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Report to the Chairman and the Ranking Minority Member, Subcommittee on Commerce, Justice, and State, the Judiciary, and Related Agencies, Committee on Appropriations, U.S. Senate

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WEATHER SATELLITES

Cost Growth and Development Delays Jeopardize U.S. Forecasting Ability

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The Honorable Ernest F. Hollings
Chairman
The Honorable Warren B. Rudman
Ranking Minority Member
Subcommittee on Commerce, Justice, and State,
the Judiciary, and Related Agencies
Committee on Appropriations
United States Senate

This report responds to your request concerning the cooperative arrangement between the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) for the development and procurement of the next generation of geostationary weather satellites. Specifically, it discusses the award of the prime contract and its principal subcontract, the current cost and schedule status of the contract, and the coordination between NASA and NOAA on the program and the degree of contract oversight by NASA.

As requested, we plan no further distribution of this report until 15 days after its issue date, unless you publicly announce its contents earlier. At that time, we will send copies to the Administrator, NASA; the Secretary, Department of Commerce; the Under Secretary for Oceans and Atmosphere, Department of Commerce; appropriate congressional committees; and other interested parties.

Please contact me at (202) 275-5140 if you or your staff have any questions concerning the report. Appendix II lists other major contributors to this report.

Mark E. Gebicke
Director, NASA Issues

Executive Summary

Purpose

To provide continuous and reliable collection of environmental data in support of weather forecasting and related services, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) are cooperating in the development and procurement of the next generation of Geostationary Operational Environmental Satellites (GOES).[1] The GOES system is made up of two satellites, but only one satellite is currently operating. Its loss would mean that the United States would no longer be able to provide real-time early warning and to continuously track severe weather patterns, such as tornadoes and hurricanes.

The next generation of five satellites, GOES-NEXT, will cost more than $1 billion (including launch services) and will not be ready for launch until at least the fall of 1990 and possibly not until mid-1991. The Chairman and the Ranking Minority Member of the Subcommittee on Commerce, Justice, and State, the Judiciary, and Related Agencies, Senate Committee on Appropriations, asked GAO to review NASA's award of the GOES-NEXT contract and its compliance with applicable laws and regulations, the cost and schedule status of the program, and NASA's and NOAA's contract oversight and agency coordination.

Background

The GOES program is part of a system of satellites that provide meteorological data for regional analysis and forecasting purposes. This type of data collection began in 1974.

GOES-NEXT is the newest series of GOES satellites for measuring the earth's atmosphere, surface, cloud cover, and electromagnetic environment. NASA awarded a cost-plus-award-fee contract to Ford Aerospace in 1985 to develop and produce five of these satellites. The principal subcontractor for instrument development is ITT Corporation.

Results in Brief

In developing the Request for Proposals, soliciting and reviewing bids, and awarding the GOES-NEXT contract, NASA followed the procedures required under procurement laws and regulations for determining the contracting method, establishing and applying source selection criteria, and disseminating proposal and contract information. NASA's cost estimates for completing GOES-NEXT—while relatively stable for the first few years—increased dramatically in 1988. Although the eventual cost

[1] A geostationary satellite orbits the earth but maintains its relative position to the earth.

of GOES-NEXT is uncertain, the total cost, including launch services, will exceed $1 billion.

Similarly, although the extent is unknown, schedule delays are likely. The initially scheduled first launch has been missed, and further delays are expected. These delays will likely increase the GOES-NEXT cost beyond current estimates. Additionally, with only one GOES satellite currently operating, the U.S. ability to provide real-time early warning and to continuously track potentially destructive storms is jeopardized.

NASA and NOAA have jointly participated in GOES-NEXT development and procurement. While NOAA does not have direct contract management authority, it participates with NASA in all program and status reviews. Although NASA's level of program oversight was less than desirable at the beginning of the contract, NASA has since corrected that problem. Also, NASA and NOAA appear to have adequately coordinated on the program since its inception.

Principal Findings

Source Selection and Contract Award

GAO found that, throughout the contract award process, NASA followed the procedures associated with determining the contracting method, establishing and applying source selection criteria, and disseminating proposal and contract information as required under the Federal Acquisition Regulation and its own acquisition regulations.

The Request for Proposals for the GOES-NEXT satellites, which was issued in June 1984, led to three proposals, which NASA's Source Evaluation Board reviewed and rated. Ford Aerospace and Hughes Aircraft Company were the final offerors. According to NASA's Selection Statement, Ford Aerospace's proposal was technically superior to Hughes'; however, Hughes' proposal was 9 percent lower in proposed cost than Ford Aerospace's. The Board concluded that the difference in cost was not significant enough to warrant acceptance of lesser technical capability. The Board noted, however, that Hughes' cost advantage was eliminated if other costs—such as the probable shuttle launch costs—were added to both Hughes' and Ford Aerospace's proposals and the total probable cost to the government was considered.

Cost Growth and Schedule Delay

The estimated program cost for GOES-NEXT has increased from a March 1984 estimate of about $294 million to a current estimate of about $725 million. The estimate includes costs for satellite acquisition, contract support, and program contingencies but does not include about $426 million estimated for launch services. Program officials told GAO that the increase in the estimated program cost was attributable to the decision to acquire additional satellites, numerous contract modifications, a lack of design studies, and underestimates of design and production difficulties.

The first GOES-NEXT satellite was initially scheduled for launch from the space shuttle in July 1989. Following the Challenger accident and the subsequent decision not to use the shuttle, the launch date was changed first to March 1990 and then to July 1990. According to a program official, it now appears that the launch cannot be earlier than the late fall of 1990 and could slip into mid-1991. Each delayed launch will further increase the program's cost because the launch services contract provides for monetary penalties for launch delays. Launch service costs also will likely increase because NOAA officials are seeking to have the contract for launch services renegotiated on a sole-source basis in order to stretch out the launch schedule. NASA officials stated that, since the contract period will be longer, the costs for the later years of the contract will increase.

Additionally, with only one GOES satellite currently operating, the U.S. ability to provide real-time early warning and to continuously track potentially destructive storms is jeopardized. Several less-than-optimal options are available if the last operational GOES satellite fails before the launch of the first GOES-NEXT. The United States could support forecasting operations with other observational data, such as data from polar-orbiting satellites or from European and Japanese geostationary satellites. However, these data sources cannot replace the constant monitoring capability of GOES satellites. At a conference attended by potential users of GOES-NEXT data, the head of the National Weather Service said that the total loss of GOES coverage would create a national emergency.

Oversight and Coordination Activities

Officials from NASA, NOAA, and the contractor agree that NASA's level of program oversight was less than desirable at the beginning of the contract because of the need to concentrate resources on completing the previous GOES contract. However, since then, there has been a buildup of the staff working on the program. For example, NASA employee staff-year charges to GOES-NEXT have risen from 7.2 in fiscal year 1985

to 41.1 in fiscal year 1988. NASA has also taken other actions, including assigning a full-time staff of nine, including a resident manager, to the Ford Aerospace facility and, most recently, assigning the equivalent of a full-time engineer to ITT.

GAO found that NASA and NOAA have coordinated throughout the life of the GOES-NEXT contract. NOAA provided the original specifications, reviewed and concurred on such documents as the Request for Proposals, had staff on the Source Evaluation Board and its supporting committees, and has offices collocated at the Goddard Space Flight Center with the GOES-NEXT program office. In addition, both NASA and NOAA have received a variety of program and financial management reports on a regular schedule from the contractor and the principal subcontractor.

Recommendations

GAO makes no recommendations.

Agency Comments

As requested, GAO did not obtain written comments on its report. However, GAO discussed its findings with agency program officials and included their comments where appropriate.

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Abbreviations

CBD	Commerce Business Daily
ELV	Expendable Launch Vehicle
FAR	Federal Acquisition Regulation
GAO	General Accounting Office
GOES	Geostationary Operational Environmental Satellite
ISAGE	Imager/Sounder Analysis Ground Equipment
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OGE	Operations Ground Equipment
RFP	Request for Proposals
SEB	Source Evaluation Board
SMS	Synchronous Meteorological Satellite

Introduction

The Geostationary Operational Environmental Satellite (GOES)[1] program is part of a system of satellites that provide meteorological data for regional analysis and forecasting purposes. Under a 1973 cooperative agreement, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) share responsibility for the GOES program. NOAA, through the Department of Commerce, establishes program requirements, operates and maintains the satellites, and acquires, processes, and distributes the data products. NASA prepares program implementation plans; designs, engineers, and procures the satellites and instruments; provides for launch of the satellites; and conducts on-orbit checkout of the satellites before transferring them to NOAA for routine operations. In 1982, NOAA and NASA program officials agreed that NOAA would provide the funding for the GOES-NEXT development effort, which had previously been funded by NASA. Within NASA, the Goddard Space Flight Center is responsible for program implementation.[2]

GOES' primary mission, operating in conjunction with ground-based support systems, is to continuously and reliably collect environmental data in support of weather forecasting and related services. The satellite data is made available to federal agencies, state and local governments, and private users. This type of data collection began in 1974 with the Synchronous Meteorological Satellite (SMS). Ford Aerospace built two prototype satellites (SMS A and SMS B) plus the first three operational GOES satellites: GOES A, B, and C. Hughes Aircraft Company built the next five satellites: GOES D, E, F, G, and H. GOES-NEXT will be the new generation of five satellites: GOES I, J, K, L, and M. NASA awarded a contract to Ford Aerospace in 1985 for the GOES-NEXT satellites.

According to NOAA officials, the GOES satellites are critical to the early and reliable prediction of severe storm patterns, such as tornadoes and hurricanes. According to the National Weather Service, the United States has a very high incidence of hazardous weather. The 1,000 tornadoes, 5,000 floods, 10,000 severe thunderstorms, and several hurricanes that hit the United States annually continue to take hundreds of lives and cause property damage approaching $10 billion.

Each GOES-NEXT satellite consists of a stable platform for instruments used in making measurements of the earth's atmosphere, surface, cloud

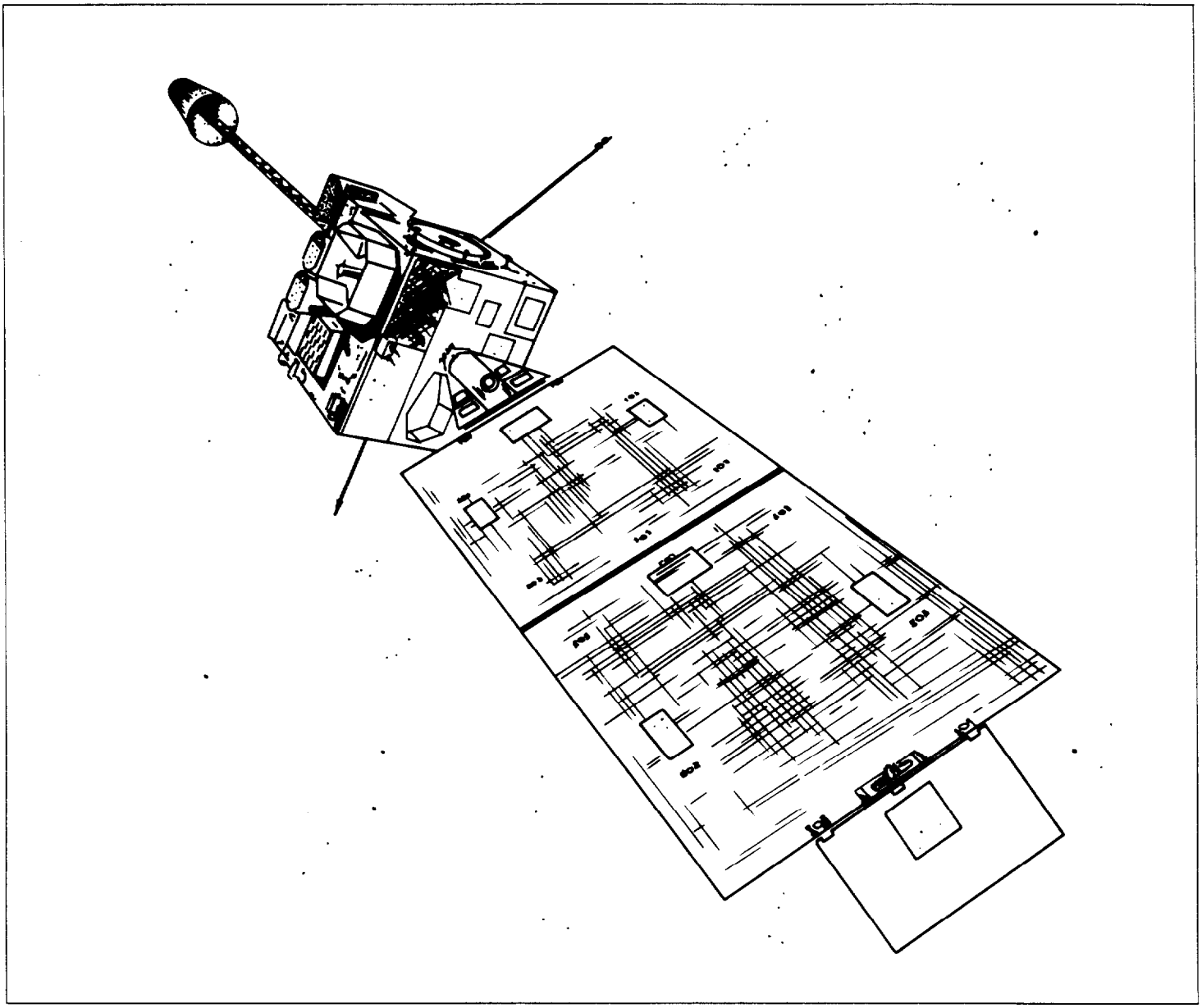
[1] A geostationary satellite orbits the earth but maintains its relative position to the earth.

[2] The Lewis Research Center is responsible for the commercial launch services contract activities associated with the GOES-NEXT satellites.

cover, and electromagnetic environment. Each GOES-NEXT satellite will carry two primary instruments—an imager and a sounder—in addition to several other instruments. The imager will produce visual and infrared images of the earth's surface, oceans, cloud cover, and severe storm developments. The sounder will produce various temperature and moisture profiles.

The GOES-NEXT satellite platform and configuration will allow the satellite sensors to continuously "stare" at the earth. (In contrast, the current generation of GOES satellites spin so that the instruments "see" the earth a maximum of only 5 percent of the time.) All the instruments will be housed within the main body of the satellite, which will be about a 7-foot cube. When fully deployed, the satellite system will be 96 feet long. The GOES-NEXT satellites were originally designed for launch from the space shuttle. However, after the Challenger accident an expendable launch vehicle (ELV) was chosen to launch them. Figure 1.1 shows an artist's conception of the fully deployed satellite.

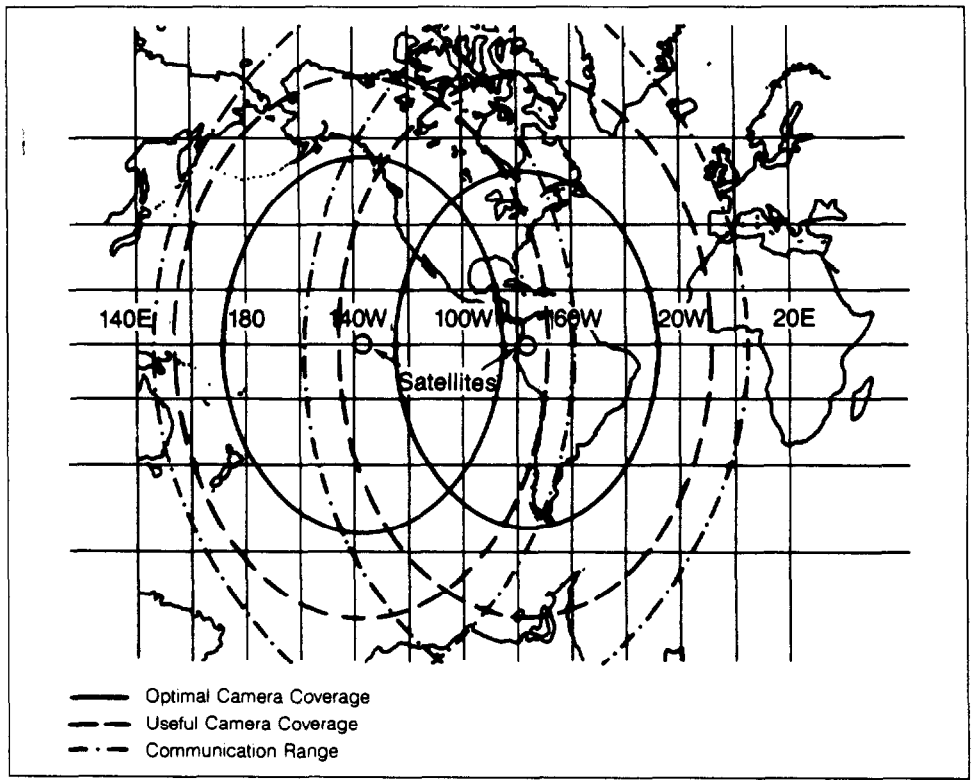
Figure 1.1. The GOES Satellite



To be in a geostationary orbit, the GOES satellite is positioned at an altitude of 22,238 miles (35,788 kilometers) above the earth's equator. At this altitude, the satellite can remain in the same relative position above the earth at all times. As with the present system, GOES-NEXT will provide information on a region covering the central and eastern Pacific Ocean, the contiguous 48 states, and the central and western Atlantic

Ocean. GOES satellites provide complete coverage through a two-satellite system—GOES West, located at 135 degrees west longitude, and GOES East, located at 75 degrees west longitude. Figure 1.2 illustrates the location and coverage of the satellites.

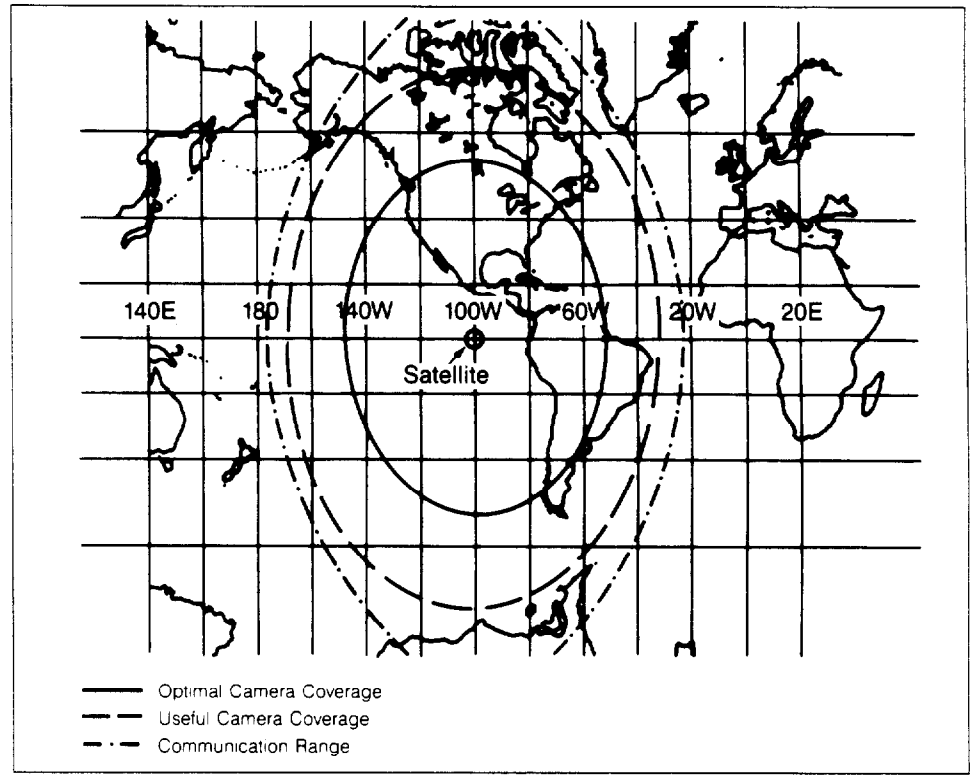
Figure 1.2: Geographic Coverage of GOES East and GOES West



Twice since the GOES program began, one satellite has served alone when the second satellite either failed in orbit or did not make it to orbit.[3] When this situation has arisen, NOAA has adjusted the remaining satellite's orbit to provide the optimum coverage of probable weather events. Figure 1.3 shows a one-satellite coverage pattern.

[3]For example, GOES-G was lost when the Delta ELV failed during launch and destroyed the satellite.

Figure 1.3: One-Satellite Geographic Coverage



Objectives, Scope, and Methodology

We were requested by the Chairman and the Ranking Minority Member of the Subcommittee on Commerce, Justice, and State, the Judiciary, and Related Agencies, Senate Committee on Appropriations, to address three major issues—NASA's award of the prime contract and its principal subcontract, the current cost and schedule status of the contract, and NASA's and NOAA's coordination and contract oversight.

To address these issues, we reviewed the laws and regulations applicable to the GOES contract. We also reviewed documents and interviewed officials of the program, procurement, and contract administration offices at NASA and NOAA, as well as at the offices of the contractor and principal subcontractor.

In assessing the award process, we did not review the technical quality of the proposals submitted or assess how well they had been evaluated. Rather, we sought only to determine whether NASA had properly followed established procedures for soliciting, evaluating, and selecting a contractor.

We performed our work at the Goddard Space Flight Center in Greenbelt, Maryland; NOAA in Suitland, Maryland; NASA Headquarters in Washington, D.C.; Ford Aerospace Corporation-Space Systems Division in Palo Alto, California; and ITT-Aerospace/Optical Division in Fort Wayne, Indiana. Our work was done between August 1988 and March 1989 in accordance with generally accepted government auditing standards.

As requested, we did not obtain official agency comments on this report. However, we discussed the results of our work with NASA and NOAA officials and considered their comments in preparing this report.

The Source Selection and Contract Award Process

The Federal Acquisition Regulation (FAR) prescribes procedures for procurement within the federal government. NASA has supplemented these regulations with the NASA FAR, which addresses agency-specific procedures. Because the GOES-NEXT satellites are being acquired under a competitively negotiated cost-plus-award-fee contract,[1] NASA was required to use the source selection process set out in its Source Evaluation Board (SEB) manual. In soliciting for, negotiating, and awarding the GOES-NEXT contract, NASA complied with the procedures associated with determining the contracting method, establishing and applying source selection criteria, and disseminating proposal and contract information as prescribed in the FAR, the NASA FAR, and the SEB manual.

Contracting Method and Source Selection Criteria

The FAR and the NASA FAR permit the use of competitively negotiated, cost-reimbursement type contracts when uncertainties involved in the contract performance do not allow costs to be estimated with sufficient accuracy to use a fixed-price type contract. NASA chose competitive negotiation as the method of contracting for the GOES-NEXT satellites because of the developmental aspects of the procurement. NASA's "Determination and Findings for Authority to Negotiate an Individual Contract" stated that no instruments capable of meeting all of the GOES-NEXT satellites' performance specifications had ever been built. In addition, the procurement involved the development of new capabilities to accompany evolving meteorological technology improvements, which required new applications of technology for use in geosynchronous orbit.

According to NASA, the developmental nature of the procurement also justified a cost-reimbursement type of contract. In its "Determination and Findings for Authority to Use a Cost-Plus-Award-Fee Contract," NASA stated that the amount of development required to meet performance requirements could not be estimated in advance with the accuracy and precision necessary to establish a fixed price. NASA also stated that a cost-plus-award-fee contract would likely be less costly to the government than any other type.

The FAR generally requires competitively negotiated procurements to include procedures for soliciting proposals and permits the use of boards, councils, or other groups for evaluating proposals that meet requirements set out in the solicitation. The FAR also specifically permits

[1] A cost-reimbursement contract that provides for a fee consisting of (1) a base amount (which may be zero) fixed at the inception of the contract and (2) an award amount, based upon a judgmental evaluation by the government, which is intended to provide motivation for excellence in contract performance.

the use of NASA's SEB procedures, as described in NASA's FAR. NASA's FAR specifies the use of a Request for Proposals (RFP) to convey information that prospective contractors need in preparing proposals properly and to request information that technical and procurement personnel need for evaluating the proposals. RFPs must describe the evaluation criteria to be used and the relative importance of each.

In order to choose among competing offers, NASA used a source selection process during which the SEB evaluated the offerors' technical proposals as well as their estimated costs. The Director of the Goddard Space Flight Center appointed an SEB on February 17, 1984, with representatives from NASA Headquarters, NOAA, and Goddard. Within the SEB, two committees—the Business Management Committee and the Technical Advisory Committee—reviewed and evaluated each offeror's cost and technical proposals using the criteria outlined in the RFP. The criteria included mission suitability, proposed cost, satellite growth capability, experience and past performance, and other factors. Only the mission suitability factor was numerically scored.

Mission Suitability

The Technical Advisory Committee evaluated mission suitability to determine the relative merits of the offerors' technical proposals. The technical proposals were evaluated against the following mission suitability factors, as described in the RFP:

- Understanding of requirements—This factor was used to evaluate how thoroughly the offeror understood and planned to meet the needs and objectives of the mission.
- Technical approach—This factor was used to evaluate whether the technical approach was adequate and thorough, how well each element of the mission was considered, and the degree to which the proposed approach was based on established engineering principles and practices.
- Management approach and capabilities—This factor was used to evaluate the offeror's approach and capability to efficiently manage the technical and administrative work involved in performing the contract, including the proposed organization, plans to measure and control performance, and plans to document status and results.

The Technical Advisory Committee judged and numerically scored the proposals in accordance with weighted evaluation criteria. The RFP described the relative importance of each factor; however, it did not specify the weight to be assigned each factor. NASA and NOAA established the weights before they received the offerors' proposals.

Proposed Cost

The Business Management Committee evaluated proposed cost for realism and, as specified in the RFP, adjusted the proposed cost to reflect the probable cost to the government, including adjustments for any improvements considered necessary to meet the procurement requirements. The Technical Advisory Committee also used the proposed cost estimates as aids in judging offerors' understanding of the mission suitability requirements.

Growth Capability

The RFP stated that the nature and length of the GOES program in relation to the overall meteorological program made it highly desirable that the new satellite be flexible and adaptable to additional or advanced requirements. As a result, the growth capability, or flexibility, inherent in an offeror's basic design was evaluated. NASA established growth capability criteria prior to its receipt of proposals.

Experience and Past Performance

Each committee evaluated experience and past performance from its respective viewpoints. The Technical Advisory Committee used the following criteria, as prescribed in the RFP, in its evaluation:

- Applicable flight and ground systems hardware and software experience—This factor was used to evaluate whether the offeror could adequately undertake this kind of program. Prior demonstrated experience in the development and successful operation of similar flight and ground system hardware was essential.
- Technical performance as contractor—This factor was used to evaluate whether the offeror's demonstrated performance on existing and completed flight and ground systems hardware contracts ensured that the offeror possessed the capability to meet the performance and schedule requirements.

The Business Management Committee evaluated the proposals to determine the relative merits of the offeror's organization, including experience in like or similar efforts in scope and magnitude, performance history, cost management history (including cost overruns and underruns), incentive/award fee history, and terminations history (including major reductions in scope).

Other Factors

The source selection official also considered other factors in making a final decision. The RFP listed these factors, which included the impact on government resources (such as launch services, government employees,

space, or installations), the stability of labor-management relations, the availability of plant or facilities, and the geographic distribution of subcontractors.

The Award Process

The award process for the GOES-NEXT contract was divided into the following stages: pre-solicitation, solicitation, evaluation, selection, and final negotiations. The FAR required that NASA publish announcements regarding the proposed procurement and contract award in the Commerce Business Daily (CBD).[2] Appendix I shows a chronology of some key contract award events, including five announcements in the CBD.

Pre-Solicitation

During the pre-solicitation stage, NASA requires the preparation of a number of documents, including the following: a procurement request with a statement of work, a procurement plan, a statement on safety and health, and "Determinations and Findings" statements for the authority to negotiate and for the method of contracting. NASA prepared each of the required documents for the GOES-NEXT contract.

Solicitation

In compliance with SEB manual requirements, the Goddard Space Flight Center requires that pre-proposal conferences be held on all procurements involving the use of an SEB to provide for a better understanding between prospective offerors and the government. Following issuance of the RFP on June 29, 1984, NASA held a pre-proposal conference. Representatives from 11 firms attended this meeting on July 13, 1984. Three firms subsequently submitted proposals—Ford Aerospace and Communications Corporation, Hughes Aircraft Company, and RCA Government Systems Division.

Evaluation

The SEB used the approach outlined in the RFP to assess the strengths and weaknesses of each proposal. On the basis of the source selection criteria described above and general guidelines in the FAR, the SEB ranked RCA's proposal significantly lower than the others for the first evaluation factor, mission suitability. As a result, RCA was eliminated from the competitive range and, therefore, from further consideration prior to the submission of "Best and Final Offers." The SEB determined

[2]The CBD is the public notification media by which U.S. government agencies identify proposed contract actions and contract awards. It is published in five or six daily editions weekly, as necessary.

that there was not a reasonable chance that RCA would be selected for award.

Following its determination of competitive range and after written and oral discussions between the remaining offerors and NASA, NASA asked them to submit their "Best and Final Offers." The SEB then did its final rating and ranking of the proposals and submitted its findings to the selection official.

In brief, Ford Aerospace's proposal was ranked higher than Hughes' in mission suitability, where its technical proposal received higher scores in most of the evaluation areas. Hughes' cost proposal was about 9 percent lower than Ford Aerospace's. The SEB concluded that the difference was relatively insignificant. The SEB also estimated the total probable cost to the government of implementing the GOES-NEXT program. The SEB estimated that Ford Aerospace's estimated cost became lower than Hughes' when other costs, such as probable shuttle launch costs, were included.

The SEB report concluded that Ford Aerospace's design had "good" growth capability, compared to Hughes' "adequate" growth potential. In the category of experience and past performance, the SEB concluded that there were no significant distinctions between the two proposals. Likewise, the SEB considered both Ford Aerospace's and Hughes' proposals generally acceptable in the "other factors" category.

Selection

The FAR does not require the acceptance of the lowest proposed cost for cost-reimbursement contracts, but rather a balanced judgment of all factors considered in the evaluation of the proposals. According to NASA's Selection Statement for the GOES-NEXT System, Ford Aerospace's proposal was technically superior to Hughes' proposal. Ford Aerospace's proposed satellite platform was deemed better for meeting such operational requirements as simultaneous imaging and sounding and improved pointing accuracy. Although Hughes' proposed cost was lower than Ford Aerospace's, the SEB believed that the difference in cost was not substantial enough to warrant acceptance of lesser technical capability.

On May 30, 1985, NASA selected Ford Aerospace as the prime contractor for final negotiations leading to award of the GOES-NEXT contract. As Ford Aerospace's bidding partner, ITT became the primary subcontractor for instrument development. Ford Aerospace selected ITT as its partner without competition and included ITT as its partner in its response

to the RFP. The selection of Ford Aerospace for final negotiations therefore signaled NASA's acceptance of ITT as the primary subcontractor. As required by the FAR, NASA notified both Ford Aerospace and Hughes of the results.

Subsequently, NASA held two fact-finding sessions with the contractor in preparation for final negotiations. Representatives of Goddard, NOAA, Ford Aerospace, the Defense Contract Administration Services Plant Representative's Office, and the Defense Contracting Audit Agency attended the first session. Representatives of Goddard, NOAA, and Ford Aerospace attended the second session. According to the minutes of the meetings, these sessions settled many minor differences about schedule, specifications, and contract administration.

Final Negotiations

From August 13 through September 11, 1985, NASA negotiated the final contract with Ford Aerospace. In addition, as required by the FAR, NASA certified that Ford Aerospace was not listed with disbarred, suspended, ineligible, or otherwise disqualified bidders. Also, the Defense Contract Administration Services Plant Representative's Office determined that Ford Aerospace's Cost Accounting Standards Disclosure Statement was adequate (an accounting system capable of determining costs under the contract is required by the FAR on a cost-reimbursement contract). The contract was signed on October 28, 1985.

Conclusions

In developing, soliciting, and reviewing bids and in awarding the contract, NASA followed the procedures specified by laws and regulations for determining the contracting method, establishing and applying source selection criteria, and disseminating proposal and contract information. The contract was awarded to Ford Aerospace even though it had proposed a slightly higher price. In the judgment of the SEB, the Ford Aerospace package was technically superior.

Cost Growth and Schedule Delays

Since NASA awarded the cost-plus-award-fee contract to Ford Aerospace for the development and construction of the GOES-NEXT satellites, the program costs have increased significantly. Program officials attribute the increase to (1) the decision to acquire additional satellites,[1] (2) the numerous contract modifications, (3) the lack of "Phase B" preliminary design studies, and (4) an underestimation of the technical complexities associated with the job. Total program cost, including launch services, will exceed $1 billion.

The original launch services contract called for the first GOES-NEXT satellite to be launched from the space shuttle during July 1989. Following the Challenger accident and the decision not to use the shuttle as the launch vehicle, the projected launch was changed to March 1990. At the request of NASA and NOAA, the contract launch date was changed to July 1990 to provide additional satellite preparation time. By early April 1989, the performance and schedule situation reached a point where the July 1990 launch date projected in the launch services contract will have to be changed. Launch delays increase the potential for additional program cost growth.

Growth in Program Cost

Generally, NASA estimates the GOES-NEXT program cost twice each year, including the estimated costs of the satellite (the contractor's costs and profits), general and administrative charges related to Goddard Space Flight Center and other contract support, and program contingencies. The contingency estimate is intended to cover expected costs above those projected by the contractor and unexpected costs in solving problems during a development program. According to NASA officials, amounts held for contingencies are also being used to fund contract modifications. The satellite cost estimates shown in table 3.1 do not include launch service costs.

[1]The original contract was for three satellites with an option for two additional satellites to be exercised by December 1985.

Table 3.1: Changes in NASA's Estimates for GOES-NEXT

Dollars in thousands

Date	Estimated cost	Change in estimate	
		Dollar	Percentage
March 1984	$294,432[a]		
July 1984	488,766[b]	$194,334	66.0
March 1985	547,048	58,282	11.9
July 1985	554,633	7,585	1.4
March 1986	452,365	−102,268	−18.4
July 1986	462,777	10,412	2.3
November 1986	476,415	13,638	3.0
March 1987	488,550	12,135	2.6
July 1987	535,855	47,305	9.7
July 1988	725,028	189,173	35.3
March 1989	725,028	0	0.0

[a]Includes the cost of three satellites.

[b]Includes the cost of five satellites.

The initial NASA estimate included the cost of three satellites. The July 1984 revised estimate added two more. The only reduction (in March 1986) was an adjustment by NASA to more accurately reflect the negotiated contract cost. Through the summer of 1987, net overall growth in the cost estimate for five satellites had not risen significantly. According to program officials, in late 1987, all parties recognized that program costs were escalating rapidly. Program officials generally attribute the large cost growth in 1988 to development problems at ITT with the imager and sounder instruments. In addition, program officials agreed that all parties had underestimated the complexity of the instruments.

Actions Taken in Response to Cost Growth

The former project manager at Ford Aerospace said that Ford Aerospace recognized a problem when cost overruns reached "alarming proportions." In response, Ford Aerospace

- directed ITT to conduct a cost reduction exercise;
- analyzed the designs of the instruments to make sure that the engineers were designing to the requirements;
- checked the reasonableness of the schedules for each part;
- verified whether the costs were realistic; and
- made numerous recommendations to ITT in areas such as organization, design, and testing.

NASA and NOAA became aware of the significant increase in costs in late 1987. In response, NASA and NOAA

- reduced the scope of a number of efforts,
- eliminated some tests,
- performed an intensive review of the contract,
- studied the alternative of buying additional GOES satellites from Hughes as a continuation of the expiring GOES contract, and
- studied putting a cost cap on the contract.

More recently, NASA

- restructured the contract award fee plan to put more emphasis on near-term cost and schedule control,
- elevated program visibility with quarterly reviews hosted by the Goddard center director and attended by vice presidents for Ford Aerospace and ITT, and
- raised the approval level for all modifications to the Goddard center director.

In following up on its 1987 initiatives, Ford Aerospace has recently

- assigned five of its staff to ITT on a full-time basis to help with software development,
- assigned its Director of Engineering and Manufacturing to ITT,
- lessened ITT's work load by transferring some production work to Ford Aerospace,
- reduced the duration of ITT's in-house testing, and
- provided ITT with administrative support.

In February 1989, NASA assigned five engineers to provide full-time (on a rotating basis) monitoring at ITT. NOAA officials said that they are pleased with this action.

Although estimated program costs stabilized from July 1988 to March 1989, program officials are cautious about future cost growth because a number of significant work steps (for example, vibration tests of instruments) are scheduled from the late spring to the fall of 1989. If problems develop while these work steps are being taken or during related testing, further cost increases are possible.

NOAA and NASA Program Cost Estimates Differ

The details of NASA's and NOAA's most recent comparable cost estimates are shown in table 3.2. NOAA's estimates are reflected in the President's fiscal year 1990 budget submission to the Congress.

Table 3.2: Current Budget Projections for GOES-NEXT

Dollars in thousands

Item	NASA	NOAA
NASA reimbursable costs[a]	$55,600	$50,000
Satellite contract and other potential costs	669,428	590,000
Total[b]	**$725,028**	**$640,000**

[a]These figures include ground support equipment, program support, store/stock items, and other general overhead items.

[b]These figures do not include the estimated launch services cost of $426.3 million, which includes $344.4 million for the contract with General Dynamics and $81.9 million for government oversight and other potential costs.

NOAA used a lower estimate of contract cost, which was based on the contractor's estimate. NASA used a higher estimate of satellite costs and included an allowance for other potential program costs. NOAA's estimate of other potential program costs was also lower than NASA's.

Increases in Satellite Cost

The original contract with Ford Aerospace called for three satellites costing about $203 million. NASA exercised an option for two additional satellites on December 20, 1985, for approximately $73 million, bringing the initial contract for the five satellites to over $276 million. Since then, the Ford Aerospace contract cost has increased to over $359 million.

NASA and NOAA officials attribute the contract cost growth to a number of factors other than the addition of the two additional satellites, including changes to contract specifications and the lack of "Phase B" studies to perform the usual NASA definition and preliminary design work.

Impact of Modifications on Contract Cost

Between the initiation of the contract and September 30, 1988, NASA made 85 change orders, or modifications, to the GOES-NEXT contract. However, most of them were for regularly scheduled funding, award fee adjustment, and no-cost performance specification changes. Table 3.3 summarizes all of the changes to the GOES-NEXT contract, and table 3.4 provides information on the eight changes listed in table 3.3 with actual or proposed costs in excess of $1 million.

Table 3.3: GOES-NEXT Contract Cost as of September 30, 1988

Description (number of changes)	Cost
GOES I/J/K - Basic contract	$203,239,678
GOES L/M option (1)	73,031,900
Subtotal—initial cost of 5 satellites	**$276,271,578**
Award fees (9)[a]	−494,552
Regularly scheduled funding (15)	0
No-cost changes (36)	0
Changes with individual cost of less than $1 million (16)	3,367,328
Changes with individual cost greater than $1 million (8)	
Operations Ground Equipment (OGE) system improvements	1,541,499
Imager/Sounder Analysis Ground Equipment (ISAGE)	2,274,856
Telemetry enhancement	4,669,187
Command encryption	6,395,429
OGE enhancements (Architecture 5)	7,977,764
ELV compatibility[b]	8,717,263
Mass margin	12,623,395
Image Navigation Registration	35,760,142
Total	**$359,103,889**

[a]The contract was reduced to compensate for unawarded fees. The original contract price included all negotiated award fees. If the contractor does not receive all or a portion of an available fee, the contract is reduced by that amount.

[b]The cost of this change has not been agreed to. The amount shown is the cost proposed by the contractor.

Table 3.4: Descriptions of and Reasons for Changes With Costs in Excess of $1 Million

Change	Initiator	Description and reason
OGE improvements	NOAA	To increase OGE capability by adding new performance specifications.
ISAGE	NASA	To add ground test equipment to demonstrate instrument capability prior to launch by testing the system or its parts or by gathering data to certify the limits of the system or subsystem.
Telemetry enhancement	NASA and NOAA	To increase the number of monitoring sensors to obtain and report more information on the operating status of the instruments and the satellite.
Command encryption	National Security Council	To add the capability to encrypt (code) commands to the satellite to prevent interference from outside sources.
OGE enhancements (Architecture 5)	NOAA	To increase capability over the initial designs for signal processing and product monitoring by adding monitors, an orbit and attitude tracking system, and new computer software.
ELV compatibility	NASA[a]	To study various launch vehicle options and to adapt the satellite to an expendable launch vehicle.
Mass margin	NASA	To increase the difference, or margin, between the predicted weight of the satellite and the weight required to accommodate growth in potential new instruments.
Image Navigation Registration	NOAA	To increase the pointing accuracy of the imager and sounder instruments to meet user requirements.

[a]This change was initiated by NASA after the space shuttle Challenger accident; however, the decision was made outside of the GOES program office.

The largest dollar change involved the Image Navigation Registration system.[2] The negotiated cost of this modification represented almost 43 percent of the total dollar increase in the contract cost from modifications through September 30, 1988. This modification to the system was made to improve the degree of pointing accuracy required of the instruments. The accuracy was initially increased beyond that specified in the RFP to meet documented user requirements; it was later relaxed somewhat.

NOAA officials stated that a lower requirement in the RFP was necessary in order to ensure competition, although initial NOAA requirements called for a higher degree of accuracy. However, they said that the agencies were unsure about whether the higher degree would be obtainable. Following contract award, research determined the possibility of the higher degree of accuracy, and it was included in the specifications through a contract change order.

[2]"Image Navigation" entails determining the accurate earth location (or latitude/longitude) for each pixel (or dot) within the image. "Registration" entails controlling the instrument so that each pixel defines the same earth location in successive images within a certain margin of error over a 24-hour period.

NASA's Usual Definition and Preliminary Design Work Not Done

NASA officials also said that the large number of modifications can be partly attributed to the fact that this program did not proceed through NASA's traditional program phases. At the program's initiation, NASA and NOAA recognized schedule pressures and the need for early delivery and launch of the first GOES-NEXT satellite to return the system to a two-satellite posture. As a result, NASA and NOAA agreed not to conduct all of the normal program phases.

NASA traditionally uses a phased approach to manage large acquisition projects. Phase A is the System Feasibility Concept Phase. During Phase A, NASA seeks to state mission requirements and objectives and identify concepts that will meet the objectives. According to a NOAA program official, preliminary cost estimates are also developed during this phase. Phase B, the Definition and Preliminary Design Phase, provides an opportunity to address questions such as how best to meet the mission requirements, how much the program will cost, and what technical challenges will be involved. During Phase C, the Detailed Design Phase, Phase B is extended by preparing detailed engineering drawings and detailed specifications for the hardware and other systems. This phase normally continues until the Critical Design Review process finalizes the design. Phase D is the Development Phase in which NASA contracts with firms to build and test the hardware. According to a NOAA program official, Phases C and D are frequently consolidated and sometimes overlap. Phase E is the Operations Phase.

For this procurement, the Phase B studies were not conducted. To compensate for the lack of these studies, NASA ensured that the contract provided funding for a number of study tasks in the early part of Phase C/D to define and propose modifications that would improve performance or meet the necessary user-defined requirements. For example, one study task examined the pointing accuracy of the Image Navigation Registration system.

A NOAA program official said that Phase A studies for the GOES program's continuation beyond GOES-NEXT are already underway. He added that NOAA must go through every phase, including Phase B design studies, for the next procurement.

Schedule Delay Likely

The original launch services contract called for the first GOES-NEXT satellite (GOES-I) to be launched during July 1989. Following the Challenger accident and subsequent evaluations and program changes, the projected launch date was changed to March 1990. At the request of NASA

and NOAA, the contract launch date was changed to July 1990 to provide additional satellite preparation time. By early April 1989, the performance and schedule situation at ITT reached a point where the July 1990 launch services contractual date will be adversely affected. According to a NOAA program official, this is the first time that any work slippage will require that the launch services contract be modified to account for a delay. The most recent unofficial launch date is in the late fall of 1990, although a NOAA official said that a mid-1991 launch date is not out of the question.

The launch services contract with General Dynamics contains a number of clauses relating to delays. Some of these provide monetary penalties to be paid by the government in the event of launch delays. NOAA and NASA officials are exploring ways to minimize the penalties. For example, NOAA and NASA are working to exchange launch dates for the first GOES-NEXT satellite and a NASA payload so as not to disrupt General Dynamics' launch flow.

NOAA officials are also seeking to have the launch services contract with General Dynamics renegotiated beginning later this year. Even without a delayed first launch, renegotiation is necessary for the contract to comply with the President's fiscal year 1990 budget, which calls for stretching out GOES-NEXT launch dates. According to NASA officials, since the contract period will be longer, the costs for the later years of the contract will increase. In addition, because NASA/NOAA will be renegotiating terms and conditions in a sole-source environment, there is even greater potential for increased costs.

Currently, only one GOES satellite is fully operational, and no additional satellites will be available until the first GOES-NEXT satellite is launched. If the current GOES satellite fails prior to the launch of the first GOES-NEXT satellite, the United States could support forecasting operations with other observational data, such as data from polar-orbiting satellites, reconnaissance aircraft, and drifting buoys. However, according to NOAA officials, none of these data sources can replace the constant monitoring capability of GOES satellites. For example, each polar-orbiting satellite only passes over a given point within the United States twice a day, while the GOES satellites normally provide a view of the entire United States every 30 minutes.

NOAA has a contingency plan in case the current GOES satellite fails and is negotiating updates to the plan with the European Space Agency and the Japanese to include additional coverage from their geostationary

weather satellites. According to a NOAA program official, the Europeans, for example, could relocate an older imager-only satellite to 50 degrees west longitude, thus providing some coverage to about half of the United States. The satellite would, however, likely remain under the control of the Europeans. In spite of this contingency plan, at a conference attended by potential users of GOES-NEXT data, the head of the National Weather Service stated that he would regard the total loss of GOES coverage as a national emergency.

Conclusions

The total cost of the GOES-NEXT program is uncertain; however, including launch services, it will exceed $1 billion. Similarly, although the extent is unknown, schedule delays are likely. With only one GOES satellite still fully operational, the U.S. ability to provide real-time early warning of and to continuously track potentially destructive storms is jeopardized.

Oversight and Coordination Activities

NASA and NOAA have jointly participated in the development and procurement of the GOES-NEXT satellites. Although NOAA does not have direct contract management authority, it participates with NASA in all program and status reviews. Officials from NASA, NOAA, and the contractor agree that NASA's level of program oversight was less than desirable at the beginning of the contract because of the need to concentrate resources on completing the previous GOES contract. However, NASA has improved its oversight through a series of actions, including increasing the number of staff assigned to the GOES-NEXT program and assigning a full-time resident manager and staff of eight to the Ford Aerospace facility.

NASA and NOAA have coordinated throughout the life of the GOES-NEXT contract. NOAA provided the original specifications, reviewed and concurred in such documents as the RFP, had staff on the SEB and its supporting committees, and has offices at the Goddard Space Flight Center collocated with the GOES-NEXT program office. Communications between NASA and NOAA appear to be open and frequent but with some degree of tension because of a difference in the agencies' motivations. According to Ford Aerospace and ITT officials, NASA is developmentally oriented, and NOAA is operationally oriented. Contractor officials said that the different signals given by the two agencies have caused them some degree of frustration.

Oversight was less than desirable during the contract's early years. NASA officials stated that the initial staffing level for the GOES-NEXT program was lower than they wanted because of the need to concentrate NASA's resources on the completion of the previous GOES contract. Since the start of the GOES-NEXT contract, there has been a general buildup of staff working at Goddard on the overall GOES program, with an increasing proportion being applied to the new contract. Table 4.1 shows the changing GOES project staffing patterns at Goddard's GOES office as staff moved from the previous contract (GOES G/H in the table) to GOES-NEXT. The table includes staff years for both in-house and outside technical support staff, but, according to the GOES-NEXT project manager, these figures do not reflect the total staff effort on the GOES-NEXT project. For example, personnel from other weather satellite programs worked temporarily on specific aspects of GOES-NEXT, and staff from other Goddard offices are involved in reviewing contractor proposals and in answering specific technical questions on the GOES-NEXT project.

Table 4.1: Staff Years Charged to GOES Projects by Fiscal Year

	1984	1985	1986	1987	1988
In-house Goddard staff					
GOES G/H	27.6	18.8	24.4	13.5	0.9
GOES-NEXT	2.2	7.2	9.2	25.1	41.1
Total	**29.8**	**26.0**	**33.6**	**38.6**	**42.0**
Outside technical staff					
GOES G/H	18.0	19.0	19.0	9.2	0
GOES-NEXT	0	0	5.0	19.8	30.0
Total	**18.0**	**19.0**	**24.0**	**29.0**	**30.0**
Total of all staff years	**47.8**	**45.0**	**57.6**	**67.6**	**72.0**

After the launch of the previous GOES contract's last satellite, NASA reassigned a full-time resident manager from the Hughes facility to the Ford Aerospace facility. The resident manager conducts on-site monitoring and oversight activities of all GOES-NEXT work at Ford Aerospace. According to Ford Aerospace officials, this reassignment significantly increased and improved NASA's oversight. However, it did not happen until about 1-1/2 years into the contract. NASA officials told us that they had attempted to place a resident manager at Ford Aerospace earlier but could not get an experienced person through an outside hire. In fact, NASA had to make special arrangements and provide additional compensation to transfer the experienced resident manager from Hughes to Ford Aerospace. Since then, NASA has assigned eight additional staff to the Ford Aerospace facility to assist the resident manager. In addition, NASA has assigned five engineers to provide full-time (on a rotating basis) monitoring at ITT.

NASA and NOAA also receive a variety of program and financial management reports on a regular schedule from Ford Aerospace and ITT. These include, but are not limited to, the following:

- Monthly Status Reviews—Written briefing documents to support oral briefings by contractor staff describing program issues, milestones, and accomplishments; operation production schedules; specific equipment issues; and financial schedules.
- Quarterly Reviews—Similar to the monthly reviews, but more general and dealing with issues, progress during the last quarter, and plans for the next quarter. They include technical issues, schedules, and financial status of the contract and are attended by NASA and NOAA senior officials and Ford Aerospace and ITT management.

- Biweekly submissions of technical correspondence—Ford Aerospace's submissions to NASA of copies of all technical correspondence between Ford Aerospace and ITT.
- Performance Measurement System reports—Monthly reports showing costs by work breakdown structure items as well as cost schedules, schedule variances, and problem analyses.
- Biweekly Progress reports—Narrative reports giving current status of hardware, discussing issues by subsystem, and providing status of work progress.
- Monthly Schedule reports—Narrative reports with charts discussing production and test schedules and issues.
- Financial (533 series) reports—Monthly and quarterly reports summarizing technical and resource performance under the contract.

Conclusions

NASA and NOAA have jointly participated in the development and procurement of the GOES-NEXT satellites. Although NOAA does not have direct contract management authority, it participates with NASA in all program and status reviews. NASA's level of program oversight was less than desirable at the beginning of the contract, but NASA has since improved its oversight. NASA and NOAA seem to have adequately coordinated on the project.

Chronology of Some Key Contract Award Events

Action	Date
CBD announcement of the release of preliminary specifications and requirements documents to obtain industry comments	July 23, 1982
Procurement Request for three satellites approved	December 12, 1983
CBD announcement of intent to solicit proposals for GOES I, J, and K	December 14, 1983
SEB membership approved	February 17, 1984
Determination and Findings for a cost-plus-award-fee contract approved	May 3, 1984
Procurement Plan approved for GOES I, J, and K	May 10, 1984
CBD announcement of the release of preliminary technical documentation	June 1, 1984
CBD announcement of an amendment of the prior synopsis to include GOES L and M option	June 18, 1984
Determination and Findings for negotiating an individual contract approved	June 19, 1984
RFP approved	June 29, 1984
Procurement Plan approved for GOES L and M	June 29, 1984
Addendum for two additional satellites approved	July 31, 1984
Contractors' proposals submitted in two parts	
Technical proposals received	August 27, 1984
Cost proposals received	September 14, 1984
Contractor selected	May 30, 1985
Contract signed	October 28, 1985
CBD announcement of post-award synopsis	November 20, 1985

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