United States General Accounting Office 131789

GAO

Report to the Honorable Albert G. Bustamante
House of Representatives

December 1986

AIRPORT RADAR ACQUISITION

FAA's Procurement of Airport Surface Detection Equipment

131789

037597 / 131789

GAO/RCED-87-18

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-218566.6

December 17, 1986

The Honorable Albert G. Bustamante
House of Representatives

Dear Mr. Bustamante:

This report, prepared in response to your November 12, 1985, request, discusses the Federal Aviation Administration's (FAA) procurement of Airport Surface Detection Equipment (ASDE). It addresses the procedures used by FAA to determine its ASDE-3 operational requirements and specifications, the adequacy of FAA's support for these requirements, and the extent of production risk inherent in the ASDE-3 specification. The report also addresses the accuracy of FAA's ASDE-3 benefit-cost study regarding planned quantities and locations for the new equipment.

We are sending copies of this report to the Secretary, Department of Transportation, and the Administrator, Federal Aviation Administration. Copies will be made available to others on request.

Sincerely yours,

J. Dexter Peach

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

At an acquisition cost of $107 million, the Federal Aviation Administration (FAA) plans to purchase new Airport Surface Detection Equipment (ASDE-3). This new radar will allow air traffic controllers to more safely and efficiently control airport surface movement in darkness and inclement conditions at 30 major airports. Because of concerns about development risk and cost effectiveness, Representative Albert Bustamante requested GAO to assess the

- adequacy of FAA's support for its ASDE-3 operational requirements and technical specifications,
- potential production schedule and performance risks inherent in the ASDE-3 specification, and
- accuracy of FAA's ASDE-3 benefit-cost study regarding planned quantities and locations for the new equipment.

Background

To assist air traffic controllers in providing safe and efficient ground control of aircraft, FAA is purchasing new generation ASDE-3s from Norden Systems, Inc. First unit testing of these ground radars, which will eventually replace obsolete ASDE-2s at 12 major U.S. airports, is scheduled to be completed by March 1988. In addition to the initial purchase of 17 ASDE-3s, the contract also contains an option for FAA to procure up to 25 additional units at fixed prices. Although the option expired on September 30, 1986, FAA obtained a 15-day extension. During this time the agency contracted to procure ASDE-3 systems for 13 more airports at a cost of $27 million.

Before initiating competition for the ASDE-3 production contract, FAA spent from 1976 to 1982 writing an operational requirement, developing and testing an engineering model, and writing a technical specification. To take advantage of new technology, FAA updated its ASDE-3 operational requirements and technical specifications in 1984.

Enhancements to the new specification raised some concerns, including (1) potentially severe production schedule and performance risks because the specification was technically beyond the state-of-the-art and (2) the potential need for extensive development because the new enhancements had not been tested properly or studied for cost effectiveness. In response to the cost concerns, the FAA Administrator agreed to buy only that equipment supported by benefit-cost analysis or other operational or safety considerations.

Results In Brief

GAO believes that FAA's ASDE-3 operational requirements and specification were, in general, supported because they were based on FAA's mission needs as required by Office of Management and Budget (OMB) Circular A-109. GAO also believes that the specification was within industry state-of-the-art and, consequently, poses manageable and reasonable schedule and performance risks.

GAO agrees with FAA that the overall 30-site ASDE-3 program is cost-justified but questions FAA's benefit-cost methodology for estimating the value of passenger time-saving benefits and safety benefits. Because it will be time-consuming for FAA to improve its methodology, GAO believes FAA's October 1986 decision to exercise its option for additional units before redoing its benefit-cost analysis was in the government's best interests. FAA is now in the process of making the needed improvements to its benefit-cost methodology.

Principal Findings

Support for Operational Requirements

FAA's process for developing the operational requirements adhered to general OMB Circular A-109 guidance and Department of Transportation (DOT) and FAA policy regarding management decisions and approvals. Both the 1977 and the updated 1984 operational requirements were based on FAA's mission need, consistent with A-109.

Support for the Specification

GAO found that FAA also based its ASDE-3 technical specifications, including the 1984 enhancements, on mission needs. Of the three enhancements questioned by a protesting offeror, GAO found that one—the remote maintenance monitoring capability—adheres to a 1982 FAA requirement for all new systems in FAA's National Airspace Systems Plan and seeks to accomplish FAA's mission more efficiently. Another—a capability that allows clutter-free radar display and avoids interference with military radars—does not pose undue development or production risk and, therefore, meets updated operational requirements. The third—an improved radar display that can present the output from one or more radars on a single or a split screen—is within the state-of-the-art and thus also meets updated operational requirements.

Production Risks

Based on its technical review and the advice of an independent consultant, GAO believes that the updated specifications represented a technically realistic approach that posed no unmanageable schedule or performance risks for production. However, it is too early to determine whether the contractor will ultimately succeed in meeting all contract requirements.

GAO did observe some scheduling problems. As of September 1986, Norden Systems was experiencing delays in designing the ASDE-3, due in part to earlier inadequate staffing levels. Additionally, subcontracting delays and problems with key tooling posed a scheduling risk for the system's radar antenna. Thus far, Norden has not missed any contract milestones, but the firm has put off its first unit testing by 3 weeks, now slated to start in late April 1987.

Some performance risks also exist, and the contractor is taking actions to manage them. Nevertheless, at least two areas—the display processor and remote maintenance—will continue to raise performance questions until system testing begins in 1987.

In reviewing production risks, GAO found that FAA's oversight of the contract was being hampered. To make key program decisions, FAA and DOT management should be fully apprised of the status of the ASDE-3 production contract. However, in the case of the recent decision to place ASDE-3s at 13 additional airports, FAA's program office did not highlight for DOT officials that Norden Systems was experiencing a slow start-up and having difficulty meeting its own schedule. This is because the contractor's program monitoring system was not at that time producing the data FAA needed to adequately monitor the contractor's progress.

FAA's Benefit-Cost Methodology Is Questionable

FAA projects that 27 of its 30 planned ASDE-3 sites will be cost-justified; training and safety justify the other three. However, GAO questions several aspects of the methodology underlying this projection. For example, according to OMB's position on valuing time (15 minute increments or more), four fewer sites would qualify as being cost beneficial. And conversely, FAA's methodology understates the value of safety benefits because it does not account for enhanced passenger safety. More accurate estimates of safety benefits could qualify additional airports for ASDE-3s.

FAA presently does not have adequate data for estimating passenger time savings and safety benefits more accurately. GAO believes that improvements to these data are important and should be made, considering the importance of passenger time savings and safety benefits for FAA's justifying future major system procurement.

Recommendations

GAO recommends that the Secretary of Transportation direct the Administrator, FAA, to formulate an action plan for developing more accurate and complete measures of ASDE-3 benefits, including estimates of the time and cost required to accomplish this. The plan should (1) examine the methodology used to value passenger time savings and (2) provide for obtaining better data with which to value passenger time savings and safety improvements.

GAO is also making other recommendations which will allow the FAA Administrator to manage the ASDE-3 program more effectively (see ch. 3).

Agency And Others' Comments

In commenting on a draft of this report, DOT concurred with GAO's findings and essentially agreed with the recommendations. DOT noted that FAA has already begun responding to GAO's recommendations by determining improvements needed in its benefit-cost methodology and using the contractor's new tracking system to identify schedule delays.

Norden Systems, Inc., also agreed in general with GAO's findings and offered several suggestions for clarifying portions of the report.

Cardion Electronics also provided information that GAO used to clarify portions of its report. Other information provided by Cardion was provided to GAO's Office of General Counsel for use in its reconsideration of Cardion's bid protest.

Contents

Abbreviations

ASDE	airport surface detection equipment
DOT	Department of Transportation
FAA	Federal Aviation Administration
GAO	General Accounting Office
GHz	giga hertz
IG	Inspector General
Lincoln Labs	Massachusetts Institute of Technology's Lincoln Laboratories
MPP	Master Program Plan
NTIA	National Telecommunication and Information Administration
OIG	Office of the Inspector General
OMB	Office of Management and Budget
OR	operational requirement
RMM	remote maintenance monitoring
RMS	remote maintenance system
TWT	traveling wave tube

Introduction

Airport surface detection equipment (ASDE) is a radar system that provides air traffic controllers with a clear picture of the airport ground surface. It is used at large hub airports to improve operations efficiency and reduce the dangers of ground collisions. ASDE-2, the radar deployed in the 1950s and used at a number of airports, monitors the movement of all vehicles on airport runways and taxiways during periods of reduced visibility due to darkness or weather. Its primary benefits are increased safety and improved airport efficiency. To replace the aging ASDE-2s and to install this capability at several additional airports, the Department of Transportation's (DOT's) Federal Aviation Administration (FAA) contracted with Norden Systems, Inc., in September 1985 to place ASDE-3s—surveillance systems incorporating state-of-the-art technology—at 17 airports. In October 1986, FAA exercised a contract option to purchase ASDE-3s for an additional 13 airports, bringing the total acquisition cost to $107 million.

FAA Responsibilities and Program for Ensuring Air Safety

The Federal Aviation Act of 1958, as amended (49 U.S.C. 1303, 1348, and 1655, subparagraph c), makes the Secretary of Transportation responsible for ensuring the safe and efficient use of the nation's airspace and for fostering civil aeronautics and air commerce. DOT has authorized FAA to provide air navigation services for in-flight navigation, access to the airway system, and guidance in the approach and landing phase of flight; air traffic services to assure separation of flights in the air and at terminal areas; and preflight and in-flight assistance to pilots. These services began in the 1930s as an air navigation network and now consist of extensive navigation, surveillance, communication, and control facilities known as the Air Traffic Control System.

An important part of the Air Traffic Control System is FAA's Airport Surface Traffic Control program, which is specifically concerned with the safe and efficient control of aircraft and other vehicles on the airport surface. This program's success depends heavily on the expertise of pilots and air traffic controllers to manage the movement of vehicles on the airport surface. The controllers' surveillance function—determining the position and identity of vehicles on all airport surfaces being used—is normally accomplished by visual observation supplemented by radioed position reports from pilots. At 12 major airports, however, ASDE supplements the controllers' visual surveillance with a radar display of the airport surface.[1]

[1] Twelve airports have ASDE-2s; another airport (Anchorage, Alaska) has a version of ASDE-3 developed in the late 1970s.

ASDE-3 Justification, Advanced Development, and Testing

In December 1975, FAA issued its initial benefit-cost study for the ASDE-3 and concluded that 23 airports qualified for installation. This study was updated in February 1986. The ASDE-3 research and development phase began in February 1976, when DOT's Transportation Systems Center issued a request for proposals to develop an engineering model to replace the ASDE-2. FAA awarded the contract in May 1977 to Cardion Electronics. Cardion delivered the prototype to FAA's Technical Center, where it was installed for operational testing during 1979-1980. The test results formed the basis for the first ASDE-3 technical specification completed in October 1982. The Cardion model was installed as an operating ASDE system at the Anchorage, Alaska, airport in 1984.

Operational Requirements Updated for ASDE-3

Although FAA had a technical specification in 1982, FAA's budget was not approved at levels sufficient to fund the ASDE-3. While awaiting procurement funds, FAA conducted a state-of-the-art survey and observed operational testing of ASDE technology developed since the 1980 ASDE-3 test model. Based on the survey and certain less-than-satisfactory performance characteristics of the ASDE-3 model during testing, FAA updated its ASDE-3 operational requirements. Based on a draft of these updated requirements, the Massachusetts Institute of Technology's Lincoln Laboratory (Lincoln Labs), under a contract with the Air Force and an interagency agreement with FAA, studied how the new technology might best satisfy the updated operational requirements. Lincoln Labs then assisted FAA in formally updating its ASDE-3 specification. On the basis of this new technical specification and with approved funding, FAA developed the steps it would use to select a contractor and issued a Request for Proposals in January 1985.

FAA received proposals from Aydin Corporation, Norden Systems, and Cardion Electronics on April 5, 1985. On April 4, 1985, however, Cardion filed a protest with FAA which claimed that the nature of the specification was restrictive and thereby limited competition. Cardion subsequently filed a similar protest with GAO on April 18, 1985. The FAA Source Evaluation Board judged the Aydin and Norden proposals to be acceptable, but it returned the Cardion proposal, describing it as technically unacceptable and requiring a complete rewrite to be acceptable. Cardion did not resubmit its proposal. On August 15, 1985, the Comptroller General denied the Cardion protest (B-218566) and on September 30, 1985, FAA awarded the ASDE-3 contract to Norden.

DOT Office of Inspector General Questions ASDE-3 Cost-Effectiveness

On October 18, 1985, the DOT Office of Inspector General (OIG) reported on FAA's procurement of ASDE-3. The OIG concluded that FAA's September 1985 ASDE-3 benefit-cost analysis did not support the procurement because (1) it did not include all costs and (2) the methodology used did not follow established guidance. The report recommended that FAA not procure any of the optional 25 units until a comprehensive benefit-cost analysis is performed and that any ASDE-3s be installed at the most cost-beneficial locations based on the new analysis. The OIG also recommended that, because costs to develop certain enhancements added to the technical specification would amount to over $20 million, FAA not commit itself to buying more than the initial quantity of 17 ASDE-3 units until the contractor successfully demonstrated the feasibility of designing and producing the system within the contract award amounts and schedule.

In responding to the OIG's report, the FAA Administrator stressed the safety aspects of the ASDE-3 and remained committed to installing as many systems as justified from both a benefit-cost and an operational safety standpoint. He noted that FAA's updated February 1986 benefit-cost study showed 27 of FAA's proposed 30 locations to be cost-effective and that the remaining 3, though not cost-effective, are nevertheless needed to fulfill special requirements.[2] He also said that the production contract risks that stem from developing the enhancements are minimal and that the costs are justified. While disagreeing with the OIG's findings, the FAA Administrator did agree to (1) continue refining the ASDE-3 benefit-cost analysis and limiting ASDE installation as appropriate to those airports meeting cost-effective criteria and (2) procure only that equipment and those options needed for each site to the extent supported by either benefit-cost analyses or other operational or safety considerations.

Objectives, Scope, and Methodology

Our review of the ASDE-3 procurement was performed at the request of Representative Albert G. Bustamante. In his letters to us of August 20, and November 12, 1985, he expressed concern that more detailed information needed to be developed regarding an ASDE-3 bid protest filed by Cardion Electronics. He also requested that we address the concerns raised in the OIG report. Based on discussions with his office, we agreed to address the

[2]The special requirements include (1) FAA's training needs at its Oklahoma training facility and (2) safety needs at Andrews Air Force Base in Maryland and at the Anchorage, Alaska, airport.

- adequacy of FAA's support for its ASDE-3 operational requirements and technical specifications,
- extent of potential production schedule and performance risks inherent in the ASDE-3 specification, and
- accuracy of FAA's ASDE-3 benefit-cost study regarding planned quantities and locations for the new equipment.

In addressing the first objective, we discussed FAA's operational requirements primarily with the Air Traffic Control Service, the ultimate user of ASDE and the organization that issued the FAA order defining the operational requirements. We reviewed the historical evolution of the requirements and the steps FAA took to develop, validate, and approve them.

To address production risks, we reviewed FAA's support for the specification as contained in FAA documents and through discussions with FAA's Program Engineering and Maintenance Service, DOT's Transportation Systems Center, and Massachusetts Institute of Technology's Lincoln Laboratory. In addition, our personnel at the contractor's facility on Long Island, New York, monitored and collected information on the progress of the contract and documented the causes and effects of any problems discovered during the contract's first 10 months. To clarify certain issues raised by Cardion regarding the technical specifications, we spoke with Cardion's counsel in Washington, D.C.

Our review of the accuracy of FAA's benefit-cost support for ASDE-3 involved (1) reviewing the OIG's October 1985 report and the economic literature on valuing time spent while traveling (a key component of FAA's study), (2) reformulating various cost and benefit assumptions based on information from the Office of Management and Budget (OMB), and (3) analyzing the benefit-cost ratios used to support each planned ASDE-3 location.

Throughout our review, especially in assessing the specification's inherent risk to production, we relied on the services and advice of a consultant with expertise in radar design and broad experience in managing federal procurement of technically complex electronic systems. (See app. I for a summary of our consultant's professional background.)

Our review, conducted during the period January to September 1986, was carried out in accordance with generally accepted government auditing standards. Comments on a draft of our report from DOT, FAA, Norden Systems, Inc., and Cardion Electronics are included as apps. II-V.

FAA's Development of the ASDE-3 Requirements Was Consistent With Federal Policy for Major System Acquisitions

On the basis of our comparison of FAA's preprocurement planning for the ASDE-3 radar system with federal policy for conducting this activity, we believe that FAA adequately supported its ASDE-3 requirements as contained in the operational requirement and the technical specification. We found that

- FAA complied with all major federal guidance when it defined its operational requirements in 1982 and updated them in 1984 and
- the product of the requirements development process—an updated technical specification for a state-of-the-art ASDE—was adequately justified and posed no undue risk to production.

Our review of FAA's 1984 ASDE-3 specification took into consideration statements by Cardion and the DOT OIG that the specification posed undue risk for production schedule and performance because it was not adequately justified by mission need and the system it described had not been adequately tested, as required by OMB.

Federal Major Acquisition Policy

Published in 1976, OMB Circular A-109 establishes policies designed to improve the acquisition of major systems through, for example,

- appropriate use of resources to purchase only systems that are needed in support of an agency's mission and
- adequate preproduction planning and testing to reduce the risk of sizable production cost and schedule overruns.

Circular A-109 cites four steps which relate to the development of system requirements:

- Identifying the agency's mission need for the system, a need arising out of the agency's effort to fulfill its statutory responsibilities. For example, part of FAA's mission is to ensure the safe and efficient movement of aircraft on the ground at airports (which will be partially met with ASDE-3).
- Soliciting alternative system design concepts using a statement of system capability based on mission need. FAA refers to this statement as an "operational requirement," which describes the system capability needed by air traffic controllers as they perform FAA's mission.
- Developing and, where feasible, conducting competitive demonstration(s) of the best system concept(s) in an operational environment.

- Contracting for full production using a statement of system performance characteristics based on mission need. FAA refers to this as the "specification," a detailed technical description of required system and subsystem performance.

Under Circular A-109, the operational requirement must be justified as meeting but not exceeding the mission need. For example, a clear view of the airport runways during moderately heavy rain, enabling safe, efficient operations 95 percent of the time may meet the mission need, while achieving these conditions 100 percent of the time may exceed the need. Similarly, the specification should satisfy, but not exceed mission need as reflected in the operational requirements.

OMB Circular A-109 recommends development and testing of a preproduction model to establish:

- technical feasibility—to show that the system can be built and
- performance feasibility—to show that the system as designed can perform in an operational environment in the way described by the operational requirements.

If these aspects of a system are not established, the technical and performance risks will be relatively unknown, and the costs and schedules negotiated in the production contract could be unreasonable and subject to change. Because there is no practical way to eliminate all risk from the production of a major new system, the object of testing is to reduce the unknowns and, therefore, as much undue risk as possible from the specification prior to contracting for production.

DOT's policy implementing Circular A-109 generally sets a cost threshold for major systems acquisitions at $150 million in total estimated acquisition cost or $25 million in estimated research and development funds, but requires that systems in the next lowest cost category, which includes the ASDE-3, follow the general approach of A-109. FAA policy primarily is concerned with process specifics—for example, what management approvals should be obtained at each step of the requirement development process.

FAA Completed ASDE-3 Requirements in 1982 and Updated Them in 1984

Between 1973 and 1982, in accordance with Circular A-109, FAA identified a mission need, developed an operational requirement (OR), solicited alternative design concepts, developed and tested an ASDE-3, and developed a technical specification. However, because funding was not available for procuring this ASDE-3, FAA reviewed the 6-year-old OR in 1983-84 and updated it on the basis of a state-of-the-art survey which revealed new technological opportunities.

FAA Identified a Mission Need for Improved Air Traffic Surface Control

OMB Circular A-109 recommends that requirements for major systems or their replacements be justified and defined in terms of the agency's mission need. In 1973-75, FAA defined its need in terms of an increasing deficiency in airport surface traffic control capability—the safe and efficient movement of aircraft on the ground, before take-offs and after landings. FAA's ground controllers manage the flow of airport ground traffic—aircraft and other vehicles—through visual surveillance in daytime, clear weather conditions. When visibility is limited, controllers must rely on a radar picture of the airport surface area, on direct radio communication with pilots and other vehicle operators, or both.

In 1975, FAA had 11 ASDE-2 radars in use in the air traffic control system. However, FAA described the ASDE-2's performance as inadequate because (1) its signal does not penetrate heavy rain; (2) its display is often unsatisfactory because of background clutter; (3) it cannot identify individual aircraft, distinguish aircraft size, or distinguish aircraft from other kinds of vehicles; and (4) its screen is not considered bright enough for daylight use. In addition, the now 25-year-old ASDE-2s are expensive to maintain, given the unavailability of replacement parts.

FAA also stated that ASDEs were needed at additional airports. The agency pointed to increasing demand for operations during poor visibility as evidence of the importance of ground surveillance for safe and efficient operations.

FAA Prepared an Operational Requirement, Solicited Design Concepts, and Tested a Full-Scale Prototype

Circular A-109 advises agencies to solicit from private industry alternative system design concepts, defined as an idea expressed in terms of general performance, capabilities, and characteristics of equipment intended to operate as a system. Accordingly, FAA prepared an operational requirement and solicited alternative concepts before taking the ASDE-3 to development. FAA awarded a contract in fiscal year 1977 for the full-scale development of an engineering model of the design concept chosen.

When the ASDE-3 model was completed, it was installed for operational testing during April-May 1980 at FAA's Technical Center in Atlantic City, New Jersey. Technical Center staff evaluated the model and delivered a report in March 1981. The report concluded that the ASDE-3 model should be considered for implementation; however, it further concluded that an extended evaluation of the display under heavy rain, fog, and snow conditions should be conducted. According to the report, six air traffic controllers who participated in the operational test found the ASDE-3 model significantly better than the ASDE-2 they were using, but the controllers observed that improvements were needed in the clarity and intensity of the screen display. The controllers also favored the addition of a capability— not included in the ASDE-3 test model—to relate aircraft images on the screen to specific flights.

After the Technical Center delivered its operational evaluation report on the ASDE-3 tests, FAA developed a specification to support an ASDE-3 procurement in 1982. However, FAA postponed the ASDE procurement when the Congress funded FAA's fiscal year 1983 budget at a level $100 million less than FAA's request.

FAA Revalidated Its Operational Requirement in Accordance With Federal Policy

During the funding hiatus, FAA began work in February 1983 on an update of the now 6-year-old 1977 operational requirement and, in support of this effort, conducted a state-of-the-art survey. In the spring and summer of 1983, representatives from Lincoln Labs, the FAA Technical Center, and FAA headquarters conducted an on-site evaluation and comparison of four ASDE prototypes that were undergoing operational testing—three were at airports in Europe and the fourth was the ASDE-3 model tested in 1980 at FAA's Technical Center.

Lincoln Labs concluded from this survey that, in response to an ASDE specification updated to reflect current state-of-the-art, it was possible that any of the vendors of the four ASDEs surveyed could provide the FAA with a satisfactory ASDE. Lincoln Labs also concluded that no new technology would be required to attain the performance called for in a state-of-the-art specification.

OMB Circular A-109 explains that mission need may result from a deficiency in capabilities or a decision to establish new capabilities in response to a technologically feasible opportunity. FAA used both of these criteria as it based its updated OR on mission need consisting of the inadequacy of the existing ASDE-2 equipment, analysis of the ASDE-3 test model's performance, and the current technological opportunities for improvement. In addition, in accordance with FAA policy, a System Requirements Team, with participation from other FAA units, drafted a system OR and obtained its approval from appropriate FAA organizational units.

To draft an updated OR, FAA convened a team consisting of four experienced air traffic controllers—three of whom were still active at major airports—and technicians from FAA and Lincoln Labs. According to FAA officials, closely involving air traffic controllers would assure that current deficiencies were well-defined, while participation of the technicians would provide the controllers with information on state-of-the-art techniques and their associated risk and cost.

The updated OR was published in February 1984 and expressed the requirements in much greater detail than did the 1977 OR. The 1984 OR also added new requirements for the ASDE-3 processing and display functions, including radar coverage for all existing runway and taxiway areas and planned additions at 28 specified airports, the ability to accommodate independent maps showing different portions of the airport surface, and the capability for split-screen presentations, so that this information could be presented on a single display.

FAA's Specification Enhancements Were Adequately Justified and Posed No Undue Risk

At FAA's request, Lincoln Labs developed an updated ASDE-3 specification on the basis of an analysis of the new OR and the four ASDE models evaluated during the state-of-the-art survey. The specification was enhanced in the areas of display features, transmission frequency, and remote maintenance monitoring. We asked an independent radar design expert to review these enhancements for the degree of risk they posed to the expected production costs and schedule, because they had not been tested as integral parts of the ASDE-3 system. While our consultant acknowledged that the enhancements added some risk to production cost and schedules, he characterized the risk as manageable—within customary industry limits for this type of system as it goes into production. Moreover, based on our review of FAA's procedures in developing the requirements and the analysis of our consultant, we believe that FAA reasonably justified the enhancements in terms of mission need.

Lincoln Labs Developed an Updated ASDE-3 Specification

To ensure that the ASDE-3 technical specification would correspond to the new OR in light of current technology, FAA asked Lincoln Labs to analyze the state-of-the-art survey findings and the new OR. From its analyses, Lincoln Labs concluded that each of the four radars evaluated in the survey had the potential to meet a performance-oriented ASDE-3 specification with perhaps some upgrading or modification, and each had desirable features, though no one system included all features.

Lincoln Labs also developed an updated specification for ASDE-3, which FAA published in November 1984. The specification contained enhancements based on the desirable features of the ASDE models surveyed, which Lincoln Labs believed would best satisfy the updated OR, including enhancements to the

- processing and display capabilities,
- radar transmission frequencies needed to support the display requirements, and
- maintenance characteristics of the ASDE.

These features, however, had never been tested on a single ASDE unit or studied for cost-effectiveness, and for this reason the OIG reported that including them in a specification that would form the basis for a production contract was certain to incur unnecessary developmental risk. Cardion also asserted in its protest that FAA did not need these features on its new ASDE-3 and that they were not technically feasible to produce within the schedule called for in the ASDE-3 solicitation.

Enhanced Processing and Display Features

The updated ASDE-3 specification contained new requirements for the radar display, which in turn required more sophisticated computer processing of the radar signals. For example, the specification required a capability for (1) a split-screen display, which combines on one screen two perspectives of the airport surface, and (2) a mosaicked display, which incorporates on one screen images from two radars. In its protest, Cardion claimed that these requirements would entail developing a display subsystem to a level of sophistication that does not now exist and that the requirements exceeded FAA's needs.

To satisfy a requirement in the revalidated OR that ASDE-3 coverage be established for all existing and planned movement areas at 28 specified airports, the specification calls for the installation of two ASDE-3s at any airport whose primary antenna site is located beyond 12,000 feet from a movement area, or whose antenna installed on the air traffic control tower does not have a clear line-of-sight to a movement area. The mosaicking and split-screen display capabilities are designed to make the presence of two radars more useful to air traffic controllers.

A split-screen display presents two different radar images by splitting the screen into two parts—the technique is often used in television broadcasts of sporting events. In an ASDE application, split-screening enables the display of two different views of the airport surface at one time, on one controller's screen. The two views may be of the same target area, but at different scale, so that the controller has a clear, "close-up" image of the aircraft on one part of the screen and an overview of the movement area on the other, highlighting the location of the target aircraft relative to other aircraft or key runway intersections.

A mosaicked display integrates the output of two radars, located at different sites at the airport, into a single image on the screen. When both radars are focused on the same target but from quite different perspectives, the result is a more sharply defined image of, for example, an aircraft at a great distance from the radar antenna or partially obscured by a structure or another aircraft. The specification requires mosaic display capability wherever dual radars are installed. This is to satisfy operational requirements for (1) detecting small aircraft and locating them within 20 feet of the displayed position and (2) distinguishing two aircraft separated by 40 feet or an aircraft and any vehicle separated by 80 feet, within the coverage area at very large airports.

Our consultant advised us that the computer programs necessary to support both split-screen and mosaicked displays are sufficiently developed to present little challenge to the potential vendors of radar equipment. His judgment is that this enhancement is no more sophisticated than the programs written for video arcade games.

A Wide Range of Transmission Frequencies

The 1984 ASDE-3 specification also required that the radar equipment be capable of transmission "agility" over any 0.5 GHz segment within the frequencies of 15.7 and 17.7 GHz[1] —a total frequency band of 2.0 GHz. Frequency agility is a technique for continuously retuning the radar to change its transmission frequency within a fixed range, thus improving the clarity of the radar image on the screen under certain conditions. Cardion has alleged, however, that achieving the 2.0 GHz of frequency range would be very difficult and would be a significant source of risk in the ASDE-3 development process.

[1]GHz is an abbreviation for giga (1 billion) hertz (cycles per second). Transmission frequency is established by the number of cycles per second, and each transmitting system (e.g., a radio station) has its own assigned operating frequency, or frequency range.

Both the 1977 and the 1984 ASDE-3 ORs required a "clutter-free" display. "Clutter" on the screen can result from rainfall or hills at the perimeter of the airport which can resemble an aircraft at a much closer range. Lincoln Labs reported that frequency agility was needed to satisfy this requirement, and that a traveling wave tube (TWT) offered the possibility of better frequency control. The 1982 specification called for transmission agility over the 0.5 GHz frequency range of 15.7-16.2 GHz, the capability of the 1977 ASDE-3 test model; the 1984 specification requires the capacity for transmission agility over a 2 GHz range (15.7-17.7 GHz).

According to FAA's Spectrum Engineering Division manager, the ability to employ frequency agility over the larger 2.0 GHz range is more effective than over the 0.5 GHz band in some conditions—for example, heavy rain or snow—in obtaining the required clutter-free display. FAA also told us the increased spectrum is needed to permit ease of frequency selection—tuning the ASDE to a different frequency within the 2.0 GHz band—where interference occurs with other transmitting devices, such as military radars. This is also described in correspondence between FAA and the Commerce Department's National Telecommunication and Information Administration (NTIA)[2] concerning NTIA's certification of radio spectrum availability, as required by OMB Circular A-11 for major systems that use the radio spectrum.

As required by NTIA, FAA conducted tests on the ASDE-3 engineering model in 1981. The tests showed that while there was some interference with Navy airborne radar, it could easily be removed by retuning the radar. NTIA approved ASDE-3 operation in the 15.7-17.7 GHz band, provided the production ASDE-3s were tunable throughout this band without modification in the field, and FAA's 1984 specification contains this requirement.

Cardion protested that the cost of the TWT required to support frequency agility across a frequency range of 2.0 GHz would exceed any benefits to be derived. However, Norden Systems was able to contract for the TWT at approximately half the cost expected. (See ch. 3.)

Remote Maintenance Monitoring System

The 1984 specification includes a number of requirements that are intended to enable remote maintenance monitoring (RMM) of the ASDE-3.

[2]NTIA is empowered to certify the availability of space in the radio spectrum for prospective users, such as radio stations, or classes of users, such as military and civilian radar systems.

RMM is an approach by which the system is able to detect and locate the source of its own malfunctions and record this information in a computer file that can be monitored from a distance through telecommunication. The RMM requirements were added to bring the ASDE-3 system into compliance with an FAA policy issued in 1982, requiring that RMM capabilities be designed into every new system acquisition. When RMM is fully implemented, FAA expects to save $100 million annually in operational costs alone.

With RMM, FAA plans to centralize routine monitoring and equipment repair to use highly paid technicians more efficiently. FAA's RMM policy requires that maintainability be considered in the design of new systems, to include modularity—partitioning of the system into physically and functionally self-contained units which can easily be removed, replaced, and repaired—and internal on-line diagnostics that can identify the faulty module and automatically switch to a spare or redundant module.

RMM capability will be added to existing systems not scheduled for replacement, but this is significantly more expensive than building it into the initial design, according to FAA. Cardion asserted that the cost of adding RMM after the ASDEs are installed will be less than the cost of building in RMM capability during production because the technology is new to ASDE equipment. However, our consultant agrees with FAA and points out that the technology for RMM has been built into a well-known line of computers for some years.

FAA policy also requires that equipment performance specifications either shall specify the level of the system which the on-line diagnostics can identify as faulty, or they shall call for cost-effectiveness studies on this issue. The 1984 ASDE-3 specification requires that the diagnostics shall isolate 85 percent of all single failures to the replaceable circuit board and/or module level with a confidence of at least 90 percent. This means that for 85 percent of all system failures, the diagnostic system must specify what is wrong, down to the level of a part which can quickly be replaced on-site, with 90 percent accuracy. Cardion has charged that this description did not adequately specify the exact diagnostic level required; however, our consultant advised us that the specification description is typical of the language used in similar system specifications and well understood in the industry.

The Risks Posed by the ASDE-3 Specification Were Manageable

OMB Circular A-109 stresses advanced development and testing of new system acquisitions in order to reduce technical risk before committing them to full-scale production. Production contract commitments are made primarily on the basis of the technical specification, which in turn reflects mission need as expressed in the OR and the results of testing a fully developed system model. FAA's 1984 contractor selection plan for ASDE-3 stated there was "no significant risk" involved in the procurement. At FAA's request, a Lincoln Labs technician provided a critique of the specification in February 1985, concluding that the majority of the features of the specification could be found in operating radars produced by U.S. and European countries and in the radar specifications of the Canadian, French, Dutch, British, and other civil aviation agencies.

We asked our consultant to examine the specification in view of the current state of radar technology as he knows it, to determine whether it contained requirements which would be unduly difficult to meet or pose undue risk to the contracted cost and schedules. In his view, any number of vendors could have responded to the specification, that posed manageable risk to production cost and time—a level of risk commonly accepted in the industry. In his judgment, the specification

- does not go beyond state-of-the-art and compares favorably with Air Force and Navy specifications for airborne electronic equipment;
- is consistent with and does not go beyond the OR;
- was clearly written, clear enough that the successful proposal essentially contained a design for the radar; and
- is properly a performance specification with the details of implementation left up to the contractor and, consequently, is responsive to OMB A-109.

Conclusions

FAA acted in accord with the philosophy and general approach articulated in OMB Circular A-109 and DOT and FAA policy for developing requirements for major system acquisitions, including full-scale development and testing of an ASDE-3 model, even though the ASDE-3 cost fell below DOT's threshold for major systems. After revalidating the OR and enhancing the specification, FAA did not develop and test a second ASDE-3 model incorporating the enhancements; however, FAA and Lincoln Labs technicians had evaluated the enhancements as a part of other ASDE systems being tested in operational environments and concluded that any one of several vendors could provide FAA with a satisfactory ASDE. Consequently, FAA elected to proceed directly into procurement and production of the ASDE-3 as specified (including the enhancements), instead of first developing and testing a second prototype. By doing this, FAA chose what it regarded as insignificant technical risk of production over a second development and testing phase. We believe FAA's decision was reasonable and find no basis to conclude the agency's actions were inconsistent with OMB A-109, DOT, or FAA policy in developing its ASDE-3 requirements.

FAA justified the updated ASDE-3 specification on the basis of the new OR—a reflection of mission need—and Lincoln Labs' conclusions that improved technology existed on which to base a new generation ASDE. A-109 clearly states that a technologically feasible opportunity such as this can be used as part of an agency's definition of its mission need; moreover, both Lincoln Labs and our independent consultant evaluated the enhancements' risk to production cost and schedules as manageable and within the capabilities of the industry. Consequently, we find no basis to conclude that the ASDE-3 specification or the enhancements thereto were not adequately justified or tested by FAA, nor that they presented undue risk to production cost and schedules.

ASDE Performance Risks Are Manageable, but System Delivery May Be Late

In advance of awarding Norden Systems the ASDE-3 production contract, FAA determined that the technical risks associated with its updated specification were not significant. Cardion and the OIG disagreed, concluding that unnecessary developmental risk would be present. Based on our review and the views of our technical expert, we do not share this conclusion. Rather, we concluded in chapter 2 that the risks inherent in the specification are manageable. We also noted that the specification cannot account for all potential problems that might occur during production. However, after the production award, the contractor's experience in designing and producing the equipment can be monitored and the sources of problems identified. While it is still too early in production to make firm predictions on the final outcome, this chapter discusses our review of Norden's progress to date.

We found that, by making some changes to its initial design, Norden has reduced most risks stemming from the new specification to a manageable level and has not sought changes to the specification. However, two subsystems— the display processor and the remote maintenance—still pose major risks because of software programming uncertainties. For reasons unrelated to the specification, namely staffing shortages and subcontracting delays, Norden faces production schedule slippage. No formal contract milestones have been missed, but Norden has delayed its internal schedule for first unit testing by 3 weeks.

Although schedule delays exist, there is no assurance that they will be reported accurately to DOT and FAA officials responsible for making decisions regarding the future of the ASDE-3 contract. To track its progress and report it to FAA, Norden is supposed to use a time-phased plan describing key events in the contract and how deviations from plans will be detected and dealt with. However, because Norden's attempts to achieve this have not been successful, we believe FAA has not had all the information it needs to properly manage the contract, brief DOT officials on ASDE-3 program status, and make decisions about future procurement actions.

Performance Risks and Schedule Delays

As discussed in chapter 2, the 1982 ASDE-3 specification was updated throughout 1983 and approved in 1984. The new version specifies that the ASDE-3 shall contain several features that were not required under the earlier specification. Because no currently produced radar incorporates all the features the new specification requires, the DOT IG said that the ASDE-3 development risks were now much greater than previously anticipated. Moreover, Cardion has alleged that some of the new features would require a lengthy development process, which we believe implies greater risk than necessary. On the other hand, FAA believes that, because the key features in the specification were demonstrated during the 1983 vendor survey (see ch. 2), the requirements are realistic and the technical risks are low. We divide these risks into two categories: performance and schedule delays. While these are not entirely independent and a performance problem could lead to a schedule delay, they are sufficiently distinct at this point in the contract to be discussed as separate risks.

Major Performance Risks Bear Watching

The ASDE-3 system will not meet the contract performance requirements unless the actions Norden has taken or plans to take are successful. These performance risks were identified by either Norden in its proposal or Cardion in materials it submitted to support its bid protest. The risks are found in the following four ASDE-3 subassemblies:

- Display processor.
- Remote maintenance system.
- Antenna subsystem.
- Transmitter-receiver.

Norden has taken some steps to increase the likelihood that these subassemblies will meet contract specifications. However, in two of these subassemblies—the display processor and remote maintenance—major risks still remain. Although Norden may eventually overcome these problems, we believe they deserve close review by FAA in the near term.

Display Processor

Substantial risk of the kind that both Norden and Cardion identified in the ASDE-3 system's display requirements still remains. The display processor allows the ASDE-3 to provide an air traffic controller with various airport viewing options. For example, one requirement provides that the controller will be able to zoom in on and enlarge the image or use a split screen to view separated areas of the airport simultaneously. Another stipulates that radar observations of the airport surface be displayed on the controller's screen in no more than one-quarter of a second.

Both of these requirements appear in the 1984 specification; we could not locate them in the 1982 version. To satisfy them, Norden's proposal stated that it would require large amounts of high-speed processing times and high-speed memory. Norden officials told us that they attempted to reduce the risks by incorporating a more powerful microprocessor and more memory than were called for in its initial design. Although these changes should better enable the contractor to meet the required processing times, Norden is behind its schedule for completing a design that will incorporate all of the required features.

Our consultant believes that the risk of the display processor not meeting the specification is increased because of the complex programming that needs to be written. Norden officials agree with his observation that these risks are unavoidable in a radar system such as ASDE-3 and represent the greatest challenge to the radar's achieving its intended purposes. Because the software is incomplete and testing is not scheduled to begin until 1987, we cannot determine now whether Norden will successfully meet this challenge.

Remote Maintenance System

Norden's design of the remote maintenance system (RMS) has not proceeded to a point where the risk of noncompliance with specifications is minimized. The RMS monitors the performance of the ASDE-3 system and identifies faulty components. Cardion reviewed the requirements for the RMS and concluded that it was risky to design a system that would monitor and identify defective components. Norden officials, however, considered the RMS a low-risk area because they believed existing technologies and techniques—both hardware and software—could be adapted for use in this system. But they are uncertain of how much this approach will have to be modified for ASDE-3.

The RMS is a feature FAA added to the ASDE-3 system in the 1984 specification to meet the agency's new maintenance policy. The RMS is required to isolate 85 percent of all system failures to the replaceable circuit board and/or module level of the system. According to the Norden engineer responsible for the RMS design, the complex software needed to monitor large numbers of circuit boards makes development of the RMS risky. He explained that Norden is reducing the risks by modifying its RMS design to make the system compatible with existing and proven software programs.

Despite Norden's explanations, we believe there continues to be a risk that the RMS will not operate as required because the RMS consists of newly designed circuits and relies, in part, on software programs that have not been written yet. In addition, although Norden is attempting to use existing programs, it is uncertain whether the programs can be used without modification and still meet the specification.

Antenna Subsystem

The antenna subsystem will meet contractual requirements only if Norden's design modifications are successful. The troublesome portion of the specification relates to electrical requirements that were identified by Norden in its proposal. At that time Norden predicted it would have difficulty achieving the required value for one of the radar's signal characteristics. This characteristic, the sidelobe structure, allows the radar to distinguish between two targets separated by a short distance. This risk arose because the 1984 specification required a higher performance level than did the original specification.

The specification requires Norden to deliver an antenna whose sidelobe power level is 24 decibels[1] lower than the main lobe. Norden officials told us that the current antenna design fell short of this requirement by 2 decibels. Officials at Lincoln Labs, who are monitoring the program and assisted in writing the 1984 specification (see ch. 2), told us that they were not concerned about this variance. They believe that given reasonable time Norden will be able to meet the specification by modifying the antenna design. To this end, Norden is currently working on modifying certain antenna subsystem components, and Norden officials believe these changes will be sufficient to meet specification requirements.

Until the antenna can be tested, it is too early to determine whether the planned modifications will be successful, and we have no reason to doubt or believe in Lincoln Labs' optimism regarding achieving the 24 decibels.

Transmitter-Receiver Subsystem

Norden virtually has eliminated a major performance risk created by the possibility of not being able to obtain a critical component. In its bid protest, Cardion alleged that a requirement to widen the ASDE-3's operating frequency range would require a major development effort because the component needed to make this possible—a specific travelling wave tube—was not commercially available. Based on discussions with Norden officials and a review of Norden's subcontracting documentation, we believe that Norden has overcome its potential problems in

[1]A decibel is a unit used to express the ratio between two amounts of power. The ratio's size shows the difference in relative size between the two amounts.

obtaining suppliers to manufacture the component necessary for the ASDE to operate in the wider frequency range.

FAA's current ASDE-3 specification requires the system to operate in a frequency range of 15.7 to 17.7 GHz (see ch. 2) rather than the 15.7 to 16.2 GHz range in the previous specification. Norden believed that it could achieve the range requirement at low risk by modifying existing TWT designs. In May 1986, Norden signed agreements with two subcontractors to produce the TWTs. Norden officials explained that two subcontracts would better assure them of having an adequate TWT supply. Both tube manufacturers estimated that total nonrecurring design cost would be about $50,000. Recurring cost for each TWT is less than $16,000. Norden's ASDE-3 Program Manager told us that these costs were below his initial estimates on which the Norden bid was based. Moreover, according to FAA's ASDE-3 program manager, this cost is considerably below the current $80,000 to $90,000 estimated cost of replacing the TWT used in the ASDE-3 prototype. We reviewed Norden's procurement files and found no indication that either supplier anticipated difficulties in delivering a tube that would meet specification requirements.

We believe these steps by Norden assure that the wider frequency range will not require a major developmental effort.

Schedule Delays Exist and More Are Likely

The development phase of the ASDE program is running behind schedule. Although Norden claims it can begin system testing of the first ASDE unit by the contracted date of September 1987, we believe its ability to do so is jeopardized by the following points:

- Norden has already postponed the start of an April 1987 in-house, predelivery testing program by 3 weeks because schedules of some major components have been delayed.
- Designs for components in the RMS and display processor are behind schedule.
- A subcontractor's schedule for manufacturing the antenna leaves no room for delay and all tasks are time critical.
- The pedestal used to hold and rotate the antenna will not be ready for the start of testing.

Testing Program Is Behind Schedule

Norden now estimates it will be unable to meet its target date for the start of the in-house testing program because of existing delays. As a result, the contractually mandated September 30, 1987, first production unit delivery to the field test site is threatened. We believe that the increasing delays experienced in the RMS and display systems, coupled with the risk that the antenna and its supporting pedestal will be delivered to Norden late, jeopardize Norden's ability to meet the revised date (late April 1987) for the start of in-house testing. And any further delays in the testing schedule increase the risks that Norden will be unable to meet the September 1987 delivery to the field test site which, in turn, would cause a delay in delivering the first system to FAA.

Norden intended to assemble a complete ASDE-3 and begin testing in late April 1987, several months before the September 1987 contractual delivery date. Norden, however, has identified two sources of schedule risk in this testing period:

- The 5-month period between the start of testing and first delivery to FAA is almost over-programmed with tasks and, according to the engineer in charge, cannot absorb additional delays.
- The FAA requirement that some tests be performed sequentially, rather than concurrently, gives Norden less total testing time and reduces its ability to compensate for potential delays caused by testing failures.

Any delays in the start of the testing program, therefore, will make it difficult for Norden to maintain its September 30, 1987, delivery date to the test site. In July 1986, Norden began projecting that testing would begin April 24, 1987, rather than April 1 as originally planned. Norden officials believe that, despite this delay, they can still meet the September milestone. However, they told us of a new "worst case" projection involving possible further delays in the program. Under this pessimistic assumption, Norden projects that delivery to FAA could be 4 months late.

In commenting on a draft of this report, FAA noted that the critical date is the completion of field testing which, by contract, is March 1988. Further, according to FAA, its engineers are working with the contractor to restructure the test activity to utilize multiple units in parallel factory tests and field test. By using this approach, FAA expects to maintain the March 1988 field test completion date.

RMS and Display System Designs Are Behind Schedule

Norden's schedule for the design of RMS and display system circuits is running late. The firm's internal planning documents indicate that the design of these circuits is now up to 6 months late. Norden attributed these delays to staffing shortages. The delays have added 1 month to the completion of these systems.

Norden is falling increasingly behind its schedule for design of these units. The firm's schedule for the design of the RMS and display system circuits called for the completion of designs by May 1986. We evaluated the status of this effort in April and May 1986 and found that these designs were running 2 to 6 weeks behind their targeted completion dates. Between April and May these delays were increasing. By June, Norden was reporting that one design, originally scheduled for completion in April, would not be ready until September.

Although Norden's low staffing level that led to these delays has increased, it has not as yet been raised to the planned level. Norden is attempting to compensate by contracting for tasks originally scheduled to be performed in-house. Even so, this will not allow Norden to get the program back on schedule. As a result, the firm is estimating that completion of these systems will be about 1 month later than originally planned. Norden attributed its inability to reach projected staffing levels to a tight labor market in the Long Island, New York, area.

Norden also attributes its problems to its engineers who failed to maintain a continuing involvement in the component after completion of the initial design. It has tried to overcome this problem by emphasizing to both engineering and management personnel that their involvement in a component extends past the initial design and lasts through the manufacture, testing, and installation of the completed units.

Antenna Schedule Risks

The antenna may not be ready for the start of testing. Norden is obtaining the antenna under a subcontract and this agreement requires delivery of a first antenna unit by March 1987. The subcontractor's planning schedule shows that the first unit is on schedule; however, almost no room for delay exists in the schedule. This creates a risk that delays in the design, fabrication, and test could result in the delayed delivery of the antenna.

Norden's antenna subcontract was signed in April 1986, but before this Norden doubted that the subcontractor could meet its proposed delivery schedule. This doubt was based on several omissions and inconsistencies in the subcontractor's proposal which, when corrected, would add to the schedule. Further, in May 1986, the subcontractor provided Norden with its best estimate of a delivery schedule, which showed that

Norden's needs could be met. However, every task was shown as critical with only 1 week available for slippage without delaying delivery of the first unit. This schedule's lack of flexibility is due primarily to the long lead time required to make the mold used in manufacturing the antenna's reflecting surface.

Norden has attempted to reduce the schedule risk. It has re-evaluated the schedule for the reflector mold and found that as the result of a light workload at the supplier and the unexpected availability of raw materials, the mold's lead time could be reduced by 1 or 2 months.

Nevertheless, we believe that a continuing risk exists that the antenna will not be ready for the start of system testing in April 1987. Although Norden's actions have reduced this risk, delivering the antenna in April depends on the timely completion of many tasks in addition to manufacturing the mold.

Antenna Pedestal May Be Late

Norden management anticipates that the antenna pedestal may not be ready for the April 1987 start of testing. The pedestal consists of a four-legged stand, a motor and belt drive, and a turntable with a bearing on top of which the antenna rotates. If the delays Norden anticipates occur, the firm plans to use a substitute pedestal in the initial testing period to prevent any delay in the overall program schedule.

Norden's ASDE-3 program manager doubts that two essential pedestal components—the bearing and the stand—will be ready in time to allow for the April 1987 start of the testing program. Norden is attempting to minimize the impact these potential delays will have on the program by using a welded pedestal stand instead of one made by a casting, thus saving the lead time required by a casting. In addition, Norden is negotiating with two vendors to obtain existing pedestals that could be substituted for the required pedestals during the initial testing periods. Although these substitutes would not meet FAA's requirements, especially in areas of reliability and maintainability, using them would minimize testing schedule delay.

If the solutions Norden has proposed to mitigate the pedestal schedule risks will increase the cost of the ASDE-3 system, Norden and not FAA will bear the cost increases, according to the firm's ASDE-3 Program Manager.

FAA Monitoring

FAA and Norden have not reached agreement on a system for monitoring the status of the ASDE-3 program. The contract requires that the contractor maintain a Master Program Plan (MPP) showing time-phased plans for completing tasks and other specifics regarding how the contract will be managed. However, according to FAA officials, Norden's attempts thus far to meet this requirement have not satisfied FAA because the resulting MPPs were too difficult to use or did not contain the required information. Therefore, FAA's program manager has not had an adequate baseline against which to measure the status of the contract and did not report accurately to management in FAA and DOT. Accurate status data is needed for making decisions regarding additional ASDE-3 procurement, whether the contract needs to be more closely managed, and what the impact on airport operations will be if ASDE-3 delivery schedules are changed.

Absence of System to Measure Contract Status

Norden's contract with FAA requires that the MPP include a

- time-phased plan for the completion of each key event;
- graph and/or narrative discussion of the events' relationships with each other;
- description of the steps to be taken and the data to be used in meeting the contract delivery schedule;
- description of what system or method will be used to communicate work plans and report progress against the work plan; and
- description of how significant deviations from the planned events will be detected, isolated, and remedied together with the results of such action and how key events will be managed, scheduled, and monitored during contract performance.

Norden's MPP achieves the first of the above characteristics. It illustrates in chart form the due-dates of items or events to be delivered or accomplished under the contract, such as reports, manuals, conferences, and design reviews. This plan also indicates with bar charts the planned beginning and end of the relevant manufacturing phases for the ASDE-3 subassemblies.

However, because Norden's MPP does not address the other four contract requirements, the firm proposed using two other systems to comply with the contract. Its First Article Manufacturing Plan listed the components in each subassembly and corresponding target start and end dates for all manufacturing phases. According to Norden officials, however, FAA was concerned about using these charts because they did not show

how much slippage the program could absorb without risking a delay in the delivery of the first ASDE-3 system. Norden then proposed using its Management and Project Planning System as a tool to track the manufacturing process. However, Norden's ASDE-3 program planner said that FAA was concerned about this system because (1) current status was not measured against planned targets, (2) the detail did not provide the management overview required by FAA, and (3) the interrelationships among the manufacturing processes were not evident.

With no acceptable reporting system, FAA has relied on several other means of monitoring the progress of the ASDE program. For example, onsite at Norden is a FAA resident Quality Reliability Officer whose primary responsibility is to monitor Norden's quality assurance system, but who also provides input on the status of the program. FAA's program manager and contracting officer also visit Norden's manufacturing facility monthly to be briefed by Norden management on contract developments. The agenda for these briefings covers a variety of topics, including the status of the program. However, at the May 1986 briefing, the presentation given on the program's status was limited to a discussion of the proposed program status reporting system, rather than a substantive discussion of the program's status itself. The extent to which slippage or delays were occurring was not discussed, even though some significant delays existed at those times. It was at the July briefing, however, that Norden informed FAA that its April 1987 testing program would be delayed by about 3 weeks.

FAA's alternate means of monitoring contract status have not been effective because some omissions have occurred in FAA's formal reporting to DOT's Office of the Secretary of Transportation. When the DOT Deputy Secretary approved the ASDE-3 program, he also directed that the program receive semi-annual program reviews and be subject to quarterly status reporting requirements. Complying with this, FAA briefed the Secretary's office on May 23, 1986, on the ASDE-3 program. During the briefing, contract status was discussed but certain key delays in the contractor's progress (for example, the 3-month delay in letting a subcontract for the TWT) were not mentioned. The briefing chart used to summarize the review stated that the contract was "on schedule." According to FAA's ASDE-3 program manager, the schedule delays occurring then were not serious enough to bring to the attention of the Secretary's office; moreover, he said that, because the contractor did not have an adequate monitoring system, some delays were not well-defined.

FAA and DOT officials should know in as much detail as possible the status of the ASDE-3 contract because of future decisions these officials will make regarding the direction of the program. One such decision was made recently when FAA exercised its option to procure additional ASDE-3s. Other decision points will arise at the critical design review toward the end of 1986 and during system testing throughout 1987. Therefore, a useful program monitoring mechanism is essential for determining current contract status and forecasting the possibility of future performance problems.

Conclusions

Although it is too early in this production contract to make definitive judgments about the outcome of certain schedule and performance risks, we conclude that Norden is taking effective actions to manage most of the risks it perceives. The risks are not all equally manageable, however, and the problem of writing software for the display processor and the remote maintenance subsystems represents the greatest challenge to meeting the specification's performance requirements. Meeting the contract's schedule will also be difficult and, because of slippage that already has occurred and more that Norden tentatively forecasts, we believe that additional schedule delays are likely.

The contractor is responsible for maintaining a program status-monitoring system. The systems Norden has implemented thus far, however, have been inadequate because they have made key information unavailable to the FAA program manager and to DOT officials responsible for overseeing the procurement. Without accurate information on program status, it will be difficult to evaluate the contractor's performance and determine whether additional management control is needed. It remains to be seen whether Norden's new system will satisfy FAA's needs.

Recommendations

We recommend that the Administrator of FAA direct the ASDE-3 program office to

- evaluate Norden's new system for tracking contract schedule against planned milestones and ensure that it, or another system if necessary, will meet FAA's needs for providing accurate information as a basis for making program decisions and
- use the results of an improved tracking system discussed above to identify performance and/or schedule areas requiring additional management control and determine together with the contractor how best to address these areas.

Agency Comments

In commenting on a draft of this report, Norden stated that it has implemented a new scheduling system and provided an updated MPP to FAA. Norden believes that FAA has found the new system effective for tracking program progress against key milestones and for identification of performance and/or schedule areas that require management attention.

In DOT's comments on our draft report, it also noted that Norden had submitted a new MPP that depicts schedule delays and the recommended solutions to maintain the critical first system delivery date of March 1988. However, DOT did not say whether this new program monitoring system would meet all of FAA's needs.

Imprecise Benefit Estimates Show Better Data Are Needed to Justify Future Acquisitions

In response to the OIG's report, FAA revised its benefit-cost study. However, it still has not performed the comprehensive study recommended by the OIG. FAA's benefit-cost methodology leads to imprecise statements of benefits due to reduced passenger time savings and aircraft and passenger safety. The effect that passenger time savings have on the ASDE-3 benefit-cost analysis is significant—if there were none, four fewer airports would qualify for ASDE-3 installation. On the other hand, by not estimating benefits for added passenger safety due to ASDE-3, FAA may be understating its total safety benefits. To the extent this is true, then more accurately stated benefits would probably permit more airports to qualify. According to FAA, however, data on which to base a more accurate analysis do not exist.

FAA Estimates Benefits and Costs

FAA's methodology for determining whether the ASDE-3 program is cost-justified and, if so, which airports around the country qualify to have the new surveillance installed involves estimating three kinds of benefits and three kinds of costs. The benefits are

- efficiencies from reduced aircraft operating time,
- savings to passengers from reduced travel time, and
- enhanced safety to aircraft from fewer accidents on the airport surface (passenger safety is not a quantifiable benefit in FAA's methodology).

The costs are

- fixed preproduction costs to design, build, and test the first ASDE-3 unit;
- variable costs associated with increasing the number of units purchased, such as procurement costs, common installation costs, and required maintenance costs; and
- site-specific costs such as unique construction costs and whether certain enhancements, like mosaicking, are needed.

After all costs for the program as a whole and for each potential airport location have been estimated, FAA uses the ratio of discounted benefits to discounted costs as a cost justification criterion: if the ratio is greater than one—if benefits exceed costs—then the airport qualifies as a candidate for ASDE-3 installation.

ASDE-3 Benefits Are Difficult to Quantify

Some aspects of quantifying ASDE-3 benefits are straightforward, such as the savings accruing to airlines because aircraft will not have to wait as long on the ground or in the air before taking off or landing during poor visibility, thus saving fuel. Based on our understanding of FAA's extensive data collection and analysis to measure aircraft operation costs, we accepted without review or validation the estimated benefits that accrue from reducing these costs. The value of other benefits, however, such as time savings to the passenger on board the aircraft and the increased safety, are not as easily quantified.

Passenger Benefits Due to Time Savings May Be Overstated

FAA estimates the monetary benefits of ASDE-3 due to reduced passenger travel time by first estimating time savings due to reduced flight delays. These savings are then multiplied by an hourly value of time to produce dollar savings. FAA calculates the time savings based on a queuing model where flight delays vary among aircraft types, airports, and times of day. These delays average less than 1 minute per take-off or landing and, while this is a short period of time, when cumulated over the number of passengers on a flight and the number of flights involved, the FAA-estimated savings are significant. The hourly value of time FAA used in this process is derived by adjusting the 1967 median family income of U.S. travelers for changes in earnings through 1985 and converting this figure to hourly earnings of $23.18. According to FAA, the most recent and accurate source of this family income data comes from the 1967 Census of Transportation.

FAA uses this $23.18 value to represent an average hourly wage rate for air passengers and applies it to all passengers, even those such as children who have no wage income, and all estimated time increments saved because of the planned ASDE-3 installations. We found three flaws in this methodology:

- The data taken from the census noted above overestimate the hourly wage earnings of individual passengers because (1) the data are from a survey of air passengers asked to record their total family income, an amount which would tend to exceed the income of the passenger responding to the survey, and (2) these income data may not always represent passengers' hourly wages because they could include nonwage and nonsalary income and earnings of the passenger responding to the survey or from family members other than the passenger for whom the time savings are being estimated.
- Applying the $23.18 wage rate to small time increments is a questionable practice. In particular, time delay reductions of 1 minute for 60 travelers may not be as valuable as saving 1 hour for a single traveler, even though the total time saved for the 60 is the same as that for the 1. This is because, to be valuable, time increments need to be significant

enough for travelers to perceive that time savings have occurred and to embark on a meaningful alternative activity. FAA's practice of valuing small time increments is based on its assumption that increments of less than a minute are useful. OMB's position, however, is that passenger time savings should be based on time increments of at least 15 minutes.

Determining what constitutes a meaningful period of time is somewhat arbitrary and likely depends on the frequency with which the time savings occur for each traveler and the degree to which ASDE-3 and other airport capital improvements complement each other in providing time savings to passengers. Because we were skeptical of OMB's position and would anticipate that time increments shorter than 15 minutes could be meaningful, we requested from FAA the distribution of passenger time savings in their queuing model. FAA could not provide these data, thus adding to our difficulty in assessing FAA's estimate of the value of passenger time benefits.

- Using an hourly wage rate—even when it is properly estimated and applied to large time increments—as a value of time saved by all air travelers at all times is also a questionable practice. After reviewing the relevant economics literature, we conclude that a distinction should be made between valuing time saved in business versus nonbusiness travel. For example, the former Civil Aeronautics Board found that passengers are more willing to sacrifice time for lower fares in vacation markets than in predominately business markets. While FAA recognizes that a distinction could be made between business and nonbusiness travel, it nevertheless applies a full hourly wage rate to all travelers and states that it does so because it believes that no clear alternative exists.

Even if passenger benefits due to time savings are not included, 23 of FAA's planned 30 airports would still qualify for ASDE-3 installation based on FAA's estimates of benefits from the other two sources of benefits. Table 4.1 shows these installations, their annual benefits, their initial costs, and the resulting benefit-cost ratio FAA calculates.[1] If passenger benefits are completely excluded from the benefits column of table 4.1, 4 of FAA's 27 qualifying airports would have ratios below 1. Completely deducting passenger benefits from the analysis causes the ratios for the first 17 installations as a group, the additional 13, and the total installations to decline by about 50 percent. However, none of

[1]These calculations are not done for 3 "special" sites of the planned 30 sites because the specials are justified based on training needs at the FAA Academy and safety needs at Andrews Air Force Base in Maryland and at the Anchorage, Alaska, airport.

these ratios falls below 1. Therefore, even without the contribution of passenger benefits due to time savings, FAA's benefit-cost analysis would show the overall ASDE-3 program to be justified.

Table 4.1: Planned ASDE-3 Sites, Benefits, and Costs

Site	Annual benefit	Equip-ment cost	Discounted benefit-cost ratio	Benefit-cost ratio without passenger benefits
Boston	$1,314	$2,575	3.89	2.06
Los Angeles	3,242	2,725	9.11	4.38
Newark	1,416	2,725	3.98	1.97
Chicago-ORD	2,478	2,875	6.63	3.52
Seattle	383	2,575	1.13	0.70
New York-JFK	5,289	2,725	14.87	6.67
San Francisco	1,198	2,425	3.75	1.95
Pittsburgh	1,526	2,538	4.58	2.29
Washington-DCA	889	2,259	2.96	1.63
Minneapolis/St. Paul	1,187	2,409	3.73	1.97
Tampa	563	2,559	1.68	1.01
Baltimore	609	2,409	1.92	1.14
Houston-IAH	1,386	4,609	2.39	1.25
New Orleans	395	2,539	1.18	0.71
Denver	4,076	5,838	5.60	2.62
Kansas City	525	2,059	1.90	1.07
FAA Academy	Special	3,138	Special	Special
First 17 sites	26,476	48,982	4.31	
Andrews AFB	Special	2,425	Special	Special
Anchorage	133	2,059	0.48	0.48
Dallas-DFW	3,346	6,138	4.38	2.10
Cleveland	601	2,575	1.78	1.00
Miami	956	2,559	2.85	1.59
Atlanta	2,105	2,725	5.92	3.12
Washington-Dulles	471	2,825	1.28	0.81
Portland	363	1,925	1.40	0.88
Memphis	751	2,709	2.12	1.22
Philadelphia	748	2,388	2.37	1.39
New York-LGA	1,154	2,559	3.44	1.74
Detroit	1,359	2,559	4.05	2.09
St. Louis	1,775	2,559	5.28	2.63
Additional 13 sites	13,762	36,005	2.63	
Preproduction cost		**22,500**		
Total for 30 sites	**$40,238**	**$107,487**	**2.91**	

Source: Appendix B of FAA's March 1986 response to the OIG's October 18, 1985, report and GAO's calculations of the benefit-cost ratios without passenger benefits.

Although Future Benefits Are Imprecisely Stated, More Precise Yearly Estimates May Not Significantly Improve Overall Accuracy

For economic analysis purposes, FAA specifies the ASDE-3 life span as 15 years (1988-2002). During this period, the value of ASDE-3's yearly benefits depends on airline traffic volume in each year for which benefits are calculated. To more accurately estimate the effect traffic has on benefits, the OIG recommended that FAA estimate benefits for each year separately and then discount and sum the estimates to determine their total present value. FAA agrees that such a method would be advantageous but believes it would require major computer programming and system modifications. As an alternative methodology, FAA estimates a mid-point (1995) benefit level based on air traffic volumes for that year, assigns this undiscounted estimate to each of the 15 years, and then discounts each of these identical benefit estimates to determine their total value in the present. FAA defends its simpler approach by referring to the results of a comparison it made between the two approaches: For the proposed ASDE-3 installation at the Cleveland airport, FAA calculated the benefits using both approaches and found them to be nearly identical.

Notwithstanding the results of FAA's comparison, we believe that FAA would benefit from having the generic ability—the required data and computer programming—to make annual benefit estimates. Recent advances in information management technology, such as capabilities to transfer data from mainframe computers to microcomputers and financial software available for microcomputers, should enhance acquiring this ability. Having it would also help FAA analyze other procurement decisions where more precise analysis would enhance the estimates' accuracy. Our review of the methodology FAA used in its approach comparison, however, did not disclose evidence that using more precise yearly estimates would significantly increase or decrease FAA's benefit estimates.[2]

Passenger Safety Benefits Are Not Valued

Although FAA includes an estimate for safety benefits in its analysis, the estimate does not include the value of passenger safety. As estimated by FAA, safety benefits represent nearly 35 percent of some airports' total benefits, but generally they are less than 20 percent of the total. FAA's methodology for determining safety benefits is to assume that the ASDE-3 would avoid the loss of one-half of a typical airliner once every 15 years at an airport with Chicago-O'Hare's traffic volume. However, FAA provides little rationale to justify either the aircraft loss rate or this

[2]Our review did not include validating the data accuracy or the calculations FAA used in its approach comparison.

methodology for determining safety benefits. In addition, this methodology actually produces an estimate of equipment savings rather than a total safety benefit because the value of human life, either at risk or forecast to be lost, is not included in the estimate. FAA recognizes this indirectly when in its justification of ASDE-3 it refers to the equipment's safety advantages in addition to its cost-benefits, meaning that FAA does not fully incorporate safety into its estimates of the equipment's benefits.

Safety benefits are difficult to quantify accurately because safety data suitable for analysis are scarce. We identified two sources of airport runway safety-related data. The first is FAA where two data bases are maintained, one for controller-related operational error reports and one for pilot-related pilot deviation reports. However, in its May 1986 study of 26 ground incidents, the National Transportation Safety Board noted that FAA currently does not have a common runway incursion data base or an effective means to correlate the data in the individual data bases. The study's director cited his difficulty in attributing cause to either air traffic controllers, pilots, or airport equipment when ground collisions occur. The Board's study cited no equipment deficiencies as causes of accidents. Moreover, its recommendations for improvement did not mention installation of ASDE-3 because, according to the study's director, the accidents covered in the study did not occur during conditions when ASDE-3 would have been helpful. The study stated that most accidents occurred during periods of low traffic and good visibility.

The second data base is maintained by the National Aeronautics and Space Administration and contains reports of unsafe incidents submitted voluntarily by pilots, controllers, or others associated with the air travel system. This data base was used as the basis for a September 1985 study done for FAA on the causes and effects of unsafe incidents on runways. The study's author said that it would not support rigorous statistical analysis because the reports are voluntary and, therefore, the extent to which they reflect the entire universe of incidents is not known.

Better Data Needed in the Future

Effective October 15, 1986, FAA and DOT exercised an option in the ASDE-3 contract to procure ASDE-3s for 13 additional airports at a cost of about $27 million. Before making this decision, time did not permit FAA to correct the deficiencies we have noted in its passenger time savings and safety benefits data without incurring a higher unit cost than stipulated in the contract. Moreover, we reported in an earlier draft of this report provided to DOT for comment that we did not believe it was in the best interests of the government for FAA to delay exercising its option so that it could improve its benefits data. However, we do believe that improved benefit-cost data will be useful in the future. We are aware of other systems acquisitions in FAA's National Airspace Plan, for example, Terminal Doppler Weather Radar and Microwave Landing System, that would benefit from better data on which to base more accurate benefit-cost studies. FAA will undoubtably consider developing and installing other systems in the future and it should be prepared to justify costs accurately before it commits itself to procuring a specific quantity of the product.

FAA's Methodology Makes Proper Use of Costs

The source of most of the costs FAA uses in its benefit-cost analysis is the negotiated, fixed price contract it has with the ASDE-3 contractor, Norden Systems, Inc. Because FAA chose the lowest bidder we are not questioning the reasonableness of the values. We did, however, review how FAA used these numbers to determine unit cost values for its anticipated ASDE-3 installations.

Deciding which of the three kinds of cost—fixed, variable, or site-specific—to use in an analysis depends on the decision being made. For example, to determine whether the total ASDE-3 program is cost-justified, all three kinds of cost should enter into the analysis. On the other hand, to determine whether one additional ASDE-3 should be procured or how many airports qualify for ASDE-3 installation after fixed costs have been incurred, only costs that have yet to be incurred—variable and site-specific costs—are relevant. The methodological distinction is that no costs are incurred if no program is initiated, while the only costs avoided by eliminating any one system are the variable and site-specific costs associated with that system.

In its October 1985 report, however, the OIG used a different methodology. Instead of using the sum of variable and site-specific costs, the OIG used average costs—defined as total costs for all airports under consideration divided by the number of airports—as a basis for its conclusions regarding how many airports qualify for ASDE-3 installation. But a unit's average cost exceeds the sum of a unit's variable and site-specific costs because it includes some portion of fixed costs. By including fixed costs in calculations of benefit/cost ratios for individual ASDE-3 installations, the ratios calculated are smaller and fewer units will qualify as being cost justified. Because we do not believe that average costs should be used for making decisions regarding whether to procure additional systems, we disagree with the OIG on this point. We agree, instead, with FAA's methodology, which excludes the contractor's preproduction costs but includes the site-specific and variable unit costs.

As shown in table 4.1, FAA's methodology yields a ratio of 4.31 (total discounted benefits are 4.31 times as much as total discounted costs) for the initial 17 units. If no additional ASDE-3 procurement had been made—if the September option had not been exercised—and these 17 systems defined the total program, FAA would include the preproduction costs in the total cost figure and the recalculated benefit-cost ratio would fall to about 3.0, which is still a cost-justified program. Further, if in addressing some of the questions we have raised regarding FAA's generic methodology for determining benefits, FAA subsequently reduces its estimate of ASDE-3 passenger benefits, the benefit-cost ratio for the initial program of 17 units would still remain above 1.

Conclusions

FAA's benefit-cost study of the ASDE-3 could have been made more accurate with better estimates of passenger time savings benefits and safety benefits. Improvements in FAA's methodology for estimating passenger time saving benefits are possible for three reasons: (1) the dollar value used to estimate savings does not accurately represent the mix of travelers' wage incomes found on a typical flight; (2) the time savings themselves are determined by aggregating small increments of time over many passengers on many flights—a practice that is somewhat arbitrary and is not supported by OMB; and (3) no distinction is made in the value of time savings for business and nonbusiness travelers. FAA's estimate of safety benefits is not based on recent accident data, and it represents an equipment savings only because it does not include a component for passenger safety. Because adequate data on which to base more accurate estimates do not exist and would have been time-consuming to collect and analyze, we believe that FAA used appropriate managerial discretion in exercising its contract option for additional ASDE-3 systems based on its existing study.

We recognize that the accuracy of benefit-cost studies depends on the assumptions and data used, and decision-makers need to use considerable judgment in applying the results of these studies. However, this kind of analysis is an important management tool in making acquisition decisions and needs to be based on the best possible data. Therefore, to support future major system procurement decisions, we believe that improvements to FAA's benefit-cost methodology are needed, especially in view of the sizable contribution passenger time and safety benefits make to FAA's cost-justifications for these systems.

Recommendations

We recommend that the Secretary of Transportation direct the Administrator, FAA, to formulate an action plan for developing more accurate and complete measures of passenger time savings and safety benefits, including estimates of the time and cost required to accomplish this. The action plan should (1) examine the methodology used to value passenger time savings and (2) provide for obtaining better data to estimate the value of passenger time savings and safety improvements.

Agency Comments

In commenting on a draft of this report, DOT said that FAA is in the process of improving its benefit-cost methodology to more accurately estimate the value of such elements as passenger time savings and safety benefits. Further, DOT said that FAA will inform the appropriate congressional committees of its progress in developing a more comprehensive benefit-cost analysis.

Professional Background of Dr. Thomas S. Amlie, Radar Systems Design Consultant to GAO

Dr. Amlie's professional background includes lengthy periods of federal service both in the Navy as an officer and a civilian and in FAA. He is currently retired from federal civil service but continues to work under a personal services contract with the Department of Defense.

After receiving a Ph.D. in electrical engineering from the University of Wisconsin in 1952, Dr. Amlie began a series of increasingly more responsible positions with the U.S. Naval Weapons Center at China Lake, California. From Project Director to Branch Head, Division Head, and ultimately Technical Director of the Weapons Center, Dr. Amlie was responsible for such activities as

- computer simulation of the SIDEWINDER missile;
- missile flight data analysis and redesign;
- directing the efforts of the prime production contractor;
- developing a radar-guided, air-to-air missile, including inventing the missile's proximity fuse;
- technical program direction of the Navy's largest research and development laboratory involving the management of 4,500 employees; and
- managing the weapon center's independent exploratory development program and reviewing industrial research and development efforts.

Dr. Amlie joined FAA in 1970 as a senior electronics engineer, and for the next decade he studied and analyzed new air traffic control concepts. He also directed contractors that were performing similar studies, designed experimental equipment, and supervised construction and testing of equipment at FAA's laboratories.

Dr. Amlie has many published articles, several of which are on classified guided missile design concepts. He also holds four patents and has lectured at the college level on circuit and electromagnetic theory.

Comments From the Department of Transportation

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

U.S. Department of Transportation

Assistant Secretary
for Administration

400 Seventh St., S.W.
Washington, D.C. 20590

OCT 15 1986

Mr. J. Dexter Peach
Director
Resources, Community and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

Enclosed are two copies of the Department of Transportation's comments concerning the U.S. General Accounting Office draft report entitled, "Airport Radar Acquisition: FAA's Procurement of Airport Surface Detection Equipment."

Thank you for the opportunity to review this report. If you have any questions concerning our reply, please call Bill Wood on 366-5145.

Sincerely,

Marissa J. Allen for

Jon H. Seymour

Enclosures

DEPARTMENT OF TRANSPORTATION REPLY
TO
GAO DRAFT REPORT OF SEPTEMBER 16, 1986,
ENTITLED
"AIRPORT RADAR ACQUISITION:
FAA'S PROCUREMENT OF AIRPORT SURFACE
DETECTION EQUIPMENT"

SUMMARY OF GAO FINDINGS AND RECOMMENDATIONS

The General Accounting Office (GAO) review was performed at the request of Congressman Albert Bustamante. The GAO report states that the Federal Aviation Administration (FAA) plans to purchase new Airport Surface Detection Equipment (ASDE-3) at an acquisition cost of $107 million. Part of the planned procurement, 17 systems, is under contract with an additional 13 systems to be procured through exercise of an option which expires on September 30, 1986. The ASDE-3, GAO reports, will allow air traffic controllers to more safely and efficiently control aircraft and other vehicles on the ground at 30 major airports. It will penetrate heavy rain and dense fog to provide controllers a real-time display of all airport surface movement. Because controllers need this assistance at more airports and the new ASDE-3 specification contained a number of improvements not contained in the old ASDE-2 or in an engineering model of the ASDE-3, some concerns were raised. These included a concern that the specification was technically beyond the state-of-the-art, thereby posing severe production schedule and performance risks. Also, extensive development could be entailed during production because the new enhancements had not been tested properly or studied for cost effectiveness.

Because of concerns about development risk, GAO was requested by Congressman Bustamante to assess the: (1) adequacy of FAA's support for its ASDE-3 operational requirements and technical specifications; (2) potential production schedule and performance risks inherent in the ASDE-3 specification; and (3) accuracy of FAA's ASDE-3 benefit-cost study regarding planned quantities and locations for the new equipment.

GAO believes that the ASDE-3 operational requirements and specification were based on FAA's mission need as required by Office of Management and Budget (OMB) Circular A-109. This includes three enhancements which were questioned by a protesting offeror. GAO also believes that the updated specification for the ASDE-3 represented a technically realistic approach, was within industry state-of-the-art, and poses production schedule and performance risks which are reasonable and manageable.

GAO, however, questions certain aspects of the methodology underlying FAA's benefit-cost justification for the 30 ASDE's. GAO recognizes that adequate data do not exist on which to base an improved analysis and that obtaining such data would be time-consuming. Although improvement to FAA's generic benefit-cost methodology is important, GAO does not believe that the best interests of the Government would be served by FAA's improving its methodology before exercising its September 30 contract option. GAO believes that using OMB's position on valuing time (15 minute increments or more), four fewer installations would qualify as being cost beneficial. GAO believes, however, that FAA's methodology understates the value of safety benefits because it does not take into account benefits of enhanced passenger safety. It further believes that a more accurate estimating of safety benefits could cause more airports to qualify for ASDE's.

GAO recommends that the Secretary of Transportation: (1) formulate an action plan for obtaining more accurate and complete data on passenger time savings and safety benefits, including estimates of the time and cost required; and (2) inform the appropriate Congressional committees of this plan and when the Congress can expect future FAA system acquisitions to be justified by more comprehensive benefit-cost analyses.

GAO further recommends that the Administrator of FAA direct the ASDE-3 program office to: (1) ensure that within a fixed period of time the contractor develops an effective and usable system for tracking the contract schedule against planned milestones so that accurate schedule information can be made available as a basis for making program decisions; and (2) use the results of an improved tracking system discussed above to identify performance and/or schedule areas requiring additional management control and determine together with the contractor how best to address these areas.

POSITION STATEMENT

The Department concurs with the GAO findings and essentially agrees with the recommendations. The report presents an excellent account of FAA's search for a vastly improved ASDE system—one needed to ensure safe and efficient movement of aircraft ground traffic at our busiest airports during periods of poor visibility.

As the GAO report notes, the current ASDE-2's are ineffective during periods of heavy rain, fog, and snow. They also are affected by ground clutter and cannot identify individual aircraft, its size, or distinguish aircraft from other kinds of vehicles. Also the age of the ASDE-2's makes them expensive to operate and maintain. The new ASDE-3's will remedy these problems and provide further enhanced improvements as well. We are pleased to note that the GAO has not taken exception to the enhancements included in the ASDE-3's and has found them to be within the state-of-the-art and meaningful.

We cannot stress too strongly the safety aspects of this equipment. Traffic at major airports has increased over the years and will continue to increase into the foreseeable future. This has brought about a need to move aircraft during periods of poor visibility at busy airports with the same safety and efficiency as that being achieved during periods of unrestricted visibility. Without an improved ASDE, aircraft movements into and out of the affected airport would need to be slowed to maintain the safety on the airport surface. This slowdown has a ripple effect by affecting flight schedules at originating and terminating airports and airports in between. It is for these reasons that we are gratified that the GAO report supports the FAA position.

ASDE is an effective tool for minimizing runway incursions and potentially dangerous situations during reduced visibility conditions. An ASDE that was placed in Anchorage, Alaska—the forerunner of the ASDE-3—prevented a potential accident between a Boeing 727 and a YS-11 aircraft within 90 days of installation. The two aircraft, operating from different runways but with intersecting flight paths, had started their departure roll at the same time. This human error was picked up from the ASDE and the YS-11 was ordered to abort its takeoff.

GAO cites the need for improved benefit-cost refinements to include passenger time savings and safety benefits. It believes that the FAA should proceed to exercise the contract option available for 13 additional systems prior to its expiration on September 30. We agree and the FAA plans to exercise the option since there is a considerable time and cost savings over reprocurement.

With respect to the GAO recommendations, the following actions will be taken:

See comment 1.

a. At the Department's request, the FAA is in the process of determining improvements in its benefit-cost methodology in order to accurately estimate the value of such elements as passenger time savings and safety benefits. Included in this study are: (1) a review of current state-of-the-art techniques as covered by professional literature with an evaluation of possible application to aviation; (2) discussions with other Government agencies, educational institutions, and the private sector; and (3) application of current microeconomic analysis techniques.

Further, it is critical to recognize that the application of the benefit-cost methodology will vary due to the unique factors which affect different modes of travel. Aircraft accidents are a rare event and unique statistical, economic, and probability theory apply to this area. This is quite different from modes of travel where large numbers of accidents can be evaluated. For example, benefit-cost studies of auto accidents may be able to use certain techniques because of the volume of available data which are not available in the aviation sector. The commercial air passenger system in the United States is characterized by the extensive use of hubbing networks and interline connections. Therefore, the value of time used in aviation analysis must reflect the potential cascading effects of a single delay at one point in the network.

The FAA will inform the appropriate Congressional committees of its progress in developing a more comprehensive benefit-cost analysis.

See comment 1.

b. The FAA has required the contractor, Norden Systems, Incorporated, to develop and provide an effective and usable system for tracking contract schedule against planned milestones so that accurate schedule information on progress can be made available. In this regard, on May 30 the FAA Contracting Officer advised Norden that the automated schedule tracking system, Management and Program Planning System, contained various deficiencies that needed improvement.

The company responded by development of a Master Program Plan (MPP) Network Diagram that will identify performance and schedule areas. Recently, the Network Diagram was used jointly by FAA and Norden to isolate and identify schedule problem areas. On September 18, the contractor formally submitted an MPP Network that depicts schedule delays and the recommended solutions to maintain the critical date of first system delivery in March 1988.

The following are GAO's comments on DOT's letter of October 15, 1986.

GAO Comments

1. The additional information DOT provides does not require a change to the report's factual substance; however, under "Agency Comments" at the end of chapters 3 and 4, we have summarized the actions FAA and Norden Systems are taking or plan to take in response to our recommendations.

Comments From the Federal Aviation Administration

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Memorandum

U.S. Department of Transportation
Federal Aviation Administration

Subject: GAO Draft Report on FAA's Procurement of Airport Surface Detection Equipment

Date: SEP 24 1986

From: Manager, Financial Programs Staff, AAA-60

Reply to Attn of: Pettinato:267-8946

To: Mr. Charles Cotton
Group Director
General Accounting Office

Attn: Eric Marts

The following comments are being furnished for your consideration in finalizing the subject report. Incidentally, we want to compliment Eric Marts on the depth of his review and the soundness of his conclusions. Needless to say, the OIG is not in agreement.

See comment 1.

1. Page 1, bottom paragraph, revise 15th and 16th lines to read as follows:

"first unit testing to be completed by March 1988. The contract contains an option for up to 25 more units at"...

See comment 1.

2. Page 4, paragraph 4, revise last five lines to read as follows:

"officials that the contractor experienced a slow start up and incurred some delays in meeting internal contractor scheduled events. This occurred as the contractor transitioned away from the manually generated master program plan to an automated plan. In actuality, he has not missed a contractual date".

See comment 1.

3. Page 27, 3rd paragraph, 3rd line, delete "unit to FAA" and substitute the following:

"to the field test site".

See comment 1.

4. Page 28, 2nd line, delete "to FAA" and substitute "to the field test site*." — and add a footnote as follows:

"*It should be noted that the critical date is the completion of field testing which by contract is March 1988. FAA engineers are working with the contractor to restructure the test activity to utilize multiple units in parallel factory tests (includes Republic Airport activity which is located close in to the contractor plant) and field tests. By using this approach, the programs office expects to maintain the March 1988 field test completion date."

See comment 2.

2

5. Change the recommendation to the Secretary of Transportation on pages 4 and 43, to the Administrator, FAA. The responsibility for formulating the action plan and informing the appropriate Congressional committees would be better served by the FAA Adminstrator rather than with the Secretary.

William D. Chandler

William D. Chandler

The following are GAO's comments on FAA's memorandum of September 24, 1986.

GAO Comments

1. Clarifications have been made in the text of the report.

2. Our policy is to address our recommendations to the highest official in the agency concerned in order to facilitate top-level consideration. To focus attention on primary responsibilities, we also identify the official who should carry out the action.

Comments From Norden Systems, Inc.

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

UNITED TECHNOLOGIES NORDEN SYSTEMS

Norden Systems, Inc.

75 Maxess Road
Melville, New York 11747
516/694-0900

26 September 1986

United States General Accounting Office
Resources, Community and Economic
Development Division
Washington, D.C. 20548

Attention: Mr. Kenneth M. Mead
Associate Director

Gentlemen:

Norden Systems, Inc. has reviewed the draft of the proposed report entitled Airport Radar Acquisition: FAA's Procurement of Airport Surface Detection Equipment. While Norden agrees in general with your findings, we would like to take this opportunity to suggest clarifications in a few areas.

See comment 1.

On page 7, in the introduction to Chapter 1, the option referred to in the next to last sentence is for 13 additional sites, not 13 additional units. The $107M potential includes a total of 42 systems and numerous related items, rather than the 30 systems stated in the report.

See comment 2.

See comment 3.

On page 17, wording such as "Cardion also stressed" and "Cardion stated... implies that Cardion is an authority. We respectfully suggest that this be changed to "Cardion asserted in its protest..."

See comment 1.

On page 19, the first paragraph should be corrected to state that the 1984 specification requires transmission agility over any 0.5 GHz segment within the 2GHz band for 15.7-17.7 GHz.

See comment 4.

With regard to the conclusion of Chapter 3 presented on page 33, Norden has implemented a new scheduling system and provided an updated Program Master Plan to the FAA. Norden believes that the FAA has found the new system effective for tracking program progress against key milestones, and for identification of performance and/or schedule areas that require additional management attention.

See comment 1.

Norden would also like to note that, while the September 1987 delivery to the FAA is an important milestone, the key date is the March 31, 1988 completion of the testing program which would allow the FAA to complete the ASDE certification process on schedule.

Norden appreciates the opportunity to provide comments on your proposed report and will remain available if any further information is desired.

Very truly yours,

David M. Nussbaum
ASDE-3 Program Manager

DMN/jk
DMNIV-4

The following are GAO's comments on Norden's letter dated September 26, 1986.

GAO Comments

1. Clarifications have been made to the text of the report.

2. According to FAA documents, the $107 million covers the cost of 30 ASDE-3 systems, associated engineering and regional support, additional hardware, and 3 dual sensor add-ons.

3. Appropriate changes in tone have been made in the text of the report.

4. Norden's actions have been explained under "Agency Comments" at the end of chapter 4.

Comments From Cardion Electronics

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

LAW OFFICES
McCAMISH, INGRAM, MARTIN, BROWN & McCULLOUGH
A PROFESSIONAL CORPORATION

PETER J BALEGA
BYRD L. BONNER
DICK TERRELL BROWN*
JAMES M. BURGER*
CURTIS W. CANNON
JAMES S. CHESLOCK
GEORGE COWDEN III
J ANDREW CRAWFORD
ROSS S CROSSLAND
J. PATRICK DEELY*
ROBIN A FASTENAU
JAMES P GALLATIN, JR.*
EILEEN M. GLEIMER*
JEFFREY A GREEN
DAVID S. HURT
JAMES E. INGRAM*
RICHARD J KENDALL*
JACK T. KOLZE
LAWRENCE R LINNARTZ*
THOMAS A MARTIN*

DALE V MATTHEWS
JOHN N. McCAMISH JR.*
JOHN A. McCULLOUGH*
PAULA J. McGEE
DONALD PANCOAST NOBLE
THOMAS M. O'BRIEN*
JONATHAN D. PAUERSTEIN
BRUCE S. RAMO*
ROBERT A. RAPP*
NANCY HAMILTON REYES
JOHN T. REYNOLDS
WILLIAM M. RORK
CHARLES W. SCHOLZ
RICHARD A. SMITH
BRUNO SONSINO
E LANDERS VICKERY
ANDREW S. VIGER*
BOB WAGGONER
O. JERROLD WINSKI

ROBERT R. MURRAY
OF COUNSEL

*ADMITTED IN DISTRICT OF COLUMBIA

2828 PENNSYLVANIA AVENUE, N.W.
WASHINGTON, D.C. 20007
(202) 337-7900
TELECOPIER (202) 338-1299

McCAMISH, INGRAM, MARTIN & BROWN
P.C.
1200 TWO REPUBLICBANK PLAZA
175 E HOUSTON
SAN ANTONIO, TEXAS 78205
(512) 225 5500
TELEX 9108711104
TELECOPIER (512) 225 1283

650 MBANK TOWER
221 WEST 6TH STREET
AUSTIN, TEXAS 78701
(512) 474-6575
TELECOPIER (512) 474 1388

October 16, 1986

Mr. J. Dexter Peach
Assistant Comptroller General
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

Attached are the comments of ISC Cardion (formerly Cardion Electronics) to GAO's draft audit report entitled Airport Radar Acquisition: FAA's Procurement of Airport Surface Detection Equipment.

Our comments are intended to point out some of the areas where the draft report agrees with Cardion's position. Our silence on other matters should not be taken as agreement with the auditor's conclusions. Cardion has discussed these issues extensively in the context of the protest now pending before GAO's Office of General Counsel.

We very much appreciate the opportunity to make these comments. Cardion has followed the ASDE program for many years and recently has installed modern ASDE's in Canada and Switzerland. We have every intention of remaining a viable source in this market and will continue to follow FAA's program with great interest.

Cordially,

Richard A. Smith

RAS:jmj

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COMMENTS ON GAO DRAFT REPORT

Introduction

Although the GAO report rules against Cardion, it is interesting that they seem to agree with Cardion on the risks involved, accurately summarizing Cardion's position that the combination of features required in the FAA specification "were not technically feasible to produce within the schedule called for in the ASDE solicitation" (Cardion's position as quoted in the middle of page 17). Indeed, they express concern that the schedule is in jeopardy, and that some specification requirements may not be met. The comments presented below discuss this in more detail; they are grouped as follows:

Risk
Frequency Range and Power
Display Processing System
RMM
Miscellaneous

Risk

See comment 1.

As a technically oriented company, Cardion is well aware that many challenging tasks can be accomplished if enough time and money is available. While most of the contested features have been demonstrated somewhere, and thus qualify as state-of-the-art, combinations of these features can result in a formidible design task. As we have noted in prior submissions, we regard the combinations of the specified Display Processing System with RMS and its associated on-line diagnostic capabilities as such a task. It appears that the GAO shares this concern with regard to both performance and schedule:

P23: DPS and RM "still pose major risks because of software programming uncertainties". (middle of page - schedule risk due to staffing problem)

P24: "However, in two of these subassemblies--the display processor and remote maintenance--major risks still remain." (under section entitled "Major Performance risks bear watching".)

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P25: Under RM - "Despite Norden's expectations, we believe there continues to be a risk that the RMS will not operate as required". (bottom of page). "Our consultant believes that the risk of the display processor's not meeting the specification is increased because of the complex programming that needs to be written...because the software is incomplete and testing will not begin for some time, we cannot determine now whether Norden will successfully meet this challenge" (second paragraph).

P28: "Norden is falling increasingly behind its schedule for design of these units" (referring to RMS and display system - 11 lines from bottom of page).

See comment 1.

The contract schedule calls for delivery in September 1987 of the first system to an airport for evaluation for 6 months of evaluation. Before this delivery can occur, much testing is required at Norden's plant. GAO notes that this is currently supposed to start in April 1987 (p. 27 - "Schedule delays exist and more are likely"), but that is probably optimistic since the testing period "is almost over-programmed with tasks and, according to the engineer in charge, cannot absorb additional delays" (p. 28 - Testing program is behind schedule - eighth line). In addition, Norden has to build and debug the first equipment before the start of testing in April 1987 (five months from now). Since they are still designing the equipment, this date is definitely in jeopardy.

See comment 2.

The second system is due at the date of completion of site evaluation, with subsequent systems following close behind it. In order to meet this delivery date, these systems must be committed to production while the first system is still in test; any changes resulting from test and evaluation will result in schedule delay (we pointed this out in the "question phase" of the RFP: Cardion Question 46 - FAA Question/Answer 74; the reply was that the Contractor is responsible for any resulting costs). Cardion can attest to the fact that this is a severe financial risk, since we have encountered this on prior FAA programs. The GAO quotes their expert consultant and notes that the technical and schedule risks involved are "within customary industry limits for this type of system as it goes into production." (p. 16 - 11 lines from bottom). GAO notes that FAA regards its decision to proceed directly with procurement and production without prior development and test as "an insignificant technical risk" (p. 21 - Conclusions - 4 lines from bottom). Cardion would not agree

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with this, based on our experience with the ASDE-3 and FAA programs in general. Earlier this year, Norden announced major losses on two radar programs. The normal debugging cycle of a system as complex as the FAA ASDE-3 will lead to late delivery by Norden, with much extra costs incurred. It is not likely that Norden will be willing to absorb further major losses; requests for relief in area of performance and additional funding is to be expected. The price of future equipment and services purchased from Norden will certainly reflect this.

Frequency Range and Power

See comment 3.

GAO notes that Norden is purchasing a TWT which covers the entire 15.7-17.7 GHz range (p. 26, 27) a range Cardion considered difficult and unnecessary. This was done by reducing the transmitter power to 3 kW, a level Cardion considers as too low to meet the FAA specification. It appears that the lower transmitter power is being justified by the use of low loss waveguide for the 100 ft run required by the specification (FAA-E-2725a, 3.5.3). However, in a control tower, a considerable length of standard waveguide will be needed, due to the necessity for many bends (low loss waveguide must be run straight-no bends). Other factors working against the use of lower transmitter power are:

1. Coverage requirement to 24000 ft. Although this requirement is somewhat vague (3.3.2.1 of FAA-E-2725a) and was not much clarified by the FAA reply to our question (Cardion Question 16, FAA Question/Reply 127, also cited in P 2, 3 of Exhibit C of our 14 June 1985 protest letter), it appears that this requirement is meant to cover the gap in covereage between the terminal radar and the ASDE, and also to permit independent operation of parallel runways spaced less than 4000 ft apart. As such, coverage in rain is required, leading to a need to make up the losses thru the additional rainfall and the additional range (R^4).

2. Coverage is required to 200 ft altitude (3.3.2.4 of FAA-E-2725a). Although this tends to conflict with the specified elevation coverage (3.3.2.3 of FAA-E-2725a), FAA declined to change either requirement (Cardion Question 17, FAA Question/Reply 128). The extra elevation coverage indicated by this requirement reduces the antenna gain. If it is desired to monitor aircraft on approach (possible intent of 24,000 ft requirement, as noted above in 1.), the antenna gain will be further reduced.

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3. Reduced antenna gain necessary to meet improved sidelobe requirement.

   Another problem resulting from the 2 GHz frequency coverage is indirectly mentioned by the GAO; this is the effect on antenna requirements which must now be met over a four times greater frequency range than the engineering model. Parameters particularly affected are sidelobes and ICR. A wideband feed will be necessary, and it must meet the same polarization requirements (ICR) as the original feed. Sidelobes can be reduced by illuminating less of the reflector (reducing antenna gain, increasing azimuth beamwidth, which impairs azimuth resolution somewhat). Norden is also modifying the radome to cover the wider frequency range, using a "C" type sandwich with considerably higher weight and cost (and increased loss, reducing antenna gain somewhat.) These items were questioned by Cardion in Questions 23, 25, 26 (FAA Question/Reply 117, 119, 120). The changes being made in the Antenna/Rotodome and Pedestal are increasing roof weight to well over the 3300 pounds specified in FAA-E-2725a (3.5.1).

With regard to Cardion's contention that the extra frequency range is not necessary we note the following:

See comment 4.

1. FAA claims that frequency agility is more effective over the 2 GHz range (p. 19 of GAO, second paragraph). We are not aware of any data supporting this claim.

See comment 1.

2. In the paragraph on p. 19 following the one cited in 1. above, the possibility of interference in the 16.3 - 17.7 GHz range is noted. However, this is the increased frequency range requested in the specification; there seems to be little need to require added bandwidth if it will cause inteference due to operation in the added bandwidth.

See comment 1.

3. It appears that all of the sites will use the 15.7 - 16.2 GHz range of the prototype system.

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Display Processing System

See comment 4.

The concern of the GAO on the schedule and performance risk has been noted above. A clarification of our position as stated by GAO would be useful. On p. 17 (under Enhanced processing and display features), GAO says that "Cardion stated that these requirements were beyond the current state-of-the-art". While all agree that no ASDE radar has the split screen and mosaicked displays required, Cardion does not think that they cannot be achieved (our proposal included a technique to achieve it). Cardion's position is that the processing speeds involved (both input and output) makes this a difficult design task; however, when combined with the diagnostic requirements of RMS, it becomes a much more difficult task, which is not going to be achieved in the time available. This was noted in Exhibit I of our 14 June 1985 protest letter. The GAO report seems to agree with our evaluation.

RMM

See comment 5.

It was noted earlier that GAO is concerned about schedule and performance risks in the Remote Maintenance area. There has been considerable confusion regarding the meaning of the specification regarding diagnostic capability. The GAO expert is quoted (p. 20 - fourth paragraph) as saying the Specification is "typical" and "well understood in the industry." The history of this program shows changes in the FAA's interpretation of the requirement; in fact, the summary cited by GAO on page 20 seems to indicate the original FAA interpretation rather than the one subsequently given or the one being used by other contractors. This is discussed in our protest letter of 14 June 1985 (p. 7, 8) and in Exhibit J (p. 2-6) attached to that letter. As noted in Exhibit J, the first FAA interpretation was given at Lincoln Laboratory on 27 June 1984, and meant that the diagnostic had to identify the <u>single</u> defective module in the system; this module would then be brought to the site and installed to restore normal operation. For 85% of all failures, the diagnostic software and hardware must identify the bad module with 90% accuracy (as stated in GAO p. 20). This is to be done remotely, without the help of a maintenance technician at the site. We suggested a modification to the accuracy requirement, citing an Air Force requirement for VORTAC (to a single module 30%, within two modules for 50%, within three modules for 70%, and within six module for 100% of all failures). This had been formally submitted before the meeting in our comments on the specification. This suggestion was clearly and emphatically rejected. Cardion regards this interpretation of the specification as being very difficult to meet for the Display Processing System, particularly for a fixed cost

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and schedule program. (With sufficient design iterations and failure experience/analysis, it can probably be achieved, but it is in the realm of a development effort, not a production program). As noted in the Exhibit J (p. 5), this interpretation and associated risks strongly influenced our perception of the program. We posed this question again when the RFP was released, asking:

> Is "circuit board and/or module level..." meant generically, or does it mean to a single (one) module?
>
> (Cardion Question 64, FAA Question/Reply 164)

The reply was that it was "meant generically".

This answer was received in the January 30, 1985 Amendment 2, and came too late to help Cardion, as the proposal was then due 25 March, 1985.

See comment 5.

In the documents received as a result of the protest, it was apparent that the other bidders had a very relaxed interpretation of this requirement; one bidder indicated that diagnosis would be "at least to the subsystem or cabinet level" (cited on p. 8 of our 14 June 1985 protest letter). Carried to the extreme, "circuit board and/or module level" would mean a determination that there was a bad module somewhere in the ASDE system, which might contain over 100 modules. This capability would be of little value, and certainly differs from the GAO interpretation on p. 20. It appears that some other FAA contractors regard this requirement as meaning the identification of the chassis which contained the failed module. Since this would then require bringing to the site all module types used in that chassis, it could easily involve more modules than suggested by Cardion in June 1984, but rejected by the FAA at that time. Cardion does not know Norden's interpretation of this requirement.

Miscellaneous

This section has miscellaneous comments on the GAO report.

See comment 4.

1. On the bottom of p. 24, reference is made to a requirement for radar data to "be displayed on the controllers screen in no more than one and one-quarter seconds." Since 3.3.1.2 of FAA-5-2725a requires this time to be "one-quarter second" (p. 15, seven lines up from bottom), we assume that this is only a typographical error in the GAO report, rather than a relaxation of the specification.

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See comment 1.

2. On the top of p. 9, the rejection of Cardion's proposal is noted, with the comment "Cardion did not resubmit its proposal." This implies that Cardion chose not to resubmit, which is not the case. In the rejection letter of 10 May 1985 from Mr. James F. Igoe, Contracting Officer, it is stated "Revisions to your proposal will not be considered."

See comment 1.

3. On p. 15, above the center of page, reference is made to deficiencies in the displays: "improvements needed in the clarity and intensity of the screen display." The displays referred to were part of the Nu BRITE Analog Scan Converter (ASC) furnished as GFE by the Government. Cardion's position at the original proposal and thereafter was that a Digital Scan Converter (DSC) would give superior performance. However, many in the FAA did not agree, deeming the ASC to be adequate (it was, however, a major improvement over prior ASDE tower displays). Cardion invested a considerable amount of its own funds in a DSC brassboard which was demonstrated to FAA personnel on several occasions; eventually FAA agreed that the DSC was superior to the ASC, and it was included in the 1984 version of the specification.

See comment 6.

4. On p. 18, there is a comment (last sentence) that "Operational tests on the ASDE-3 model had revealed that display clutter from medium to heavy rainfall was still a problem." We know of no basis for this statement. The report on performance in rain (FAA-RD-81-41, "Detection Performance Evaluation of the ASDE-3 using Fixed Frequency and Frequency-Agile Operation") states on page 2 that the specified rainfall performance in 16 mm/hr of rainfall was met, and that good performance might be achieved up to rate of 50 mm/hr. (We think the latter is too optimistic). The specified rainfall rates in FAA-5-2725a is 16mm/hr.

See comment 4.

5. On p. 17, eight lines from bottom, GAO says "Split-screening and mosaicking are display capabilities designed to take advantage of the presence of two radars". We assume this is a grammatical error rather than a relaxation of the specification, since split-screen is clearly required in the specification for all sites, including sites with only one radar.

DR/M15

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The following are GAO's comments on Cardion's letter of October 16, 1986.

GAO Comments

1. This is one of several of Cardion's comments that are either explanatory in nature, amplify on its prior position, or do not address issues directly discussed in the text of our report. Therefore, while we do not believe that this additional information requires a change to the text of the report, we have provided Cardion's comments in their entirety to our Office of General Counsel for its use in reconsidering Cardion's bid protest.

2. Cardion raises the issue of the financial risk facing Norden Systems if it cannot meet ASDE-3 scheduled delivery dates. Cardion suggests that Norden would not be willing to absorb the losses that might accompany extended schedules resulting from design changes based on the results of system test and evaluation. Cardion further suggests that Norden would, therefore, seek relief in either the performance or funding area. Cardion believes that this risk is higher than we or FAA estimate it to be. Although the scope of our work did not include assessing Norden's financial resources or its willingness to absorb losses, we believe that we have adequately discussed in chapter 3 the source and nature of both the performance and the schedule risks Norden is facing. Therefore, we do not believe that the additional information provided by Cardion requires a change to the text of our report.

3. In documents supporting its bid protest, Cardion has consistently claimed that the ASDE-3 specification requirement for a transmitting capability over a 15.7-17.7 GHz range is difficult and unnecessary. In commenting on statements in our draft report that Norden seems to be successfully achieving this capability at a reasonable price, Cardion now asserts that it is being done at the expense of adequate transmitter power and postulates several risks to meeting the specification because of using a low-power (3 kilowatt) transmitter. Our review, however, of (1) the specification and Norden's response to it, (2) FAA's management of the solicitation and monitoring of the production contract, and (3) Norden's progress through September 1986 in designing the ASDE-3 did not identify low power as a significant performance risk. Moreover, based on our review, we believe that, to the extent any risks exist, Norden and FAA should be able to manage them successfully and thereby meet the specification. Finally, the question Cardion poses regarding

transmitter power is the kind of issue that is appropriate for FAA to consider during its "critical design review," a contract milestone currently scheduled for December 1986.

4. Clarifications have been made to the text of the report.

5. We agree with Cardion's comments that it will be difficult for Norden to meet the ASDE-3 remote maintenance monitoring requirements. In this regard, we report in chapter 3 that Norden is encountering such problems—including developing new software and adapting existing software to ASDE-3 applications—and that a continuing risk exists that the remote maintenance system will not operate as required. We note that this risk and Norden's difficulties stem from the uncertainty associated with unwritten and untested software programs. Regarding the issue of whether our interpretation of the specification is correct, we note that it reflects what we learned through discussions with FAA officials and that FAA agrees with our characterization of it in the report. Moreover, in the judgment of our consultant, the specification's language describing the remote maintenance requirement is clear. Therefore, we do not believe that the additional information provided by Cardion requires a change in the text of our report.

6. This statement was deleted from the report text.

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