ORDER

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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SUBJ: SYSTEM REQUIREMENT STATEMENT/ACQUISITION AUTHORIZATION FOR REPLACEMENT OF AIRPORT SURVEILLANCE RADAR-4/5/6 SYSTEMS

1. SYSTEM REQUIREMENT. Replacement of all airport surveillance radar (ASR)-4/5/6 systems together with associated air traffic control beacon interrogator (ATCBI)-3 equipment is certified as a valid system requirement. The replacement equipment shall be designed to meet current operational requirements and shall include remote maintenance monitoring and diagnostic features to the extent that they are cost-effective.

2. SYSTEM DESCRIPTION. The ASR and the associated ATCBI equipment provide surveillance of airspace up to 20,000 feet above ground level within a 60-nautical-mile radius of the airport. The ASR provides range and azimuth information on aircraft within this airspace, and the ATCBI, in conjunction with the transponder installed in the aircraft, adds altitude and identity information. Data from these two complementary systems are used to accomplish control and separation of aircraft by geographical position rather than by time and altitude, thus expediting the safe flow of traffic in the crowded terminal environment. Upon completion of the currently approved establishment program, approximately 180 ASR/ATCBI systems will be in commissioned service.

3. BACKGROUND.

a. Approximately half of the total ASR/ATCBI inventory (96 ASR, 69 ATCBI systems) consists of aging, obsolescent vacuum-tube ASR-4/5/6 and ATCBI-3 equipment. The three radar systems, essentially identical, were originally procured in 1958. The first system was commissioned in 1960 and the last in the 1964-65 time frame. The ATCBI-3 is of comparable vintage. Thus, the average age of the hardware is currently 15 years; the design, which is an inherent and basic limitation on system performance, is over 20 years old and must be considered crude by current standards. Radar detection range for small aircraft in the clear varies from 25 to 35 nautical miles depending on aircraft course, attitude, position in the antenna beam, etc. The probability on a tangential course is marginal at any range. Processing and display of weather in a usable form is not provided.

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b. While a skilled controller can usually work around these limitations, the quality of data provided by the ASR-4/5/6 radars will not effectively support the automated systems scheduled for implementation in the future. False alarms generated by weather and clutter reduces the effectiveness of the automation system.

c. A steadily deteriorating logistics support capability, primarily a result of the industry-wide transition from vacuum-tube to solid-state technology, is aggravated by increasing evidence of system wearout. In addition, the inherently low stability and reliability of analog circuitry implemented by vacuum-tube technology has further decreased with age. Despite the continuing deterioration of equipment reliability, an acceptable level of operational availability is being achieved on the ASR-4/5/6 and ATCBI-3 systems. This is accomplished, however, only at the expense of a correspondent increase in maintenance workload and support cost.

4. RELATED FACTORS.

a. Data from ASR-4/5/6 systems are used at very-high-activity terminals such as Washington National, Los Angeles, and Oakland as well as low-activity terminals such as Casper, Wyoming. Consequently, these older systems must achieve the same operational availability as the new solid-state systems.

b. There is mounting evidence of mechanical wearout of such major system components as the antenna, stable local oscillator (stalo) and parametric amplifer. Each ASR-4/5/6 system uses over 900 receiving tubes of more than 40 different types. Vacuum-tubes are becoming expensive and difficult to obtain. Over the last few years, the average unit price for all receiving type vacuum-tubes has gone up at an annual rate of 13 percent. Some tube prices have increased at a much faster rate. The stalo tube unit price increased from $69 for a lot of 1,300 to $98 for a lot of 2,700 over a period of one year. With an annual demand in excess of 2,000 tubes, the annual cost for this tube alone is over $200,000. Solid-state device costs, by contrast, continue to fall.

c. Recent technical developments, specifically the development and evaluation of the moving target detector (mtd) by Lincoln Laboratories/SRDS, indicate that correction of most if not all of the performance deficiencies of the ASR-4/5/6 systems is well within the state-of-the-art. The mtd provides a very significant improvement in detection of airplanes over clutter and/or on courses tangential to the radar. The mtd also has the flexibility to provide simultaneous optimum detection of targets and weather.

d. Recognizing the limited capability of the ASR-4/5/6 radar to detect small aircraft under adverse conditions, the National Transportation Safety Board several years ago recommended that FAA undertake the development of an airborne device to increase the radar cross section of small aircraft. An extensive R&D effort directed towards this end concluded that such a device was not practicable. The alternative is to improve the detection capability of the radar.

e. A radar beacon system independent of primary radar is not considered adequate for terminal application because of the significant portion of the general aviation fleet not equipped with transponders; the possibility of transponder failure; and the need to detect, process, and display weather data.

f. The Air Traffic Service has stated a requirement for primary radar in the terminal area for at least the next fifteen years. If the ASR-4/5/6 and ATCBI-3 systems are not replaced, a capital investment estimated at $6.5 million and increase in support costs will be necessary merely to sustain operation with no opportunity to realize savings in support and maintenance costs or provide needed performance improvements.

g. Analysis indicates a net present value in excess of $6.05 million through more efficient utilization of airspace, increased safety, and lower support costs resulting from replacement of the current systems with one of superior small target and weather detection capability and state-of-the-art technology.

h. The ASR-4/5/6 equipment does not meet the emission characteristics specified by the Office of Telecommunications Policy in the radar spectrum engineering criteria (RSEC). Extensive filtering or perhaps total replacement of the transmitter would be necessary to bring the equipment into compliance. This cost is not included in the estimated costs for the minimum investment required to sustain operation.

i. The Discrete Address Beacon System (DABS) is the logical successor to the ATCRB. However, since the decision to implement DABS has not yet been made, it is necessary to proceed with the first phase of an ATCBI-3 replacement program. It is anticipated that the decision to implement DABS will be made at a time such that it will be necessary to procure only a minimum number of ATCBI systems prior to the implementation of DABS.

5. <u>OPERATIONAL REQUIREMENTS</u>. The operational requirements as stated by the Air Traffic Service will be met with the following reservations:

a. Maximum range coverage on small aircraft at a viewing aspect presenting the minimum radar cross section (1 square meter) will be limited to 55 miles rather than the stated 60 miles. Small aircraft viewed at more than the minimum aspect will be detected to 60 miles. This is considered a reasonable compromise to alleviate detection and display of more distant, larger aircraft as second-time-around targets.

b. The radar will detect and process six levels of weather. It must be recognized, however, that radar returns from weather do not necessarily correlate to a high degree with areas of potentially hazardous turbulence.

c. Air Traffic Service requested 100 percent operational availability. Design of an infallible system is not physically possible. The new radar will, however, be designed for an availability in excess of .995.

d. System resolution capable of supporting 1-1/2 miles separation to a range of 25 nautical miles from the radar is possible. The probability of garbled beacon replies is higher at such separations, however. Garbled replies cannot be used for beacon tracking nor can they be correctly decoded for altitude and identity.

6. OPTIONS. The following alternatives were considered as potential solutions to the problem of continuing radar service as slightly more than half of the ASR inventory approaches the end of its operational/functional life:

a. Continue to operate the existing equipment with the minimum capital investment necessary to sustain the current level of performance.

b. Replace the existing ASR/ATCBI equipment with systems currently in production. Potential candidates include the ASR-8 and Air Force GPN (XX) radars and the ATCBI-5. Moving target detector will be added to the radar.

c. Replace the existing systems with a new system design, specified to meet current operational requirements and support the agency's objective of maintenance growth rate management.

7. COST ANALYSIS.

a. An economic analysis of the proposed ASR replacement program involves a comparison of the costs of maintaining the present 95 operational ASR-4/5/6 systems with the cost of their replacement with one of two alternatives:

(1) Installation of ASR-8 with mtd.

(2) Installation of a newly designed radar.

b. In calculating the cost of maintaining the present system from 1980-2005, the total support costs of maintaining 95 ASR-4/5/6 sites were conservatively increased at the rate of 2 percent per year to account for REAL increase in logistic support cost and other related maintenance expenses. Additionally, capital improvements to the older radars will be necessary in order to keep them operating to the year 2005. The program continues to 2005 since the last of the proposed replacement radars will be installed in 1986 and will reach the end of their life 20 years later.

c. In calculating the total potential benefits that would result from replacement of the ASR-4/5/6, a number of factors were considered:

(1) The savings in operating and maintenance costs.

(2) The replacement radar's improved potential for avoiding midair collisions through use of mtd capabilities.

(3) The replacement radar's improved weather detection capability which has the potential for reducing the number of air carrier and general aviation accidents where severe weather is a cause or contributing factor.

d. After an examination of operating and maintenance costs, aircraft accidents, and future air traffic activity, an analysis was performed with the following results:

(1) The internal rate of return of a replacement system utilizing an ASR-8 radar with a separate mtd is 9.4 percent (25-year program life, $167M investment).

(2) The internal rate of return of a replacement system utilizing newly designed radar and beacon interrogator systems is 10.6 percent (25-year program life, $154M investment).

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a. The manufacture [illegible] and related [illegible] country will [illegible]. Sellers' market will [illegible] escalation [illegible] quality.

b. [illegible] contrast, the manufacture of microelectronic circuits continues to increase, resulting in lower cost. Two factors affect cost:

(1) Price of individual devices is declining.

(2) Complexity of devices is increasing, so that fewer devices are required to perform a given function. The second factor also tends to increase system reliability.

c. A wholesale replacement of electromechanical components, not only in the operating systems but also in the environmental support system, will be required to extend the life of the existing system out to the minimum 15-year period specified by the Air Traffic Service. Replacement/modification programs inevitably result in service disruptions.

d. There is no practical way to correct the inherent performance deficiencies or add the required weather detection and processing capability to the current systems. Operational performance is marginal in the current semiautomated air traffic environment. Full capability of an automated system such as the ARTS III cannot be realized with data of the quality available from the current systems.

e. Replacement of the existing systems with an ASR-8, even with the addition of mtd, is not fully responsive to the stated operational requirements. In addition, since it is comparable in cost and does not provide the full benefits of a new system, it is less cost-effective.

f. DABS, like ATCRB, cannot adequately replace primary radar in the terminal environment because it relies on a positive response from an operational transponder in the aircraft. In addition, it does not provide the required weather data.

g. The only impact of the replacement program upon National Airspace System (NAS) users will be an improvement in air traffic control service to nontransponder equipped aircraft.

h. The replacement program will result in no change in environmental impact from that of the current system.

i. There are no potential rulemaking actions resulting from replacement of the vacuum-tube ASR/ATCBI equipment.

9. ALTERNATE SELECTED. Based on the foregoing analysis, option 6c is selected as being the most cost-effective method of providing radar service consistent with the stated operational requirements. The radar will include mtd, weather detection and processing capability, and maintenance diagnostics and monitoring features. The replacement ATCBI system will be similar to the ATCBI-5.

10. IMPLEMENTATION CRITERIA. This system requirement for replacement of the vacuum-tube ASR systems is certified subject to the implementation criteria noted below. The program sponsor will provide the System Requirement Group (SRG) with an assessment on the continued validity of this system requirement if a determination is made that it is unable to meet any of these criteria.

a. The new radar shall exhibit a significant measurable and discernible improvement over the existing radar capability to detect small aircraft in adverse clutter environment and to detect weather hazardous to aircraft.

b. The new equipment shall possess reliability and maintainability characteristics, including remote maintenance monitoring, necessary to support a system availability in excess of 0.995, and a reduction of at least 50% in maintenance workload.

c. A site-by-site analysis shall be performed to optimize system coverage/establishment cost in light of the reduction of siting restrictions expected from the new equipment. Where operationally appropriate (Washington National/ Andrews, Los Angeles, for example) the feasibility of replacing dual-radar systems with a single, optimally sited facility shall be investigated.

d. Progress of the DABS program bears directly on the replacement of the ATCBI-3. Prior to awarding a contract for replacement ATCBI equipment, the progress of the DABS program must be assessed to verify the continuing requirement for new ATCBI equipment. If an ATCBI contract does result, it must be structured so as to permit adjustment of quantity as a function of DABS progress. DABS progress must be monitored and assessed at appropriate checkpoints to be established in the implementation plan.

e. The program sponsor shall insure that arrangements are made for necessary logistics support, training etc., at a time consistent with the acquisition schedule for the prime mission equipment.

f. Cost and schedule verification procedures shall be included in the implementation plan. These procedures shall be capable of tracking and projecting actual program costs and performance schedules to detect any deviation from the planned cost and schedule. The total estimated investment cost of $154 million plus 6 percent shall be considered the upper limit beyond which revalidation of the program requirement is necessary.

11. KEY MILESTONE EVENTS. For planning and control purposes, the following dates have been established as program goals. The program manager shall inform the SRG of any proposed or actual revisions of these dates.

a. Completion of implementation plan	October 1978
b. Acquisition paper to Transportation Systems Acquisition Review Council	December 1978
c. Specification complete	September 1979
d. Contract award	June 1980

12. REFERENCES.

a. System Requirement Study ASR-4/5/6 Replacement Program, AAF-324, July 7, 1977, as revised April 30, 1978.

b. 1976 Electronic Market Data Book, Electronic Industries Association.

c. Description and Performance Evaluation of the Moving Target Detector (MTD), L. Cartledge and R. M. O'Donnel, March 8, 1977, Lincoln Laboratory Report No. ATC-69.

d. Pacific Region FY-79 budget submittal, pages 90040 through 90043.

e. "Operational Benefits of Proposed ASR Replacement", R. M. Loughlin, ASP-220, Feb. 1, 1978.

f. "Economic Analysis of Replacement ASR-4/5/6 System", K. M. Lauterstein, Stefan Hoffer, ASP-120, May 16, 1978.

13. ACQUISITION AUTHORIZATION.

a. This acquisition authorization for replacement of the ASR-4/5/6 does not address the question of optimum implementation strategy in depth for the following reasons:

(1) The program will not result in any significant change in service.

(2) The program does not involve any proposed rulemaking or changes in the NAS procedures.

(3) The program does not involve any user equipment. Accordingly, the details of optimum implementation strategy are to be addressed in the implementation plan scheduled to be completed in October 1978.

b. Authorization is granted for the system and program identified herein to move into an implementation phase as defined in the latest edition of Order 1810.1, System Acquisition Management.

Langhorne Bond
Administrator