United States General Accounting Office

GAO

Report to the Honorable
Tim Roemer, House of Representatives

May 1993

SPACE STATION

Program Instability and Cost Growth Continue Pending Redesign

GAO/NSIAD-93-187

GAO

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

National Security and
International Affairs Division

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May 18, 1993

The Honorable Tim Roemer
House of Representatives

Dear Mr. Roemer:

This report responds to your request that we (1) update the information provided in our May 1, 1991, testimony on the total cost of the National Aeronautics and Space Administration's (NASA) space station program; (2) update our analysis concerning the share of NASA's future years' budgets that the space station and related activities would likely require under the current design; and (3) report on the current and prospective status of financial reserves for the space station program.

As you know, the administration has determined that the space station, as currently planned, is unaffordable in light of budget constraints. Therefore, the President has called for another major restructuring of the space station, the fifth such redesign since 1984. NASA was directed to propose three options for an orbiting base that could complete development within a 5-year budget plan ranging from $5 billion to $9 billion. A separate blue-ribbon panel will comment on NASA's options to the White House in June. As you requested, this report addresses the space station's existing design. Our analysis relates to prior estimates and potential cost implications of continuing the existing program. This report does not reflect the revisions that are expected to be announced next month.

Background

Since the outset of the space station program in the mid-1980s, there has been concern that future budget constraints would render it virtually impossible to design, test, and build the station as originally envisioned. As a result, the space station Freedom was redesigned and the program rescoped three times prior to 1990. Despite these changes, in the fiscal year 1991 Conference report discussion of NASA's appropriation, the Congress again stressed that the existing space station design could not be supported within the fiscal year 1991 budget and estimated out-year budgets. NASA was once again directed to redesign the space station in an effort to accommodate the program within anticipated out-year funding constraints on domestic discretionary spending. NASA's fourth redesign, completed in March 1991, reduced the size and complexity of the space station structure and stretched out the schedule for first element launch,

shuttle-tended use, and permanent occupancy. Some of the basic differences between the currently approved design and its immediate predecessor are shown in table 1.

Table 1: Comparison of 1990 and 1991 Space Station Design, Cost, and Schedule Parameters Through 1999

Parameter	1990	1991
Length	493 feet	353 feet
U.S. module length	44 feet	27 feet
Crew size	8	4
Electrical power	75 Kw	56 Kw
Data system	300 mbs	50 mbs
First element launch	1995	1996
Shuttle-tended use	1996	1997
Permanent occupancy	1997	1999
Assembly complete	1999	TBD
Program cost estimate[a]	$38.3 billion	$30 billion

[a]The 1990 cost estimate provides for complete assembly; the 1991 cost estimate represents cost through initial permanent occupancy.

Results in Brief

By December 1992, significant cost overruns were being reported for the 1991 design. In March 1993, NASA revised its cost estimate for the station to $31.3 billion. At the same time, NASA stretched the schedule for having permanent occupants in the space station to 2000. The $31.3 billion estimate, like previous estimates, excluded substantial budgetary resources required to successfully complete development and support the station over its planned 30-year life. Additional funding necessary to support and outfit the station for permanent occupancy would be another $11.7 billion. Further, at least $78 billion would be required to bring the facility to its full planned capability and maintain, supply, and operate the station after permanent occupancy was achieved. When these costs are included, the space station funding requirements through 2027 would be at least $121 billion.

Assuming no additional cost growth, appropriations to support NASA's $31.3 billion estimate would have had to average about $3 billion for each of the next 5 years. Support and outfitting, such as for the assured crew return vehicle, centrifuge facility, and science experiments increases the estimate of the station's annual funding needs to an average $3.4 billion, or 22 percent of NASA's estimated budgets over the same period. From 1998

through 2000, the space station and all related support, including shuttle flights, would use 39 percent of NASA's annual budgets.

Since the program restructuring in 1991, we have expressed concern that NASA was not maintaining financial reserves commensurate with the program risks. Maintaining adequate financial reserves is necessary in high risk research and development programs to offset unanticipated program requirements and to avoid cost growth and delays. Prior to its last redesign, NASA had determined that a 30 percent to 35 percent reserve was appropriate for the space station. In July 1992, we reported that the total remaining reserves in the program through permanent occupancy had been reduced to about 12 percent. We also noted that the amounts estimated for reserve funds through fiscal year 1994 were less than 4 percent of the estimated development and operations budgets for the station. Since that time, additional commitments of reserves have been necessary, and NASA has acknowledged that the reserves estimated and allocated for fiscal years 1993 through 1995 would be insufficient to cover likely cost increases.

NASA officials told us in May 1993 that part of its adjustments to recent contractors' cost growth included restoring an average financial reserve margin of about 19 percent to the overall program estimates through 2000. However, this margin is based on annual station development and operations appropriations of about $2.5 billion. To the extent that these large annual funding levels estimated for the space station in future years failed to materialize, financial reserves after 1995 likewise would not be available to help deal with problems arising during the building, testing, launching, and assembly of the station.

Space Station Cost Growth and Program Instability

In May 1991, we testified that NASA's estimate of $30 billion did not include some cost elements attributable to the space station program. First, it did not include at least $10 billion in program cost attributable to the program prior to permanent occupancy. Second, it did not include at least $78 billion in funding required after permanent occupancy. When these costs were considered, the space station estimate was at least $118 billion. We cautioned in our testimony that the remaining technical challenges and risks associated with the program could also be understated. We noted that some cost elements were still undefined and significant cost growth could occur during hardware development.[1]

[1]For a more detailed discussion see Questions Remain on the Costs, Uses, and Risks of the Redesigned Space Station (GAO/T-NSIAD-91-26, May 1991).

In testimony before the Congress on March 2, 1993, NASA acknowledged substantial new cost growth for research and development of the space station program through permanent occupancy. The preliminary results of a program cost assessment review team attributed the program cost growth to

- an inability to meet the management challenges that had been incorporated into the program as a result of the 1991 restructure;
- an inability to achieve productivity gains assumed in contractors' and subcontractors' bids and projections;
- an overall lack of space station design maturity, which resulted in underestimating costs;
- change orders issued by NASA to its contractors;
- unanticipated increases in contractors' overhead rates; and
- the need to begin funding spare parts which require a long lead-time.

NASA pointed out that the data supporting the fiscal year 1991 redesign cost estimate were incomplete and costs became higher than anticipated. For example, the avionics and software designs and verification requirements and implementation plans were not fully developed, and the avionics themselves were more complex and expensive than anticipated.

When we testified on NASA's original $30 billion station estimate in May 1991, we pointed out that the cost of other planned elements, such as an assured crew return vehicle, a centrifuge facility, science experiments, and additional shuttle costs, would add about $10 billion, bringing total costs to $40 billion. Today, based on revised NASA figures, these elements are estimated to cost about $11.7 billion. Together with NASA's revised estimate of $31.3 billion, the total cost of the current program to permanent occupancy in 2000 is estimated at $43 billion. Table 2 provides a breakdown of the current cost elements that make up the space station program and the annual appropriations that will be required to support those elements. It covers both NASA's latest estimate of $31.3 billion and those additional items we believe are also attributable to the space station program through 2000.

Table 2: GAO Estimate of Space Station Cost Through Fiscal Year 2000 - May 1993 Estimates (NASA Data Except Where Noted—In Billions of Then Year Dollars)

Cost Components	Prior	1994	1995	1996	1997	1998	1999	2000	Total
Research and Development									
Development	8.921	2.210	2.131	1.827	.892	.581	.342	.123	17.027
Operations		.030	.309	.843	1.688	1.919	1.858	1.902	8.549
Shuttle Modifications	.205	.089	.106	.107	.058	.060			.625
Flight Telerobotic Servicer	.283								.283
Program Definition	.612	.010							.622
Space Flight, Control and Data Communications									
Shuttle Transportation		.012	.031	.168	.230	.367	.350	.324	1.482
Communications & Data Systems	.033								.033
Construction of Facilities									
Construction of Facilities	.171	.031	.043	.044	.027	.019	.004		.339
Research and Program Management									
Civil Service Personnel	.909	.182	.190	.199	.208	.217	.228	.238	2.371
NASA Estimates	**11.134**	**2.564**	**2.810**	**3.188**	**3.103**	**3.163**	**2.782**	**2.587**	**31.331**
Additional Appropriations to Support Space Station Program									
Assured Return Vehicle[a]	.016		.366	.369	.332	.239	.200	.150	1.672
Centrifuge Facility[b]	.018	.021	.037	.084	.106	.133	.200	.200	.799
Science Experiments[b]	.064	.077	.155	.196	.221	.236	.300	.359	1.608
Additional Appropriations	**.098**	**.098**	**.558**	**.649**	**.659**	**.608**	**.700**	**.709**	**4.079**
Allocation of Additional Shuttle Costs									
Additional Shuttle Cost[c]						**2.524**	**2.541**	**2.567**	**7.632**
Grand Total	**11.232**	**2.662**	**3.368**	**3.837**	**3.762**	**6.295**	**6.023**	**5.863**	**43.042**

[a]NASA has estimated that about $1.7 billion would be required to produce an assured crew return vehicle (ACRV) for a permanently manned capability. The agency is currently studying the feasibility of developing a less costly ACRV by modifying the Russian Soyuz-TM spacecraft. Ten million dollars is allocated under program definition for this purpose in fiscal year 1994. However, in the absence of any new development estimates we have maintained the $1.7 billion to account for this requirement.

[b]NASA's planning did not provide funding estimates for development of science experiments or the centrifuge beyond fiscal year 1998. Amounts for fiscal years 1999 and 2000 are notional estimates we developed based on continuing funding requirements and are subject to change when official NASA estimates are made available.

[c]Figures are based on NASA's estimates of 7 assembly or utilization flights per year at an average $413.5 million per flight less shuttle transportation costs already included in its $31.3 billion estimate. NASA's "average cost per flight" does not include any of the approximately $30.2 billion spent through 1992 to develop the shuttle, acquire reusable hardware and equipment, and construct and modify facilities. Nor does it include any of the more than $1 billion that NASA estimates will be needed annually for shuttle upgrades.

Not included in table 2 is an estimated $78 billion (uninflated) necessary to support the space station after the year 2000. This estimate consists of $54 billion to maintain, supply, and operate the station for 27 years at $2 billion annually, and about $24 billion necessary to bring the station to its full planned capability, provide shuttle transportation, conduct scientific research, and pay civil service salaries. Estimates of these out-year costs have not changed since we reported them in 1991. When these costs are considered, the total space station life cycle cost estimate through 2027 is at least $121 billion.

Existing Space Station Design Would Require 22 Percent of Estimated Future Budgets

In September 1992, we reported that NASA's large programs threaten to consume increasing shares of the agency's annual appropriations.[2] The space station, as currently designed, is NASA's single largest and most costly research and development program, with an estimated cost of $43 billion. Additional unplanned cost growth typical of complex research and development programs could push funding requirements for the space station even higher.

According to NASA, over $11.2 billion has been appropriated for the space station and related development through fiscal year 1993. To complete the current program, including the estimated costs of an assured crew return vehicle, a centrifuge facility, and science experiments, NASA would have to have appropriations totaling $24.2 billion, or about $3.4 billion annually over the next 7 years. This would represent about 22 percent of NASA's estimated annual budgets through 1998.[3]

In fiscal years 1998 through 2000, virtually all shuttle flights would be dedicated to assembling or using the existing space station design. The cost of these flights over what NASA has allocated within its $31.3 billion estimate, would be $7.6 billion or about $2.5 billion annually. Space shuttle transportation in these years would push the annual funding needed to support the existing station design to over $6 billion. Together, the space station program and all related support would use about 39 percent of NASA's estimated annual budgets from 1998 through 2000.[4]

[2]NASA: Large Programs May Consume Increasing Share of Limited Future Budgets (GAO/NSIAD-92-278, September 4, 1992).

[3]Source: Budget of the United States Government, Fiscal Year 1994, Current Services Budget Authority by Agency, page 150.

[4]The President's fiscal year 1994 budget projections show only modest nominal increases for NASA through 1998 which may, or may not, be realized. The 39 percent estimate for 1998-2000 is based on an average of the current planning figures for fiscal years 1994 through 1998.

Inadequate Financial Reserves

In May 1991, and again in July 1992, we expressed concern that the space station program was not maintaining adequate financial reserves to cover unanticipated contingencies commensurate with the high risk nature of this program.[5] During the latter part of 1991 and into 1992, program managers faced a large number of unfunded program requirements, with the total estimated over $2.1 billion. In June 1992, after extensive evaluation, program officials committed $1.1 billion of reserves to fund these requirements. This action left only a small amount of reserves for the next 3 fiscal years and reduced overall planned reserves through fiscal year 1999 to only about 12 percent. According to program officials, the commitment of financial reserves resolved all outstanding demands on program reserves. However, later that same year additional demands on reserves surfaced because of contractor cost growth.

In its March 1993 testimony on these most recent cost overruns, NASA stated that increased cost estimates for the current station design exceed the reserves for the next 3 years (1993-1995). NASA stated further that there is a very significant risk for additional cost growth in fiscal year 1996 and beyond without immediate and specific management action across the program. The full extent of the cost overruns are still being assessed, however, based on what is known to date, program officials have increased the program cost estimate and extended its schedule. NASA officials told us in May 1993 that part of these program adjustments included restoring an average financial reserve of about 19 percent to the overall program estimates through 2000.

We examined NASA's latest program estimates and are concerned that NASA may not be able to maintain its current financial reserve estimates without further reductions in program content. In our opinion, the future reserve margins planned after fiscal year 1995 would not likely be available since they are contingent on much larger annual space station budgets than have been appropriated to date. Specifically, NASA's 19 percent reserve estimate is based on anticipated station development and operations appropriations of $2.3 billion in fiscal year 1994, and $2.4 billion, $2.7 billion, $2.6 billion, and $2.5 billion in fiscal years 1995 through 1998, respectively. To the extent that NASA's planned space station budgets are not fully funded, reserve margins would not be maintained. As reserve margins continue to be inadequate, the space station program will perpetuate its cycle of reducing program content, delaying its schedule, and/or increasing its cost estimate.

[5]Space Station: Status of Financial Reserves (GAO/NSIAD-92-279, July 20, 1992).

Agency Comments and Our Evaluation

As requested, we did not obtain written comments on this report, but we obtained the views of responsible NASA officials and considered them in preparing this report. Some of NASA's comments regarding our display of space station cost estimates have been addressed in prior reports. These comments are summarized below.

NASA has objected to our including in the space station estimate the additional appropriations required to support development of an assured crew return vehicle, centrifuge facility, and science experiments and the allocation of additional shuttle costs. We have included NASA's arguments in prior reports and its position has not changed. In responding to our September 1992 report, (GAO/NSIAD-92-278), NASA took exception to including the estimated development cost of an assured crew return vehicle because less costly alternatives are being considered. NASA also claimed the inclusion of the centrifuge facility and science experiments was inappropriate because, in its opinion, they were analogous to cargo being flown on a cargo plane. We believe that until a decision is made on the developmental approach for the assured crew return vehicle, the estimate currently available should stand. Also, we disagree with NASA's cargo analogy. Since the centrifuge facility and the science experiments are being designed to meet the unique engineering requirements of the space station, they should be considered as part of that spacecraft's cost.

NASA also objects to allocating the average shuttle flight cost to the space station program. These objections were set out in NASA's response to our recommendation that it allocate this cost during the period that the space station is the predominant user of shuttle capabilities.[6] NASA's view was that most of the elements of the average cost per flight were fixed in that NASA is committed to six to eight shuttle flights annually through at least 2005, even if there is no space station program.

NASA's practice is to allocate only the marginal cost of a shuttle flight to the space station program, that is, those additional costs, such as fuel and other consumables, that are incurred or avoided when a flight is added to or deleted from the shuttle program. While this practice is appropriate for incremental changes to the flight manifest, it is not appropriate with regard to the space station.

NASA claims it will fly the shuttle with or without the space station, but this is based on the premise that only NASA and the administration make

[6]Space Transportation: The Content and Uses of Shuttle Cost Estimates (GAO/NSIAD-93-115, Jan. 1993).

resource allocation decisions for NASA programs. If this were true, then shuttle costs could be viewed as substantially independent of the space station program. However, we believe the role of the Congress needs to be recognized and that sound congressional decision-making is best served by analyses recognizing that the duration and content of the shuttle program would become an open issue if the space station were abandoned. NASA's "fixed" costs are most certainly subject to congressional review and any significant flight rate reduction could reduce resource requirements and, ultimately, some of those costs.

NASA should also not use marginal cost exclusively during the time the shuttle is substantially dedicated to the space station because such heavy, prolonged use imposes an opportunity cost; that is, other uses of the shuttle must be foregone, or at least deferred. From this perspective, while it is entirely possible that even the average cost per flight may understate the decision-relevant cost of a shuttle flight, the average cost is still a more appropriate measure than the marginal cost.

Scope and Methodology

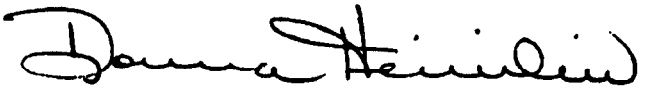
To update our prior work, we interviewed space station program officials at NASA headquarters and reviewed program planning and budgeting documents in support of NASA's fiscal year 1994 budget request. We also reviewed recent testimony by NASA officials and work conducted by the Congressional Research Service. The information provided in this report is based on NASA estimates, and we did not verify those estimates. The Administrator of NASA has commissioned an in-house cost assessment to determine the validity of the present cost and schedule of the program. The results of this assessment are not yet available.

We conducted our review from March to May 1993 in accordance with generally accepted government auditing standards.

Information on the total cost of the space station program is also being reported to Senator John Warner at his request. We are sending copies of this report to the Administrator, NASA; appropriate congressional committees; and other interested parties upon request.

If you or your staff have any questions, I can be reached at (202) 512-8412. The major contributors to this report were David R. Warren, Associate Director; Frank Degnan, Assistant Director; and William W. Crocker, Evaluator-in-Charge.

Sincerely yours,



Donna M. Heivilin, Director
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