the Air Force Titan IV Rocket Program, to assist in its workforce planning efforts. Other efforts have been initiated or are planned, such as enlisting the help of human capital experts and revising the acquisition strategy for updating the space shuttle's propulsion system prime contracts; however, actions taken thus far have been limited. NASA's prime contractor for space shuttle operations has also taken some preliminary steps to begin to prepare for the impact of the space shuttle's retirement on its workforce, such as working with a consulting firm to conduct a comprehensive study of its workforce. However, its ability to progress with these efforts is reliant on NASA making decisions that impact contractor requirements through the remainder of the program. Making progress toward developing a detailed strategy, however, will be important given the potential impact that workforce problems would have on NASA-wide goals. For example, a delay to the space shuttle's schedule due to workforce problems would delay the agency's ability to proceed with space exploration activities. NASA and its prime contractor for space shuttle operations have already indicated that they could face challenges sustaining their critically skilled workforces if a career path beyond the space shuttle's retirement is not apparent. In addition, governmentwide fiscal realities call into question whether funding will be available to support the use of incentives, such as retention bonuses, that could help NASA sustain its space shuttle workforce.

Several factors hamper the Space Shuttle Program's ability to develop a detailed long-term strategy to sustain the critically skilled workforce necessary to support safe space shuttle operations through retirement. For example, because of the program's near-term focus on returning the space shuttle to flight, other efforts, such as assessing hardware and facility needs that will ultimately aid the program in determining workforce requirements, are being delayed. In addition, program officials indicated that they are faced with uncertainties regarding the implementation of future aspects of the Vision and lack the requirements needed on which to base their workforce planning efforts. Despite these factors, our prior work on strategic workforce planning has shown that there are steps, such as scenario planning, that successful organizations take to better position themselves to address future workforce needs.

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## **Abbreviations**

GPRA	Government Performance and Results Act
ISS	International Space Station
JSC	Johnson Space Center
KSC	Kennedy Space Center
MSFC	Marshall Space Flight Center
NAPA	National Academy of Public Administration
NASA	National Aeronautics and Space Administration
SFOC	Space Flight Operations Contract

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United States Government Accountability Office  
Washington, DC 20548

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March 9, 2005

The Honorable Daniel K. Inouye  
Co-Chairman  
Committee on Commerce, Science, and Transportation  
United States Senate

The Honorable John McCain  
United States Senate

On January 14, 2004, the President articulated a new vision for space exploration (Vision) for the National Aeronautics and Space Administration (NASA). Part of the Vision includes the goal of retiring the space shuttle following completion of the International Space Station (ISS), planned for the end of the decade.<sup>1</sup> The space shuttle, NASA's largest individual program,<sup>2</sup> is an essential element of NASA's ability to implement this Vision, because it is the only launch system presently capable of transporting the remaining components necessary to complete assembly of the ISS. NASA currently projects that it will need to conduct an estimated 28 flights over the next 5 to 6 years to complete assembly of and provide support to the ISS. However, because of the tragic loss of the Space Shuttle Columbia and its crew in February 2003, NASA will do so with an overriding focus on ensuring safety of operations.<sup>3</sup>

The safety of the space shuttle is largely contingent on NASA's ability to sustain the critically skilled workforce necessary to support space shuttle

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<sup>1</sup>The Vision includes a return to the moon that is intended to ultimately enable future exploration of Mars and other destinations. To accomplish this, NASA plans to (1) complete its work on the ISS by 2010, fulfilling its commitment to 15 international partner countries; (2) begin developing a new manned exploration vehicle to replace the space shuttle; and (3) return to the moon as early as 2015 and no later than 2020 in preparation for future, more ambitious missions.

<sup>2</sup>The Space Shuttle Program accounted for 27 percent of NASA's fiscal year 2005 budget request.

<sup>3</sup>Following the Space Shuttle Columbia accident, the Columbia Accident Investigation Board made recommendations to NASA aimed at significantly reducing the chances of further accidents in the space shuttle's remaining flights. Since that time, the Space Shuttle Program has worked to implement these recommendations and has made other efforts aimed at improving the space shuttle's safety. *Columbia Accident Investigation Board, Report Volume I* (Washington, D.C.: August 2003).

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operations through retirement. Moving forward, this will be a concern, as the process of retiring the space shuttle will last several years and impact thousands of critically skilled NASA civil service and contractor employees that support the program. This workforce has been the focus of many reviews<sup>4</sup> in the past, which have highlighted significant issues concerning the depth of critical skills available to the program and other cultural, organizational, and safety issues that impact the program's ability to safely support space shuttle operations. These reviews recommended, among other things, that NASA assess the quantity and quality of its space shuttle workforce in terms of experience and special skills; transform its culture; and take steps to strengthen its safety organization.

As agreed with your offices, we reviewed the status of NASA's efforts to position itself to sustain the critically skilled space shuttle workforce necessary to support space shuttle operations through retirement. Specifically, we identified (1) the progress of NASA's efforts to develop a strategy for sustaining a critically skilled space shuttle workforce through retirement and (2) factors that may have impeded these efforts.

To perform our work, we interviewed various NASA officials, including Space Shuttle Program, Human Resources, and Safety officials. We obtained and analyzed NASA documents related to human capital management, such as human capital plans, policies and procedures for workforce planning, and information on NASA's workforce analysis tools. Further, we obtained and reviewed Space Shuttle Program documents related to the program's retirement, such as its lessons learned reports. In addition, we interviewed officials from NASA's prime contractor for space shuttle operations, United Space Alliance, and obtained and reviewed contractor documents related to its workforce and support of space shuttle operations. We also gathered information from human capital experts and reviewed GAO human capital reports and guidance regarding strategic workforce planning. Complete details of our scope and methodology can be found in appendix I. We performed our work from

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<sup>4</sup>GAO, *Space Shuttle: Human Capital Challenges Require Management Attention*, [GAO/T-NSIAD-00-133](#) (Washington, D.C.: Mar. 22, 2000) and GAO, *Space Shuttle: Human Capital and Safety Upgrade Challenges Require Continued Attention*, [GAO/NSIAD/GGD-00-186](#) (Washington, D.C.: Aug 15, 2000); *Columbia Accident Investigation Board, Report Volume I* (Washington, D.C.: August 2003); Aerospace Safety Advisory Panel, *Annual Report for 2001* (Washington, D.C.: March 2002); and Behavioral Sciences Technology, Inc., *Assessment and Plan for Organizational Culture Change at NASA* (Ojai, Calif.: March 15, 2004).

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April 2004 to March 2005 in accordance with generally accepted government auditing standards.

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## Results in Brief

The Space Shuttle Program has made limited progress toward developing a detailed long-term strategy for sustaining its workforce through the space shuttle's retirement. The program has taken preliminary steps, including identifying the lessons learned from the retirement of programs comparable to the space shuttle, such as the Air Force Titan IV Rocket Program, to assist in its workforce planning efforts. Other efforts have been initiated or are planned, such as enlisting the help of human capital experts and revising the acquisition strategy for updating the space shuttle's propulsion system prime contracts; however, actions taken thus far have been limited. United Space Alliance has taken some preliminary steps begin to prepare for the impact of the space shuttle's retirement on its workforce, such as working with a consulting firm to conduct a comprehensive study of its workforce. However, its ability to progress with these efforts is reliant on NASA making decisions that impact contractor requirements through the remainder of the program. Making progress toward developing a detailed strategy, however, will be important given the potential impact that workforce problems would have on NASA-wide goals. For example, a delay to the space shuttle's schedule due to workforce problems would delay NASA's ability to proceed with space exploration activities. NASA and United Space Alliance have already indicated that they could face difficulty in sustaining their critically skilled workforces if a career path beyond the space shuttle's retirement is not apparent to employees. In addition, governmentwide fiscal realities call into question whether funding will be available to support the use of incentives, such as retention bonuses, that could help NASA sustain its space shuttle workforce.

Several factors hamper the Space Shuttle Program's ability to develop a detailed long-term strategy to sustain the critically skilled workforce necessary to support safe space shuttle operations through retirement. For example, because of the program's near-term focus on returning the space shuttle to flight, other efforts, such as assessing hardware and facility needs that will ultimately aid the program in determining workforce requirements, are being delayed. In addition, program officials indicated that they are faced with uncertainties regarding the implementation of future aspects of the Vision and lack the requirements needed on which to base their workforce planning efforts. Despite these factors, our prior work on strategic workforce planning has shown that there are steps, such as scenario planning, that successful organizations take to better position themselves to address future workforce needs.

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In this report, we are recommending that NASA take steps aimed at better positioning the Space Shuttle Program to sustain a critically skilled workforce through retirement. In particular, we are recommending that the Space Shuttle Program begin identifying its future workforce needs based upon various future scenarios the program could face. In written and oral comments on a draft of this report, NASA concurred with our findings, conclusions, and recommendation.

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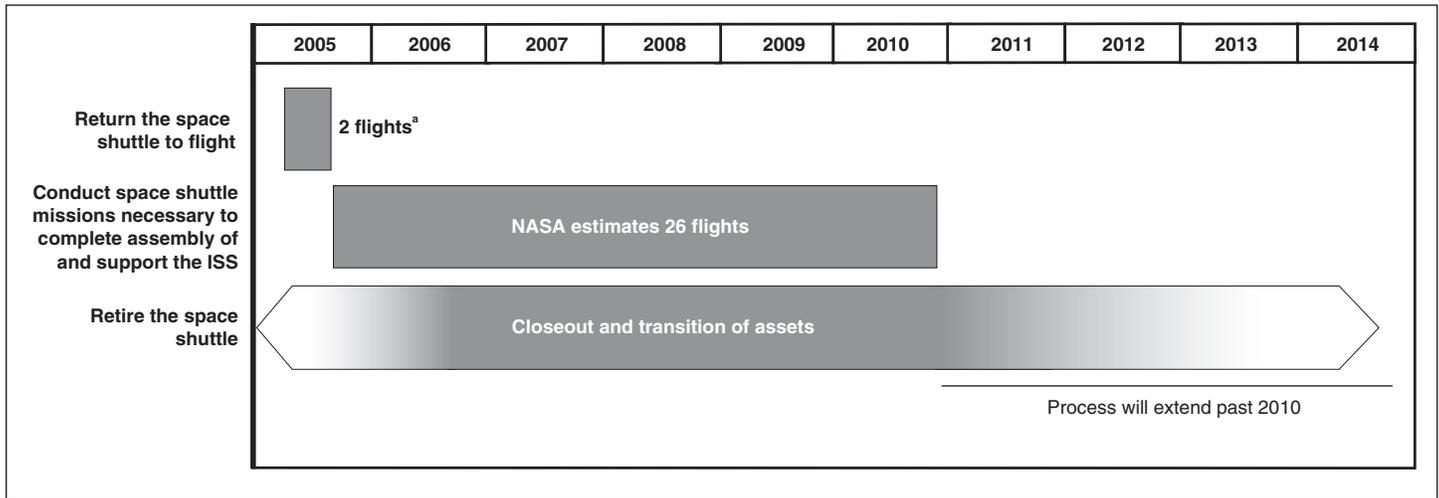
## Background

Prior to retiring the program, NASA will need to first return the space shuttle to flight<sup>5</sup> and execute the remaining missions needed to complete assembly of and provide support for the ISS. At the same time, NASA will need to begin the process of closing out or transitioning to other NASA programs the space shuttle's assets, such as its workforce, hardware, and facilities, which are no longer needed to support the program. The process of closing out or transitioning the program's assets will extend well beyond the space shuttle's final flight (see fig. 1).

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<sup>5</sup>To return the space shuttle to flight, NASA will conduct two flights. The planning window for the first flight is May 12 through June 3, 2005, and the planning window for the second flight is July 10 through August 2, 2005. The purpose of these flights is to test and evaluate new procedures for flight safety implemented as a result of the Space Shuttle Columbia accident.

**Figure 1: Estimated Timeline for the Process of Retiring NASA's Space Shuttle**



Source: NASA; GAO (presentation).

<sup>a</sup>The planning window for the first flight is May 12 through June 3, 2005. The planning window for the second flight is July 10 through August 2, 2005.

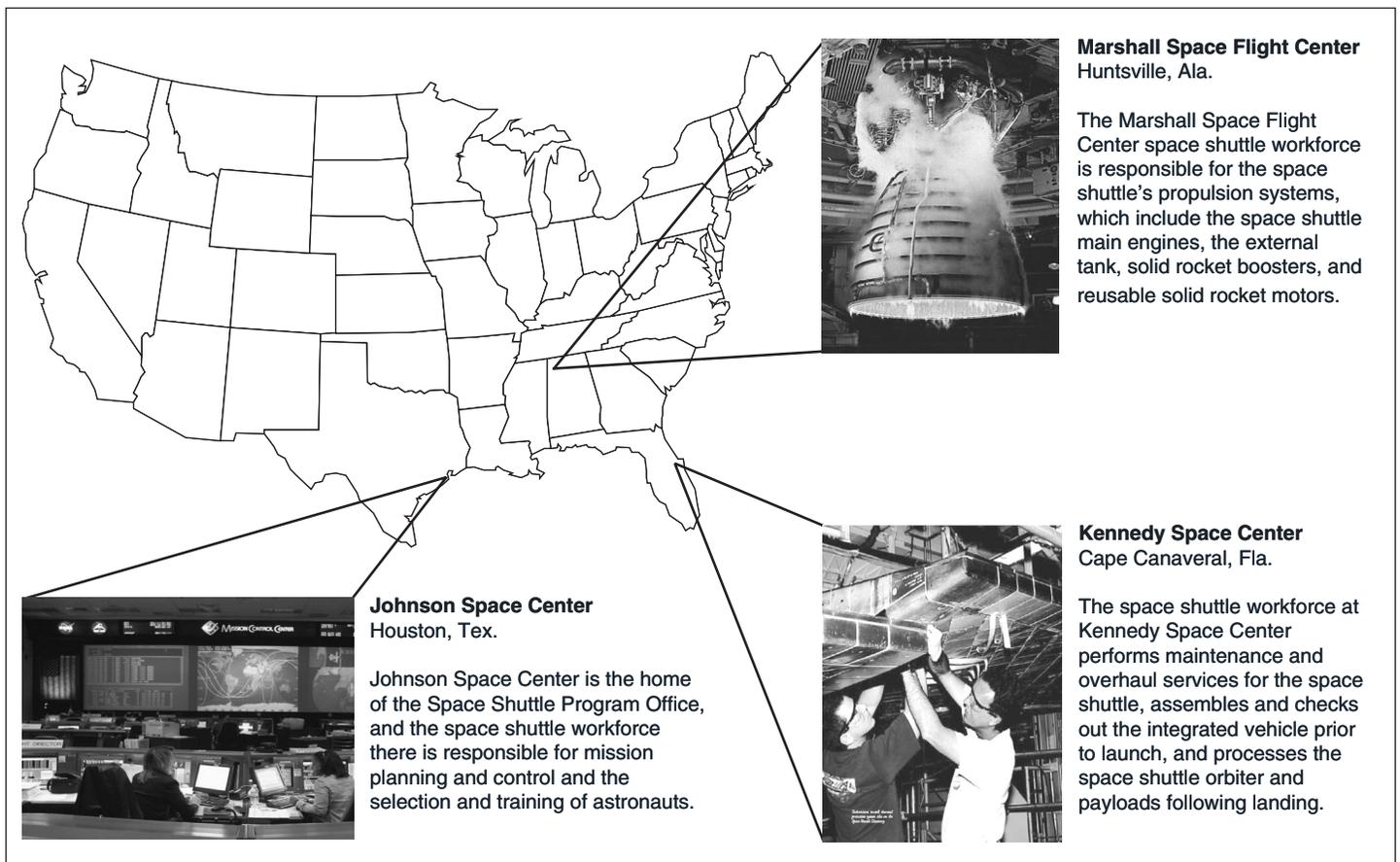
Retiring the space shuttle and, in the larger context, implementing the Vision, will require that the Space Shuttle Program rely on its most important asset—its workforce. The space shuttle workforce consists of approximately 2,000 civil service<sup>6</sup> and 15,600 prime contractor<sup>7</sup> personnel, including a large number of engineers and scientists. In addition to these personnel, there are a large number of critical, lower level subcontractors and suppliers throughout the United States who support the program. The program's workforce is responsible for conducting such things as space

<sup>6</sup>Number is based on a full-time equivalent calculation. Full-time equivalent is a measure of staff hours equal to those of an employee who works 40 hours per week in 1 year; therefore, the actual number of employees who work part-time or full-time on the Space Shuttle Program is greater than 2,000. The number was calculated by averaging the number of civil service employees over fiscal year 2004.

<sup>7</sup>The number was calculated by averaging the number of contractor employees over fiscal year 2004. This number includes data from NASA's prime contractor for space shuttle operations, United Space Alliance, and other NASA contractors. United Space Alliance, established in 1996 as a joint venture between Lockheed Martin and Boeing to consolidate NASA's various Space Shuttle Program contracts under a single entity, and its approximately 10,400 employees are responsible for conducting the space shuttle's ground and flight operations under the Space Flight Operations Contract. The remaining contractor personnel are associated with other space shuttle components, such as its propulsion systems.

shuttle payload processing, mission planning and control, ground operations, and for managing the space shuttle's propulsion systems. While each of the NASA centers support the Space Shuttle Program to some degree, the vast majority of this workforce is located at three of NASA's Space Operations Centers—Johnson Space Center, Kennedy Space Center (KSC), and Marshall Space Flight Center (MSFC) (see fig. 2).

**Figure 2: NASA Space Operations Centers**



Sources: GAO and NASA.

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The space shuttle workforce and NASA's human capital management has been the subject of many GAO<sup>8</sup> and other reviews<sup>9</sup> in the past. These reviews showed that the space shuttle workforce had suffered from agency downsizing in the mid 1990s and that NASA faced challenges recruiting and training new employees, sufficiently staffing its workforce with qualified workers, and dealing with an aging workforce and signs of overwork and fatigue in its remaining workforce. In the past, NASA officials said that these challenges posed significant flight safety risks for the program. While the Space Shuttle Program had taken some steps to address these issues, sustaining critical skills in many key areas such as subsystems engineering remained a problem. In addition, in 2003 the Columbia Accident Investigation Board noted that years of workforce reductions and outsourcing negatively impacted NASA's experience and systems knowledge base. Further, the Columbia Accident Investigation Board noted that safety and mission assurance personnel were eliminated and careers in safety lost organizational prestige. Additional studies highlighted recent trends affecting the science and engineering labor pool from which employers like NASA draw from. For example, the National Science Board reported in 2004 that worldwide competition for individuals with science and engineering skills was increasing, while the potential pool of individuals with these skills was decreasing.<sup>10</sup> NASA's former Administrator has testified that this situation poses a significant challenge to the agency's ability to maintain a world-class workforce, because it relies on a highly educated and broad science and engineering workforce to accomplish its mission.

Over the past few years, GAO and others in the federal government have underscored the importance of human capital management and strategic workforce planning. For example, we designated strategic human capital management as a governmentwide, high-risk area in 2001, 2003, and 2005, and continue to highlight it as a major management challenge specifically

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<sup>8</sup>GAO/T-NSIAD-00-133 and GAO/NSIAD/GGD-00-186.

<sup>9</sup>Columbia Accident Investigation Board, *Report Volume I* (Washington, D.C.: August 2003); Aerospace Safety Advisory Panel, *Annual Report for 2001* (Washington, D.C.: March 2002); and Behavioral Sciences Technology, Inc., *Assessment and Plan for Organizational Culture Change at NASA* (Ojai, Calif.: March 15, 2004).

<sup>10</sup>National Science Board, *Science and Engineering Indicators 2004*. Volume 1, NSB 04-1 (Arlington, Va.: National Science Foundation, 2004).

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for NASA.<sup>11</sup> Strategic Management of Human Capital was also placed at the top of the President's Management Agenda,<sup>12</sup> and the Office of Management and Budget and Office of Personnel Management have made efforts to improve governmentwide human capital management and strategic workforce planning.<sup>13</sup> Recognizing the need for guidance related to strategic human capital management, GAO has issued various reports that outline a strategic human capital approach and provided tools, such as a Model of Strategic Human Capital Management and Human Capital Self Assessment Checklist for Agency Leaders,<sup>14</sup> that agencies can use to aid in addressing this challenge.

In response to an increased focus governmentwide on strategic human capital management, NASA has taken several steps to improve its human capital management. These include steps such as devising an agencywide strategic human capital plan, developing workforce analysis tools to assist in identifying critical skills needs, and requesting and receiving additional human capital flexibilities to help the agency compete successfully with

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<sup>11</sup>GAO, *High-Risk Series: An Update*, [GAO-01-263](#) (Washington, D.C.: January 2001); GAO, *High-Risk Series: An Update*, [GAO-03-119](#) (Washington, D.C.: January 2003); GAO, *High-Risk Series: An Update*, [GAO-05-207](#) (Washington, D.C.: January 2005); GAO, *Performance Accountability Series—Major Management Challenges and Program Risks: A Governmentwide Perspective*, [GAO-01-241](#) (Washington, D.C.: January 2001); GAO, *Major Management Challenges and Program Risks: A Governmentwide Perspective*, [GAO-03-95](#) (Washington, D.C.: January 2003); GAO, *Major Management Challenges and Program Risks: National Aeronautics and Space Administration*, [GAO-01-258](#) (Washington, D.C.: January 2001); and GAO, *Major Management Challenges and Program Risks: National Aeronautics and Space Administration*, [GAO-03-114](#) (Washington, D.C.: January 2003). See also [www.gao.gov/pas/2005](http://www.gao.gov/pas/2005).

<sup>12</sup>The President's Management Agenda was launched in fiscal year 2002 as a strategy for improving the management and performance of the federal government. It focuses on five governmentwide initiatives, including strategic human capital management, where deficiencies were most apparent and where the government could begin to deliver concrete, measurable results. Executive branch agencies continue to be evaluated quarterly based upon their progress in implementing actions to address the five initiatives.

<sup>13</sup>Based on an Office of Management and Budget standard of strategic management of human capital and developed in conjunction with GAO, the Office of Personnel Management issued its Human Capital Assessment and Accountability Framework in October 2002, which lists six "Human Capital Standards for Success," including one on workforce planning.

<sup>14</sup>GAO, *A Model of Strategic Human Capital Management*, [GAO-02-373SP](#) (Washington, D.C.: Mar. 15, 2002) and GAO, *Human Capital: A Self-Assessment Checklist for Agency Leaders*, [GAO/OCG-00-14G](#) (Washington, D.C.: Sept. 1, 2000).

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the private sector in attracting and retaining employees and to reshape and redeploy its workforce to support its mission.<sup>15</sup>

GAO's prior work on strategic human capital management has shown that workforce planning is needed to ensure that the right people with the right skills are in the right place at the right time. Workforce planning addresses two critical needs: (1) aligning an organization's human capital program with its current and emerging mission and programmatic goals and (2) developing long-term strategies for acquiring, developing, and retaining staff to achieve programmatic goals. Although approaches to such planning may vary according to an organization's specific needs and mission, our work suggests that, irrespective of the context in which workforce planning is done, such a process should address five key elements. These include (1) involving top management, employees, and other stakeholders in developing, communicating, and implementing the strategic workforce plan; (2) determining the critical skills and competencies that will be needed to achieve the future programmatic results; (3) developing strategies tailored to address critical skills and competency gaps that need attention; (4) building the capability needed to address administrative, educational, and other requirements important to supporting workforce strategies; and (5) monitoring and evaluating the agency's progress toward its human capital goals and the contribution that human capital results have made toward achieving programmatic goals.

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## Progress toward Developing a Strategy to Sustain the Space Shuttle Workforce Is Limited

The Space Shuttle Program has made limited progress toward developing a detailed long-term strategy for sustaining its workforce through the space shuttle's retirement. While NASA recognizes the importance of having in place a strategy for sustaining a critically skilled workforce to support the space shuttle's operations, it has only taken preliminary steps, such as identifying lessons learned from the retirement of programs comparable to the space shuttle, to do so. Other efforts have been initiated or are planned, such as enlisting the help of human capital experts and revising the acquisition strategy to update the space shuttle's propulsion system prime contracts; however, actions taken thus far have been limited. NASA's prime contractor for space shuttle operations has also taken some preliminary steps, but its ability to progress with these efforts is reliant on

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<sup>15</sup>Enacted in February 2004, the NASA Flexibility Act of 2004 (P.L. 108-201) amends title 5, United States Code, by inserting a new chapter 98 in that title, which provides new authorities to NASA. On March 26, 2004, NASA submitted a written workforce plan for using its new authorities to Congress.

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NASA making decisions that impact contractor requirements through the remainder of the program. Making progress toward developing a detailed strategy, however, will be important given the potential impact that workforce problems would have on NASA-wide goals.

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### The Space Shuttle Program Has Taken Preliminary Steps toward Developing a Strategy for Sustaining a Critically Skilled Workforce

To begin its planning efforts for the space shuttle's retirement, the program identified the lessons learned from the retirement of programs comparable to the space shuttle, such as the Air Force Titan IV Rocket Program, the Navy Base Realignment and Closure activity, and the NASA Industrial Facility closure. Among other things, the lessons learned reports highlight the practices used by other programs when making personnel decisions, such as the importance of developing transition strategies and early retention planning to the success of the space shuttle's retirement. (See app. II for a summary of NASA's reports to date on the lessons learned that are applicable to the retirement of the space shuttle.) Program officials said that this preliminary effort is the first step in an approach they expect to take to plan for retiring the space shuttle. According to these officials, they plan to use the information collected from this preliminary effort to guide in the development of a management plan for retiring the space shuttle. This management plan is expected to include such things as the overall plan, processes, schedule, and roles and responsibilities related to retiring the space shuttle. To inform this management plan, the program expects sometime around mid-2005 to assess its hardware and facility needs through retirement to determine whether to maintain, closeout, or transition assets to other NASA programs—such as space exploration activities.<sup>16</sup> Once these hardware and facility assessments have been completed, the program plans to conduct an assessment of its workforce needs. Officials said that they must understand the program's hardware and facility needs before they can conduct an assessment of its workforce needs through retirement.

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### While Other Efforts Have Been Initiated or Are Planned, Limited Actions Have Been Taken

In addition to the Space Shuttle Program's preliminary work to prepare for sustaining its workforce through retirement, the program has contracted with the National Academy of Public Administration (NAPA) to assist it in planning for the space shuttle's retirement and transitioning to future

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<sup>16</sup>Prior to conducting these assessments, NASA will hold an Integrated Space Operations Summit to evaluate space shuttle and ISS assets and devise a set of strategic implementation plans to meet the agency's future needs.

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programs. Specifically, NAPA is to (1) benchmark the best practices of public and private sector organizations that have dealt with workforce issues resulting from the retirement, transition, or elimination of programs comparable to the space shuttle, such as in number of employees affected; (2) assess and review the workforce aspects of the program's retirement strategy throughout the course of its development to ensure that it is addressing the problem adequately; and (3) to the extent possible, assist the program in devising innovative strategies for mitigating the impact of the space shuttle's retirement on the workforce. According to NAPA officials, it has conducted preliminary benchmarking efforts and is awaiting further direction from NASA for its next steps with regard to this task. Although the additional tasks NAPA is to undertake have been identified, it has yet to undertake efforts associated with these tasks. Because NAPA will be reviewing NASA's management plan for retiring the space shuttle as it is developed, the majority of its efforts will not be undertaken until NASA begins to plan more earnestly for sustaining its critically skilled workforce through the program's retirement, which, according to NASA, will likely occur after the space shuttle's return to flight.

In addition, because the Space Shuttle Program is heavily reliant on its contractor workforce to support the space shuttle's operations, NASA officials said that they could include provisions in future Space Shuttle Program contracts that require contractors to take steps to prepare for sustaining their workforces through the space shuttle's retirement. However, the program has yet to do so. For example, in September 2004 the Space Shuttle Program exercised the final 2-year option of its Space Flight Operations Contract (SFOC).<sup>17</sup> At this point, NASA did not require that United Space Alliance take any steps to prepare for sustaining its workforce, such as by submitting a critical skills retention plan. A senior NASA official recognized the need for United Space Alliance to devise such a plan, and said that this type of requirement would likely be included as part of the new contract NASA intends to award to United

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<sup>17</sup>NASA has extended the SFOC through September 2006 and has begun proceedings with United Space Alliance to award the follow-on contract to be effective on October 1, 2006, through the end of the program. NASA chose to exercise the 2-year extension under the current SFOC to allow the Space Shuttle Program to remain focused on returning the space shuttle to flight. Further, this option was exercised to provide better clarity into the content for the follow-on contract necessary to safely complete ISS assembly and support and retire the space shuttle.

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Space Alliance in 2006, once workforce requirements for the remainder of the program have been determined.

Separate from the SFOC, the Space Shuttle Propulsion Office at MSFC has begun devising an acquisition strategy for updating its propulsion system prime contracts to take into account the Vision's goal of retiring the space shuttle following completion of the ISS. Although at the time of our review this acquisition strategy was not yet complete, officials said that the updated contracts will likely include a requirement for the contractor to submit a critical skills retention plan. This plan would outline the strategies the contractor plans to implement to sustain the critical skills necessary to support the program through retirement. In addition, officials said that they could take advantage of the award fee<sup>18</sup> provisions available in the space shuttle's propulsion prime contracts to incentivize contractors to put in place strategies for sustaining a critically skilled workforce through retirement and monitor their success in doing so.

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### NASA's Prime Contractor for Space Shuttle Operations Has Taken Preliminary Steps to Prepare for the Space Shuttle's Retirement

United Space Alliance has taken preliminary steps to begin to prepare for the space shuttle's retirement and its impact on the company's workforce. For example, the company has begun to define its critical skills needs to continue to support the Space Shuttle Program; has devised a communication plan; contracted with a human capital consulting firm to conduct a comprehensive study of its workforce; and continues to monitor indicators of employee morale and workforce stability. While these efforts are underway, contractor officials said that further efforts to prepare for the space shuttle's retirement and its impact on their workforce are on hold until NASA first makes decisions that impact the space shuttle's remaining flight schedule and thus the time frames for retiring the program and transitioning its assets. Once these decisions have been made and United Space Alliance's contract requirements have been defined, these officials said that they would then be able to proceed with their workforce planning efforts for the space shuttle's retirement, a process that will likely take 6 months to complete.

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<sup>18</sup>Award-fee provisions may be used in fixed-price contracts when the government wishes to motivate a contractor and other incentives cannot be used because contractor performance cannot be measured objectively. Federal Acquisition Regulation ¶16.404 (a).

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## The Potential Impact of Workforce Problems and Other Challenges the Space Shuttle Program Faces Highlight the Need for Workforce Planning

Making progress toward developing a detailed strategy for sustaining a critically skilled space shuttle workforce through the program's retirement will be important given the potential impact that workforce problems could have on NASA-wide goals. According to NASA officials, if the Space Shuttle Program faces difficulties in sustaining the necessary workforce, NASA-wide goals, such as implementing the Vision and proceeding with space exploration activities, could be impacted. For example, workforce problems could lead to a delay in flight certification for the space shuttle, which could potentially result in a delay to the program's overall flight schedule, thus compromising the goal of completing assembly of the ISS by 2010. In addition, officials said that space exploration activities could slip as much as 1 year for each year that the space shuttle's operations are extended because NASA's ability to progress with these activities is reliant on funding and assets that are expected to be transferred from the Space Shuttle Program to other NASA programs.

One workforce issue that has already been identified that could impact the program's ability to support space shuttle operations through retirement is an inadequate safety workforce. For example, Safety and Mission Assurance Directorate officials at KSC indicated that they already face difficulties in maintaining a sufficient number of safety personnel to support the Space Shuttle Program. An analysis done by the Safety and Mission Assurance Directorate at KSC shows that it lacks an adequate number of employees to fully perform all of its required functions for the Space Shuttle Program, which increased due to additional safety requirements put in place following the Space Shuttle Columbia accident. Due to this analysis, some additional workforce was added to provide support in this area. Although the Safety and Mission Assurance Directorate now believes that it can meet its inspection schedule, officials said that should the Directorate be unable to complete all of its required inspections, they would deny the space shuttle's certification for flight readiness. This would delay the program's flight schedule.

NASA officials told us they expect to face various challenges in sustaining the critically skilled workforce necessary to support the space shuttle's operations through its retirement, including retaining the current workforce, many of whom may want to participate in or will be needed to support future phases of implementing the Vision, and providing a transition path to other programs for the workforce that is needed to support the Space Shuttle Program through retirement. Additional challenges that could affect the program's ability to support space shuttle operations include:

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- *Impact on the prime contractor for space shuttle operations.* United Space Alliance may not be able to offer a long-term career path to its employees beyond the space shuttle's final flight. This problem results from the company having been established specifically to perform ground and flight operations for the Space Shuttle Program. As such, its future following the space shuttle's retirement remains uncertain. Given this uncertainty, contractor officials stated that they will likely face difficulty recruiting and retaining employees to continue supporting the space shuttle as it nears retirement because of the perceived lack of long-term job security. In addition, they said that the lack of job security may be reflected in poor morale, inattention to details, errors, accidents, absences, and attrition. In addressing problems that may result from this challenge, United Space Alliance has the ability to outplace some employees who work with the Space Shuttle Program to its parent companies. However, contractor officials said that other steps it may have to take to address workforce issues, such as paying retention bonuses, are likely to require funding above normal levels.
  - *Governmentwide budgetary constraints.* Throughout the process of retiring the space shuttle, NASA, like other federal agencies, will have to contend with urgent challenges facing the federal budget that will put pressure on discretionary spending—such as investments in space programs—and require it to do more with fewer resources. As a result, the Space Shuttle Program's ability to make use of tools that require additional funding—such as certain aspects of NASA's new workforce flexibilities like recruitment or retention bonuses—may be limited. Further, GAO has reported that NASA has had difficulties in accurately estimating the costs of its programs.<sup>19</sup> Given this, the agency may not be able to provide a sound and accurate business case to support the use of such tools. Workforce planning efforts that identify gaps in critical skills based upon expected future needs and support the use of strategies to address these gaps could provide the information needed to support a sound business case.

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<sup>19</sup>See GAO, *NASA: Lack of Disciplined Cost-Estimating Processes Hinders Effective Program Management*, [GAO-04-642](#) (Washington, D.C.: May 28, 2004).

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## Several Factors Have Impeded Efforts to Develop a Long-Term Strategy to Sustain a Critically Skilled Space Shuttle Workforce

While the Space Shuttle Program is still in the early stages of planning for the program's retirement, its development of a detailed long-term strategy to sustain its future workforce is being hampered by several factors. These include (1) the program's primary near-term focus on returning the space shuttle to flight and (2) uncertainties with respect to implementing the Vision. Space Shuttle Program officials assert that these factors limit the steps they are able to take at this time to plan for the program's future workforce needs. However, our prior work on strategic workforce planning has shown that there are steps that successful organizations take to better position themselves to address future workforce needs, even when faced with uncertainties.

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## Near-Term Focus on Returning the Space Shuttle to Flight Has Left Future Workforce Needs Unaddressed

Since the Space Shuttle Columbia accident, the program has focused on its near-term goal of returning the space shuttle to flight. While this focus is understandable given the importance of the space shuttle's role in completing assembly of the ISS, it has led to the program delaying efforts to determine future workforce needs. For example, in developing the management plan for retiring the space shuttle, program officials said that the majority of the assessments the program is to complete to support decisions regarding whether to maintain, closeout, or transition the program's assets will not be undertaken until after the space shuttle has returned to flight. According to these officials, one reason for this delay is that personnel needed to conduct the assessments are currently focused on supporting return to flight activities. Because the workforce assessment will not be conducted until after the program determines its hardware and facility requirements, its future workforce needs will likely remain unidentified until well after the space shuttle has returned to flight.

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## Uncertainties with Respect to Implementing the Vision Limit the Space Shuttle Program's Ability to Identify Future Workforce Needs

While the Vision has provided the Space Shuttle Program with the goal of retiring the space shuttle by 2010 upon completion of the ISS, the program lacks well-defined objectives or goals on which to base its workforce planning efforts. For example, NASA has not yet determined the final configuration of the ISS or the type of vehicle that will replace the space shuttle and be used for space exploration. These decisions are important because they affect the time frames for retiring the space shuttle. Once made, these decisions will also provide important information that officials have said will be used to guide Space Shuttle Program retirement planning efforts, including efforts to determine whether to maintain, closeout, or transition the program's facilities, hardware, and workforce as they are no longer needed to support the program. Lacking this

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information, officials have said that their ability to progress with detailed long-term workforce planning is limited.

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### Despite Uncertainties, the Space Shuttle Program Could Follow a Strategic Human Capital Management Approach to Plan for Sustaining Its Critically Skilled Workforce

Studies by several organizations, including GAO, have shown that successful organizations in both the public and private sectors follow a strategic human capital management approach, even when faced with an uncertain future environment. For example, following a strategic human capital management approach can help an organization to (1) prepare its workforce to meet present and future mission requirements, (2) plan for future human capital needs in an uncertain environment, and (3) address future human capital issues that could jeopardize the accomplishment of goals.<sup>20</sup> As part of this approach, strategic workforce planning begins with establishing a strategic direction and setting goals to guide planning efforts for the organization early on in the planning process.<sup>21</sup> When this is not possible due to an uncertain future environment, scenario planning is one approach that can be used as part of a strategic workforce planning process.

Scenario planning is used to describe different future environments that an organization may face and can provide a basis for developing and planning strategies to meet the challenges posed by those scenarios rather than planning to meet the needs of a single view of the future. For example, following the terrorists attacks of September 11, 2001, and during the creation of the Department of Homeland Security, the U.S. Coast Guard undertook scenario planning to guide its short-term operational and human capital planning efforts due to uncertainties. For the Space Shuttle Program, scenario planning could guide workforce planning efforts because it can be undertaken despite uncertainties the program faces and without having definitive requirements for program hardware and facility needs through retirement. Scenario planning could

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<sup>20</sup>GAO-02-373SP and GAO, *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39 (Washington, D.C.: Dec. 11, 2003).

<sup>21</sup>A strategic direction is a clear set of organizational intents—including a clearly defined mission, set of core values, goals and objectives, and strategies to achieve these. Setting a strategic direction and program goals is part of the general performance management principles that Congress expects federal agencies to follow under the Government Performance and Results Act of 1993 (GPRA), Pub. L. No. 103-62. GPRA calls for agencies to address human capital in the context of performance management and requires annual performance plans for each program activity in the agency's budget, which describes how agencies will use resources to accomplish their strategic direction and program goals.

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also provide the space shuttle program with flexibility in its workforce planning efforts because it does not rely on information provided by hardware and facility assessments and could be undertaken by NASA personnel not currently focused on returning the space shuttle to flight. The information provided by scenario planning could then be used by program officials to support workforce assessments once decisions about the programs hardware and facility needs have been made.

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## Conclusions

This is one of the most challenging periods in the history of the Space Shuttle Program. Not only must NASA demonstrate that the space shuttle can safely fly again, it must begin the process of retiring its largest program while preparing for the uncertain future of space exploration. The necessity to plan for sustaining a critically skilled space shuttle workforce at this time is critical given the impact that expected workforce problems would have on the program and other larger NASA goals. While the Space Shuttle Program acknowledges that sustaining its critically skilled workforce through the program's retirement is important, the absence of a detailed long-term strategy for doing so makes it unclear how the program will actually accomplish this. By delaying steps to address future workforce needs until other decisions have been made, the program is not taking advantage of valuable time that it could use to better position itself to implement workforce strategies to address expected future challenges and sustain a critically skilled workforce through retirement. Approaches to workforce planning that take in to account uncertainties and provide the program with flexibility in determining future workforce requirements would be particularly relevant to the Space Shuttle Program given the issues that must be resolved before the program can proceed with more detailed workforce planning efforts.

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## Recommendation for Executive Action

To better position the agency to sustain a critically skilled space shuttle workforce through retirement, we recommend that the Acting Administrator direct the Associate Administrator for the Office of Space Operations to implement an approach, as part of its preliminary planning efforts, for identifying the program's future workforce needs that takes into account various future scenarios the program could face. The program should then use this information to develop strategies for meeting the needs of its potential future scenarios. The information collected and strategies devised during scenario planning will then be readily available to be incorporated into the program's detailed workforce planning efforts once any uncertainties have been resolved.

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## Agency Comments and Our Evaluation

In written and oral comments on a draft of this report, NASA indicated that it concurred with our findings, conclusions, and recommendation. NASA reiterated that its primary near-term focus is on safely returning the space shuttle to flight, but stated that the agency is laying the foundation needed to move forward with a comprehensive approach for transitioning the Space Shuttle Program through its Integrated Space Operations Summit process. NASA plans to use this process to provide the agency with an independent view of the respective issues surrounding the mission execution and transition of the Space Shuttle Program and its assets. According to NASA, the information provided by this process will allow the agency to review the risks and opportunities related to a number of alternate scenarios that the Space Shuttle Program might support within the Vision.

We are encouraged that NASA is laying the foundation needed for transitioning the Space Shuttle Program. NASA has the opportunity to use the Integrated Space Operations Summit process, specifically the alternate future scenarios for the Space Shuttle Program that it will provide, to proceed with identifying the program's future workforce needs based upon such scenarios. As our recommendation stated, this information could then be readily available to support the program's detailed workforce planning efforts once any uncertainties have been resolved. NASA's comments are reprinted in appendix III.

NASA also provided technical comments, which we addressed throughout the report as appropriate.

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As agreed with your offices, unless you announce its contents earlier, we will not distribute this report further until 30 days from its date. At that time, we will send copies to NASA's Acting Administrator and interested congressional committees. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

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If you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or [lia@gao.gov](mailto:lia@gao.gov). Key contributors to this report are acknowledged in appendix IV.

A handwritten signature in black ink that reads "Allen Li". The signature is written in a cursive style with a large initial "A" and a distinct "Li" at the end.

Allen Li, Director  
Acquisition and Sourcing Management

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# Appendix I: Scope and Methodology

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To identify the progress that the National Aeronautics and Space Administration (NASA) and United Space Alliance have made toward developing a strategy for sustaining their critically skilled workforces through the space shuttle's retirement, we:

- Obtained and analyzed NASA documents and briefing slides related to human capital management, including NASA's Strategic Human Capital Plan and Implementation Plan, NASA center Strategic Human Capital Implementation Plans, NASA's Workforce Plan for Use of the NASA Flexibility Act of 2004 Authorities, policies and procedures for workforce planning, and information on NASA's integrated human capital management tools—such as its Competency Management System, Workforce Integrated Management System, and workforce analysis tools.
- Obtained and reviewed NASA documents and briefing slides related to the space shuttle's operations and retirement, including reports identifying the “lessons learned” from the Air Force Titan IV Rocket Program, Navy Base Realignment and Closure activity, NASA Industrial Facility closure, and the Boeing A/V-8B and F/A-18 production line transition, and plans and projected schedules for future space shuttle flights and manifests.
- Interviewed United Space Alliance officials regarding their support of space shuttle operations and involvement with space shuttle retirement planning efforts. We also obtained and analyzed documents related to United Space Alliance's workforce, including demographic data, workforce strategies, and critical skills identification.
- Reviewed previous GAO reports on NASA, the Space Shuttle Program, and on human capital and workforce planning best practices. We also reviewed human capital reports and guidance from the Office of Personnel Management and the Office of Management and Budget, and interviewed officials from the National Academy of Public Administration regarding human capital management. In addition, we reviewed a report issued by the National Science Board on issues facing the U.S. science and engineering workforce.
- Interviewed NASA and United Space Alliance officials and received written and oral responses to questions regarding the space shuttle workforce, its demographics, space shuttle operations, and space shuttle retirement planning efforts; NASA operations and management; NASA and United Space Alliance human capital and workforce planning practices; the NASA Flexibility Act of 2004; NASA Safety and

Mission Assurance activities; and space shuttle contracts, including the Space Flight Operations Contract.

To identify any factors that may have impeded efforts to develop a strategy for sustaining a critically skilled workforce through retirement, we:

- Interviewed NASA and United Space Alliance officials to obtain an understanding of the challenges they face in planning for the space shuttle's retirement and in addressing workforce issues that may arise as a result of the decision to retire the space shuttle.
- Obtained and analyzed NASA and United Space Alliance responses to questions that asked for information regarding their goals and strategies for retiring the space shuttle, the processes they expect to follow to achieve these goals, and the tools and strategies they might use to address workforce issues through the space shuttle's retirement.

To accomplish our work, we visited and interviewed officials responsible for space shuttle operations at NASA Headquarters, Washington, D.C.; and at three NASA centers designated as Space Operations Centers, including Johnson Space Center (JSC), Texas; Kennedy Space Center (KSC), Florida; and Marshall Space Flight Center (MSFC), Alabama. These centers were chosen because they maintain primary responsibility for conducting space shuttle operations and are the centers at which the vast majority of the space shuttle workforce is located. The offices we met with at each of these centers included Safety and Mission Assurance and Human Resources. Additional information was attained from the Space Shuttle Program Office at JSC; the Space Shuttle Processing Directorate and Space Shuttle Strategic Planning Office at KSC; the Space Shuttle Propulsion Office, Customer and Employees Relations Directorate, and Space Transportation Directorate at MSFC; and the Offices of Space Operations, Exploration Systems, and Procurement at NASA Headquarters.

We conducted our review from April 2004 to March 2005 in accordance with generally accepted government auditing standards.

# Appendix II: Summary of NASA Reports on Lessons Learned Applicable to the Space Shuttle Program

To prepare for the space shuttle’s retirement, NASA identified the lessons learned from the closeout or retirement of programs comparable to the space shuttle, including the Air Force Titan IV Rocket Program, the Navy Base Realignment and Closure activity, and the NASA Industrial Facility closure.<sup>1</sup> NASA’s reports capture lessons learned that might be applicable to the Space Shuttle Program’s retirement planning. NASA’s highlights from these studies are shown in table 1.

**Table 1: Summary of NASA Reports on Lessons Learned Applicable to the Space Shuttle Program**

Report	NASA’s highlights
Air Force Titan IV Rocket Program Closeout	<ul style="list-style-type: none"> <li>• Successful program mission execution is the goal. This is a large consideration, as mission success is the top priority, focusing on safety and quality. Implicit in this is the successful retention of personnel, as well as retention through closeout to follow-on programs.</li> <li>• A fundamental change in mindset must occur to ensure successful mission execution. Because the supply line of spares will terminate, the Space Shuttle Program must establish the mindset that identifies and preserves all materials necessary for mission execution.</li> <li>• Management information should not be based on rumors. The ground rules for the retirement effort should be established early with buy-in from the stakeholders and be carried through the entire program. These rules can change over the program, but should only be from official direction, such as from congressional directive.</li> <li>• Environmental assessment and remediation will be a large consideration for resources. Informed and active planning will require knowledge and ongoing effort with regulations, local laws, and Federal Acquisition Regulations.</li> <li>• Communication with stakeholders, Space Shuttle Program managers, and particularly all Space Shuttle Program personnel must be consistent and clear from the start of planning through program retirement.</li> <li>• Most importantly, begin the planning process early.</li> </ul>
Navy Base Realignment and Closure Activity: Closure of Naval Station Roosevelt Roads	<ul style="list-style-type: none"> <li>• Develop an overarching, long-term strategic plan involving integration of the Space Shuttle Program retirement and follow-on programs to optimize NASA resources by minimizing costs and ensuring that planned milestones do not slip.</li> <li>• Consider special legislation to earmark funds from property sales to return to NASA.</li> <li>• Know the environmental conditions and liabilities of all closeout sites. Perform environmental baseline surveys early so that the results can be used in strategic planning.</li> <li>• Environmental assessment and remediation require time and will be a considerable portion of the closeout budget.</li> <li>• Develop and implement a strong communication plan that is proactive and open with all audiences—internal, congressional, and external.</li> </ul>

<sup>1</sup>NASA also identified the lessons learned from the closeout of the Boeing A/V-8B and F/A-18 production line transition. This report, however, was not completed in time for our reporting purposes.

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**Appendix II: Summary of NASA Reports on  
Lessons Learned Applicable to the Space  
Shuttle Program**

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<b>Report</b>	<b>NASA's highlights</b>
NASA Industrial Facility Closure in Downey, California	<ul style="list-style-type: none"><li>• Major decision drivers will be the congressional direction for closing and transitioning the Space Shuttle Program, the disposition of tooling, transitioning or retaining critical capabilities, and possibly personnel issues.</li><li>• The Space Shuttle Program needs to perform a strategic assessment of the total program's assets, skills, and capabilities. Identify phase-out candidates and streamline operations to gain efficiencies.</li><li>• The challenges in the closeout effort include environmental remediation, historical preservation, personnel retention, and property disposition.</li><li>• Significant costs were for personnel relocation, moving equipment, and environmental remediation.</li><li>• A significant challenge will be to determine the extent to which NASA's activities contributed to the current environmental condition of each site and the extent to which NASA is responsible for remediation of the site.</li><li>• The closeout team should include representatives of external organizations such as historical, environmental, and political (local, state, and federal) organizations, the General Services Administration, the Defense Contract Audit Agency, etc., and internal contractors.</li><li>• Communicate internally and externally with honesty and clarity. Prevent rumors with an effective communication process. A public relations firm may provide expertise in strategic communication to garner goodwill with the surrounding community.</li></ul>

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Source: NASA.

# Appendix III: Comments from the National Aeronautics and Space Administration

National Aeronautics and  
Space Administration  
**Office of the Administrator**  
Washington, DC 20546-0001



February 25, 2005

Mr. Allen Li  
Director, Acquisition and Sourcing  
Management Team  
United States Government Accountability Office  
Washington, DC 20548

Dear Mr. Li:

NASA acknowledges the hard work and professionalism that the GAO has put forth in their audit of the workforce issues surrounding the transition of the Space Shuttle Program (SSP) in support of the Vision for Space Exploration. We are in accord with your findings and conclusions. Our primary near-term focus is safely returning the Space Shuttle to flight to complete the assembly of the International Space Station (ISS). However, we are also carefully and methodically laying the foundation that will be needed to address a comprehensive transition approach. This effort will accelerate as near-term Vision objectives are achieved and decisions made as to whether Space Shuttle assets will be used to provide lift capability in support of Vision objectives following completion of ISS assembly.

To transition a program of the size and complexity of the SSP will not be easy. As was stated in the report, we are studying the lessons of those who have preceded us. In addition to the transition-focused activities within the SSP, we are gathering information from our well-established Integrated Space Operations Summit (ISOS) process. This year's ISOS has been modified and enhanced to include an SSP Mission Execution panel and an SSP Transition panel. Each panel is chartered to provide an independent strategic view of the respective issues surrounding the SSP. This effort includes review of the risks and opportunities related to a number of alternate scenarios that the SSP might support within the Vision for Space Exploration.

We look forward to our continued work with the GAO as we proceed with implementing the Vision for Space Exploration.

Sincerely,

A handwritten signature in black ink that reads "Fredrick D. Gregory". The signature is written in a cursive style with a large, sweeping "F" and "G".

Fredrick D. Gregory  
Acting Administrator

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# Appendix IV: GAO Contact and Staff Acknowledgments

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## GAO Contact

Allen Li (202) 512-4841

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## Staff Acknowledgments

In addition to the individual named above, Wesley A. Johnson, Robert Lilly, James Morrison, Shelby S. Oakley, and T.J. Thomson made key contributions to this report.

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