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Weather Satellites: The U.S. Geostationary Satellite Program Is at a Crossroad

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Before the
Subcommittees on Environment and Investigations
and Oversight
House Committee on Science, Space,
and Technology

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the National Oceanic and Atmospheric Administration's (NOAA) and the National Aeronautics and Space Administration's (NASA) joint efforts to develop the next generation of geostationary weather satellites, GOES-Next. These satellites are needed to replace the sole U.S. geostationary weather satellite which is currently at risk and to provide unique information on severe storm conditions such as hurricanes and tornadoes.

Today, you released our report on the GOES-Next program and the implications of problems in that program for the National Weather Service. In my testimony, I will discuss the causes of the cost, schedule, and technical problems which have occurred in this program. I will also discuss the alternatives available to NOAA to remedy the current situation.

I should point out that there are slight differences between my statement and our report. My statement includes late-breaking information made available to us.

RESULTS IN BRIEF

The GOES-Next program has experienced a 143-percent contract cost overrun, is over 3 years behind schedule, and has been plagued by severe technical problems. Since the fiscal year 1991 budget was submitted by NOAA, total estimated funding requirements for the program (including launch services) increased about $400 million, from $1.3 billion to over $1.7 billion, and the scheduled launch date of the first GOES-Next satellite slipped from June 1991 to December 1992. The most recent delay is because of a discovery of a problem in the wiring of the instruments. Further delays are possible, and NOAA is currently considering how to proceed.

There are many reasons for the past and current program difficulties, all of which are intertwined. We believe that design complexity, inadequate management of the program by NASA and NOAA, and poor contractor performance all contributed to the cost, schedule, and technical problems experienced by the program. However, we could not determine each cause's precise contribution to these problems.

NOAA's ability to respond to continuing delays in the GOES-Next program is limited. GOES-7, the sole geostationary weather satellite now in operation, could fail at any time. If it fails before GOES-Next or a replacement satellite is in orbit, the United States would experience a lack of geostationary satellite coverage for a potentially lengthy period. Even if GOES-7 remains operational, forecast uses of GOES-7 will begin to degrade by February 1993. Some uses will be lost by August 1993. The United States does not possess a replacement satellite.

Several options are available to minimize the risk of a complete loss of geostationary satellite coverage and degraded weather forecast operations. These options range from purchasing a foreign-owned satellite, to doing nothing and assuming the risk that GOES-7 could fail before the launch of an operational GOES-Next satellite. The preferred option or options depend upon whether NOAA decides to significantly delay the GOES-Next program.

BACKGROUND

Since 1975, geostationary weather satellites have been used by the United States to provide meteorological data for weather research and forecasting. Typically, two geostationary satellites have been used to provide continuous observations of the eastern and western portions of North and South America.

In the 1980s, as part of its modernization program, the National Weather Service and the National Environmental Satellite, Data, and Information Service (NESDIS), which are both activities within NOAA, set out to determine what new missions could be performed by GOES-Next. The National Weather Service indicated that the GOES-Next satellites should sustain existing forecast capabilities, enhance severe weather forecasting, and advance the state-of-the-art in numerical weather prediction.[1] This would be accomplished by enhancing existing imaging and "earth location" capabilities and by adding a sounder that would operate continuously.[2]

In 1985, NASA selected the Ford Aerospace Corporation, later renamed Space Systems/Loral, Inc. (SS/L), and the Aerospace/Communications Division of the International Telephone and Telegraph Defense Corporation (ITT) to develop and build five satellites, GOES-I through M. ITT was to produce the two principal weather instruments, the imager and sounder, under a subcontract to SS/L. NESDIS participated and concurred in this decision.

COST INCREASES AND SCHEDULE DELAYS PLAGUE THE PROGRAM

In our June 1989 report entitled Weather Satellites: Cost Growth and Development Delays Jeopardize U.S. Forecasting Ability (GAO/NSIAD-89-169), we reported that contract costs had grown from the original estimate of $276 million to over $359 million and that launch of the first GOES-Next would be delayed form July 1989 to

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[1]Numerical weather prediction models are used to supplement the activities of weather forecasters.

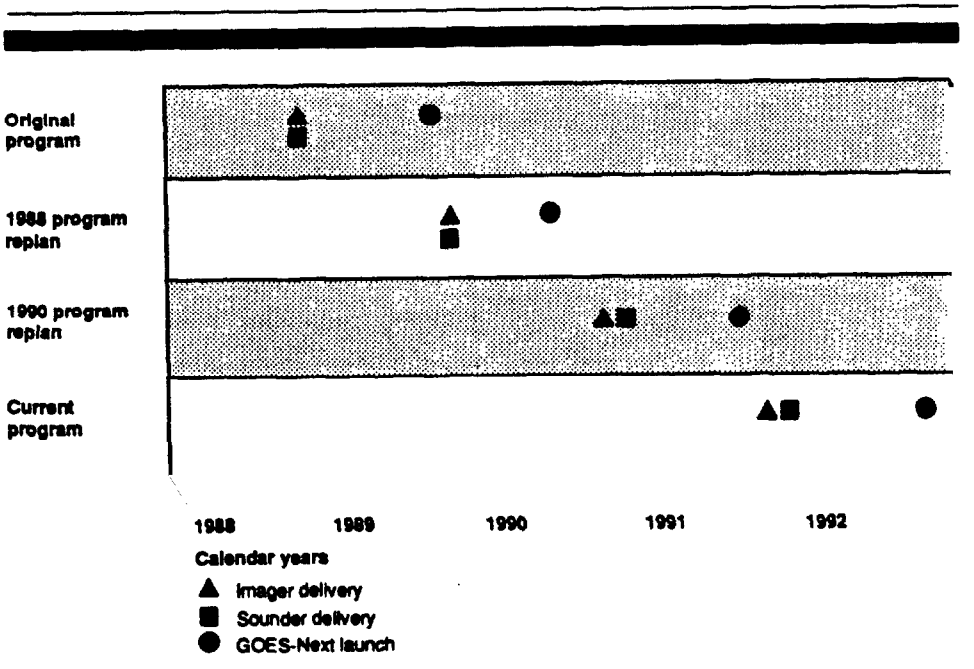
[2]An imager provides pictorial views of cloud systems; a sounder provides a complex data stream about the temperature and humidity of the atmosphere. The GOES-7 sounder is an experimental instrument that is unavailable during periods of severe storms because of the priority given to imaging.

the late fall of 1990. Since then, the program has experienced additional technical difficulties which, in turn, have resulted in additional cost increases and program delays.

The first GOES-Next satellite, GOES-I, is currently scheduled to be launched in December 1992. This is over a 3-year delay since the original June 1989 launch date. The estimated total program cost (including launch services, ground support, and other government expenses) has increased by over two and one-half times, from a low of $640 million in 1986 to about $1.7 billion in 1991. Contract costs, the major component of program costs, grew at the same time from $276 million to $876 million.

Exhibit A shows the delays that have occurred in the program.

Exhibit A



CURRENT EVENTS IN THE GOES-NEXT PROGRAM

The first two GOES-Next satellite spacecraft (GOES-I AND J) have been constructed. The GOES-I spacecraft completed its environmental tests in mid-June 1991, using prototype weather instruments. Assembly of the GOES-J spacecraft was completed in April 1991; tests are scheduled to begin during the summer of 1992.

The GOES-Next program is currently at a standstill until ITT delivers the imager and sounder. Since last fall, the GOES-I flight instruments have been undergoing testing at ITT, but their scheduled delivery to SS/L has repeatedly slipped. The imager, historically the more useful instrument in weather forecasting, experienced a problem in June 1991 which has caused an interruption in testing. The sounder, an operational version of an experimental instrument aboard GOES-7, is still in its initial calibration and performance tests. Further testing of the instruments is scheduled between now and January 1992 before delivery to SS/L will be possible. About 10 months are needed for additional testing and pre-launch procedures prior to the GOES-I launch.

GOES-J is scheduled to be launched 1 year after GOES-I. Its instruments are currently being assembled. Work on GOES-K, L, and M has been halted until 1993, pending review of the current situation.

TECHNICAL STATUS OF THE PROGRAM

At this early stage of imager and sounder testing, NASA and NOAA determined that both instruments cannot meet important contractual specifications and will require a waiver of those specifications if GOES-I is to be launched as soon as possible. The reason for this lack of performance has not yet been fully explained, however, and it is possible that GOES-I will be launched before these problems are entirely understood.

According to NASA and contractor officials, the ITT instruments are very complex, and the problem or problems are difficult to pinpoint. Though NASA and NOAA officials claimed that the imager and sounder will be better than the current weather satellite's operational and experimental capabilities, they also expressed concern about the quality of the ITT instruments and reservation about the instruments' reliability.

Images from one of the GOES-Next infrared imaging channels, which are important to nighttime observation of the earth's clouds, for example, do not equal the quality of GOES-7. Other imager specifications are also not being met, although GOES-I will exceed GOES-7 performance in these areas. Sounder performance falls short of specifications in all of the channels of the instrument.- These conditions have been under review for over a year, and in February 1991, NASA and the contractors asked NOAA to waive certain performance specifications for the first GOES-Next satellite.

Recently, SS/L determined a major reason for poor instrument performance was the manufacturing technique used for the instruments' electro-optical detectors[3] by the vendor that supplies the articles to ITT. NASA officials do not believe that this problem entirely explains the instruments' lack of performance, however.

In addition, there is evidence that the sensitivity of some detectors to light has degraded since their delivery to ITT. New detectors will be installed on future satellites, assuming their performance is acceptable, but NASA and NOAA may launch GOES-I with the currently installed set of detectors, since these have not shown any degradation. The contractors and the agencies are unable

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[3] Detectors are used to record light values for small areas of the earth. These light values are then combined to make up a large-scale image.

to determine the reason for the degradation, and poor manufacturing control and test of the detectors makes judgments about the reasons for these problems uncertain.

Finally, last month, wiring used to transmit the detectors' signal to amplifying equipment in the instruments was found to be the wrong type. This wire is affected by temperature changes that would cause the imager's detector output to be indecipherable. This problem is the reason for the delay in the launch date to December 1992.

NOAA is currently reviewing these and other program issues and plans to decide soon how to proceed. If NASA and NOAA decide to rebuild portions of the GOES-I instruments, further delays of 6 to 9 months could occur. Alternatively, NOAA may decide to significantly delay the GOES-Next program while it seeks to procure other proven satellites for use in its operations over the next several years.

CAUSES OF THE PROBLEMS IN THE GOES-NEXT PROGRAM

There are diverse reasons for the difficulties in this program: design complexity, inadequate technical management, and poor contractor coordination and workmanship.

SS/L's Design Was More Complex Than Originally Anticipated

According to government and contractor officials, all of the parties involved underestimated the level of difficulty they would encounter in trying to image and sound from a "staring" satellite. Because GOES-Next "sits" and "stares" at the earth, it is subjected to thermal stresses and other motion effects that make it difficult to achieve the desired level of "pointing accuracy." GOES-7, in contrast, is a spinning satellite that is more stable.

NOAA wanted its process of obtaining accurate satellite data to be automated. Currently, many ground-based data processing systems are required to convert GOES-7 satellite imagery into useful information for analyzing winds and tracking storm systems. By designing this capability into GOES-Next, NOAA expected to simplify its reprocessing of satellite data and to deliver higher quality satellite data to National Weather Service forecast offices in a more timely manner.

When the program began, the government and the contractors did not fully understand the thermal effects and motion disturbances on the satellite and its instruments. Initial analyses proved to be inadequate, and initial designs needed to be redone. The "earth location" and "precise organization" of GOES-Next's images and soundings will not be verified until the satellite is placed in orbit.

Problems Occurred in Technical Management and Contractor Workmanship

Questionable management decisions by NASA and NOAA were later compounded by poor direction and technical management of the GOES-Next program and insufficient coordination between SS/L and ITT. The result was that problems with the design tended to remain unresolved as new problems emerged.

NOAA did not authorize, and NASA did not require, that initial engineering studies be conducted before the satellite was produced. The program also made little use of early engineering models, which could have been used to work out design problems.

NASA officials expressed concern about the quality of the technical management of the program's principal contractor and the workmanship of the subcontractor. NASA claimed that SS/L did not

properly direct the work of ITT, and there is evidence that SS/L and ITT poorly coordinated their work. Also, ITT's performance is considered poor by NASA due to its many errors in design, manufacture, quality control, and instrument testing.

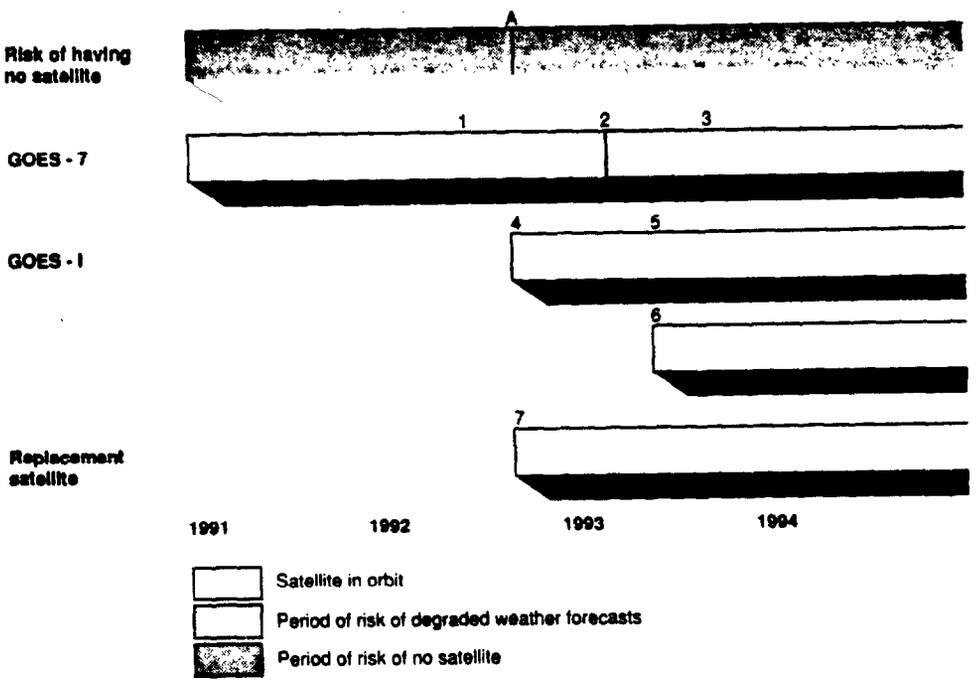
NASA also provided insufficient technical management of the contract. NASA exercised little oversight of the work of ITT because ITT was performing under a subcontract to SS/L, even though NASA has acknowledged that ITT was not fully prepared to design and manufacture such a complex set of instruments. There is also evidence that NASA provided inadequate technical support in several key areas of specialization, including optics, satellite control systems, and thermal engineering.

CURRENT RISK OF A LOSS OR DEGRADATION OF GEOSTATIONARY SATELLITE COVERAGE

The future of the geostationary satellite program involves several complex scenarios, each with its attendant risks and benefits. The United States will experience a loss of geostationary satellite coverage should GOES-7 fail unexpectedly before a replacement satellite, either GOES-Next or another satellite, can be placed in orbit. A replacement will not be available to NOAA until late 1992 at the earliest.

Exhibit B documents the key dates for assessing the risk to NOAA operations.

Exhibit B



A Point in time when a replacement for GOES-7 may be available. There is no replacement available before this date.

1 Start of drift of GOES-7
2 Decay in forecasting begins
3 Some forecast uses lost
4 Earliest launch of GOES-I
5 End of on-orbit verification period
6 Estimated 6-month delay of GOES-I launch
7 First available launch of a replacement satellite

Even if GOES-7 does not fail, it will begin to drift from its position over the equator in June 1992. Critical satellite uses, such as hurricane tracking, will begin to degrade in February 1993. Though useful imagery could still be obtained for several years, some uses will be lost altogether beginning in August 1993.

NOAA's decision on how to proceed with the GOES-Next program will affect the extent and quality of available geostationary satellite coverage. If NOAA proceeds as planned, GOES-I could be fully operational 6 months after its current launch date of December 1992, although current technical problems could cause this launch date to slip. NOAA could assume the risk that GOES-7 will not fail

before GOES-I is launched, but forecast coverage could degrade until GOES-I is fully operational. If GOES-Next is significantly delayed by further problems or NOAA's decision to slow the program, the United States would be exposed to a lengthy period of time in which a gap or severe degradation of its weather satellite coverage could occur.

SEVERAL ALTERNATIVES ARE AVAILABLE TO NOAA

In February 1991, NOAA began to explore the purchase of a foreign-owned satellite because of continuing problems in the GOES-Next program. Subsequently, a formal task force study was initiated to identify and evaluate options available to the government. The study, completed in late May 1991, included no recommendations on how to proceed, but the international parties that would be involved in the purchase of one of the foreign-owned satellites have been contacted, and discussions are ongoing.

In June 1991, NOAA officials indicated that because of their continuing concern about the status of GOES-Next, they were considering delaying the program and procuring one or more GOES-7 type satellites under production for foreign customers. Delivery of these satellites would take from 36 to 48 months.

Japan and the European Economic Community currently have satellites in production that the United States could use as interim replacements for GOES-Next. The United States could deploy one of these satellites sometime in late 1992, depending on when formal discussions begin, when launch services could be obtained, and how long ground verification and testing of the satellite and its unique ground control system would take.

Outright purchase of one of these two foreign satellites would require an expenditure of about $160 million to $180 million, according to NOAA, depending upon which satellite is chosen. This

figure includes the launch of the satellite. NOAA officials said that purchase of a foreign satellite would require a supplemental appropriation to its current fiscal year 1992 request if this purchase is added to NOAA's other obligations. We were informed by European representatives that NOAA could also secure an option to procure one of its satellites, which could be executed at a later date. This option would not protect the United States from some period of loss or degradation, however.

OPTIONS TO RESOLVE NEAR-TERM RISKS
DO NOT PRECLUDE LATER RISKS

Near-term decisions about GOES-Next have long-term consequences. Even if NOAA decides to proceed with the current schedule for the GOES-Next program, redesign of GOES-K, L, and M may delay availability for those satellites until the late 1990s. SS/L officials stated that if the decision to redesign the instruments is not made soon, another gap in geostationary satellite coverage could occur late in the decade.

On the other hand, if the GOES-Next program is abandoned altogether (which is currently not under consideration), the National Weather Service's long-range objectives could be threatened. The additional purchase of one or more satellites like GOES-7 would preclude expected advances in the use of geostationary sounding data in weather forecasting because the National Weather Service considers geostationary sounding to be important to its future forecast system, and the sounding system designed for GOES-Next is not currently available on any other geostationary satellite in the world.

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This concludes my prepared remarks. I would be pleased to answer your questions.