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ENGINEERING AND DEVELOPMENT PROGRAM PLAN - DISCRETE ADDRESS BEA--ETC(U)
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16. Abstract

The DABS development program consists of three major phases, ~~Phase I,~~ System Design & Validation, ~~Phase II,~~ Engineering Development, and ~~Phase III,~~ Production Deployment. ~~In Phase I,~~ a single sensor design compatible with ATCRBS, including an integral data link, was realized. This effort resulted in developing Engineering Requirements for procurement of three industry built engineering model DABS sensors for further engineering development in ~~Phase II,~~ the current phase of the program. This Phase ~~II~~ is system oriented, focusing on investigations of such problems as multiple sensor coordination, target hand-off, ATC interface and procedures, failure mode operation, ATARS(formerly IPC) operation, etc. The ~~Phase II~~ experiments and tests will result in two technical data packages, one for single site and one for network operations for hand-off to the operational services for production implementation. ~~in Phase III.~~ This document addresses primarily the second phase of the DABS development program since ~~Phase III,~~ deployment is dependent upon efforts related to the decision to implement DABS and the attendant transition planning.

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EXECUTIVE SUMMARY

The need for a Discrete Address Beacon System (DABS) was highlighted in recommendations by the Department of Transportation Air Traffic Control Advisory Committee and accepted by the Federal Aviation Administration (FAA) to provide improved surveillance and ground-air communications in support of air traffic control automation.

The Air Traffic Control Radar Beacon System (ATCRBS) has inherent capacity and performance limitations which preclude its ability to meet future demands particularly the Automated Traffic Advisory and Resolution Service (ATARS) and support data link automation of the ATC. The ATCRBS limitations such as target capacity, resolution and range accuracy arise because of its basic signal structure. These could not be overcome by simple redesign and modification and therefore, a different concept was needed, one having the following characteristics:

* It had to be totally compatible with existing ATCRBS for evolutionary implementation at a cost to the user commensurate with the benefits attained.

* It had to provide improved surveillance and data link communications to support automated ATC requirements.

The only design concept that met these objectives was one that used the same frequencies as ATCRBS but assigned each aircraft a unique or discrete address that allowed the sensor to control the interrogations and consequently the number of replies received. In this manner, the DABS sensor could control its own operating environment. The critical issues addressed in the development of DABS were:

* Performance Requirements - These were based on an examination of the automated ATC functions which DABS was to support.

* Environment - Insuring compatibility with the present ATCRBS was the overriding issue in systems design, and also, having the inherent capacity to meet traffic growth and still perform air traffic surveillance and data link communications functions to provide service well into the next century.

* Economics - Using common frequencies yielded a high degree of commonality with ATCRBS permitting the use of common hardware in many areas.

* Transition - The DABS design permits evolutionary and modular implementation over an extended period thereby minimizing the impact upon the existing system. The low cost basic single site sensor will be deployed initially in those areas where the DABS improvements are most needed. The basic site sensor is

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upgradable to higher capacities, ATARS operation and network operation as required by the operational environments.

Some of the beacon system improvements are equally attainable by DABS or improved ATCRBS. However, ATCRBS is limited in its growth potential and reliability because of synchronous garble. DABS virtually eliminates synchronous garble and offers more capabilities and growth potential. DABS provides improved surveillance of DABS and ATCRBS equipped aircraft and data link service to DABS aircraft as an integrated system. In addition, it performs radar/beacon correlation of radar target reports from a collocated radar. Since DABS has been designed as an evolutionary replacement for the current ATCRBS, it can be introduced into the present ATCRBS environment without impacting present ATCRBS service. It will in fact improve present ATCRBS service as well as providing the additional DABS related services such as ATARS and data link communications. DABS transponder costs are expected to be only slightly higher than ATCRBS and implementation in aircraft will be through natural attrition and replacement. This allows the full utilization of present ATCRBS transponder investments while at the same time providing for a rapid implementation for those desiring the additional DABS services.

The Phase II Test and Evaluation activity will result in the availability of two Technical Data Packages (TDP) for handoff to the operational services. The first Technical Data Package will be available in April 1980 and will address DABS single site operation. The second TDP will address DABS sensor network operation and will be available in April 1982. Funding requirements for Phase II of the DABS Development Program are as follow: FY-78 $8,803; FY-79 $7,212; FY-80 $6,203; FY-81 $2,395; FY-82 $1,995 in thousands of dollars.

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I. INTRODUCTION/BACKGROUND

1.1 Problems to be Corrected

In today's Air Traffic Control (ATC) System, a prime reliance is placed upon primary and beacon radar systems for the surveillance of air traffic movements. Communication interchanges between the ground and air are provided almost exclusively by voice on radio channels. Aircraft separation services are provided by the ATC System through controller personnel who employ surveillance and communications elements in conjunction with published common system rules, procedures and standard operating practices.

The current ATC System structure has been in use for nearly 3 decades. Significant increases in air traffic and the mixture of propeller and jet driven aircraft have been successfully handled by the introduction of automation and improvements in both communications and surveillance. Looking towards the next 10 to 15 years, with additional growth of air traffic and requirements presented by the increasing automation of ATC, still greater demand for integrity, capacity and efficiency gains for surveillance, communications and aircraft separation can be anticipated. Even today, at some locations where air traffic is most dense, the existing system is being used to its upper limits to accommodate even the routine surveillance, communications and separation service needs. During the busiest periods, system operations routinely back up and user delays become commonplace.

The results of such system pressures have been a focus of attention towards further improvements to the existing system, and, at the same time, companion activities looking towards the availability of new generation ATC System components and capabilities. Unfortunately, this has (and is) creating situations that are counter to one another - where improvement efforts aimed at existing system components are often in direct competition with plans and programs to transition to new systems. This interleaving of today's improvement needs with tomorrow's goals and objectives gives rise to a subsidiary set of problems for which intelligent and reasonable solutions must be found. Examples of such problems are:

a. ATC System surveillance demands are generating the need for immediate additional improvements to the existing Air Traffic Control Radar Beacon System (ATCRBS). Such improvements should, for technical and economic reasons, be completely compatible and fully adaptable to the established agency goals and objectives registered for the Upgraded Third Generation ATC System.

b. Communications improvement demands are generating requirements for the employment of advanced technologies for both voice and digital communications. Such developments, if conceived in isolations of the introduction of digital data link into ATC ground-air-ground and ground-ground communications, could result in designs which are neither cost effective considering realistic life cycle costs, nor efficient considering future goals which include the use of digital data link in the ATC system.

c. Upgraded Third Generation ATC System automation advancements require the use of a digital data link to increase ATC System capabilities. Ground hardware and software systems must be provided a direct communications channel to aircraft that can function without a high degree of controller intervention if automation benefits are to be accrued.

d. ATC System safety gains can be realized by the addition of a common use cooperative aircraft collision avoidance method as an add-on ATC System capability. The collision avoidance technique(s) finally selected must be fully compatible with the totality of ATC System concepts as projected for Upgraded Third Generation ATC System operations.

e. The addition of an automatic collision avoidance method that is interactive with the ATC System structure which will operate in high density traffic environments as an augmentation and backup to ATC services must be compatible with any other collision avoidance or proximity warning hardware being considered for the common system.

The utilization of radar beacon technology of advanced design which embodies significant surveillance and communications improvements in an integrated design forms the basis for the contents of this program plan. The designs being pursued are in full accord with the objective of incremental hardware/software introductions. Although there are numerous references to an integrated companion cooperative collision avoidance capability, this utilization of DABS will be the subject of the ATARS Program Plan FAA-ED-03-3.

1.2 Program Objectives

The concept of an integrated surveillance, communications, and collision avoidance technical approach to satisfy the growing demands of the ATC System was established by the Department of Transportation (DOT) Air Traffic Control Advisory Committee in December 1969. Following an examination of various candidate methods that might be employed, the committee recommended the agency proceed with the development and implementation of an improved active radar beacon type interrogator/transponder system offering integral ground-air-ground digital data link communications as an evolutionary replacement for the existing National Airspace Common System ATCRBS.

The recommended combined radar beacon and digital data link communications system development provided a natural vehicle for integration of a new collision avoidance system that would perform automatically using the same basic radar/data link equipment. The proposed new hardware/software system was designated the Discrete Address Beacon System (DABS). The companion collision avoidance concept was called Intermittent Positive Control (IPC) and later integrated with Proximity Warning Indication (PWI) and augmented to become the Automated Traffic Advisory and Resolution Service (ATARS).

The major objectives that have guided the design of the DABS/ATARS are:

a. To provide improved surveillance and digital data link communications to support the ATC automation system needs including collision avoidance for the projected 1980 and beyond air traffic environments.

b. The design selected should permit evolutionary introductions at reasonable costs commensurate with the benefits to be attained by the ATC System.

c. Assure total design compatibility with the existing ATCRBS.

It was recognized that substantial increases in system performance and reliability were required to fulfill the needs of ATARS. Since the basis for ATARS is to provide an automatic ground-based conflict detection and resolution service that is to operate as a highly reliable backup to the ATC System, it must, therefore, embody not only high integrity and reliability but also features which will permit an efficient and effective integration into the ATC.

1.3 Critical Issues

The critical issues which have been addressed in the assembly of the basic design structure of the DABS sensors are:

a. DABS must be designed to operate in a mixed ATCRBS and DABS environment and the basic design must permit a gradual and economical transition to a total DABS supported ATC System over an extended period of time.

b. The total cost factors (agency and user) must be acceptable to the aviation community. (It has been projected that by the time an effective deployment of the DABS could commence in the early 1980's there will be as many as 200,000 aircraft equipped with ATC transponders and approximately 500 ATCRBS ground interrogator installations.)[1]

c. DABS must be implementable in a time frame appropriate to the need considering not only basic surveillance and communications improvements but also those program activities associated with the attainment of Upgraded Third Generation ATC System objectives.

1.4 Alternative Approaches

Different types of beacon-based surveillance systems in combination with various ground-air-ground digital data link systems have been analyzed to determine their ability to meet the requirements of the Upgraded Third Generation Air Traffic Control System through the 1990's. Addressable and non-addressable beacon surveillance systems were considered in the analysis. These systems were combined with digital data link systems integrated with the beacon surveillance function and digital communications systems employing a VHF data link.

It was found that some of the beacon surveillance system improvements are equally attainable by the Discrete Address Beacon System (DABS) or by improving the Air Traffic Control Radar Beacon System (ATCRBS). However, the improved ATCRBS would not be immune from synchronous garble in the high density areas projected for the future. The synchronous garble imposes limits to the growth and reliability of the Air Traffic Control (ATC) system with ATCRBS. Therefore, a concept embodying a form of selective addressing was desirable. DABS offered more capabilities including growth potential and also provides an integral digital data link capable of supporting ATC automation

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[1] Sources:

(1) "Report of DOT ATC Advisory Committee," Vols. 1, 2, Dec. 1969.

(2) "The National Aviation System Plan-Ten Year Plan, 1972-1981," DOT, Mar. 1971.

(3) "Beacon System Interference Problem Subgroup; Minutes of Meeting," Nov. 17, 1971.

(4) "Problems confronting the Federal Aviation Administration in the Development of an Air Traffic Control System for the 1970's," Twenty-Ninth Report by Committee on Government Operations House Report No. 91-1308, July 16, 1970.

functions and Aircraft Separation Assurance (ASA) services whether ground-based or airborne. Information regarding DABS cost benefits as an element of the Upgraded Third Generation ATC System can be found in "Policy Analysis of the Upgraded Third Generation Air Traffic Control System," Report No. FAA-AVP-77-3, January 1977.

1.5 DABS Program Structure

The DABS Program consists of three distinct major phases.

Phase I - Concept Validation and System Definition.

This phase began in January 1972 with the selection of MIT's Lincoln Laboratory (MIT/LL) as the DABS System Engineering Contractor (SEC). MIT/LL established a DABS Experimental Facility (DABSEF) to support the pursuit of system validations and definitions. In addition, the SEC conducted a broad range of technical and economic studies designed to establish the system parameters. The major accomplishment of this phase was the development of specifications for Phase II procurement of engineering developmental model DABS sensors and avionics for single site (stand alone mode) and for multiple sensor network operation suitable for FAA testing.

In Phase II, the SEC will continue to perform the overall system engineeering contractor role in providing technical expertise to the FAA in developing the DABS engineering model systems and assist with the overall test and evaluation and ATC integration.

Phase II - System Engineering and Evaluation.

Phase II began in October 1974 with the issuance of engineering requirements for DABS/ATARS hardware and software. This phase consists of several major efforts:

Initial Effort - The procurement of three DABS engineering model sensors with two-way ground-air digital link, ground-to-ground communications and ATARS capability. In February 1976, Texas Instruments, Inc., was selected as the DABS Systems Development Contractor (SDC) for the fabrication and delivery of three engineering developmental model DABS sensors to be installed in the vicinity of the FAA's National Aviation Facilities Experimental Center (NAFEC) located at Atlantic City, New Jersey. These sensors will be interfaced and integrated, for test purposes, with the terminal and en route automation facilities at NAFEC.

Second Effort - Following installation and checkout of the three DABS sensors at NAFEC and the surrounding area, the focus will be on acquiring system performance data, refining system design, performing DABS/ATARS system tests both under simulated and live conditions, culminating in a field demonstration of the following:

a. Improved surveillance capability.

b. The functional utility of the DABS digital data link communications particularly in support of ATARS.

c. DABS hardware/software interfaces with ARTS III and NAS Stage A automation systems.

d. DABS interfaces with other Upgraded Third Generation ATC automation programs (as available).

Other efforts to be conducted include continuation of DABS system engineering, and planning for the third phase, DABS deployment. A limited number of DABS/ATARS avionics will be procured for installation in test and possible operation aircraft to support the DABS and ATARS testing and demonstrations.

Phase III - Procurement and Deployment of DABS

The proposed procurement and operational deployment plan for the DABS as an ATC common system element of the National Airspace System will be performed in this phase. The principle inputs to this phase will be the technical data packages handed off to the operating services (AAT/AAF). An FAA-wide Transition Planning Working Group has been established to develop recommendations for DABS implementation and therefore the DABS Program Plan is, at this time, directed almost totally towards the Phase II aspect of the program.

1.6 Interfacing and Related Programs

Certain other major activities, closely related to the design of DABS, were initiated concurrently with the Phase I period of the DABS development program and will continue throughout the program. These activities will not be a formal part of the DABS program; they will be managed and funded under other major program activities with the FAA, as part of the Upgraded Third Generation ATC System development. These efforts represent important aspects of the future DABS-based ATC surveillance and data communications systems.

a. Automated Traffic Advisory and Resolution Service (ATARS)

ATARS is an automatic collision avoidance function which provides proximity warning (PWI) and conflict resolution service to DABS/ATARS equipped aircraft via the ground-air data link. The ATARS algorithm resides within the DABS sensor computer subsystem and communicates with remote ATARS functions through the sensor-sensor communications links.

ATARS investigations took place within the DABS program to optimize tradeoff decisions to be made between ATARS performance and DABS performance.

DABS sensors being procured have ATARS capability. ATARS refinement in both single site and multiple sensor network environments will continue during Phase II of the DABS program.

b. NAS Stage A/ARTS Developments

Both hardware and software modifications and refinements of the NAS Stage A and ARTS III control systems will be required to interface with DABS and make efficient use of the improved surveillance and communications capabilities which DABS provides. This activity will be performed within the respective NAS Stage A/ARTS development programs, and will include the generation of the ATC control commands (data link messages) for transmission to the DABS site for relay to the aircraft.

c. Data Link/ATC/ATARS Displays

In addition to the effort taking place within the DABS program, a separate, parallel effort will be undertaken to develop, test and evaluate airborne displays for general aviation (GA), air carrier, and military aircraft for use with the DABS data link. These displays are of various types with many possible configurations including ATARS only, ATARS plus ATC, and ATARS plus ATC plus extended-length messages. This activity will be closely coordinated with the DABS program to insure consistent system design.

d. Data Link Activities

The National Airspace System (NAS) has progressed to a high level of automation especially as it relates to the air traffic controller. However, it still relies heavily on voice for communications with the aircraft. DABS will provide a high capacity data link which can be used for automatic exchange of data between the ground and the aircraft. The data link will allow an extension of the benefits of automation to the pilot to relieve him as well as the controller of workload as well as provide additional services to the pilot.

An effort separate from DABS is underway which will identify practical ATC applications for the data link and will develop the interface devices (both ground and airborne) required to make use of the data link. Identification of applications will continue for several years, however, the following have been selected as candidates for the initial development effort:

i. Hazardous weather advisories

ii. Digital Automated Terminal Information Service (with real time inputs)

iii. ATC take off clearance confirmation

iv. Altitude assignment confirmation

v. Altitude echo (Mode C readout uplink)

vi. Active runway winds

vii. Automatic Pilot reports (downlink)

viii. Request and reply weather (downlink and uplink)

e. Beacon Collision Avoidance Systems (BCAS)

The BCAS is an airbone collision avoidance system utilizing the aircraft altitude encoder, and ATCRBS transponder (or future DABS transponder) and an ATCRBS (or DABS) interrogator to communicate between aircraft.

All aircraft in specified areas would carry transponders and altitude encoders. Those aircraft desiring positive protection would in addition carry BCAS processing equipment to evaluate the threat of collision with other transponder equipped aircraft and display evasive maneuver instructions to the pilot. The BCAS provides the first equipped aircraft immediate protection relative to all transponder equipped aircraft. It also provides protection beyond the coverage areas of both the ground-based ATC surveillance system and the future ground-based DABS/ATARS system.

II. TECHNICAL APPROACH

2.1 Functional Description of the Technical Approach Selected

The Discrete Address Beacon System, which is comprised of ground-based sensors and airborne transponders, is a cooperative surveillance and communications system for air traffic control.

The principal and unique capability of DABS is the discrete address. Using an aircraft's discrete address, DABS can direct interrogations to a particular aircraft and can unambiguously identify DABS transponder replies. A principle system advantage gained through the DABS is the timing of interrogations which precludes the sychronous garble problem of replies from closely spaced aircraft as exists with ATCRBS. The unique address also permits data link communications to and from a particular aircraft as an integral part of the DABS surveillance interrogations and replies. The digital data link will augment existing voice radio ATC system command and control interchanges.

The DABS sensor provides surveillance of all beacon equipped aircraft, and data link service to DABS equipped aircraft. In addition, the DABS sensor accepts digitized collocated radar data and performs radar/beacon correlation. Digital circuits are used by the DABS sensor to transmit surveillance data to, and exchange messages with, en route and terminal ATC facilities. Each DABS sensor has the ability to operate in a multiple sensor network. In this environment, the DABS sensor communicates directly with adjacent DABS sensors for target hand-off and to provide backup surveillance and communications functions in the event of a link failure.

An automatic conflict advisory and resolution service function ATARS resides within the DABS sensor computer complex. This function provides automatic proximity warning (PWI) and conflict resolution service to aircraft suitably equipped (DABS transponder and associated cockpit displays) via the ground-air-ground data link.

The DABS transponder performs all of the functions of the present secondary surveillance radars (SSR) transponders, and adds to these the ability to decode DABS interrogations and to format and transmit the appropriate replies. For data link, the transponder functions primarily as a modem for optional copkpit input/output devices. On receipt of a ground-to-air transmission, it verifies the correctness of the received message using an error detecting code. Once verified, the transponder transfers the message contents to one or more external display devices. For air-to-ground messages, the transponder accepts the message contents from an external input device and formats and encodes the data for transmission as part of the reply to a subsequent interrogation. A much more complete description of DABS may be found in FAA-RD-74-189: "DABS: A System Description."

2.2 Major Tasks

DABS Phase I - Concept Validation and System Definition

* Establishment of DABS Experimental Facility (DABSEF)
* Concept Validation
* System Definition
* Perform Technical Studies
* Produce DABS Engineering Requirements

DABS Phase II - System Engineering and Evaluation

* Procurement of three DABS engineering developmental model sensors with ATARS capability.
* Procurement of DABS general aviation and commercial airline type avionics for installation in test aircraft.
* Procurement of ATARS and ATC message displays for installation in test aircraft.
* Produce U. S. National Aviation Standard for DABS.
* Produce specifications for DABS/ATC interface.
* Produce test and evaluation plans and procedures.
* Development/refinement of DABS/ATC interface and operational software.
* Perform DABS sensor factory tests.
* Perform field acceptance tests at NAFEC.
* Perform system level performance tests at NAFEC.
* Perform DABS/ATC system tests at NAFEC.

* Preparation of a Technical Data Package for procurement of operational DABS sensors.
* Preparation of a Technical Data Package for interconnection of DABS sensors for operations in a network environment.
* Preparation of a Technical Data Package for integration of DABS into the National Airspace ATC Common System.

DABS Phase III - Procurement and Deployment

Procurement and deployment recommendations for DABS as a National Airspace System component will be developed as part of the Transition Planning Working Group's activities in parallel with the DABS Phase II effort.

2.3 Operational Effectiveness of Development Activities

The DABS Phase I "Concept Validation and System Definition" activities which began in January 1972 produced the DABS Engineering Requirements (ER) documentation. These ER's resulted in the DABS Phase II engineering model procurement actions which were initiated in February 1976 under a contract negotiated with Texas Instruments, Inc., Dallas, Texas.

Texas Instruments, as the DABS System Development Contractor (SDC), has the responsibility for the design, fabrication, delivery and installation of three DABS engineering model sensors with ATARS capability. The placements of these sensors will be as follows:

Sensor 1 - A terminal version to be installed at NAFEC Radar/Beacon Test Facility (RBTF). Sensor 1 will be operated in conjunction with a modified ASR-7 radar. This sensor will be interfaced with the five foot open array antenna when it becomes available.

Sensor 2 - An en route version to be installed at Elwood, New Jersey. Sensor 2 will be operated in conjunction with a modified ARSR-2 radar interfaced with a back-to-back antenna to provide a 5-second update rate which will be sufficent to demonstrate ATARS.

Sensor 3 - A terminal version sensor to be installed at Clementon, New Jersey, adjacent to the Philadelphia International Airport. Sensor 3 will be interfaced with an ASR-8 antenna system and a radar digitizer.

All of the DABS sensors will be capable of operating in a single site (stand alone) mode and in a multiple sensor network mode. Sensor 2 will contain an additional algorithm for processing and scheduling interrogations with a back-to-back antenna. These placements will permit the start of the DABS Development, Test and Evaluation (DT&E) program at NAFEC which consists of three principle test elements:

Test Element I	-	Field Acceptance Testing
Test Element II	-	DABS Performance Testing
Test Element III	-	DABS/ATC System Testing

2.3.1 Field Acceptance Testing

The field acceptance tests for each sensor will be initiated immediately following installation by the SDC. The purpose of these tests will be:

a. To assure that transportation, handling and installation have not altered single site sensor operation.

b. To perform sensor tests that could not be performed at the factory.

c. To verify that the multiple sensor network operation satisfies the engineering requirements.

d. To verify that the DABS sensors can be interfaced and operate with the SSF and TATF.

2.3.2 DABS Performance Tests

The purpose of the DABS performance tests is to establish the parametric and functional performance characteristics of the DABS sensors in an environment similar to that in which it will operate. The performance testing will begin following acceptance testing at NAFEC. The DABS Performance Test Element consists of the following major activities:

a. DABS Single Site Tests

i. Surveillance performance including radar data processing

ii. Communications including data link

iii. Failure/recovery Modes

iv. Capacity/response time

v. Computer performance measurements

vi. Performance Monitoring

b. DABS Multiple Sensor Network Tests

i. Network surveillance performance

ii. Network Communications link performance

iii. Network failure/recovery mode

iv. Network capacity/response time

v. Computer performance measurements

See FAA-RD-76-147: "Performance Test Requirments for the DABS Engineering Models" for more details of the Performance Test element.

2.3.3 DABS/ATC System Testing

The purpose of the DABS/ATC System Test element is to establish DABS/ATC compatibility in an experimental environment. The DABS/ARTS III (modified) and DABS/NAS Stage A automation systems will be evaluated, including Air Traffic Controller interfaces, using simulated and live target inputs. During this period refinements will be made to improve compatibility. The major activites of this test element are:

a. DABS/ARTS III (modified) System Testing

This activity will consist of the following efforts:

i. Full system level validation and refinement of single site DABS/ARTS III (modified) operation in a simulated Philadelphia environment.

ii. Data link testing using Control Message Automation (or an equivalent function) where data to be transmitted is generated with an existing

Upgraded Third Generation automation function (e.g., Minimum Safe Altitude Warning). This will evaluate the potential utilization of the DABS integral data link.

iii. Single site DABS/ATARS evaluation and refinement in a simulated Philadelphia environment.

iv. DABS data relay mode evaluation and refinement.

v. Testing and refinement of various levels of ATC system and communications failure modes.

b. DABS/NAS Stage A Testing

i. Full system level validation and refinement of a DABS single site and multiple sensor network operation when interconnected with the NAS Stage A control system.

ii. Testing of various network management schemes to obtain a cost effective and efficient design for operational network implementation.

iii. Testing and refinement of the various levels of ATC system and site-to-site communications failure modes.

iv. DABS/ATARS evaluation and refinement in a multiple sensor network environment.

2.4 DABS Performance

DABS must provide reliable and accurate surveillance and data link communications for large numbers of aircraft to adequately support an increasingly automated air traffic control system and collision avoidance functions. The performance of DABS can be summarized as follows:

Range	200 N. M.
Range Accuracy	50 feet (1 sigma)
Azimuth Accuracy	0.1 degree (1 sigma)
Surveillance capacity	400 - 700 aircraft/sensor

Surveillance capacity (typical)	400 aircraft/sensor (any mix of ATCRBS, DABS and radar targets)
Update Rate	4 seconds (nominal)
Data link capacity	4 megabit uplink 1 megabit downlink
Data link delivery	99% per scan
Data link undetected error rate	1 in 10^7

2.5 Program Responsibilities

The following is a summary of the organizations responsible for management of the various portions of the DABS Program as well as support organizations:

Activity	Lead	Support
DABS Program Manager	ARD-200	
	Phase I	
DABS System Engineering	ARD-200	Lincoln Laboratory (LL), AEM
Preparation of ER's	ARD-200	LL
DABSEF	ARD-200	LL
DABS Interference Studies	ARD-200	Electromagnetic Compatibility Analysis Center (ECAC)
	Phase II	
DABS System Engineering	ARD-200	LL, AEM-20
DABS Sensor Development	ARD-200	Texas Instruments, Inc.
FAA Test Requirements	ARD-200	ANA-100, MITRE, LL. AEM-20
Preparation of FAA Test Plans	ANA-100	ARD-200, MITRE, LL, AEM-20
Performance of FAA Tests	ANA-100	ARD-200, MITRE, LL, ARD-100

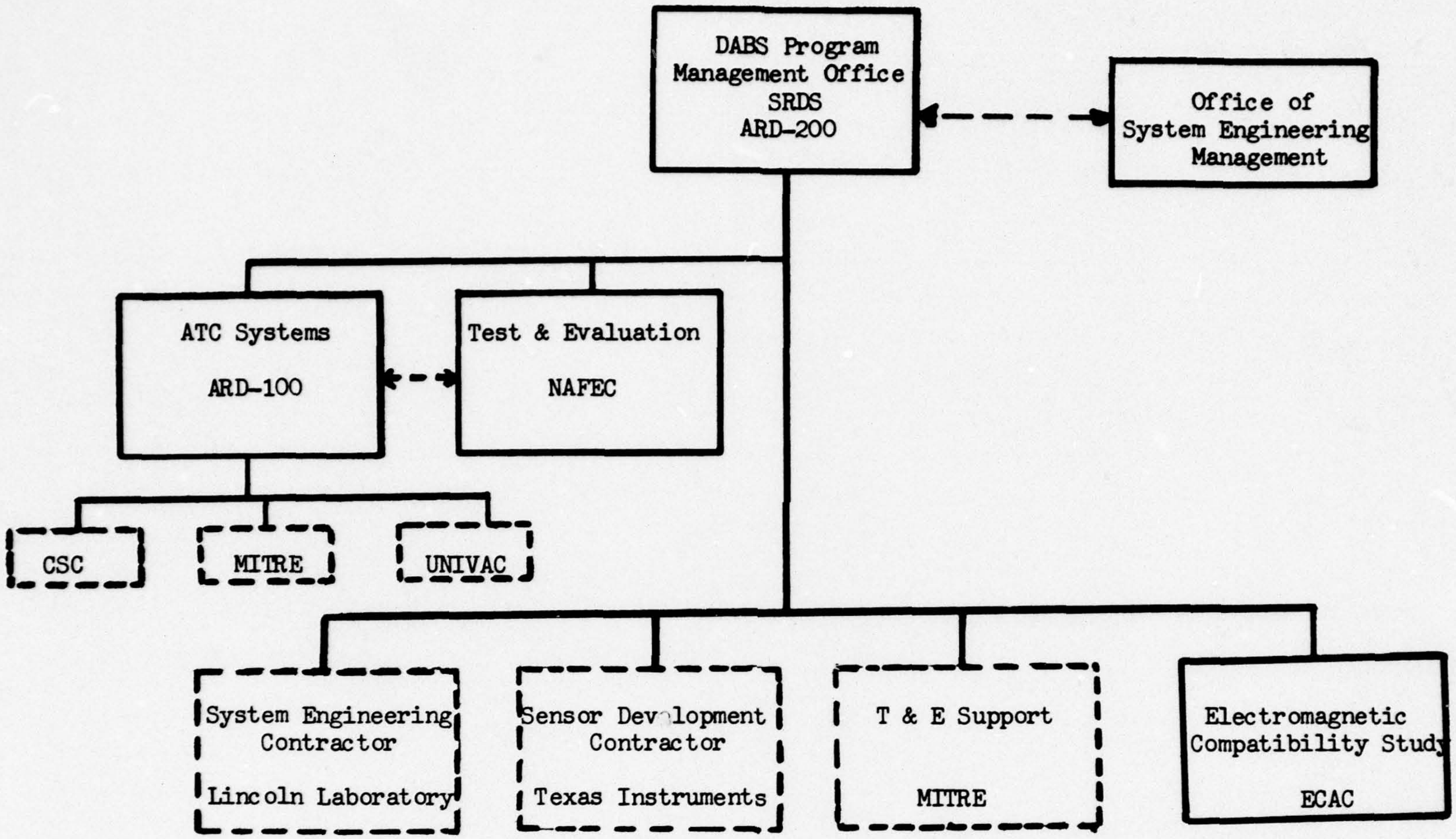
Activity	Lead	Support
	Phase II	
DABS Data Reduction and Analysis	ANA-100	ARD-200, MITRE, LL
DABSEF	ARD-200	LL
DABS Configuration Control	ARD-200	ANA-100
Transportable Measurement Facility	ARD-200	LL
Airborne Measurement Facility	ARD-200	LL
DABS Interference Studies	ARD-200	ECAC
DABS Software Maintenance	ANA-100	ARD-200
ATC Software Development	ARD-100	ANA-100,200,700 MITRE, UNIVAC, Computer Science Corporation (CSC)
ATC Software Validation	ARD-100	ANA-100,200, MITRE, UNIVAC, CSC
ATC System Performance	ARD-100	ANA-100, MITRE, UNIVAC, CSC
ATC DR&A Software Development	ARD-100	ANA-100, MITRE, UNIVAC, CSC
ATC Tests	ANA-100	ARD-100, MITRE, UNIVAC, CSC
Testbed Site Preparation	ANA-100	ARD-200
Avionics	ARD-200	ANA-100, LL

Figure 2-1 depicts the DABS Phase II development functional interface structure.

2.6 Identification of Test Sites, Facilities, Equipment and Software

2.6.1 Test Sites

Three DABS ground sensor equipments to be acquired under Phase II will be located at three separate, but adjacent, sites to form an engineering model complex that is suitable for test and evaluation of DABS operational and technical capabilities. The sensors being provided each facility are designed to provide surveillance and air-ground-air communications with test aircraft that will be equipped with the DABS type transponders. Each sensor will also contain its associated ATARS function. The



DABS Phase II Development
Functional Interface Structure

Figure 2-1

services to be provided by the SDC include the installation and integration of all equipments comprising each of three DABS facilities. The test sites for the DABS equipment placement are:

Site # 1 - Atlantic City, N.J. (NAFEC)
Site # 2 - Elwood, N.J.
Site # 3 - Clementon, N.J. (adjacent to Philadelphia International Airport)

The three DABS sensors will first be operated in the single site mode to verify the surveillance and communications performance of DABS. Testing will then proceed to system level single site evaluation when interfaced with the NAS Stage A and ARTS III (modified) ATC automation systems. Following this, the three DABS sensors will be interconnected to form a multi-sensor DABS and ATARS network. This network will be interfaced with the NAFEC NAS Stage A control system, and tested to evaluate and refine DABS network operation.

2.6.2 Site Preparation

NAFEC has the responsibility for preparing the sites for DABS sensor installation. This activity includes construction of the necessary foundations, air conditioning and AC power. At the RBTF site, NAFEC will also provide the required shelters and work areas. NAFEC will coordinate with the telephone company to provide lines for interconnection of the DABS sensors and lines for the DABS/ATC interfaces.

2.6.3 Test Facilities

The following facilities and control systems will be used during the DABS testing program at NAFEC:

i. An ARTS III (modified) control system located at the Terminal Automation Test Facility (TATF). ARD-100 will be responsible for providing the ARTS hardware as described in FAA-RD-74-159-IV for the DABS/ARTS surveillance and Common ICAO Data Interchange Network (CIDIN) communications interface.

ii. An en route ATC automation system located at the System Support Facility (SSF). The SDC will provide a Front End Processor (FEP) for the DABS/

En route automation CIDIN communications interface. ARD-100 will be responsible for providing the en route hardware and software for (1) receiving and transmitting of communication messages to the FEP, and (2) receiving surveillance data directly from the DABS sensors.

Scheduling of the above test facilities will be the responsibility of ANA-100.

iii. Air Traffic Control Simulation Facility (ATCSF)

The ATCSF will be interfaced to the TATF and SSF for ATC software verification prior to DABS testing. In addition, the ATCSF can be used to support ATC operational testing. ANA-100 will be responsible for the necessary hardware and software modifications required to interface the ATCSF with the ATC facilities.

2.6.4 Test Equipments

i. Aircraft Reply and Interference Environment Simulator (ARIES)

ARIES is a unit of special test equipment that has the ability to simulate a heavy target (up to 400 DABS or ATCRBS) and fruit environment for a DABS sensor. ARIES interfaces with the RF front end of a DABS sensor and introduces the simulated replies and fruit into the sensor at IF. ARIES is also designed to operate with a mix of simulated and live targets. ARIES will be available to support all phases of the DABS testing at NAFEC. Two ARIES will be available to support DABS network testing. By proper coordinate conversion of a single traffic model, the ARIES units will present a consistent multi-site environment to the DABS network. One ARIES will be supplied by MIT/LL and the second ARIES will be supplied by NAFEC.

ii. System Test Console (STC)

The STC has the capability to receive, display and record on magnetic tape all DABS/ATC surveillance and communications data, sensor-to-sensor messages, ATARS messages, status and performance monitoring data. The STC also provides the console operator the capability of formatting and transmitting NAS-to-DABS messages to a selected sensor or sensors. The STC will be available to support all DABS testing and to monitor the live flight ATARS tests to ensure safety.

iii. Computer Performance Measurement Equipment

NAFEC is responsible for providing the hardware and software necessary for monitoring and obtaining DABS computer performance measurement data during the DABS performance tests.

iv. Test Target Generator (TTG).

This unit has the capability of simulating transponder replies to provide realistic test inputs for verification and fault analysis of the ATCRBS and DABS reply processors. It provides synchronous digital inputs representing test targets into each of the reply processors in a repetitive fashion. The unit functions even when the DABS sensor is not connnected to an antenna.

2.6.5 Avionics

DABS avionics will be built for test with the engineering model sensors. Action will be taken to procure approximately 40 DABS transponders. Two types of transponders will be procured. One will be a low-cost general aviation type transponder. The second type will be a more elaborate transponder built to commercial airline standards. All transponders will have full DABS capability, including the ability to send and receive short data link messages for ATARS and other purposes, and also Beacon Collision Avoidance System (BCAS) signal capability. The commercial airline type transponders will have the additional features of antenna diversity required for aircraft carrying BCAS equipment, and extended length message capability, for sending and receiving long air-ground data link messages efficiently, using cockpit devices such as teleprinters. In addition, action will be taken for procurement of ATARS and ATC message cockpit displays which will use the DABS data link via the DABS transponders.

2.6.6 ATC Software Requirements

The ATC software requirements identified herein are presented in the form of "software packages" for ease of identification. The packages listed are considered the minimum required, but not necessarily limited to that presented, for demonstrating the operation and technical capabilities of the DABS/ATARS system with interfaces with ATC automation both terminal and en route. This software will be provided by ARD-100.

1. DABS/ARTS III (modified) Software

   a. Interface Test Software

   An interface test software package is required to support DABS sensor acceptance testing at NAFEC. The software shall have the capability of receiving surveillance data and the receipt and transmission of communications messages. Software to record data and provide offline data reduction and analysis shall also be part of this package.

   b. Operational Software

   The following software packages are required to support the DABS/ATC system testing at NAFEC:

   i. Surveillance Processing Package - The ARTS III (modified) shall have the capability to process DABS surveillance data. This software package should also include the capability to process communication messages related to surveillance processing (e.g., ATCRBS ID request) and the processing of sensor status messages.

   ii. ATARS and Communication Processing Package - This software package is required to process and display ATARS messages for controller alert and to record ATARS messages. This package should also provide for the processing and recording of the messages described in FAA-RD-74-63A.

iii. Data Link Processing Package - Software should be developed for transmission of messages via the DABS data link. Upgraded Third Generation ATC algorithms such as terminal metering and spacing, conflict resolution, and minimum safe altitude warning should be modified to provide the data link processing function software messages for data link transmission.

2. NAS Stage A En Route Software

a. Interface Test Software

An interface test software package is required to support DABS acceptance testing at NAFEC. This software should have the capability of receiving surveillance data and the receipt and transmission of communications messages. This package should also provide for an exercise of the FEP/9020 protocol. Software to record data and provide offline data reduction and analysis shall also be part of this package.

b. Operational Software

The following software packages are required to support the DABS/ATC system testing:

i. Surveillance Processing Package - The en route ATC automation system shall have the capability to process DABS surveillance data. Processing of surveillance related communications messages should be included as part of this package as well as the processing of sensor status messages. Data recording, reduction and analysis software shall also be part of this package.

ii. ATARS and Communication Processing Package - This software package is required for the processing of ATARS generated messages. Appropriate display software should be developed for displaying ATARS controller information. This package should also provide for processing the messages described in FAA-RD-74-63A.

iii. Data Link Processing Package - Software should be developed for receipt and transmission of ATC data link messages. Upgraded Third Generation ATC functions such as en route metering, conflict resolution, conflict probe, etc., should be modified to provide the data link processing package messages to be relayed to DABS for data link transmission.

2.6.7 Data Reduction Software (DABS & ATC)

1. DABS Data Reduction Programs

The SDC is responsible for the development and delivery to the FAA the following data reduction programs:

* Quick Look Data Processing Program (runs on the 990/10 Program Support Equipment)

* Extended Data Analysis Programs (runs on an IBM 360 series computer)

NAFEC is responsible for providing the computer resources required for the use of these programs. In addition, NAFEC will be responsible for the maintenance and refinement of these programs as required. The SDC is responsible for delivery to the FAA of the 990/10 Program Support Equipment.

2. ATC Data Reduction Programs

ARD-100 is responsible for providing software for data reduction and analysis of DABS/ATC system test data. These programs will operate on the data processed by the SSF and the TATF.

3. Data Evaluation and Test Reports

NAFEC is responsible for the reduction, analysis, and evaluation of the computer performance measurement data, the DABS performance test and DABS/ATC system test data and the generation of the required test reports.

2.7 Preliminary Implementation Criteria

Implemenatation criteria is to be developed in conjunction with the Transition Planning Working Group activites.

Three levels of DABS sensor capabilities/capacities have been identified which would permit deployment of a DABS sensor tailored to a particular site's needs. The levels are defined as follows:

Level 1. Basic DABS sensor - a low-cost single site surveillance and data link system with moderate (400 aircraft) capacity.

Level 2. Level 1 capability with increased capacity.

Level 3. DABS Network operation, high capacity, including ATARS operation.

All levels are upgradable to the higher levels.

2.8 Management Techniques for Coordinating and Integrating Interface Efforts

a. DABS Management

The Systems Research and Development Service (SRDS) has the overall responsibility for management of the DABS development program. To fulfill the responsibility for management and direction of the DABS program, the FAA has established a Surveillance Branch with a DABS section, within the FAA's Systems Research and Development Service. The Surveillance Branch is headed by the DABS Program Manager (PM). The DABS PM is supported by other elements of the FAA in the areas of contract negotiations, procurement and contract administration. In addition, the SEC will provide direct support to the PM in executing his responsibilities. To provide a formal mechanism for coordination with other government agencies and with aviation interests, various groups were established as adjuncts to the Program Manager.

b. Group Activities and Responsibilities

1. The DABS Program Manager

The FAA will be the primary agency of the Government responsible for the implementation of the DABS development plan. The general responsibilities of the DABS Program Manager include:

i. Management of the overall DABS design and development effort, including FAA facilities and resources as well as those of the SEC.

ii. Planning and coordination with other FAA, DOT and DOD organizations on DABS development.

iii. Communication and coordination with non-military user groups, both domestic and international, and the pursuit of ATCRBS and DABS related international agreements.

iv. Establishment of the management structure to carry out the operational testing phase as the system definition and system evaluation phases near completion.

v. Funding and managing contracts to the participating agencies (e.g., SEC, SDC, ECAC, etc.)

2. User Laision Group

Representation of user interest in the DABS development program will require participation of many user organizations. The necessary communications with ARINC, which will probably assume the responsibility of developing the final airline equipment specifications, should be provided through this group. Similarly, the international coordination activities required for eventual ICAO standardization of the DABS may be pursued, at least initially, by this group.

3. Development, Test and Evaluation Advisory Group

Due to the technical complexity of the DABS/ATARS/ATC system and the extensive coordination involved between various elements of government, the Development, Test and Evaluation Advisory Group (DT&E) was established to assist SRDS DABS management during the test and evaluation phase of the DABS development program.

Specifically, the Advisory Group is responsible for:

i. Developing a high level of coordination between the working elements.

ii. Evaluating test specifications, procedures and analysis.

iii. Monitoring the progress of the DABS testing throughout each test phase.

iv. Provide a forum for information exchange between the developing elements and the operational services.

4. DABS/ATARS/ATC Automation Configuration Control Group

The Configuration Control Group was established jointly by the ATC Systems Division (ARD-100) and the Communications Division (ARD-200) to maintain an approved DABS/ATARS/ATC baseline interface configuration. Procedures have been developed which permit the Configuration Control Group to establish and maintain a uniform system of baseline configuration identification, control and accounting of the DABS and the ATARS algorithm to ATC automation system interfaces.

5. System Engineering Contractor (SEC)

During Phase I, the SEC (Lincoln Laboratory) had a lead role in the DABS program, with responsibility for demonstrating the feasibility of the DABS concept. The SEC established a DABS Experimental Facility (DABSEF) to support the DABS concept validation and system definition. During Phase II, the SEC is providing technical expertise to the FAA in the design and evaluation of engineering model DABS sensors. In addition, the SEC carries out analysis and simulation studies to further validate the DABS design and investigate any ATC integration problems that may be uncovered during Phase II test and evaluation.

6. Government and Non-Profit Agency Support

A number of government and government related agencies have special facilities and areas of competence which have provided, and will continue to provide a valuable source of support for the DABS program. There are DABS related efforts underway at NAFEC, ECAC, Lincoln Laboratory, and the MITRE Corporation among others. These efforts can be readily continued and expanded to adequately support the DABS program. DOD technical agencies will be involved in the military aspects of the program.

7. System Development Contractor (SDC)

During Phase II, the SDC (Texas Instruments, Inc.) is responsible for the design, development, fabrication, and installation of engineering development DABS sensors for test and evaluation at NAFEC. The SDC will also support NAFEC in initiating and executing system tests if required.

2.9 DABS Critical Technology

DABS Data Integrity and Reliability

The data integrity and reliability requirements are more stringent for DABS processing than for the current en route and terminal processing. In the current en route and terminal processing, the controller, using voice communications, completes the loop between the computer and the pilot. With DABS or any other data link system the processor automatically generates and transmits messages to aircraft. Clearly the DABS processor requires more stringent reliability and the ability to detect and isolate errors soon enough to prevent data contamination which might result in erroneous aircraft communications.

A redundant distributed processing minicomputer architecture is being implemented by the SDC to meet these reliability and data integrity requirements. Although the hardware and software tasks have been modeled and simulated and appear to satisfy the requirements, there remains an undefinable element of risk associated with the distributed processing concept since no large real-time distributed processing systems have been built to date.

III. DABS END ITEM PRODUCTS/SCHEDULE

The DABS end-item products and program schedule are shown in Figure 3-1.

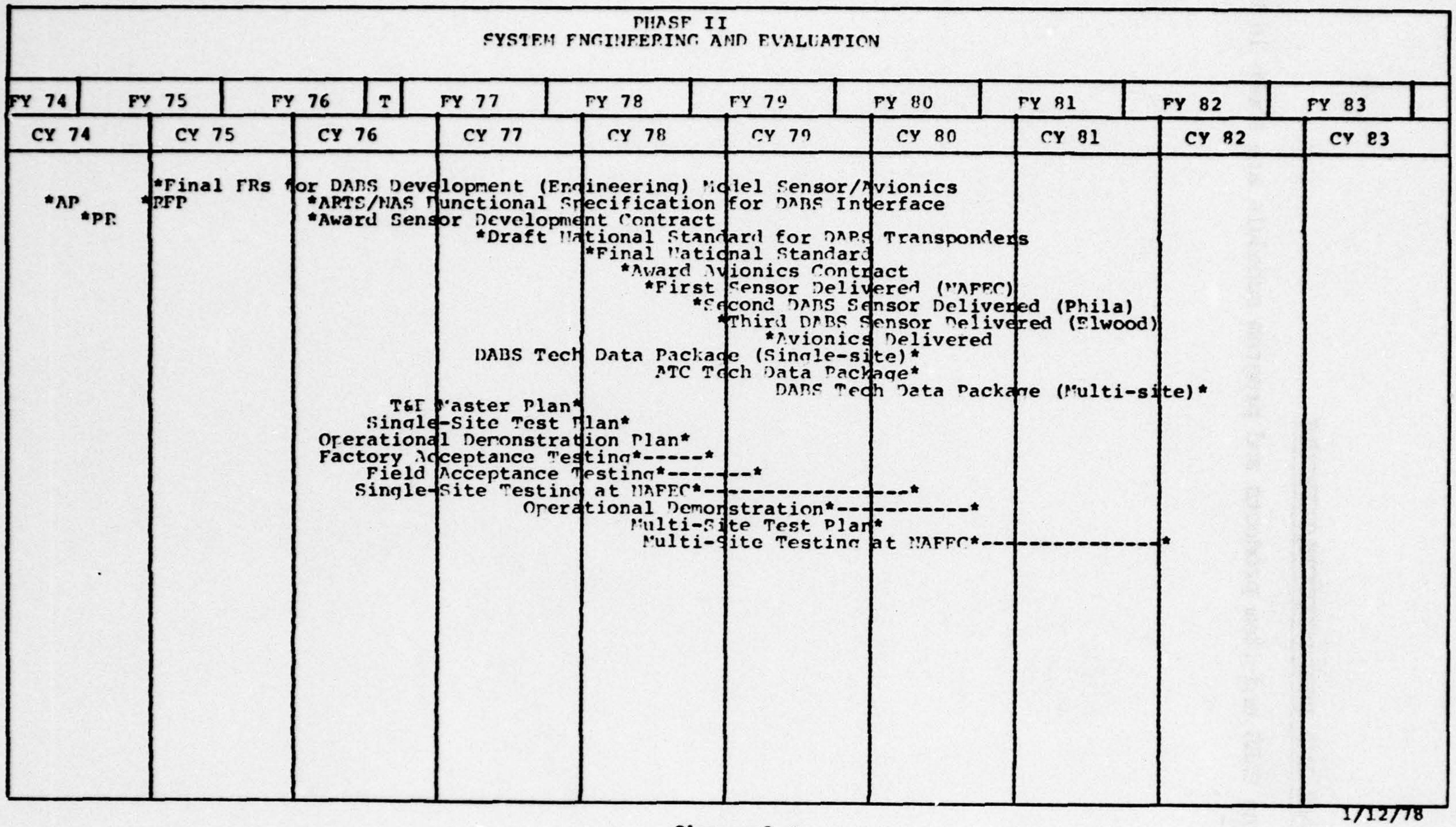

PHASE II
SYSTEM ENGINEERING AND EVALUATION
FY 74
FY 75
FY 76
T
FY 77
FY 78
FY 79
FY 80
FY 81
FY 82
FY 83
CY 74
CY 75
CY 76
CY 77
CY 78
CY 79
CY 80
CY 81
CY 82
CY 83
*AP
*PR
*RFP
*Final FRs for DABS Development (Engineering) Model Sensor/Avionics
*ARTS/NAS Functional Specification for DABS Interface
*Award Sensor Development Contract
*Draft National Standard for DABS Transponders
*Final National Standard
*Award Avionics Contract
*First Sensor Delivered (NAFEC)
*Second DABS Sensor Delivered (Phila)
*Third DABS Sensor Delivered (Elwood)
*Avionics Delivered
DABS Tech Data Package (Single-site)*
ATC Tech Data Package*
DABS Tech Data Package (Multi-site)*
T&E Master Plan*
Single-Site Test Plan*
Operational Demonstration Plan*
Factory Acceptance Testing*------*
Field Acceptance Testing*--------*
Single-Site Testing at NAFEC*------------------*
Operational Demonstration*-----------*
Multi-Site Test Plan*
Multi-Site Testing at NAFEC*---------------*
1/12/78

figure 3-1

IV. <u>DABS FUNDING REQUIREMENTS</u>

Funding requirements for the DABS program are shown in Figure 4-1.

Program Title/Code	Approp Code	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82
DABS 034-241	R & D	$ 7316	$ 8803	$ 7212	$ 6203	$ 2395	$ 1995

Funding Requirements *
(in thousands of dollars)

* Availability of estimated funds is subject to DOT/OMB/Congressional Actions. Funding estimates reflect planned Program milestones subject to availability of funds. Current year estimates are consistent with Fiscal Program.

Figure 4-1

APPENDIX A
List of Abbreviations

ARIES	Aircraft Reply and Interference Environment Simulator
ARINC	Aeronautical Radio, Inc.
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ATARS	Automated Traffic Advisory and Resolution Service
ATC	Air Traffic Control
ATCAC	Air Traffic Control Advisory Committee
ATCRBS	Air Traffic Control Radar Beacon System
BCAS	Beacon Collision Avoidance System
CIDIN	Common ICAO Data Interchange Network
CSC	Computer Science Corporation
DABS	Discrete Address Beacon System
DABSEF	DABS Experimental Facility
DOT	Department of Transportation
DT&E	Development, Test and Evaluation
ER	Engineering Requirements
ECAC	Electromagnetic Compatibility Analysis Center
FAA	Federal Aviation Administration
FEP	Front End Processor
GA	General Aviation
ICAO	International Civil Aviation Organization
IFF	Identification Friend or Foe
NADIN	National Airspace Data Interchange Network
NAFEC	National Aviation Facilities Experimental Center

NAS	National Airspace System
NM	Nautical Mile
OSEM	Office of Systems Engineering Management
PM	Program Manager
RBTF	Radar/Beacon Test Facility (NAFEC)
SDC	System Development Contractor (Texas Instruments, Inc.)
SEC	System Engineering Contractor (MIT/LL)
SRDS	Systems Research and Development Service (FAA)
SSF	System Support Facility (NAFEC)
STC	System Test Console
TATF	Terminal Automation Test Facility (NAFEC)
TSC	Transportation Systems Center (DOT)
TTG	Test Target Generator

APPENDIX B

DABS PROJECT REPORTS

FAA-RD-	ATC	TITLE
71-79	-	Technical Development Plan for a Discrete Address Beacon System
-	4	Draft Technical Development Plan for a Discrete Address Beacon System, 19 August 1971.
-	5	Interim Report - Transponder Test Program, 29 Sept. 1971.
	& Suppl. 1	Interim Report - Transponder Test Program, 7 March 1972
72-7	8	*Interrogation Scheduling for the Discrete Address* Beacon System, 24 January 1972.
72-30	9	Final Report - Transponder Test Program, 12 April 1972.
72-84	12	A Comparison of Immunity to Garbling for Three Candidate Modulation Schemes for DABS, 14 August 1972.
72-77	13	Parallel Approach Surveillance, 14 September 1972.
72-100	15	The Influence of Surveillance System Parameters on Automated Conflict Detection and Resolution, 29 November 1972.
73-126	19	Interrogation Scheduling Algorithms for a Discrete Address Beacon System, 17 October 1973.
74-4	20	The Effects of ATCRBS P_2 Pulses on DABS Reliability, 28 January 1974.
74-20	22	Summary of Results of Antenna Design Cost Studies, 19 Feb. 1974.
73-160	25	Final Report - DABS/ATCRBS Transponder Bench Testing Program, 28 November 1973.
74-17	27	A Summary of the DABS Transponder Design/Cost Studies, 1 March 1974.
74-123	28	A Simulation of the DABS Sensor for Evaluating Reply Processor Performance, 16 September 1974.

FAA-RD	ATC	TITLE
74-142	29	DABS TIMING: Clocks, Synchronization and Restart, 13 December 1974.
73-175	30	Provisional Signal Formats for the Discrete Address Beacon System, 9 November 1973.
74-62 (Rev.1)	30	Provisional Signal Formats for the Discrete Address Beacon System (Revision 1), 25 April 1974.
74-5	31	Report on DABS/ATCRBS Field Testing Program, 13 Feb. 1974
74-21	32	The Effect of Phase Error on the DPSK Receiver Performance, 4 February 1974.
74-63	33	Provisional Message Formats for the DABS/NAS Interface, 25 April 1974.
74-63A (Rev.1)	33	Provisional Message Formats for the DABS/NAS Interface, 10 October 1974.
74-64	34	Provisional Data Link Interface Standard for the DABS Transponder, 25 April 1974.
74-83	35	Provisional Message Formats and Protocols for the DABS IPC/PWI Display, 24 May 1974.
74-84	36	Provisional Message Formats and Protocols for the DABS 32-character Alphanumeric Display, 20 May 1974.
74-144	37	An Analysis of Aircraft L-Band Beacon Antenna Patterns, 15 January 1975.
74-162	40	DABS Uplink Encoder, 4 March 1975.
74-186	41	DABS Link Performance Considerations, 28 April 1975.
74-189	42	DABS: A System Description, 18 November 1974.
74-197	43	DABS Channel Management, 8 January 1975.
75-75	44	Model Aircraft L-Band Beacon Antenna Pattern Gain Maps, 16 May 1975
75-8	45	Network Management, 16 May 1975
74-210	46	Plan for Flight Testing Intermittent Positive Control, June 1975

FAA-RD-	ATC	TITLE
75-23	47	Scale Model Pattern Measurements of Aircraft L-Band Beacon Antennas. 4 April 1975
75-61	48	DABS Downlink Coding. 12 September 1975
75-62	49	DABS Uplink Coding. 25 July 1975
75-91	50	Impact of Obstacle Shadows on Monopulse Azimuth Estimate. 17 July 1975
75-92	51	DABS Sensor Interactions with ATC Facilities. 22 April 1976
75-93	52	DABS Modulation and Coding Design - A Summary. 12 March 1976
75-112	53	A Summary of DABS Antenna Studies. 3 February 1976
75-113	54	Design Validation of the Network Management Function. 2 February 1976
75-145	56	Discrete Address Beacon System (DABS) Test Plan for FY-1976. 14 November 1975
76-22	57	IPC Design Validation and Flight Testing - Interim Results. 16 March 1976
75-233	60	The Airborne Measurement Facility (AMF), System Description. 25 March 1976
75-234	61	Empirical Characterization of IPC Tracker Performance Using DABS Data. 9 June 1976
76-2	62	Beacon CAS (BCAS), An Integrated Air/Ground Collision System. 23 March 1976
76-39	65	ATCRBS Mode of DABS. 31 January 1977
77-143	71	Proposed Technical Characteristics for the Discrete Address Beacon System (DABS). 27 September 1977
76-219	72	DABS Monopulse Summary. 4 February 1977
77-7	75	DABS Coverage (draft)

FAA-RD-	ATC	TITLE
77-113	79	Verification of DABS Sensor Surveillance Performance (ATCRBS Mode) at Typical ASR Sites Throughout CONUS. 21 September 1977
74-159	-	Interface Definition, DABS Engineering Model/ATC (NAFEC)
I.		Introduction. September 1974, Vol. I
II. Series 1		Enroute Data Formats. January 1975, Vol.II
II. Series 2		Digital Simulation Facility Data Formats. December 1975, Vol. II
III.		Enroute Hardware Configuration. September 1974, Vol. III
IV. Rev. 1		Terminal Hardware Configuration, February 1977 Vol. IV
V.		Digital Simulation Facility Configuration. December 1975 Vol. V

MITRE REPORTS

MTR-7299	Preliminary Functional Specifications: En Route Multiple Radar Data Processing (MRDP) for the DABS/ATCRBS Surveillance Environment. March 1977
MTR-7423	Preliminary Functional Specification: En Route Automatic Tracking for the DABS/ARCRBS Surveillance Environment