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SPACE STATION

Status of Russian  
Involvement and Cost  
Control Efforts

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss our ongoing work on the National Aeronautics and Space Administration's (NASA) International Space Station. We are currently responding to both the committee's request to review the status of Russian involvement in the program and the subcommittee's request to address the prime contractor's progress in implementing cost control measures and NASA's efforts to oversee the program's nonprime activity. We plan to finalize our work and report on these issues in the next few months. Today, I will address NASA's efforts to (1) develop a contingency plan to mitigate the possibility of unforeseen problems, including future Russian nonperformance, (2) ensure that Russian quality assurance and manufacturing processes are acceptable, and (3) control prime contract and nonprime activity costs.

Last December, NASA accomplished an important and significant step in its construction of the International Space Station: coupling the first two elements, the Functional Cargo Block and Node 1, on orbit. The subcommittee is well aware of the many challenges NASA has faced in developing and building the International Space Station. These challenges, which include Russia's difficulties in meeting its commitment to deliver a key component on schedule and continuing U.S. prime contractor cost increases, have translated into schedule delays and higher program cost estimates to complete development. While the on orbit assembly of the first two elements of the space station was a noteworthy achievement, our ongoing work shows no abatement in the number of challenges NASA will face in the years to come.

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## Results in Brief

Uncertainty regarding future Russian involvement will require NASA to continuously plan and implement contingency initiatives. As an International Space Station partner, Russia agreed to provide equipment, such as the Service Module; Progress vehicles to reboost the station; dry cargo; and related launch services throughout the station's life. However, Russia's funding problems have delayed delivery of the Service Module—the first major Russian-funded component—and raised concerns about Russia's ability to support the station during assembly and once it is completed. NASA is implementing a multi-faceted contingency plan to mitigate the risk of further delay of the Service Module and the possibility that Progress vehicles for reboosting the station cannot be provided by the Russians. The first step of this plan includes the development of the U.S.-built Interim Control Module and modifications to the Russian-built and

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U.S.-financed, Functional Cargo Block. In the second step, NASA is developing its own permanent reboosting capability. NASA's plan also includes payments to the Russian Space Agency to complete near-term work on the Service Module, and Progress and Soyuz space vehicles. While the ultimate cost of NASA's plan is uncertain at this time, the agency currently estimates that the cost to protect against Russian nonperformance will be about \$1.2 billion.

Although NASA has a contingency plan to mitigate Russian nonperformance, it does not have an approved overall contingency plan to address issues such as late delivery or loss of critical hardware. The agency acknowledges that the lack of an overall contingency plan is a program risk item.

NASA is satisfied that Russian quality assurance and manufacturing standards are acceptable. However, the Service Module's inability to meet current station requirements with regards to debris protection is a potential safety issue. The module will require improvements after it is launched to meet the station's debris protection requirement. Based on the module's current launch date, it will be about 3 ½ years after launch before improvements can be completed.

Pressures on the program's budget continue to mount. NASA's cost estimates assume assembly completion in 2004. However, the agency acknowledges the difficulty in maintaining that schedule. If the schedule is not met, total program costs for the U.S. segment of the station will increase further. The prime contract has experienced significant cost and schedule variances between the contract baseline and actual performance. The prime contractor's estimate of overrun at completion has been increased several times and currently stands at \$986 million. At the same time, the nonprime portion of the program—activities related to science facilities and ground and vehicle operations—is also experiencing cost increases. In 1994, the nonprime component of the program's development budget was \$8.5 billion; today, it is over \$12.4 billion. The increase is due largely to added scope and schedule slippage. The agency has begun to subject the nonprime area to increased scrutiny, and modifications are being made to a centralized database of potential risk areas to include the identification of the cost of such risks. These actions could potentially improve the agency's ability to manage future cost growth.

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## NASA Contingency Planning

Because of Russia's continuing funding problems, NASA developed a multi-faceted contingency plan to mitigate the risk of further delay of the Service Module and the possibility that a reboost capability cannot be provided by the Russians. Payments to Russia for the completion of the Service Module have also been made. Although NASA has developed a strategy to deal with Russian nonperformance, it has not completed an overall contingency plan to address a broader range of potential problems.

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## Russian Nonperformance Contingency Plan Has Multiple Steps

Beginning in late 1995, NASA became increasingly concerned about Russia's ability to meet its space station commitments. The greatest concern at the time was that the Service Module would be delayed due to shortfalls in Russian funding. Later, those delays were acknowledged, and the scheduled delivery of the Service Module slipped by 8 months. Subsequently, Russia's continued funding problems caused additional slippage.

NASA responded by developing a plan to address Russian nonperformance. The first step, which has been underway since early 1997, is designed to protect against further Service Module delays and includes the development of the U.S.-built Interim Control Module and modifications to the Russian-built and U.S.-financed Functional Cargo Block.

The second step includes the development of a U.S. capability to provide permanent reboost and attitude control. Russia is responsible for providing Progress vehicles, dry cargo, and related launch services throughout the station's life. Because of Russia's continuing funding problems, NASA began focusing on the development of a U.S. capability to provide similar functions. Key elements of this second step include the development of a propulsion module, shuttle modifications, and construction of logistics carriers at an estimated cost of about \$740 million. The propulsion module is the most expensive component of the new hardware. While there has been some uncertainty regarding this component, NASA currently estimates that the propulsion module could cost at least \$550 million. The agency estimates that the other components—shuttle modifications to permit reboosting of the station and logistics carriers to carry dry cargo on the shuttle—will cost about \$90 and \$100 million, respectively.

To mitigate the risk of Russian nonperformance in the near term, the second step of the plan also includes transfer payments to the Russian

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Space Agency to complete near-term work on the Service Module and Progress and Soyuz space vehicles. A \$60-million payment was made in 1998 and additional funds may be provided in 1999. In return for the \$60-million payment, NASA will receive 4,000 hours of Russian crew research time and stowage volume in the Russian segment of the station. According to program officials, the cost of research time on the Mir space station was used as the basis for the negotiation.

NASA is monitoring the flow of funds resulting from the transfer. In October 1998, officials began reviewing Russian contracts related to the Service Module and launch vehicles to confirm that purchase orders were in place. In November 1998, NASA officials began reviewing Russian disbursement documentation to determine the amount of transferred funds that had been released to suppliers. NASA officials said they found no evidence to date of U.S. funds being used for purposes other than those covered in the terms of the transfer. We did not independently verify NASA's finding.

NASA also plans to provide, if needed, \$100 million to the Russian Space Agency in 1999 in return for goods and services. In testimony given before the House Science Committee on February 24, 1999, the NASA Administrator stated that no decision will be made regarding further transfers without assessments of progress in the following three areas: (1) Service Module launch schedule, (2) the future disposition of the Mir space station, and (3) status of other Russian hardware and launch vehicle commitments. According to NASA, it is extremely problematic for Russia to support commitments to both Mir and the International Space Station.

While the ultimate cost of the contingency plan to address Russian nonperformance is uncertain at this time, NASA currently estimates that it will be about \$1.2 billion. To help pay some of the costs of Russian contingency requirements, the program transferred \$110 million from the space station research budget with the expectation that the funds would be replaced in the out-years. According to program officials, recent assembly sequence delays made it possible to delay planned research expenditures to later in the development program. According to NASA, station research programs will be impacted as a consequence. Preliminary assessments show that it may be necessary to delay the number of flight research investigators assigned to station work, and defer some research activities.

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**Overall Contingency Plan  
Not Yet Approved**

NASA has identified the lack of an overall contingency plan as a program risk item. In response, the station program has drafted a plan to address issues such as late delivery or loss of critical hardware, but it has not fully costed out all contingencies.

The absence of cost estimates has already caused some uncertainty. For example, NASA's recent decision to develop a U.S. capability to reboost the station requires that it develop a propulsion module. NASA initially relied on a contractor quote to estimate the cost of this capability, but subsequently refined its propulsion module requirement, resulting in a much higher cost estimate. Some of this uncertainty could have been avoided had a fully costed contingency plan been in place. According to program officials, the higher priority items included in the overall contingency plan will ultimately be costed, and the final plan should be approved later this year.

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**Quality and Safety of  
Russian Segment**

NASA is satisfied that Russian quality assurance and manufacturing processes are acceptable. However, NASA and the Russian Space Agency will need to continue working together to improve Russian hardware to meet orbital debris protection requirements.

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**Comparison of Quality  
Assurance Standards**

NASA believes Russia's attention to quality is comparable to that of the United States. The agency's conclusion is based on a combination of review of standards and on-site observations. In early 1994, NASA undertook an assessment of Russian quality standards. Over a 2-year period, it reviewed over 265 standards and documents and concluded that the key standards used by Russia were acceptable. Also, when the U.S.-financed Functional Cargo Block was being built in Russia, tools available to NASA's prime contractor to assess Russian manufacturing quality included technical surveys, test assessments, and test witnessing.

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## Safety Impact of Inadequate Orbital Debris Protection

NASA defines the space station's requirement to withstand orbital debris impacts in terms of the likelihood of not being penetrated.<sup>1</sup> When Russia entered the program as a full partner, it assumed responsibility for a significant amount of hardware. At that time, space station partners agreed to an 81-percent probability of not being penetrated by orbital debris, for the 10-year period beginning on the initial station launch. Subsequently, the requirement was reduced to 76 percent, in part, because of assembly sequence revisions and configuration changes that increased the station's surface area. When the current performance of Russian-funded hardware is included, the station cannot meet this requirement.

NASA and the Russian Space Agency are working on strategies to improve Russian components' debris protection performance. This includes adding shielding to hardware components on orbit, studying penetration effects, and developing repair techniques and procedures. The most pressing issue is protecting the Russian-funded Service Module from debris. Under the current schedule, it will be launched about 3 ½ years before installation of needed protective shielding can be completed.

NASA's International Space Station Safety Review Panel is assessing debris protection and other Service Module design characteristics. For example, according to NASA, the module will not operate fully in a depressurized environment. Such a situation could occur after impact with orbital debris, and could require the crew's evacuation. In addition, according to NASA, the Service Module's windows do not meet the requirements applied to other station components and are more vulnerable in the event of debris impact. Estimated costs to correct these deficiencies have not been fully developed. We will continue to monitor these issues as part of our ongoing work.

Under the current plan, NASA will launch the Service Module by granting a waiver at the time of launch and correcting the debris protection deficiency on orbit. NASA believes it is appropriate to maintain the Service Module's launch schedule because (1) the module adds capabilities that would otherwise be unavailable and (2) the risk is acceptable. NASA's analysis shows that the estimated probability of a Service Module debris

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<sup>1</sup> The chance of debris colliding with a spacecraft relates directly to the size and orbital lifetime of the spacecraft. NASA calculates overall capability to withstand debris impacts by determining the product of the capabilities of the individual components. For example, when Russia entered the program, the resulting overall capability of the combined U.S. and Russian segments was 81 percent (0.9 times 0.9).

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penetration prior to the planned augmentation is low. Also, due to the relatively small surface area of the windows, NASA believes the likelihood of a problem caused by a window puncture is very small.

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## Prime Contract and Nonprime Activity Costs

Difficulties in maintaining cost and schedule performance under the prime contract have prompted substantial contractor and program office attention. There are now some indications of similar problems in the nonprime portion of the program, which includes activities related to science facilities, ground and vehicle operations, and launch processing. This is problematic because nonprime activity comprises more than 50 percent of total estimated development costs and about 70 percent of remaining development costs. Program officials have now increased their oversight of nonprime activity, identifying this activity's potential cost and schedule growth as a program concern. In addition, the program recently addressed deficiencies in its centralized risk management database to better focus on cost issues in both the prime and nonprime areas.

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## Prime Contract Cost Growth

On a number of occasions in the past several years, we have reported and testified on the cost and schedule status of the prime contract.<sup>2</sup> We have pointed out that cost growth began almost immediately after the contract was awarded and that it posed an ongoing challenge to program managers from a budgetary standpoint. We noted that the program had penalized the prime contractor in terms of both award and incentive fee largely because of the contractor's problems in controlling and reporting costs.

Cost variances were eventually reflected in the prime contractor's estimate of overrun at completion, although its reluctance to do so in a timely fashion was criticized by NASA program managers. At about the same time as our last cost control report, the contractor undertook a number of initiatives designed to help reverse the trend of ever increasing cost growth.

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<sup>2</sup>Space Station: Cost Control Difficulties Continue (GAO/NSIAD-96-135, July 17, 1996); Space Station: Cost Control Difficulties Continue (GAO/T-NSIAD-96-210, July 24, 1996); Space Station: Cost Control Problems Continue to Worsen (GAO/T-NSIAD-97-177, June 18, 1997); Space Station: Cost Control Problems Are Worsening (GAO/NSIAD-97-213, Sept. 16, 1997); Space Station: Deteriorating Cost and Schedule Performance Under the Prime Contract (GAO/T-NSIAD-97-262, Sept. 18, 1997); and Space Station: Cost Control Problems (GAO/T-NSIAD-98-54, Nov. 5, 1997).

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Cost control initiatives implemented by the prime contractor included organizational restructuring and staff reductions. The organizational changes involved consolidating subcontractor activities and streamlining the managerial oversight of the program's three geographic manufacturing bases. The staff reduction initiative involved establishing target personnel levels based on the achievement of hardware delivery milestones.

In February 1997, the prime contractor reported a peak staffing level of 7,040 equivalent personnel. In March 1999, the prime contractor reported a level of 4,396, a 38-percent drop. However, NASA has cited problems with the current skill mix. For example, according to NASA, the lack of adequate skills has adversely affected both assembly and qualification testing schedules. NASA has identified the retention of critical skills, such as software engineers, as a top program risk that is worsening over time.

Despite the implementation of cost control initiatives, the prime contract continues to experience monthly cost and schedule variances. In June 1998, the estimate of overrun at completion was \$783 million and by April 1999, it had increased to \$986 million. According to the prime contractor, most of the latest growth was attributable to additional overhead costs, software and hardware development problems, and the need to increase its funding reserves.

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### Increased Oversight of Nonprime Activities

Since 1995, the prime contract effort has received considerable attention and oversight from program managers. Recently, the agency has begun to subject the nonprime area to increased scrutiny, and some problem areas are being identified. In 1994, the nonprime component of the program's development budget was \$8.5 billion. By early 1999, it had increased to over \$12.4 billion. According to NASA officials, much of that increase is attributable to schedule slippage. In addition, the program has increased in scope. For example, since 1994, the program has added \$1.2 billion to address the consequences of Russian fiscal problems.

NASA has recently undertaken a number of initiatives to improve its oversight of nonprime activity. The initiatives include requiring periodic evaluations similar to award fee evaluations of each activity and increasing visibility through high-level reviews. In October 1998, station officials held a formal review of activities funded outside the prime contract. This review was held at the program level and involved representatives from nonprime activities. Subsequent reviews were elevated to the Johnson

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Space Center Director level, an indication of the attention now being given to this area.

The program has identified and is currently assessing a number of nonprime activities in which cost, schedule, or technical problems are possible. These areas include research, operations, and vehicle facilities.

Nonprime activities now account for a larger portion of the station's development budget than the prime contractor activities, meaning that the budgetary impact of unforeseen cost growth could be significant. NASA considers the resolution of nonprime issues a top concern. We will continue to monitor nonprime activity status as part of our ongoing work.

Cost estimates assume that assembly of the station will be completed in 2004. NASA has acknowledged the difficulty in maintaining that schedule. If the schedule is not met, total program costs will increase further.

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## Risk Management Database Inadequacies

One mechanism that can help managers deal with cost risks is a thorough risk management plan. Ideally, such a plan forces managers to identify and cost out all major program risks and then develop remedies for risk areas.

We found that the station program's centralized database of potential risk areas did not capture all risk items or quantify the impacts of cost-driving risk items it did capture. As a result, the database fails to give program managers sufficient insight and early warning into many emerging problem areas. For example, the current database, while identifying retention of critical skills as a major program risk, does not identify the potential cost impact of losing key personnel. Regarding nonprime risk, the database included government-furnished equipment integration as a major risk item, but did not provide cost impact information.

Recognizing the inadequacy of the current database, the former station program manager directed the Program Risk Assessment Board to scrutinize all existing risks for cost impacts. He emphasized the importance of early identification of risk. We will continue to monitor progress in this area during our ongoing work.

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## Conclusions

NASA and its partners have successfully begun the International Space Station assembly, a noteworthy achievement. However, many of the program's greatest challenges lie ahead. NASA's most immediate challenge

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is to protect against Russian nonperformance. To do so, the agency is implementing a contingency plan that provides financial assistance to the Russian Space Agency and develops additional U.S. hardware. The total cost of this plan is estimated at about \$1.2 billion. In addition, when NASA finalizes its overall contingency plan and identifies how it will address issues such as late delivery or loss of critical hardware, additional costs may be identified.

NASA and the Russian Space Agency will have to work together to resolve potential safety issues involving the Service Module. These issues relate to protection against orbital debris. Estimated costs of the improvements that must be made after the Service Module is on orbit have not been fully developed.

The estimated cost of completing the U.S. segment continues to rise. The current estimated overrun under the prime contract is \$986 million and nonprime costs have increased by \$3.9 billion due primarily to schedule slippage and increased scope of work. To its credit, NASA has now begun to refine and improve its mechanisms for identifying and mitigating costs risks in the program. However, given the uncertainties and risks remaining through assembly completion, cost control will remain a tremendous challenge.

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Mr. Chairman, this concludes our statement. We will be happy to answer any questions you or members of the Subcommittee may have.