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BY THE COMPTROLLER GENERAL

# Report To The Congress

OF THE UNITED STATES

## NASA Should Provide The Congress Complete Cost Information On The Space Telescope Program

NASA's space telescope will be the largest, most complex space observatory ever developed. Life-cycle costs--\$530 million in development costs, including \$296 million for project reserves, and \$600 million in operations costs to the year 2000--total an estimated \$1.1 billion.

Excluded from the life-cycle estimate were civil service salaries, studies and support costs, and inflation. Had they been included, the total would have been about \$2.2 billion.

NASA's semiannual Space Telescope Project Status Report should fully disclose the amount and use of reserves in the program estimate and include all applicable program costs. The Congress would then be in a more informed position to determine the program's progress and outlook.



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COMPTROLLER GENERAL OF THE UNITED STATES

WASHINGTON, D.C. 20548

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To the President of the Senate and the  
Speaker of the House of Representatives

This is our third report on the National Aeronautics and Space Administration's Space Telescope Program. It describes the levels of management reserves in the program's cost estimate and discusses why the National Aeronautics and Space Administration should provide more complete cost data to the Congress. *Approved*

This review was made as a part of our continuing effort to apprise the Congress of the status of major system acquisitions and to assist it in exercising its legislative and review functions. A copy of this report was reviewed by agency officials responsible for the management of the project, and their comments are incorporated as appropriate.

We are sending copies of this report to the Director, Office of Management and Budget, and to the Administrator, National Aeronautics and Space Administration.

A handwritten signature in cursive script, reading "James A. Heath".

Comptroller General  
of the United States

D I G E S T

In 1983, the National Aeronautics and Space Administration (NASA) will launch the space telescope aboard the space shuttle into orbit where, unhindered by atmospheric distortion and absorption, it will see objects 7 to 10 times better than the largest telescope on Earth and over a wavelength reaching far into the ultraviolet and infrared portions of the spectrum. It is expected to operate until at least the year 2000.

Currently the high-priority program is on schedule and within its budget, and it appears that all the telescope's scientific instruments will meet or exceed the established performance requirements. Current delays in the Shuttle Program, according to NASA officials, are not of sufficient magnitude to delay the telescope launch.

NASA should provide the Congress with better financial information on the project, including information on program reserves, contract costs, and more accurate development and life-cycle cost estimates.

NASA's comments have been included in the report where appropriate and are contained in their entirety as appendix II.

PROJECT RESERVES AND CONTRACT  
COSTS NOT DISCLOSED

Although NASA's July 1979 Space Telescope Project Status Report lists the development cost estimate as \$530 million, it does not show that \$296 million of that amount consists of project reserves. Nor, does it show contract cost growth information.

NASA officials strongly oppose publishing detailed financial data in such quasi-public documents as the project status reports that,

in their opinion, would prejudice the Government's negotiating position. They recommended that GAO omit explicit data on reserves from this report. (See p. 9.)

GAO understands NASA's reluctance to disclose project reserves and Government estimates of runout costs on individual contracts. However, negotiated contract prices, contract changes, and total project reserves can be reported without prejudicing the interests of the Government.

#### DEVELOPMENT COSTS UNDERSTATED

NASA's \$530 million development cost estimate should be increased to include \$104 million for civil service salaries, \$32 million for early study effort and support costs, and any provisions for future inflation. For example, at an annual inflation rate of 7 percent, the telescope's development cost would be increased by \$50 million. These additional costs will bring the total development cost to \$716 million.

NASA officials have said civil service salaries were excluded because these costs are considered to be relatively fixed and not usually sensitive to the impact of any one project on the NASA budget.

They also excluded \$5 million for very early study efforts from the development estimate and the project status report because these costs were incurred prior to congressional approval of the project. The remaining \$27 million for additional studies and tracking and data acquisition was also excluded from the development estimate but reported as supporting costs.

Inflation is excluded because of the uncertainty involved in forecasting it. In commenting on this report, NASA officials said the Office of Management and Budget and the Congress understand that the Space Telescope Project budget estimates are being handled in current budget year dollars. (See pp. 12 and 13.)

LIFE-CYCLE COSTS UNREPORTED  
AND UNDERSTATED

Life-cycle costs, those incurred in the development and operation of a system over its useful life, also should be included in the project status report. Although NASA has made a life-cycle cost estimate for the Telescope Program, the project status report includes only the development costs. The report would give the Congress more perspective if life-cycle costs were shown.

NASA's May 1979 life-cycle cost estimate of over \$1.1 billion included the \$530 million development cost and an estimated \$600 million for telescope operations.

As with the development estimate, NASA does not include all costs in the operations cost estimate. Civil service salary costs to support the Telescope Program may amount to \$168 million. If inflation continues, for example, at a 7-percent rate, another \$705 million will be incurred. Thus, the total operations costs could amount to almost \$1.5 billion, which added to the development costs of \$716 million, gives a life-cycle cost estimate of almost \$2.2 billion. (See p. 14.)

NASA officials oppose expanding the project status reports to include cost elements over which the Project Manager has little or no control. However, all costs, variable and fixed, have an impact on the NASA budget. Furthermore, the inclusion of these costs as a part of the space telescope's total cost is in accordance with the intent of the Office of Management and Budget's Circular A-109. GAO believes they should be identified and reported as a part of the life-cycle estimate in the project status report to give the Congress as complete and accurate an estimate as possible.

CONCLUSIONS

Although NASA officials are reluctant to include more than the development cost estimate on the project status report for the Telescope Program, the Congress should have complete

information on the amount and use of all program funds in order to make informed judgments on the program's future. To this end, the Space Telescope Project Status Report should show reserve funds and contract cost data and identify all development and operational costs in the estimates, including civil service salaries and early study efforts. Further, the Congress should be made aware that, because of inflation, funds needed for dealing with future budgets and appropriations may be considerably more than the estimates presented.

#### RECOMMENDATIONS

GAO recommends that the NASA Administrator make sure that future project status reports on the space telescope include

- the amount of reserve funds in the initial project cost estimate presented to the Congress (see p. 11),
- the current amount of reserve funds and an explanation of the variance (see p. 11),
- the initial negotiated and current contract prices and an explanation of the variance (see p. 11),
- total project development costs which include civil service salaries and early study efforts (see p. 15),
- cost estimates in budget-year dollars with projections of total development costs at different inflation rates (see p. 15), and
- an estimate of life-cycle costs with projections of these costs at different inflation rates. (See p. 15.)

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ABBREVIATIONS

GAO General Accounting Office

NASA National Aeronautics and Space Administration

PSR project status report



## CHAPTER 1

### INTRODUCTION

The space telescope, approved for development by the Congress in July 1977, will be the largest, most complex space observatory ever developed by the National Aeronautics and Space Administration (NASA). It will see objects 7 to 10 times better than the largest telescope on Earth and over a wavelength reaching far into the ultraviolet and infrared portions of the spectrum. As such, the telescope has been given a high priority. Scheduled for launch aboard the shuttle in December 1983, it is expected to be operational through the year 2000. According to NASA officials, current delays in the Shuttle Program are not of sufficient magnitude to delay the telescope launch, the time of which is not critical to the success of the mission.

This report contains the results of our third review 1/ of the Telescope Program and information on the program's cost, schedule, and performance status. Currently it is on schedule and within its budget, and it appears that all the telescope's scientific instruments will meet or exceed the established performance requirements. However, this report emphasizes the need for improved reporting of reserve funds and complete costs to the Congress.

### PROGRAM DESCRIPTION

The program includes the design, development, production, integration, launch, orbital verification, and preparation for mission operation of an astronomical observatory. The telescope's configuration is pictured on page 2.

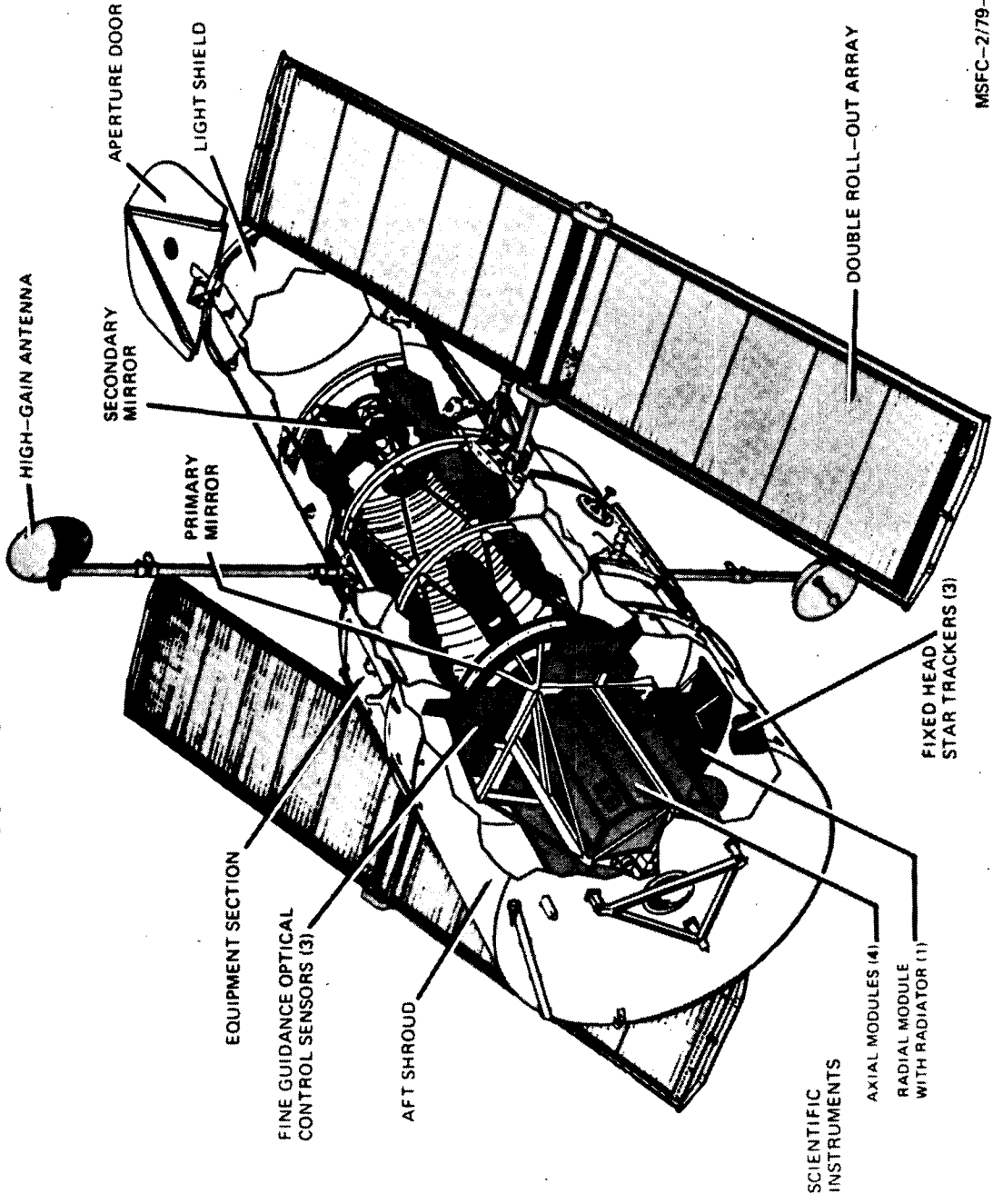
The telescope will be launched from the Kennedy Space Center on a shuttle and put in a circular orbit about 270 nautical miles above the Earth. A control center will send operational commands to the spacecraft, monitor the status of its systems, determine failures, and identify degraded systems.

The shuttle is to rendezvous with the telescope when necessary for limited maintenance and servicing. When major maintenance or refurbishment is needed to extend its life and upgrade its scientific capability, the shuttle will return the telescope to Earth.

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1/Prior GAO reports: "Space Telescope Project" (PSAD-76-66, Jan. 1976) and "Status and Issues Pertaining to the Proposed Development of the Space Telescope Project" (PSAD-77-98, May 1977).

# SPACE TELESCOPE CONFIGURATION



## PROGRAM OBJECTIVES

The primary objective of the program is to develop and operate a large optical space telescope system which will be useful to the international scientific community while significantly extending our knowledge of the universe. The specific scientific objectives are to develop a better understanding of the universe's (1) origin and evolution, (2) physical aspects, and (3) stars and galaxies, including the nature and behavior of materials and fields between them. Details on the mission and technical characteristics of the telescope are contained in the July 1979 NASA Space Telescope Project Status Report (PSR). (See app. I.)

## NASA MANAGEMENT RESPONSIBILITY

NASA's Office of Space Science is responsible for the overall management of the program, such as establishing policy and technical requirements, approving plans, determining goals and objectives, and allocating funds. The Marshall Space Flight Center, NASA's lead center for the program, is responsible for implementing the program and meeting cost, schedule, and performance goals. The Goddard Space Flight Center is responsible for developing four scientific instruments and performing mission and data operations. The Johnson Space Center is responsible for shuttle and telescope interface, and the Kennedy Space Center is responsible for launch operations. NASA's Office of Tracking and Data Acquisition will be responsible for providing tracking and data acquisition support. The European Space Agency is responsible for providing the solar array, one scientific instrument, and the equivalent of one shift of personnel for performing mission and data operations.

NASA plans to establish the Space Telescope Science Institute as the science operations element of the program which will provide services to a wide spectrum of the scientific community, including Government scientists. The Institute will have a staff of scientists and will be operated by a consortium of universities or contractors. NASA, which will fund the Institute, will select a contractor by July 1980.

## PRINCIPAL CONTRACTORS AND INVESTIGATORS

Development of the primary elements of the telescope is well underway. A contract was awarded in October 1977 to the Lockheed Missile and Space Company for the design and development of the support systems' module and for overall telescope systems' engineering integration. During the same month, a contract was awarded to the Perkin-Elmer Corporation

for the design and development of the optical telescope assembly. As of June 28, 1979, the Lockheed contract totaled \$104.2 million, and the Perkin-Elmer contract totaled \$69.3 million. Five principal investigators have also been selected to develop instruments for the telescope's initial operations.

#### SCOPE OF REVIEW

We reviewed program plans, status reports, correspondence, and other documents prepared by NASA, its contractors, and other organizations. We also discussed various aspects of the program with NASA; the Space Science Board, National Academy of Sciences; and National Science Foundation officials.

## CHAPTER 2

### NASA SHOULD PROVIDE INFORMATION ON

#### PROGRAM RESERVES AND CONTRACT COSTS TO THE CONGRESS

The telescope is in its third year of development, and its status has been included semiannually in a PSR since January 1978. The PSR's purpose is to inform the Congress on cost, schedule, and technical aspects of the program. NASA needs to include additional information on program reserves and contract cost data in its Space Telescope PSR.

The PSR system was started in October 1975 at the request of the chairman of the HUD-Independent Agencies Subcommittee of the Senate Appropriations Committee. He viewed the PSR as a forerunner of a reporting system that can provide complete information on NASA projects. The Space Telescope PSR should disclose the \$296 million of reserves included in the \$530 million project cost estimate and report on the use of these reserve funds.

Including program reserve and contract cost data in the PSR would provide the Congress with early indications of possible or probable program cost overruns, such as those recently experienced in the Space Shuttle Program.

#### PROJECT RESERVES OF \$296 MILLION NOT DISCLOSED

The many unknowns in research work, coupled with development periods of several years, make it impossible to accurately estimate at the start of a project what the final costs will be. Accordingly, when making up project budget estimates, NASA officials include amounts for reserves to cover such things as technical uncertainties and potential changes. The amount of reserves that are included in a project's budget varies with the number and nature of uncertainties involved. NASA is not required to and normally does not inform the Congress of the amount of reserve funds included in project cost estimates or how the funds are subsequently used.

As shown in appendix I, NASA's July 1979 PSR listed the development cost estimate for the telescope as \$530 million. However, it does not show that more than half (\$296.2 million) of that amount consists of project reserves. Further, it does not show contract cost growth information.

We explain NASA's \$530 million development cost estimate for the telescope in the following schedule. NASA submitted a \$500 million development cost estimate to the Congress in

February 1978. NASA has increased the estimate to \$530 million solely because of inflation. The reserves and other cost data in the schedule are also escalated to fiscal year 1980 dollars. These figures have since changed and will continue to change as reserves are used and contracts modified.

February 1978 Telescope Cost Estimate

		(millions in fiscal year 1980 dollars)
Base contracts, proposals, and firm requirements		<u>a/\$229.9</u>
Reserves:		296.2
Contractor management reserves	a/\$ 9.9	
Project Office potential additions	104.9	
Project Office reserves	91.3	
NASA Headquarters Program Office reserves	50.7	
Administrator's reserves (range)	39.4	
Headquarters contract administration		<u>3.9</u>
Total		<u><u>\$530.0</u></u>

a/The Telescope Project Office reported a figure of \$239.8 million, which includes \$9.9 million for contractor management reserves. For purposes of this schedule, we have reduced the base contracts figure by this amount and included it under reserves.

Contractor management reserves

The provision for reserves in NASA's cost estimate begins at the contractor level. NASA negotiated contracts for the support system module and optical telescope assembly elements that included \$9.9 million for contractor management reserves. This gives the contractor some flexibility in providing for increasing costs if the work proves more difficult and time consuming than initially estimated.

Project Office potential additions

As shown above, the total amount for the negotiated contracts, firm proposals, and requirements for all elements was \$239.8 million (including the \$9.9 million contractor management reserves). However, NASA's estimated development cost for these same elements was \$344.7 million, providing a reserve of \$104.9 million for potential additions to the contracts. NASA officials do not consider this a "pure reserve." Based on

management experience and judgment, project officials identify and list potential additions to each major element of a contractor's proposal. The degree of certainty for these additions varies and therefore the list does not remain static. For example, some items do not materialize and are deleted, while others not previously identified are added and funded.

#### Project Office reserves

In addition to the above reserves for potential additions, the Project Office added \$91.3 million to the development estimate for technical uncertainties which cannot specifically be identified, but the magnitude of which officials are certain will occur. Project officials could not provide documentation supporting this amount, but said it was based on the Project Office staff's engineering and management experience and judgment.

#### NASA Headquarters Program Office reserves

Project-level estimates are subject to additional review and adjustment by NASA Headquarters, and the provision for reserves begins to pyramid. For the Telescope Program, the NASA Headquarters Program Office developed estimates for additional uncertainties, which added \$50.7 million to the development estimate. The headquarters reserve is normally included to cover major scope changes, additional engineering development, and any program stretchout due to NASA budget constraints.

#### NASA Administrator's reserves

Finally, the program estimate was stated in terms of a range to reflect future uncertainties. The lower end of the range is usually just a little below the program's specific dollar estimate, and the upper end is determined by top-level management at a figure within which the NASA Administrator has some confidence that the project can be completed. In the case of the telescope, the difference between the specific dollar estimate of \$490.6 million and the upper limit of the range was \$39.4 million.

#### CONTRACT COSTS NOT REPORTED TO THE CONGRESS

At the time NASA submitted its February 1978 development estimate to the Congress, it had negotiated contracts for the primary elements of the telescope and had obtained firm proposals for the science instruments. NASA had also identified certain firm requirements for program support and

the institutional management systems. The cost of these elements amounted to \$239.8 million, or about 45 percent of the \$530 million estimate submitted to the Congress.

NASA officials do not routinely provide the Congress with the data on contract costs unless it causes NASA's total project estimate to increase. The telescope contracts and firm requirements could more than double in this case before the Government's development estimate is exceeded and before NASA reports cost growth to the Congress. By being informed of initial contract amounts and up-to-date changes, the Congress would have a better perspective on the need for and use of reserve funds. It is to be noted that the Department of Defense submits periodic project reports to the Congress that show initial and current contract costs. These reports have been beneficial to appropriate committees in monitoring the progress of Defense projects.

#### NASA RELUCTANT TO DISCLOSE RESERVES AND CONTRACT COSTS

NASA's reluctance to report project reserves and contract cost data is illustrated by the following examples.

The NASA Comptroller, when testifying in 1978 before a Subcommittee of the House Committee on Appropriations, said:

"It has been the experience, at least my experience in DOD [Department of Defense] and elsewhere, that if one ever identified any contingency as such, that was the first thing that came out of a project."

Testifying before a Senate subcommittee, a former NASA Administrator, in response to a question on reserves contained in the space shuttle cost estimate, said that to properly manage the Shuttle Program, NASA tries to keep the amount of reserves reasonably confidential because if the contractors were to find out what the reserves are they might tend to want to spend them.

In response to one of our previous reports, <sup>1/</sup> NASA officials said that disclosure of estimated project contingency requirements in documents readily available to contractors would weaken the Government's negotiating position. More specifically, in regard to providing detailed contractor data in PSRs, a NASA official said:

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<sup>1/</sup>"National Aeronautics and Space Administration Should Provide the Congress with More Information on the Pioneer Venus Project" (PSAD-77-65, Nov. 7, 1977).



"\* \* \* estimates of run-out costs of individual contracts must be protected from public disclosure to (1) avoid prejudicing the Government in future negotiations with the contractors and (2) avoid the disclosure of data which would permit contractors to predicate their claims on NASA's estimates of projected costs."

The official further stated that it would not be appropriate to provide detailed information on contract cost changes because:

"\* \* \* in the case of research and development procurement, the project is subject to considerable change during its lifetime. The initial contract price is subject to later amendments as more knowledge is acquired about the research and development program. Current contract target and ceiling prices are subject to readjustment. The contractor's estimated price at completion will change as the scope of work is impacted by development events.

"The key to project cost administration lies in the government's ability to provide properly for anticipated changes and to administer the project so that total project cost is controlled. The PSR should focus on this total, not the partial picture represented by contract price at any one time."

#### AGENCY COMMENTS AND OUR EVALUATION

In commenting on this report (see app. II), NASA officials restate their position that they are particularly opposed to publishing in quasi-public documents, such as PSRs, detailed financial data which would prejudice the Government's negotiating position with contractors. However, NASA officials do not object to furnishing such data on a restricted individual basis to interested Members of Congress. In addition, NASA officials stated that raw contract cost estimates could be easily misinterpreted and may not represent the total project estimate as do the project estimates now shown in the PSR.

NASA officials also strongly recommended that explicit data on Space Telescope Project reserves be omitted from this report. They believe that published data on reserves could mislead the reader and also be counterproductive to NASA's efforts to manage project costs. Furthermore, they stated that we treat the term reserves in a simplistic manner, lumping several categories of requirements under that heading and implying that there may be no need of funds. NASA stated:

"The most glaring example is the figure (35 percent of the GAO stated total reserves) for Project Office potential additions [\$104.9 million]. Much of the amount budgeted in this category was for known, discrete requirements, whose definition and magnitude were not precise enough at the time for inclusion in the basic contracts. Included were such items as neutral buoyancy hardware and testing, onboard safing, ST software requirements, thermal isolation of Scientific Instruments, transportation, etc. It is simply inaccurate and misleading to identify as reserves the estimates for such requirements."

The \$104.9 million figure was taken directly from a Marshall Space Flight Center program operating plan and clearly labeled "potential additions." With respect to known requirements, these were identified separately on the program operating plan and we were careful not to include them in our reserve total.

NASA believes the establishment and proper use of contingency estimates represent a prudent management technique to achieve the objectives of highly complex research and development projects, such as the space telescope, on plan and within the cost estimates.

We agree that the key to cost administration lies in the Government's ability to provide adequately for anticipated changes and to administer the project so that the total cost is controlled. As early as 1973, 1/ we reported that NASA needed to give increased emphasis to providing for uncertainties in cost estimates.

Since we did not evaluate how NASA developed the telescope cost estimate, we are neither supporting nor questioning NASA's need for \$296.2 million of reserves in the development cost estimate. Our position is that whatever the reserve level, the Congress should have complete information on the amount and use of these funds. Providing this information only to individual interested Members of Congress will not provide total visibility.

Regarding NASA's reluctance to disclose project reserves, or Government estimates of runout costs on individual contracts, we believe NASA can report negotiated contract prices,

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1/May 30, 1973, letter to the Associate Administrator, Office of Organization and Management, NASA.

contract changes, and total project reserves to the Congress without prejudicing the interests of the Government. The reasons NASA officials gave for not reporting contract cost data in the PSR--the fact that (1) the telescope project is subject to considerable change over its lifetime, (2) the initial contract prices are subject to later amendments as more knowledge is acquired, (3) contract target and ceiling prices are subject to readjustment, and (4) the contractors' estimated prices at completion will change as the scope of work is affected by subsequent events--all appear valid reasons why the Congress should be provided contract cost data.

In summary, we believe that providing reserve fund and contract cost data in the PSR will give the Congress a better understanding of the reasons for project changes.

#### CONCLUSIONS AND RECOMMENDATION

Establishing and properly using reserves are prudent techniques in managing research and development projects. Cost estimates, if they are to be realistic, must provide for uncertainties. NASA officials normally do not disclose project reserves because of concern that these funds might be eliminated from the project. They are also concerned about reporting Government estimates of runout costs on individual contracts and providing contractor cost data in PSRs.

In our opinion, the information needs of the Congress override NASA's concerns. The Congress would be in a more informed position to approve programs and to determine if a program should be continued, modified, or discontinued if NASA provided contract cost data and the status of reserve funds in its semiannual PSRs.

Accordingly, we recommend that the NASA Administrator modify future Space Telescope PSRs to include

- the amount of reserve funds included in the initial project cost estimate presented to the Congress,
- the current amount of reserve funds and an explanation of the variance, and
- the initial negotiated and current contract prices and an explanation of the variance.

## CHAPTER 3

### NASA SHOULD PROVIDE MORE ACCURATE DEVELOPMENT AND LIFE-CYCLE COSTS TO THE CONGRESS

NASA estimates that the life-cycle cost of the space telescope will be over \$1.1 billion. This combines the development estimate of \$530 million with the telescope's projected 17 years of operational costs of \$600 million. However, NASA has excluded \$186 million from its development estimate and \$873 million from its operations cost estimate for civil service salaries, projected inflation, and early study effort and support costs. Including these additional costs would increase the life-cycle estimate to almost \$2.2 billion. The Space Telescope PSR provides a ready vehicle to furnish the Congress with this type of information.

#### DEVELOPMENT COSTS UNDERSTATED

NASA's \$530 million estimate for telescope development should include civil service salaries of \$104 million, inflation costs of \$50 million, and early study effort and support costs of \$32 million. These costs total \$186 million. Adding these costs to the program would bring the development cost estimate to \$716 million.

#### Civil service salaries

NASA officials do not include in the development cost estimate the cost of civil service personnel working on the program. They take the position that these costs are relatively fixed and usually are not sensitive to the impact of any one project on the NASA budget. NASA officials say the bulk of such costs are involved in achieving and maintaining a capability which changes over time in response to policy decisions regarding the level of space and aeronautical research and development, rather than in response to specific project requirements.

All costs, variable and fixed, have an impact on the NASA budget, and those which are incurred to support telescope development, including salaries, should be charged to the program. Our position is consistent with the intent of the Office of Management and Budget's Circular A-109, Major System Acquisitions, which requires that life-cycle cost estimates cover all phases of the acquisition process. This provides a means of assessing cost, schedule, and performance experience against predictions and provides information to evaluation officials for consideration at key decision points. The circular defines life-cycle cost as:

"\* \* \* the sum total of all direct, indirect, recurring, nonrecurring, and other related costs incurred, or estimated to be incurred, in the design, development, production, operation, maintenance, and support of a major system over its anticipated useful life span."

### Inflation

According to NASA, it does not include estimates for future inflation in its telescope development budget because the estimates would be of doubtful value in view of the great uncertainty involved in forecasting inflation. NASA also said that the Office of Management and Budget and the Congress understand that the Space Telescope Project budget estimates are being handled in current budget-year dollars. However, in response to a congressional request, NASA escalated its life-cycle cost estimate which included a \$50 million increase in development costs using a projected inflation rate of 7 percent. Although estimating the future rate of inflation is speculative and does not provide any guarantee of actual costs to be incurred, the Congress should be aware that funds needed for dealing with future budgets and appropriations may be considerably more than the estimates presented.

### Early study effort and support costs

Excluded from the \$530 million is \$19 million of early study effort and additional support costs of \$13 million for tracking and data acquisition and facilities. Early studies (1965-73) applicable to the telescope totaled \$5 million. These costs were excluded because they were incurred prior to congressional approval of the project. The Congress appropriated \$14 million specifically for telescope studies during the 1973-76 period. This \$14 million and the \$13 million for tracking and data acquisition and facilities are shown under support costs in NASA's Space Telescope PSR. (See p. 22.)

In commenting on our report draft, NASA officials said they are opposed to expanding the PSRs to include indirect and pro rata estimates of NASA cost elements over which the Project Manager has little or no control. They point out that these cost elements, which are relatively fixed, are based on NASA-wide management decisions and budget determinations. Regardless of who in NASA has control of these funds, these costs are a part of the space telescope's total cost. We therefore believe these costs should be identified in the PSR to give the Congress as complete and as accurate an estimate as possible at the time NASA seeks congressional approval.

NASA officials said that "\* \* \* the Development Estimate, as defined by NASA and previously concurred in by the GAO, is the most appropriate estimate to use in the PSR." Our Office has not concurred with NASA's position. In our opinion, the estimate NASA provides the Congress when requesting program approval should include all costs as discussed above. These costs should be reported in the PSR as the basis for measuring program progress.

#### LIFE-CYCLE COSTS UNREPORTED AND UNDERSTATED

Life-cycle costs include those incurred in the development and operation of a system over its useful life. Although NASA has made a life-cycle cost estimate for the Telescope Program, only the development costs are reported in the Space Telescope PSR. The PSR would give the Congress more perspective if life-cycle costs were shown. This is of particular importance for the space telescope and similar programs because operating costs will impact NASA's budget for many years after development.

NASA's May 1979 life-cycle cost estimate of over \$1.1 billion included the \$530 million development cost and an estimated \$600 million for telescope operations. As with the development estimate, NASA does not include all costs in its \$600 million operations estimate. Civil service salary costs to support the telescope are estimated at \$168 million. In addition, inflation, if projected at a 7-percent rate, would add another \$705 million to the estimated cost. Thus, the total operations costs could amount to over \$1.4 billion, which, added to our \$716 million development estimate, gives a life-cycle cost estimate of almost \$2.2 billion. NASA officials' reasoning for excluding these costs and our evaluation of their reasoning are discussed previously under development costs.

#### CONCLUSIONS AND RECOMMENDATION

The Space Telescope PSR would be more useful to the Congress if the project's total costs are identified and included in the cost estimate. Telescope development costs could easily amount to \$716 million rather than the \$530 million estimate that NASA reported to the Congress.

In order to make more informed decisions on whether to fund new projects and to evaluate the progress of ongoing projects, the Congress should be aware of the life-cycle costs involved. NASA's PSR provides a ready vehicle to furnish the Congress with this type of information.

In order to provide the Congress better information for tracking the costs of the telescope, we recommend that the NASA Administrator make sure that future PSRs on the space telescope include

- total project development costs which include civil service salaries and early study efforts,
- cost estimates in budget-year dollars with projections of total development costs at different inflation rates, and
- an estimate of life-cycle costs with projections of these costs at different inflation rates.

## National Aeronautics and Space Administration

SPACE TELESCOPE  
PROJECT STATUS REPORT

- A. 1. Dates  
a. As of date: June 30, 1979  
b. Submission date: July 31, 1979
2. Designation: Space Telescope
3. Nomenclature: Space Telescope
4. Popular Name: ST
5. Mission and Description:  
The Astrophysics Program is directed primarily toward the expansion of our knowledge of the Earth's space environment, the stars and the more distant celestial bodies. This activity is in furtherance of a broad objective of the agency: to study the nature and evolution of the universe. The Space Telescope (ST) will result in a significant increase in our understanding of the universe (past, present, and future) through observations of celestial objects and events.

The ST Program is conceived as a long-term program in space astronomy that will provide mankind with an astronomical capability not achievable by any current or foreseeable ground-based telescope. Earthbound telescopes have limited resolution because of the blurring effect caused by turbulence and light scattering in the Earth's atmosphere. Also, the wavelength region observable from the Earth's surface is limited by the atmosphere to the visible part of the spectrum. Unlike groundbased telescopes, the 2.4-meter ST will possess and can effectively utilize an optical quality of such precision that its resolving power is limited only by the diffraction limit of the optics. The ST will be taken into Earth orbit by the Space Shuttle and, from there, unhindered by atmospheric distortion and absorption, it will see objects with a resolution about 7-10 times better than that obtainable even with the large telescopes on Earth and over a wavelength region which reaches far into the



ultraviolet and infrared portions of the spectrum. Objects at seven billion light years, for example, will be seen with the ST with as much detail as objects at one billion light years can be seen with the best Earthbound telescopes.

Like ground-based telescopes, the ST will be designed as a general-purpose instrument, capable of utilizing a wide variety of scientific instruments at its focal plane. This multi-purpose characteristic will allow the ST to be effectively used as a national facility, capable of supporting the astronomical needs of an international user community. Up to five scientific instruments will be accommodated at the focal plane.

The ST will differ from existing automated satellites in that it will be designed to permit on-orbit maintenance and repair by a space-suited astronaut and be retrievable by the Space Shuttle for return to Earth for refurbishment and subsequent relaunch. A feature of the design will be the provision for replacement of any of the focal-plane scientific instruments at the time of on-orbit visits or during ground refurbishment. This will allow updating of the instrumentation and the use of the ST to fulfill a broad range of scientific requirements over its lifetime, which is expected to exceed a decade. The on-orbit visits and/or refurbishments are nominally scheduled for 30-month intervals; however, the exact timing will depend on the operating efficiency and scientific program of the ST.

The ST Project includes the design, development, production, integration, launch, orbital verification, and preparation for mission operations of an unmanned astronomical observatory consisting of an Optical Telescope Assembly (OTA), Scientific Instruments (SI's), Support Systems Module (SSM), and certain unique equipment and procedures needed to test, handle, launch and support on-orbit operations.

6. Prime Contractor:

No Prime Contractor--the following are principal associate contractors:

Lockheed Missiles and Space Company - responsible for design and development of the Support Systems Module (SSM) and overall ST Systems Engineering and Integration

Perkin-Elmer Corporation - responsible for design and development of the Optical Telescope Assembly (OTA)

7. NASA Components:

Overall Program Management  
Office of Space Science  
Astrophysics Division

Overall Project Management  
Marshall Space Flight Center (MSFC)

Mission Operations and Scientific Instruments  
Goddard Space Flight Center (GSFC)

Space Shuttle Management Center  
Johnson Space Center (JSC)

Launch Operations  
Kennedy Space Center (KSC)

8. Other Governmental and International Components

High Resolution Spectrometer  
GSFC

Observatory Solar Arrays and Faint Object Camera  
European Space Agency (ESA)

B. Current Summary:1. Program Progress, Problems and Pending Decisions:

The ST is progressing well toward a scheduled launch in December 1983. The principal activities of the project during FY 1978 and 1979 focused on the preliminary design of the three major spacecraft elements; the Scientific Instruments (SI's), the Optical Telescope Assembly (OTA), and the Support Systems Module (SSM). The Preliminary Design Reviews (PDR's) of the five SI's (four American and one European) were completed in January 1979. The OTA PDR was completed in April 1979, with the SSM PDR

scheduled for July 1979. Final design of the SI's OTA, and SSM will continue until the Critical Design Reviews (CDR's) are completed in FY 1980. Most fabrication activities will begin following these CDR's.

Confirmation of the Investigation Definition Teams (IDT's) which are involved in the development of the SI's was accomplished in May 1979. A contract to design, develop and deliver an SI Command & Data Handling (C&DH) system and to conduct the instruments acceptance test program was awarded in March 1979 to the IBM Federal Systems Division, Gaithersburg, Md. The PRR will be conducted in July 1979. The PDR is scheduled for December 1979 and the CDR in mid 1980. SI C&DH simulators will be provided to the PI's in 1980 to permit early verification of hardware and software interfaces.

Normally, fabrication of flight hardware does not start until after a PDR. However, due to the long lead times associated with large optics fabrication, an early procurement of the flight primary mirror blanks was initiated after the OTA contract award in October 1977. The first mirror blank has been successfully fabricated by Corning Glass and shipped to the OTA contractor, Perkin-Elmer Corporation, for grinding and polishing. Polishing of the mirror, which will be performed by a new computer-controlled polishing machine has been demonstrated by Perkin-Elmer by polishing a 60-inch flexible mirror to the desired ST specifications. Polishing of the flight primary mirror is scheduled to begin in January 1980. A second backup flight primary mirror was fabricated and delivered to Eastman Kodak in June 1979, where it will be polished using traditional techniques.

The ST is planned for operation for more than a decade with attendant in-orbit maintenance; recovery, refurbishment, and relaunch; and update of the focal plane SI's. During the operational period, the ST will be used the majority of the time by "general observers" who will be selected on the basis of proposals submitted in response to periodic solicitations. In developing observing schedules for the Telescope, the requirements of these observers will be integrated with those of investigators who are involved with development of specific focal plane instruments. The ST operations, including the investigation selection, scheduling, maintenance, refurbishment, etc., can be viewed as quite analogous to the operations of a large, ground-based telescope.

An important consideration with respect to the science operations for the Telescope has been the question of whether or not a Space Telescope Science Institute will be established. After studying this question at considerable length, using inputs from both in-house and external study groups, it was decided that

the most efficient and scientifically-satisfactory approach to science operations will involve the establishment of a Space Telescope Science Institute which will be operated under a long-term contract, with NASA retaining operational responsibilities for the spacecraft/observatory. Current plans call for the release, in early FY 1980, of a Request for Proposals for the operation of the Institute. The Institute will be built up slowly to full strength prior to launch of the Telescope in the last quarter of 1983.

The European Space Agency (ESA), in addition to providing one of the focal plane instruments and the solar array for the observatory, will provide a number of the personnel who will staff the science operations activity. ST Project personnel are currently working with ESA on the detailed implementation of their participation.

C. Mission/Technical Characteristics

	<u>Development Estimate</u>	<u>Last PSR</u>	<u>Current Estimate</u>
1. <u>Launch Date:</u>	1983	Same	Same
2. <u>Orbital Parameters:</u>	500 km @ 28.8° incl.	Same	Same
3. <u>Design Life:</u>	10-15 years (with on-orbit maintenance, experiment exchange, and periodic retrieval, refurbishment and return to space).		
4. <u>Science Objectives:</u>	To determine:		
	a. The constitution, physical characteristics, and dynamics of celestial entities;		
	b. The nature of processes which occur in the extreme physical conditions existing in and between astronomical objects;		

- c. The history and evolution of the universe; and,  
 d. Whether the laws of nature are universal in the space-time continuum.

	<u>Development Estimate</u>	<u>Last PSR</u>	<u>Current Estimate</u>
5. <u>Gross Weight:</u>	9,400 kg	Same	11,070 kg
<u>Variance Analysis:</u> Estimate of gross weight now provides total weight, including reserve allocation not included in the development estimate.			
6. <u>Stabilization:</u>	Reaction Wheels	Same	Same
7. <u>Launch Vehicle:</u>	Space Shuttle	Same	Same
8. <u>Science Payload:</u>			
Wide Field/Planetary Camera		Same	Same
Faint Object Spectrograph			
High Resolution Spectrograph			
High-Speed Photometer			
Faint Object Camera			
Astrometry (Using Observatory Fine Guidance System)			

D. Scheduled Milestones:

Authority to Proceed	October 1977	Same	Same
Complete Project Requirement Reviews	2nd QTR 1978	3rd QTR 1978	Same
Complete Preliminary Design Reviews	2nd QTR 1979	4th QTR 1979	Same
Complete Critical Design Reviews	2nd QTR 1980	Same	Same
Delivery of ST Elements for Integration and Test	4th QTR 1982	Same	Same
ST Flight Readiness Review	3rd QTR 1983	Same	Same
Launch Operations	4th QTR 1983	Same	Same
Operational Readiness Review	1st QTR 1984	Same	Same

Variance Analysis

Variance in Previous Report from Development Estimate

Project Requirements Review (PRR) for High Resolution Spectrograph was delayed until August 1978, due to unanticipated delay in procurement of subcontract effort. All other PRR's for the Science Payload and the observatory were completed by the end of the second quarter of 1978. Preliminary Design Review (PDR) for the SI Command & Data (C&D) System has been rescheduled for October 1979 to permit greater maturity of interfaces and design at PDR.

E. <u>Program Acquisition Costs (\$M)</u>	Development		3		5
	(2/78)	2	Last	4	Current
	<u>Estimate</u>	<u>Change</u>	<u>PSR</u>	<u>Change</u>	<u>Estimate</u>
Space Telescope	530	--	530	--	530

Assumptions:

- (a) Estimates in dollars of FY 1980 budget (range \$485-\$530M), which equate to the original planning estimate of \$435M-\$470M in dollars of the FY 1978 budget, furnished to the Congress in January 1977, and to the original Development Estimate of \$500M (FY 1979 Budget Dollars) in PSR of 7/31/78.
- (b) Estimate covers ST Development plus one month of on-orbit checkout.
- (c) See Item G below (International Participation).

<u>Funding</u>	<u>Prior Years</u>	<u>FY 1980</u>	<u>To Complete</u>	<u>Total</u>
		(Dollars in Millions)	(Dollars in Millions)	
Space Telescope	115.2	112.7	302.1	530

F. <u>Support Costs:</u>	1		3		5
	Development	2	Last	4	Current
	<u>Estimate</u>	<u>Change</u>	<u>PSR</u>	<u>Change</u>	<u>Estimate</u>
Early SR&T Effort	4.0		4.0	--	4.0
Advanced Technical Development	10.0		10.0	--	10.0
Tracking and Data Acquisition	12.1		12.1	--	12.1
Facilities (Modification for Space Telescope Operations Control Center (STOCC) and Science Interface area at GSFC)	0.6	+0.4	1.0	--	1.0

Variance Analysis  
Variance in Previous Report from Development Estimate

Facilities increase reflects a revised assessment of the scope of work required.

Grand total current project and support estimate: \$557.1M

G. International Participation

The Faint Object Camera experiment, the Solar Array, and a portion of operations personnel requirements will be provided by the European Space Agency (ESA).



National Aeronautics and  
Space Administration

Washington D C  
20546

OCT 5 1979

Reply to AIR-01 L

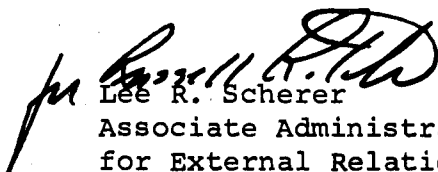
Mr. J. H. Stolarow  
Director  
Procurement and Systems  
Acquisition Division  
U.S. General Accounting Office  
Washington, DC 20548

Dear Mr. Stolarow:

Thank you for the opportunity to comment on the GAO draft report entitled, "NASA Can Provide The Congress With More Useful Information On The Space Telescope Program", (Code 952231). The enclosed comments are keyed to the segments of the proposed report to which they pertain.

As stated in the enclosure, the factors relating to GAO's recommended changes in NASA project status reports have been considered several times with your staff and NASA's position remains unchanged. We are particularly opposed to publishing in project status reports detailed financial data which would prejudice the Government's negotiating position with contractors. Also, we strongly recommend that explicit data on Space Telescope Project reserves be omitted from the final version of GAO's report.

Sincerely,

  
Lee R. Scherer  
Associate Administrator  
for External Relations

Enclosure



## National Aeronautics and Space Administration

## COMMENTS ON

DRAFT OF A GAO PROPOSED REPORT:  
NASA CAN PROVIDE THE CONGRESS WITH MORE USEFUL  
INFORMATION ON THE SPACE TELESCOPE PROGRAM  
(CODE 952231)

NASA has reviewed the GAO Draft Report and notes that the GAO identifies no substantive technical or programmatic matters of concern at this time associated with the Space Telescope Project. However, the Report does raise four administrative issues under the blanket statement that "There are opportunities available to NASA to provide the Congress with better information on the project's financial aspects":

- Project reserves not disclosed;
- Contract cost growth information not shown;
- Development costs understated; and
- Life-cycle costs unreported and understated.

The GAO then embodies these items in its recommendation that future Space Telescope Project Reports (PSR's) include additional detailed financial data on these subjects.

All of these matters have been discussed several times in the past with GAO staff. They have also been the subject of written NASA comments on previous GAO reports, and written NASA answers to Congressional questions. NASA again takes issue with the underlying tone and implications of the Report; that is, that NASA is failing to keep the Congress informed, or that NASA is somehow misleading the Congress. General NASA comments on the two pertinent Chapters of the Report follow:

CHAPTER 2: "NASA CAN INCREASE CONGRESSIONAL VISIBILITY WITH INFORMATION ON PROGRAM RESERVES AND CONTRACT COSTS." The GAO Draft Report contends that the PSR should be expanded to provide additional detailed data, for the sake of Congressional visibility.

COMMENT: It remains NASA's conviction that the PSR as currently constituted provides the proper balance of project status overview data with key supporting detail. We believe that additional detail as proposed by the GAO would tend to obscure the important overview aspects of the report, while providing only superficial "visibility." Specifically, we believe that raw contract cost estimates could be easily misinterpreted by the reader of the PSR. Such figures may not represent the total project estimate as do the project estimates now shown in the PSR.

Similarly, NASA believes that publishing data on "reserves" as proposed by the GAO could be misleading to the reader and counterproductive to the Agency's efforts to manage project costs. The GAO Report treats the term "reserves" in a simplistic manner, lumping several categories of requirements under that heading and implying that there may be no need for the funds. The dollar figures for certain items identified as "reserves" represent requirements which, under any reasonable definition of that term, should not be included. The most glaring example is the figure (35% of the GAO stated total "reserves") for "Project Office potential additions." Much of the amount budgeted in this category was for known, discrete requirements, whose definition and magnitude were not precise enough at the time for inclusion in the basic contracts. Included were such items as neutral buoyancy hardware and testing, onboard safing, ST software requirements, thermal isolation of Scientific Instruments, transportation, etc. It is simply inaccurate and misleading to identify as "reserves" the estimates for such requirements.

It is NASA's position that the establishment and proper use of contingency estimates represents a prudent management technique to achieve the objectives of highly complex R&D projects, such as Space Telescope, on plan and within the cost estimate. NASA believes that the Government's responsibility to the Congress and to the taxpayers is best served by treating the contingency estimates as internal management data. The Agency is entirely willing to make available to any member of Congress, on a private basis, whatever financial detail he may require on a given

project. However, we are strongly opposed to publishing in a quasi-public document, detailed financial data which would prejudice the Government's negotiating position with contractors. For these reasons, we strongly recommend not only that such data not be included in the PSR but also that explicit data on Space Telescope Project reserves be deleted from the final version of the GAO Report.

CHAPTER 3: "NASA CAN INCREASE CONGRESSIONAL VISIBILITY BY PRESENTING COMPLETE COST INFORMATION." The GAO Draft Report contends that NASA has excluded large amounts from its development estimate and from its life-cycle cost estimate.

COMMENT: The GAO again raises an administrative issue that has been addressed on several occasions in the past. It is still NASA's position that the Development Estimate, as defined by NASA and previously concurred in by the GAO, is the most appropriate estimate to use in the PSR. This figure, along with the readily identifiable supporting costs which are also carried in the PSR, represents the type of cost estimate which is meaningful, and trackable, for a report such as the PSR. So-called "life-cycle" cost estimates have been prepared and furnished to the Congress as specifically requested, most recently in response to a request earlier this year by the Chairman of the Senate Subcommittee on Appropriations for HUD-Independent Agencies.

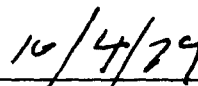
We are opposed to expanding the PSR concept to include indirect and pro rata estimates of NASA cost elements over which the Project Manager has little or no control. These cost elements, which are relatively fixed, are based on NASA-wide management decisions and budgetary determinations.

The GAO Draft Report implies that NASA has been misleading the Congress by failure to include potential inflation in project cost estimates. From the Project's beginning, it has been clearly understood by the OMB and the Congress that the Space Telescope Project budget estimates are being handled in dollars of the current budget year. Accordingly, each time projected Project costs have been reported, clear notation of the budget year basis for such estimates has been included.

The subject of inflation has been treated in connection with prior GAO reports. The Agency's position remains that it is neither useful nor revealing, for purposes of tracking the progress of current NASA projects, to speculate on the value of the dollar in the year 2000. Inflation models are readily available for those who feel the need for them.



Thomas A. Mutch  
Associate Administrator  
for Space Science



Date

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