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U. S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

APPLICATIONS TECHNOLOGY SATELLITE

F and G PROJECT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FEBRUARY 1973

Contents

APPLICATIONS TECHNOLOGY SATELLITE (ATS) F and G PROJECT

DESCRIPTION AND STATUS

The ATS project is a part of the National Aeronautics and Space Administration's (NASA) unmanned space program assigned to its Goddard Space Flight Center, Greenbelt, Maryland. The ATS F and G project was included in a series of seven spacecraft to conduct experiments and related data gathering studies. Five spacecraft have been launched. The ATS F spacecraft is scheduled for launch in April 1974 and the ATS G spacecraft was canceled in January 1973.

COMING EVENTS

The spacecraft F assembly must be completed and testing started by July 3, 1973 or the April 1974 launch date could be in jeopardy. The Goddard Project Manager stated that he is confident the launch date will be met.

COST

At the time of the award of the spacecraft contract in January 1971, the total estimated cost of the ATS project including launch vehicles, amounted to about $230 million. As of July 1972, NASA's estimate of the project including launch vehicle costs amounted to about $252 million.

The cost impact because of the cancellation of the ATS G spacecraft was not known as of January 1973.

CONTRACT DATA

The prime contractor for the ATS F and G spacecraft is Fairchild Industries, Inc., Space and Electronics Division, Germantown, Maryland. Information on the contract appears on page 7.

TEST AND EVALUATION

Since Goddard's disapproval of Fairchild's test plan in July 1971, Fairchild has been unable to obtain approval of most sections of the plan. This has occurred because of the absence of agreements, at least to Fairchild's satisfaction, as to what should be included

in the test plan to make it acceptable. Also, Fairchild has not, generally, submitted test procedures on a timely basis which in some cases has caused delays in testing.

We have been advised by the Goddard Project Manager that as of October 1972, action has been initiated to facilitate the preparation, review, and approval of the test plan and procedures.

COST ESTIMATING

Our review of the cost estimating process was hindered because of the lack of adequate documentation to support what was done and why. NASA officials have advised us that in their opinion adequate documentation exists. They stated that in developing the estimates, the engineers experience, knowledge, and judgment were the key factors; however, such factors cannot be completely documented.

PERFORMANCE

Our review showed no evidence of performance degradation since inception of the spacecraft contract.

PROGRAM MILESTONES

During fiscal year 1972, the ATS project slipped the launch dates of May 1973 for the F mission and May 1975 for the G mission to April 1974 and July 1975, respectively.

PROGRESS MEASUREMENT

In our opinion, the progress measurement system was not effectively used by the ATS Project Office to provide information necessary for timely and effective management decisions. This is evidenced by the fact that it was not until January 1972, that the ATS Project Office announced that the launch dates were in jeopardy, although continual cost increases and schedule slippages occurred prior to this period.

NASA officials advised us that while the confidence level for achieving the launch dates was decreasing, it was not until January 1972 that it was apparent that the schedule would not be met.

MATTERS FOR CONSIDERATION

As a result of the cancellation of the ATS G mission, we believe the Congress may wish to closely monitor the effects of this action

on the project's objectives and the cost estimates. NASA advised us in November 1972, that it has agreed to provide semiannually, the progress and cost of several of its projects including the ATS project to the Chairman of the Subcommittee on NASA Oversight of the House Committee on Science and Astronautics. Also, in November 1972, we were advised that NASA has commenced to meet with the Chairman of the Subcommittee on Space Science and Applications on a bimonthly basis to discuss the status of major projects, including program highlights and major changes in cost and schedule and the reasons for these changes.

The Congress may wish to consider arrangements under which the information provided by NASA to selected committees may be more widely distributed in the Congress.

AGENCY REVIEW

A draft of this staff study was reviewed by NASA officials. We have studied their comments and made revisions we considered to be appropriate. At NASA's request we have included the full text of their comments as Appendix II.

CHAPTER 1

INTRODUCTION

The General Accounting Office, as a part of its program to provide the Congress with data on the status of major defense weapon systems, has included the status of selected civil systems. This staff study includes the status of a NASA system, the ATS F and G project, for the use of the Congress in the regular authorization and appropriation processes.

PROJECT DESCRIPTION

The ATS project was included in a series of seven spacecraft to conduct experiments and related data gathering studies and to confirm data for various technologies having wide applications in space and space flight. Five spacecraft have been launched. The ATS F spacecraft is scheduled for launch in April 1974. In January 1973, the ATS G spacecraft was canceled. NASA officials advised us that the spacecraft was canceled because of severe agency funding constraints and because of the decision to phase-out communications satellite program activity based on its experience with prior satellites and private industry's capability to finance and manage communications satellites.

The primary objectives for the ATS project are (1) to demonstrate the feasibility of deploying a 30-foot diameter parabolic antenna in space, (2) to point the antenna toward the earth from orbit with very high accuracy, and (3) to provide a stable platform for communications, meteorological, technological, and scientific experiments.

The ATS F spacecraft will weigh about 2,900 pounds and measure about 52 x 28 feet when fully deployed in orbit. The spacecraft has an expected life of at least 2 years and will conduct its experiments in a stationary orbit at an altitude of about 19,000 nautical miles. After a 1 year period over the United States, the spacecraft will be repositioned over Africa to perform among other experiments, a

cooperative experiment with the Government of India. After 1 year, the spacecraft will be returned to its original position.

All experiments for the ATS G spacecraft had not been selected at the time of our review.

PROJECT HISTORY

The ATS project was conducted by NASA under the concept of phased project planning as discussed below.

Phase A (preliminary analysis) contracts were awarded in 1966 to three contractors to study the concept and develop methods of deploying a 30-foot dish-type antenna. Goddard assessed these studies and arrived at what it considered a preferred approach to ATS F and G.

In September 1968, phase B/C (definition) contracts were awarded to two of the phase A contractors. This phase included completion of the conceptual design, generation of designs and specifications for the spacecraft, fabrication and testing of engineering models of technically new or risky items, and preparation of proposals for phase D (development operations).

A phase D letter contract, NAS5-21100, was awarded to Fairchild in January 1971, and was definitized in June 1971. This contract, a cost-plus-award-fee type, required, among other things, the delivery of two spacecraft -- ATS F and G.

SCOPE

Information on the ATS project was obtained by reviewing plans, reports, correspondence, and other records, and by interviewing agency and contractor officials. We evaluated management policies and the procedures and controls related to the decision-making process, but we made no detailed analysis or audit of the basic data supporting program documents. We made no attempt to assess the need for the ATS project or involve ourselves in decisions while they were being made.

Our review was conducted at the Goddard ATS Project Office and at the Fairchild ATS Program Office. We included and updated information obtained from NASA Headquarters during a previous review.

CHAPTER 2

PROGRAM STATUS

COST EXPERIENCE

The initial cost estimate of about $92 million for the ATS project was presented by NASA to the Congress in April 1967, during the 1968 NASA authorization hearings. This estimate was never considered by NASA to be a total estimate for the project since it included the cost of initial experiment definition but not the cost of development and fabrication. Further, the estimate did not include the cost of ground operations. According to NASA officials, a more complete project estimate of about $218 million was provided to a congressional subcommittee in October 1969.

At the time of the award of the contract to Fairchild, the project cost was estimated at about $230 million. This estimate was composed of $94 million for spacecraft, $79 million for experiments, $12 million for ground operations, $44 million for two launch vehicles and $1 million for contract administration. As of July 1972 the project cost was estimated at about $252 million. This estimate was comprised of $117 million for spacecraft, $66 million for experiments, $14 million for ground operations, $48 million for two launch vehicles, $2 million for contract administration, and $5 million for contingencies.

The major increases in the cost estimates since 1967 were due to further definition of requirements in the spacecraft, experiments, and ground operations, and to a change in launch vehicles. The vehicle change was due, in part, to the increased weight requirements for the experiments and expected growth in spacecraft weight. In addition we found no estimates to identify the cost impact because of an 11-month delay in the launch of the ATS F spacecraft. NASA also has not identified the cost impact due to inflation which NASA officials stated is consistent with Government policy. We believe, however, under long-term programs such as the ATS project that inflation should have been identified and available to congressional committees. See our report B-176873, dated December 14, 1972, entitled "Estimates Of The Impact Of Inflation On The Costs Of Proposed Programs Should Be Available To

Committees Of The Congress".

Spacecraft contract

In June 1971 the negotiated cost of contract NAS5-21100 was about $56 million, excluding fee, for the ATS spacecraft. Subsecuent cost increases, schedule slippages, and funding constraints, necessitated a program redirection in March 1972.

The negotiated cost of the contract, excluding fee, increased to about $58 million in September 1972. Fairchild estimated that the contract cost would exceed $99 million excluding fee. This estimate included unnegotiated contract modifications, the largest of which could cost about $11 million, and an estimated overrun of $15 million. As of September 1972, about 55 percent of the estimated contract cost applied to subcontracts. The cost impact because of the cancellation of one spacecraft was not known as of January 1973.

SCHEDULE EXPERIENCE

During the initial stages of the project in April 1967, the launch dates for ATS F and G were planned for May 1972, and May 1973, respectively. Subsecuently, the launch dates were extended as a result of budget constraints. At the time of the award of the contract to Fairchild, the launch dates were May 1973 for ATS F and May 1975 for ATS G. In May 1972 Goddard established new launch dates--April 1974 for ATS F and July 1975 for ATS G. The extension of launch dates was due, in part, to the tight schedules which could not be maintained by Fairchild or its major subcontractors.

According to the Goddard Project Manager, if testing of the assembled spacecraft is not started by July 3, 1973, the April 1974 launch date could be in jeopardy. However, he stated that he is confident the launch date will be met.

PERFORMANCE EXPERIENCE

The technical performance requirements for the ATS project were established prior to the award of the contract to Fairchild. Technical performance is primarily evaluated through testing which is discussed in Chapter 3.

CHAPTER 3

TEST AND EVALUATION

The ATS spacecraft differs from defense weapons systems in that it is not only "one-shot" but "one-of-a-kind". A spacecraft and its various components individually and collectively are subjected to extensive testing to minimize risk and to assure a high probability of successful performance in space.

According to the Goddard Project Manager's Handbook the six objectives of a spacecraft test program are (1) to verify that system, subsystem, and component designs meet performance requirements; (2) to verify that particular hardware samples meet performance requirements; (3) to eliminate defects in material and workmanship; (4) to discover unexpected interactions between subassemblies, particularly when the system is exposed to environmental stress; (5) to verify that ground-support and data-processing equipment are compatible with the spacecraft; and (6) to train spacecraft operations and data-processing personnel.

TEST PLANS

The initial work involved in a test program is the preparation of a test plan which includes the test objectives and the type and sequence of tests to be performed. In June 1971, Fairchild submitted a test plan to Goddard and in July 1971, Goddard advised Fairchild that the test plan was unacceptable because it lacked necessary detail. Fairchild, however, felt that Goddard wanted more procedural detail than could reasonably be expected at that time.

Subsequent meetings were held between Fairchild and Goddard to discuss the test plan, resolve any differences, and establish a course of action which would lead to a joint agreement and acceptance of the plan. As a result of these meetings, Fairchild agreed to submit a section-by-section revision of the test plan. However, it appears that differences were not resolved nor were agreements reached, at least to Fairchild's satisfaction, as to the action necessary to make the plans

acceptable.

As of October 1972, of the 25 sections of the test plan that were resubmitted, five sections have been approved by Goddard. As a result, test procedures were being submitted by Fairchild to Goddard for review without approved test plans. Although the Goddard ATS Spacecraft Manager believed that adequate guidance and direction were given, no written instructions were provided Fairchild evidencing the action necessary to revise the plans and make them acceptable.

Considering the importance of adequate test plans to a spacecraft test program, we believe the Goddard ATS project management should have taken more timely and effective action to assure that Fairchild provided acceptable test plans.

TEST PROCEDURES

Test procedures describe the step-by-step operations to be followed in the performance of a test. In most cases Fairchild has not submitted test procedures to Goddard 30 days prior to testing as required by the contract. Our review revealed that in some cases, the absence or lateness of test procedures has caused delays in testing. NASA considers these delays to be minimal. While a draft copy is sometimes provided prior to formal submission of the test procedures, Goddard has had to expedite its review and approval process to avoid the delay of testing. We believe that this situation unnecessarily increases the risk that the spacecraft may not be tested adequately.

We were advised by the Goddard Project Manager that action has been initiated to facilitate the preparation, review and approval of test plans and procedures. Working groups consisting of Fairchild and Goddard engineers have been established to provide consultation and to review test plans. We were also advised that a Goddard engineer was recently assigned full time at Fairchild to assist in the preparation of test plans and procedures, and additional engineers were to be assigned in the near future.

TEST OPERATIONS

During our review, Fairchild was testing the engineering model

of the spacecraft to demonstrate proof of design and to provide a greater degree of confidence in the success of testing the flight spacecraft. The major subcontractors were performing various tests on spacecraft components to determine if they met mission requirements and to detect material defects.

Integration of the components into the F spacecraft is scheduled prior to July 1973, when testing of the assembled spacecraft is to begin.

TEST WAIVERS

Tests and test specifications have been waived in some cases. Requests for a waiver are reviewed by a waiver review board at Fairchild to determine initial approval or disapproval. Waiver requests submitted by Fairchild are reviewed by the responsible Goddard personnel to determine potential effects of the waiver on cost, schedule, and technical performance of the project. If the waiver will not adversely affect project objectives, it is approved by the Goddard ATS Technical Officer. Our review showed no evidence of performance degradation as a result of the test waivers. The Project Manager at Goddard and the Program Manager at Fairchild stated that technical performance has not been degraded.

TEST REPORTS

Formal reports are required to be submitted to Goddard within 30 or 45 days, depending on the type of test, after the test. Although only 3 of the 14 test reports submitted at the time of our review had been examined by Goddard, we were advised that the Goddard project office is apprised of test results immediately following each test.

Within 48 hours of a test failure, Fairchild is required to submit a written report to Goddard describing the failure. A committee of Fairchild personnel and a Goddard representative is convened as soon as possible after a failure to determine the cause and corrective action. A follow-up report is prepared based on the committee's decision.

CHANGES IN FAIRCHILD'S TEST ORGANIZATION

From January 1971 to the program redirection in March 1972, the

test organization within the Fairchild ATS program management structure reported to the Director of Operations who was responsible for several functional areas in addition to testing. At the apparent insistence of Goddard, Fairchild upgraded its test organization at the time of the redirection by appointing a Director of Integration, Test and Flight Operations who reported directly to the Program Manager.

In April 1972, Fairchild had a private consultant evaluate its test operations. The consultant reported that the organizational structure prior to the redirection resulted in unsatisfactory lines of communications between the Fairchild, Goddard, and subcontractor test personnel. The consultant also reported that the subcontractors often received uncoordinated direction from Fairchild and Goddard concerning the same tests. He advised us that Fairchild's test organization should have played as prominent a role in the beginning of the program as it does presently.

TEST REVIEW

On March 9, 1972, the Goddard Deputy Director assigned a committee, independent of the ATS Project Office, to evaluate the plans and capabilities of Fairchild to perform the integration and testing of the ATS spacecraft. The committee issued its report on March 30, 1972.

The committee had doubts about Fairchild's abilities to perform the required integration and test task, under the then present planning, without major schedule slips. According to the committee's report, fundamental deficiencies existed in the overall project management at Goddard and Fairchild; Fairchild did not realize the full significance of some integration and test problems; and the time intervals and contingency provided in the test schedule were inadequate.

In October 1972, a review of Fairchild's test program was conducted by the Integration and Test Manager for the ATS Project Office. The test manager reported that Fairchild had eliminated most of the deficiencies found by the committee in March 1972. He also reported that, "The progress that has been made recently in the integration and test area is quite encouraging. Fairchild will undoubtedly encounter some difficulty in implementing the plan as proposed; however, it appears that they are headed in the right direction."

CHAPTER 4

PROGRESS MEASUREMENT

To measure a program's progress, management should have a system that provides current and accurate information in terms of cost, schedule, and technical performance. Such information should provide a measurement of work completed against work that was expected to be completed. The purpose of such a system is to alert management on a timely basis to avoid cost overruns, schedule slippages, and performance degradations.

Beginning in about February 1972, the ATS project was reassessed by Goddard and Fairchild to develop new cost estimates and schedules. Previously the cost estimates were underestimated and schedules were overly optimistic. Fairchild identified about $8 million in cost overruns in December 1971 and neither Fairchild nor its major subcontractors could maintain the tight schedules. This situation occurred within a year after the award of the contract to Fairchild.

COST ESTIMATING AT GODDARD

The ATS Project Office semiannually revalidates and updates its cost estimates for the ATS project. These estimates are included with other Goddard project office estimates and provided to NASA Headquarters, Office of Applications, who includes them in their planning estimates identified as program operating plans. The plans are designed to furnish basic financial data needed for budget planning and financial management.

During the period of January 1971 to February 1972, two cost estimates were prepared by the ATS Project Office. These estimates were based, for the most part, on the initial contract estimates negotiated with Fairchild and on financial management reports submitted by the contractor. At the time of the reassessment, the ATS Project Manager requested that his staff make a complete and independent cost estimate of the project. Each engineer assigned to monitor a system or component prepared a cost estimate. The engineers were given verbal instructions as to the level of detail to be included in the estimate. In addition, the engineers were given cost estimating forms to provide a standard format for their estimates. However, each engineer was to use whatever techniques he deemed necessary to arrive at the cost estimate, subject to the approval of the Spacecraft Manager.

Our review of selected estimates was hindered because of inadequate documentation showing what was done and why. A large part of the estimates was determined by the engineers' judgment and experience for which no documentation exists. For example, one engineer told us that an on-site evaluation was made of the work completed and a percentage factor was developed as to what work had to be done based on his judgment and experience. Another engineer stated that he relied on his judgment and experience in estimating a factor for contingency. In neither case was there documentation disclosing how the percentages were determined or the considerations given in their development.

According to the Spacecraft Manager, he and the Project Manager toured Fairchild's and subcontractors' plants to evaluate the project's status prior to reviewing the engineer's cost estimates. These

estimates were compared to Fairchild's estimates and to a parametric estimate developed by Goddard's Program Support Division. The estimates prepared by the engineers generally remained unchanged and were provided to NASA Headquarters for approval.

NASA officials have advised us that, in their opinion, adequate documentation exists. They stated that in developing the estimates the engineers' experience, knowledge, and judgment were the key factors; however, such factors cannot be fully documented.

The absence of adequate supporting documentation does not permit an effective independent review of the estimates. In our opinion, it would be useful to provide Goddard management with information as to the methods and procedures used and considerations that were and were not included in the estimates. In addition, the lack of complete documentation prevents effective use of the estimates for comparing costs incurred with costs estimated and for developing future estimates.

COST ESTIMATING AT FAIRCHILD

In March 1972, as the result of program redirection, Fairchild developed new cost estimates and schedules to complete the program.

As we found at Goddard, there was an absence of adequate documentation supporting what was done and why, which prevented our understanding the development of the cost estimates selected for review. A large part of the estimates were developed based on the estimators' (engineers') judgment and experience for which there was no supporting documentation.

Fairchild officials advised us that the documentation was adequate for its intended purposes, reasonably extensive, and in accordance with normal industry cost estimating practices.

After the estimates were completed, they were reviewed by program management. At the direction of the Program Manager, the labor estimates were reduced by 10 percent. The revised labor estimates, identified as project directive budgets, served as the basis for measuring progress at the operating levels. Further, to determine the estimated labor costs, an hourly rate by wage class which included a yearly inflationary factor of about 5.5 percent, was applied to the estimated hours.

According to the Program Manager, the engineers were requested not to include any contingencies in their labor estimates as such allowances were to be made at the management level. Although we were advised that a management reserve in the amount of $640,000 was established in March 1972 to cover anticipated cost growth, we were provided no detail to identify what the amount was related to or how it was determined. We were informed that a large part of the reserve was related to subcontracts.

SCHEDULES

Schedules chart the sequence of activities that are required to be completed. Schedules are time-phased and include the tasks required to achieve the project's objectives for each system or component of the spacecraft in accordance to previously agreed work steps. As the work is completed, it is noted on the schedules.

According to the Goddard Spacecraft Manager, the schedules used during January through December 1971 were tight but achievable. He stated that the engineers were not required to approve the schedules for the reason that they were considered to be primarily technically

oriented. These schedules have been referred to by the project officials as success oriented schedules that left little time to solving problems without affecting the launch date. In our opinion, since the schedules originally agreed to by Fairchild and Goddard did not adequately provide for such contingencies, it was virtually inevitable that the schedules could not be maintained and the launch dates would have to be rescheduled.

The Goddard Project Manager instructed his engineers to thoroughly review the schedules and with Fairchild, develop new schedules. According to the Spacecraft Manager, all schedules were revised during the period of about February to June 1972, and each engineer was involved in this process. He stated that when the engineers had completed their work, which involved reviewing and discussing with Fairchild what revisions had to be made, the schedules were reviewed with the Project Manager. The schedules were then further discussed with Fairchild and the final schedules were presented to NASA Headquarters for approval.

We could not determine the reasonableness of the new schedules because of the absence of adequate documentation revealing their development.

TECHNICAL PERFORMANCE

The technical performance requirements for the ATS spacecraft were established prior to the award of the contract to Fairchild and have remained basically unchanged. Technical performance is primarily evaluated through testing which is discussed in Chapter 3.

PROGRESS MEASUREMENT SYSTEM

Under the ATS project, a system has been used which can provide a successive summarization of information for management, as to where the project stands relative to the cost, schedule, and technical performance.

Progress measurement at Goddard

The ATS Project Office monitors Fairchild's and the major subcontractors' progress by reviewing the documentation submitted by Fairchild, visiting Fairchild's and the subcontractors' plants, and through its day-to-day contact with the contractors. The documentation furnished by Fairchild includes weekly status reports, monthly progress reports, monthly financial management reports, schedules, weekly position reports, and various test reports. The project office also receives information and reports from its engineering and reliability and quality assurance representatives assigned to monitor activities at Fairchild and two of the major subcontractors.

The manpower sections of the weekly status reports and the monthly financial management reports are used as a means of monitoring cost. Since the major cost is labor, the hours used are monitored closely. If there are unreasonable variances in hours used, the Project Manager is notified. According to the Project Manager, he acts immediately to determine the reason — going to the subcontractors if necessary — and takes action to correct the problem. He advised us that labor variations often point out problems in schedule and technical performance. The financial management report which identifies, among other things, costs incurred and the estimate at completion,

provides summaries of the differences between the current and previous report, and between the negotiated contract value and estimate at completion. The report is also used by the project office to develop cost reports for higher levels of management.

Schedules are monitored through the use of the Program Evaluation and Review Technique system and are usually updated weekly, to reflect the work completed. Additional information to measure schedule progress, is obtained from the Fairchild weekly position reports which identify problem areas, action taken, and impact on the schedules.

Technical performance is primarily measured by testing the item and reviewing test reports. In addition, test deviations affecting performance requirements must be approved by the ATS Project Office.

The weekly status reports and monthly progress reports are used, according to the Project Manager, to monitor overall status and progress. The weekly status report also includes: overall project status, current problems and proposed corrective actions, test failures of the previous week, key personnel changes, and work to be performed in the subsequent week. The monthly progress reports are reviewed for accuracy by the project staff and provide a history of the program.

The project office also receives reports from the Defense Contract Administration Services, on its reviews in the quality assurance and testing areas and from the Defense Contract Audit Agency, which gathers financial data used in negotiations and performs audits of the contract.

To inform Goddard and NASA Headquarters management of project status and progress, the project office prepares a monthly Project

Management Report. The report is to provide an early warning of potential problems which may effect cost, schedule, or technical performance.

In light of the continual cost increases and schedule slippages during the period of January 1971 to January 1972, it appears that the progress measurement system was not effectively used by the ATS Project Office to provide information necessary for timely and effective management decisions. Although a number of problems were evident by November 1971 and the confidence level for achieving the launch dates was decreasing, we were advised that it was not until January 1972 that the ATS Project Office could determine that the launch dates were in jeopardy. The problems included:

1. The general test plan was unacceptable. A basic requirement, on which much was dependent for adequate testing, was incomplete.
2. Test procedures were continually provided late and revised test plans were unacceptable.
3. Problems with two of Fairchild's major subcontractors necessitated assignment of NASA personnel at the subcontractors' plants.
4. Lengthy negotiations were required by Fairchild to definitize contracts with the major subcontractors.
5. Fairchild had not placed sufficient emphasis on test operations and required additional technical personnel.
6. Success oriented schedules left insufficient time for completing tasks and solving problems and corrective action plans were, in many cases, incomplete or nonexistent.
7. Deliverable hardware was due, but in many cases was not ready.
8. Actual costs exceeded estimated costs.

Our review of the monthly Project Management Reports revealed that it was not until January 1972, that the report showed the scheduled launch dates were in jeopardy. However, as previously discussed, it

was recognized that there were problems but they were either not identified or effectively presented in the reports to keep Goddard and NASA Headquarters' management aware of the status of the project. We believe that Goddard management's decision to appoint a new ATS Project Manager in February 1972, was a positive step to strengthen the project's management.

Progress measurement at Fairchild

Fairchild monitors subcontractor progress by reviewing the documentation furnished by the subcontractors, visiting the subcontractors' plants, and from information received in its day-to-day contact with subcontractor personnel. Fairchild also receives information and reports from its representatives assigned to monitor the activities at the major subcontractors' plants.

The documents furnished by the subcontractors include weekly status reports, monthly financial management reports, schedules, and test reports. These documents, reflecting the individual subcontractor's activities, are similar in content and format to the reports Fairchild submits to the Goddard Project Office. They are used by Fairchild to determine subcontractor progress and to form the basis for its reports to Goddard.

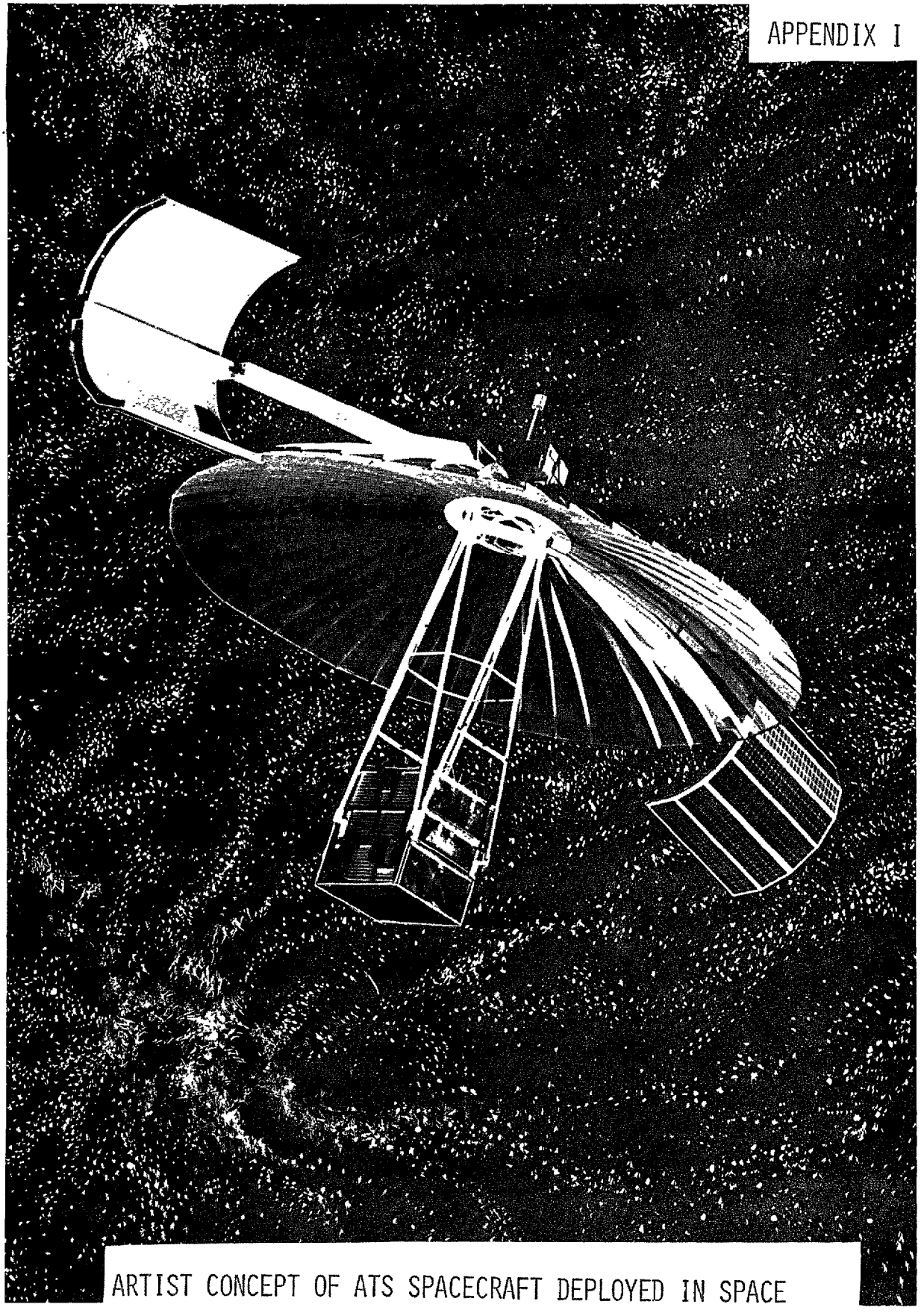
Fairchild measures its own progress primarily through the use of the documents prepared for Goddard. The program office also uses two additional methods: (1) a report which compares actual labor hours against project directive budget hours and (2) monthly charts which, among other things, identify the actual costs and estimated costs of

tasks completed.

According to the engineers responsible for monitoring labor hours used, the project directive budget does not reflect the most current estimate of labor hours. To make a comparison of hours used to budgeted, the engineers must add to the budget, estimates prepared for new or additional work approved since the budget was last updated. A Fairchild official told us that the project directive budget is updated only when a new estimate is made for the total program and that this has not been done since March 1972.

In our opinion, the project directive budget should be updated more regularly so as to provide management with the visibility necessary to effectively measure performance and identify problem areas on a timely basis. We were advised by NASA officials that Fairchild has been instructed to update its budget at least once every 3 months. While this will be an improvement, we believe the budget should be updated as often as necessary to enable management to effectively measure performance.

Our review of the monthly charts revealed that Fairchild's estimates have been conservative and unrealistic. Fairchild's estimated cost overrun has increased from about $8 million in December 1971 to about $15 million as of September 1972.



ARTIST CONCEPT OF ATS SPACECRAFT DEPLOYED IN SPACE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF:
D

February 20, 1973

Mr. Hassell B. Bell
Deputy Director for Major Acquisitions
Procurements and Systems Acquisitions Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Bell:

Thank you for the opportunity to review GAO's proposed staff study of the Applications Technology Satellites F and G, which was forwarded by GAO's letter dated January 19, 1973.

There are enclosed the Office of Applications' comments on your study, which are arranged in the same order as the segments of the report to which they pertain. As noted in the opening statement of the enclosure, many actions have already been taken by NASA and by the contractor to overcome the problems identified in the study and the Office of Applications is making a continuing effort to keep Congress fully informed of its progress with this and other programs.

It is important to emphasize an additional point in connection with the discussion of increases in NASA's cost estimates for the ATS-F and G project, as mentioned on page 4 of the enclosure. In accordance with our earlier discussions with you and consistent with prior GAO audit reports, NASA agrees that development estimates, in lieu of planning estimates or other preliminary projections, should be used as baselines for measuring cost growth and actual performance.

A development estimate is made after all of the key elements of the project have been identified and their estimated cost developed in some detail, but before committing the expenditure of the great bulk of the money that will be required. On page 6 of GAO's proposed study report NASA's cost estimate of about $230 million is related to the time of the award of the contract to Fairchild Industries in January 1971; this is the development estimate for the ATS-F and G project.

While the October 1969 planning estimate of $218 million is discussed on page 4 of the enclosure it admittedly was not fully definitive and the April 1967 estimate, cited on page 6 of GAO's proposed study report, was

even more preliminary and incomplete. We believe it is very misleading for GAO to imply that the observation "ATS-F and G project cost estimates have continued to increase each year since 1967" is a valid basis for evaluating performance. NASA accepts the $230 million development estimate as the cost baseline for the ATS-F and G project.

With regard to the documentation supporting the cost estimates made by experienced engineers, especially those estimates which are independently validated by other technology experts, it must be remembered that a great deal of reliance is placed upon the estimator's experience, knowledge, and judgment. Further, NASA's project and program officials who review and approve such estimates are well qualified to understand and assess the estimator's efforts. The degree of documentation that must be retained in connection with any type of estimate is a matter of judgment, but this does not warrant conclusions that "*** no one other than the estimator actually knows what is included in the estimate" or that "effective independent review of the estimates" was not permitted.

In view of the short time available for your staff study report, we suggest that NASA's comments be made an integral part of GAO's report for the benefit of members of the House and Senate Committees on Appropriations. We will be glad to discuss NASA's comments with you or members of your staff at your convenience.

Sincerely,

Richard C. McCurdy
Associate Administrator for
Organization and Management

Attachment: As stated

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF EP

FEB 16 1973

MEMORANDUM

TO: D/Associate Administrator for Organization and Management

FROM: E/Associate Administrator for Applications

SUBJECT: GAO Staff Study on Applications Technology Satellites F and G, Assignment 951003

Enclosed is our program office response to requests for comments on the subject study.

Charles W. Mathews

Attachment

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

COMMENTS ON

U.S. GENERAL ACCOUNTING OFFICE STAFF STUDY

APPLICATIONS TECHNOLOGY SATELLITES

F and G PROJECT

The staff study has been reviewed by appropriate NASA officials. Many of the problems cited in the study have already been recognized and vigorous action has been taken, including organizational and personnel changes by the contractor and by NASA, to overcome the problems and preclude their recurrence. Those problems which pertain particularly to the November 71 to January 72 time frame were reported in depth to Congress on May 2, 1972. The Office of Applications is making a continued effort to keep Congress fully informed on the progress of this and other Applications Programs. More specific comments on this study are as follows:

Chapter 1: INTRODUCTION

GAO Comment

"However, funding constraints necessitated cancelling the ATS-G spacecraft."

GAO Comment

"However, because of funding constraints the ATS-G spacecraft was cancelled in January 1973."

Response

The decision to cancel ATS-G was made in the context of severe overall funding constraint for NASA and a decision to phase-out communications satellite program activity. Space Communications is the oldest and most mature of NASA's Applications activities and the progressive efforts of ECHO, RELAY, SYNCOM, and earlier ATS missions have borne fruit.

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COMSAT, a direct spin off of these efforts, is a viable and growing commercial industry providing international communications satellite services. Based upon these developments, today private industry is able and prepared to finance and manage domestic communications satellites to serve the United States. Therefore, the cancellation of ATS-G must be viewed within a larger historical and budgetary context.

GAO Comment

". . .Fairchild has not in most cases submitted test procedures on a timely basis, therefore, Goddard has had to compromise its review and approval of the procedures to avoid a delay of testing."

Response

While it is true that test procedures have not been submitted on a timely basis, we consider the conclusion to the effect that "Goddard has had to compromise its review and approval of procedures. . ." to be unwarranted; no compromise was made. More comments on this subject are covered under the response to Chapter 3, "Test and Evaluation."

GAO Comment

"Our review of the cost estimating process was hindered due to inadequate documentation showing what was done and why."

Response

Cost estimates were generated by the most knowledgeable engineers at the GSFC project at the component level and the results of this were recorded in a format designed to present all of the information; overall costs thus developed were supported by an independently generated estimate based on use of a cost model. Copies of this material have been consolidated and were made available to the GAO representatives. Additional comments on the subject of cost estimating are covered in the response to Chapter 4, "Progress Measurement."

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GAO Comment

"In the light of continual cost increases and schedule slippages in the period January 1971 to January 1972 it appears the progress measurement system was not effectively used by the ATS Project Office to provide information necessary for timely and effective management decisions."

Response

There were indications in November 1971 that the confidence level for achieving launch date was decreasing as difficulties were encountered in meeting interim milestones. "Work around" plans were developed as an approach to adhering to the scheduled launch date; however, in early January 1972, a parts procurement problem at a subcontractor made it apparent that the schedule would not be met. This resulted in an immediate in-depth investigation by NASA Headquarters' Office of Applications and GSFC Management. It was determined that project management had permitted various elements of the spacecraft development to get out of phase, so that progress in highly visible areas was not matched in equally critical but less visible areas, and the technical risks in the project were unnecessarily increased. Action was taken to strengthen management at GSFC and the spacecraft contractor through personnel and organizational changes. The launch was delayed and the level of effort reduced while the proper relationship among the various project elements was reestablished. Progress on the revised launch schedule and cost plan since these actions were taken has been satisfactory, and the technical risks have been reduced. More specific comments on this subject are included in the response to Chapter 4, "Progress Measurement."

Chapter 2: PROGRAM STATUS

GAO Comment

"The initial cost estimate of about $92 million for the ATS F and G project was presented by NASA to the Congress on April 18, 1967, during the 1968 NASA authorization hearings.

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This estimate was comprised of $68 million for spacecraft, $4 million for experiments, and $20 million for two launch vehicles and was based on experience gained from earlier ATS projects because preliminary design work for ATS F and G had not been completed."

Response

The cost experience cited does not reflect NASA response to another draft GAO assignment (39930): "Increase Cost for Unmanned Flight Projects." In that response it has been noted that the April 1967 project cost figure of about $92 million was not only incomplete, it was based upon incomplete preliminary design work. Considering the very tentative nature of those estimates it is suggested that another figure be used as the departure point for discussing ATS cost experience.

The earliest estimate presented to Congress that could be treated as the planning estimate for the complete ATS-F and G project was a total of $218 million discussed in October 1969 in Supplemental Review Hearings before the House Subcommittee on Space Science and Applications. Even this total estimate was not fully definitive, because the "G" mission experiments had not yet been selected and the final contractor for the ATS-F and G spacecraft had not been selected. This $218 million estimate was comprised of: $140 million for F and G spacecraft (including $34 million for "F" mission experiments only); $44 million for two launch vehicles (Titan IIIC); plus a tentative estimate that "G" mission experiments would cost about the same as those for the "F" mission ($34 million).

GAO Comment

"Although there had been an eleven month delay (May 1973 to April 1974) in the launch of the ATS-F spacecraft, we found no estimates identifying the cost impact as a result of this change. We also could not determine the cost impact due to inflation since such costs were not identified under the ATS F and G project."

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Response
The cost estimate prepared in the Spring of 1972 was based on the overall schedule being generated at that time. Included in the estimate were the costs associated with the stretch-out of experiment and ground equipment contracts as well as the costs of manpower and other resources required by Fairchild to meet the new launch schedule. We agree, these costs were not separately identified in our budget submission.

With reference to the impact of inflation on the estimate, please be advised that in developing our figures we followed Government policy. For a discussion of this subject see OMB Circular A-11 - Sections 22.1 - 22.2, June 1971. Briefly, the Circular prohibits the incorporation of factors designed to reflect future economic conditions.

GAO Comment

"Under the contract (to) Fairchild, among other things, was to assemble one prototype and two flight models of the ATS spacecraft."

Response
Two prototypes (F&G) were required by the contract. One of the models was to be a rework of the first unit. A thermal/structural model was also required.

GAO Comment

"The negotiated value of the contract, less fee, increased to about $60 million by September 30, 1972."

Response
The negotiated value of the contract, as of September 30, 1972, was $58,488,000.

Chapter 3: TEST and EVALUATION

GAO Comment

"However, it appears that differences were not resolved nor were agreements reached, at least to Fairchild's satisfaction, as to the action necessary to make the plans acceptable.

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Although the Goddard ATS Spacecraft Manager believed that adequate guidance and direction were given, no written instructions were provided Fairchild evidencing the action necessary to revise the plans and make them acceptable."

"Considering the importance of adequate test plans to a spacecraft test program we believe the Goddard ATS project management should have taken more timely and effective action to assure that Fairchild provided acceptable test plans."

Response

Fairchild Industries (FI) plans were considered to require strengthening in the test area. Recognizing this, FI was required to deliver test plans and procedures well in advance of use dates to permit problems to be identified and resolved. Initial plans and procedures submitted by FI were, in fact, inadequate and an extended series of exchanges between GSFC and FI was initiated to resolve problem areas.

In July 1971, after advising Fairchild that the test plan submitted in June was unacceptable, Project Management decided that the best approach to an acceptable program was to have Goddard test engineers work directly with their counterparts at Fairchild. This relationship was commenced in July 1971 and has continued until the present time. Shortly after the two groups began working together it became apparent to the Goddard engineers that a training program was required at Fairchild and that, both, Fairchild, and the project, required increased staffing in the testing area. Accordingly, experienced test engineers were added to each group and the situation began to improve.

As a result of these exchanges, FI has developed a more realistic test program. In areas where there were potential delays in tests due to lack of test plans and procedures steps were taken to complete the specific plans and procedures involved in time to avoid all except insignificant and minor delays in tests. FI is now in a greatly improved position in the test area, and performing acceptably.

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GAO Comment

"Our review revealed that, in some cases, the absence or lateness of test procedures has caused delays in testing."

"Goddard must compromise the review and approval process to avoid the delay of testing. We believe that the lack of adequate time to review test procedures unnecessarily increasing the risk that the spacecraft may not be tested adequately."

Response

Only minimal delays in testing have resulted from late submission of test procedures. Such delays in testing as have been experienced were in the order of hours. Late submissions of test procedures have not affected the review and approval process. No compromises have been made, and all tests conducted have been more than adequate.

Chapter 4: PROGRESS MEASUREMENT

GAO Comment

"Beginning in about February 1972, the ATS project was reassessed by Goddard and Fairchild to develop new cost estimates and schedules."

"At the time of reassessment, the ATS Project Manager requested that his staff make a complete and independent cost estimate of the project. Each engineer assigned to monitor a system or component prepared a cost estimate. The engineers were given verbal instructions as to the level of detail to be included in the estimate. However, each engineer was to use whatever techniques he deemed necessary to arrive at the cost estimate, subject to the approval of the Spacecraft Manager."

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Response
At the time the reassessment was made, in addition to verbal instructions, each engineer was provided a set of cost estimating forms designed to correlate with the project work breakdown structure as well as to provide a standardized format for compilation of the total estimate. In most cases, the engineer reviewed the status of each spacecraft component, assessed the percentage of completion of the hardware, or percentage of testing, etc. As the estimates were completed, they were reviewed in detail by the Project staff and assembled into a total budget estimate.

GAO Comment

"Our review of selected estimates was hindered because of inadequate documentation showing what was done and why. A large part of the estimates was determined by the engineers' judgement and experience for which no documentation exists."

Response
The amount of documentation required to adequately support a cost estimate can vary. In our opinion adequate documentation was compiled by experienced engineers, possessing considerable knowledge in their respective areas of responsibility.

Project Engineers reviewed the estimated cost factors proposed for each component, including those which were in process of development, or manufacture, and those which were in a phase of testing.

The information resulting from this effort was documented and comprised the Project's cost estimate.

In addition, the estimate was independently validated by a support group on Center, through the application of computerized cost modeling techniques, developed from historical data generated by other flight programs.

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GAO Comment

"The absence of adequate supporting documentation does not permit an effective independent review of the estimates."

"In addition, the lack of documentation prevents the effective use of the estimates as a basis for future estimates because no one other than the estimator actually knows what is included in the estimate."

Response

We feel that adequate documentation exists on file, and is available for review. In developing estimates such as was done in February 1972, each engineer's past experience, knowledge, and judgement, as applied to his area of technical responsibility were the key factors in the effort. Unfortunately, such factors cannot be completely documented. However, it should be pointed out that the estimate of February 1972 has remained essentially unchanged to date and appears to be a realistic basis for funds required to complete the program.

GAO Comment

"These schedules have been referred to by the project officials as success oriented schedules that have left little time to solving problems without affecting the launch date. In our opinion, the schedules originally agreed to by Fairchild and Goddard did not adequately provide for such contingencies, and as a consequence, it was virtually inevitable that the launch dates would have to be rescheduled."

Response

The twenty-seven month schedule negotiated could be described as "tight" but achievable. In regard to this subject, it should be noted that each of the Phase B/C contractors originally proposed less time for delivery. Fairchild proposed twenty-two months, and General Electric proposed twenty-four months.

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GAO Comment

"We were advised by Goddard officials that the schedules developed during February to June 1972 are more realistic than those developed prior to this period. However, we could not determine the reasonableness of the new schedules because of the general absence of documentation at Goddard and Fairchild revealing their development."

Response

During the period from February to June 1972, many meetings were held with Fairchild for the purpose of developing new schedules. In most cases the specific reasons for revising the individual PERT span times or work plans were not formally documented. However, the ATS Project Engineers did not approve the new schedules until extensive review and analysis had been completed. The detailed PERT networks, and the general documentation supporting them, including the notes taken during the meetings of April 27 and 28, 1972, are available for review.

GAO Comment

"In the light of the continual cost increase and schedule slippages during the period of January 1971 to January 1972 it appears that the progress measurement system was not effectively used by the ATS Project Office to provide the information needed for timely and effective management decisions. Although a number of problems were evident by November 1971 we were advised it was not until January 1972 that the ATS Project Office could determine that the launch date was in jeopardy."

Response

There were indications in November 1971 that the confidence level for achieving the launch date was decreasing. Fairchild was experiencing difficulties in meeting interim milestones. As a consequence, "work around" plans were developed as an approach to adhering to the launch schedule. Fairchild continued to maintain in all of its reports that, because of these plans, the schedule would be met.

However, in early January 1972, Fairchild reported a four month slip in the delivery of the communications subsystem. The slippage, which was caused by a parts procurement problem, made it apparent that the launch schedule could no longer be maintained.

GAO Comment

"Based on our review of the monthly charts, it appears Fairchild's estimates have been conservative and unrealistic. . . .by December 1971, Fairchild estimated cost overruns in the amount of about $8 million which has continued to climb to about $15 million as of September 1972."

Response

We agree that Fairchild's estimates were too conservative. However, some of the problems encountered as a result of such conservatism may not have developed had Fairchild updated its Project Directive Budget (PDB) more frequently. The PDB had been updated only when a new estimate was made for the total program. This infrequent updating appears to be directly related to the difficulties experienced. Fairchild has been instructed to update the PDB on a regular basis of at least every three months so as to assure that progress measurements may coincide with current estimates.