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Report to Congressional Requesters

August 1999

SPACE STATION

Russian Commitment and Cost Control Problems

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

National Security and
International Affairs Division

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August 17, 1999

The Honorable John McCain
Chairman, Committee on Commerce, Science and Transportation
United States Senate

The Honorable Bill Frist
Chairman, Subcommittee on Science, Technology and Space
Committee on Commerce, Science and Transportation
United States Senate

The National Aeronautics and Space Administration (NASA) faces many challenges in developing and building the International Space Station (ISS). These challenges, such as Russian difficulty in completing its components on schedule due to insufficient funding and continuing U.S. prime contractor cost increases, have translated into schedule delays and higher program cost estimates to complete development. As requested, we reviewed the status of Russian involvement in the ISS program. We also examined the prime contractor's progress in implementing cost control measures and NASA's efforts to oversee the program's nonprime activity. Specifically, we (1) assessed NASA's progress in developing contingency plans to mitigate the possibility of Russian nonperformance and the loss or delay of other critical components, (2) identified NASA's efforts to ensure that Russian quality assurance processes meet the station's safety requirements, and (3) determined the effectiveness of cost control efforts regarding the prime contract and nonprime activities.

Results in Brief

As an ISS 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.[1] However, Russia's funding problems have delayed delivery of the Service Module—the first major Russian-funded component—and raised questions about its ability to support the station during and after assembly. NASA is implementing a

[1]The Service Module is the primary Russian station contribution and early living quarters. It will provide life support system functions to all early elements. In addition, it is to provide station flight control and propulsion. Although many of its systems will be supplemented or replaced by later components, it will always remain the structural and functional center of the Russian segment.

multi-faceted contingency plan to mitigate the risk of further delay of the Service Module and the possibility that the Russians will not provide Progress vehicles for reboosting the station. The first step of this plan includes the development of the U.S.-built Interim Control Module and modifications to the Russian-built and U.S.-financed Functional Cargo Block (Zarya). 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 its plan is uncertain at this time, NASA 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 such a plan is a program risk item. According to program officials, the higher priority risk items will ultimately be costed, and the final contingency plan should be approved later this year.

NASA is satisfied that Russian quality assurance standards are acceptable. However, the Service Module's inability to meet debris protection requirements is a potential safety issue. The module will require improvements after it is launched to meet this requirement. Based on the module's current launch date, it will be about 3 ½ years after launch before improvements can be completed. In addition, NASA and the Russian Space Agency will have to work together to address other safety issues such as improving fire protection and reducing noise levels.

Despite efforts to control cost growth, 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 had significant cost overruns and schedule delays. 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 costs of the nonprime portion of the program—activities related to science facilities and ground and vehicle operations—are also increasing, due largely to added scope and schedule slippage. In 1994, the nonprime component of the program's development budget was $8.5 billion; today, it is over $12.4 billion. The agency has begun to subject the nonprime area to increased scrutiny. Also, recognizing the inadequacy of the current risk database, the Program Risk Assessment Board was directed to scrutinize

all existing risks for cost impacts. These actions could potentially improve the agency's ability to manage future cost growth.

We recommend that the NASA Administrator direct the station program manager to finalize the overall ISS contingency plan before the Service Module is launched.

Background

NASA and its international partners—Japan, Canada, the European Space Agency, and Russia—are building the space station as a permanently orbiting laboratory to conduct materials and life sciences research, earth observation, and commercial utilization, and related uses under nearly weightless conditions. Each partner is providing station hardware and crew members and is expected to share operating costs and use of the station. The NASA space station program manager is responsible for the cost, schedule, and technical performance of the total program. The Boeing Corporation, the prime contractor, is responsible for development, integration, and assembly of the station. (See fig. 1.)

Figure 1: Artist's Conception of Fully Assembled ISS in Orbit

Source: Johnson Space Center.

In December 1998, NASA accomplished an important and significant step in its construction of the ISS: coupling the first two elements—Zarya and Node 1 (Unity). (See fig. 2.)

Figure 2: Zarya and Unity in Orbit

Source: Johnson Space Center.

In May 1998, we reported that the program's development costs had increased from $17.4 billion to $21.9 billion.[2] We cited a schedule slippage of 18 months—June 2002 to December 2003—for completion of assembly as contributing significantly to the increase. We also identified delays in the manufacture of the Service Module as contributing to the schedule slippage, as well as prime contractor cost overruns. NASA now estimates that development costs will range from $24 billion to $26 billion, depending on the station's completion date. The agency attributes this increase to further schedule slippage and Russian manufacturing delays.

[2]International Space Station: U.S. Life-Cycle Funding Requirements (GAO/NSIAD-98-147, May 22, 1998).

NASA Contingency Planning Focuses on Russian Concerns

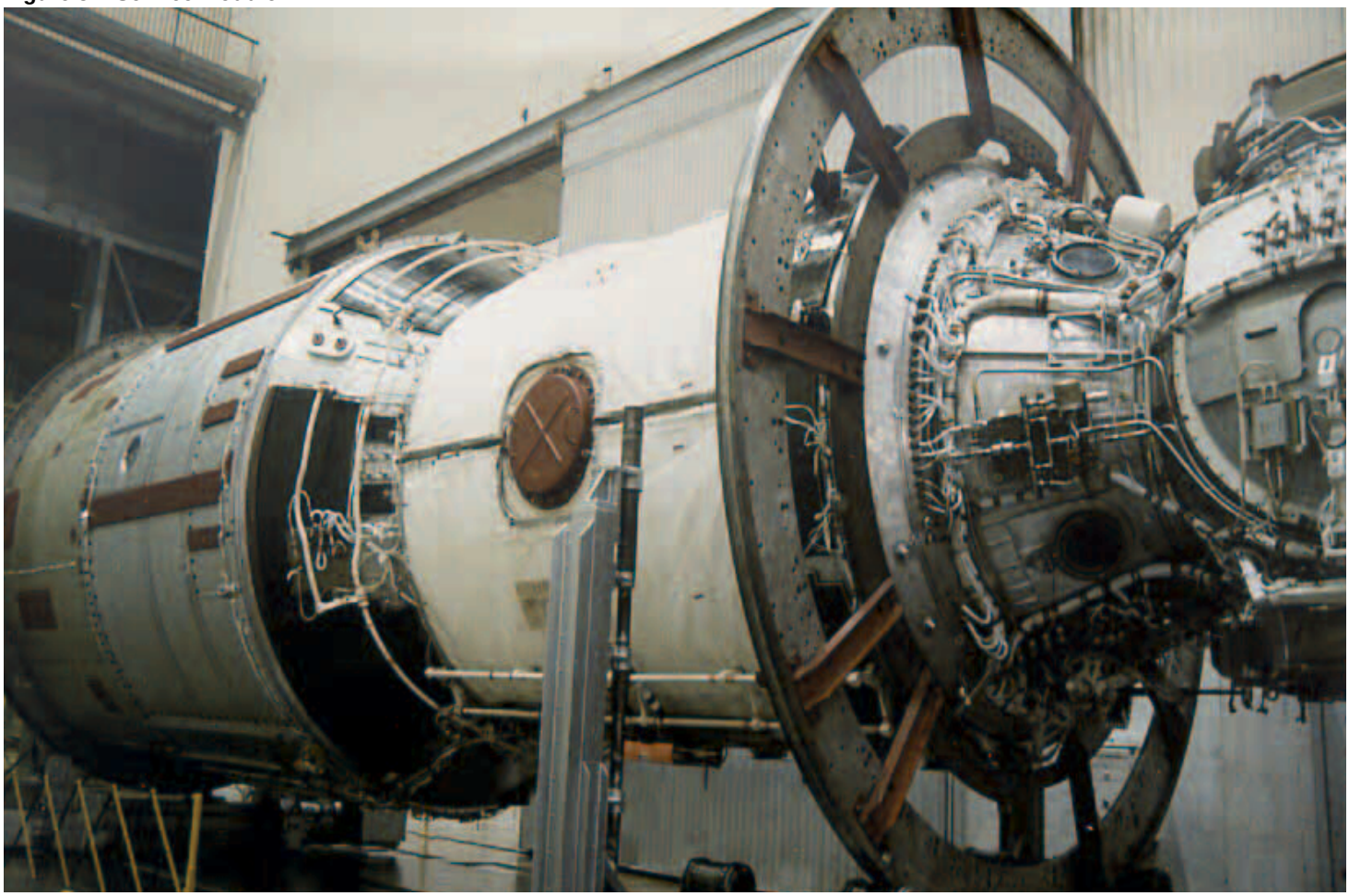
Because of Russia's continuing funding problems, NASA developed a multifaceted contingency plan to mitigate the risk of further delay of the Service Module and the possibility that the Russians cannot provide a reboost capability. Payments to Russia for the completion of the Service Module have also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

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 (see fig. 3) 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 under way 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 Zarya. According to NASA, the cost to implement this step will be about $261 million.

Figure 3: Service Module



Source: Johnson Space Center.

The second step includes developing 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, such as a propulsion module, shuttle and docking module modifications, and the purchase of logistics carriers and services at an estimated cost of about $730 million. The propulsion module is the most expensive component of the new hardware. While there has been some

uncertainty regarding the cost of this component, NASA currently estimates that it could cost about $540 million. The agency estimates that the other components—shuttle modifications to permit reboosting of the station and logistics carriers designed to safely transport dry cargo on the shuttle—will cost about $90 million 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 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, for which the United States will receive 4,000 hours of crew time, previously allocated to Russia, to conduct U.S.-directed research. The United States will also receive storage space in the Russian segment of the station. According to program officials, the cost of research time on the Mir space station was the basis for the negotiation.[3]

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 $100 million to the Russian Space Agency in 1999 in return for goods and services. The two agencies have compiled a list of goods and services that could be provided in return for the additional payments. That list includes the potential purchase of a Soyuz crew return vehicle, a space station virtual reality trainer, and Russian hardware mockups.

NASA has placed conditions on any fund transfers beyond those already made. 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

[3]For the purposes of the funding transfer negotiation, NASA applied a rate of approximately $11, 000 per hour for crew research time. This was based on the 1994 negotiated rate for research time on the Mir space station.

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 difficult for Russia to support launch commitments to both Mir and ISS. Russia's unwillingness to deorbit Mir on schedule would be viewed as a severe threat to maintaining its support of ISS.

While the ultimate cost of the contingency plan to address Russian nonperformance regarding their current commitments is uncertain at this time, NASA 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. However, 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.

Overall Contingency Plan Not Yet Approved

While NASA has a plan to deal with Russian nonperformance, it does not yet have an approved overall contingency plan to address development issues involving all partners. NASA has identified the lack of an overall contingency plan as a program risk item. In response, a station program plan to address issues such as late delivery or loss of critical hardware has been drafted, but the potential cost of all contingencies has not been estimated.

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 the cost of the contingencies been estimated.

NASA's Office of the Inspector General recently issued a report on space station program contingency planning.[4] It cited similar concerns, concluding that, in the absence of a completed plan, "NASA cannot fully reduce [space station] risks through advance planning and the establishment of response plans." The report also concluded that ". . . without estimated costs, [NASA], the Administration, and the Congress cannot adequately assess the feasibility of proposed responses or determine budgetary impact." In response, NASA agreed that cost information is needed, but stated that it should be maintained separately from the contingency plan because of its sensitivity.

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.

NASA Is Satisfied With Russian Segment Quality Standards but Design Improvements Are Needed

NASA is satisfied that Russian quality assurance processes are acceptable. However, NASA and the Russian Space Agency will need to continue working together to improve Russian hardware to protect against orbital debris and address other potential safety issues.

Comparison of Quality Assurance Standards

Agency officials explained that Russian procedures are governed by contract in the case of Zarya and by bilateral protocols, agreements, and plans in the case of Russian-funded hardware. 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 Zarya was being built in Russia, tools were available to NASA's prime contractor to assess Russian quality, including technical surveys, test assessments, and on-site witnessing of tests.

[4] Audit Report: Space Station Contingency Planning for International Partners (IG-99-009; Mar. 9, 1999).

Safety Improvements Will Require Ongoing U.S./Russian Commitment

Based on the current schedule, the Service Module will be launched in November 1999. This component will be necessary to begin station habitation on a permanent basis. However, it will be necessary for NASA and the Russian Space Agency to work together both before and after its assembly to address and mitigate a number of safety risks associated with the Service Module, including risks related to potential debris impacts and work environment issues.

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.[5] 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 configuration changes that increased the station's surface area and assembly sequence revisions. When the current performance of Russian-funded hardware is included, the station does not 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 needed protective shielding is installed.

In addition, some Service Module design characteristics could increase its vulnerability in the event of a debris impact. For example:

- The module was not certified to operate in a depressurized environment, and its capability to function in that environment cannot be assured. According to NASA, depressurization could occur after impact with orbital debris, requiring the crew's evacuation and loss of station control functions. This risk can be minimized if Russia identifies, redesigns, and replaces the Service Module components that would not

[5] 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).

operate in a depressurized environment. In the interim, NASA believes the risk of flight control loss will be mitigated when U.S. guidance, navigation, and control software is installed on a later assembly flight. Under the current schedule, that backup capability will not be available until more than 1 year after the Service Module is deployed. Thus, the full resolution of this issue will require ongoing NASA and Russian Space Agency cooperation.

- The Service Module's windows do not have the same protection against debris as the windows on other station components and are not designed to be replaceable on orbit. The windows in the Russian module have two layers while the U.S.-designed windows will have four layers.[6] The additional layers are to provide protection against debris on the outside of the window and scratches caused by working inside the station. Under existing plans, if a window in the Service Module is damaged, it will have to be covered with a metal shield.

According to NASA officials, these Service Module issues are largely the result of (1) differing manufacturing philosophies, (2) the fact that the Russian hardware is based on designs applied to the Mir station, and (3) the Russian position that its lengthy Mir experience demonstrates the robustness of its design characteristics. However, the ISS will be significantly larger than Mir and will therefore be more exposed to orbital debris; the ISS will have about eight times more total surface area than the Mir station.

Under the current plan, NASA will grant a waiver at the time of the Service Module launch and the debris protection deficiency will be corrected 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 penetration prior to the planned augmentation is less than 10 percent. 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.

Risks Associated With the Working Environment

NASA and the Russian Space Agency are also working to reduce risks associated with the working environment in the Service Module. These initiatives include modifications to the Solid Fuel Oxygen Generator to reduce the risk of an on-board fire and improved acoustics to reduce noise

[6]All station partners except Russia will use U.S.-designed windows.

levels and the risk of hearing loss. These issues surfaced during the Mir-Shuttle program.[7]

The Russian Solid Fuel Oxygen Generator will be used as a backup method to generate oxygen for the space station and will be located in the Service Module. While in use on the Mir space station, it caught fire, resulting in a near catastrophic event in February 1997. A Russian investigation identified several possible causes, the most likely of which was a misaligned or damaged igniter. NASA and the Russian Space Agency have agreed to some changes to help contain the spread of fire in the ISS. However, a redesign to reduce the likelihood of a fire will have to be incorporated on orbit. This issue continues to be a major topic in technical interchange meetings between NASA and the Russian Space Agency.

In addition, during the Mir-Shuttle program, NASA became aware of the fact that some Russian cosmonauts had permanent hearing loss due to Mir's interior noise. U.S. astronauts visiting Mir also complained about the noise. The ISS program, in order to prevent these problems experienced on Mir, instituted noise level requirements for the Russian and U.S. on-orbit segments. Noise levels in the Service Module exceed station requirements and, without mitigating measures, could cause some short- or long-term hearing loss in crew members. NASA and the Russian contractor have jointly developed an acoustic mitigation plan to reduce noise levels, but cannot fully implement the plan until after the Service Module is launched.

Prime Contract and Nonprime Activity Costs Continue to Increase

Difficulties in maintaining cost and schedule performance under the prime contract have prompted substantial contractor and program office attention. There are now indications of problems in the nonprime portion of the program, which includes activities related to science facilities, ground and vehicle operations, and launch processing. This is difficult because nonprime activity comprises more than 50 percent of total estimated development costs and about 70 percent of remaining development costs. The program has increased its oversight of nonprime activity and, according to officials, is attempting to incorporate a system to improve its ability to track performance trends. In addition, the program

[7]To prepare for the ISS assembly, NASA and the Russian Space Agency undertook a cooperative effort involving the space shuttle and the Mir space station. During the Mir-Shuttle program, seven U.S. astronauts visited Mir between 1995 and 1998 to conduct experiments and gain operational experience on long-duration missions.

recently addressed deficiencies in its centralized risk management database to better focus on cost issues in both the prime and nonprime areas.

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.[8] 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 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 time of our last cost control report in September 1997, the contractor undertook a number of initiatives designed to help reverse the trend of ever increasing cost growth.

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.

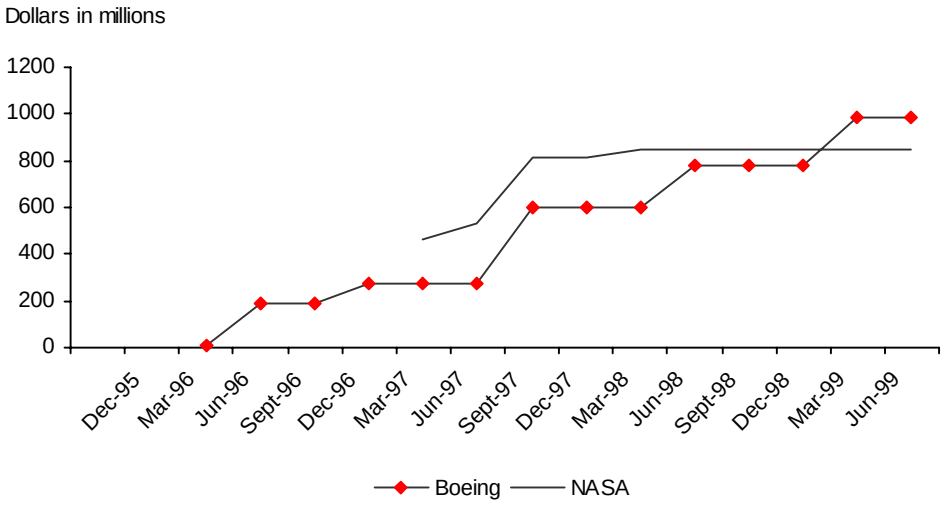
In February 1997, the prime contractor reported a peak staffing level of 7,040 equivalent personnel. In March 1999, the prime contractor reported a level of 4,396 personnel, a 38-percent drop. However, NASA has cited problems with the current skill mix. For example, according to NASA, the lack of adequate skills has adversely affected both assembly and qualification testing schedules. NASA identifies the retention of critical

[8] 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); Space Station: Cost Control Problems (GAO/T-NSIAD-98-54, Nov. 5, 1997); and Space Station: Status of Russian Involvement and Cost Control Efforts (GAO/T-NSIAD-99-117, Apr. 29, 1999).

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 have monthly cost and schedule variances. In June 1998, the estimate of overrun at completion was $783 million; by March 1999, it had increased to $986 million.[9] The new estimate exceeds the program's current budget for prime contract overrun by about $140 million, which means funding reserves will be needed to cover the difference. According to the prime contractor, most of the latest growth in the estimate was attributable to additional overhead costs, software and hardware development problems, and the need to increase its funding reserves. Figure 4 shows the trend of estimated cost overruns for the prime contract portion of the development program and NASA's budget for overruns.

Figure 4: Estimates of Prime Contract Overruns at Completion



Shortly after the prime contractor announced its March 1999 overrun estimate, NASA's Administrator requested that the agency's Office of the Inspector General evaluate prime contract performance management. In a letter dated April 8, 1999, NASA's Assistant Inspector General for Auditing

[9]The prime contractor first reported the overrun increase in a March 1999 quarterly review. It was formally reported to NASA in April 1999 in a monthly Performance Measurement System Report.

announced a review to include assessments of the timeliness of the prime contractor's reports to NASA management and the reasonableness of overhead rates applied. The Inspector General plans to issue the report by late August 1999.

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 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.[10] 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 undertaken a number of initiatives to improve its oversight of nonprime activity. The initiatives include requiring periodic evaluations 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 Space Center Director level, an indication of the attention now being given to this area.

More recently, the program has undertaken an initiative designed to provide nonprime status in a format that will permit improved tracking of performance trends. The station's nonprime area is comprised of hundreds of individual activities. The program's strategy is to establish integrated cost and schedule baselines, which will permit assessments of actual work performed measured against the budget. Program managers believe such a system, if successful, would enable them to quantify cost and schedule variances in nonprime problem areas. The establishment of valid baselines is fundamental to this approach. As of May 1999, the baselines had not been completed.

[10]For comparison purposes, both estimates include research costs. In 1994, the research budget was managed separately from the station development budget.

Based on available information to date, 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's activities, meaning that the budgetary impact of unforeseen cost growth could be significant. NASA considers the resolution of nonprime issues a top concern.

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. 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. As a result, the database fails to give program managers sufficient insight and early warning into many emerging problem areas. Recognizing the inadequacy of the current database, the Program Risk Assessment Board was directed to scrutinize all existing risks for cost impacts, emphasizing the importance of early identification of risk.

NASA Planning Document and the Administration's Budget Submittal Reference Importance of ISS Issues

In January 1999, we reported on major performance and management issues facing NASA, as part of a series of similar reports covering 20 federal agencies.[11] At that time, we identified space station cost control as one of NASA's foremost challenges. In March 1999, NASA identified specific space station program objectives for fiscal year 2000 in its fiscal year 2000 Performance Plan.[12] These include deploying the U.S. Lab, completing

[11] Major Management Challenges and Program Risks: National Aeronautics and Space Administration (GAO/OGC-99-18, Jan. 1999).

[12] As required by the Government Performance and Results Act of 1993, NASA issued its annual Performance Plan, titled NASA Fiscal Year 2000 Performance Plan, in March 1999. Along with other requirements, the act requires agencies of the federal government to prepare an annual performance plan to describe (1) the agency's performance goals and measures, (2) the strategies and resources to achieve these goals, and (3) procedures to verify and validate reported performance.

preparations for initial research capability, and conducting operations with a three-person crew.

The Administration has recognized the challenge of building the space station. The management risk associated with building the space station is identified in the President's fiscal year 2000 budget submittal as 1 of the top 24 government management challenges.

Conclusions

NASA and its partners have successfully begun ISS assembly, a noteworthy achievement. However, many of the program's greatest challenges lie ahead. NASA's most immediate challenge is to protect against Russian nonperformance. To do so, it is implementing a contingency plan that provides financial assistance to the Russian Space Agency and develops additional U.S. hardware. The total cost of the plan is estimated at about $1.2 billion.

In addition, resolving potential safety issues involving the Service Module will require cooperation between NASA and the Russian Space Agency. These issues include fortifying the module to protect it from orbital debris impacts, ensuring continuing operations should it become depressurized, reducing the risk of an on-board fire, and lowering noise levels. Most of these improvements will be made after the Service Module is on orbit. Based on the current schedule, this will require several years to complete.

At the same time, the cost of completing the U.S. segment continues to rise. The current estimated overrun under the prime contract is $986 million. NASA has now begun to refine and improve its mechanisms for identifying and mitigating costs risks in the program. In addition, the agency is undertaking initiatives to improve its oversight of nonprime activities, which are now estimated to total $12.4 billion. These actions could potentially improve the agency's ability to manage future cost growth.

The space station program recognizes the need to adopt an overall contingency plan to identify and cost out the impacts from potential loss or delay of critical components. However, as of June 1999, its plan was still being drafted, even though the first two station components had already been assembled in orbit. Under the current schedule, several major components will be added within the next year, including the Service Module and the U.S. Lab. We believe completion of such a plan is critical if potential disruptions and related cost increases are to be minimized.

Recommendation

To minimize the potential of further schedule disruptions and related cost increases, we recommend that the NASA Administrator direct the station program manager to finalize the overall ISS contingency plan before the Service Module is launched.

Agency Comments

In commenting on a draft of this report, NASA stated that it was in agreement with the content and data in the report, with one exception. NASA recommended that, in our discussion of nonprime cost increases, we state the reasons for the increases at the beginning of the relevant sections. We revised the report language in the results in brief section to make it clear that much of the nonprime increase was attributable to added scope and schedule slippage. We did not revise the section in the report body because we believe that section adequately delineates that added scope and schedule slippage were the reasons for much of the nonprime cost growth. NASA's response is reprinted in full in appendix I.

Scope and Methodology

To assess the extent to which NASA has studied options to minimize the possibility of future Russian nonperformance and the loss or delay of other critical components, we reviewed contingency plans to determine the scope and evolution of NASA's efforts. We also reviewed contract documentation and protocols to understand the formal governing arrangements between NASA and the Russian Space Agency and budget information to assess the potential impact on NASA's funding requirements. In addition, we reviewed internal briefings and interviewed officials in the Space Station Program Office to gain further insights.

To identify NASA's efforts to monitor Russian quality assurance, we reviewed internal quality assurance records, governing agreements, and briefings. To assess the space station's vulnerability to orbital debris, we reviewed performance requirements, risk reports, engineering analyses, and independent assessments. For example, we compared the design parameters of U.S. and Russian-built windows. We also interviewed officials in NASA's Office of Space and Life Sciences, the station program's Office of Safety and Mission Assurance, and the Space Station Independent Assessment Office.

To determine the effectiveness of prime contract and nonprime activity cost control efforts, we reviewed contractor cost reports to determine the current estimate of cost overrun at contract completion, and budget

information to compare the contractor's overrun estimate to NASA's current funding profiles. In addition, we reviewed nonprime activity technical task agreements and internal assessments to identify the scope of the nonprime effort. We also assessed the program office's efforts to monitor and control nonprime cost growth. In addition, we interviewed officials with the space station program, the prime contractor, and NASA's Cost Assessment and Validation Task Force to gain their perspectives on NASA's overall cost control efforts.

We conducted our review from June 1998 to May 1999 in accordance with generally accepted government auditing standards.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from its issue date. At that time, we will send copies to Senator Ernest Hollings, Ranking Minority Member, Senate Committee on Commerce, Science and Transportation; Senator John Breaux, Ranking Minority Member, Subcommittee on Science, Technology and Space, Senate Committee on Commerce, Science and Transportation; the Honorable Daniel Goldin, NASA Administrator; the Honorable Jacob Lew, Director, Office of Management and Budget; and other interested parties. We will also make copies available to others on request.

Please contact me at (202) 512-4841 if you or your staff have any questions about this report. Other key contributors to this report are acknowledged in appendix II

Allen Li
Associate Director,
Defense Acquisitions Issues

Contents

Abbreviations

ISS	International Space Station
NASA	National Aeronautics and Space Administration

Comments From the National Aeronautics and Space Administration

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

JUL 26 1999

Mr. Allen Li
Associate Director
Defense Acquisition Issues
General Accounting Office
Washington, DC 20548

Dear Mr. Li:

Thank you for the opportunity to review and comment on the recent draft report entitled, "Space Station – Russian Involvement and Cost Control Problems (GAO code 707357)." Based upon the results of the July 7 - 9, 1999, telephone conferences between Mr. John Gilchrist of your staff, and Messrs. Robert Soltess and Daniel Hedin of the Office of Space Flight, we are in agreement with the content and data shown in the draft report, with the following exception.

See p. 19.

Pages 3 and 18 of the report contain descriptions of nonprime cost increases that NASA believes are misleading. The sections read in part, "In 1994, the nonprime component of the program's development budget was $8.5 billion; today, it is over $12.4 billion;" and "By early 1999, it [the nonprime component] had increased to over $12.4 billion." The sections are each followed by a description of the cost growth which indicates that the growth can be attributed to content changes and schedule slips rather than cost overruns, but these descriptions do nothing to mitigate the impact of the opening sentences. NASA recommends that the reasons for the cost increases be clearly stated at the beginning of each section so as to accurately show that the cost increases resulted from content and schedule changes, rather than implying that the figures represent cost overruns.

Please contact Mr. Robert Soltess at 358-1895, if further assistance is required. The preparation and staffing of this response consumed 12 work hours.

Sincerely,

J. R. Dailey
Associate Deputy Administrator

GAO Staff Acknowledgments

Acknowledgments

Jerry Herley, John Gilchrist, James Beard, Fred Felder, and Marcus Ferguson made key contributions to this report

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