COPY 3
TN
85
35

technical note technical note

Loran C Pilot Monitor Flight Support Project Plan

Project Plan

Robert D. Till
Robert Erikson

FEDERAL AVIATION ADMINISTRATION
SEP 17 1985
TECHNICAL CENTER LIBRARY
ATLANTIC CITY, N.J. 08405

August 1985

DOT/FAA/CT-TN85/35

Document is on file at the Technical Center Library, Atlantic City Airport, N.J. 08405

U.S. Department of Transportation
Federal Aviation Administration

Technical Center
Atlantic City Airport, N.J. 08405

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/35		

4. Title and Subtitle	5. Report Date
LORAN C PILOT MONITOR FLIGHT SUPPORT PROJECT PLAN	August 1985
	6. Performing Organization Code ACT-140
7. Author(s) Robert Till and Robert Erikson	8. Performing Organization Report No. DOT/FAA/CT-TN85/35
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. T0702I
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Technical Note June 1985
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The National Association of State Aviation Officials is interested in forming a cooperative effort with the Federal Aviation Administration to resolve outstanding issues and implement nonprecision approaches at selected sites in several states. This project plan describes Loran C nonprecision approach flight tests using existing Instrument Landing System (ILS) approach plates and procedures. The flight tests will be conducted at a minimum of one airport (Bedford, Massachusetts) and may be extended to other states. The flight tests, if successful, will permit a letter of authorization to be generated to request the use of Loran C nonprecision approaches based on existing approach procedures.

17. Key Words	18. Distribution Statement
Loran C Monitor Approach Procedures	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	10	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	vii
INTRODUCTION	1
Objective	1
Background	1
Related Documentation	
EQUIPMENT AND DATA COLLECTION	1
Technical Center Aircraft Systems	1
Cockpit Display and Controls	2
Technical Center Airborne Data Acquisition System	2
Position Reference System	2
Spectrum Analyzer	2
TEST PROCEDURES	2
DATA ANALYSIS	7
COORDINATION - AREAS OF RESPONSIBILITY	7
SCHEDULE	9

LIST OF ILLUSTRATIONS

Figure		Page
1	Data Collection System	3
2	ILS Approach RWY 13 (ACY)	5
3	ILS Approach RWY 11 (BED)	6
4	Antenna Pattern Cloverleaf	8

EXECUTIVE SUMMARY

The National Association of State Aviation Officials is interested in forming a cooperative effort with the Federal Aviation Administration to resolve outstanding issues and implement nonprecision approaches at selected sites in several states. This project plan describes Loran C nonprecision approach flight tests using existing Instrument Landing System (ILS) approach plates and procedures. The flight tests will be conducted at a minimum of one airport (Bedford, Massachusettes) and may be extended to other states. The flight tests, if successful, will permit a letter of authorization to be generated to request the use of Loran nonprecision approaches based on existing approach procedures.

INTRODUCTION

OBJECTIVE.

The objective of this project is to provide technical support for the Loran C Pilot Monitor Project. The flight tests, if successful, will permit a letter of authorization to be generated to permit the use of Loran C nonprecision approaches based on existing approach procedures.

BACKGROUND.

The Federal Aviation Administrator has included Loran C in the National Airspace System Plan. The National Association of State Aviation Officials (NASAO) is very enthusiastic about Loran C. NASAO is interested in forming a cooperative effort with the Federal Aviation Administration (FAA) to resolve outstanding issues and implement nonprecision approaches. NASAO has requested that approval be granted on a limited basis for Loran C nonprecision approaches at selected sites in Vermont and/or Massachussets, Oregon, Ohio, and Texas.

The FAA is installing Loran C monitors in a pilot project at eight airports at selected sites in the United States to support NASAO. The purposes of the Pilot Monitor Project are: to give affected FAA organizations the opportunity to work with Loran C on a limited basis before national implementation and to show an early response to the aviation communities request that the FAA should respond to the increasing use of Loran C. The monitors will continuously monitor Loran C signals and provide advisories on signal status to assure safe nonprecision approach operations. The monitor receives Loran signals from a single chain of stations and compares measured time differences with expected differences for the geographic position of the monitor. In the event observed time differences or signal-to-noise ratio (SNR) exceed specified limits, or other monitored parameters such as blink or loss of signal occurs, an alarm signal shall be sent to the Air Traffic Control Point (ATCP) and to the Remote Monitoring Subsystem (RMS) to advise Loran C users in the vicinity. The monitors will furnish time difference (TD) correction values for nonprecision approaches. The TD correction values are necessary to resolve seasonal TD variations and reduce airborne receiver coordinate conversion biases. Additional monitors, as specified in the National Airspace System (NAS) Plan, will be installed in the future.

RELATED DOCUMENTATION.

1. Erikson, Robert and Till, Robert D., "Loran C Flight Inspection Project Plan," FAA Technical Center, DOT/FAA/CT-TN85/31.

2. "Minimum Operational Performance Standards for Airborne Area Navigation Equipment Using Loran C Inputs", Seventh Draft, Radio Technical Commission for Aeronautics, Paper 53-85/SC137-182, February 1, 1985.

EQUIPMENT AND DATA COLLECTION

TECHNICAL CENTER AIRCRAFT SYSTEMS.

The Technical Center CV-580 aircraft is equipped with five airborne Loran C receivers: Teledyne TDL-711, Micrologic ML-4000, Texas Instruments TI-9000, and two Advanced Navigation ANI-7000 units. All units are production models. The ANI-7000 receiver will be primarily used for the flight tests. Other receivers may be replaced or deleted as the need arises.

COCKPIT DISPLAY AND CONTROLS.

The Loran C receiver control heads are mounted in the rear cabin of the Technical Center CV-580. Crosstrack deviation and a navigation valid flag will be provided the pilot on a course deviation indicator (CDI).

TECHNICAL CENTER AIRBORNE DATA ACQUISITION SYSTEM

A Norden militarized PDP 11/34M computer will be used to collect the data. The data will be recorded on a Miltope 9-track tape recorder. A Technical Center designed aircraft systems coupler (ASC) is used to interface the Loran receivers, aircraft state sensors, and position reference system to the Norden computer. Figure 1 is a block diagram of the system. Data recorded on the 9-track tape recorder are presented in table 1.

POSITION REFERENCE SYSTEM

The Technical Center will provide a Global Positioning System (GPS) receiver, the Magnavox Z-set, as a position reference system for the Technical Center CV-580 aircraft.

SPECTRUM ANALYZER.

AVN will provide a Hewlett Packard (HP) 8566 spectrum analyzer for installation in the Technical Center CV-580 aircraft. Currently, a Tektronix 7L5 spectrum analyzer is installed in the Technical Center CV-580 aircraft and will be provided if AVN cannot furnish an HP 8566 spectrum analyzer.

TEST PROCEDURES

Loran C nonprecision approach flight tests using existing Instrument Landing System (ILS) approach plates and procedures will be conducted at the FAA Technical Center, Atlantic City (ACY), and Bedford, Massachusetts. The approach plates are presented in figures 2 and 3. The ANI-7000 receiver will be used for guidance and basic data collection. The pilot in command will execute a Loran C nonprecision approach using guidance from the ANI-7000 receiver. The copilot will monitor the Loran C approach through comparison with ILS localizer presentation on his CDI. A minimum of five approaches will be conducted at each airport using a straight in localizer only approach for category D type aircraft. The Transporation Systems Center (TSC) will provide a pilot evaluation questionnaire that will be completed at the conclusion of the five approaches.

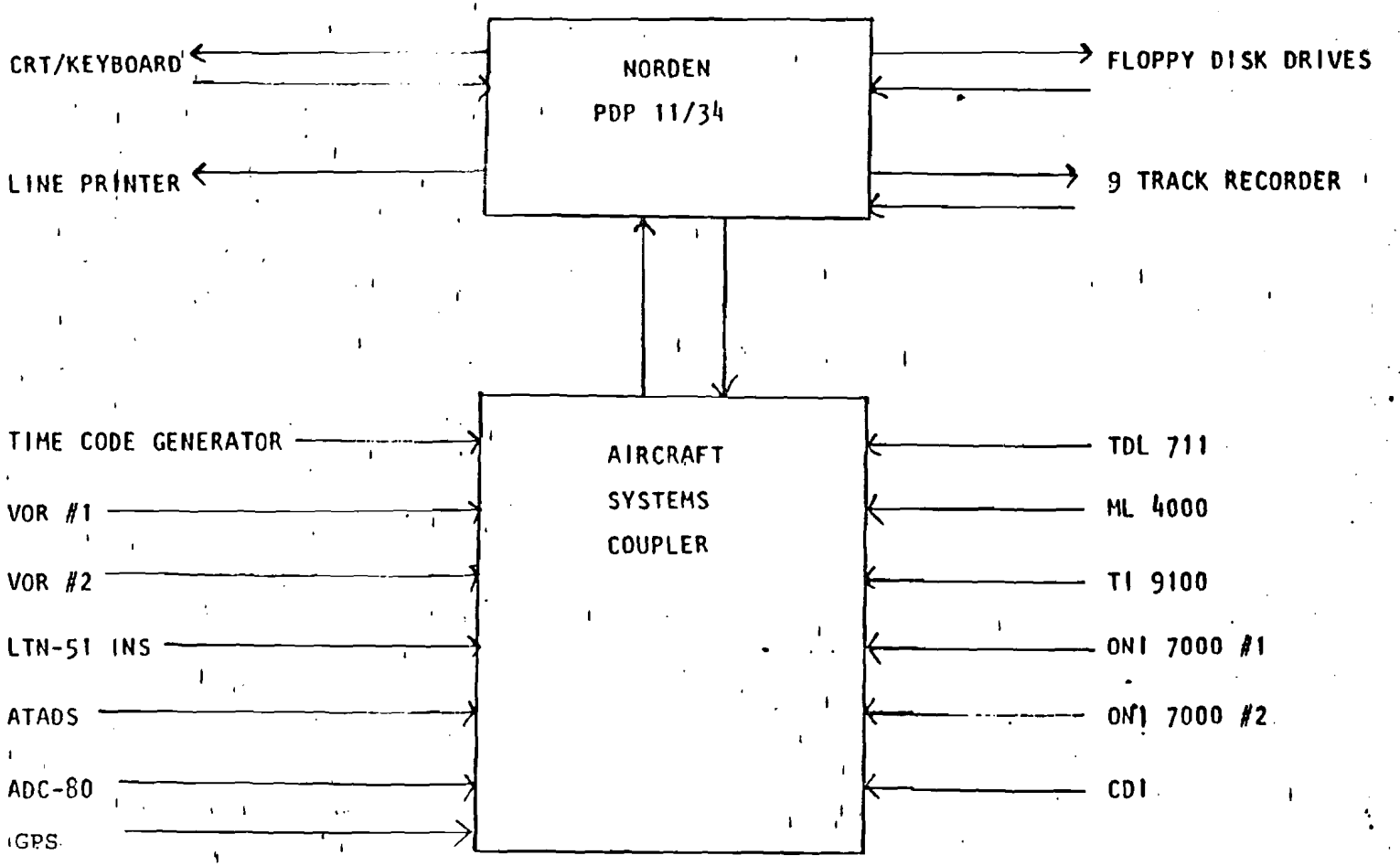


FIGURE 1. DATA COLLECTION SYSTEM

TABLE 1. RECORDED DATA

Aircraft Sensors and Time

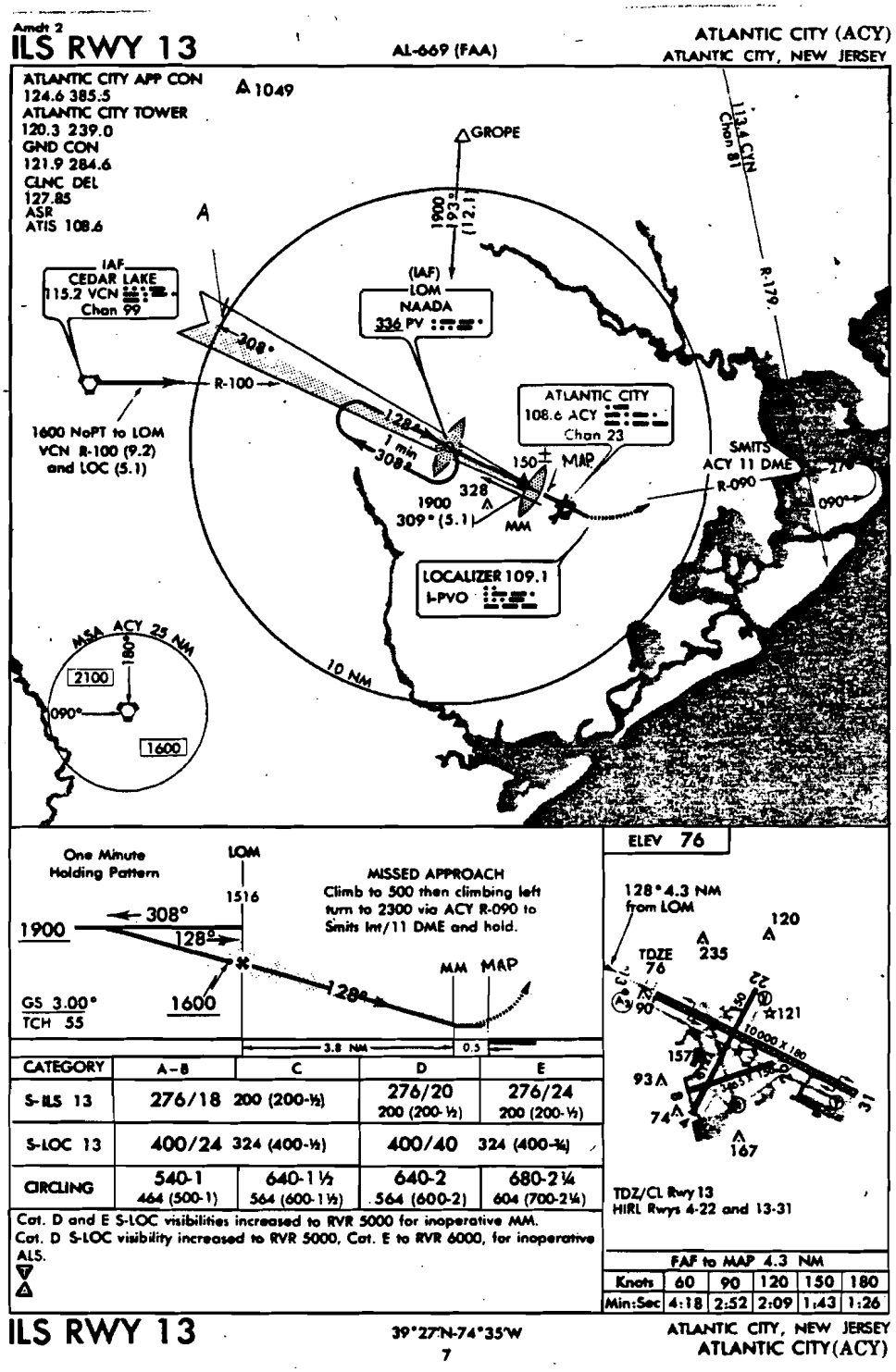
Time:	Hours, minutes, seconds
LTN-51 INS:	Present position, heading, track angle, ground speed
ADC-80:	True airspeed, altitude
ATADS:	Multi-DME ranges with time tags
VOR No. 1:	Bearing
VOR No. 2:	Bearing
CDI:	Analog CDI
INS:	Inertial navigation system
GPS:	Earth centered position, velocities, and time

Loran C Receivers Recorded

	TDL-711	ML-4000	ANI-7000	TI-9100
Present Position Lat/Long	x	x	x	x
Station Status	-	M + 5	8	-
Station SNR's	M + 3	M + 5	8	-
Time Differences	2	2	8 TOA	-
ECD's	M + 3	-	8	-
To Waypoint Lat/Long	x	x	x	x
From Waypoint Lat/Long	x	x	-	x
Crosstrack Error	x	x	x	x
Ground Speed	-	x	x	x
Distance to Go	x	x	x	x
Front Panel Switch Setting	-	x	x	-
En Route/Approach	-	-	x	-
Annunciator Lamps	-	-	x	-
Receiver Status	x	-	x	x
Grid Reference	-	-	x	-
Bearing to Waypoint	-	-	x	x
Desired Track	-	-	x	x
Estimated Time En Route	-	-	x	x
Notch Filter Setting	-	-	x	-
Secondary Phase Delay	-	-	x	-
Triad in Use	-	-	x	-
Station Field Strength	-	-	x	-

Note:

x = Data present in digital output
M = Master
TOA = Time of arrival



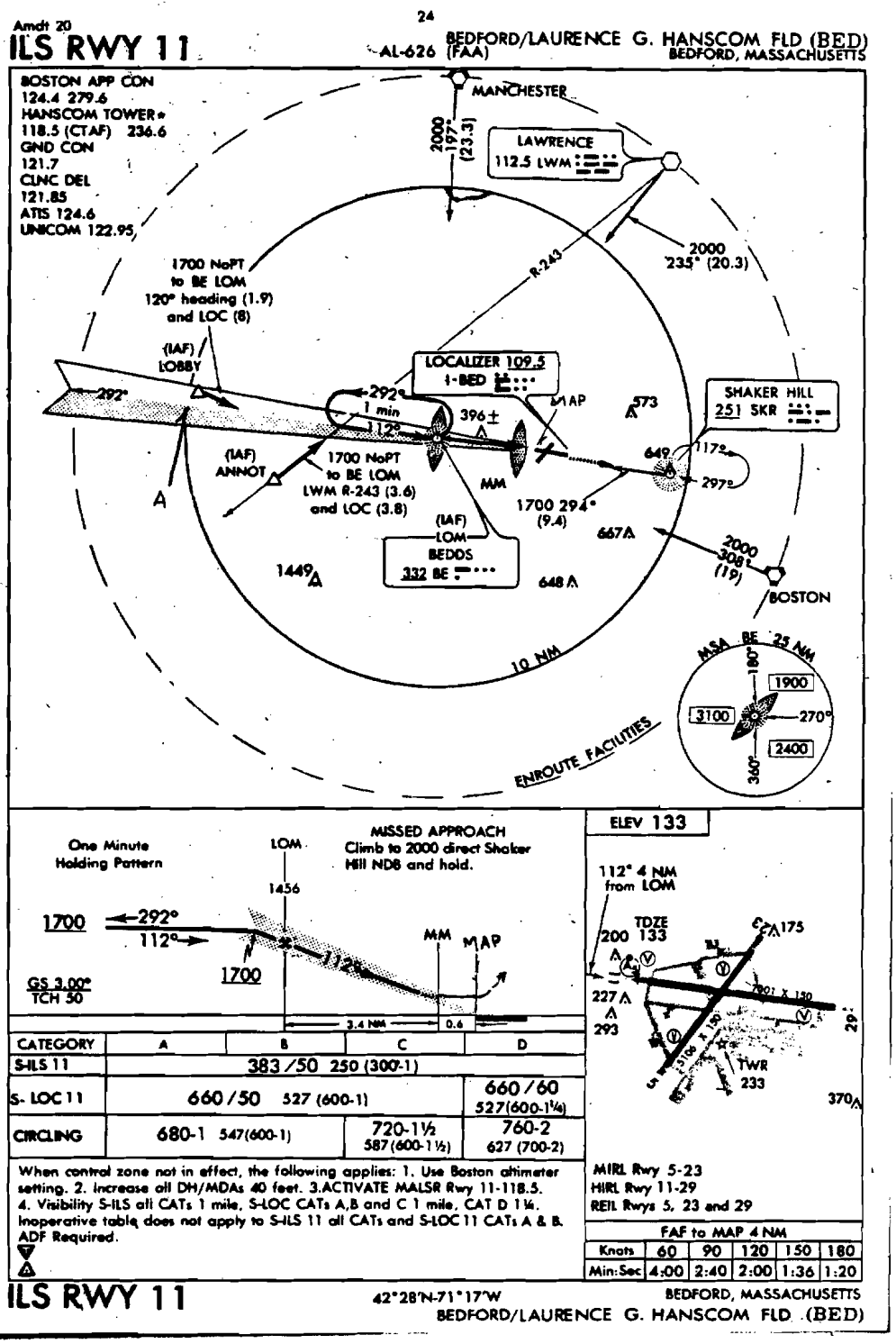
CATEGORY	A-B	C	D	E
S-ILS 13	276/18 200 (200-½)		276/20 200 (200-½)	276/24 200 (200-½)
S-LOC 13	400/24 324 (400-½)		400/40 324 (400-¾)	
CIRCLING	540-1 464 (500-1)	640-1½ 564 (600-1½)	640-2 564 (600-2)	680-2¼ 604 (700-2¼)

Cat. D and E S-LOC visibilities increased to RVR 5000 for inoperative MM.
Cat. D S-LOC visibility increased to RVR 5000, Cat. E to RVR 6000, for inoperative ALS.

FAF to MAP 4.3 NM					
Knots	60	90	120	150	180
Min:Sec	4:18	2:52	2:09	1:43	1:26

Waypoint	Latitude	Longitude
A (INWP)	N 39°34'34"	W 74°51'51"
LOM (FAWP)	N 39°29'52"	W 74°40'24"
MAP (MAWP)	N 39°27'51"	W 74°35'29"

FIGURE 2. ILS APPROACH RWY 13 (ACY)



Waypoint	Latitude	Longitude
A (INWP)	N 42°30'00"	W 71°36'50"
LOM (FAWP)	N 42°28'47"	W 71°23'21"
MAP (MAWP)	N 42°28'18"	W 71°18'3"

FIGURE 3. ILS APPROACH RWY (BED)

At Atlantic City, TD correction values will be obtained using the measured TD and a reference position obtained from the GPS receiver. The tests at Atlantic City will be conducted to check out the data collection system and procedures. The triad selected from group repetition interval (GRI) 9960 chain will be the master (Seneca), and secondaries X (Nantucket) and Y (Carolina Beach).

The antenna pattern reception of the Advanced Navigation Incorporated (ANI) receivers will be examined by flying a cloverleaf pattern over a fixed location at the Technical Center (reference figure 4).

At Bedford, Massachusetts, the triad selected from GRI 9960 will be the master (Seneca), and secondaries W (Caribou) and X (Nantucket). TD correction values will be obtained using the location of the monitor station, north latitude (42°27'54.8"), west longitude (71°17'21.8"), and the TD values measured by the monitor.

While in the Bedford area the U.S. Coast Guard control segment at Nantucket will be contacted to obtain a power level reading to enable calibrating the field strength signal obtained from the ANI receivers.

The approaches may be conducted at other airports in the future.

DATA ANALYSIS

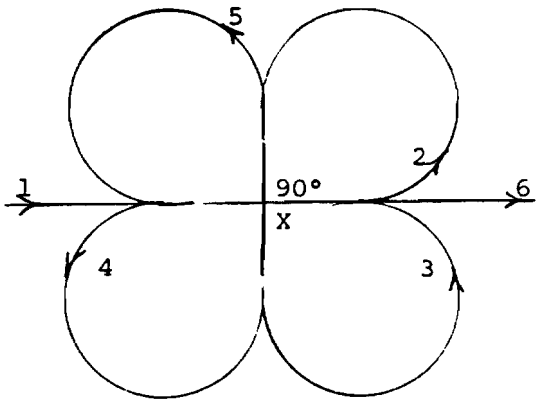
Mean and two sigma errors will be determined post flight for northing and easting errors, along track, crosstrack, flight technical error, and total system crosstrack for each approach. Composite statistics will be determined for multiple approaches. Mean values for signal-to-noise ratio (SNR) and the envelope-to-cycle discrepancy (ECD) will be determined for each approach; composite mean values will be determined for multiple approaches. The data will be presented in an ACT-100 Engineering Division report.

COORDINATION AND AREAS OF RESPONSIBILITY

ACT-140 will provide Technical Center project management and coordination with flight inspection (AVN), Transportation Systems Center (TSC), and the sponsor (APM). ACT will be responsible for conducting the data flights, collecting, reducing, and analyzing the flight test data for the Engineering Division report.

ACT-600 will be responsible for providing project aircraft, pilots, maintenance, and for approving the flight test schedule.

APM-420 will be responsible for subprogram management and allocation of program funding. TSC will be responsible for operation of the Loran C monitors and providing time difference data and a pilot questionnaire.



NOTES: Altitude > 3000 feet

X - Monument on Ground

FIGURE 4. ANTENNA PATTERN CLOVERLEAF

SCHEDULE

Flight Test	6/85 - 7/85
Data Report	10/85