FAA TECHNICAL CENTER LETTER REPORT

PRELIMINARY ATAS PERFORMANCE TEST PLAN

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OBJECTIVE.

The objective of the Preliminary ATAS (P-ATAS) performance test is to verify that the delivered P-ATAS system software performs in accordance with the Software Design Document. Since the P-ATAS code is based on the already existing code for the Automatic Traffic Advisory and Resolution Service (ATARS), Revision 1, only those areas of P-ATAS which were not tested under the ATARS program will be included in this test plan.

The overall objective has been broken down into the following sub-objectives:

1. The P-ATAS system should process surveillance reports on all aircraft tracked by the collocated Mode S equipment and maintain tracks on all aircraft within the ATAS service volume.

2. The P-ATAS system should detect all ATAS equipped aircraft which violate restricted airspace or a Terminal Control Area (TCA).

3. The P-ATAS system should issue advisories to ATAS equipped aircraft which are involved in encounters with non-Mode C (altitude encoding) equipped aircraft.

4. The P-ATAS system should issue advisories to ATAS equipped aircraft which are involved in encounters with aircraft not equipped with transponders (primary radar targets).

SUMMARY OF OPERATIONAL PERFORMANCE ISSUES.

This section outlines the performance issues that will be addressed by this test program. The test matrix (figure 1) references these issues by number.

1. Tracking

a. Are tracks initialized within one scan of their acquisition by Mode S? Are the logic control flags and firmness values initialized to their proper values?

b. Are tracks deleted:

1. When the firmness level reaches zero?

2. When Mode S drops the track?

3. When the aircraft leaves the ATAS coverage area?

c. Do tracks which require coasting have their firmness levels decremented and their smoothed values updated?

d. Are smoothed and predicted values updated? In particular, does the level-occupancy vertical tracker accurately track aircraft making rapid vertical maneuvers?

TEST MATRIX

Operational Issue	Objective	Analysis	Acceptance Criteria
1a.	To ensure that tracks are started and maintained as specified in the SDD	Examine CTS records	Track should be started within one scan of its acquisition by Mode S
1b.	To ensure that tracks are dropped as specified in the SDD	Examine CTS records	a. Track should be deleted within one scan of leaving coverage area. b. Track should be deleted when firmness reaches zero.
1c.	To ensure that tracks are coasted as specified in the SDD	Examine CTS records	Firmness values should be decremented and smoothed values updated.
1d.	To ensure that the vertical tracker tracks as specified in the SDD	Compare P-ATAS and Nike-Hercules track data	Differences within Mode S error range will indicate satisfactory performance
2a.	To ensure that aircraft which violate a restricted airspace receive adviso-ries	Plot aircraft tracks, restricted airspace boundaries, and advisories	Advisory should be issued within one scan of an air-craft violating a restricted airspace and dropped within one scan of leaving
2b.	To ensure that aircraft which violate a TCA receive advisories	Plot aircraft tracks, TCA boundaries, and advisories	Advisory should be issued within one scan of an air-craft violating a TCA and dropped within one scan of leaving

FIGURE 1. TEST MATRIX

TEST MATRIX (Continued)

Operational Issue	Objective	Analysis	Acceptance Criteria
3a.	To ensure that tracks for non-Mode C aircraft are properly initialized	Examine CTS records	Non-Mode C flag set Altitude firmness set to zero
3b.	To ensure that proximity and priority advisories are issued for encounters involving non-Mode C aircraft	Plot encounters and advisories	Advisory should be issued to ATAS equipped aircraft
4a.	To ensure that tracks for primary radar targets are properly initialized	Examine CTS records	ATCRBS and Radar/Beacon flags should be cleared. Altitude firmness should be set to zero.
4b.	To ensure that proximity and priority advisories are issued for encounters involving primary radar targets	Plot encounters and advisories	Advisories should be issued to ATAS equipped aircraft

FIGURE 1. TEST MATRIX

Central Track Store - External

Variable	Word	Bits
External Predicted X (2^{-7} NM)	1	0-15
External Predicted Y (2^{-7} NM)	2	0-15
External Predicted Z (10 feet)	3	0-15
Ext. X Velocity Est. (2^{-15} NM/S)	4	0-15
Ext. Y Velocity Est. (2^{-15} NM/S)	5	0-15
Ext. Z Velocity Est. ($10x2^{-8}$ F/S)	6	0-15
Prediction Time (2^{-4} S)	7	0-15
Predicted Range (2^{-7} NM)	8	0-15
Predicted Azimuth (1 AU)	9	0-15

Central Track Store - Internal

Internal Predicted X (2^{-7} NM)	1	0-15
Internal Predicted Y (2^{-7} NM)	2	0-15
Int. X Velocity Est. (2^{-15} NM/S)	3	0-15
Int. Y Velocity Est. (2^{-15} NM/S)	4	0-15
Horizontal Maneuver Status	5	2-3
Internal Firmness	5	4-7
External Firmness	5	8-11
Altitude Firmness	5	12-15
Time of Last R,A Report (2^{-4} S)	6	0-15
Time of Last Altitude Report (2^{-4} S)	7	0-15

FIGURE 2. CENTRAL TRACK STORE

2. Restricted Airspace Avoidance

a. Are restricted airspace violation messages generated within one scan of an aircraft entering a restricted airspace? Is the message terminated within one scan of the aircraft leaving the restricted airspace?

b. Are Terminal Control Area (TCA) violation messages generated for uncontrolled aircraft entering a TCA? Are the messages terminated when the aircraft leaves the TCA?

3. Non-Mode C

a. Are the altitude firmness values for non-Mode C aircraft set to zero and is the non-Mode C flag set?

b. Are proximity and priority advisories generated for encounters involving non-Mode C aircraft?

4. Primary Radar

a. Are the firmness values for primary radar targets set to one and are the ATCRBS and Radar/Beacon flags cleared?

b. Are proximity and priority advisories generated for encounters involving primary radar targets?

PROGRAM OVERVIEW.

All performance testing of Preliminary ATAS will be carried out using simulated inputs. Scenarios are currently being developed for this purpose. The tracking function will be tested using scenarios in ARIES (Aircraft Reply and Interference Environment Simulator) format (reference 3), since this system includes a stochastic model of surveillance error. All other scenarios will be in ARCON Simulator format (reference 4).

Data Reduction will be performed using the ATARS (Revision 1) DR & A software (reference 5), which has been modified to process ATAS data extraction (DX) tapes. Further enhancements to this system and additional software to process Nike-Hercules data will be required.

DATA COLLECTION AND ANALYSIS.

This section describes the data collection and analysis procedures that will be used to test each of the performance issues. The data collection and analysis procedures are summarized in the test matrix in figure 1. The contents of the central track store that will be used in this study are given in figure 2.

a. Tracking

The tracking function is divided into four sub-functions. The first three

will use the same ARIES scenario, which is currently under development. It will consist of two aircraft, one of which will pass through the ATAS coverage area to test track initiation and track deletion. The other aircraft will terminate without having its drop bit set in the ARIES track record, thus forcing ATAS to coast the track until it is dropped by ATAS. Both aircraft will follow a straight and level flight path at 160 knots.

The data collection and analysis procedures will now be discussed individually.

1. Track Initialization

The CTS records from the DX tape will be examined to verify that the state vector has been initialized within one scan of acquisition by Mode S, that the ATCRBS and RADAR/Beacon flags have been set, the non-Mode C flag has been cleared, and that the firmness levels have all been initialized to 1.

2. Track Deletion

The CTS records from the data extraction tape will be examined to verify that the track has been deleted within one scan of leaving the ATAS coverage area and within one scan of the firmness reaching zero.

3. Track Coasting (Miss Processing)

The CTS records from the DX tape will be examined to verify that the firmness values have been decremented and that the predicted tracker values from the previous scan became the smoothed values for the current scan.

4. Smoothing and Prediction

On November 26, 1980, and December 8, 1980, two project flights were flown using Interim ATARS and the Nike-Hercules trackers. The data extraction tapes for these flights will be processed by the PLAYBACK program, which generates an ARIES scenario from the surveillance reports on a DX tape. This ARIES scenario will be used as input to the P-ATAS system and a new DX tape (from P-ATAS) produced.

An additional ARIES scenario will be developed in order to test the new level-occupancy vertical tracker. It will consist of an ATAS equipped aircraft flying a straight flight path at 160 knots. It will include a segment of level flight, a rapid climb (2000 feet per minute), level flight, a rapid descent (2000 feet per minute), and level flight. This test will determine the improvement, if any, over the alpha-beta tracker used in ATARS.

The central track store (CTS) records from the DX tape will be examined and the predicted values (shifted by one scan period, 4.78 seconds) will be compared to the interpolated Nike-Hercules track data. If the difference is greater than the surveillance data error given in the ATAS Algorithm document (reference 1), this scan will be flagged as unsatisfactory performance (see figure 3).

Source	Radial Error	Tangential Error
Mode S Beacon	150 feet	.002 x Range feet
ATCRBS Beacon	180 feet	.002 x Range feet
Radar	215 feet	.004 x Range feet

FIGURE 3. SURVEILLANCE DATA ERROR STANDARD DEVIATIONS

b. Restricted Airspace Avoidance

An ARCON simulator scenario is being developed which will contain two aircraft, one passing through the Philadelphia TCA and one passing through the Fort Dix Warning Area (which has been implemented as a restricted airspace in the P-ATAS software). Both aircraft will be flying straight flight paths at 160 knots. The intrusions will occur in both the horizontal and vertical planes.

A plot will be generated from the DX tape for each violation, showing the boundary of the TCA or restricted airspace, and any violation advisories generated. This will be used to verify that an advisory is generated within one scan of an aircraft entering a restricted airspace or TCA and dropped within one scan of its leaving such an area.

An example of the plots (without the restricted airspace or TCA boundaries) appears in figures 4a and 4b.

c. Non-Mode C

An ARCON simulator scenario is being developed which will consist of a straight and level encounter (at 160 knots) between an ATAS equipped aircraft and a non-Mode C aircraft. The closest point of approach (CPA) will be within the miss distance thresholds established for the issuance of priority advisories.

The CTS records will be examined to verify that the non-Mode C flag is initially set and the altitude firmness is initialized to zero. A plot will be generated from the DX tape showing the tracks of the two aircraft and any advisories generated. This will be used to verify that advisories are being generated for the non-Mode C aircraft.

d. Primary Radar

An ARCON simulator scenario is being developed which will consist of a straight and level encounter (at 160 knots) between an ATAS equipped aircraft and a primary radar target. The CPA will be within the miss distance thresholds established for the issuance of priority advisories.

The CTS records of the primary radar target will be examined to verify that the ATCRBS and Radar/Beacon flags have been initially cleared and the altitude firmness initialized to zero. A plot will be generated from the DX tape showing the tracks of the two aircraft and any advisories generated. This will be used to verify that advisories are being generated for the primary radar target.

REQUIRED SOFTWARE.

All required software will be designed to run on the Honeywell 66/60 General Purpose Computer at the FAA Technical Center.

Most of the data reduction will perform using the ATARS (Revision 1) data reduction software, which has been modified to accept input in the form of P-ATAS DX tapes. An enhancement to this system will be required to plot the track of an aircraft violating a restricted airspace or TCA (and any advisory messages issued) along with the boundaries of the restricted airspace or TCA.

An additional program will be required which will merge tracker data from the P-ATAS DX tape and Nike-Hercules tracker data. For each scan it will be required to display:

a. Internal and external smoothed data (from P-ATAS),

b. Internal and external predicted data from the previous scan (from P-ATAS),

c. X, Y, and Z tracker data interpolated to the P-ATAS measurement time (from Nike-Hercules).

PROGRAM COORDINATION.

The management of the Preliminary ATAS Test Program is the responsibility of ACT-100A.2 of the Systems Test and Evaluation Division. Several organizations at the FAA Technical Center are required to provide support. Oeganizational responsibilities are:

ACT-100A.2, J. Resnick - Responsible for this test activity. Coordinates with ACT-100A.3 for Mode S sensor support. Interfaces with ARD-241, Input Output Computer Services (IOCS), and the ARCON Corporation.

IOCS, Inc., G. Zerdian - Provides modifications and enhancements to already existing DR & A software. Generates required scenarios. Processes data extraction tapes.

ACT-750, Range, Programming and Analysis Branch, E. Gibson - Processes Nike-Hercules data tapes.

REFERENCES.

1. Lentz, R.H., et al., Automatic Traffic Advisory Service (ATAS) Algorithms, Draft, MITRE Corporation, March, 1982.

2. Goon, M., et al., The Aircraft Reply and Interference Environment Simulator (ARIES), MIT Lincoln Laboratory, Contract DOT FA77WAI-261, FAA-RD-78-96 (ATC-87), 3 volumes, March 1979.

3. ARCON Corporation, ATARS Capacity Simulator Tape Generation Program (TAPGEN) Users Manual, Report TN-80-1, Contract DOT-FA79NA-6054, April, 1980.

4. IOCS, Inc., IOCS Multisite System (IMS) (ATARS DR & A Software) Documentation (Phase A, Release 9), 3 volumes, Contract DOT-FA79NA-6054, January, 1982.