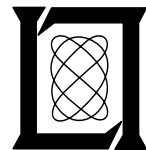


**Project Report
ATC-4
Volume II**

**Technical Development Plan
for a Discrete Address Beacon System
Volume II**

19 August 1971

Lincoln Laboratory
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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Prepared for the Federal Aviation Administration,
Washington, D.C. 20591

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

DRAFT

TECHNICAL DEVELOPMENT PLAN
FOR A DISCRETE ADDRESS BEACON SYSTEM
VOLUME II

PROJECT REPORT ATC-4
(Air Traffic Control)

19 AUGUST 1971

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ABSTRACT

The Technical Development Plan for a Discrete Address Beacon System is published in two volumes. Volume I is the basic plan, while this volume (Volume II) contains a more detailed description of the 46 tasks recommended for accomplishment during Phase 1 of the development cycle. It also includes cost estimates for each task.

TASK DESCRIPTIONS

Introduction

As presented in Chapter IV of Volume I, the plan for Phase 1 - System Definition and Feasibility Demonstration, consists of a total of 46 individual tasks. This volume lists these tasks with brief descriptions of the objective, principal activities, and required outputs of each task. An appropriate agency for accomplishing each task is also included.

The staffing and funding of each task could vary significantly depending on the program schedule and the outcomes of other related tasks. As an aid in visualizing the relative magnitudes of these tasks, annual staffing and funding estimates are included. These estimates correspond to the figures given in the charts and diagrams of Chapter IV of Volume I.

TASK GROUP A: DEFINITION OF PERFORMANCE SPECIFICATIONS

Task: A-1. Coordination of Efforts to Define DABS Performance Specifications

Objective: To determine bounds on DABS performance specifications sufficient to allow system definition and design to proceed.

Activities: This lead task deals with the complete set of DABS-dependent ATC functions or services. It involves:

1. Coordination and direction of the efforts of:
 - a. The technical teams doing the DABS requirement analysis tasks A-2 through A-4 (the main output of these tasks will be a set of trade-off analyses which relate the quality of ATC service to the quality of the surveillance data which supports it);
 - b. Groups involved in IPC activities outside the DABS program;
 - c. Groups involved in data acquisition, automation and control procedures outside the DABS program.
2. Analysis of the role of DABS in the ATC system based on the trade-off analyses from the above-listed groups and identification of those ATC functions which have the most stringent DABS performance requirements. This should include trade-offs between the DABS surveillance and communications functions.
3. Final selection of the performance specifications to be imposed on DABS.

- Outputs:
1. General task descriptions, specifications, detailed plans, and continuing guidance for DABS performance analysis tasks A-2 through A-4.
 2. A statement of overall DABS performance specifications.

Agency: System Engineering Group (SEG).

Cost Summary:

Year	1	2	3	4
Av. Staff	6	4	0	0
Av. \$	360K	240K	0	0

Task: A-2. IPC Analysis

Objective: To determine parametric relations between the overall technical characteristics of DABS and the quality and type of IPC service.

Activities: This task begins with the concept of IPC presented in the ATCAC Report and proceeds with:

1. Identification of the types of IPC service and the associated systems which appear feasible.
2. Definition of principal quantitative parameters affecting the quality of IPC service such as detection, false alarm and message delivery probabilities, ability to determine correct avoidance maneuvers, etc.
3. Analysis of the IPC systems identified in 1 to determine, for a range of assumed traffic models, the trade-off relationships between IPC quality and DABS performance specifications, such as:

- a. surveillance data accuracy, data rate, and reliability;
- b. communications capacity, reliability, and delay;
- c. IPC message repertoire.

Outputs: Trade-off data relating DABS surveillance and communication performance specifications to the quality of IPC service.

Agency: Government or Non-Profit Agency (G/NPA)

Cost Summary:

Year	1	2	3	4
Av. Staff	4	2	0	0
Av. \$	240K	120K	0	0

Task: A-3. ATC Data-link Analysis

Objective: To determine parametric relations between the overall characteristics of DABS and the performance of a DABS digital data-link for ATC messages.

Activities: This study considers both time-critical ATC messages (IPC, vectors, flight path monitoring, intruder detection, etc.) and non-critical ATC messages (ATC clearances, weather clearances, etc.). It begins with the output of the FAA Data-link Development Study and involves the following basic activities:

1. Determination of requirements to support automatic ATC communications via data-link, including mes-

sage types and frequencies, formats and information content, tolerable delays and delivery probabilities for time-critical and non-time critical messages, up-link and down-link, in both terminal and enroute environments. These requirements should be provided largely by others, chiefly by those involved in the FAA Data-Link Development Program.

2. Development of a number of candidate coding schemes suitable for ATC message transmission. This task should be done in cooperation with the Modulation and Coding lead Task D-1.
3. Performance of trade-off analyses between those properties of the DABS design which affect the data-link (such as interrogation and up and down message durations, character of error protection provided by the modulation/coding scheme, scan rate and number of hits per scan) and the resulting data-link performance in terms of communications capacity, reliability and delay.

Outputs: Trade-off data relating DABS communication specifications to the performance of the ATC data-link.

Agency: Government or Non-Profit Agency (G/NPA)

Cost Summary:

Year	1	2	3	4
Av. Staff	2	1	0	0
Av. \$	120K	60K	0	0

Task: A-4. Analysis of DABS Surveillance Functions

Objective: To determine parametric relations between DABS surveillance characteristics and the performance and feasibility of ATC surveillance functions which may be supported by DABS during its operational lifetime.

Activities: This study will refine existing analyses of surveillance data requirements for all ATC functions other than IPC and ATC data-link which might be supported by DABS in order to determine, in each case, the trade-off relations between ATC performance and DABS data quality. These functions include the general surveillance now performed by ATCRBS in support of NAS and ARTS, terminal area metering and spacing by computer, monitoring of approaches to closely spaced parallel runways, detection of intruders in controlled airspace, V/STOL traffic surveillance, and airport surface surveillance. The trade-off analysis must define measures of ATC system performance suitable for each function and relate these, for a variety of assumed traffic models, to the parameters which characterize surveillance quality, such as data accuracy, reliability and rate, and communications capacity, access, reliability, and delay.

Outputs: Trade-offs relating DABS surveillance performance specifications to the performance of each ATC surveillance function.

Agency: Government or Non-Profit Agency (G/NPA)

Cost Summary:

Year	1	2	3	4
Av. Staff	3	1-1/2	0	0
Av. \$	180K	90K	0	0

TASK GROUP B: INTERFERENCE ENVIRONMENT MODELING

Task: B-1: Coordination of Tasks to Develop DABS/ATCRBS Interference Prediction Models

Objective: To obtain a series of models of the combined ATCRBS and DABS up-link and down-link environments to be used in the initial DABS system design and design validation efforts, and to provide a projection of the estimated mutual and self-interference environment to the end of the DABS operational lifetime with multiple sensors and arbitrary aircraft deployment.

Activities: This lead task deals with the analytical, experimental and computer simulation efforts necessary to develop a series of validated beacon interference prediction models, including all planning, coordination and guidance.

Outputs:

1. Specifications, detailed plans, and continuing guidance for tasks B-2 through B-5.
2. 1st Interference Prediction Model (IPM), based primarily on analytical results with some use of interim experimental data.
3. 2nd IPM based on ATCRBS models developed and validated by comparison of measured data and computer simulations, and models of the selected DABS system configuration and parameters.

Agency: System Engineering Group (SEG)

Cost Summary:

Year	1	2	3	4
Av. Staff	2	2	2	0
Av. \$	120K	120K	120K	0

Task: B-2. ATCRBS Transponder Characteristic Measurement

Objective: To obtain data necessary to model the performance of representative ATCRBS transponders for prediction of transponder responses to the ATCRBS interrogation environment, and prediction of transponder responses to candidate DABS waveforms.

Activities: This task will involve experimental measurements of a selection of commercial, general aviation, and military transponder models. The measurements will include:

1. Standard ATCRBS tests including measurements of transponder sensitivity, selectivity, AOC operation, suppression and dead time, power output, frequency, and pulse shapes;
2. Measurement of transponder responses to candidate DABS waveforms to determine the degree of ATCRBS interference caused by each modulation format and to assess the practicality of modifying ATCRBS transponders for increased compatibility with DABS.

Outputs: Measured data and conclusions concerning relative ATCRBS interference ratings of candidate DABS waveforms.

Agency: Government or Non-Profit Agency (G/NPA)

Cost Summary:

Year	1	2	3	4
Av. Staff	1	0	0	0
Av. \$	100K	0	0	0

Task: B-3. ATCRBS Channel Loading Measurements

Objective: To obtain measurements of ATCRBS channel loading to use both as an input data base and as verification for the ATCRBS IPM's obtained in task B-2.

Activities: This task will involve a series of experiments to obtain channel loading data in a variety of interrogation and traffic environments. Two basic measurements are required:

1. The detailed interrogation environment at the aircraft;
2. The down-link reply environment at the sensor.

Outputs: Measured data and descriptions of typical ATCRBS interrogator and traffic environments.

Agency: Industry or Government/Non-Profit Agency

Cost Summary:

Year	1	2	3	4
Av. Staff	4	0	0	0
Av. \$	400K	0	0	0

Task: B-4. ATCRBS Channel Loading Simulation Program Development

Objective: To develop simulation models primarily for the ATCRBS portion of the 2nd beacon interference prediction model for task B-1.

Activities: This task will involve an extension of the existing ATCRBS statistical simulations as well as new programs characterizing the interrogation and fruit environments of the ATCRBS

system. It will develop realistic programmable models for ATCRBS transponders and the ATCRBS channels in coordination with the efforts of tasks B-2 and B-3.

Outputs: Computer simulation programs with supporting documentation including results of test runs.

Agency: Industry or Government/Non-Profit Agency

Cost Summary:

Year	1	2	3	4
Av. Staff	3	2	0	0
Av. \$	240K	160K	0	0

Task: B-5. DABS Channel Loading Simulation Program Development

Objective: To develop simulation models primarily for the DABS portion of the 2nd beacon interference prediction model for task B-1.

Activities: This task will involve a modification of the existing ATCRBS statistical simulations as well as new programs characterizing the interrogation and fruit environments of the combined ATCRBS-DABS system. It will develop realistic programmable models for DABS transponders and the DABS channels in coordination with the efforts of tasks B-2, B-3, and B-4.

Outputs: Computer simulation programs with supporting documentation including results of test runs.

Agency: Industry or Government/Non-Profit Agency

Cost Summary:

Year	1	2	3	4
Av. Staff	0	2	2	0
Av. \$	0	160K	160K	0

TASK GROUP C: MODULATION AND CODING

Task: C-1. Modulation and Coding Design and Specification of Transponder Characteristics

Objective: To select the DABS modulation and coding format and provisional DABS transponder specifications based on a coordinated analysis of all pertinent technical, economic, interference and operational constraints.

Activities: This lead task will consist of:

1. Technical analysis of a number of candidate binary signal formats for DABS including pulse amplitude modulation, phase shift keying, frequency shift keying, pulsed phase shift keying, and pulsed frequency shift keying. In each case the following will be evaluated: performance in gaussian noise, multipath, and interfering signals; communication capacity and efficiency; spectrum occupancy; ranging accuracy; and monopulse operation.
2. Technical analysis of a number of candidate coding formats with consideration of surveillance and data-link requirements of the DABS system.
3. Planning, specifying, overseeing, and evaluating the results of the transponder design and costing studies in Tasks C-2, C-3, and C-4.
4. Interacting with and evaluating the relevant results and conclusions of all other tasks which bear on the modulation and coding design, including particularly close coordination with the groups studying IPC and data-link performance (Tasks A-2 and A-3); interference (Tasks B-1 and B-2); monopulse

requirements (Task Group D); sensor signal processing, interrogator management, and target assignment considerations (Task Group E).

5. Directing the interference measurement and modeling efforts of Task Group B by identifying those channel loading and interference characteristics which are most needed to select a modulation and coding format.

- Outputs:
1. Work statements for Tasks C-2, C-3, and C-4.
 2. Specification of data required from Task Group B to facilitate the selection of modulation and coding formats.
 3. Final selection of DABS modulation and coding formats.
 4. Specifications for DABS experimental transponders.

Agency: System Engineering Group (SEG)

Cost Summary:

Year	1	2	3	4
Av. Staff	3	3	1	0
Av. \$	180K	180K	60K	0

Task C-2. Transponder Design and Costing Studies

Objective: To provide a set of cost, reliability, and performance estimates on DABS transponders employing candidate modulation and coding schemes.

Activities: The circuitry to be studied includes the RF front end, the

decoder, the encoder, and the control circuitry. Specific techniques to be investigated include: decoding and storing extended-length, discrete-address codes; demodulating and modulating candidate DABS waveforms; multi-frequency transmitters and receivers; improved range accuracy; transponder diversity; expandible modular construction, including modification kits for standard ATCRBS transponders.

Outputs: A report of estimated cost, reliability and performance data for DABS transponder circuit designs with the above listed characteristics, including detailed circuit designs, experimental data, costing rationale, and overall conclusions and recommendations.

Agency: Industry (3 avionics manufacturers, representative of general aviation, air carrier, and military equipment builders)

Cost Summary:

Year	1	2	3	4
Av. Staff	NA ⁽¹⁾	0	0	0
Av. \$	300K	0	0	0

Notes: (1) NOT APPLICABLE, major costs are not staff-related.

Task: C-3. ATCRBS Aircraft Antenna Pattern Measurements

Objective: To provide the experimental data for making decisions regarding DABS aircraft antenna diversity specifications for various types of aircraft and to determine the

feasibility of applying diversity standards or antenna pattern standards to DABS-equipped aircraft.

- Activities: 1. Experimental measurement of transponder antenna patterns for a characteristic selection of light aircraft, executive and air carrier aircraft, and medium and large size military aircraft (including military aircraft in operational configurations with external stores).
2. Analysis of experimental data to determine general relationships, if any, between aircraft type and antenna pattern coverage.

Outputs: A report including descriptions of experimental techniques, antenna pattern data, conclusions on the relationship between aircraft type and patterns, recommendations for diversity standards and inspection and enforcement procedures.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	3	0	0	0
Av. \$	240K	0	0	0

Task: C-4. Transponder Development

Objective: To procure experimental transponders of two quality levels for use in design evaluation, costing, sensor testing, and system testing.

Activities: Development and construction of experimental DABS

transponders and antenna systems built to experimental DABS specifications. This task will be contracted to two manufacturers, one of whom will concentrate on a high quality air carrier design, while the other develops a low-cost general aviation design.

- Outputs:
1. Six experimental DABS transponders and antenna systems of general aviation quality suitable for aircraft installation and operation.
 2. Six experimental DABS transponders and antenna systems of air carrier quality suitable for aircraft installation and operation.
 3. Refined costing estimates on production quantities of the above specified transponders.

Agency: Industry (Two avionics manufacturers)

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽¹⁾	-	0
Av. \$	0	400K	-(2)	0

- Notes:
- (1) NOT APPLICABLE, major costs are not staff related.
 - (2) Work continues in Year 3, but total commitment falls in Year 2.

TASK GROUP D: ANTENNA AND MONOPULSE

Task: D-1. Antenna and Monopulse Design and Task Coordination

Objective: To define the DABS sensor and monopulse characteristics and to make a final selection of the DABS antennas to be fabricated for system and feasibility testing.

Activities: This lead task deals with the direction of all efforts towards the resolution of technical uncertainties and the development of interrogator antennas and monopulse techniques including:

1. Planning, coordinating, specifying and overseeing tasks D-2 through D-15.
2. Analysis of monopulse performance and a comparative evaluation of antenna characteristics, costs, and aptness for DABS system use, based on data from Tasks D-2 through D-15 and all other relevant task groups.
3. Final selection of a set of antenna configurations to be used in the various classes of DABS sites.
4. Writing of specifications for experimental interrogator/receiver RF and video hardware to interface with DABS interrogator antennas. These specifications will be based on decisions on modulation and coding formats from Task Group B and signal processing and interface requirements from Task Group E.

Outputs:

1. Work statements and specifications for all tasks of Task Group D.
2. Final decisions on DABS antenna types, major design specifications, monopulse specifications,

and siting and collocation policy for feasibility testing.

Agency: System Engineering Group (SEG)

Cost Summary:

Year	1	2	3	4
Av. Staff	4	4	2	0
Av. \$	240K	240K	120K	0

Task: D-2. Monopulse Studies

Objective: To evaluate techniques for implementing monopulse on ATCRBS and DABS beacon returns; to determine the quantitative relationships between monopulse performance and beacon and multipath interference levels; and to determine the impact of receive monopulse on modulation and coding formats and other system parameters.

- Activities:
1. Definition and analytical evaluation of candidate monopulse techniques for both rotating and array antennas.
 2. Analytical studies of monopulse performance in a beacon interference and multipath environment.
 3. Construction of an experimental monopulse test bed and calibration facility.
 4. Use of this test bed for experimental evaluation of candidate monopulse techniques under realistic interference and multipath conditions for a range of target densities.

Outputs: Recommendations on monopulse techniques preferred

for each candidate type of DABS antenna, preferred modulation and coding formats, and maximum allowable system interference and multipath levels.

Agency: Government/ Non-Profit Agency

Cost Summary:

Year	1	2	3	4
Av. Staff	5	5	0	0
Av. \$	500K	500K	0	0

Task: D-3. Study of Sensor Site Characteristics

Objective: Clarification of sensor siting requirements with particular emphasis on the issue of collocation with existing FAA radars.

Activities: This task involves a broad investigation of the technical, economic, and operational factors influencing the selection of sensor sites including specifically:

1. A determination, by measurement at existing sites, of typical and worst-case siting characteristics with respect to low angle coverage, ground features, etc.
2. A determination of typical site acquisition and development costs.
3. A study of the feasibility and impact on DABS of collocating DABS antennas with primary radar installations.

Outputs: Recommendations on siting and collocation policy.

Agency: Government/Non-Profit Agency

Cost Summary:

Year	1	2	3	4
Av. Staff	2	2	0	0
Av. \$	120K	120K	0	0

Task: D-4. DABS Rotating Antenna Design and Cost Study

Objective: To define the technical characteristics and cost-performance trade-off relations of a new rotator configuration for use in system design decisions.

Activities: This task will involve design and costing studies of a large aperture, fast rotating antenna in both single-reflector and back-to-back configurations, including monopulse. A range of design parameters will be considered, including the following:

1. Azimuthal beamwidth - ranging from the present ATRBS beamwidth down to 1° or less (between 3 db points).
2. Elevation coverage - a variety of profiles will be considered, covering a range of values of null depth and gain drop-off at maximum elevation.
3. Rotation rate - up to 15 RPM, with and without the use of a radome.
4. Isolation between channels (back-to-back case) - up to 100 db at a common frequency.

The sensitivity of performance and cost to variations in the major design parameters will be determined.

Outputs: A design report containing:

1. Technical characteristics and costs of a number of configurations meeting specifications in the range of design parameters.
2. Cost-performance trade-off relations.
3. Major unresolved technical and cost uncertainties.

Agency: Industry (2 Simultaneous contracts)

Cost Summary:

Year	1	2	3	4
Av. Staff	4	0	0	0
Av. \$	200K ⁽¹⁾	0	0	0

Notes: (1) Staffing and cost are totals for 2 contracts.

Task: D-5. DABS Array Antenna Design and Cost Study

Objective: To define the technical characteristics and cost-performance trade-off relations of new phased array configurations for use in system design decisions.

Activities: This task will involve design and costing studies of a large aperture, phased array antenna with full beam agility in azimuth, limited beam agility in elevation (beam lifting), and monopulse capability. A range of design parameters will be considered, including the following:

1. Minimum azimuthal beamwidth - ranging from present ATCRBS beamwidth down to 1° or less (between 3 db points).

2. Variation of azimuthal beamwidth with elevation - ranging from a factor of ten to a factor of three.
3. Elevation coverage - a variety of profiles covering the range of values of null depth and gain drop off at maximum elevation to be specified by Task D-1.
4. Total number of beam positions - ranging up to twenty times the number of elements.
5. Beam switching and settling time - down to 1 μ sec.

The sensitivity of performance and cost to variations in the major design parameters will be determined.

Outputs: A design report containing:

1. Technical characteristics and costs of a number of configurations meeting specifications in the range of design parameters.
2. Cost-performance trade-off relations.
3. Major unresolved technical and cost uncertainties.

Agency: Industry (2 Simultaneous contracts)

Cost Summary:

Year	1	2	3	4
Av. Staff	5	0	0	0
Av. \$	250K ⁽¹⁾	0	0	0

Notes: (1) Staffing and cost are totals for two contracts.

Task: D-6. Design and Cost Study of Modifications to ATCRBS Boom Antenna

Objective: To achieve a low-cost DABS antenna by modifying the

existing ATCRBS antenna.

Activities: This task will involve design and costing studies of possible modifications to a standard ATCRBS 28' boom antenna to include receive monopulse and improved elevation beam shaping by vertical stacking of booms.

Outputs: A design report containing:

1. Technical characteristics and cost of the recommended modification program.
2. Cost-performance trade-off relations.
3. Major unresolved technical and cost uncertainties.

Agency: Industry (2 Simultaneous contracts)

Cost Summary:

Year	1	2	3	4
Av. Staff	3	0	0	0
Av. \$	150K ⁽¹⁾	0	0	0

Notes: (1) Staffing and costs are totals for 2 contracts.

Task: D-7. Design and Cost Study of ASR Antenna Modifications for DABS

Objective: To achieve a low-cost DABS antenna by modifying the existing ASR radar antenna to serve as a dual radar/beacon antenna.

Activities: This task will involve design and costing studies of possible modifications to the ASR radar to incorporate DABS and ATCRBS with elevation beam-shaping and monopulse on beacon receive. Particular attention will be given to the azimuthal accuracy and elevation coverage which can be achieved in this way.

Outputs: A design report containing:

1. Technical characteristics and cost of the recommended modification program.
2. Cost-performance trade-off relations.
3. Major unresolved technical and cost uncertainties.

Agency: Industry (2 Simultaneous contracts)

Cost Summary:

Year	1	2	3	4
Av. Staff	3	0	0	0
Av. \$	150K ⁽¹⁾	0	0	0

Notes: (1) Staffing and costs are totals for 2 contracts.

Task: D-8. Design and Cost Study of ARSR Antenna Modification for DABS

Objective: To achieve a low-cost DABS antenna by modifying the existing ARSR radar antenna to serve as a dual radar/beacon antenna.

Activities: This task will involve design and costing studies of possible modifications to the ARSR radar to incorporate DABS and ATRBS with elevation beam-shaping and monopulse on beacon receive. Particular attention will be given to the azimuthal accuracy and elevation coverage which can be achieved in this way.

Outputs: A design report containing:

1. Technical characteristics and cost of the recom-

mended modification program.

2. Cost-performance trade-off relations.
3. Major unresolved technical and cost uncertainties.

Agency: Industry (2 Simultaneous contracts)

Cost Summary:

Year	1	2	3	4
Av. Staff	3	0	0	0
Av. \$	150K ⁽¹⁾	0	0	0

Notes: (1) Staffing and costs are totals for 2 contracts.

Task: D-9. Fabrication of Monopulse and Agile-Beam Capability for
ATCRBS E-Scan Antenna

Objective: To provide the ATCRBS E-Scan antenna with monopulse and beam agility for the DABS system feasibility demonstration.

Activities: The design, fabrication, installation, and checkout of equipment necessary to achieve beam agility and monopulse angle estimation capability with the ATCRBS E-Scan antenna.

Outputs: Equipment installed in the ATCRBS E-Scan antenna to provide it with the monopulse and agile beam capability specified by Task D-1.

Agency: ATCRBS E-Scan Contractor

Cost Summary:

Year	1	2	3	4
Av. Staff	NA ⁽¹⁾	-	0	0
Av. \$	50K	-(2)	0	0

- Notes: (1) NOT APPLICABLE, major costs are not staff related.
- (2) Work continues in Year 2, but total commitment falls in Year 1.

Task: D-10. Fabrication of Experimental DABS Rotating Antenna⁽¹⁾

Objective: To provide a DABS rotator for sensor experiments and system feasibility tests.

Activities: Fabrication, installation, and checkout of the experimental DABS rotating antenna. This antenna configuration will be selected by Task D-1 based on the design studies of Task D-4.

Outputs: Antenna and monopulse equipment installed at the site for feasibility tests.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽²⁾	-	0
Av. \$	0	600K	-(3)	0

- Notes: (1) This task is optional, dependent on system decisions as to required DABS antenna types.

- (2) NOT APPLICABLE, major costs are not staff related.
- (3) Work continues in Year 3, but total commitment falls in Year 2.

Task: D-11. Fabrication of Experimental DABS Array Antenna⁽¹⁾

Objective: To provide a DABS array for sensor experiments and system feasibility tests.

Activities: Fabrication, installation, and checkout of the experimental, high capability DABS array antenna. This antenna configuration will be selected by Task D-1 based on the design studies of Task D-5.

Outputs: Antenna and monopulse equipment installed at the site for feasibility tests.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽²⁾	-	0
Av. \$	0	1500K	- ⁽³⁾	0

- Notes:
- (1) This task is optional , dependent on system decisions as to required DABS antenna types.
 - (2) NOT APPLICABLE, major costs are not staff related.
 - (3) Work continues in Year 3, but total commitment falls in Year 2.

Task: D-12. Fabrication of Modified ATCRBS Boom Antenna⁽¹⁾

Objective: To provide a low-cost DABS rotator for DABS sensor experiments and system feasibility tests.

Activities: Fabrication, installation, and checkout of modified ATCRBS boom antenna for DABS. This antenna will be selected by Task D-1 based on the design studies of Task D-6.

Outputs: Antenna and monopulse equipment installed at the site for feasibility tests.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽²⁾	-	0
Av. \$	0	100K	- ⁽³⁾	0

- Notes:
- (1) This task is optional, dependent on system decisions as to required DABS antenna types.
 - (2) NOT APPLICABLE, major costs are not staff related.
 - (3) Work continues in Year 3, but total commitment falls in Year 2.

Task: D-13. Fabrication of Modified ASR Antenna⁽¹⁾

Objective: To provide a low-cost DABS rotator for DABS sensor experiments and system feasibility test.

Activities: Fabrication, installation, and checkout of modified

ASR Antenna for DABS. This antenna modification will be selected by Task D-1 based on the design studies of Task D-7.

Outputs: Antenna with monopulse installed at the terminal site for feasibility tests.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽²⁾	-	0
Av. \$	0	200K	- ⁽³⁾	0

- Notes:
- (1) This task is optional, dependent on system decisions as to required DABS antenna types.
 - (2) NOT APPLICABLE, major costs are not staff related.
 - (3) Work continues in Year 3, but total commitment falls in Year 2.

Task: D-14. Fabrication of Modified ARSR Antenna⁽¹⁾

Objective: To provide a low-cost DABS rotator for DABS en route sensor experiments.

Activities: Fabrication, installation, and checkout of modified ARSR antenna for DABS. The antenna modification will be selected by Task D-1 based on design studies of Task D-8.

Outputs: Antenna with monopulse installed at en route radar

site for feasibility tests.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽²⁾	-	0
Av. \$	0	300K	-(3)	0

- Notes:
- (1) This task is optional, dependent on system decisions as to required DABS antenna types.
 - (2) NOT APPLICABLE, major costs are not staff related.
 - (3) Work continues in Year 3, but total commitment falls in Year 2.

Task: D-15. Interrogator Receiver Development

Objective: To provide sensor RF equipment for each of the experimental antenna/monopulse systems being developed, to be used in sensor experiments and system feasibility demonstration.

Activities: Development, fabrication, and testing of two or more DABS interrogator sets with characteristics as follows:

1. Transmitter must accept defined digital control information to control DABS/ATCRBS interlace, discrete-address messages and schedule times, and generate ATCRBS interrogations and DABS interrogations and messages with prescribed RF power levels.

2. Receiver must filter, amplify, and mix DABS/ ATCRBS replies to produce output at IF or low pass (whichever specified) to serve as an input to the analog data processing unit.

Outputs: Sensor RF equipment to work with specified inputs and outputs, bench tested, and installed at experimental sensor locations.

Agency: Industry

Cost Summary:

Year	1	2	3	4
Av. Staffing	0	NA ⁽¹⁾	-	0
Av. \$	0	500K	-(2)	0

Notes: (1) NOT APPLICABLE, major costs are not staff related.

(2) Work continues in Year 3, commitment in Year 2.

TASK GROUP E: DATA PROCESSING AND INTERFACES

Task: E-1. Data Processing and Interface Design and Task Coordination

Objective: To select a DABS data processing system configuration, including the definition of on-site and central data processing functions, algorithms and equipment configurations, and to identify the interface between the DABS surveillance system and the ATC control system.

Activities: This lead task is responsible for specifying, directing, and coordinating all tasks in this task group, in addition to the following specific activities:

1. Definition of the major interface between the DABS surveillance system and the ATC control system, as embodied in NAS and ARTS. The definition required is more jurisdictional than technical, and the object is to specify the exact limits of the DABS development program and the interface problems which must be solved by a joint effort with those involved in the NAS and ARTS programs. The areas of greatest interest include:
 - a. The final tracking of targets, involving the merging of DABS, ATRBS, and primary radar data, and the utilization of redundant coverage.
 - b. The relationship of the multi-sensor coordination tasks, described in Task E-4 below, to the central ATC control function.
 - c. The interface between the message handling, routing and transmission functions of DABS

and the message generation and display functions in both aircraft and ground control, for both IPC and ATC messages.

2. Definition of the technical interfaces between the DABS surveillance system and NAS and ARTS, including definition of modifications required for these systems, and preparation of the general specifications for the corresponding development and fabrication efforts included in Tasks E-7 and E-8.
3. Selection of algorithms and equipment configurations to perform the interrogation management, sensor data processing, and surveillance system data processing tasks described in Tasks E-2, E-3, and E-4, based on the analyses and recommendations of these task teams.
4. Development and analysis of a variety of system configurations for the entire data processing load, ranging from highly centralized organizations to a distributed organization with a high degree of sensor autonomy provided by on-site processing and control capability. These configurations should be evaluated in terms of economy, technical effectiveness, and reliability. Special emphasis should be placed on failure modes, redundancy and resistance to failure, and the assessment of minimum operating characteristics achievable in each failure mode.
5. Selection of a final configuration for the entire data

processing system, including a determination of the total computational requirements of the DABS surveillance system, in both en route and terminal cases. Generation of the general specifications for the development and fabrication effort included in Tasks E-5, E-6, and E-7.

- Outputs:
1. Specifications for all tasks in this task group.
 2. Definition of the jurisdictional and technical interfaces between DABS and NAS and ARTS.
 3. Selection of data processing techniques for Tasks E-5, E-6, and E-7.
 4. Selection of system configuration for Task E-7.
 5. Evaluation of system reliability and behavior in various failure modes.

Agency: System Engineering Group (SEG)...

Cost Summary:

Year	1	2	3	4
Av. Staff	3	3	2	2
Av. \$	180K	180K	120K	120K

Task: E-2. Interrogation Management Design Study

Objective: To devise and evaluate a number of interrogation scheduling schemes and roll-call algorithms for a mixed ATCRBS - DABS environment.

Activities: The determination of methods to schedule discrete-

address interrogations so that the replies do not garble one another or ATCRBS replies. Included therein are:

1. An analysis of the trade-offs between the performance of a DABS interrogator on ATCRBS targets and runlength, assuming various applications of monopulse angle measurement techniques. Performance will be characterized by detection and false alarm probabilities, angular accuracy, and the probability of correct code readout and validation. These trade-offs are important in evaluating various interrogation scheduling schemes with respect to DABS target capacity and performance on ATCRBS targets.
2. The development of schemes for interlacing DABS and ATCRBS interrogations on a common beam and of algorithms for ordering discrete-address interrogations to prevent garbling of any discrete-address replies. Schemes should be considered for both rotators and array antennas.
3. An analysis of the tracking accuracy required to allow position prediction adequate to support the various interrogation scheduling algorithms devised in 2 above.
4. An assessment of the flexibility of the various interrogation scheduling schemes in terms of the ease with which they may be adapted to multi-sensor coordination or synchronization procedures.
5. An evaluation for each scheduling scheme of the

DABS target capacity (total number of targets which can be accommodated and permissible peaking in azimuth), performance with both DABS and ATCRBS targets, and communications capacity, together with the costs in terms of computational load and complexity.

6. A definition of the interfaces between the interrogation management processing task and the other processing tasks including interrogator control, target assignment, central tracking, etc.

- Outputs:
1. Candidate interrogation management schemes, for both rotators and array antennas, which provide a wide range of target capacities, data refresh rates, and performance (detection, angle measurement, and code readout).
 2. Evaluation for each of the above schemes of both economic and technical costs. Technical costs will include the tracking precision required to support the scheme and the feasibility of multi-sensor coordination.
 3. Definition of interfaces between this and other data processing tasks.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	3	2	0	0
Av. \$	180K	120K	0	0

Task: E-3. Sensor Data Processing Design Study

Objective: To evaluate techniques for the performance of those processing tasks which involve single-sensor data and control.

Activities: This task includes the evaluations of several diverse techniques whose common feature is a direct connection with a single sensor. These techniques will most likely be performed on-site. These evaluations include:

1. A design study of analog techniques for defruiting, all or part of the monopulse processing, pulse acceptance, and analog-to-digital conversion.
2. A design study of reply processing techniques including: reply detection and ranging; code and message readout with garble sensing and degarbling; and single reply monopulse processing on DABS targets.
3. A design study of reply correlation processing techniques, probably all digital, including: ATCRBS target detection and angle measurement; code and message validation; and DABS target angle measurement.
4. A development of simple tracking techniques adequate to meet the needs of the candidate interrogation scheduling algorithms. A simple range-only tracker should be included for consideration.
5. An analysis of the interrogator control task and preliminary design of equipment for the timing of interrogations and the generation of rapid

steering commands for an array antenna.

6. An estimation of the total processing requirements in this task area, and a definition of interfaces with other parts of the system.

- Outputs:
1. Recommended techniques for each of the processing functions described above.
 2. Evaluation of the performance of these techniques, including trade-off relations, where applicable.
 3. Estimation of the total processing load and definition of system interfaces.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	2	2	0	0
Av. \$	120K	120K	0	0

Task: E-4. Surveillance System Data Processing Design Study

Objective: To evaluate techniques for the performance of those processing tasks which involve the coordination of multiple sensors.

Activities: This task includes several related technique evaluations of processing functions involving coordination and control of multiple sensors. These evaluations include:

1. Development of algorithms and procedures for performing target assignment, lockout control

and target insertion for discrete-address targets.

2. Development of methods of coordinating and/or synchronizing the interrogation schedules of several sensors in order to minimize mutual interference. This activity requires close coordination with the activities of Task E-2 and Task B-1 (interference modeling).
3. Development of algorithms and procedures for handling and routing IPC and ATC messages and integrating this function with the other sensor coordination functions and the interrogation scheduling processors of individual sensors.
4. An estimation of the total processing requirement in this area and a definition of interfaces with other parts of the system.
5. A survey of tracking techniques, both single-sensor and multiple-sensor, and the conflict detection and resolution techniques in use or planned. The purpose of this activity is to provide guidance to Task E-1 in its consideration of system configurations and interfaces, but not necessarily to do original work in these areas.

Outputs:

1. Recommended techniques for each of the processing functions described above.
2. Evaluations of the performance of these techniques, including trade-off relations, where applicable.
3. Estimation of total processing load and definition of system interfaces.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	3	2	0	0
Av. \$	180K	120K	0	0

Task: E-5. Interrogation Management Processor Development and Fabrication

Objective: To develop the computer programs and produce the hardware necessary to carry out the data processing functions associated with interrogation management for system feasibility testing.

Activities: The following steps will be undertaken to produce experimental interrogation management processors for DABS feasibility testing:

1. Develop computer programs employing the experimental interrogation management algorithms analyzed in Task E-2 and selected in Task E-1.
2. Procure and program the data processing equipment required for interrogation management at each experimental sensor site. This equipment will likely consist of small commercial general purpose digital computers which may be shared with one or more of the other experimental data processing functions addressed in Tasks E-6 through E-9.
3. Fabricate all hardware needed to integrate the

interrogation management data processor with the experimental sensors, including input and output interfaces, special purpose processing logic (if appropriate) and processor controllers.

4. Install and checkout the interrogation management data processor and associated hardware at the experimental DABS sensor sites.

Outputs: Interrogation management data processing equipment and programs to support at least two experimental DABS sensors for use in system feasibility testing.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽¹⁾	-	0
Av. \$	0	800K	-(2)	0

Notes: (1) NOT APPLICABLE, major costs are not staff related.

(2) Work continues in Year 3, commitment in Year 2.

Task: E-6. Sensor Data Processor Development and Fabrication

Objective: To develop the computer programs and produce the hardware necessary to carry out the data processing functions associated with a single sensor for system feasibility testing.

Activities: The following steps will be undertaken to produce experimental sensor processors for DABS feasibility testing:

1. Develop computer programs employing the experimental sensor data processor algorithms analyzed in Task E-3 and selected in Task E-1.
2. Procure and program the data processing equipment for implementation of the above computer programs at each experimental sensor site. This equipment will likely consist of commercial general purpose digital computers which may be shared with one or more of the other experimental data processing functions addressed in Tasks E-5, E-7, E-8, and E-9.
3. Fabricate all hardware needed to integrate the sensor data processor with the experimental sensors, including input and output interfaces, special purpose processing logic (if appropriate) and processor controllers.
4. Install and check out the sensor data processor and associated hardware at the experimental DABS sensor sites.

Outputs: Single-sensor data processing equipment and programs to support at least two experimental DABS sensors for use in system feasibility testing.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽¹⁾	-	0
Av. \$	0	500K	-(2)	0

- Notes:
- (1) NOT APPLICABLE, major costs are not staff related.
 - (2) Work continues in Year 3, commitment in Year 2.

Task: E-7. Surveillance System Data Processor Development and Fabrication

Objective: To develop the computer programs and produce the hardware necessary to carry out the data processing functions associated with multi-sensor coordination for system feasibility testing.

Activities: The following steps will be undertaken to produce an experimental surveillance system data processor for DABS feasibility testing:

1. Develop computer programs employing the experimental surveillance system processing algorithms analyzed in Task E-4 and selected in Task E-1.
2. Procure and program data processing equipment for implementation of the above computer programs. This equipment will likely consist of a commercial general purpose digital computer which may be shared with one or more of the other experimental data processing functions addressed in Tasks E-5, E-6, E-8, and E-9.
3. Fabricate all hardware needed to integrate the surveillance data processor with the experimental sensors and the experimental ATC center or terminal, including input and output interfaces, special purpose processing logic (if appropriate),

and processor controllers.

4. Install and check out the interrogation surveillance system data processor and associated hardware at the experimental DABS surveillance control site.

Outputs: Surveillance system data processing equipment and programs to support the coordination of at least two experimental DABS sensors for use in system feasibility testing.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	NA ⁽¹⁾	-
Av. \$	0	0	700K	-(2)

Notes: (1) NOT APPLICABLE; major costs are not staff related.

(2) Work continues in Year 4, commitment in Year 3.

Task: E-8. NAS Modifications and Interface Equipment Development and Fabrication

Objective: To carry out the modifications to the NAS system and to produce the NAS - DABS interface equipment and programs necessary for DABS feasibility testing.

Activities: The steps required to complete this task depend strongly on the chosen experimental configuration and the location of the NAS - DABS interfaces. However, the following measures will likely be necessary regardless

of the detailed system selection:

1. Modify the NAS processors to accept and handle DABS surveillance reports, which may include increased or variable data rates. The major modification to the processors will likely involve new tracking routines.
2. Procure and program additional NAS data processing capability, as required, to handle increased DABS data and tracking loads and to implement format conversion and data buffering at the DABS - NAS interface.
3. Fabricate all hardware needed to augment the NAS data processing capability of the experimental en route control center used in the DABS feasibility tests.
4. Install and check out the modifications at the experimental NAS en route control center for the DABS feasibility tests.

Outputs: NAS modifications and NAS - DABS interface hardware and programs to allow NAS/DABS operation for system feasibility testing.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	NA ⁽¹⁾	-
Av. \$	0	0	400K	-(2)

- Notes: (1) NOT APPLICABLE, major costs are not staff related.
- (2) Work continues in Year 4, commitment in Year 3.

Task: E-9. ARTS Modifications and Interface Equipment Development and Fabrication

Objective: To carry out the modifications to the ARTS system and to produce the ARTS - DABS interface equipment and programs necessary for DABS feasibility testing.

Activities: The steps required to complete this task depend strongly on the chosen experimental configuration and the location of the ARTS - DABS interfaces. However, the following measures will likely be necessary regardless of the detailed system selection:

1. Modify the ARTS processors to accept and handle DABS surveillance reports which may include increased or variable data rates. The major modification to the processors will likely involve new tracking routines.
2. Procure and program additional ARTS data processing capability, as required, to handle increased DABS data and tracking loads and to implement format conversion and data buffering at the DABS - ARTS interface.
3. Fabricate all hardware needed to augment the ARTS data processing capability of the experimental terminal control site used in the DABS feasibility tests.

4. Install and check out the modifications at the experimental ARTS terminal control site for the DABS feasibility tests.

Outputs: ARTS modifications and ARTS - DABS interface hardware and programs to allow ARTS/DABS operation for system feasibility testing.

Agency: Government/Non-Profit Agency or Industry

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	NA ⁽¹⁾	-
Av. \$	0	0	400K	-(2)

- Notes:
- (1) NOT APPLICABLE, major costs are not staff related.
 - (2) Work continues in Year 4, commitment in Year 3.

TASK GROUP F: FEASIBILITY TEST TASKS

Task: F-1. Experiment Planning and Test Procedure Development

Objective: To design and coordinate a series of experiments to demonstrate the feasibility of the selected system design.

Activities: This lead task involves selection of experiments, planning for the use of test facilities, and developing test procedures for the DABS feasibility demonstration.

Outputs: The experimental plan, schedules, and test procedures for DABS feasibility demonstration.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	1	2	2	2
Av. \$	50K	100K	100K	100K

Task: F-2. Test Facility Preparation

Objective: To prepare sites for the DABS feasibility demonstration.

Activities: This task involves the preparation of sensor sites, data processing centers, and auxiliary measurement and calibration instrumentation for the DABS feasibility demonstration. It also includes preparation and check-out of the ATCRBS E-scan antenna for DABS testing.

Outputs: Facilities for the DABS feasibility tests.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	0	NA ⁽¹⁾	NA	0
Av. \$	0	700K	800K	0

Notes: (1) NOT APPLICABLE; major costs are not staff related.

Task: F-3. DABS Transponder Test and Evaluation

Objective: To evaluate the performance of the DABS transponder and aircraft antenna systems in a realistic ATCRBS environment.

Activities: This task includes:

1. Transponder bench tests.
2. Limited transponder flight tests of the three or more transponder models resulting from Task C-4.

Outputs: Operating characteristics of the various DABS transponder models.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	2	0
Av. \$	0	0	100K	0

Task: F-4. Experimental Feasibility Demonstration of DABS Sensor Design

Objective: To provide data for evaluation of DABS sensor

performance and to demonstrate the operation of all basic sensor capabilities.

Activities: This task includes bench tests and limited flight tests using the experimental sensor antennas and interrogator/receivers procured in Tasks D-9 through D-15 including:

1. Demonstration of discrete-address beacon sensor operation, including the use of all DABS modes (surveillance, IPC, data link, insertion, etc.) to obtain: estimates of DABS surveillance accuracy and reliability with DABS targets; and estimates of message delivery delay and reliability.

2. Demonstration of the DABS sensors with APCRBS targets, including the use of short run lengths, monopulse azimuth estimation, and data processing for interference rejection to obtain estimates of the surveillance accuracy and reliability of the DABS sensors with APCRBS targets.

Outputs: Experimental data to be compared with validation studies and analysis of basic sensor accuracy and reliability.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	0	4
Av. \$	0	0	0	1000K

Task: F-5. Experimental Feasibility Demonstration of NAS and ARTS Interface

Objective: To evaluate an experimental interface between a single DABS sensor and the NAS and ARTS control centers.

Activities: This task involves an experimental evaluation of the interface and other hardware and software modifications to the NAS and ARTS sub-systems developed in Tasks E-8 and E-9. It includes a demonstration of NAS and ARTS provisions for: data link operations and message handling; target assignment and handover mechanics; and the processing of DABS surveillance data.

Outputs: Evaluation of the feasibility of modified NAS and ARTS to work with DABS.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	0	0
Av. \$	0	0	0	1000K

Task: F-6. Experimental Feasibility Demonstration of Multi-Sensor Operation

Objective: To provide experimental data with which to evaluate the DABS sensor network control system and multi-sensor processor.

Activities: This task involves ground tests and limited flight tests

(in a realistic traffic environment) of the surveillance system data processor developed in Task E-7. The aspects of the system operation to be investigated in this task include:

1. Effectiveness of the DABS multi-sensor data processing system in achieving reliable surveillance data refresh and message delivery;
2. Effectiveness of system operation in various failure modes;
3. Measurement of interference parameters of combined DABS/ATCRBS system operation, for comparison with "design validation studies" to verify the system capacity.

Outputs: A report containing experimental data and conclusions including:

1. Estimates of combined blip/scan ratios for multiple DABS and ATCRBS sensors;
2. Estimates of system accuracy, reliability, and capacity in various failures modes.

Agency: NAFEC

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	0	3
Av. \$	0	0	0	1400K

TASK GROUP G: DESIGN VALIDATION

Task: G-1. Design Validation Studies and Evaluation of Experimental Data

Objective: To arrive at a reasonable DABS deployment strategy by analyzing and simulating those special aspects of DABS system operation which cannot be practically investigated experimentally, such as ATCRBS to DABS phaseover, failure modes, and saturation phenomena.

Activities: This effort will use ATCRBS and DABS channel loading models and will simulate and analyze:

1. System operation in the transition period between DABS start-up and ATCRBS phaseout, focusing on such aspects of combined operation as: location of DABS sensors to provide increased system capacity; evolution of system organization as more DABS sensors are deployed; and evaluation of various control measures to reduce self and mutual interference of the combined DABS/ATCRBS system.
2. System operation and capacity in heavy traffic environments to determine DABS saturation characteristics.
3. System operation and capacity in failure modes.
4. System operation of the DABS feasibility demonstration sensor networks.

After satisfactory agreement is reached between experiment and simulation, this effort will conclude with the formulation of a validated DABS deployment strategy.

- Outputs:
1. Estimates of system performance in various configurations during the transition period.
 2. Final selection of the strategies for DABS sensor deployment during the transition period.

Agency: System Engineering Group

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	8	8
Av. \$	0	0	560K	500K

Task: G-2. Preparation of DABS Specifications and Plans

Objective: To generate specifications for ground equipment for the prototype engineering phase, provisional minimum operating characteristics for transponders, and plans for prototype engineering and system implementation.

Activities: This effort draws on the conclusions and design decisions of all the previous tasks to:

1. Generate equipment and software specifications for sensor, interface, and control center equipment to be manufactured in the prototype engineering phase, and provisional standards (or Minimum Operating Characteristics) for DABS transponders. It is anticipated that no new design considerations will be introduced in this specification writing effort.
2. Develop plans, with costing and schedules, for

the prototype engineering and implementation phases of the DABS program with particular emphasis on Phase I planning, including the selection of a suitable terminal area for prototype testing.

- Outputs:
1. Equipment and system engineering specifications for prototype ground equipment; standards and minimum operating characteristics for transponders.
 2. DABS prototype engineering and system implementation plans.

Agency: Systems Engineering Group

Cost Summary:

Year	1	2	3	4
Av. Staff	0	0	0	6
Av. \$	0	0	0	300K

TASK GROUP H: SYSTEM ENGINEERING

Task: H-1. System Engineering

Objective: To design the overall DABS system.

Activities: The system engineering task will carry out the DABS system definition, design, and design validation. To accomplish this, a principal activity of this task is to coordinate all other tasks to assure that all necessary technical, economic, and operational data is available at the proper times to provide a basis for sound design decisions. To this end, the majority of the system engineering activity is performed by the same personnel who are engaged in the lead tasks of the above-listed task groups. The system engineering personnel not directly associated with these lead tasks will be responsible for overall program planning and coordination, to assure that all aspects of the system design are considered.

Outputs: (See lead tasks of other task groups.)

Agency: Systems Engineering Group

Cost Summary:

Year	1	2	3	4
Av. Staff	5	7	8	9
Av. \$	280K	390K	450K	600K

Notes: This task is staffed at a level such that the total staffing of the System Engineering Group remains relatively constant over the 4 year program.