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Report to the Congress; by Robert F. Keller, Acting Comptroller General.

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Pioneer Venus is a space flight project designed to increase knowledge of our nearest planetary neighbor and to obtain information for solving atmospheric problems on earth. The project involves launching two spacecraft to Venus in 1978. Findings/Conclusions: Costs for the project have grown and technical problems have cropped up in the project. The National Aeronautics and Space Administration's (NASA'S) quality assurance policy has not been applied in this program. NASA has showing congressional attempted to cooperate with the Soviet Union in joint planetary missions, but the Soviets have chosen to restrict the relationship to one of coordinating planetary goals and exchanging the results of complete missions. European Space Agency participation in the project was anticipated, but never materialized. Recommendations: The Administrator of NASA should: provide the Congress with an estimate of total Pioneer Venus project costs; inform congressional committees of the amounts of project reserve funds in budget requests for new projects and of how such funds are used; provide congressional committees with information semiannually on the status of Pioneer Venus funds showing congressional authorizations, allotments, obligations, and expenditures compared to the NASA budget plan; provide congressional committees with information on NASA's and the prime contractor's current estimates of the spacecraft's contract cost at completion, causes of contract cost growth, and NASA's estimate of the maximum fee the contractors can earn at completion; direct that future Pioneer Venus project status reports include information on current problems; and review past and current actions taken under the Ames quality assurance program for the Pioneer Venus spacecraft contract to assure that the Government's interests are protected. (Author/SC)

REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

National Aeronautics And Space Administration Should Provide The Congress With More Information On The Pioneer Venus Project

NASA will launch two Pioneer spacecraft in 1978 to get information on Earth's closest neighbor, Venus. These missions will be the latest in a series of U.S. Venus flights which began in 1961. Costs have grown and technical problems have cropped up in the project. NASA's quality assurance policy has not been applied in this program. Efforts at international cooperation in exploring Venus should be continued.

Improvements can be made in the financial and management information being provided to the Congress.

FSAD-77-65

NOVEMBER 7, 1977

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-183134

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

This report discusses the cost, schedule, and performance status of the National Aeronautics and Space Administration's Pioneer Venus project. It contains recommendations which, if implemented, will provide the Congress with increased information on the project.

We made our review as part of our continuing effort to keep the Congress informed about the status of major acquisitions and to assist it in exercising its legislative and review functions.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Acting Director, Office of Management and Budget; and the Administrator, National Aeronautics and Space Administration.

ACTING Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION SHOULD PROVIDE THE CONGRESS WITH MORE INFORMATION ON THE PIONEER VENUS PROJECT

D I G E S T

Pioneer Venus is a space flight project designed to increase knowledge of our nearest planetary neighbor, Venus, and to obtain information for solving atmospheric problems on Earth. The project involves launching two spacecraft to Venus in 1978.

GAO's recommendations would require NASA to provide more information regarding NASA programs to the congressional committees with legislative and oversight responsibility for NASA programs.

FINANCIAL ASPECTS OF THE PROJECT

NASA's January 1977 budget estimate for the Pioneer Venus project was $231 million. This is not the full project cost. GAO identified another $19.5 million of direct project costs. Further, NASA's estimate did not include costs of launching, tracking, and acquiring data from the spacecraft. (See p. 6.)

Included in the budget estimate was $53 million in reserve for such things as contract changes, potential cost growth, and inflation. Information on the size and use of reserve funds helps the Congress identify areas where appropriations may be questionable because programs have not progressed to the stage where more funds are justified. (See p. 9.)

NASA's semiannual report on the status of the Pioneer Venus project does not give the Congress enough information on the budgetary and fiscal effects of the Pioneer Venus project funding. (See p. 11.)

The principal contractor expects his contract, originally valued at $59.6 million, to increase by $29.6 million to $89.2 million due mainly to

inflation, overhead rate growth, and unanticipated technical problems. NASA's semiannual report on the status of the Pioneer Venus project does not provide enough detail on contractor costs. (See p. 13.)

TECHNICAL PROBLEMS

Technical problems involving spacecraft parachute design, a spacecraft window, thermal insulation, and increases in spacecraft weight have resulted in cost increases and unmet test schedules. NASA officials believe that the spacecraft will be ready by 1978 and that most mission objectives will be met.

GAO believes that NASA should keep the Congress aware of how technical problems are being treated and their effect on the cost, schedule, and performance of the project. (See p. 16.)

QUALITY ASSURANCE

The Ames Research Center's reliability and quality assurance program for the Pioneer Venus project has not guaranteed that the spacecraft's equipment meets the project's technical requirements. (See p. 21.)

INTERNATIONAL PARTICIPATION

The Soviet Union has also been actively exploring Venus. NASA has attempted to cooperate with the Soviet Union in joint planetary missions. However, the Soviets have chosen to restrict the relationship to one of coordinating planetary goals and exchanging results of completed missions. (See p. 29.)

European Space Agency participation in the project was anticipated but never happened, because the Europeans put their resources into other missions. (See p. 30.)

RECOMMENDATIONS FOR NASA

GAO recommends that the NASA Administrator:

--Provide the Congress with an estimate of total Pioneer Venus project costs, including

a proration of support costs for launching, tracking, and acquiring data from the spacecraft. (See p. 9.)

--Inform congressional committees of (1) the amounts of project reserve funds in budget requests for new projects and (2) how such funds are used. (See p. 11.)

--Provide congressional committees with information semiannually on the status of Pioneer Venus funds showing congressional authorizations, allotments, obligations, and expenditures compared to the NASA budget plan. (See p. 13.)

--Provide congressional committees with information on (1) NASA's and the prime contractor's current estimates of the spacecraft's contract cost at completion, (2) causes of contract cost growth such as inflation, project scope changes, and technical difficulties, and (3) NASA's estimate of the maximum fee the contractors can earn at completion. (See p. 15.)

--Direct that future Pioneer Venus project status reports include information on current problems. (See p. 20.)

--Review past and current actions taken under the Ames quality assurance program for the Pioneer Venus spacecraft contract to assure that the Government's interests are protected. (See p. 24.)

AGENCY COMMENTS

NASA is concerned about openly disclosing the amounts of reserves in project budgets and current estimates of contract costs and fees. The agency did not object, however, to furnishing such data on a restricted, individual basis to interested Members of Congress. NASA did not agree with GAO's recommendation to include all project-related costs in project budget estimates. (See app. II.)

Contents

ABBREVIATIONS

DOD	Department of Defense
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration

CHAPTER 1

INTRODUCTION

We made this review of the National Aeronautics and Space Administration's (NASA's) Pioneer Venus project at the request of the Chairman, Senate Subcommittee for HUD--Independent Agencies, Committee on Appropriations. The chairman asked that our report cover project cost, schedule, performance, and problems associated with the project.

Pioneer Venus is a space flight project to increase scientific knowledge of our nearest planetary neighbor, Venus, and to obtain information that can aid in understanding and solving atmospheric problems on Earth. The project will send an orbiter and a multiprobe spacecraft to Venus in 1978. The orbiter, to be launched in May 1978, and the multiprobe spacecraft, to be launched in August 1978, will have unique functions on reaching Venus.

The orbiter will be placed in an elliptical orbit around Venus and will carry instruments to measure the planet and its surrounding medium. The spacecraft is to remain in orbit and should be fully operational for at least 243 days. The scientific objectives for the orbiter mission are to determine

--detailed structure of the upper atmosphere and ionosphere of Venus,

--interaction of the solar wind with the Venusian ionosphere and with the small magnetic field in the vicinity of the planet,

--characteristics of the atmosphere and the surface of Venus by use of remote-sensing experiments, and

--more about the planet's gravity.

The spacecraft for the multiprobe mission consists of a bus (which is the carrier and delivery system for the probes), a large probe, and three identical small probes, each carrying scientific instruments. The probes will be released from the bus before encountering Venus to measure physical and chemical properties at widely separated points through the atmosphere to the planet's surface. The bus will be targeted for entry after the probes have been released and will measure Venus' upper atmosphere before burning up. The scientific objectives for the multiprobe mission are to determine the

--nature and composition of the clouds,

--composition and structure of the atmosphere from the surface to high altitudes, and

--general circulation pattern of the atmosphere.

WHY EXPLORE VENUS?

In several respects, Venus and Earth appear to be almost twin planets. They are about the same size and have about the same density. The difference in their distance from the sun is relatively small; however, Venus receives about twice the amount of solar energy over a given area as does Earth. If neither planet had an atmosphere and the surface reflection was similar, the surface temperature on Venus would only be slightly higher than that on Earth.

Yet, there are striking differences between the two planets. For example, Earth is covered with an atmosphere and has oceans which are conducive to life as we know it. In comparison, Venus is covered with a hot, dry atmosphere of which 90 percent or more is apparently carbon dioxide. There is almost no oxygen or water. The surface atmospheric pressure on Venus is about one hundred times greater than the surface pressure on Earth, and the temperature is about 800 degrees Fahrenheit at the surface.

Why did NASA decide to explore Venus? Primarily to determine why Venus, which is so similar to Earth in many respects, differs so much from Earth in other respects. Why is a planet that might be our twin so hostile to our type of life? NASA and other scientists want to determine whether Venus started with certain essential differences from Earth which caused it to follow a different evolutionary path or whether Earth could still evolve as did Venus. Furthermore, scientists may be able to learn something of the possible effects on Earth from the increasing carbon dioxide in our atmosphere (a result of burning fossil fuel) and the result of depleting the blanket of ozone in our stratosphere.

In a June 1970 study by the Space Science Board of the National Academy of Sciences entitled "Venus: Strategy for Exploration," the question "Why explore Venus now?" was addressed. The report pointed out that problems such as the origin of the solar system, the origin of life, and the large-scale processes that control man's environment, would have

to be considered in terms of information on several planets rather than a single planet. The report indicated that the detail of these studies would differ from one planet to another. For example, much more would be known about Earth's environment as compared to the very small amounts of information on some of the outer planets and the difficulty of substantially increasing this information. It also stated that the most striking weakness in our information about the inner planets was the absence of almost any firm information about the solid surface and lower atmosphere of Venus.

The report pointed out that

> "If we consider the need for Venus research in terms of particular examples we find striking examples of how knowledge of this planet can illuminate our knowledge of Earth. The surprise effect of the unexpected ionospheric data on both Mars and Venus has led to timely re-examination of fixed ideas about the earth's ionosphere. Studies of atmospheric circulations in slowly rotating atmospheres have provided new ideas applicable to tropical meteorology. The extensive cloud systems of Venus have led to investigations of the coupling between clouds and motions not yet undertaken on earth. The question of why Venus has a complete cloud cover and a high surface temperature is beginning to interest those concerned with possible environmental changes on earth. This is not so much in the belief that earth might go the way of Venus if the atmosphere is sufficiently polluted but rather with the thought that Venus is an observable example of a class of problem that concerns our own environment."

In summary, scientists believed that sufficient reasons existed to explore Venus and that the time was right for the combined orbital and atmospheric entry probe missions of the Pioneer Venus project.

ORIGIN OF PIONEER VENUS PROJECT

Planning for the Pioneer Venus project began about 1968. Before that time there had been a number of U.S. and Russian (Venera) missions to Venus. (See app. I.) In June 1968 the Space Science Board published a study entitled "Planetary Exploration 1968-1975," which suggested that a number of planetary exploration missions be conducted to cover

a broad range of scientific disciplines. The Board recommended that NASA initiate a spacecraft program for orbiting Venus and Mars and for exploring other planets. During the period 1968--1970, several studies were conducted on the feasibility of orbiter and probe missions to Venus.

In June 1970 the Space Science Board recommended that Venus exploration be prominent in NASA's program and that NASA actively seek collaboration of other nations' space organizations in carrying out such exploration. At NASA's request, the Space Science Board in July 1970 began "A Study on Priorities in Space Science and Earth Observations." The study's purpose was to determine the criteria for relative priorities and to recommend levels of effort and support to be allocated to various NASA programs. The study group considered the continuing exploration of Venus as a base mission which should be a part of any space science and applications program in the 1970s.

The study group believed that close scrutiny of Mars and Venus, our nearest planetary neighbors, was very important to our space science program. Considering missions to Venus as a key ingredient of the planetary program, the group recommended:

> "* * * a launch schedule involving two probes in 1975, followed by an orbiter in 1976, and follow-up missions whose character should be strongly influenced by results obtained in the early flights. We consider low-cost surface science to be of high priority. The Planetary Explorer shows promise of providing this option. It should be carefully studied, and we would warmly endorse it if the cost is in line with the Planetary Explorer concept * * *."

The feasibility study for the Venus missions was conducted at Goddard Space Flight Center. In January 1972 NASA transferred the project to Ames Research Center.

After the project was moved to Ames, teams headed by two major aerospace companies--TRW, Inc., and Hughes Aircraft Company--conducted a competitive system definition study. Hughes received the spacecraft system contract in May 1974. Ames has issued additional contracts and letters of agreement to other contractors and NASA space centers for design and fabrication of the spacecraft scientific instruments.

NASA headquarters currently estimates the total cost of the Pioneer Venus program, including the launch vehicle, flight support, and tracking and data acquisition costs, at about $231 million.

PROJECT MANAGEMENT

NASA's Office of Space Science is responsible for the overall direction of the Pioneer project. The Associate Administrator for Space Science has management responsibilities for overall program development, selection of scientific experiments and experimenters for the missions, technical direction and evaluation of the project, and continuing leadership in external relationships.

Detailed project management responsibility for all Pioneer missions has been assigned to Ames Research Center, which established a Pioneer project office. The Jet Propulsion Laboratory, which operates the NASA Deep Space Network, is responsible for tracking and data acquisition. NASA's Lewis Research Center manages launch vehicles, and Kennedy Space Center is responsible for launch operations.

SCOPE OF REVIEW

Our review was conducted at Ames Research Center, Moffett Field, California, and at NASA headquarters, Washington, D.C. We reviewed project plans, reports, correspondence, and other documents, and held discussions with Ames and NASA headquarters personnel.

NASA's comments on our proposed report appear in appendix II.

CHAPTER 2

FINANCIAL ASPECTS OF PROJECT

The Pioneer Venus project will cost over $250 million. This chapter presents information on NASA's estimates of project costs, costs not included in NASA's estimates, reserve accounts, project funding, and contract cost growth.

PROJECT COSTS

NASA's October 1974 project cost estimate of $208 million has increased by $23 million to $231 million. The following table compares NASA's October 1974 and January 1977 project cost estimates.

Pioneer Venus Project Cost Estimates

Cost element	NASA estimate October 1974 (note a)	Changes	NASA estimate January 1977 (note b)
	(millions)		
Spacecraft, experiments, and ground operations	$170.0	$ 9.3	$179.3
Launch vehicles	30.8	6.8	37.6
Flight support (note c)	7.0	(4.6)	2.4
Tracking and data acquisition	-	11.8	11.8
Total	$207.8	$23.3	$231.1

a/Estimate contained in NASA's "Pioneer Venus Project Approval Document."

b/Estimate contained in NASA's January 1977 project status report.

c/Flight support is the computer processing and display capability to support telemetry, tracking, and command functions for all planetary spacecraft.

The $9.3 million increase in costs of spacecraft, experiments, and ground operations is a reserve account held by NASA headquarters. (See p. 10.) We did not perform a detailed analysis of the $6.8 million increase in costs of launch vehicles; however, technical problems and inflation appear to be the major causes of this increase.

The $4.6 million decrease in flight support costs resulted primarily from a determination that some of the support could be provided by the project office at Ames using existing computers. NASA had originally assumed that the bulk of this support would be provided by the Jet Propulsion Laboratory (JPL).

The $11.8 million added for tracking and data acquisition costs covers equipment bought for the project, modifications to existing equipment, and unique engineering and operation support.

Costs not included in NASA estimates

NASA's estimates do not contain $19.5 million of direct costs needed to support the project--$10 million for personnel, $8.8 million for advanced design effort, and $0.7 million incurred by the Energy Research and Development Administration (ERDA). In addition, NASA has not allocated certain costs, such as operating and maintenance costs at JPL and Kennedy Space Center, incurred to support the project.

The $10 million for personnel costs is our estimate of civil service salary and related costs incurred by Ames to support the project. It is based on an Ames estimate that 354 staff-years would be required for the project. NASA takes the position that project civil service salaries should not be classed as project costs because they

> "* * * are relatively fixed, are not sensitive to the inclusion or exclusion of any one project and would be misleading as to the economic impact of the project on the budget if they were included."

We take the position that all of NASA's costs have an economic impact on its budget and that project cost estimates should include the salaries and related costs of civil service personnel supporting the project.

Ames' funding summaries show that $8.8 million of advanced technology development funds were used during the early stages of the project for advanced design definition and preliminary design efforts. NASA stated that $4.5 million of the $8.8 million (1) relates to work which, while applicable to Pioneer Venus, was undertaken and partially carried out before a specific Pioneer Venus mission was defined and (2) would also be applicable to other missions. The $4.3 million balance related to funds used to extend the definition and conceptual design phase of the project. Although there are notations in NASA's project status reports identifying the $4.3 million, the amount is not included in the $231.1 million January 1977 cost estimate.

The $4.3 million clearly should be included in the project cost estimates as it was all directly related to the project. Although other missions may have benefitted from some of the work paid for with the $4.5 million, Ames officials apparently felt that the Pioneer Venus project benefitted sufficiently to allocate the total costs to it. While more precise allocations might be made, we believe that assignment of the entire $8.8 million to the Pioneer Venus project is reasonable.

ERDA is participating in the design and development of one of the project's scientific instruments. The value of this effort is estimated at $0.7 million. NASA informed us that it does not have the responsibility or ability to monitor other agencies' costs and that attempts to include them in project cost estimates could lead to inaccuracies.

The launch vehicle and tracking and data acquisition costs contained in NASA's estimates are directly associated with the project. Substantial amounts of support costs are involved in launching, tracking, and acquiring data from spacecraft which are not included in the estimate. These costs are incurred at such places as JPL, the Goddard Space Center, and the Kennedy Space Center. NASA's rationale for excluding allocations of these support costs from its project cost estimate is the same as its rationale for excluding civil service costs.

Our concern about the need for NASA to include all project-related costs in its estimates was discussed in our report to the Congress "Improved Reporting Needed on National Aeronautics and Space Administration Projects," (PSAD-77-54, Jan. 27, 1977). We recommended that the Administrator of NASA modify the semiannual project status reports to provide an additional single figure showing total project costs which

include civil service support directly assigned to the project, a proration of NASA's fixed costs, and costs incurred by other agencies supporting the project. NASA did not accept our recommendation. Accordingly, Pioneer Venus project status reports do not provide the Congress with information on total project costs.

In commenting on a proposed copy of this report, NASA did not change its position on giving the Congress an estimate of total Pioneer Venus project costs.

Conclusions and recommendation

The Congress needs complete cost information on projects it authorizes and funds. NASA's project budget estimates should include civil service support directly assigned to the project and a proration of relatively fixed support costs for launching, tracking, and acquiring data from the spacecraft. We recognize that fixed costs will continue unchanged over the short run if a project is not undertaken; however, in the long run, all of NASA's costs--fixed and variable--have an economic impact on the NASA budget.

Project budget estimates should also include costs incurred by other agencies in support of the project. Only a minimum of effort would be required for NASA to solicit this data from participating agencies and include it in the estimates.

NASA estimates the Pioneer Venus project cost at $231 million. However, we identified additional project costs amounting to $19.5 million--not including a proration of support costs for launching, tracking, and acquiring data from the spacecraft.

We recommend that the NASA Administrator provide the Congress with an estimate of total Pioneer Venus project costs, including a proration of support costs for launching, tracking, and acquiring data from the spacecraft. NASA stated that costs of this type represent a baseline capability not sensitive to inclusion or exclusion in the budget of any one project.

RESERVE ACCOUNTS

When requesting us to review the Pioneer Venus project, the chairman of the Senate Subcommittee for HUD--Independent Agencies, Committee on Appropriations said that the subcommittee is concerned with identifying areas where the

appropriation of funds may be questionable because programs have not yet progressed to the stage where additional funds are justified. Accordingly, we inquired into project reserve accounts and project funding.

When making up project budget estimates, NASA officials include an amount for reserves to cover such things as contract changes, potential cost growth, and inflation. NASA officials have stated that a research and development project is subject to considerable change during its lifetime. As more knowledge is acquired, contract prices are subject to readjustment. They also stated that the key to project cost administration lies in the Government's ability to retain reserves for changes and to administer the project so that total project cost is controlled. NASA officials have also stated that they do not believe project reserves should be openly reported because of the possibility of compromising the Government's position in contract negotiations.

We identified and examined project reserve accounts relating to the $179.3 million cost estimate for spacecraft, experiments, and ground operations. About 30 percent, or $53.3 million, of the estimate consisted of reserves.

The 1974 project estimates prepared by Ames included reserve accounts of $44 million for the Ames project office. Ames officials advised us that the size of the reserve and its use over the life of the project are normal and expected on a project of this nature. Prior Pioneer project cost experience and estimates were used in computing the reserve accounts. We analyzed the use of 11 reserve accounts containing $14.6 million in fiscal year 1976 and found that $12.1 million had been transferred to specific cost accounts during that year.

In addition to the reserves at Ames, NASA headquarters held in reserve $4.3 million of fiscal year 1975 funds and $5 million of fiscal year 1977 funds.

Conclusions and recommendation

Establishing and properly using reserves is a prudent management technique. There is, of course, a danger of becoming lax in managing resources because of knowledge that there are reserves available to bail one out of difficulty. This danger is heightened in cases where the Government is procuring items under cost-type contract. Such situations

require that clear understandings on the respective responsibilities of Government and contractor be reached during negotiations and that the Government adequately monitor the contractor's cost and technical performance.

We understand NASA's reluctance to report project reserves openly. Presumably such knowledge could give a contractor a better negotiating position. However, we do not believe that this information should be kept from the Congress. The Congress should know of the amounts of reserve funds built into project estimates and how they are actually used. With such knowledge the Congress will be in a better position to review requests for increased project funds.

We recommend that the NASA Administrator inform cognizant congressional committees of (1) the amounts of project reserve funds in budget requests for new projects and (2) how such funds are used. In commenting on our proposed report, NASA stated that it had no objection to furnishing such data on a restricted basis to interested Members of Congress.

PROJECT FUNDING

As previously discussed, we inquired into reserve accounts because of congressional concern over possible premature appropriations. We also inquired into project funding because of this concern. We analyzed the use of authorized funds as of September 30, 1976, for that part of the project under the control of Ames officials, as shown in the table on the following page. The budget plan data was taken from the October 1974 Pioneer Venus project plan and represents the planned release of funds to Ames. The allotment data represents funds actually released to Ames by NASA headquarters. Obligation and expenditure data include transactions for Ames made by Goddard Space Flight Center and the Jet Propulsion Laboratory.

Our concern about the need for NASA to provide the Congress with more detailed information on the status of project funds was discussed in our report to the Congress "Improved Reporting Needed on National Aeronautics and Space Administration Projects," (PSAD-77-54, Jan. 27, 1977). In that report we stated that NASA's semiannual reports do not present sufficient funding information. We recommended that NASA provide information in its semiannual project status reports showing the status of congressional authorizations, allotments, obligations, and expenditures compared to the project budget plan on a year-by-year basis.

AMES RESEARCH CENTER STATUS OF FUNDS FOR PIONEER VENUS PROJECT SPACECRAFT, EXPERIMENTS, AND GROUND OPERATIONS AS OF SEPTEMBER 30, 1976

	Fiscal Years								
	1975	1976	197T	1977	1978	1979	1980	1981	Total
	(millions)								
Budget plan	$17.5	$62.2	$15.3	$36.0	$18.7	$10.9	$7.0	$1.2	$168.8
Allotted to Ames	17.5	61.2	15.3						94.0
Obligated by Ames	17.0	58.5	12.0						87.5
Expended by Ames	8.5	54.6	11.5						74.6

NASA did not accept our recommendation. Accordingly, Pioneer Venus project status reports do not give the Congress detailed information on the status of project funds.

NASA takes the position that the semiannual report is not a suitable vehicle for detailed fiscal analysis and that data on its projects are always available to the Congress.

Conclusion and recommendation

The Congress will be better informed of the budget and fiscal effects of individual projects if it has more detailed project funding information. Such information should help the Congress in deciding on the amounts and timing of authorizations and appropriations. We believe that this information is fundamental and should be automatically provided to the Congress periodically.

Therefore, we recommend that the NASA Administrator provide cognizant congressional committees with information semiannually on the status of Pioneer Venus funds showing congressional authorizations, allotments, obligations, and expenditures compared to the NASA budget plan. It is NASA's position that the project status reports should not contain such information and that fiscal progress reporting is already covered in complete detail in its regular management information system.

CONTRACT COST GROWTH

On May 1, 1974, Ames Research Center entered into a two-phase contract with Hughes Aircraft Company, El Segundo, California. Phase I, initially priced at $2.8 million and later increased to $3.6 million, was for the conceptual design of the Pioneer Venus multiprobe and orbiter spacecraft. The contract included an option to incorporate Phase II for the design, development, and operation of the spacecraft systems. Ames exercised its option on November 11, 1974, entering into a cost-plus-award-fee contract with an estimated cost of $59.6 million (including the Phase I cost) and a maximum award fee of about $8.9 million.

In August 1976 Hughes submitted a cost growth proposal totaling about $19.3 million. The company attributed the cost growth to

--$11.5 million for inflation and an increase in the approved overhead rate and

--$8 million for unanticipated technical problems.

Considering this cost growth and previously proposed contract change orders, Hughes estimated that the cost of the spacecraft contract at completion would be about $81.6 million--$22 million more than the negotiated cost. The company also pointed out that there might be additional unanticipated problems and requested that a reserve of $5.1 million be apportioned to the contract to deal with such problems should they occur. Hughes March 1977 estimate of contract cost at completion was $89.2 million.

Contract cost growths of this size are matters of concern to the Congress. The Chairman of the Senate Subcommittee for HUD--Independent Agencies, Committee on Appropriations, requested during fiscal year 1976 hearings that NASA prepare semiannual status reports on its projects patterned after the Department of Defense's (DOD's) selected acquisition reports. DOD submits periodic reports to the Congress that provide detailed information on contract cost changes because of technical difficulties, inflation, and project scope changes incurred on selected projects. However, NASA's project status reports do not contain this information. Accordingly, the Pioneer Venus project status reports do not give the Congress information on contract cost growth.

NASA objects to including detailed contractor data in project status reports. In commenting on this report, NASA stated

> "* * * the type of contractor cost data that is included in Department of Defense Selected Acquisition Reports might be more appropriate when procuring to well-defined specifications and prime contractor performance can be relatively independent of development problems. However, in the case of research and development procurement, the project is subject to considerable change during its lifetime.
>
> "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."

NASA's primary concern appears to be that its

> "* * * estimates of run-out costs of individual tracts must be protected from public disclosure (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."

Conclusions and recommendation

The Congress will be better informed of the reasons for project cost growth if provided with more detailed contract cost data. We understand NASA's reluctance to openly report this information, but we believe it should be reported to those committees exercising legislative responsibilities over NASA's activities.

Accordingly, we recommend that the NASA Administrator provide cognizant congressional committees with information on (1) NASA's and the prime contractor's current estimates of the cost of the spacecraft's contract cost at completion, (2) causes of contract cost growth, such as inflation, project scope changes, and technical difficulties, and (3) NASA's estimate of the maximum fee the contractor can earn at completion.

In commenting on a draft of this report, NASA said it would have no objection to furnishing such data on a restricted individual basis to interested Members of Congress.

CHAPTER 3

TECHNICAL PROBLEMS

Our review of selected aspects of the design, development, and procurement of the spacecraft and scientific instruments disclosed problems that have caused significant cost increases and affected test schedules. Ames officials, however, believe that the spacecraft will be ready by the 1978 launch dates and that the planned mission objectives will be substantially achieved.

SPACECRAFT TECHNICAL PROBLEMS

The important problems in the design and development of the spacecraft that concern project officials are discussed in the following paragraphs.

Large probe parachute

The large probe will descend through the upper atmosphere of Venus on a parachute and fall freely through the lower atmosphere after the parachute is released. The prime contractor has experienced major problems in the development and test of the parachute which have affected system test schedules and increased project costs.

For example, Ames officials advised us that the parachute's test schedule had slipped about 6 months. The project originally required only two parachute drop tests and two flight qualification tests. Because of four successive drop test failures, the requirement was increased to a total of eight tests, and the parachute had to be redesigned several times. The most recent design was being tested at the time of our review. We subsequently learned that the tests were successfully completed.

Systems environmental tests were originally planned to include the parachute. However, because of the most recent change in design and resulting schedule delays, the parachute will not be ready for environmental tests with the other systems. Therefore, Ames now plans to test the parachute separately. Ames officials advised us that this decision would cause a slight risk in achieving a trouble-free mission.

As a result of these problems and decisions, the cost estimate for developing and testing the parachute increased

from about $1 million to $2.1 million. In addition, a scientific instrument had to be modified at a cost of $84,400 because of a decision to release the parachute at a higher altitude.

Spacecraft window

Developing a satisfactory window in the large probe for one of the scientific instruments has been a problem. Unless this problem is solved, the large probe infrared radiometer positioned at the window may not meet its mission objectives.

The radiometer will provide scientific data to

--better understand the dynamics and properties of the Venusian atmosphere,

--detect the location of the cloud layers and indicate their composition, and

--measure the quantity of water vapor in the lower atmosphere.

While most instrument windows in the large probe are made of sapphire, diamond was found to be the only material capable of both meeting the optical requirements of the infrared radiometer and surviving in the Venusian temperature and pressure. Using natural diamond increased costs by about $118,000. The diamond window will be shaped in the form of a 32-sided polygon, and it is to be brazed, or sealed, to the metal window support. Although diamond-to-metal brazes are possible, a vacuum-tight braze between diamond and metal has never been made.

Ames officials advised us that the prime contractor has been working on the brazing problem for about a year without complete resolution. They stated that unless this problem is resolved, the infrared radiometer on the large probe will be unable to do what it was designed for. The Ames project manager agreed that this was a major problem. He stated that alternate types of window supports would be tested before giving up on the use of this scientific instrument. He expects the problem to be resolved before the launch date.

Spacecraft weight

Spacecraft weight problems have confronted the prime contractor since the design phase of the contract in 1974. At that time, Ames was very critical of the prime contractor's approach to solving the problem, pointing out that the spacecraft weight requirements " * * * have grown at an excessive rate with very little evidence that the designers were being pressed to justify these increases, or to live within their prescribed budgets." Although the contractor subsequently established a weight review and control program and tracked potential changes in weight, the spacecraft weight continued to increase.

To alleviate the weight problem, several critical and costly design decisions were made. For example, one of the most crucial design problems occurred early in 1975 when weight increases necessitated a decision to change the large and small probe pressure vessels from steel to titanium. Not only did this decision create problems in keeping the overall project on schedule, it also resulted in substantial cost increases. NASA estimated that the maximum cost increase for the weight reduction program was about $1.1 million.

Even with these changes, spacecraft weight continued to be a critical problem. When it became apparent early in 1976 that the prime contractor was faced with substantial cost increases to control spacecraft weight, Ames decided to:

--Reduce the launch opportunity (the time periods that the launches may take place) by 4 to 6 days each.

--Release the launch vehicle nose fairings (structures to reduce drag) at a lower altitude during the launch.

--Boost each spacecraft into a lower Earth orbit before placing it into a flight trajectory toward Venus.

While these decisions permit a higher weight limit for the spacecraft, they are not entirely without risk. Ames officials believe that these decisions may involve additional risks in spacecraft heating and contamination. They believe, however, that the actions were necessary to keep the contractor from spending excessive funds or compromising system performance.

INSTRUMENT TECHNICAL PROBLEMS

The instrument contractors generally are required to deliver test instruments for design verification and interface compatibility testing before delivering the flight instruments. Management reports at Ames showed that the current qualification testing and delivery schedules for a number of the design verification units are from 1 to 6 months behind their original schedules.

To determine the reasons for these schedule slippages and their impact on the project, we reviewed data relating to 12 of the project's instruments. We learned that:

--The most prevalent problem involved delays in delivery of electronic parts to the contractors. (See discussion in the following section.)

--Several of the instruments experienced technical problems, resulting in costly redesign effort.

Ames officials advised us that these problems either had been or would be resolved.

Officials at Ames also advised us that they considered the technical problems experienced with the instruments normal for this type of project. They said that the instrument problems we have mentioned will have no important effect on project test schedules, and they do not expect planned flight schedules to be affected.

PROCUREMENT OF ELECTRONIC PARTS

In April 1975 Ames signed a fixed-price contract with DCA Reliability Laboratory, Mountain View, California, to buy and screen common electronic parts required by several scientific instrument contractors. Ames believed that consolidated purchasing and screening would be cost effective.

Problems encountered in managing this parts program included:

--Contractors ordered parts before completing their designs, resulting in many change orders, new parts orders, and subsequent delays in parts deliveries.

--Parts suppliers had difficulties in filling orders.

--DCA waited too long to consolidate procurements and then did not expedite delivery to the instrument contractors after receiving the parts from suppliers.

As a result of these and other problems in obtaining electronic parts, some instrument contractors projected delays of several months in having their instruments ready for project tests.

This attempt to procure and screen electronic parts on a consolidated basis has turned out to be more expensive than originally anticipated. According to Ames officials, the late delivery of parts has already resulted in claims from contractors amounting to over $1 million and additional claims are expected. In addition, DCA has proposed increasing the contract price, stating that the many unexpected problems caused the company to incur costs of more than $500,000 on its $102,000 fixed-price contract. Ames was considering this proposal at the time of our fieldwork. Later, we learned that Ames rejected the proposal and that DCA has submitted a rebuttal.

CONCLUSIONS AND RECOMMENDATIONS

The problems discussed in this chapter have caused cost increases and delayed test schedules; however, Ames officials believe that the spacecraft will be launched on schedule.

We believe that NASA should keep the Congress informed of how technical problems are being treated and of their effect on the cost, schedule, and performance of the project. Therefore, we recommend that the NASA Administrator direct that future Pioneer Venus project status reports include information on current problems.

After reviewing a proposed copy of this report, NASA issued its July 1977 status report which discusses some Pioneer Venus technical problems. This is a step in the right direction, and we look forward to more of the same on future status reports.

CHAPTER 4

NEED FOR AN EFFECTIVE PIONEER VENUS QUALITY ASSURANCE PROGRAM

Ames' reliability and quality assurance program for the Pioneer Venus project has been inadequate for making sure that the spacecraft hardware meets the project's technical requirements. As a result, NASA was assuming a major risk that was not warranted for this important project. Ames initiated its quality surveillance program at the contractor's plant after we completed our fieldwork; however, we do not know if the program is adequate.

NASA procurement regulations require that (1) quality assurance inspections on behalf of the Government shall be conducted in all cases prior to acceptance of products from contractors, (2) inspection shall be done by or under the supervision of Government personnel, and (3) contract provisions shall not preclude the Government from performing these inspections. Section 14.103 of the regulations provides that:

> "In the interest of achieving economy and efficiency in the inspection of contract items, procurement offices shall utilize the services of other executive agencies to ensure the most economical and effective inspection consistent with the best interests of the Government. The purpose of inspection interchange agreements is to eliminate duplication, overlapping, or multiple assignments of Government inspection activity in any one plant."

While this section of the regulations is very specific, Section 51.304 provides that contracting officers have the option of delegating reliability and quality assurance functions to other Government organizations or retaining such responsibilities within their installations.

NASA's policy is to make optimum use of contract administration and related contract support functions available from DOD and other Government agencies. For Pioneer Venus, however, we were advised that NASA placed special emphasis on low cost and encouraged bidders to suggest methods for cost savings.

Hughes Aircraft Company, in submitting its spacecraft contract proposal in 1973, pointed out that the request for

procurement indicated that quality assurance functions would be delegated by Ames to Air Force plant representatives at the Hughes plant. Hughes recommended that in the interest of reducing costs the quality assurance function not be delegated. The company said that the delays caused by delegating Government inspection functions would cost it about $200,000 and recommended that Hughes in-house quality control be relied on.

Ames officials told us that they disagreed with the recommendation and suggested that Hughes add the $200,000 to its total proposed cost. They further stated that:

1. Hughes told Ames personnel during contract negotiations that the $200,000 was a meaningless figure, and that it would be necessary for the company to submit an entirely new contract cost proposal if the recommendation was not accepted.

2. After discussing Hughes quality assurance program with other Government agency officials and considering the effects on the project's cost and schedules by not accepting the contractor's recommendation, Ames management determined that the degree of risk associated with Hughes recommendation was acceptable.

As a result, the spacecraft contract with Hughes does not allow delegation of Government responsibility for quality assurance functions. Ames remains responsible for these functions as well as for final inspection and acceptance of items to be delivered under the contract. NASA advised us that Ames considered accomplishing its technical and quality assurance surveillance functions by hiring in-plant technical representatives and later, during the systems' integration and test phase, contracting for quality assurance personnel.

During a March 1975 NASA headquarters survey of safety, reliability, and quality assurance functions at Ames, it was noted that NASA's standard practice of using available DOD activities to perform selected quality assurance tasks had been completely deleted from the Pioneer Venus contract. The survey report stated that:

> "The elimination of the DOD QA [Defense quality assurance] surveillance and in-process mandatory inspection does not provide NASA with the assurance that flight hardware meets the workmanship and quality standards required to successfully perform

the Venus orbit and multiprobe missions. This condition is doubly significant because of the limited quantity of flight hardware * * *."

The survey report recommended that Ames (1) renegotiate the contract to permit delegation of quality assurance functions to the Air Force Plant Representative's Office or (2) assign a sufficient number of quality assurance personnel to accomplish these functions.

Ames reply to the survey report was that it had agreed with Hughes during negotiations that nondelegation of the quality control function would result in major savings to the low cost program. Therefore, Ames had exercised its project management prerogative to implement this decision by contract. According to Ames officials, it is now too late to renegotiate the contract. The officials said that this may be the only major NASA contract to contain such a provision.

At the time of our review, Ames officials were apprehensive about the current situation. They stated that problems generally do not become visible until an item or system is tested. As an example of a quality assurance problem, they cited an instance of a probe structure that fell apart during a vibration test because the screws and screw hole drillings holding the structure together were inadequate. They also stated that they do not know whether the contractor's reliability and quality assurance program has been effectively implemented on the Pioneer Venus project because the Government was not monitoring the contractor's inspection program.

According to Ames officials, quality assurance inspections had not been conducted at the contractor's plant because of insufficient staffing. They told us that Ames had been considering either (1) increasing the number of personnel assigned to Ames quality assurance office or (2) requesting that Air Force quality assurance personnel be temporarily detailed to work for Ames, but that neither of these alternatives had been carried out. The Ames project manager said that he has two spacecraft technical representatives assigned to the contractor's plant, but that they are primarily responsible for technical liaison functions rather than quality assurance functions.

Officials at Ames said that the lack of Government quality assurance functions at the contractor's plant created a significant risk that the Pioneer Venus missions would not

be completed successfully. If major problems are encountered during final systems tests, remedying the situation on a timely basis could become very costly.

CONCLUSIONS AND RECOMMENDATION

Ames has deviated from NASA's policy of delegating quality assurance responsibilities to Government representatives at the Hughes plant and has performed only limited quality assurance inspections on its own. Accordingly, the Pioneer Venus project, costing in excess of $250 million, has been carried out without the usual Government control (Air Force plant representatives performing inspections) over the quality of the items being bought under the spacecraft contract. We do not believe such a risk was warranted.

In a proposed copy of this report, we recommended that the NASA Administrator review the Ames quality assurance program for the Pioneer Venus spacecraft contract and take action, if needed, to adequately protect the Government's investment in the project.

After we completed our fieldwork Ames placed three quality assurance representatives at the contractor's plant. NASA told us that this had been Ames intended procedure for providing quality assurance surveillance. We understand also that Ames is planning to contract for additional personnel for its quality assurance efforts at the contractor's plant.

NASA believes that this surveillance, plus an award fee that depends mostly on successful spacecraft performance, offers good protection to the Government. The agency said that the effectiveness of this approach cannot be evaluated, however, until the final test results and the spacecraft flight performance are available.

We recommend that the NASA Administrator review the past and current actions taken under the Ames quality assurance program for the Pioneer Venus spacecraft contract to assure that the Government's interests are protected.

CHAPTER 5

INTERNATIONAL COOPERATION

Substantial and increasing amounts of money are being spent on space exploration. The United States and the Soviet Union have spent hundreds of millions of dollars in exploring Venus. As shown in appendix I, the Soviet Union has launched 10 Venera spacecraft to Venus compared to 4 Mariner spacecraft launched by the United States. NASA considers the two programs to be complementary since Soviet emphasis is on the geology and chemistry of Venus' surface, while Pioneer Venus is primarily concerned with detailed information on Venus' atmosphere. Although specific Soviet mission tasks may have differed from U.S. tasks in technical approach and objectives, there has been concern about duplication in the two independent exploration programs and the need for more cooperation between the United States and the Soviet Union.

NASA recognizes the problem of spiraling costs in space exploration and has indicated that international cooperation will be necessary for the United States to undertake a significant portion of its hoped-for projects during the next 15 years. With respect to Venus, NASA's 5-year plan envisions a fiscal year 1980 new start for an orbiting-imaging radar to map the surface of the planet.

The National Academy of Sciences has recommended for many years that the United States actively seek cooperation and collaboration with other nations in planetary exploration, particularly of Venus. Although NASA has made efforts in this regard, the Soviets have not chosen to cooperate in coordinating their planetary programs with the United States.

In July 1968 the Space Science Board of the National Academy of Sciences issued a report addressing the need for cooperation in planetary exploration between the United States and the Soviet Union. Its report showed duplication in the programs of the two countries for exploring Venus. For example, the U.S. Mariner 5 Venus flyby mission in 1967 partially duplicated the Soviet's Venera 4 mission that had just been completed, during which a probe penetrated the atmosphere of Venus. While agreeing that some duplication may have been valuable during the early stages of space exploration, the Board recommended that representatives of NASA, the Department of State, and the National Academy of Sciences informally contact Soviet scientists about the possibility of joint planning of planetary exploration.

A space task group report to the President in September 1969 pointed out that numerous specific technical opportunities for cooperation with the Soviet Union were available. Many of these opportunities had been offered to the Soviet Union over the years with little success. The report concluded that in view of the heavy Soviet commitment, planetary exploration appears to offer unusual opportunities for complementary activities.

In a June 1970 report entitled "Venus - Strategy for Exploration," the Space Science Board stated that there had been a number of international collaboration projects in geophysics and that similar collaboration in planetary exploration was a natural extension of these successful projects. Considering that the investigation of Venus was most suitable for collaboration with scientists of other nations, the Board again recommended that NASA actively seek other national space organizations to participate in planning and carrying out these investigations.

A 1971 staff report to the Senate Committee on Aeronautical and Space Sciences indicated that the Soviet Union, according to its political and scientific leaders, was committed to the principle of space cooperation. For example, the Soviet Union formally initiated cooperation with France as early as June 1966 and has engaged in cooperative scientific endeavors with communist bloc nations. Although advancing the principle of space cooperation in international relations, the Soviets have failed in the past to respond wholeheartedly to U.S. offers of cooperation. NASA considers that Soviet programs with Eastern Europe and France are limited in scope.

In 1972 NASA formed a Pioneer Venus Science Steering Group to enlist the scientific community's widespread participation in establishing the science requirements for the Pioneer Venus missions. In analyzing the effect of various Venus exploration programs on the current Pioneer Venus program, the group concluded that:

"We see the opportunity for a real scientific collaboration in which United States, Soviet Union, and ESRO 1/ programs can build upon and complement each other within the agreements for collaboration that have been negotiated between Governments and National space programs * * *."

They pointed out that although no specific agreements had been reached, initial planning had begun to determine the feasibility of cooperating with the European Space Agency on the Pioneer Venus orbiter mission.

In hearings before the Congress in 1974, NASA testified:

"We are committed by statute and policy to international cooperation in space research and we have made agreements with 55 nations for cooperation in space science activities * * *."

"Our relationship with the Soviet Union involves both cooperation and competition. While we have made considerable progress in exchanging lunar samples and data from our planetary and magnetospheric studies, there is not quite the close and integrated cooperation that features our relationship with the nations of Western Europe * * *."

"We intend to encourage cooperation between the United States and other nations in our present and future space science programs * * *."

SOVIET VENERA PROJECTS

The Soviet Union has been interested in the exploration of Venus since the early 1960s; it launched its first Venera spacecraft in February 1961. The first three Venera spacecraft provided little information about the planet because the spacecraft communications failed before they reached the planet. The next seven missions succeeded in obtaining atmospheric and, to some degree, surface measurements. The United States has had three successful Mariner flyby missions to Venus. (See app. I for listing of spacecraft missions to Venus.)

1/ESRO is the European Space Research Organization--later renamed European Space Agency.

For a time, NASA was very concerned about the extent of duplication between the Pioneer Venus project and the Soviet Venera program. Due to the Soviet's past policy of secrecy concerning its space program, NASA knew very little about the Venera 9 and 10 programs. The agency was concerned that successful Soviet missions might have an adverse effect on the funding of the Pioneer Venus project. Following the Soviet's release of information on their program, the scientific community considered the extent of technological duplication between the projects of the two countries to be slight.

The most recent Soviet spacecraft to Venus, Venera 9 and 10, were launched on June 8 and 14, 1975, respectively. On reaching Venus, descent vehicles separated from the main spacecraft and made soft landings on the planet on October 22 and 25, 1975. The spacecraft were placed into an orbit around Venus. During descent and for about one hour thereafter, the scientific instruments studied such things as atmosphere, environment, surface composition, temperature, and wind velocity.

Superficially, the Venera and Pioneer Venus missions appear to be very similar with their simultaneous use of entry probes and orbiters. Although many of the instruments appear to be duplicates, scientists believe that the Pioneer Venus instruments are much more sophisticated than their Venera counterparts.

After meeting with Soviet scientists in June 1976, American scientists associated with the Pioneer Venus project made the following observations:

--Venera scientific investigations emphasized surface science rather than atmospheric science. Excellent pictures of the planet's surface were taken, and good measurements of surface wind speeds obtained.

--Some good atmospheric measurements of solar energy and cloud data were obtained; however, other atmospheric measurements were disappointing. For example, the Soviets apparently questioned the validity of data obtained from one of their instruments. In another instance, American scientists were disappointed in some cloud measurement data.

In summary, little change in American scientific concepts of Venus resulted from the Venera 9 and 10 missions. American scientists believed that the Soviets (1) presented all available information at the June 1976 meetings but (2) have not analyzed all the data from these latest Venera missions. NASA scientists have concluded that the total science accomplished on Venera 9 and 10 was relatively poor.

COOPERATION WITH THE SOVIET UNION

NASA has attempted to cooperate with the Soviet Union in joint planetary missions. However, the Soviets have chosen to restrict the relationship to one of coordinating planetary goals and exchanging results of completed missions.

Officials at Ames advised us that there have been many discussions concerning joint space ventures, but that generally such discussions have not been productive. The exception is the joint Apollo-Soyuz mission in 1975. Ames officials expressed the opinion that the time has not been ripe for a joint venture with the Soviet Union in exploring Venus. They stated that the Soviet Union is currently somewhat ahead of the United States in the exploration of Venus in that it has already soft-landed a vehicle on the planet and has taken pictures and other measurements.

United States and Soviet relationships in space exploration are discussed in some detail in Volume II of "Soviet Space Programs, 1971-75, Goals and Purposes, Organization, Resource Allocations, Attitudes Toward International Cooperation, and Space Law," an August 30, 1976, staff report for the Senate Committee on Aeronautical and Space Sciences. The report stated

> "Soviet Space politics with respect to the United States since 1971 suggest *** that the governing factor in space relations is the political environment in which they function. Simply stated, an environment of tension produces negative responses; one of detente, positive responses. In both cases, space exploration is manipulated to achieve certain political purposes. The Apollo-Soyuz project probably would have been inconceivable in 1971; in 1975 it was a logical outgrowth of detente; it made political sense. In large measure, therefore, the future of Soviet space politics will be determined, as in the past, by the character of Soviet-American political relations."

NASA has said that there could be cost reductions in Venus exploration if the United States were aware of future Soviet plans and if agreements were made that each mission, whether launched by the Soviet Union or the United States, would be comprised of experiments developed by the scientific communities in each country.

The NASA Administrator, during a June 1977 press conference, stated that a series of uncoordinated missions to Mars or Venus or any other planet clearly would be less strong than a series in which the United States and the Soviets could agree on objectives. He said that he thinks it important that the United States explore with the Soviets how the two planetary programs complement each other so that they would be stronger than they would be if they were completely independent.

COOPERATION WITH THE EUROPEAN SPACE AGENCY

At an April 1972 meeting, representatives of NASA and the European Space Agency decided to examine the terms on which both organizations could cooperate on the Venus orbiter mission. The principles of such cooperation, which would not involve any exchange of funds between the two organizations, were as follows:

--NASA would produce and provide the Europeans with the orbiter spacecraft and common equipment.

--The Europeans would adapt the spacecraft as appropriate, and specific orbiter mission equipment and carry out the integration of scientific experiments and qualification tests.

--The orbiter would then be returned to NASA for launch and flight operations.

Although the Europeans did participate substantially in the planning phase, they decided that they would not participate in the fabrication of hardware for the orbiter spacecraft. Ames officials advised us that European funding priorities were a factor in this decision. The Europeans chose to put their resources into an X-ray astronomy mission and a magnetospheric physics mission.

FOREIGN PARTICIPATION IN PROJECT

Despite the European Space Agency's pullout from the project, England and Germany are participating as follows:

Country	Instrument	Estimated participating cost	Estimated NASA cost
		(millions)	
England	Orbiter infrared radiometer	a/ $0.1	$2.8
Germany	Bus neutral mass spectrometer	b/ 2.5	-
Germany	Orbiter retarding potential analyzer	a/ .8	1.0

a/ The estimated cost of subassemblies to be furnished to U.S. instrument contractors.
b/ Instrument being designed and developed in Germany.

Ames officials advised us that NASA will benefit from such participation by obtaining the data without having to incur the full cost of the instruments.

CONCLUSIONS

U.S. relations with other nations involve elements of competition and cooperation. It can be argued that space technology and scientific knowledge are valuable assets which should be closely held to protect the U.S. technical and scientific lead. It can also be argued that full cooperation and sharing with other nations would generate sufficient international goodwill to offset short-range U.S. technological losses. We believe there is a balance somewhere between these two extremes which would best serve the interests of the United States.

NASA officials testified before the Congress in 1974 that they were committed to encouraging international cooperation between the United States and other nations in current and future space programs. While we noted some degree of cooperation with other nations, there has been only one instance of a major cooperative space effort with the Soviet Union--the Apollo-Soyuz project. We recognize that the political climate has, at times, caused a negative Soviet reaction to NASA attempts at cooperation.

A number of nations are interested in the exploration of Venus--most notably, the United States and the Soviet Union. At the present time the scientific objectives of

these two nations differ. The United States is emphasizing atmospheric science, while the Soviet Union is emphasizing landed science. Scientists have noted that many of the instruments used by the Soviet Union in their exploration of Venus are similar to instruments to be used on the Pioneer Venus project. NASA considers the Venus exploration programs to be complementary.

Spending hundreds of millions of dollars on the exploration of Venus by the United States and the Soviet Union inherently involves massive duplication of effort. In our view, space race competition contributed to the lack of more meaningful cooperation in exploring Venus. However, the lack of cooperation in the past should not discourage future efforts.

Pronouncements by the NASA Administrator as recently as June 1977 indicate that NASA shares our view that cooperative space exploration is potentially beneficial. Attempts to obtain closer cooperation with the Soviets in planetary exploration might result in stronger programs at less cost.

CHAPTER 6

MATTERS FOR THE CONSIDERATION OF THE CONGRESS

This report contains recommendations which, if implemented, will provide the Congress with better information on Pioneer Venus project costs, reserves, funding data, contractor cost data, and the quality assurance program.

NASA, for the most part, does not concur in our recommendations. As a result, congressional committees with legislative and oversight responsibility for NASA programs will have less than full information. Accordingly, we recommend that these committees request, to the extent they need more program information, that NASA implement our recommendations.

APPENDIX I

UNITED STATES (MARINER) AND SOVIET UNION (VENERA)

MISSIONS TO VENUS

Spacecraft	Launch	Results
Venera 1	Feb. 1961	Communications failed before arrival. Passed Venus at 100,000 km.
Mariner 1	July 1962	Launch vehicle veered off course. Had to be destroyed.
Mariner 2	Aug. 1961	Passed Venus at 34,833 km. Obtained measurement of surface temperature, cloud cover structure, magnetic field, and radiation.
Venera 2	Nov. 1965	Communications failed before arrival. Passed Venus at 24,000 km.
Venera 3	Nov. 1965	Communications failed before arrival. Struck Venus 450 km from center of visible disk.
Venera 4	June 1967	Provided detailed measurements of atmospheric composition, pressure, and temperature. Entry probe probably came within 25 km of surface before destruction.
Mariner 5	June 1967	Passed Venus at 4,100 km. Obtained measurements of mass and size, atmosphere, magnetic field, and radiation.
Venera 5	Jan. 1969	Refined data from Venera 4. Signals ceased before entry probe reached surface.

APPENDIX I

Spacecraft	Launch	Results
Venera 6	Jan. 1969	Further refined data obtained from Venera 4. Signals from entry probe ceased before reaching surface.
Venera 7	Aug. 1970	Bus and probe made atmospheric measurements. Probe survived on surface for 20 minutes, measuring atmosphere, temperature, and pressure.
Venera 8	Mar. 1972	Measurements made in upper atmosphere. Entry probe took measurements of lower atmosphere. Probe survived about 50 minutes after soft landing, taking measurements of surface composition, temperature, and pressure.
Mariner 10	Nov. 1973	Performed radar mapping of planet. TV cameras took a total of 4,165 pictures of Venus.
Venera 9	June 1975	Orbiter made measurements of atmosphere, cloud cover, and magnetic field. Entry probe soft-landed, surviving for 53 minutes. Made some surface measurements, and sent back photographs of landing site.
Venera 10	June 1975	Orbiter and entry probe took similar measurements as Venera 9. Probe operated for 65 minutes on surface and returned photographs of its landing site.

APPENDIX II

National Aeronautics and
Space Administration

Washington, D C.
20546

Reply to Attn of W

JUN 15 1977

Mr. R. W. Gutmann
Director
Procurement and Systems
Acquisition Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Gutmann:

Thank you for the opportunity to comment on the GAO draft report entitled "Analysis of the Pioneer Venus Project" (Code 952147). The enclosed NASA comments are keyed to the segments of the draft report to which they pertain. In addition to these specific comments, we are concerned about two significant general aspects of the draft report: the proposed treatment of project reserves, and misstatements of facts in three major areas of the draft report.

With regard to disclosure of Pioneer Venus contingency funds, NASA is always ready to provide the Congress with detailed information. However, it is essential that NASA's continuing internal cost assessments be treated as privileged management information. Such internal information should not be available to contractors through (1) the GAO reports, per se, or (2) subsequent agency reports in the manner recommended by GAO.

In March 1971 GAO and NASA agreed that the agency's 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. (See B-159835, 5/11/71. Also, GAO's report on NASA's Skylab Program (B-172192, 6/17/71) was "restricted" for these reasons.) Subsequently, these limitations were published in NASA's operating instructions (NMI 1325.3) which GAO reviewed while the instructions were being developed.

APPENDIX II

The subject draft report states:

- Page 16 - "We understand NASA's reluctance to openly report project reserves. Such knowledge could presumably give a contractor a better negotiating position. However, we believe that the information needs of Congress are overriding ..." (Underscoring supplied.)

- Page 17 - "We recommend that the Administrator of NASA inform cognizant congressional committees of the amounts of project reserves contained in budget requests for new projects and how such funds are subsequently used."

- Page 22 - "... we recommend that the Administrator of NASA provide cognizant committees with information on (1) NASA's and the contractor's current estimates of the cost of the Pioneer Venus Spacecraft contract cost at completion, ... and (3) NASA's estimate of the maximum fee which can be earned by the contractor at completion."

[See GAO note 1, p. 47.]

The implication of these recommendations is that the information should be openly reported in the Project Status Reports. We strongly disagree with this for the reasons stated above. If, on the other hand, the GAO has in mind the furnishing of such data on a restricted, individual basis to interested members of Congress, we would have no objection. Accordingly, we disagree with the inclusion of the foregoing statements and recommendations, or any other similar language, in the proposed report.

With respect to the accuracy of facts, there are three subject areas of concern (1) the administration of the reliability and quality assurance program for the Pioneer Venus project, (2) the technical problems relating to the parachute, and (3) international cooperation. We are confident that the cognizant NASA Headquarters officials can clarify and correct information that the auditors may have already assembled that is incorrect as indicated in our enclosed comments.

Sincerely,

Kenneth R. Chapman
Assistant Administrator for
DOD and Interagency Affairs

APPENDIX II

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

COMMENTS ON

GAO DRAFT REPORT TO THE CONGRESS OF THE UNITED STATES

ANALYSIS OF THE
PIONEER VENUS PROJECT
(CODE 952147)

NASA has completed its review of the GAO draft report on the analysis of the Pioneer Venus project, and our comments follow:

Page i, 1st paragraph under FINANCIAL ASPECTS OF PROJECT

COMMENT: This summary comparison of the GAO and NASA project cost estimates should specify that the difference lies in the GAO's inclusion of certain prorations of indirect support elements which NASA believes should not be classified as project costs.

[See GAO note 2, p. 47.]

Page ii, last full sentence

START THIS SENTENCE:

—In our opinion— (if this is still true)
See comment referring to page 38, line 17.

[See GAO note 2, p. 47.]

APPENDIX II

[See GAO note 2, p. 47.]

Pages 10 to 14, COSTS NOT INCLUDED IN NASA ESTIMATES

COMMENT: In our response to the GAO report on Project Status Reports (PSR's) dated January 27, 1977, as in our response to prior GAO comments of a similar nature, we noted that to provide an estimate of Pioneer Venus costs including a paperwork proration of support costs for launching, tracking and acquiring data from the spacecraft would be misleading. To do so would be to suggest that, were it not for the project, these prorated costs would be avoidable. On the contrary, costs of this type represent a baseline capability not sensitive to inclusion or exclusion in the budget of any one project.

We do provide a single figure in the PSR's of all costs which can be considered project-related. These include unique, additive costs of launch vehicles, facilities, tracking and data, and flight support as well as costs of the project itself. This reporting conforms to the GAO's expressed concept, with which we agree, that project cost reporting should reflect the project's economic impact on the NASA budget.

[See GAO note 2, p. 47.]

[See GAO note 2, p. 47.]

Pages 14 to 17, RESERVE ACCOUNTS

COMMENT: The reason given by GAO for inquiring about the amount of project reserves included in the budget was that the Congress is concerned with identifying areas where appropriation of funds may be questionable because programs have not progressed to the stage where additional funds are justified.

This concept is not in accord with the way in which administration of incrementally funded Research & Development projects takes place. Progress toward the stage where additional funds are justified is measured by project development status and the rate at which costs are incurred against appropriated funds--not by the amount of reserves which may be planned in the total project. Reserve requirements are typically not estimated on a fiscal year basis but rather are related to the development uncertainties in the total scope of work.

Disclosure of estimated project contingency requirements in documents readily available to contractors would weaken the government's negotiating position, as the GAO itself has observed. We stand ready, as always, to provide the Congress any information it desires on any project, but, especially with respect to estimated contingency requirements, we believe this should be done in a manner to protect the government's interest.

[See GAO note 2, p. 47.]

[See GAO note 2, p. 47.]

Page 17-20, PROJECT FUNDING

COMMENT: The Selected Acquisition Report, on which the PSR is modeled, contains data only on project funding. It contains no data on allotments, obligations, and expenditures. In attempting to make the PSR an all-purpose, all encompassing document the GAO goes far beyond the original intent of the PSR as a convenient project summary. The PSR is not a suitable vehicle for detailed fiscal analysis. To include these details in the PSR would be to burden the covered projects with details out of all proportion to their place in the total NASA program which includes many other important activities for which such data would not be shown in this fashion. We do not recommend such unbalanced handling of fiscal data. Fiscal progress reporting is already covered in complete detail in the agency's regular management information system. Data on all our projects are always available to the Congress.

Page 20 to 22, CONTRACT COST GROWTH

COMMENT: In responding to the GAO report on "Improved Reporting Needed on National Aeronautics and Space Administration Projects" (Final report dated January 27, 1977), we pointed out that the type of contractor cost data that is included in Department of Defense Selected Acquisition Reports might be more appropriate when procuring to well-defined specifications and prime contractor performance can be relatively independent of development problems. However, 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.

APPENDIX II

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.

For these reasons, we suggest that prime contractor cost data, if added to the PSR's, would complicate the report and could lead to serious misinterpretation of project status. We would not recommend their inclusion.

In each successive PSR, we do discuss at project level, the reasons for such cost growth as may have occurred, noting whether due to inflation, project scope changes, technical difficulties, or other reasons.

[See GAO note 2, p. 47.]

[See GAO note 2, p. 47.]

Pages 28 and 29, last line on page 28 and first two on page 29

REPLACE WITH: --believe, however, that the risk is very small and that the potential cost savings was great.

COMMENT: The launch window is believed adequate to insure a successful launch. Earlier release of the nose fairing still leaves heating and dynamic pressure at half their design value. Viking and Helios used a 90 nautical mile coast orbit, as is now planned for Pioneer Venus.

[See GAO note 2, p. 47.]

[See GAO note 2, p. 47.]

Page 33, first two sentences

COMMENT: NASA does not agree. If these sentences represent the current GAO opinion, they should start with "In our opinion."

Page 33, 3rd sentence

REPLACE WITH THE FOLLOWING: Since Ames did not plan to add their quality surveillance until after we completed our field work, we do not know if it was adequate.

COMMENT: See comment on page 35, line 16.

Page 34, after line 11

ADD A PARAGRAPH AS FOLLOWS: For Pioneer Venus, however, NASA placed special emphasis on low cost and encouraged bidders to suggest methods for cost savings.

COMMENT: This statement is needed to place the discussion in proper perspective.

Page 35, line 16

ADD THE FOLLOWING: Ames planned to accomplish these functions by hiring in-plant-representatives and later, as flight hardware activities began, by contracting for quality assurance people.

Page 38, 1st sentence

ADD THE FOLLOWING: --, as had been planned by Ames.

COMMENT: This change is recommended to preclude the possible misimpression that this action was taken in response to the GAO review.

Page 38, line 15

REPLACE WITH: --the benefit of the usual Government control (delegated surveillance) over the--

COMMENT: Since the only significant difference between the Pioneer Venus contractor surveillance program and the usual Government control relates to the delegation of surveillance responsibility to other Government organizations, it is considered important to clarify this point.

Page 38

COMMENT: The sentence starting on line 17 implies an undisputed risk in not using delegated surveillance. Ames management, the Pioneer Project Office, and the Pioneer Program Office feel that the risk is currently no greater with Pioneer surveillance than with the delegated mode. If the GAO feels the risk is greater, then the sentence should be more like, "We believe that Pioneer surveillance involves a greater risk than delegated surveillance and that this risk is not warranted."

[See GAO note 2, p. 47.]

APPENDIX II

[See GAO note 2, p. 47.]

[See GAO note 2.]

Noel W. Hinners
Associate Administrator
for Space Science

GAO notes: 1. Page numbers in this appendix refer to a preliminary copy of this report.

2. Portions of the appendix have been deleted because they are no longer relevant to the matters discussed in this report.

APPENDIX III

PRINCIPAL NATIONAL AERONAUTICS AND SPACE ADMINISTRATION OFFICIALS RESPONSIBLE FOR ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
ADMINISTRATOR:		
Robert A. Frosch	June 1977	Present
Alan M. Lovelace (acting)	May 1977	June 1977
James C. Fletcher	Apr. 1971	May 1977
George M. Low (acting)	Sept. 1970	Apr. 1971
DEPUTY ADMINISTRATOR:		
Alan M. Lovelace	June 1976	Present
George M. Low	Dec. 1969	June 1976
ASSOCIATE ADMINISTRATOR FOR OFFICE OF SPACE SCIENCE:		
Noel W. Hinners	June 1974	Present
John E. Naugle (acting)	Mar. 1974	June 1974
John E. Naugle	Dec. 1971	Mar. 1974

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