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EN ROUTE DABS/ATC BUILD II TESTING

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PROJECT PLAN

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1. OBJECTIVES.

The primary purpose of these tests is to determine the performance of the aircraft control state (ACS) function in an en route environment. This function has been incorporated in the en route Discrete Address Beacon System/Air Traffic Control (DABS/ATC) Build II software system. It allows the en route DABS/ATC Build II system to perform primary/secondary assignments to DABS sensors for controlled aircraft within the sensor surveillance environment.

Secondary objectives of this test activity are to evaluate the performance of the Build II startover function and to verify that the performance test results obtained during Build I testing can be achieved using the Build II software.

2. BACKGROUND.

The National Airspace System (NAS) en route A3d2.4 software system has been modified to provide for simultaneous processing of both DABS and Air Traffic Control Radar Beacon System (ATCRBS) information in an en route environment. The software modifications were implemented in sequential deliverables known as Build I and Build II. This software is developmental for use in the En Route System Support Facility (ESSF) at the Federal Aviation Administration (FAA) Technical Center with the DABS engineering model.

Build I software provided the capability to process surveillance data from a single DABS sensor and multiple ATCRBS sensors. In addition, surveillance-related communication messages to and from the DABS sensor were also processed.

Build II software provides the following additional functions:

a. DABS ACS assignment
b. Altitude assignment confirmation (ACC)
c. Automated Radar Terminal System (ARTS) interface
d. Moving target detector (MTD) search message processing
e. Startover capability
f. Multiple DABS sensors

Build II software will be used during the time period covered by this project plan to accomplish the following:

a. Regression testing which will verify that the addition of the new functions did not degrade the Build I system.

b. Verification of the startover function.

c. Verification that the ACS function is compatible with DABS sensors in fully netted, partially netted, and stand-alone configurations.

A fully netted sensor configuration allows each DABS sensor to coordinate and exchange surveillance and surveillance-related communication data with other DABS sensors. A partially netted DABS sensor configuration allows only the connected DABS sensors to coordinate and exchange data, and a stand-alone DABS sensor configuration does not allow DABS sensors to coordinate and exchange data with other sensors.

DABS/ATC related functions (data link, automatic traffic advisory and resolution service (ATARS), interfacility, and radar improvements) are not within the scope of this document, but will be the subject of future documents.

3. RELATED DOCUMENTS AND PROJECTS.

This test plan is prepared in accordance with "Test Requirements for the DABS/ En Route ATC System (Build I and II)" received from ARD-100 in June 1979. The DABS sensors to be used are defined in the DABS Engineering Requirement, FAA-ER-240-26.

Air Traffic Control Simulation Facility (ATCSF) software to be used is defined in ACT-242's Letter of Understanding for Phase II ATCSF/DABS Testing.

The A3d2.4 system is described in the Computer Program Functional Specifications (CPFS's) NAS-MD-310 through 318 and NAS-MD-320 through 326 that include change levels A, B, C, and D only. The A3d2.4 system modifications required to process DABS/ ATCRBS data are defined in the CPFS for DABS surveillance processing (CSC/TM-78/6232), revision 3, containing "change pages to DABS Surveillance Processing Build I CPFS for Build II," CSC/TM-79/6178, Revision 1, September 1979.

The format of messages to be transmitted between DABS/ATCSF and ATC systems is defined in DABS/ATCSF/ATC Message Formats FAA-RD-74-63B, Revision 2, and FAA-RD-74-159.11.1, Revision 1.

4. SYSTEM/EQUIPMENT CONFIGURATION.

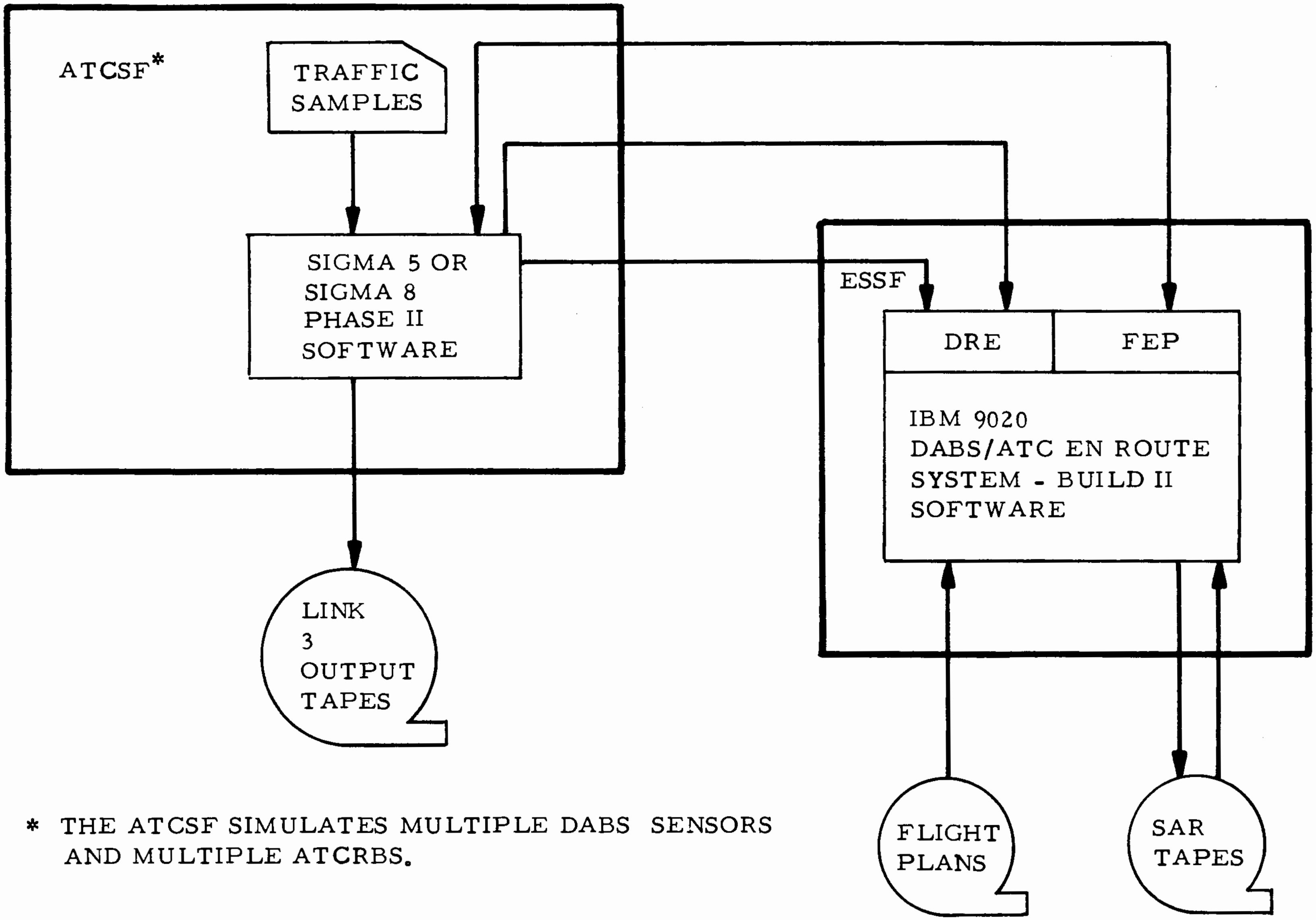
Each test will be conducted using one of three system configurations.

The first configuration (figure 1) involves the use of the ATCSF as the source of data input to the ESSF. The ATCSF will be employed to simultaneously emulate three DABS sensors and three ATCRBS sites. The driving source for the ATCSF will be test scenarios consisting of target data having predetermined flightpaths, target codes, and altitudes. Surveillance related communication data will also be generated by the ATCSF and DABS/ATC systems during processing.

The surveillance data lines will transfer the target (surveillance) data from the ATCSF to the ESSF. The target update rate will be twice per scan in order to simulate the DABS en route back-to-back antenna configuration. Full duplex communication lines are used to accomplish sensor ATC communication message transfer employing a Common International Civil Aviation Organization (ICAO) Data Interchange Network (CIDIN) protocol.

The second test configuration (figure 2) will employ two DABS sensors operating in a stand-alone configuration or in a fully netted configuration. Each sensor will be directly interfaced with an aircraft reply and interference environment simulator (ARIES). In addition, the ARIES systems will be interfaced to each other in order to provide timing for scenario synchronization and the proper transponder

THE FOLLOWING CONFIGURATION DEPICTS THE FACILITIES AND HARDWARE REQUIRED TO TEST ATCSF INTERFACED WITH ESSF.



* THE ATCSF SIMULATES MULTIPLE DABS SENSORS AND MULTIPLE ATCRBS.

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FIGURE 1. AIR TRAFFIC CONTROL SIMULATION FACILITY/EN ROUTE SYSTEM SUPPORT FACILITY

THE FOLLOWING CONFIGURATION DEPICTS THE FACILITIES AND HARDWARE REQUIRED TO TEST THE DABS SENSORS INTERFACED WITH THE ARIES AND ESSF.

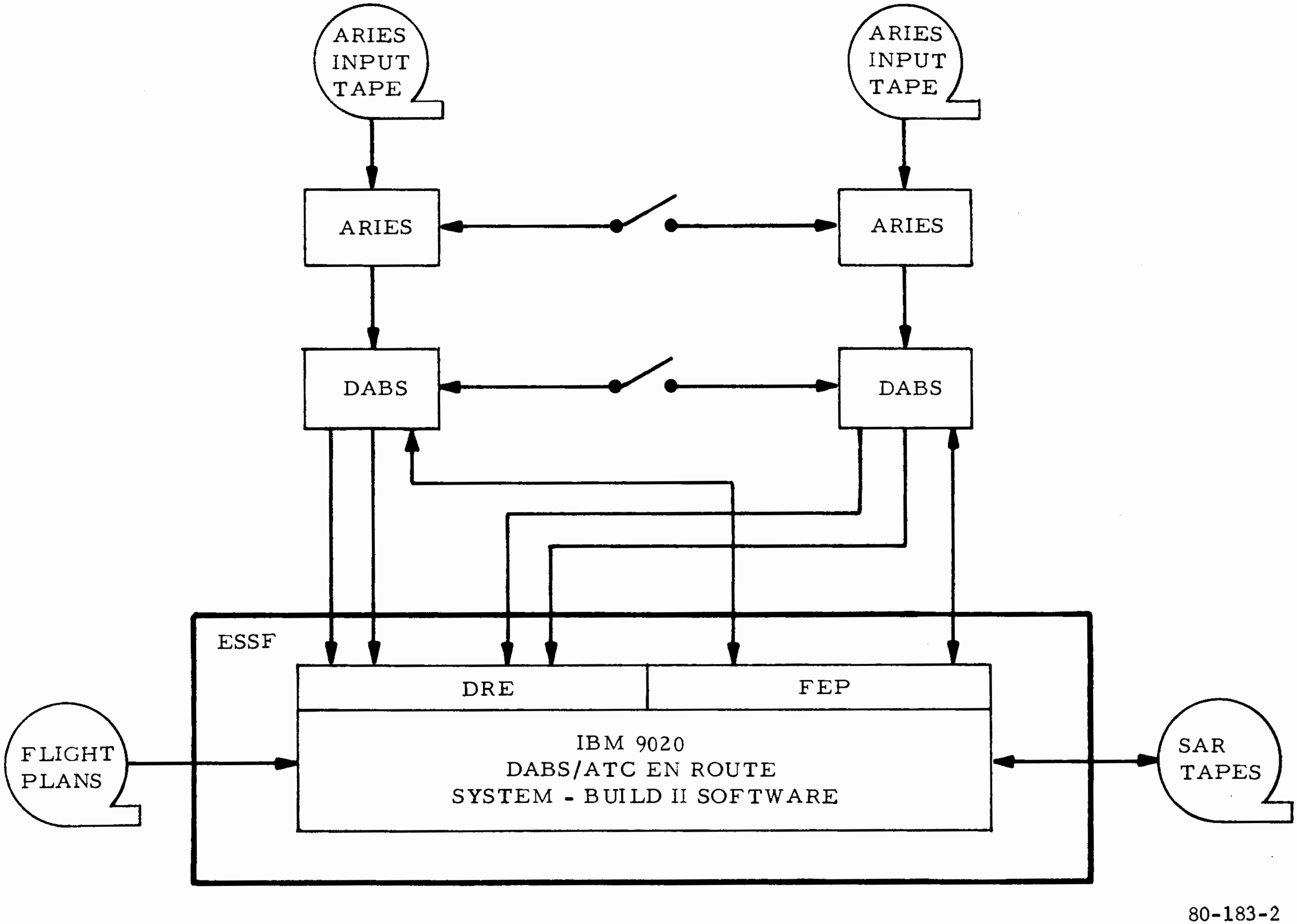

FIGURE 2. DISCRETE ADDRESS BEACON SYSTEM/AIRCRAFT REPLY AND INTERFERENCE ENVIRONMENT SIMULATOR/EN ROUTE SYSTEM SUPPORT FACILITY TEST ENVIRONMENT

lockout management required in areas of sensor overlap coverage. The traffic samples, used as scenario inputs to ARIES, will be developed off-line using the ATCSF scenario generator program.

The ARIES provides replies for both ATCRBS and DABS targets based on the ARIES input scenario. The DABS sensor's surveillance data will be processed by the ESSF via the data receiving equipment (DRE); surveillance-related communications information will be provided to the ESSF for processing via the front end processor (FEP).

The third test configuration (figure 3) will employ the actual DABS engineering models located at the Technical Center and Elwood and Clementon, New Jersey. These sensors will be tested in a fully netted, partially netted, and stand-alone configuration. Test aircraft will be employed during these tests.

The DABS sensors will receive data from the aircraft and transmit it to the ESSF for processing via the DRE and FEP.

The fourth configuration (figure 4) involves the use of simulated DABS and ATCRBS data generated by DABS direct simulation (DABSIM) as input to Build I and Build II.

5. DATA COLLECTION.

Prior to ACS testing with multiple DABS sensors the Inter-ARIES modification must be verified through Inter-ARIES test scenarios. The Inter-ARIES modification provides for proper lockout control of the DABS aircraft and timing between the two ARIES scenarios in such a manner as to permit a multiple DABS sensor configuration to operate and process aircraft data as if the aircraft were a common point target observed by two DABS sensors. In addition, tests conducted using the ATC simulator, which provides predetermined ACS and Comm A messages as inputs to all sensors, will be verified through test scenarios. This simulator is part of a modification incorporated into the DABS system test console (STC) at the Technical Center sensor. During each test, data will be collected manually by test participants and automatically by the ATCSF and/or DABS sensor extractor programs. Data collected by the DABS sensor extractor program are:

a. DABS and ATCRBS surveillance messages
b. Communications data
c. Intersensor messages
d. ACS messages received

Additionally, the ESSF will automatically collect data via the en route DABS/ATC Build II system's analysis recording (SAR) function.

SAR will be employed to record the following types of data:

a. Surveillance
b. Track
c. Interfacility
d. Keyboard
e. Flight plan

THE FOLLOWING CONFIGURATION DEPICTS THE FACILITIES AND HARDWARE REQUIRED TO TEST DABS SENSORS WITH THE ESSF.

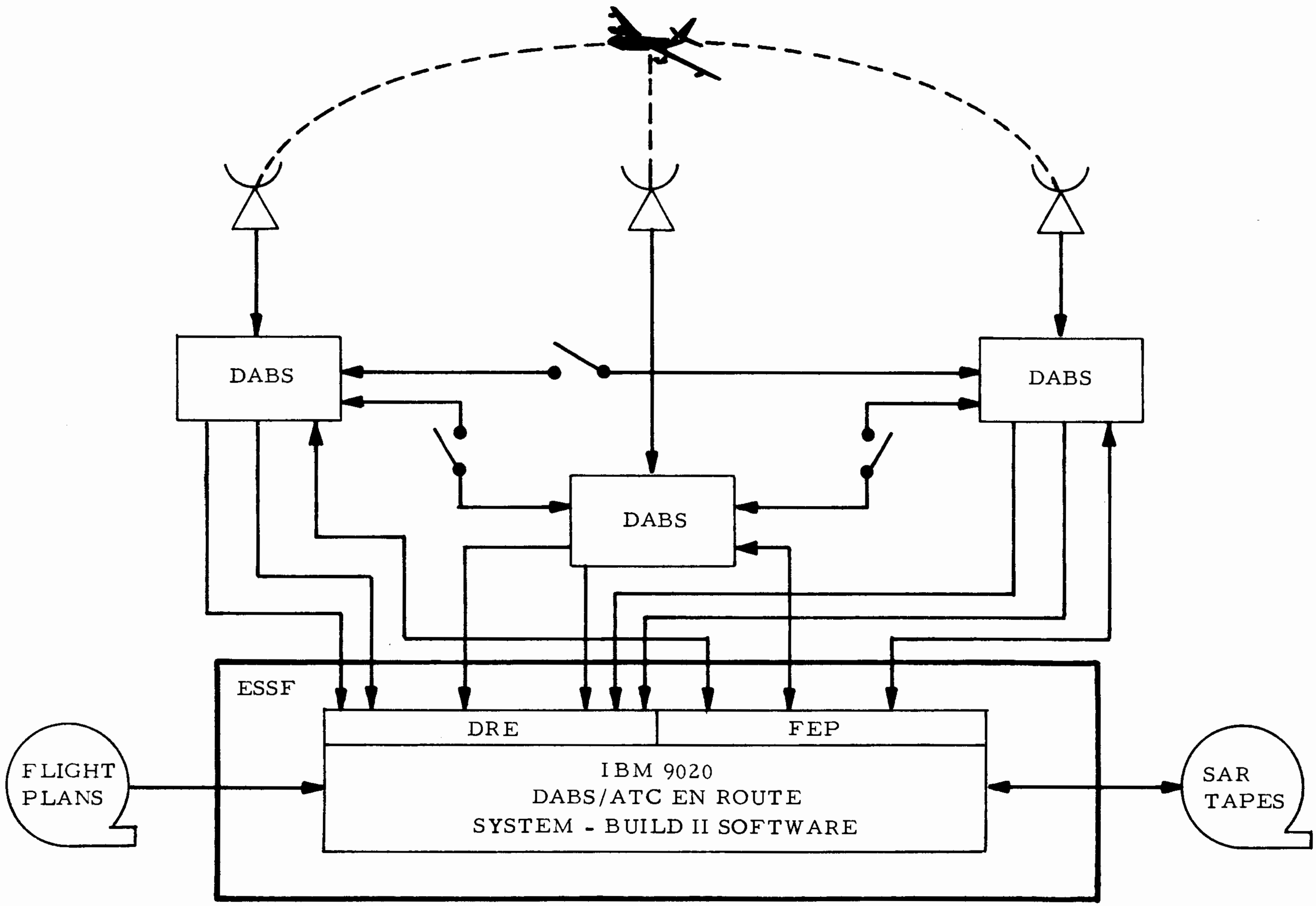

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FIGURE 3. DISCRETE ADDRESS BEACON SYSTEM SENSORS/EN ROUTE SYSTEM SUPPORT FACILITY TEST ENVIRONMENT

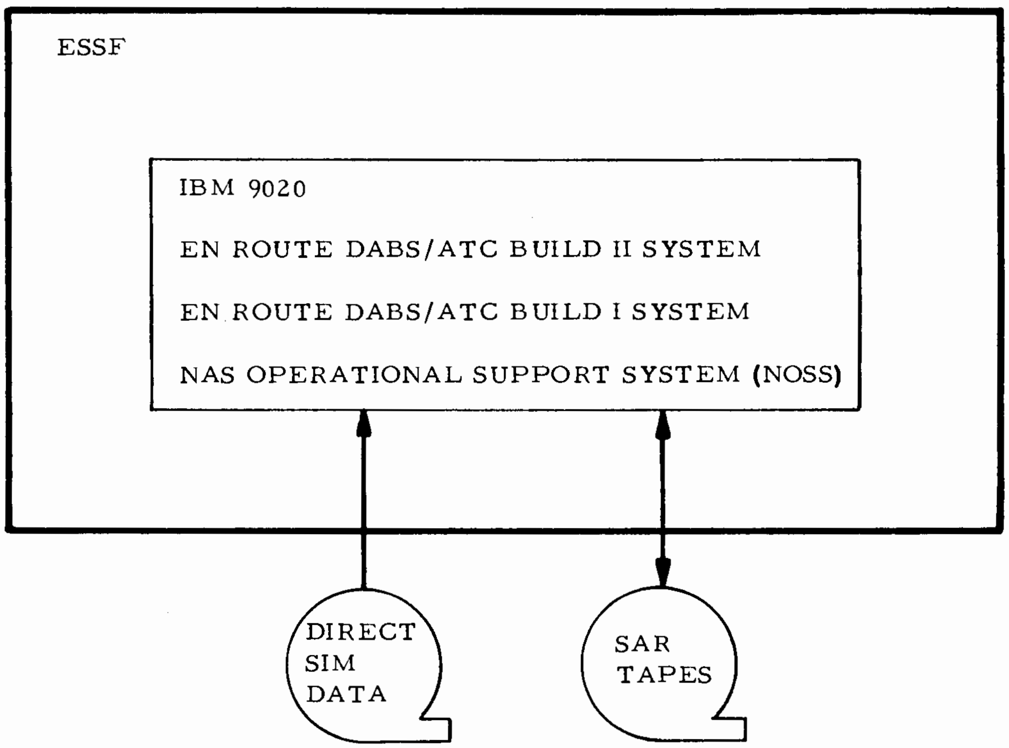

FIGURE 4. DIRECT SIMULATION/EN ROUTE SYSTEM SUPPORT FACILITY TEST ENVIRONMENT

f. Time and analysis records (TAR)
g. Communications
h. Communications related data

SAR extracts this data from compool tables, pool storage, input/output buffers, system control tables, and internal program buffers.

5.1 REGRESSION TESTING.

These tests will be conducted to verify that the performance test results attained during Build I testing can be achieved using Build II software. Direct simulation depicted in figure 4 will be employed to simulate a DABS and ATCRBS environment using predetermined target scenarios. The evaluation will be concerned with data collected in the following areas:

a. Track initiation
b. Track continuity
c. Track swap
d. ATCRBS identification request
e. ATCRBS identification code message
f. Message rejection delay notice

Tests will be conducted with simulated sensor coverage of the following types:

a. Tracks in ATCRBS coverage only, using direct simulation data.

b. Tracks in DABS coverage only, using ARIES and direct simulation data.

c. Tracks crossing between DABS and ATCRBS coverage, using direct simulation data.

The major variables to be considered during testing for track initiation, track continuity, and track swap are:

a. Flightpaths:

1. Straight lines
2. Turns
3. Aircraft speed
4. Aircraft crossing angle for swap situations
5. Aircraft speed differential for swap situations
6. Aircraft altitude differential for swap situations

b. DABS beacon with and without search data

c. ATCRBS discrete and nondiscrete beacon with and without search data

d. Simulated blip/scan ratios of 100 and 75 percent

e. Simulated range and azimuth jitter of 25 feet and 0.05 degrees (ATCSF only)

f. Constant turn rate of 2.4 degrees per second

g. ATCRBS fruit rates of 0 and 4,000 fruit per second (ARIES only)

5.2 DABS AIRCRAFT CONTROL STATE (ACS) MESSAGE TESTING.

The ACS function will be tested using simulated data provided from the ATCSF or DABS sensors with inputs derived from the ARIES. The configuration employing the ATCSF (figure 1) and the DABS sensors with ARIES (figure 2) will be tested under the following conditions:

a. Blip/scan ratios of 100 and 75 percent
b. Azimuth and range jitter of 0.05 degrees and 25 feet (ATCSF only)
c. Increased target loads for ACS capacity testing
d. For ARIES only, ATCRBS fruit rates of 0 and 4,000 fruit per second

In addition to the DABS/ARIES and ATCSF tests, a test aircraft will be employed with the three DABS sensors, as depicted in figure 3, to evaluate ACS performance.

The three system configurations described in section 4 will be utilized to transmit surveillance and surveillance-related communications data to the ESSF, in accordance with predetermined target scenarios. The target scenarios will simulate aircraft with flightpaths that traverse the various types of radar sort box (RSB) adaptation as described in table 1. The simulated and test aircraft will be employed to test the ability of the ACS function to assign the primary, secondary, or uncontrolled status of aircraft being tracked by a DABS sensor. The ACS assignment will be based on the track control status (TCS) of the Build II DABS track and the adaptation of the RSB in which the predicted track position resides.

TABLE 1. DABS RADAR SORT BOX ADAPTATION

Preferred Site	Alternate Preferred Site	Remaining Sites
DABS	None	DABS or ATCRBS
DABS	DABS	DABS or ATCRBS
DABS	ATCRBS	DABS or ATCRBS
ATCRBS	DABS	DABS or ATCRBS
ATCRBS	ATCRBS	At least one DABS
ATCRBS*	None	ATCRBS

*RSB has no DABS adaptation but lies within DABS coverage

A Build II flight plan scenario, hereafter referred to as the baseline scenario, will be employed for ACS testing in conjuction with the ATCSF and the ARIES target scenarios. The baseline scenario will have the following characteristics:

a. Interfacility handoffs
b. Drop track requests
c. DABS address and equipment qualifier modifications
d. Manual start track actions
e. Manually induced sensor failures

In addition, flight plan load will increase in conjunction with the ATCSF and ARIES scenario target loads in order to perform ACS capacity testing.

The SAR function will be employed to record data associated with the following ACS tasks:

a. ACS TCS designation
b. ACS status determination
c. ACS monitoring
d. ACS assimilation

The primary data tables that will be recorded for the ACS function are listed below with a brief description relating the data to the tasks of the ACS function.

a. The Radar Buffer Table (RH) is the input buffer for the DABS surveillance data needed to monitor the ACS primary/secondary sensor indicators and determine the initial ACS status. The ACS monitoring and ACS status determination tasks are the primary ACS users of this data.

b. The Radar Data Table (RT) contains radar data needed for automatic track initiation and initial TCS designation. The ACS TCS and ACS status determination tasks primarily use this data.

c. The Tracking Data Table, part 1, (TK) contains, in addition to tracking data, RSB identifications (ID) needed for ACS status updates. This data is needed by the ACS status determination task.

d. The DABS Address Table (DB). Some of the more important data contained in this table are the DABS address, primary site ID, TCS, ACS request indicators, and ACS time interval counters. This data is used by all of the ACS tasks.

e. System Parameter Table (SY) contains the time limit parameters required to update TCS and ACS primary sensor designations. The parameters are used mainly by the ACS assimilation task.

f. Pool Storage (PO) is dynamic storage used to process input/output messages. These messages can be either local (keyboard entered) or remote (interfacility). This storage is needed primarily by the ACS assimilation task.

5.3 STARTOVER TESTING.

A startover (STVR) message will be entered from a keyboard to the en route DABS/ ATC Build II system in order to initiate the startover function. This function provides the ability of the system to recover from system failures. The SAR function will be employed to record data associated with the following tasks of the startover function:

a. Reestablishment of the ACS status for each controlled DABS track.

b. Initialization of the FEP/Build II interface.

c. Retransmission of ATCRBS ID requests for each DABS track.

In addition, track-related data will be recorded to determine the quality of tracking following startover.

6. DATA REDUCTION AND ANALYSIS.

6.1. DATA REDUCTION.

Data for analysis will be provided by various data reduction software programs prepared for the ESSF, Digital Equipment Corporation (DEC) model PDP-11 computer, and the Honeywell 66/60 computer.

a. The data analysis and reduction tool (DART) reduces SAR data for analysis in accordance with the following user requested functions:

1. Log function - input/output of all activity in the en route DABS/ATC Build II system.

2. History function - chronological history of correlations for specified tracks in the en route DABS/ATC Build II system.

3. Track function - outputs a time ordered listing of the track data base ordered by aircraft and a summary of information describing the average performance of the tracks in the en route DABS/ATC Build II system.

b. The interface verification off-line data reduction and analysis program preprocessor (DIVARP) produces a communications output tape and a surveillance output tape for subsequent input to the interface verification off-line data reduction and analysis program (DIVAR).

c. DIVAR produces communication summary reports and surveillance summary reports from DIVAR output tapes for analysis purposes.

d. Data reduction programs developed by ACT-100 and ACT-700 will be employed to produce plots of required surveillance data, track data, and listings of surveillance data.

e. The timing analysis reduction program (TARP) selectively prints timing and supervisor call (SVC) information from SAR recordings. Reports selected will be the program element execution time study and the SVC/subprogram summary. The high resolution timer (HRT) generation option will also be employed to produce an HRT tape as input for the HRT reduction program (REDUC).

f. REDUC will be employed to produce detailed statistical information in order to evaluate the timing characteristics of the ACS function.

6.2 ANALYSIS.

6.2.1 Regression Test Analysis.

A comparison of the performance of the en route DABS/ATC Build II software to the previously achieved performance of the Build I software will be made. The comparison will be performed by:

a. Processing the same input data as described in section 5.1, Regression Testing.

b. Reduction of SAR tapes to produce the following:

1. All input/output (I/O) activity of each system
2. History of all tracks of each system
3. Performance of all tracks of each system
4. Surveillance reports of each system
5. Communication reports of each system

The analysis of the data for each system will establish if the performance of Build I software was unchanged, improved, or degraded.

6.2.2 ACS Message Testing Analysis.

The overall analysis will insure that the ACS function can determine if a DABS equipped aircraft in DABS coverage is CONTROLLED or UNCONTROLLED, and assign the DABS sensor as primary for a given aircraft. The analysis must also determine if ACS messages are transmitted to the DABS sensors in a timely manner, and that no undue ACS related delays occur when the Build II system is placed under capacity track and target loads. In addition, analysis must determine if the DABS sensors properly revert to their internal coverage maps after a controlled DABS address is designated uncontrolled, and that at least one DABS sensor is indicating primary status. This analysis will be accomplished through examination of the primary/secondary settings in the DABS surveillance data disseminated to the ESSF.

The ACS function must perform four major tasks in order to assign and manage ACS status designations. The analysis of these tasks is described in the following paragraphs.

6.2.2.1 ACS Track Control Status (TCS) Designation.

Analysis will determine the ability of this task to assign the TCS values of CONTROLLED TENTATIVE, CONTROLLED, or UNCONTROLLED to Build II tracks. The specific conditions to be examined for CONTROLLED TENTATIVE assignments are:

a. Automatic track initiation.

b. Automatic track reinitiation from coast.

c. Acceptance of track control from an adjacent ATC facility.

d. Modification to the DABS ADDRESS and/or equipment qualifier.

e. The loss of surveillance data containing the DABS ADDRESS assigned to a track presently assigned a TCS value of CONTROLLED.

After a track becomes CONTROLLED TENTATIVE it is then eligible to be designated CONTROLLED. Analysis will, therefore, insure that a track's TCS value is changed from CONTROLLED TENTATIVE to CONTROLLED when a surveillance data containing the respective track's assigned DABS ADDRESS is first received. This is the only condition that requires a TCS assignment of CONTROLLED. The last TCS value to be evaluated will be UNCONTROLLED and the analysis will involve an examination of TCS assignment changes from CONTROLLED or CONTROLLED TENTATIVE to UNCONTROLLED when any one of the following events occurs:

a. Track control is transferred to an adjacent ATC facility.

b. A track is manually or automatically dropped.

c. The DABS ADDRESS or equipment qualifier is modified to indicate no DABS equipment.

d. The track does not meet the requirements for CONTROLLED or CONTROLLED TENTATIVE.

6.2.2.2 ACS Status Determination.

Analysis will be separated into three areas and will be discussed in the following order:

a. Initial ACS status determination
b. ACS Status Updates
c. Primary sensor reestablishment due to dynamic RSB reassignment

Initial status determination will be evaluated to insure that the DABS sensor, from which the first DABS data is received, containing the respective track's DABS ADDRESS is stored as the TEMPORARY PRIMARY sensor with an ACS status of CONTROLLED PRIMARY. The initial status evaluation will also insure that the DABS sensor stored as a TEMPORARY PRIMARY matches the sensor adapted as PRIMARY in the RSB of the track. If this match is not achieved, an ACS status request must be made designating the adapted PRIMARY sensor as CONTROLLED PRIMARY and all other DABS sensors to CONTROLLED SECONDARY. After the initial ACS status has been determined, an examination of ACS status updates will be conducted. An event requiring an ACS status update is when a track moves into an RSB having an adapted PRIMARY sensor different from the current PRIMARY sensor. In this case, analysis will insure that a request is made designating the new DABS sensor as CONTROLLED PRIMARY and all other sensors as CONTROLLED SECONDARY. In addition to CONTROLLED PRIMARY/SECONDARY updates, ACS status updates of UNCONTROLLED will also be analyzed for the following conditions:

a. The track is dropped due to a manual or automatic action.
b. The DABS ADDRESS is deleted.
c. The equipment qualifier is changed to indicate no DABS capability.

The final area for analysis will evaluate this task's ability to reestablish the primary DABS sensor for each track with a TCS of CONTROLLED when a dynamic RSB site reassignment occurs.

6.2.2.3 ACS Monitoring.

Analysis will evaluate the ability of this task to insure that:

a. The DABS sensors comply with ACS status assignment designations expected for a given DABS ADDRESS.

b. Only the designated DABS sensor is indicating PRIMARY status for a given DABS ADDRESS.

If compliance with these two conditions is not met, ACS messages must be transmitted to correct any conflicting PRIMARY/SECONDARY sensor assignments.

6.2.2.4 ACS Assimilation.

Analysis will examine this task's ability to concatenate ACS requests for different DABS ADDRESSES intended for the same DABS sensor into one ACS message. Analysis must also insure that any multiple ACS requests, for a given DABS ADDRESS, that constitute a conflict in ACS status are resolved.

6.2.3 Startover Test Analysis.

Analysis will be concerned with two major areas. The first area will be the ACS startover tasks including:

a. Reestablishment of the ACS status for each CONTROLLED DABS track in each DABS sensor.

b. Initialization of the FEP/Build II interface.

The second area of concern will be surveillance and track related recovery including:

a. Extrapolation of tracks along predicted routes and associated flightpaths for the amount of time the system was down.

b. Reestablishment of the track to the correct aircraft.

c. Continuity of tracks after startover.

d. Transmission of ATCRBS ID requests.

The same scenarios will be conducted with and without startovers for the purpose of comparing the quality of tracking after a startover. The analysis will determine if the processing from the point of startover is equivalent to that of a test conducted without a startover.

7. INSTRUMENTATION AND FACILITIES.

a. NAS En Route System Support Facility (ESSF). The function of the ESSF is described in Handbook NASP-5204-01 (Volumes I and II), "Hardware Environment and Support Services," June 1979.

b. Air Traffic Control Simulation Facility (ATCSF). The function of the ATCSF is described in the "Digital Simulation Facility User's Guide," June 1975.

c. Discrete Address Beacon System (DABS) Sensor. A description of the DABS sensors required hardware and software is defined in FAA Report FAA-RD-74-189.

d. Aircraft Reply and Interference Environment Simulator (ARIES). A description of the ARIES can be obtained in Report No. FAA-RD-78-96, Volumes 1 and 2, March 22, 1979.

8. AREA OF RESPONSIBILITIES.

The area of responsibilities for the en route DABS/ATC testing is shown in table 2.

TABLE 2. ORGANIZATIONAL RESPONSIBILITIES FOR EN ROUTE DABS AIR TRAFFIC CONTROL (ATC) TESTING

Organizational Responsibility	Products
ACT-100A.1	Test Plan Test Procedures Test Conduct Coordination Analysis Test Report Program Trouble Report (PTR) detection and recording
ACT-240	Data Preparation Scenario Building Data Reduction Programs Data Reduction Processing
ACT-240/ACT-762	System Processing
ACT-762	Data Reduction Processing
ARD-100	DABS/ATC En Route System Build II DABS/ATC En Route System Data Reduction Program System Build and Bring-up Activities Program Trouble Report (PTR) detection, recording, and correction Parameter Changing and Setting Answer questions regarding the design and operation of the programs Program Checkout and Execution

9. SCHEDULE.

TEST ACTIVITY	A	M	J	J	A	S	O	N	D	J	F	M	A
	1980									1981			
REGRESSION TESTING					▲								
Build I Performance Versus Build II Performance													
ACS MESSAGE TESTING													
DABS/ATC En Route/ATCSF							▲						
DABS/ATC En Route/ARIES/ DABS Sensors								▲					
DABS/ATC En Route/DABS Sensors								▲					
STARTOVER TESTING									▲				
DRAFT TEST REPORT											▲		
FINAL TEST REPORT												▲	