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Office of Flight
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Washington, D.C. 20591

Air Traffic Control Radar Beacon System Transponder Performance Study and Analysis

Vol. II: Appendixes

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FAA's Air Traffic Control
Radar Beacon System (ATCRBS)
Analysis Team

September 1986

Final Report

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Technical Report Documentation Page

1. Report No. DOT/FAA/FS-86/1,II	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle AIR TRAFFIC CONTROL RADAR BEACON SYSTEM TRANSPONDER PERFORMANCE STUDY AND ANALYSIS VOLUME II: APPENDIXES		5. Report Date September, 1986
		6. Performing Organization Code AFS-300
7. Author(s) ATCRBS ANALYSIS TEAM		8. Performing Organization Report No.
9. Performing Organization Name and Address Federal Aviation Administration Maintenance Division 800 Independance Avenue, S.W. Washington, D.C. 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Office of Flight Standards 800 Independance Avenue, S.W. Washington, D.C. 20591		13. Type of Report and Period Covered FINAL REPORT
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This document contains Appendixes, refered to in Volume I, which detail test procedures, collected data, and other related background material.

17. Key Words ATCRBS Transponder	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	399	

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

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APPENDIX 1

FLIGHT TEST VALIDATION PLAN

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS)

ANALYSIS AND TEST PROGRAM

PHASE I

FLIGHT TEST VALIDATION PLAN

FOR

ATLANTA TRACON

ATLANTA ARTCC

JACKSONVILLE ARTCC

(MACON AND COLUMBUS TRACON'S)

November 26-30, 1984

Prepared by: AWS-300
Date: November 9, 1984

FOREWORD

This plan prescribes the methodology for the conduct of a flight test validation plan to be carried out November 26-30, 1984, to collect data essential to the analysis and evaluation of existing Air Traffic Control Radar Beacon Systems (ATCRBS's), inclusive of operational ground and airborne system components.

Aircraft resources of the Federal Aviation Administration (FAA), the United States Air Force (USAF), the U.S. Air Force Reserve (AFRES), and the Georgia Air National Guard (GA ANG) will be utilized to conduct this test. Other tasks and responsibilities are prescribed for various FAA activities. The responsiveness and preparedness of these activities to support this plan are critical to the conduct of economical flight operations, and the collection of test data representative of the ATCRBS performance in total.

Raymond E. Ramakis

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Office of Airworthiness
Associate Administrator for Aviation Standards
Federal Aviation Administration

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CHAPTER 1

GENERAL

1. BACKGROUND.

a. During the FAA Regional Director's Meeting held in Washington, D.C., on September 21, 1984, the Southern Region presented discussions which suggested airborne transponders of both the general aviation and military community are not operating to standards, and may be an important factor limiting the overall performance of the FAA RADAR/NAS/ARTS systems.

b. The Administrator directed the Associate Administrator for Aviation Standards to conduct an investigation of the alleged conditions.

c. On October 2, 1984, the HQ FAA ATCRBS Analysis Team, with representation from AWS, AVN, AFO, AAT, and APM was formed and met to develop a plan of action and to identify the "terms of reference". The Manager of the Aircraft Maintenance Division, AWS-300, was designated the HQ FAA ATCRBS Analysis Team Chief.

d. Terms of Reference and a proposed methodology for the analysis were developed. In that the proposed plan entailed the participation of USAF aircraft, the team met with appropriate HQ USAF authorities to discuss the situation and requirements for participation by flying units of the USAF, the AFRES, and the Georgia ANG. The Director of Operations, HQ USAF/XOO, approved of the proposal and "working-level points-of-contact" were established. It was agreed the HQ USAF Representative located at the FAA Southern Region would participate as the HQ USAF/XOO official observer, provide liaison for the team requirements, and provide HQ USAF/XOORF appropriate appraisal of events.

e. The proposed plan of action, terms of reference, and methodology presented to the Administrator received his approval; and, the HQ FAA

ATCRBS Team received instructions regarding periodic status reporting to the Administrator.

2. SCOPE. This flight test validation plan is designed to analyze the ATCRBS within the terminal and enroute environments in FAA Southern Region. The analysis will encompass investigation of ground beacon systems, the performance of airborne transponders within the known ground beacon system environment, and evaluation of the maintenance and calibration practices employed for transponder systems installed in military aircraft and general aviation aircraft. The aircraft transponder performance and the ground beacon facilities will be evaluated for comparision of performance in areas of overlying coverage between independent ground facilities throughout the flight test profiles.

3. METHODOLOGY. October 15-26, 1984, the HQ FAA ATCRBS Analysis Team, utilizing the FAA Southern Region headquarters as their operating location, met with the Director and his staff. Working sessions were conducted with personnel from the Air Traffic and Airway Facilities Division to discuss the Southern Region's perception of the stated problem, and to collect information necessary to the conduct of the test program. The Atlanta TRACON and the Dobbins ASR-8 site were visited. Additionally, a visit was made to the Tampa TRACON to view and discuss the ARTS-3A configuration which provides primary radar tracking in their terminal system. Visits were also made to the Jacksonville and Atlanta ARTCC's. The methodology for the conduct of this flight test plan represents the collective inputs from various sources within the Southern Region and was accepted by the Southern Region as completely adequate to incorporate the parameters of concern to their headquarters and facility managers.

a. One TERMINAL and one ENROUTE test profile will be flown. In each case, an FAA flight inspection aircraft will fly each route in its entirety with the transponder operating in the NORMAL/NORMAL, NORMAL/ LOW, and finally the LOW/LOW position to establish the baseline for the evaluation and analysis of subsequent beacon system performance, utilizing other aircraft.

b. For all flights, including the FAA flight inspection aircraft, data collection for each entire route of flight will be accomplished by three methods:

(1) Raw data collection utilizing computer programming;

(2) Video recording on a scope in each air traffic control facility along the route of flight and/or where radar overlap permits other facilities to observe the beacon target; and

(3) Visual observer in each facility to grade the beacon target real time, utilizing grading criteria defined for the purpose of this program.

c. Prior to each aircraft being flown in this test, including the FAA flight inspection aircraft, the transponder and antenna system shall be inspected to ensure compliance with FAR Part 43, Appendix F, and additional parameters. Conditions and parameters found will be recorded in each case.

d. In the event abnormalities in the beacon target are observed during the test flight and members of the team suspect the cause may be attributed to a malfunction of the airborne transponder/antenna system, the aircraft system shall be inspected in more detail immediately after landing.

4. FLIGHT TEST PROFILES.

a. The TERMINAL PROFILE is designed to evaluate the operational performance of the ATCRBS in the Atlanta terminal environment and, for comparison, provide overlap with the terminal beacon systems located at Columbus, Georgia; Macon, Georgia; and the Air Force ASR-8 at Dobbins Air Force Base which is located on the northwest side of the city of Atlanta. Aircraft to be flown on this profile are the F-4, C-130, C-90 King Air, and the BE-E55 Beechcraft. The altitude of 5,000 MSL was selected in coordination with the Southern Region Air Traffic and Airway Facilities Division to ensure the aircraft will be at the minimum altitude where all radar sites would see the aircraft and also, the altitude selected will be representative of where "problem transponder traffic" operate.

b. The ENROUTE PROFILE evaluates the enroute systems and overlap of various long-range radar sites utilized by Jacksonville and Atlanta ARTCC's. The route extends from the Charleston, South Carolina, VORTAC to a point northwest of the Atlanta long-range radar site. The route will be flown by an Air Force KC-135 aircraft, utilizing FL 350.

CHAPTER 2

RESPONSIBILITIES

1. RADAR DATA ANALYSIS BRANCH, APM-162.

a. In coordination with the HQ FAA ATCRBS Analysis Team, determine requirements for the collection of raw data and develop computer programs for the various beacon systems in the terminal and enroute facility configurations.

b. Ensure programs for the collection of raw data are complete, and each facility and/or location where raw data collection is to be accomplished are programmed and tested not later than 11:00 p.m., November 26, 1984.

c. Provide technical guidance and assistance to facility personnel, as required.

d. Provide data reduction and analysis of computer data in a format to be prescribed by the ATCRBS Team Chief.

2. AVIATION STANDARDS NATIONAL FIELD OFFICE. The Manager, Flight Programs Division, AVN-200, shall provide flight inspection aircraft and avionics support through the Atlanta Flight Inspection Field Office (ATL FIFO).

a. Manager, ATL FIFO shall:

(1) Provide Sabre 80 flight inspection aircraft to conduct flight test of the TERMINAL and ENROUTE profiles as specified by Chapters 7 and 8 of this plan.

(2) Provide a qualified and properly equipped Avionics Team and van to conduct transponder system inspections on all aircraft to be flown in this test plan. The transponder system inspection shall be accomplished and recorded in accordance with the provisions of Chapter 6 of this plan.

(3) Provide the BE-E55 and crew to fly the TERMINAL Profile in accordance with the specifications of Chapter 7 of this plan.

3. RADAR BRANCH/RADAR DATA ANALYSIS BRANCH, APM-320/162.

a. Shall locate video recording equipment and ensure installation and testing at each facility is completed prior to 11:00 p.m., November 26, 1984.

b. Upon completion of flight testing, collect film/cassettes for processing. One copy of the Video products shall be provided to the Team Chief; a second copy of the Video shall be provided to APM-162 for correlation with the analysis of raw data.

4. SOUTHERN REGION.

a. Director, ASO-1, shall provide the Region C-90 aircraft and a qualified crew to participate in the TERMINAL profile test, as specified in Chapter 7 of this plan.

b. Manager, Air Traffic Division, ASO-500, shall ensure facility managers involved are familiar with the content of this plan and are prepared to provide appropriate air traffic control services for the participating aircraft.

c. Manager, Airway Facilities Division, ASO-400, shall ensure field personnel are familiar with the content of this plan and provide assistance to APM-320 and APM-162, as required, in preparing for the raw data collection and video recording of the radar scope display in each appropriate facility.

5. MANAGERS, AIR TRAFFIC CONTROL FACILITIES (ENROUTE AND TERMINAL).

a. Ensure appropriate personnel are familiar with the provisions of this plan, and with regard to the flight profiles ensure that:

(1) ATC clearances provided for the altitude and routes of flight prescribed.

(2) Discrete codes are assigned.

b. Provide documentation of existing weather and temperature at altitudes along routes of flight for each flight test profile.

c. Designate air traffic controllers to visually evaluate the beacon target and record target quality on each sweep in accordance with the provisions of Chapter 5.

6. 19th AIR REFUELING WING, ROBINS AFB, GEORGIA.

a. Provide a primary and backup KC-135 aircraft to fly the ENROUTE Profile in accordance with the specifications contained in Chapter 8 of this plan.

b. Provide for the flight line access of the FAA Avionics Team and test van.

c. Provide appropriate assistance and support to the FAA Avionics Team during the inspection of the KC-135 transponder and antenna system.

7. 94th TACTICAL AIRLIFT WING (AFRES), DOBBINS AFB, GEORGIA.

a. Provide a primary and backup C-130 aircraft to fly the TERMINAL Profile in accordance with the specifications contained in Chapter 7 of this plan.

b. Provide for the flight line access of the FAA Avionics Team and test van for both the C-130 and the F-4 transponder inspection activities.

c. Provide appropriate assistance and support to the FAA Avionics Team during the inspection of the C-130 transponder and antenna system.

8. 116th TRACTICAL FIGHTER WING (GA ANG) DOBBINS AFB, GEORGIA.

a. Provide a primary and backup F-4 aircraft to fly the TERMINAL Profile in accordance with the specifications contained in Chapter 7 of this plan.

b. Provide appropriate assistance and support to the FAA Avionics Team during the inspection of the F-4 transponder and antenna system.

CHAPTER 3

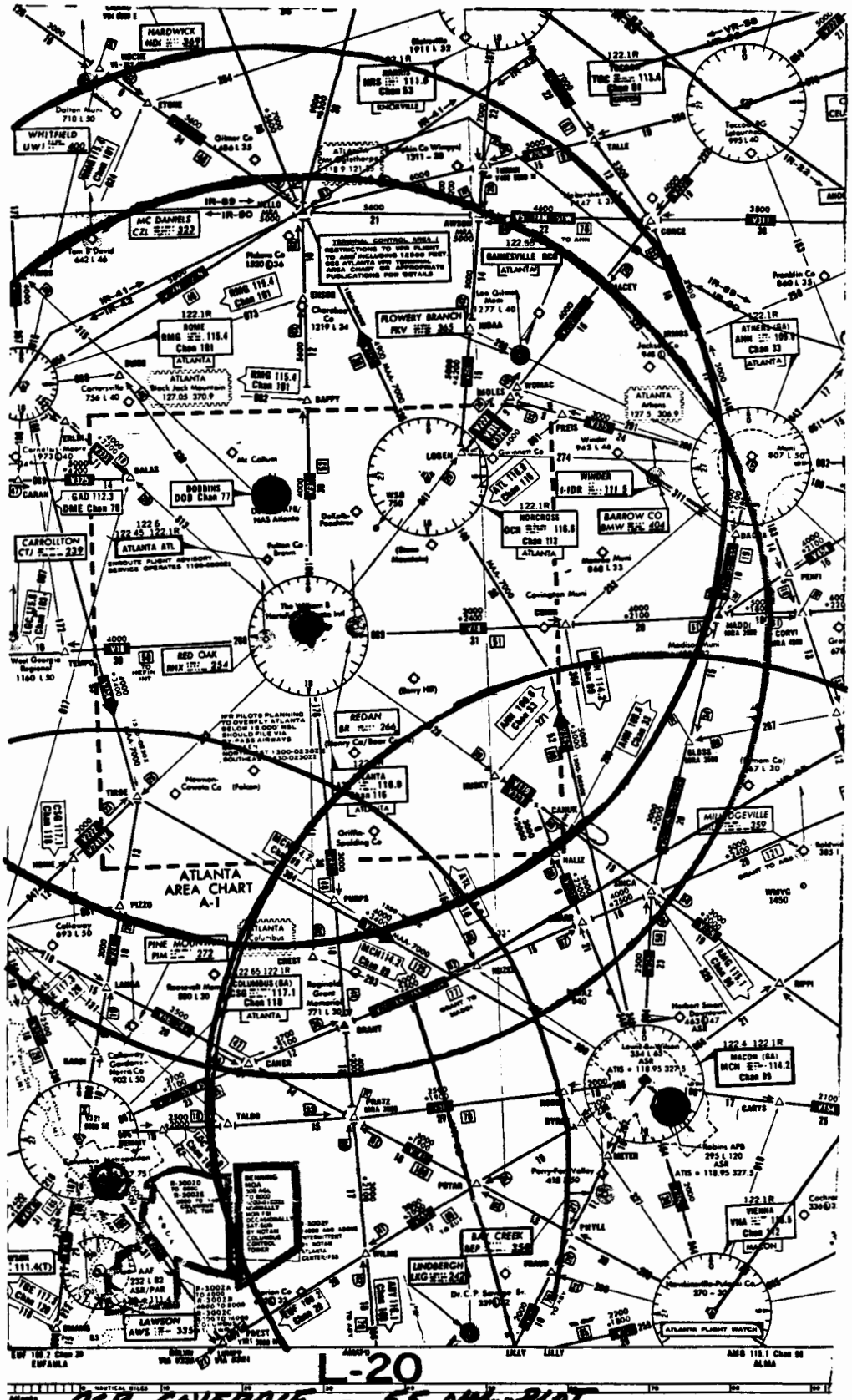
TERMINAL RADAR CONFIGURATION/DATA

1. GENERAL. The Atlanta TRACON is served primarily by the ASR-7 located on the airport. The backup surveillance radar system is an ARS-8M, located on Dobbins Air Force Base, 17 nautical miles north, northwest of the Atlanta airport. The Dobbins system is remoted to the Atlanta TRACON by RML. To the southeast of the Atlanta airport, the Macon ASR-5, located on Robins Air Force Base, provides an overlap of the Atlanta and Dobbins coverage. To the southwest of the Atlanta airport the Columbus ASR-8 also provides an overlap with the Atlanta and Dobbins radars, as well as the Macon ASR-5 located 69 nautical miles east of Columbus, Georgia. (A map depicting these sites and the radar/beacon coverage overlaps is provided as Appendix 1 to this Chapter.)

2. TERMINAL RADAR DATA.

NAME	ATLANTA	COLUMBUS	MACON	DOBBINS
INDENT	ATL	CSG	MCN	MGE
LAT/ LONG	33 37 44 84 25 48	32 31 15 84 56 39	32 38 45 83 36 18	33 55 14 84 31 15
ELEV(MSL)	1030'	441'	312'	1032'
ANT HGT (AGL)	17'	67'	37'	77'
PRIMARY TYPE	ASR-7	ASR-8	ASR-5	ASR-8M
PRIMARY ANT	ASR-7	ASR-8	ASR-7	ASR-8
BEACON TYPE	ATCBI-4	ATCBI-5	ATCBI-4	TPX-42A
BEACON ANT	OPA*	OPA*	OPA*	OPA*
DISPLAY PROCESSOR	ARTS-III	TPX-42	ARTS-II	ARTS-III

OPA = FA 9764
* Open Planar Array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AREA CHART
A-1
HARDWICK
WHITFIELD
MC DANNELS
ROME
FLOWERY BRANCH
GAINESVILLE
DOBBINS
CARROLLTON
RED OAK
REDAN
WINDER
NORCROSS
BARROW CO
MILLEDGEVILLE
PINE MOUNTAIN
COLUMBUS
MACON
BAR CREEK
LINDBERGH
LAWSON
VIENNA
ATLANTA FLIGHT WATCH
L-20
ASR COVERAGE - 55 NM PILOT

CHAPTER 4

ENROUTE RADAR CONFIGURATION/DATA

1. GENERAL. The flight test of the high altitude enroute system under this plan will involve the Jacksonville and Atlanta ARTCC's. Each ARTCC, in most instances, utilize common long range radar sites in their computer programs. The differences are the choices of sites each ARTCC has prioritized for the Radar Sort Block Program. The ten long range sites identified in this test plan do provide multiple overlapping coverage throughout the flight profile to be flown. (A map depicting site locations, and overlapping radar/beacon coverage is presented as Appendix 1 to this Chapter.)

2. ARSR SITES.

NAME	IDENT	LOCATION (RHO/THETA)
BENSON	QRL	RDU 158/25
JEDBURG	ORJ	CHS 330/15
WHITEHOUSE	NEN	JAX 277/19
VALDOSTA	VAD	TAY 310/44
LINCOLNTON	QNK	AGS 310/21
CROSSVILLE	QRV	TYS 269/38
ATLANTA	ATL	ATL 350/15
MONTGOMERY	MGM	MGM 101/10
HALEYVILLE	QPC	VUZ 330/45
MEDIAN	CLT	SPA 047/49

3. ATLANTA ARTCC DATA.

a. ARSR Site Data.

NAME	ATLANTA	MAIDEN	LINCOLNTON	HALEYVILLE	MONTGOMERY	GROSSVILLE	VALDOSTA
IDENT	ATL	CLT	QNK	QPC	MGM	QRV	VAD
LAT/ LONG	33 53 39 84 29 55	35 36 38N 81 14 18W	33 45 34.7 82 28 01.7	34 24 56 87 32 23	32 12 58 86 10 00	35 52 05 84 53 39	30 58 32 83 12 48
ELEV (MSL)	1043'	899'	517'	1175'	276'	2820'	233'
ANT HGT (AGL)	71'	71'	67'	65'	62'	90'	39'
PRIMARY TYPE	ARSR-1E	ARSR-1E	ARSR-3	FPS 67B	ARSRI-10	-------	FPS-20A
PRIMARY ANT	ARSR-1E	ARSR-2	ARSR-3	MK 748:MIL	ARSR-2	-------	ARSR-1
BEACON TYPE	ATCBI-4	ATCBI-3	ATCBI-5	ATCBI-3	ATCBI-3	ATCBI-5	ATCBI-3
BEACON ANT	NADIF	NADIF	ARSR-3	NADIF	NADIF	BEACON ONLY OPA*	NADIF
IDENT FOR COMPUTER ADAPTION	1	2	5	9	4	7	8

* OPA - Open Planar Array

b. Radar Sort Block Data. (Correlates Atlanta ARTCC Radar Sort Blocks with the KC-135 flight test profile from the Atlanta/Jacksonville ARTCC boundary northwest to a point approximately 40 miles beyond the Atlanta ARSR site).

RADAR SORT BLOCK I.D.	PRIMARY RADAR SITE	SECOND SITE	THIRD SITE	SUPPL SITE
951	QNK	ATL	VAD	CLT
1005	QNK	ATL	VAD	CLT
1059	QNK	CLT	ATL	VAD
1004	QNK	ATL	VAD	CLT
1058	QNK	ATL	CLT	VAD
1003	QNK	ATL	VAD	CLT
1057	QNK	ATL	CLT	VAD
1002	QNK	ATL	VAD	CLT
1056	QNK	ATL	CLT	VAD
1110	QNK	ATL	CLT	VAD
1055	QNK	ATL	VAD	CLT
1109	QNK	ATL	CLT	QRV
1054	QNK	ATL	VAD	MGM
1108	QNK	ATL	VAD	QRV
1107	QNK	ATL	CLT	QRV
1161	ATL	QNK	QRV	CLT
1106	ATL	QNK	QRV	MGM
1160	ATL	QNK	QRV	MGM
1105	ATL	QNK	MGM	QRV
1159	ATL	QNK	QRV	MGM

(Continued)

RADAR SORT BLOCK IDENT	PRIMARY RADAR SITE	SECOND SITE	THIRD SITE	SUPPL SITE
1213	ATL	QNK	QRV	MGM
1104	ATL	QNK	MGM	QRV
1158	ATL	QNK	QRV	MGM
1212	ATL	QRV	QNK	QPC
1157	ATL	QRV	MGM	QPC
1211	ATL	QRV	QPC	QNK
END OF TRACK (32NM NORTHWEST OF DOB TACAN)				

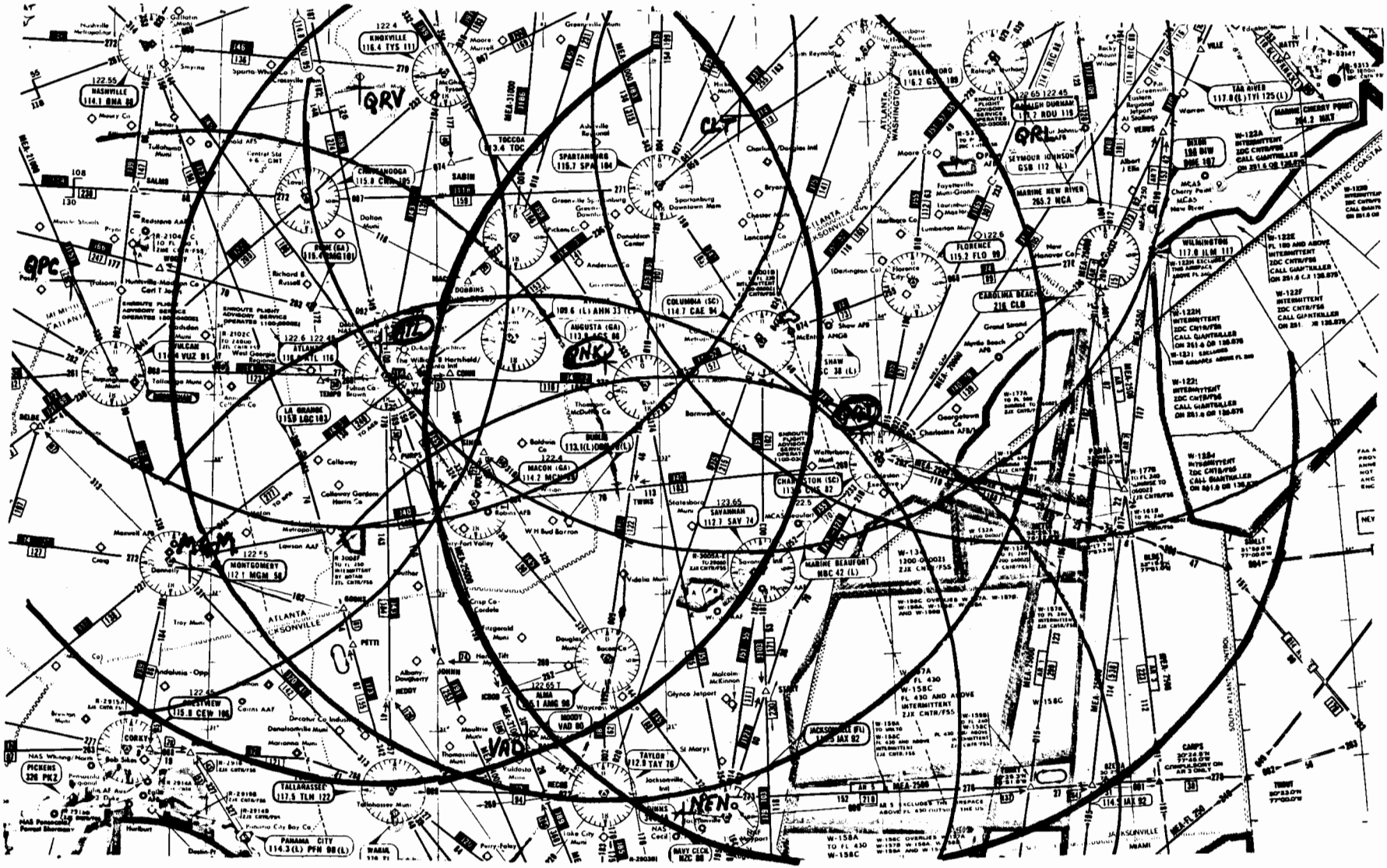
4. JACKSONVILLE ARTCC DATA.

a. ARSR Site Data.

NAME	JEDBURG	LINCOLNTON	VALDOSTA	BENSON	MONTGOMERY	WHITEHOUSE
INDENT	QRJ	QNK	VAD	QRL	MGM	NEN
LAT/ LONG	33 04 11.5 80 13 14	33 45 34.7 82 28 01.7	30 58 32 83 12 48	35 30 40 78 32 58	32 12 42 86 10 06	30 20 45 81 52 26
ELEV (MSL)	54'	517'	233'	282'	276'	91'
ANT HT (AGL)	69'	67'	39'	62.4'	62'	62'
PRIMARY TYPE	ARSR-60M	ARSR-3	FPS-20A	ARSR-1D	ARSR-1D	ARSR-60M
PRIMARY ANT	ARSR-2	ARSR-3	ARSR-1	ARSR	ARSR-2	ARSR-2
BEACON TYPE	ATCBI-5	ATCBI-5	ATCBI-3	ATCBI-5	ATCBI-3	ATCBI-5
BEACON ANT	NADIF	ARSR-3	NADIF	NADIF	NADIF	NADIF
IDENT FOR COMPUTER ADAPTION	1	6	Ø	4	5	3

b. RADAR Sort Block Data. (Correlates Jacksonville ARTCC Radar Sort Blocks with the KC-135 flight test provile from over the Charleston VORTAC northwest to the Jacksonville/Atlanta ARTCC.

RADAR SORT BLOCK I.D.	PRIMARY RADAR SITE	SECOND SITE	THIRD SITE	SUPPL. SITE
1574	QRJ	QNK	QRL	NEN
1638	QRJ	QNK	QRL	NEN
1573	QRJ	QNK	NEN	QRL
1637	QNK	QBJ	QRL	NEN
1636	QRJ	QNK	NEN	QRL
1635	QRJ	QNK	NEN	QRL
1699	QRJ	QNK	QRL	NEN
1634	QRJ	QNK	VAD	NEN
1698	QRJ	QNK	QRL	NEN
1633	QRJ	QNK	VAD	NEN
1697	QNK	QRJ	VAD	NEN
ATL ARTCC BOUNDARY				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NASHVILLE
114.1 BNA 86
TOCCOA
113.4 TOC
CHATTANOOGA
115.8 CHA 105
SPARTANBURG
115.7 SPA 104
GREENVILLE
116.2 GSP 109
RALEIGH DURHAM
117.2 RDU 119
TAR RIVER
117.9 (L) TYI 125 (L)
MARINE CHERRY POINT
MARINE NEW RIVER
265.2 NCA
FLORENCE
115.2 FLO 99
WILMINGTON
117.0 ILM 111
CAROLINA BEACH
216 CLB
COLUMBIA (SC)
114.7 CAE 94
AUGUSTA (GA)
113.8 AGS 88
SHAW
SC 38 (L)
LA GRANGE
115.9 LGC 103
MACON (GA)
114.2 MCN 94
CHARLESTON (SC)
113.1 CHS 82
SAVANNAH
112.7 SAV 74
MARINE BEAUFORT
NBC 42 (L)
MONTGOMERY
112.1 MGM 58
COLUMBUS
115.8 CEW 106
ALMA
115.1 AMG 98
MOODY
VAD 80
TAYLOR
112.9 TAY 76
JACKSONVILLE (FL)
114.5 JAX 92
PICKENS
326 PKZ
TALLAHASSEE
117.5 TLH 122
PANAMA CITY
114.3 (L) PFN 98 (L)
NAVY CECIL
NZC 88
ATLANTA
JACKSONVILLE
MIAMI
ATLANTIC CONSTAL
SOUTH ATLANTIC
QRV
CLT
QPC
ATL
QNK
QRL
QRM
VAD
LNEN

CHAPTER 5

DATA ACQUISITION REQUIREMENTS

1. GENERAL. The ATCRBS deficiencies identified by the Southern Region thus far are: (1) excessive coasting; (2) alphanumeric tag drops; and (3) beacon target quality ranging from no display to weak and intermittent display. Data collection will be designed to evaluate these as well as other parameters considered appropriate by the ATCRBS Analysis Team, APM-320, and APM-162.

2. METHODS. The collection of data during flight testing will be accomplished by three methods.

a. Digital Radar Data Through Computer Programming. APM-320 and APM-162, in coordination with the ATCRBS Analysis Team, shall develop computer programs to record data off of the Atlanta, Macon, Columbus, and Dobbins ASR terminal beacon systems. The same requirement also exists for the Jacksonville and Atlanta ARTCC's.

b. Video Recording. APM-320 and ASO-400 will oversee the positioning of video cameras on radar scopes in the Atlanta, Macon, and Columbus TRACON's, as well as the Jacksonville and Atlanta ARTCC's. Each flight will be video recorded to document the beacon target image presented on the radar scope for the controller. In areas of overlapping coverage, respective video(s) will provide the means to visually compare scope presentation of one terminal system with the video of the overlapping system(s). Each facility manager shall ensure all video products are forwarded by Express Mail to APM-320 not later than the end of the duty day, November 30, 1984.

c. Visual Observer and Manual Grading. Each ATC facility manager shall designate an air traffic controller as observer and grader of the target and data block presented on the radar scope.

(1) Grading shall be accomplished utilizing the following criteria, definitions, and values:

Target Strengths

1 = Usable	Target is satisfactory for ATC Purposes.
0 = Unusable	Target is unsatisfactory for ATC purposes.
C = Coast	NOTE: Where coasting appears, numerical grading will be followed by "C".

(2) Grading shall be recorded on forms to be provided. Completed forms shall be forwarded by express mail to APM-162 not later than the end of the duty day, November 30, 1984.

3. PROCEDURES.

a. All data recording shall commence as the aircraft is taking off and shall continue until the landing at the end of each flight.

EXCEPTION: When the KC-135 aircraft has completed its final run, which will be at a point approximately 40 nautical miles northwest of the Atlanta ARSR site at FL 350 on a northwest heading, data recording may be discontinued.

b. Each TRACON shall coordinate with the adjacent TRACON, with sufficient lead time, for that TRACON to start data collection as the test aircraft enters the new area of coverage. The preceding TRACON shall continue data collection until such time as the beacon target and data block leaves the area of coverage. Otherwise, simultaneous data collection will continue from all locations.

c. All times will be recorded Greenwich Mean Time (local plus 5 hours).

d. The Visual Observer will verify and record the ground speed for each leg of flight.

4. RECORDING REQUIREMENTS BY TYPE PROFILE.

a. Terminal Profile. All methods discussed in this plan will be used during each flight conducted. Both the Atlanta ASR-7 and the Dobbins ASR-8 will be recorded from separate systems/displays which are located in the Atlanta TRACON. Other TRACON's requiring data collection and video recording capability are Columbus and Macon. Additionally, the Southern Region has requested data collection also be accomplished at the Atlanta ARTCC during the flights to be flown on the TERMINAL Profile, in that the Atlanta ARSR coverage overlies the TERMINAL Profile.

b. Enroute Profile. All methods discussed in this plan will be required in the Jacksonville and Atlanta ARTCC's. Additionally, the Southern Region has requested the Atlanta and Dobbins systems also be recorded for the flights on this profile, in that both ASR's "look-up" onto the high altitude (FL 350) track to be flown.

CHAPTER 6

TRANSPONDER INSPECTION PROCEDURES

1. BACKGROUND. The airborne transponder system of each aircraft selected to fly the test profiles will be examined to determine that the system, in its entirety, is operating within prescribed tolerances and specifications. Such an inspection will be accomplished by an FAA Avionics Team, utilizing an FAA equipped test van. The inspection will be conducted just prior to the aircraft being flown on the test profile. If, during the flight, abnormalities in the beacon target are observed and the ATCRBS Analysis Team suspects the transponder system might be the cause, the FAA Avionics Team will conduct a more extensive inspection of the aircraft transponder and antenna system immediately after the airplane lands.

2. SCOPE. The following actions will be taken to assess the effectiveness of the airborne transponder equipment and the periphery systems that support the airborne transponder equipment for this test plan.

a. Visit military and FAA avionics repair facilities.

b. Evaluate the types of test equipment being used.

c. Review the calibration records for the test equipment.

d. Determine how the aircraft antenna system testing is accomplished.

e. Review the maintenance program for transponders.

f. Review transponder records to determine the frequency of failure and repair.

g. Test each antenna system and transponder in each aircraft prior to the test flight.

3. COORDINATION. Initial visits to all test participants and the avionics support facilities were made October 25-26, 1984. The FAA Avionics Supervisor will coordinate with appropriate military and civil counterparts regarding preparations and details for conducting the aircraft transponder inspections prior to the scheduled flight tests.

4. DOCUMENTATION. The FAA Avionics Team shall record all appropriate information regarding the transponder system as each aircraft is inspected prior to the flight test. This information shall be provided to the ATCRBS Team Chief at the end of the normal duty day, November 30, 1984. The format for data to be recorded is contained as Appendices 1, 2, and 3 to this Chapter.

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE _____

AIRCRAFT NUMBER: _____ [ ] PRIMARY AIRCRAFT

TYPE: _____ [ ] BACK-UP AIRCRAFT

LOCATION: _____

TRANSPONDER TYPE: _____ SERIAL NUMBER: _____

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL		
LO		
LO/LO (FAA SABRE-80 ONLY)		

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL		
LO/LO (FAA SABRE-80 ONLY)		

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristics	Test Reading	
1. Dead Time	_____	us
2. Suppression Time	_____	us
3. Reply Power	NORMAL /LOW	dbm
4. Frequency	_____	MHz
5. F_1 Pulse Width	_____	ns
6. F_2 Pulse Width	_____	ns
7. Sensitivity	NORMAL /LOW	dbm
8. Delay Time Difference	_____	ns
9. Reply Jitter	_____	ns
10. Mode A Delay	_____	us
11. Mode C Delay	_____	us
12. F_1 - F_2 Pulse Spacing	_____	us
13. Side Lobe Suppression Decode Accuracy	_____	us
14. Mode A Decode Accuracy	_____	us
15. MOde C Deconde Accuracy	_____	us

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA ☐ Air Carrier ☐ Military ☐ Air Taxi ☐ General Aviation ☐

2. TEST EQUIPMENT.

Manufacturer: _____

Model: _____

Calibration Frequency: _____

Last Calibration Date: _____

Calibration Within Limits? yes ☐ no ☐

3. TRANSPONDER.

Manufacturer: _____

Model: _____

Serial Number: _____

TSO'd? yes ☐ no ☐

Class 1B - 2B: _____

Class 1A - 2A: _____

Calibration Instructions (Obtain Copy)? yes ☐ not available ☐

Calibration Instructions in Consonance with Appendix F, Part 43? yes ☐ no ☐

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes ☐ no ☐

Approved Aircraft Inspection Program? yes ☐ no ☐

Scheduled Bench Maintenance? yes ☐ no ☐ frequency: _____

Scheduled Inspection in Aircraft? yes ☐ no ☐ frequency: _____

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

5. AIRCRAFT.

Type:_____

Number of Transponders Installed:_____

Date Transponder System Installed:_____

Coax. Type:_____

Antenna Type:_____

Antenna Checked Periodically? yes ☐ no ☐

Coaxial Cable Tested Periodically? yes ☐ no ☐

Transponder in Aircraft Systems Check Performed? yes ☐ no ☐

Frequency: Periodically_____ Demand_____

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 $\pm$ 3MHz):_____

Transponder Power Output:_____

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 $\frac{\text{Interrogations}}{\text{Sec}}$):_____

Class 1A & 2A (230-1200 $\frac{\text{Interrogations}}{\text{Sec}}$):_____

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response $\leq$ 1%):_____

P_2 Pulse Amplitude 9db $<$ P_1 Pulse Amplitude (Response $\geq$ 90%):_____

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73$\pm$4dbm):		
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73$\pm$4dbm):		

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm):_____

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db):_____

Record:

Complied with Provisions of FAR 43.9 as to:

Content:_____

Form:_____

Disposition of Records:_____

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints:_____

Number of Correlating Bench Check Verifications:_____

Mean Time Between Removals (MTBR):_____

Confirmed Failure Rate of MTBR:_____

8. COMMENTS.

CHAPTER 7

TERMINAL PROFILE - TEST PLAN

1. GENERAL. This profile will be flown by military aircraft based at Dobbins Air Force Base (MGE), and FAA and general aviation aircraft based at Fulton County Airport (FTY). The route is approximately 288 nautical miles in length and will be flown at an altitude of 5,000 MSL. All aircraft will originate flight within the Atlanta TRACON and progress clockwise around the Atlanta VORTAC, transiting Macon and Columbus TRACON radar coverage before returning to the Atlanta TRACON control. The FAA flight inspection aircraft will fly the route three times to establish the baseline reference for transponder operation in NORMAL/NORMAL, NORMAL/LOW and LOW/LOW. After each circuit, the FAA flight inspection aircraft will land at Fulton County to refuel before beginning the subsequent circuit. All other aircraft (except the BE-E55) will fly circuits, operating the transponder in NORMAL on the first circuit and then in LOW position for the second circuit of flight. These aircraft will fly the route two times without having to land for fuel. All aircraft except the F-4, C-130, and the BE-E55 will, upon reaching the TEMPO intersection each time, receive radar vectors for one low approach to the active runway at Hartsfield, and return to the test profile route of flight, with radar vectors provided by Atlanta Departure Control.

2. ROUTE OF FLIGHT.

a. Dobbins Air Force Base (MGE) F-4, C-130.

MGE ⊕→ DALLAS (ATL 313/29)

⊕→ LOGAN (ATL 041/29)

⊕→ FREIS (AHN 288/24)

⊕→ CONNI (ATL 089/31)

⊕→ HUSKY (ATL 128/29)

-D→ GRANT (ATL 176/48)

-D→ TIROE (ATL 228/29)

-D→ TEMPO (ATL 268/30)

-D→ DALLAS (ATL 313/29)

b. Fulton County Airport (FTY), Sabre 80, C-90, BE-E55.

Route	Distance(NM)
FTY -D→ DALLAS (ATL 313/29)	20
-D→ LOGEN (ATL 041/29)	40
-D→ FREIS (AHN 288/24)	15
-D→ CONNI (ATL 089/31)	26
-D→ HUSKY (ATL 128/29)	20
-D→ GRANT (ATL 176/48)	36
-D→ TIROE (ATL 228/29)	38
-D→ TEMPO (ATL 268/30)	20

THENCE:

(Sabre 80 and C-90 radar vectors for low approach to the active runway at Hartsfield)

THENCE:

(Sabre 80 -D→ to FLANC NDB and refueling at FTY)

(C-90 -D→ DALLAS intersection to begin second circuit, transponder low)

(BE-E55 route is -D→ DALLAS from TEMPO)

3. OPERATIONAL GUIDANCE.

a. All flights shall be conducted on IFR flight plans.

b. For all aircraft, the route profile will be flown at 5,000 feet MSL.

c. Pilots shall maintain a constant ground speed throughout all segments, with the exception of vectors for approach and landing.

d. Each aircraft shall squawk "IDENT" after take-off when radar contact is first established and over each intersection (turn point) along the route of flight.

e. The notation "ATCRBS FLIGHT TEST" shall be entered in the remarks section of all flight plans.

f. Flight plans shall be filed not later than one hour prior to the scheduled take-off time.

g. The flight schedule and take-off times specified in Chapter 9 of this plan will be followed. In the event the primary aircraft must abort, the pilot-in-command will notify air traffic control through clearance delivery of the delay, and the estimated time of take-off in the backup aircraft.

4. WEATHER MINIMUMS.

a. 116 TFW, F-4.
500 and 2

b. 94 TAW, C-130.
200 and 1/2

5. SUMMARY OF TERMINAL PROFILE FLIGHTS.

a. SABRE	ALTITUDE		TRANSPONDER
#1	5,000 MSL	NORMAL/NORMAL	350 W+50W output -75 dBM ± 1dbm sensitivity
#2	5,000 MSL	NORMAL/LOW	350 W+50W output -69 dBm ± 1dbm sensititity
#3	5,000 MSL	LOW/LOW	80 W+20W output -69 dbm ± 1dbm sensitivity
(with refueling)			
b. C-90			
#1	5,000 MSL		NORMAL
#2	5,000 MSL		LOW
(without refueling)			

c. BE-E55

	ALTITUDE	TRANSPONDER
#1	5,000 MSL	NORMAL

(BE-E55 does not have LOW)

d. F-4

#1	5,000 MSL	NORMAL
#2	5,000 MSL	LOW

(without refueling)

3. C-130

#1	5,000 MSL	NORMAL
#2	5,000 MSL	LOW

(without refueling)

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CHAPTER 8

ENROUTE PROFILE - TEST PLAN

1. GENERAL. This profile will be flown by a KC-135 aircraft baseed at Robins Air Force Base, Georgia. The FAA flight inspection Sabre 80 aircraft will fly in trail to the KC-135 aircraft to establish the baseline data for transponder operations in NORMAL/NORMAL, NORMAL/LOW, and LOW/LOW power output and sensitivity. The KC-135 aircraft will fly the profile in LOW and NORMAL to evaluate the ATCRBS operation in the enroute environment.

2. ROUTE OF FLIGHT. As a matter of economy and to release aircraft as soon as possible for operational missions, the route and transponder operations for each aircraft are as follow:

a. Route.

(1) Sabre 80, Fulton County Airport (FTY). Depart FTY proceeding direct to the VUZ 344/49 to rendezvous with the KC-135 and fly the test profile in trail to the KC-135, utilizing standard ATC separation. Reverse course and proceed on track to the MCN 017/61, thence direct CHS VORTAC at FL 330, TRANSPONDER-NORMAL/NORMAL. Reverse course, and at FL 350, fly the reciprocal to the VUZ 344/49 with the TRANSPONDER-NORMAL/NORMAL. After refueling at FTY fly the track from the VUZ 344/49, direct MCN 017/61, direct CHS VORTAC, FL 330, with the TRANSPONDER-NORMAL/LOW. Reverse course and fly the reciprocal to the VUZ 344/49, TRANSPONDER LOW/LOW, FL 350.

(2) KC-135, Robins AFB, GA. Depart Robins AFB direct VUZ 344/49. Reverse course and proceed on tract to the MCN 017/61, thence the CHS VORTAC at FL 330 with TRANSPONDER-LOW. Reverse course so as to be over the CHS VORTAC, FL 350, at 1520 GMT, outbound to the MCN 017/61, thence direct VUZ 344/49 with TRANSPONDER-NORMAL.

3. OPERATIONAL GUIDANCE.

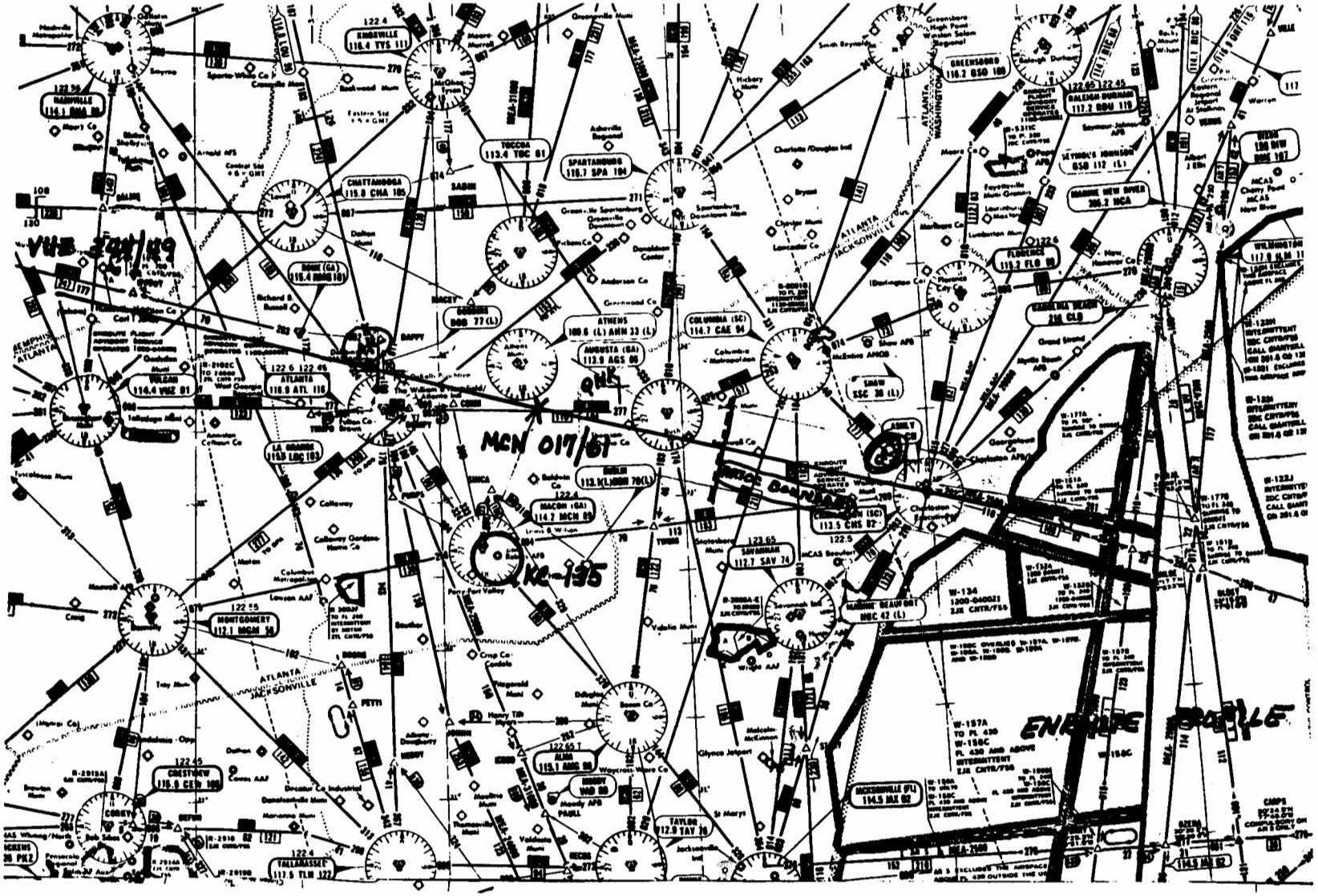
a. A constant ground speed shall be maintained throughout the route of flight by the Sabre 80 and the KC-135 aircraft.

b. The notation "ATCRBS FLIGHT TEST" shall be entered in the remarks section of the flight plan.

c. Flight plans shall be filed not later than 2 hours prior to the scheduled take-off time.

d. The flight schedule and take-off times specified in Chapter 9 of this plan will be followed. In the event the primary aircraft must abort, the pilot-in-command will notify air traffic control through Clearance Delivery of the delay and the estimated time of take-off in the backup aircraft.

e. As a minimum, aircraft shall be required to squawk "IDENT" at the VUZ 344/49, the ARTCC boundary, and over the Charleston VORTAC each time.


KNOXVILLE
116.4 TYS 111
NASHVILLE
TOCCOA
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SPARTANBURG
115.7 SPA 104
CHATTANOOGA
115.0 CHA 105
GREENSBORO
116.7 GSO 108
RALEIGH DURHAM
117.2 RDU 119
MARINE NEW RIVER
ATLANTA
JACKSONVILLE
ATHENS
COLUMBIA (SC)
114.7 CAE 94
AUGUSTA (GA)
113.9 AGS 86
ATLANTA
116.9 ATL 110
LA GRANGE
MACON (GA)
114.2 MCN 89
SAVANNAH
117.7 SAV 74
MONTGOMERY
112.1 MGM 74
CRESTVIEW
115.0 CEW 105
TALLAHASSEE
117.5 TLH 122
JACKSONVILLE (FL)
114.5 JAX 92
MCN 017/67
KC-135
ENGINE
W-134
1200-040021
EJR CNTR/FSS
W-157A
TO FL 430
W-158C
FL 430 AND ABOVE
INTERMITTENT
EJR CNTR/FSS

CHAPTER 9

TRANSPONDER INSPECTION AND FLIGHT SCHEDULE

1. SCHEDULE OF EVENTS.

DATE	DAY/A.M. or P.M.		AIRCRAFT TRANSPONDER INSPECTION	FLY	TAKE-OFF (LOCAL TIME)
11/26/84	MONDAY				
		A.M.	-	-	-
		P.M.	Sabre 80	-	-
11/27/84	TUESDAY				
		A.M.	C-90	Sabre 80	9:00 A.M. 12:00 Noon
		P.M.	F-4	Sabre 80	3:00 P.M.
11/28/84	WEDNESDAY				
		A.M.	BE-E55	F-4 C-90	9:30 A.M. 11:30 A.M.
		P.M.	KC-135	BE-E55	1:00 P.M.
11/29/84	THURSDAY				
		A.M.	(ENROUTE PROFILE)	Sabre 80	9:15 A.M. 1:00 P.M.
		A.M.	-	KC-135	9:10 A.M.
		P.M.	C-130	-	-
11/30/84	FRIDAY				
		A.M.	-	C-130	10:00 A.M.
		P.M.	-	-	-

2. GUIDANCE.

a. The FAA Avionics Team Chief shall coordinate with military counterparts to establish scheduled hours aircraft will be available for transponder inspection.

b. In the event of weather conditions which would not permit a scheduled flight, the entire schedule will slip 24 hours. In the event such conditions are anticipated, the ATCRBS Analysis Team Chief will coordinate scheduled changes with appropriate military authority real-time.

c. In the event of a major data acquisition malfunction, the entire schedule will slip 24 hours.

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APM-310	1
Colonel Charles Corder HQ FAA (AAT-4)	1
APM-160	1
AVN-1	1
AVN-200	1
MGR, ATL FIFO	2
ASO-1	1
ASO-200	1
ASO-400	3
ASO-500	3
MGR, Atlanta Tower	3
MGR, Columbus Tower	3
MGR, Macon RAPCON	3
MGR, Atlanta ARTCC	3
MGR, Jacksonville ARTCC	3
ATCRBS Analysis Team Members (10)	1 ea
Airspace and Air Traffic Services Division HQ USAF/XOORF Pentagon Washington, D.C. 20330-5054	2
Air Force Representative FAA Southern Region, ASO-900 P.O. Box 20636 Atlanta, GA 30320	1
19th Air Refueling Wing/DO Robbins AFB, GA 31098	3
94th Tactical Airlift Wing/CC Dobbins AFB, GA 30069	3
116th Tactical Fighter Wing/DO Dobbins AFB, GA 30069	3

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Robert J. Marlott Mgr., Atlanta Flight Inspection Field Office	242-6860
Billy Shipp Supervisor, Avionics Section Atlanta Flight Inspection Field Office	242-6850

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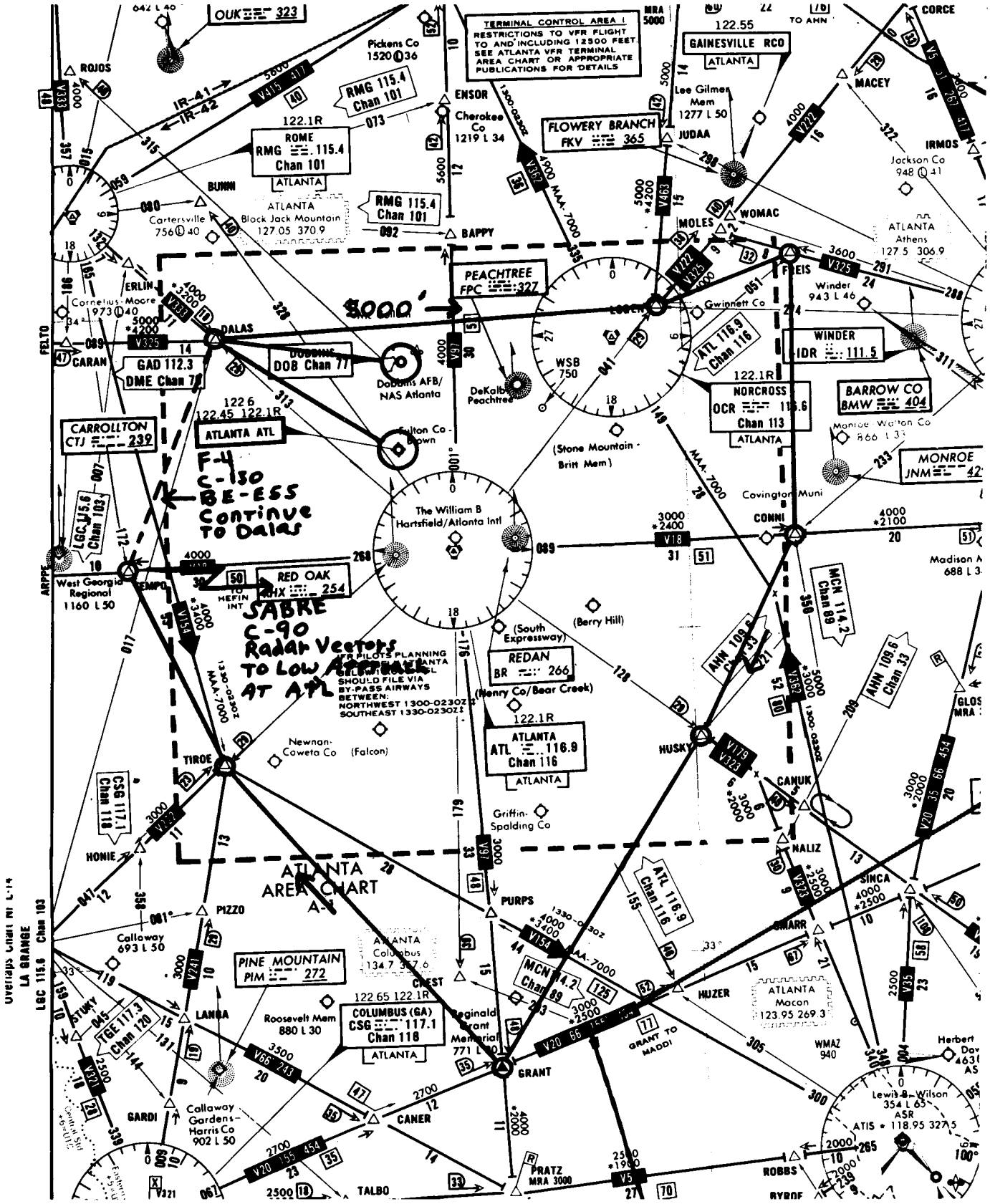
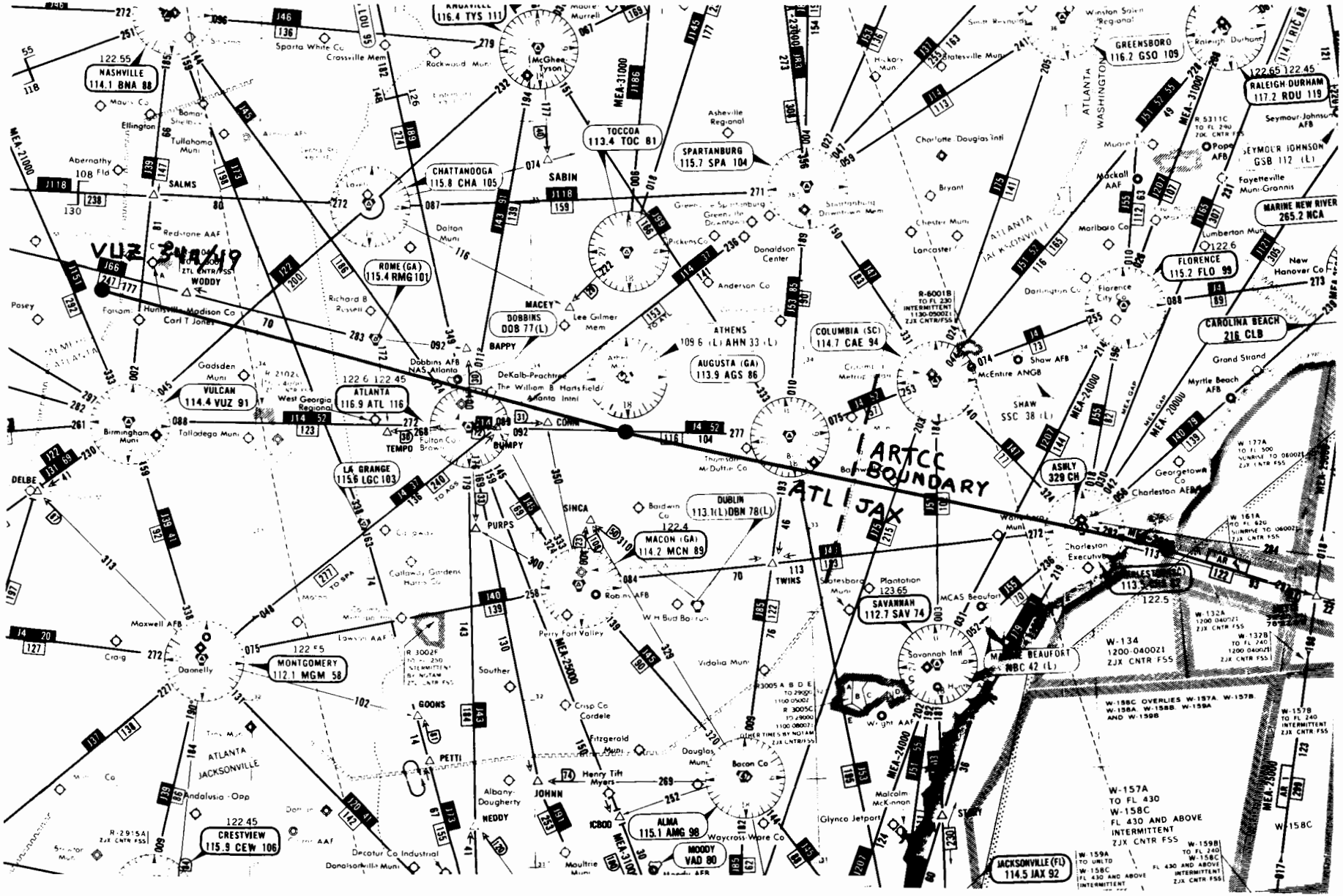
Bill Ardies Flight Programs, AVN-200	749-2766
Milton Hill Avionics Specialist, ASO-250	246-7411
Rufus Olufs FAA Technical Center, APM-160	482-5120
Rebecca Link Aircraft Maintenance Division, AWS-310	426-8203
Jacqueline Renaud Aircraft Maintenance Division, AWS-300a	426-3546



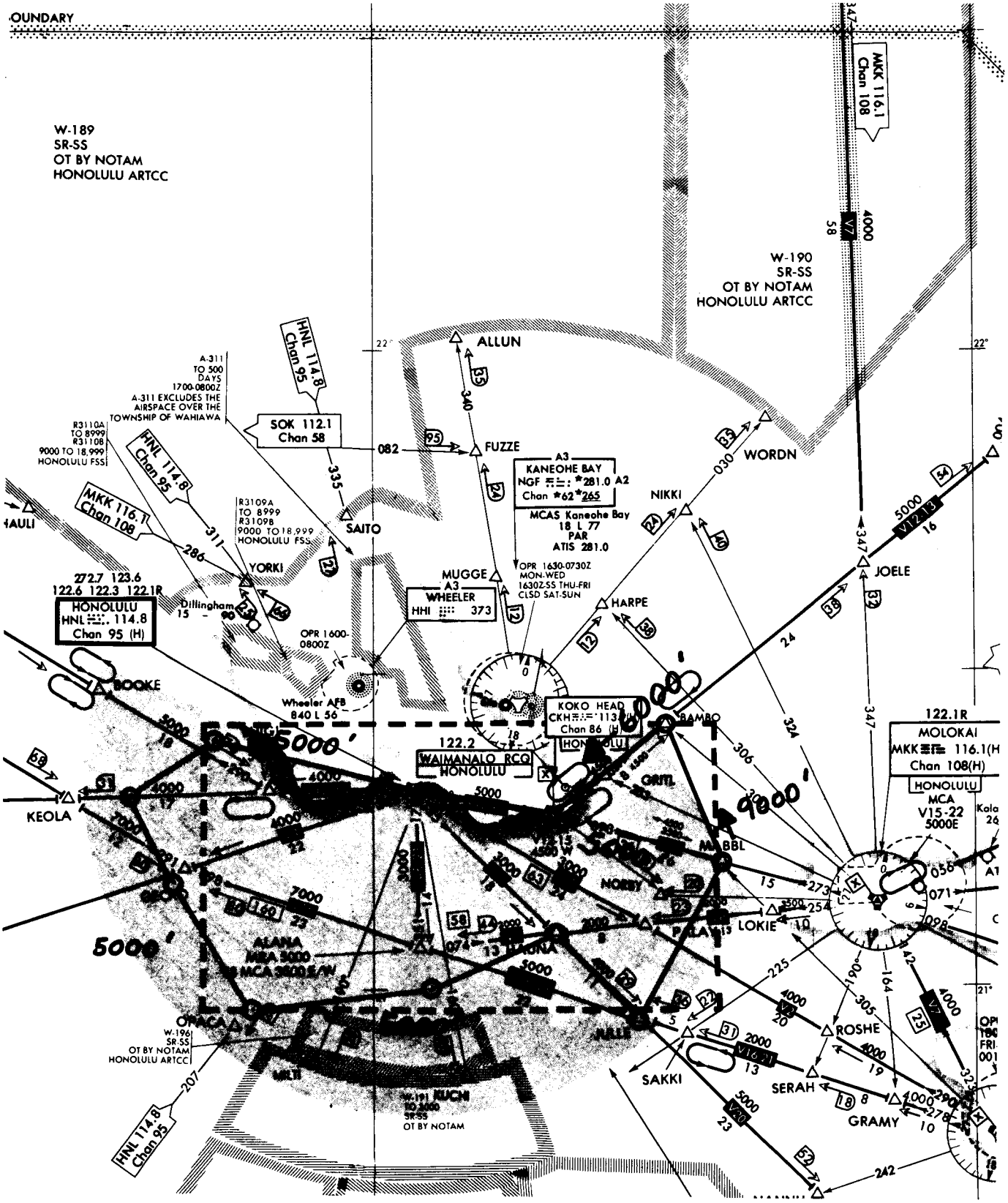
APPENDIX 2

ATLANTA TERMINAL TEST FLIGHT PROFILE



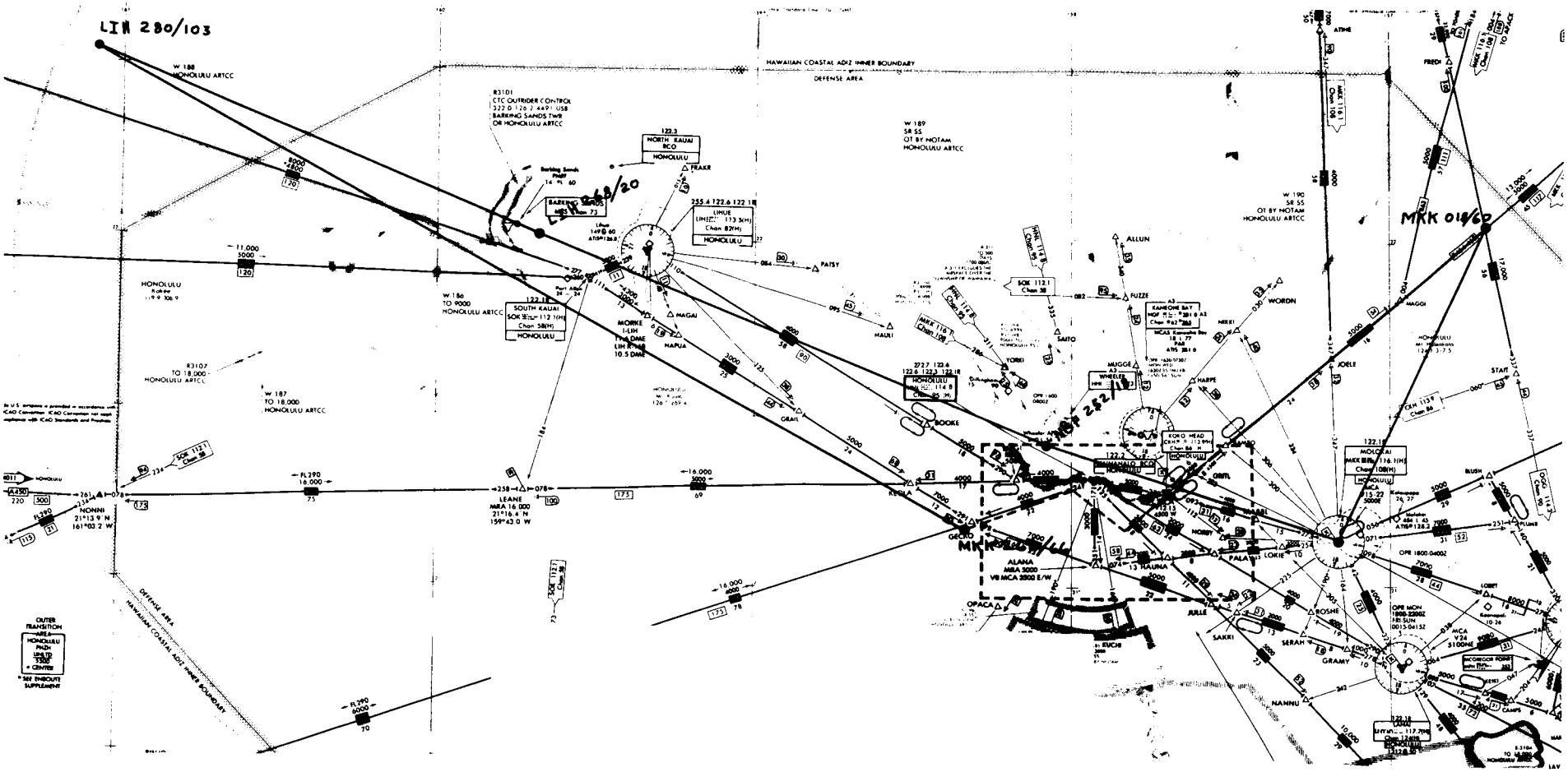
APPENDIX 3

ATLANTA/JACKSONVILLE HIGH ALTITUDE ENROUTE TEST FLIGHT PROFILE



APPENDIX 4

HONOLULU TERMINAL TEST FLIGHT PROFILE



APPENDIX 5

HONOLULU ARTCC HIGH ALTITUDE TEST FLIGHT PROFILE

APPENDIX 6

COMDIG SUMMARY

LOW ALTITUDE PROFILE PERFORMANCE STATISTICS

NOVEMBER 27, 1984. Dobbins ASR-8 Low Altitude Profile

SabreLiner Normal/Normal

Beacon Code: 5207 Altitude: 5,000 feet

Start Time: 13:59:37.8

Start Range: 19 5/8 nm Azimuth: 277

Exit Time: 14:31:37.4

Exit Range: 58 7/8 nm Azimuth: 167

In system 487 scans, missed 74, detection = 84.8%

8 misses occurred last 2 nm most other misses occurred while in turns

Re-Entry Time: 14:36:51.7

Re-Entry Range: 55 1/8 nm Azimuth: 181

End Time: 14:47:27.6 Altitude: 5,000 feet

End Range: 48 o/8 nm Azimuth: 231

In system 116 scans, missed 0, detection = 100%

Total scans 603, missed 74, total detection = 87.7%

* Lost data from 14:27:29 to 14:28:40 = 14 scans; not calculated in detection.

NOVEMBER 27, 1984. Dobbins ASR-8 Low Altitude Profile

SabreLiner Normal/Low

Beacon Code: 5225 Altitude: 5,000 feet

Start Time: 17:00:036

Start Range: 17 o/8 Azimuth: 283

Exit Time: 17:32:13.9

Exit Range: 55 o/8 nm Azimuth: 163

In system 513 scans, missed 51, detection = 90.1%

41 misses occurred while aircraft was in a turn

2 misses occurred last 2 miles of coverage

Re-Entry Time: 17:39:30

Re-Entry Range: 55 2/8 nm Azimuth: 181

End Time: 17:58:59 Altitude: 5,000 feet

End Range: 17 4/8 nm Azimuth: 201

In system 320 scans, missed 2, detection = 99.4%

Total scans 833, missed 53, total detection = 93.6%

NOVEMBER 28, 1984. Dobbins ASR-8 Low Altitude Profile

F-4 Normal

Beacon Code: 5231 Altitude: 5,000 feet

Start Time: 14:35:39

Start Range: 17 3/8 nm Azimuth: 279

Exit Time: 14:57:22.7

Exit Range: 59 0/8 nm Azimuth: 163

In system 348 scans, missed 8, detection = 97.7%

Re-Entry Time: 15:02:15.2

Re-Entry Range: 55 1/8 nm Azimuth: 183.3

End Time: 15:13:59:7 Altitude: 5,000 feet

End Range: 16 7/8 nm Azimuth: 279

In system 192 scans, missed 8, detection = 95.8%

Total scans 540, missed 16, total detection = 97.0%

NOVEMBER 28, 1984. Dobbins ASR-8 Low Altitude Profile

King Air C-90 Normal

Beacon Code: 5116 Altitude: 5,000 feet

Start Time: 16:37:54.6

Start Range: 17 1/8 nm Azimuth: 277

Exit Time: 17:12:56.5

Exit Range: 59 1/8 nm Azimuth: 167

In system 561 scans, missed 22, detection = 96.1% *

9 misses associated with aircraft in turn

Re-Entry Time: 17:20:13.7

Re-Entry Range: 55 2/8 nm Azimuth: 181

End Time: 17:34:44.2 Altitude: 5,000 feet

End Range: 31 3/8 nm Azimuth: 232

In system 239 scans, missed 13, detection = 94.6%

Total scans 800, missed 39, total detection = 95.1%

* Loss of data from 16:38:34.8 to 16:39:01.3 = 10 scans; not used in calculation of detection

NOVEMBER 30, 1984. Dobbins ASR-8 Low Altitude Profile

C-130

Beacon Code: 5274 Altitude: 4,900 feet

Start Time: 15:06:55.1

Start Range: 17 2/8 nm Azimuth: 277

Exit Time: 15:37:09.3

Exit Range: 59 1/8 nm Azimuth: 166

In system 500 scans, missed 81, detection = 83.8%

59 misses occurred between 30-46 nm from site

From 46-59 nm there were no misses

Re-Entry Time: 15:42:37.8

Re-Entry Range: 55 1/8 nm Azimuth: 180

End Time: 15:57:24.5 Altitude: 5,000 feet

End Range: 17 4/8 nm Azimuth: 277

In system 240 scans, missed 8, detection = 96.7%

7 of 8 misses occurred between 30-44 nm from site

Total scans = 740, missed 89, total detection = 88%

NOVEMBER 30, 1984. Dobbins ASR-8 Low Altitude Profile

Beech BE-E55 Normal

Beacon Code: 5224 Altitude: 5,000 feet

Start Time: 18:59:28.9

Start Range: 29 3/8 Azimuth: 132

Exit Time: 19:07:43.3

Exit Range: 57 4/8 Azimuth: 162

In system 135 scans, missed 13, detection = 91.11%

9 misses occurred within last 2 miles of coverage

Re-Entry Time: 19:17:23.1

Re-Entry Range: 55 0/8 Azimuth: 175

End Time: 19:26:44.3 Altitude: 5,000 feet

End Range: 40 3/8 Azimuth: 199

In system 153 scans, missed 34, detection = 77.78% *

25 consecutive scans missed from 53 6/8 to 50 6/8 nm on re-entry leg

Total scans = 288, missed 47, total detection = 83.68

* Data lost for re-entry leg for last 10 nm

NOVEMBER 27, 1984. Atlanta ASR-7 Low Altitude Profile

SabreLiner Normal/Low

Beacon Code: 5,225

Start Time: 17:00:06 Altitude: 5,000 feet

Start Range: 30 2/8 nm Azimuth: 316

Ending Time: 17:59:00 Altitude: 4,700 feet

Ending Range: 10 7/8 nm Azimuth: 276

In system 763 scans, missed 28, detection = 96.3%

NOVEMBER 27, 1984. Atlanta ASR-7 Low Altitude Profile

Beacon Code: 5,207

Start Time: 13:59:40 Altitude: 5,000 feet

Start Range: 31 3/8 nm Azimuth: 311

Ending Time: 14:42:25 Altitude: 5,000 feet

Ending Range: 29% Azimuth: 225

In system 534 scans, missed 5, detection = 99.1%

A/C made approach to A/P (Hartsville) from fix:

Starting Range: 29 1/8 nm Altitude: 5,000 feet

Azimuth: 264

Ending Range: 1 1/8 nm Altitude: 1,400 feet

Azimuth: 25

On approach 155 scans, missed 4, detection = 97.4%

NOVEMBER 28, 1984. Atlanta ASR-7 Low Altitude Profile

F-4 Normal

Beacon Code: 5,231

Start Time: 14:36:00 Altitude: 5,000 feet

Start Range: 30 2/8 nm Azimuth: 313

Ending Time: 15:13:59 Altitude: 5,000 feet

Ending Range: 28 7/8 nm Azimuth: 318

In system 484 scans, missed 8, detection = 98.4%

NOVEMBER 28, 1984. Atlanta ASR-7 Low Altitude Profile

King Air C90 Normal

Beacon Code: 5,116

Start Time: 16:37:52 Altitude: 5,000 feet

Start Range: 29 2/8 nm Azimuth: 313

Ending Time: 17:34:55 Altitude: 5,000 feet

Ending Range: 29 6/8 nm Azimuth: 269

In system 723 scans, missed 15, detection = 97.9% *

* Loss of data 16:38:34 to 16:39:02 = 5 scans; not used in calculation of detection

A/C made low approach to A/P (Hartsville) from fix:

Start Range: 29 k2/8 nm Altitude: 5,000 feet

Azimuth: 271

Ending Range: 1 3/8 nm Altitude: 1200 feet

On approach 254 scans, missed 14, detection = 94.49%

NOVEMBER 30, 1984. Atlanta ASR-7 Low Altitude Profile

C-130 Normal

Beacon Code: 5,274

Start Time: 15:06:56 Altitude: 5,000 feet

Start Range: 29 4/8 nm Azimuth: 313

Ending Time: 15:57:24

Ending Range: 29 4/8 Azimuth: 313

In system 646 scans, missed 8, detection = 98.8%

NOVEMBER 30, 1984. Atlanta ASR-7 Low Altitude Profile

BE-E55 Normal

Beacon Code: 5,224

Start Time: 18:59:29 Altitude: 5,000 feet

Start Range: 29 3/8 Azimuth: 133

Ending Time: 19:47:28.6

Ending Range: 20 0/8 nm Azimuth: 300

In system 620 scans, missed 20, detection: 96.7%

WARNER ROBINS DATA LOW ALTITUDE PROFILES

NOVEMBER 27, 1984. Robins ASR-7 Low Altitude Profile

Sabreliner Normal/Normal

Beacon Code: 5207 Beginning Range: 55 1/8 nm

Terminating Range: 46 1/8 nm

Within system 174 scans, missed 6, detection = 96.6%

NOVEMBER 27, 1984.

Sabreliner Normal/Low

Beacon Code: 5225 Beginning Range: 55 1/8 nm

Terminating Range: 46 4/8 nm

Within system 182 scans, missed 15, detection = 91.8%

NOVEMBER 28, 1984.

F-4D Normal

Beacon Code: 5231 Beginning Range: 55 1/8 nm

Terminating Range: 50 2/8 nm

Within system 140 scans, missed 3, detection = 97.86%

NOVEMBER 28, 1984.

King Air C90 Normal

Beacon Code: 5116 Beginning Range: 55 1/8 nm

Terminating Range: 54 3/8 nm

Within system 268 scans, missed 16, detection = 94.03%

WARNER ROBINS DATA LOW ATLTITUDE PROFILE

NOVEMBER 30, 1984

C-130 Normal

Beacon Code: 5274

Beginning Range: 55 2/8

Terminating Range: 55 0/8

Within system 200 scans, missed 5, detection = 97.5%

NOVEMBER 30, 1984.

Beech-BE E55 Normal

Beacon Code: 5224

Beginning Range: 55 1/8 nm

Terminating Range: 43 5/8 nm

Within system 290, missed 31, detection = 89.31%

COLUMBUS ASR-8 DATA COLLECTION

NOVEMBER 27, 1984. Sabre Liner Normal

Beacon Code: 5207

In system 223 scans, 6 misses; detection = 97.31%

All misses occurred on exiting system

NOVEMBER 27, 1984. Sabre Liner Normal/Low

Beacon Code: 5225

In system 224 scans, 9 misses; detection = 95.98%

8 misses occurred last 10 miles of flight

NOVEMBER 28, 1984. F-4 Normal

Beacon Code: 5231

In system 175 scans, 1 miss; detection = 99.43%

1 miss in turn

NOVEMBER 28, 1984. King Air C90 Normal

Beacon Code: 5116

In system 309 scans, 3 misses; detection = 99.03%

2 misses occurred in fringe exiting

NOVEMBER 30, 1984. C-130 Normal

Beacon Code: 5274

In system 230 scans, 1 miss; detection = 99.57%

NOVEMBER 30, 1984. Twin Beech Normal

Beacon Code: 5224

In system 349 scans, 19 misses; detection = 94.56%

HIGH ALTITUDE PROFILE PERFORMANCE STATISTICS

DECEMBER 19, 1984. Atlanta LRR High Altitude Profile

KC-135 Normal 9 dB, P1-P2 Compare

Beacon Code: 5136 Eastbound

Start Time: 13:30:45.3 Altitude: 33,000 feet

Starting Range: 47 5/8 nm Azimuth: 285.56

End Time: 13:58:37.9

Ending Range: 152 3/8 nm Azimuth: 102.48

In system 167 scans, missed 30, detection = 82.04%

SEGMENT OF TRACK UNDER INFLUENCE OF SLS

Start Time: 13:30:45.3 Altitude: 33,000 feet

Starting Range: 47 5/8 nm Azimuth: 285.56

End Time: 13:44:59.3 Altitude: 33,000 feet

Ending Range: 55 4/8 nm Azimuth: 102.12

Under influence of SLS 86 scans, missed 30; detection = 65.12%

Missed A/C 29 consecutive scans

17 5/8 nm west of site to 19 7/8 nm east

Cone of silence 37 1/2 nm in diameter

DECEMBER 19, 1984. Atlanta LRR High Altitude Profile

KC-135 Normal 5 dB, P1-P2 Compare

Beacon Code: 5136 and 3104 Westbound

Start Time: 14:06:22.8 Altitude: 35,100 feet

Starting Range: 152 0/8 nm Azimuth: 103.8

Ending Time: 14:44:52.3

Ending Range: 47 5/8 Azimuth: 283.54

In system 202 scans, missed 32, detection = 87.3%

SEGMENT OF TRACK UNDER INFLUENCE OF SLS

Start Time: 14:25:25.0 Altitude: 35,100 feet

Starting Range: 55 3/8 nm Azimuth: 101.86

End Time: 14:44:52.3

Ending Range: 47 5/8 nm Azimuth: 283.54

Under influence of SLS: 117 scans, missed 31, detection = 73.5%

Although the detection rate for the -5 db calibrated transponder does not appear to have been improved significantly, the true cone of silence consisted of 12 consecutive scans missed starting at 9 0/8 nm west of the site to 7 6/8 nm east, giving the cone of silence 16 6/8 nm diameter. Of the 31 misses there were 12 spurious misses which would not cause the 9020 operational program to drop the track. There were 7 misses consisting of 3 consecutive misses, 1 detection, then 4 consecutive misses at a range of 30 to 37 miles which are inconsistent with the characteristics of the SLS influence of this radar site, and appears to be caused by some other abnormality. However, to maintain consistency, these misses have been identified as a suppression of beacon report by SLS in the statistics, but in judgement should not be weighted against the improved performance of the transponder.

DECEMBER 19, 1984. Lincolnton LRR High Altitude

KC-135 Normal -9 db, P1-P2 Compare

Beacon Code: 5136 Eastbound

Start Time: 13:30:42.1 Altitude: 33,000 feet

Starting Range: 149 2/8 Azimuth: 278.52

End Time: 13:58:38.2 Altitude: 34,300 feet

Ending Range: 54 0/8 nm Azimuth: 119.79

In system 143 scans, missed 29, detection = 79.72%

SEGMENT OF TRACK UNDER INFLUENCE OF SLS

Start Time: 13:43:54.5

Starting Range: 55 5/8 Azimuth: 268.59

End Time: 13:58:38.2

Ending Range: 54 0/8 nm Azimuth: 119.79

Under influence of SLS 77 scans, missed 28, detection = 63.64%

All but (1) miss occurred under influence of SLS

DECEMBER 19, 1984. Lincolnton LRR High Altitude Profile

KC-135 Normal -5 db, P1-P2 Compare

Beacon Code: 3,104 Eastbound

Start Time: 14:06:14.8

Starting Range: 55 3/8 nm Azimuth: 123.13

End Time: 14:44:58

Ending Range: 149 2/8 nm Azimuth: 277.82

In system 194 scans, missed 0, detection = 100%

APPENDIX 7

ANALYSIS OF TEST FACILITIES AND TRANSPONDERS

FEDERAL AVIATION ADMINISTRATION AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE ANALYSIS 1/

ORGANIZATION	F.A.A.	F.A.A.	F.A.A.	94th T.A.W.	116th T.F.W.	19th AREFW	19th AREFW	19th AREFW	19th AREFW
AIRCRAFT TYPE	NA-265-80	C-90	BE-E55	C-130H	F4D	KC-135	KC-135	KC-135	KC-135
AIRCRAFT NUMBER	N-52	N-19	N-2014U	AF-81-0626	AF-66-7588	AF-60-0330	AF-56-3634	AF-59-1449	AF-59-1449
TRANSPONDER TYPE	621A-6	TDR-90	TDR-950	APX-72	KY532B/ASQ	APX-64	APX-64	APX-64	APX-64
TRANSPONDER SERIAL NUMBER	2561	9469	16646	4143	61	3822	0057	3822 3/	496 4/
DEAD TIME (usec)	29.0	45.0	29.0	93.0	120.0	122.0	29.0	122.0	110.0
SUPPRESSION TIME (usec)	30.0	31.5	N/A	30.0	27.2	33.0	35.0	33.0	36.0
REPLY POWER (watts)	725	380	200	950	600	900	660	900	1120
FREQUENCY (MHz)	1090.0	1090.0	1088.7	1089.1	1090.0	1090.0	1089.5	1090.0	1090.0
F_1 PULSE WIDTH (usec)	0.45	0.55	0.45	0.50	0.45	0.55	0.50	0.55	0.42
F_2 PULSE WIDTH (usec)	0.45	0.55	0.45	0.50	0.45	0.55	0.50	0.55	0.42
SENSITIVITY, NORMAL (dBm)	-77.0	-74.5	-59.6	-77.2	-76.8	-76.8	-77.2	-78.4	-74.5
SENSITIVITY, LOW (dBm)	-71.5	-71.5	N/A	-63.0	-58.2	-64.0	-65.2	-64.0	-63.5
DELAY TIME DIFFERENCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPLY JITTER (usec)	0.01	0.05	0.01	0.01	0.0	0.0	0.0	0.0	0.0
MODE A DELAY (usec)	3.2	2.5	2.8	3.2	3.0	3.0	3.0	3.0	3.2
MODE C DELAY (usec)	3.2	2.5	2.8	3.2	3.0	3.0	3.0	3.0	3.2
F_1 - F_2 SPACING (usec)	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
SLS DECODE ACCURACY (usec) 2/	1.5/2.5	1.6/2.4	1.5/2.4	1.7/2.3	1.0/2.8	1.7/2.5	1.6/2.4	1.7/2.5	1.5/2.5
MODE A DECODE ACCURACY (usec) 2/	7.5/8.5	7.5/8.5	7.6/8.4	7.5/8.6	7.4/8.55	7.4/8.2	7.6/8.4	7.4/8.2	7.55/8.5
MODE C DECODE ACCURACY (usec) 2/	20.5/21.5	20.6/21.4	20.6/21.6	20.5/21.7	20.6/21.4	20.1/21.2	20.3/21.4	20.1/21.2	20.2/21.8

1/ Test data recorded at transponder actually used in the Flight Test Profile.
2/ Lower Limit/Upper Limit
3/ Receiver Side Lobe Suppression set at 9dB.
4/ Receiver Side Lobe Suppression set at 5dB.

FEDERAL AVIATION ADMINISTRATION AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE ANALYSIS, CONTINUED.

ORGANIZATION	F.A.A.	F.A.A.	F.A.A.	15 AMS SQD	15 AMS SQD				
AIRCRAFT TYPE	B-727	B-727	F-90	EC-135J	EC-135J				
AIRCRAFT NUMBER	N-77	N-77	N-18	63-8055	63-8055				
TRANSPONDER TYPE	621A-6	621A-6	TDR-90	APX-64	APX-64				
TRANSPONDER SERIAL NUMBER	1854	1864 5/	14720	3491 4/	4492 3/				
DEAD TIME (usec)	75.8	75.8	34.0	N/A	N/A				
SUPPRESSION TIME (usec)	35.0	35.0	35.0	35.0	35.0				
REPLY POWER (watts)	555	725	375	1000	631				
FREQUENCY (MHz)	1090.0	1090.0	1087.0	1090.1	1089.5				
F_1 PULSE WIDTH (usec)	0.45	0.45	0.45	0.5	0.50				
F_2 PULSE WIDTH (usec)	0.45	0.45	0.45	0.5	0.50				
SENSITIVITY, NORMAL (dBm)	-76.0	-76.0	-77.1	-78.0	-78.0				
SENSITIVITY, LOW (dBm)	-70.0	-70.0	-64.0	-66.0	-67.0				
DELAY TIME DIFFERENCE	0.0	0.0	0.0	0.0	0.0				
REPLY JITTER (usec)	0.08	0.04	0.01	0.0	0.0				
MODE A DELAY (usec)	3.1	3.0	3.0	3.0	3.0				
MODE C DELAY (usec)	3.1	3.0	3.0	3.0	3.0				
F_1 - F_2 SPACING (usec)	20.3	20.3	20.3	20.3	20.3				
SLS DECODE ACCURACY (usec) 2/	1.4/2.4	1.4/2.5	1.5/2.5	1.5/2.5	1.5/2.8				
MODE A DECODE ACCURACY (usec) 2/	7.2/8.5	7.2/8.4	7.4/8.7	7.5/8.5	7.7/8.55				
MODE C DECODE ACCURACY (usec) 2/	20.5/21.4	20.4/21.5	20.4/21.8	20.5/21.6	20.5/21.6				

5/ TRANSPONDER SLS SET AS CLOSELY TO 9dB AS POSSIBLE WITHOUT COMPONENT CHANGE. SEE TRANSPONDER PERFORMANCE TEST DATA.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/26/84

NA-265-80 N-52

FAA ATLANTA FLIGHT INSPECTION FIELD OFFICE

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	29.0	us.
2. Suppression Time	30.0	us
3. Reply Power	Normal 725 /Low 725	Watts
4. Frequency	1090.0	MHz.
5. F_1 Pulse Width	0.43	us.
6. F_2 Pulse Width	0.43	us.
7. Sensitivity	Normal -77.0 /Low -71.5	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.01	us.
10. Mode A Delay	3.2	us.
11. Mode C Delay	3.2	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.5/2.5	us.
14. Mode A Decode Accuracy	7.5/8.5	us.
15. Mode C Decode Accuracy	20.5/21.5	us.

NA-265-80
N-52
#1 Transponder, Collins 621A-6, S/N 2561

NOTE: This transponder was used during the Flight Test Profile.

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/26/84

AIRCRAFT NUMBER: N-52

TYPE: NA-265-80

LOCATION: Atlanta FIFO (FTY)

[X] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: Collins 621A-6

SERIAL NUMBER: 2561 (#1)

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-74.5 dBm
LO	N/A	-69.0 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	-68.0 dBm

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	320 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	120 watts

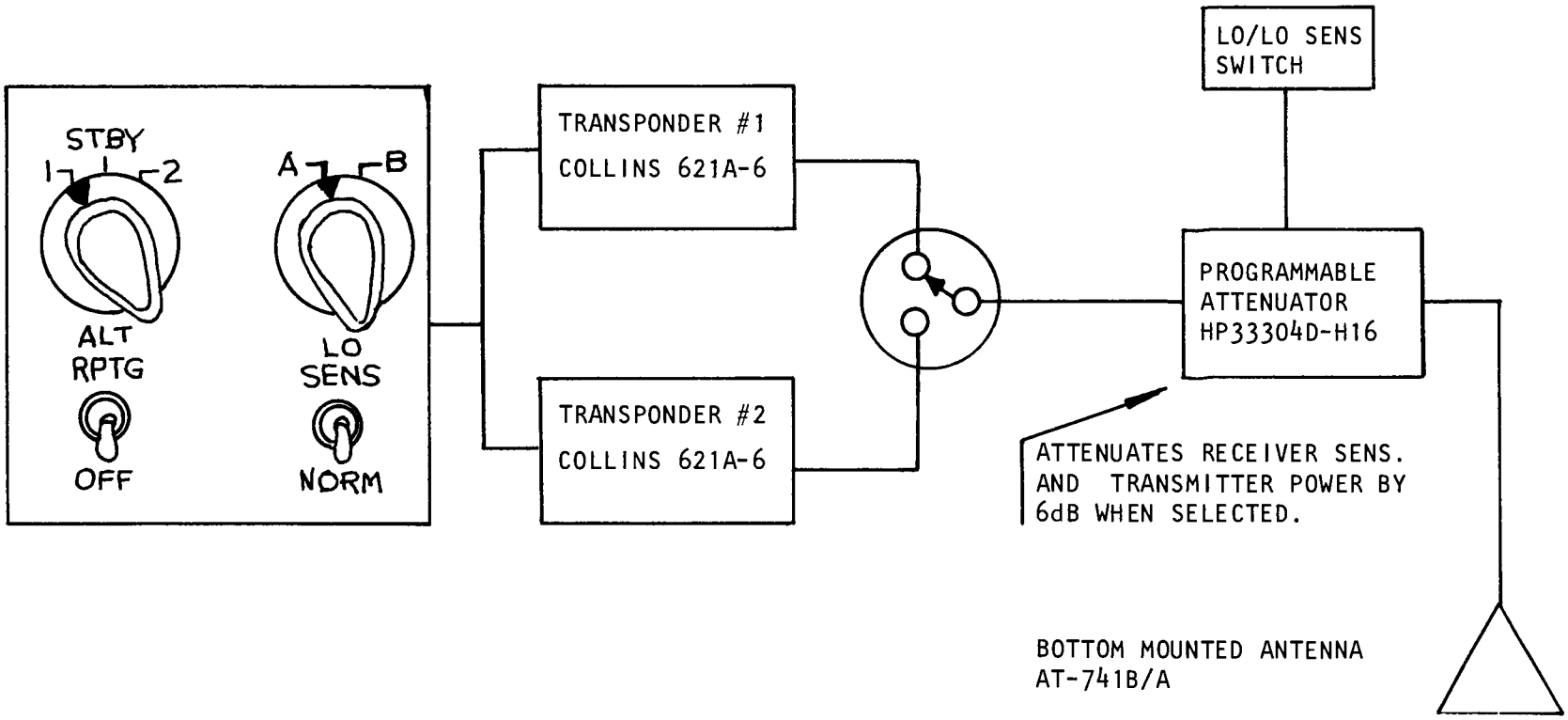
REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

NOTE: This transponder was used during the Flight Test Profile.

TRANSPONDER CONFIGURATION

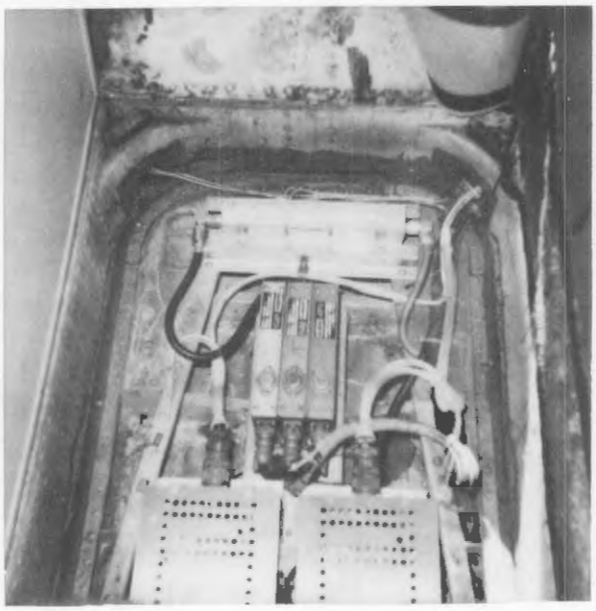
NA-265-80

TRANSPONDER CONFIGURATION
NA-265-80



Transponder antenna location on bottom of aircraft just aft of speed brakes.

View beneath aisle floorboard in front of equipment racks. The black "U-" shaped coaxial cable connects the programmable attenuator (for Lo-Lo operation) to the antenna located beneath the attenuator.



TRANSPONDER SYSTEMS ANALYSIS

NA-265-80

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [XX] Air Carrier [ ] Military [ ] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: Boonton Radio Co.

Model: 8925A DME/ATC Test Set

Calibration Frequency: 270 days

Last Calibration Date: March 29, 1984

Calibration Within Limits? yes [XX] no [ ]

3. TRANSPONDER.

Manufacturer: Collins

Model: 621A-6

Serial Number: #1 S/N 2561 #2 S/N 2508

TSO'd? yes [XX] no [ ]

Class 1B - 2B:

Class 1A - 2A: TSO-C74b;DO-138/AG/A/LO/JN/AAEXXXXX

Calibration Instructions (Obtain Copy)? yes [XXX] not available [ ]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [XXX] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XX] no [ ]

Approved Aircraft Inspection Program? yes [XX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XX] frequency: DEMAND

Scheduled Inspection in Aircraft? yes [XX] no [ ] frequency: 300 Hrs

COPY — FAA

5. AIRCRAFT.

Type: NA-265-80

Number of Transponders Installed: 2

Date Transponder System Installed: 1973

Coax. Type: RG-115A/U

Antenna Type: AT-741B/A

Antenna Checked Periodically? yes [XX] no [ ]

Coaxial Cable Tested Periodically? yes [XX] no [ ]

Transponder in Aircraft Systems Check Performed? yes [XX] no [ ]

Frequency: Periodically 300 Hours (Segment Insp. Card) Demand _____

6. TRANSPONDER TEST. #1 Transponder, S/N 2561

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1090.0 MHz.

Transponder Power Output: 725 watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): x

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response $\leq$ 1%): O.K.

P_2 Pulse Amplitude 9db $<$ P_1 Pulse Amplitude (Response $\geq$ 90%): O.K.

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	-74.5dBm	-69.0dBm
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):	-77.0dBm	-71.5dBm

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No Difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: Yes

Form: Yes

Disposition of Records: Yes

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: 4

Number of Correlating Bench Check Verifications: 2

Mean Time Between Removals (MTBR): Less than 1 in 6 months

Confirmed Failure Rate of MTBR: 50%

8. COMMENTS.

RAMP CALIBRATION PROCEDURES

COLLINS 621A-6

ITEM NO.

RAMP CALIBRATION ATC TRANSPONDER

PROCEDURES

1 General

a. This card provides procedures for calibrating transponder receiver sensitivity to -69 dBm on low sensitivity at 450 ± 20 reply pulses and to check transmitter power.

b. Equipment required:

(1) ATC Test Set 8925A
(2) ATC Test Set 578X-1
(3) Oscilloscope 545
(4) Coax cable RG-8, 10 foot or less
(5) Coax cable RG-58, 20 foot in length
(6) Various connectors
(7) HP 431 Power Meter with 478A Coaxial Thermistor Mount

NOTE: This test equipment requires two (2) hours warm up.

2 Preliminary

a. Check transponders No. 1 and No. 2 for correct installation.

b. Connect power to aircraft and turn on all equipment needed to accomplish ATC ramp calibration.

Cockpit control:

Power	- Select No. 1 XPDR
SENS	- Lo SENS
Mode	- A
ALT RPTG	- OFF
Code	- 0000

c. Gain access to ATC Antenna.

Connect test set to RG-8 coax cable at the antenna end.

ITEM NO.	RAMP CALIBRATION ATC TRANSPONDER (CONT'D)
	d. Connect RG-58 coax from the XPDR suppressor coaxial "T" connector (disconnected from bulkhead) to the AC input on test set counter. The reply rate of counter should be 500 ± 10 replies. (Refer to Card 9149.)
3	Receiver Calibration at Aircraft
	a. Turn attenuator from -50 dBm towards -69 dBm. Watch counter and stop turning attenuator when reply pulses are 450 ± 20 pps. Note attenuator reading and record reading. See tolerance, Step 6, this card.
	b. Reset attenuator to -50 dBm, set XPDR to normal and activate LO-LO circuit.
	c. Repeat step 3.a. for LO-LO circuit.
	d. Repeat steps 3.a. through 3.c. for No. 2 transponder.
	NOTE: If the sensitivity reading is out of tolerance the transponder may be removed to the shop for recalibration. This recalibration should be based on measured loss (dB) in the airplane antenna cable. Refer to TI 4179.13, page 747 (TIEO 75-E-10, Part B-II page 2) instruction.
4	Transmitter Power Out
	a. Set XPDR to NORMAL 77dB, activate LO-LO circuit and set attenuator to -50 dBm at antenna end of cable.
	b. Remove coax from monitor SLG Gen. to Video out on Peak Power Calibrator.
	c. With MON/CAL/MEAS switch in MON/CAL, adjust NULL CONTROL until the two lines on the scope are merged together.
	d. Select MEAS with MON/CAL/MEAS switch, adjust COARSE CONTROL until top line rests on top of pulses. Adjust FINE CONTROL if needed.
	e. Observe Meter for Power Out in Watts. See tolerance, Step 6, this card.
	f. Remove interrogation pulses from transponder and zero the 431 Power Meter.
	NOTE: It is critical that the Power Meter be zeroed.
	g. Set the Power Meter to the 0.1 mw scale and connect its probe to the Power Meter output jack of the 13505A 1 Solator-Monitor (Part of the 8925 Radar Beacon Test Set).

ITEM NO.	RAMP CALIBRATION ATC TRANSPONDER (CONT'D)

h. Interrogate the transponder at a rate (500 - 700 nominal) sufficient to give 0dB reference level on the Power Meter.

i. Switch the LO-LO SENS Circuit IN.

j. Observe the Power Meter reading in dB below the reference Level. See tolerance, Paragraph 6, this card.

k. Repeat steps 4.a. through 4.j. above for No. 2 transponder.

5 Over Interrogation Monitor

a. Set XPDR to NORMAL and deactivate LO-LO circuit.

b. Set attenuator at -50 dBm. Increase dial slowly while observing counter. Increase reply rate through 1000 RPS. The indicator light at console should light between 950 and 1050 replies per second.

Repeat steps a. and b. above for No. 2 transponder.

6 ATC Ramp Tolerances

FUNCTION	CONDITION	SPEC. VALUE + TOL.
Receiver Sensitivity	LO, 450 Replies/Sec LO-LO, 450 Replies/Sec	-69 ± 1.0 dB Within ± 1.0 dB of -69 dBm
Transmitter Power	LO LO-LO/Normal	280 Watts (Minimum) -6dB ± 1 dB
Over-Interrogation Rate	-50 dBm Attenuation Lamp Normal Intensity	1000 ± 50 Replies/Sec
Antenna Cable Loss	TXPDR to Antenna (Not normally measured; See Step 3 NOTE)	3dB (Max)

ITEM NO. | CALIBRATION OF ATC CABLE LOSS

PROCEDURES

1 General

a. This card provides procedures for calculating the transponder cable loss in db's from transponder to antenna. This check is to make sure that the db loss is below 3 db's. For each 3 db's will reduce the power out by 1/2.

b. Equipment required:

(1) 8925A Test Set.
(2) 578X-1 Test Set.
(3) RG-8 coax cable not to exceed 10 ft.
(4) Connectors to make proper connections.

c. Tolerance.

Total db's not to exceed 3 db's.

d. Allow 2 hours warm up of test equipment.

e. Apply proper power to aircraft and turn on all equipment required to accomplish this card.

2 Cable loss procedure

a. Gain access to transponder antenna.

NOTE: Both XPDRS have a common antenna located under aircraft and uses a coax switch relay to select No. 1 or No. 2 XPDR.

Open door in floor, under carpet, to the right of aircraft entrance to expose top of transponder antenna.

b. Connect test set to open end of antenna coax cable using only necessary adapters.

c. Connect RG-58 coax cable from the XPDR suppressor coaxial "T" connector (disconnected from bulkhead) to the AC input on test set counter.

ITEM	CALIBRATION OF ATC CABLE LOSS (CONT'D)

d. Set up test set to check the MTL on Lo Sens. (Refer to card 9149).

e. Select No. XPDR on control head with sensitivity selector switch in LO SENS and ALT RPTG/OFF switch in OFF.

f. Turn attenuator clockwise until counter reads 450 reply pulses per second.

g. Take note of attenuator reading.

h. Turn XPDR off.

i. Disconnect test set from antenna coax and reconnect test set to coax labeled ATC 1-2 that is located at FS-50 in nose of aircraft.

NOTE: This connection is the nearest to the XPDR that is accessible in nose.

j. Turn XPDR ON.

k. Repeat steps 2e and f.

l. Subtract step f from step j. This number is the db loss from FS-50 bulkhead to antenna. It should be less than 2 db.

m. Add 1.0 db to results found in step 2k. Also add .3 db for each connector used making connection to cable.

NOTE: This 1.0 db is the calculated loss between XPDR rack through coax switch relay to FS-50 bulkhead.

Example:	Calculated cable loss	=	1.5
	Add constant db		1.0
	add 1 connector		.3
	TOTAL		2.8 db

n. Tag cable at bulkhead FS-50 with the calculated db loss. Use a small hard tag with string attached. Write date and cable loss as in the example.

o. Reconnect cables and restore aircraft for flight.

NOTE: If the sensitivity reading is out of tolerance the transponder may be removed to the shop for recalibration. This recalibration should be based on measured loss (dB) in the airplane antenna cable. Refer to TI 4179.13, page 747 (TIEO 75-E-10 Part B-II page 2) instruction.

4. Transmitter Power Out

a. Set XPDR to Lo Sens and set attenuator to -50 dbm at antenna end of cable.
b. Remove coax from monitor SLG Gen. to Video out on Peak Power Calibrator.
c. With MON/CAL/MEAS switch in MON/CAL, adjust NULL CONTROL until the two lines on the scope are merged together.
d. Select MEAS with MON/CAL/MEAS switch, adjust COARSE CONTROL until top line rests on top of pulses. Adjust FINE CONTROL if needed.
e. Observe Meter for Power Out in Watts. See tolerance, Para. 6.
f. Remove interrogation pulses from transponder and zero the 481 Power Meter.
   NOTE: It is critical that the Power Meter be zeroed.
g. Set the Power Meter to the 0.1 mw scale and connect its probe to the Power Meter output jack of the 13505A 1 Solator-Monitor (Part of the 8925 Radar Beacon Test Set).
h. Interrogate the transponder at a rate (500 - 700 nominal) sufficient to give 0dB reference level on the Power Meter.
i. Switch the LO-LO SENS Circuit IN.
j. Observe the Power Meter reading in dB below the reference level. See tolerance, Para. 6.
k. Repeat steps a. through j. above for No. 2 transponder.

5. Over Interrogation Monitor

a. Set XPDR to NORMAL and deactivate LO-LO circuit.

b. Set attenuator at -50 dbm. Increase dial slowly while observing counter. Increase reply rate through 1000 RPS. The indicator light at console should light between 950 and 1050 replies per second.

Repeat steps a. and b. above for No. 2 transponder.

6. ATC Ramp Tolerances

FUNCTION	CONDITION	SPEC. VALUE + TOL.
Receiver Sensitivity	LO, 450 Replies/Sec LO-LO, 450 Replies/Sec	-69 ± 1.0 dbm Within ± 1.0 dbm of above measure value..
Transmitter Power	LO LO-LO	280 Watts (Minimum) -6dB ± 1 dB
Over-Interrogation Rate	-50 dbm Attenuation Lamp Normal Intensity	1000 ± 50 Replies/Sec
Antenna Cable Loss	TXPDR to Antenna (Not normally measured; See Para. 3 NOTE)	3 dB (Max)

CALIBRATION INSTRUCTIONS:

1. General

a. This card provides procedures for calibrating transponder receiver sensitivity to -69 dbm on low sensitivity at 450 ± 20 reply pulses and to check transmitter power.

b. Equipment required:

(1) ATC Test Set 8925A
(2) ATC Test Set 578X-1
(3) Oscilloscope 545 or equivalent
(4) Coax cable RG-8, 10 foot or less
(5) Coax cable RG-58, 20 foot in length
(6) Various connectors
(7) HP 431 Power Meter with 478A Coaxial Thermistor Mount.
NOTE: This test equipment requires two (2) hours warm up.

2. Preliminary

a. Check transponders No. 1 and No. 2 for correct installation.

b. Connect power to aircraft and turn on all equipment needed to accomplish ATC ramp calibration.

(1) Cockpit control:

Power - Select No. 1 XPDR
SENS - Lo SENS
Mode - A
ALT RPTG - OFF
Code - 0000

c. Gain access to ATC Antenna which is located under floor to the right of aircraft door.

(1) Connect test set to RG-8 coax cable at the antenna end.

d. Connect RG-58 coax coax from the XPDR suppressor coaxial "T" connector (disconnected from bulkhead) to the AC input on test set counter. The reply rate of counter should be 500 ± 10 replies. (Refer to Card ~~0575~~ 9149.)

3. Receiver Calibration at Aircraft

a. Turn attenuator from -50 dbm towards -69 dbm. Watch counter and stop turning attenuator when reply pulses are 450 ± 20 pps. Note attenuator reading and record reading. See tolerance, Para. 6.

b. Reset attenuator to -50 dbm, set XPDR to normal and activate LO-LO circuit.

c. Repeat step a for LO-LO circuit.

d. Repeat steps a through c for No. 2 transponder.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

C-90

11/27/84

FAA ATLANTA FLIGHT INSPECTION FIELD OFFICE

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	45.0	us.
2. Suppression Time	31.5	us
3. Reply Power	Normal 380 /Low 380	Watts
4. Frequency	1090	MHz.
5. F_1 Pulse Width	0.55	us.
6. F_2 Pulse Width	0.55	us.
7. Sensitivity	Normal -74.5 /Low -71.5	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.05	us.
10. Mode A Delay	2.5	us.
11. Mode C Delay	2.5	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.6/2.4	us.
14. Mode A Decode Accuracy	7.5/8.5	us.
15. Mode C Decode Accuracy	20.6/21.4	us.

C-90
N-19
#2 Transponder, S/N 9469, Collins TDR-90

NOTE: This transponder was actually used during the Flight Test Profile.

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/27/84

AIRCRAFT NUMBER: N-19

[X] PRIMARY AIRCRAFT

TYPE: C-90

[ ] BACK-UP AIRCRAFT

LOCATION: ATLANTA FIFO (FTY)

TRANSPONDER TYPE: Collins TDR-90

SERIAL NUMBER: 9469

#2 Transponder

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-72.0 dBm
LO	N/A	-68.5 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

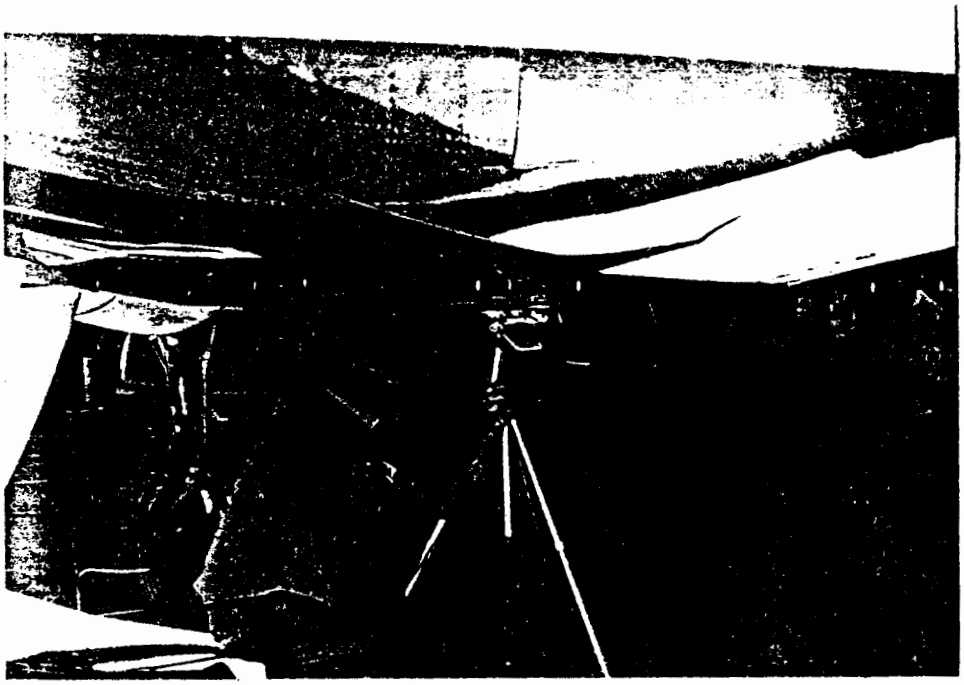
TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	300 Watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

NOTE: This transponder was used during the Flight Test Profile.

TRANSPONDER CONFIGURATION

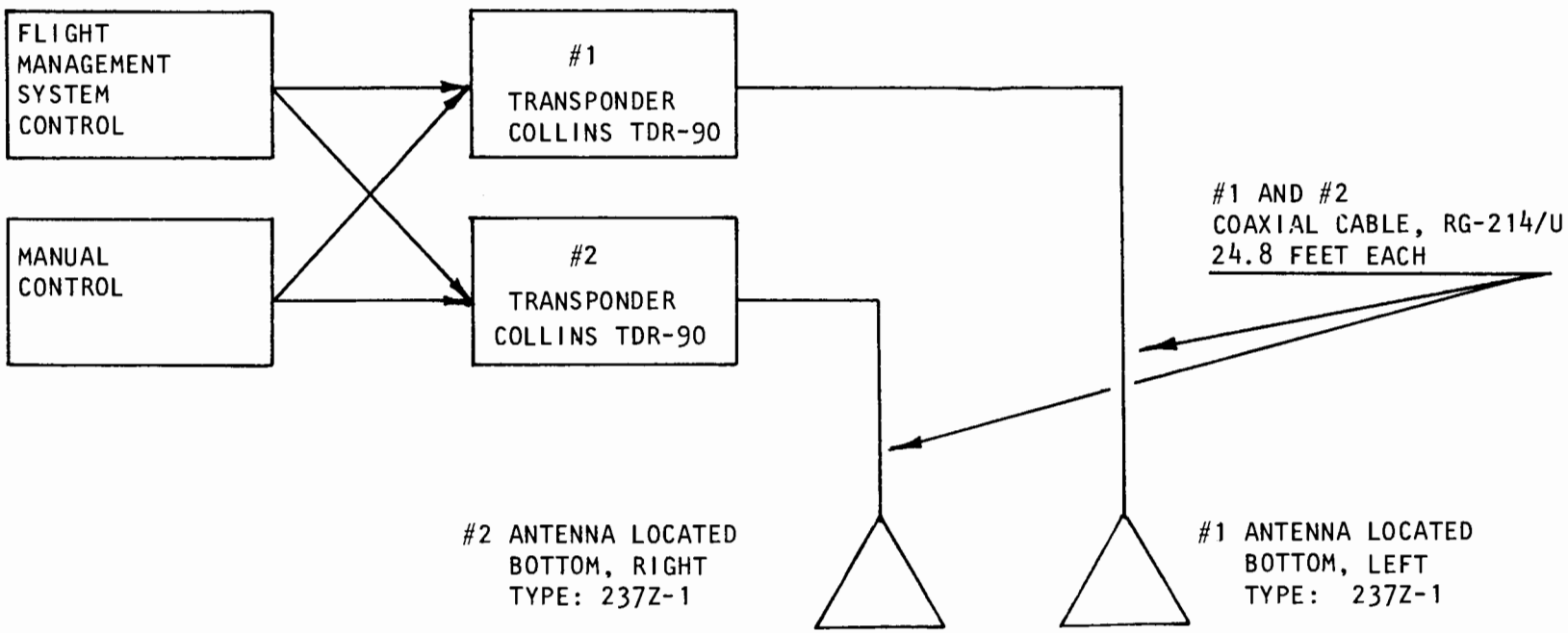
C-90



F-90 TRANSPONDER RAMP CHECK

TRANSPONDER CONFIGURATION

C-90



TRANSPONDER SYSTEM ANALYSIS

C-90

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [XX] Air Carrier [ ] Military [ ] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: FIXED BASE OPERATOR

Model: _____

Calibration Frequency: _____

Last Calibration Date: _____

Calibration Within Limits? yes [ ] no [ ]

3. TRANSPONDER.

Manufacturer: COLLINS

Model: TDR-90

Serial Number: 9469

TSO'd? yes [XX] no [ ]

Class 1B - 2B: _____

Class 1A - 2A: X RTCA DO-138(ENV CAT AD/A/G/IN/AAAEXXXXX)

Calibration Instructions (Obtain Copy)? yes [ ] not available [X]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [X] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [X] no [ ]

Approved Aircraft Inspection Program? yes [X] no [ ]

Scheduled Bench Maintenance? yes [ ] no [X] frequency: DEMAND

Scheduled Inspection in Aircraft? yes [X] no [ ] frequency: 300HRS

5. AIRCRAFT.

Type: C-90

Number of Transponders Installed: 2

Date Transponder System Installed: _____

Coax. Type: RG-214/U

Antenna Type: 237Z-1

Antenna Checked Periodically? yes [x] no [ ]

Coaxial Cable Tested Periodically? yes [X] no [ ]

Transponder in Aircraft Systems Check Performed? yes [X] no [ ]

Frequency: Periodically SEGMENT INSPECTION Demand _____

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1090.0 MHz.

Transponder Power Output: 380 Watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): X

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response $\leq$ 1%): O.K.

P_2 Pulse Amplitude 9db $<$ P_1 Pulse Amplitude (Response $\geq$ 90%): O.K.

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	-72dBm	-68.5dBm
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):	N/A	N/A

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: YES

Form: YES

Disposition of Records: YES

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: 1 (Control head --not transponder)

Number of Correlating Bench Check Verifications: 0

Mean Time Between Removals (MTBR): insufficient data

Confirmed Failure Rate of MTBR: insufficient data

8. CONTENTS.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/28/84

BE-55

FAA ATLANTA FLIGHT INSPECTION FIELD OFFICE

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER) 1/

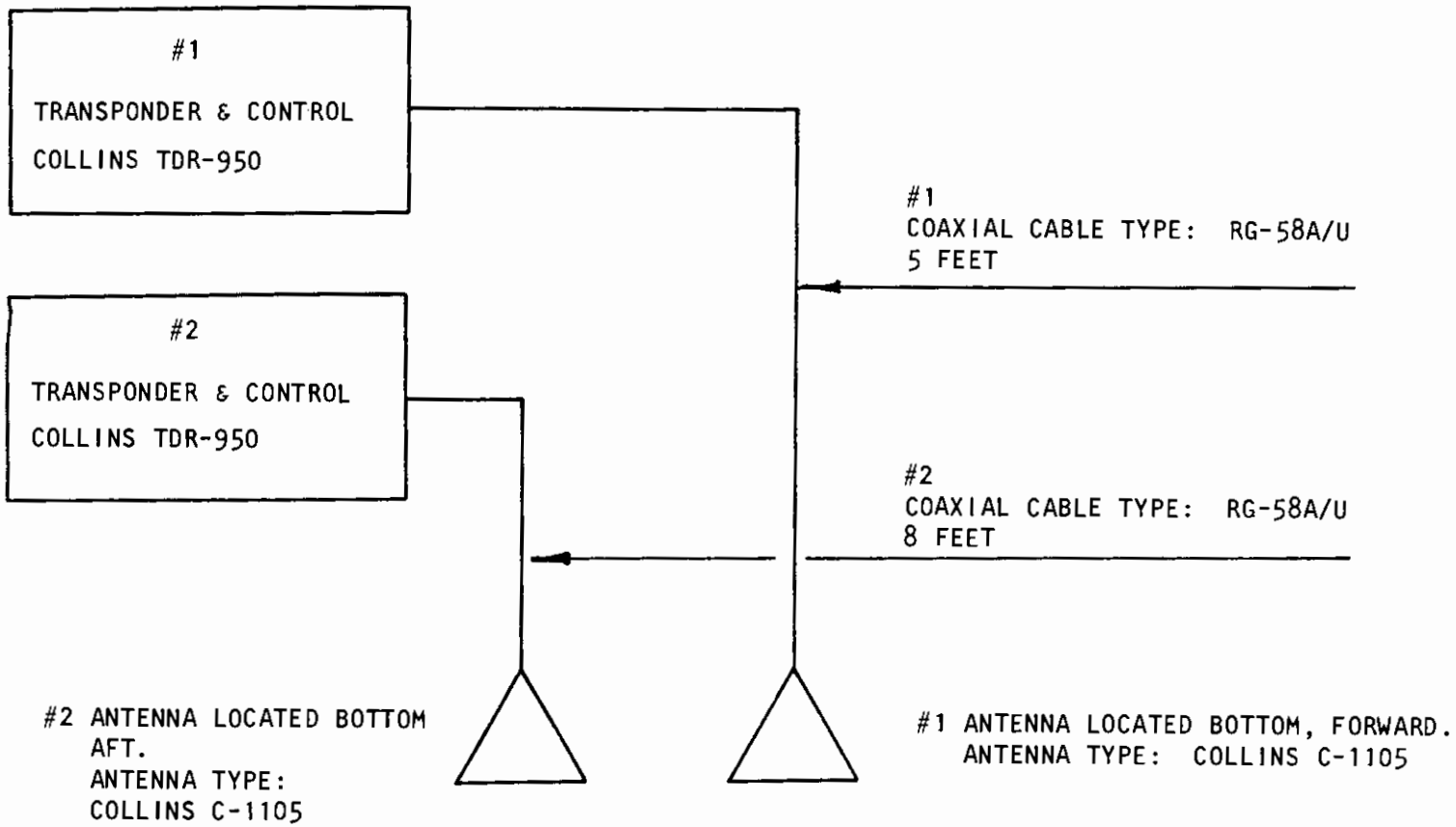
Characteristic	Test Reading	
1. Dead Time	29.0	us.
2. Suppression Time	N/A	us
3. Reply Power	Normal 200 /Low N/A	Watts
4. Frequency	1088.7	MHz.
5. F_1 Pulse Width	0.4	us.
6. F_2 Pulse Width	0.4	us.
7. Sensitivity	Normal -59.6 /Low N/A	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.01	us.
10. Mode A Delay	2.8	us.
11. Mode C Delay	2.8	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.5/2.4	us.
14. Mode A Decode Accuracy	7.6/8.4	us.
15. Mode C Decode Accuracy	20.6/21.6	us.

BE-E55
N-2014U
TDR-950 S/N 16646 2/

1/ Mock-up not available. Parameters measured at antenna.

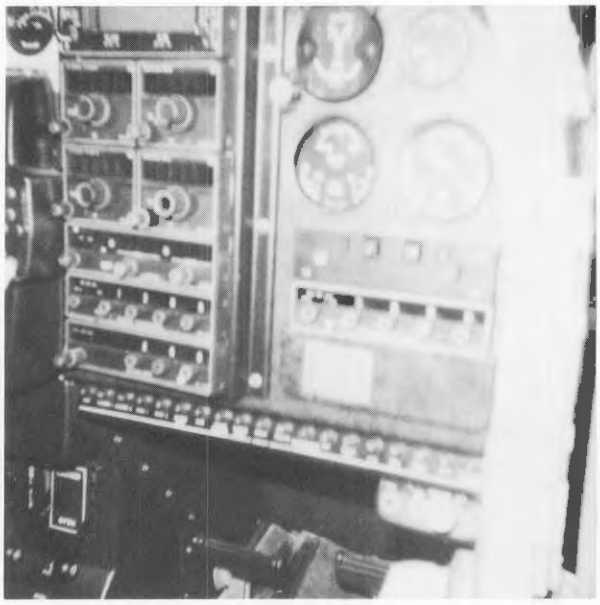
2/ This transponder was used in the Flight Test Profile.

TRANSPONDER CONFIGURATION
BE-E55



BE-E55 N-2014U

1. Transponder Antenna Location.
2. Coaxial Connection to Antenna.
3. Transponder Control Head.
4. Test Set Hook-Up.



TRANSPONDER SYSTEM ANALYSIS

BE-E55

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [ ] Air Carrier [ ] Military [ ] Air Taxi [ ] General Aviation [XX]

2. TEST EQUIPMENT.

Manufacturer: Fixed Base Operator

Model: _____

Calibration Frequency: _____

Last Calibration Date: _____

Calibration Within Limits? yes [ ] no [ ]

3. TRANSPONDER.

Manufacturer: Collins

Model: TDR-950

Serial Number: 16646

TSO'd? yes [XX] no [ ]

Class 1B - 2B: _____

Class 1A - 2A: X

Calibration Instructions (Obtain Copy)? yes [ ] not available [X]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [X] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XX] no [ ]

Approved Aircraft Inspection Program? yes [XX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XX] frequency: Demand

Scheduled Inspection in Aircraft? yes [ ] no [XX] frequency: Demand

5. AIRCRAFT.

Type: BE-E55

Number of Transponders Installed: 2

Date Transponder System Installed: 04/20/81

Coax. Type: RG-58A/U

Antenna Type: C-1105 (Collins, blade)

Antenna Checked Periodically? yes [ ] no [XXX]

Coaxial Cable Tested Periodically? yes [ ] no [XXX]

Transponder in Aircraft Systems Check Performed? yes [ ] no [XXX]

Frequency: Periodically NO Demand Yes

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1088.7 MHz.

Transponder Power Output: 200 watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): X

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response $\leq$ 1%): O.K.

P_2 Pulse Amplitude 9db $<$ P_1 Pulse Amplitude (Response $\geq$ 90%): O.K.

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	-59.6	N/A
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):	N/A	N/A

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: Yes

Form: Yes

Disposition of Records: Yes

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: 1

Number of Correlating Bench Check Verifications: 1

Mean Time Between Removals (MTBR): Insufficient data

Confirmed Failure Rate of MTBR: Insufficient data

8. CONTENTS.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

03/19/85

F-90 FAA HONOLULU FIFO, HONOLULU, HAWAII

TRANSPONDER CALIBRATION VERIFICATION

DATE 03-18-85

AIRCRAFT NUMBER: N-18

TYPE: F-90

LOCATION: HONOLULU FIFO

[XX] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: TDR-90

SERIAL NUMBER: 14720

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	- 74.0 dBm
LO	N/A	- 67.7 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

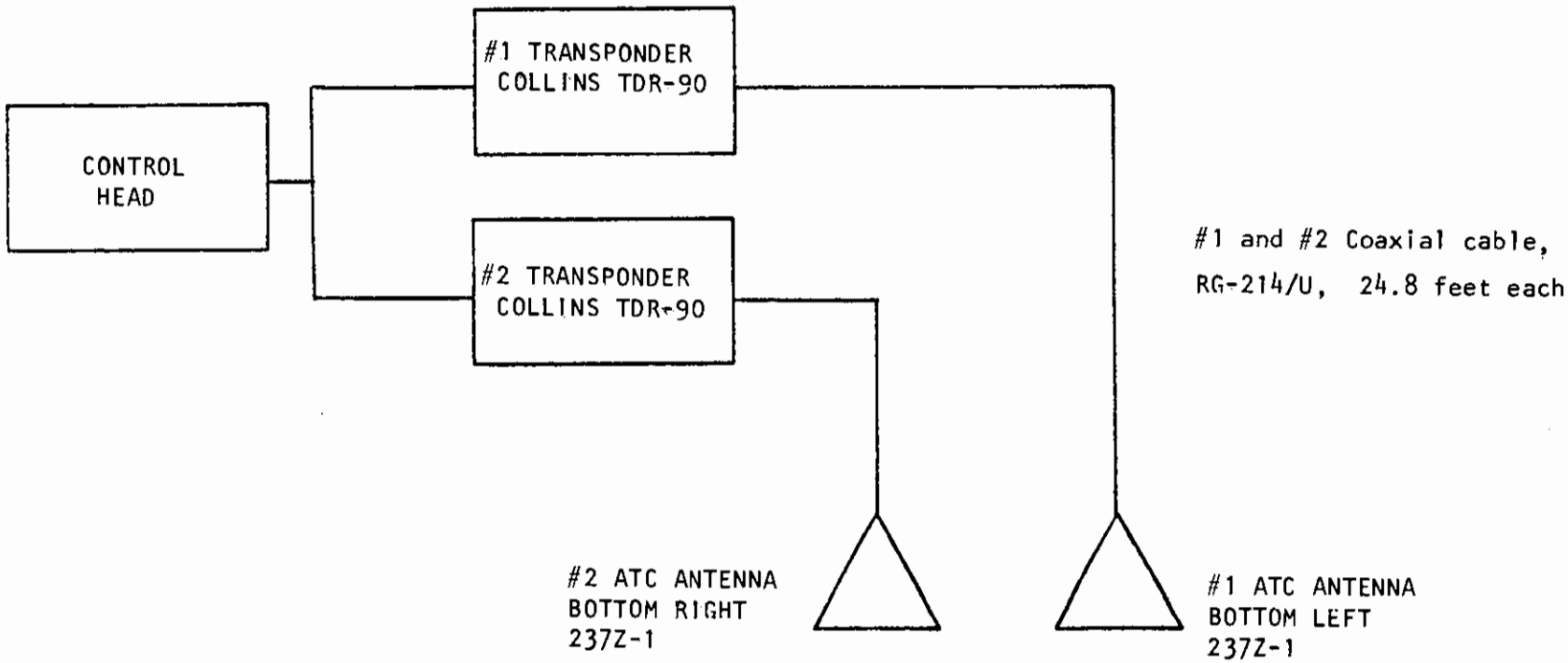
TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	220 WATTS
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS:

1 TRANSPONDER

TRANSPONDER CONFIGURATION

F-90



F-90 TRANSPONDER RAMP CHECK

TRANSPONOER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

03/19/85

B-727 FAA HONOLULU FIFO, HONOLULU, HAWAII

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	75.8	us.
2. Suppression Time	35.0	us
3. Reply Power	Normal 555 /Low 555	Watts
4. Frequency	1090.0	MHz.
5. F_1 Pulse Width	0.45	us.
6. F_2 Pulse Width	0.45	us.
7. Sensitivity	Normal -76.0 /Low -70.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.08	us.
10. Mode A Delay	3.1	us.
11. Mode C Delay	3.1	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.4 / 2.4	us.
14. Mode A Decode Accuracy	7.2 / 8.5	us.
15. Mode C Decode Accuracy	20.5/21.4	us.

* DATE 03/01/85

TRANSPONDER TYPE COLLINS 621A SERIAL NUMBER 1854 POSITION NUMBER 1

AIRCRAFT TYPE B-727 NUMBER N-77

*Verified 03/11/85

TRANSPONDER CALIBRATION VERIFICATION

DATE 03-12-85

AIRCRAFT NUMBER: N-77

TYPE: B-727

LOCATION: HONOLULU FIFO

[XX] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: COLLINS 621A

SERIAL NUMBER: 1854

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-75.8 dBm
LO	N/A	-69.7 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	-69.9 dBm

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	540 WATTS
LO/LO (FAA SABRE-80 ONLY)	N/A	120 WATTS

REMARKS:

#1 TRANSPONDER

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	75.8	us.
2. Suppression Time	35.0	us
3. Reply Power	Normal 725 /Low 725	Watts
4. Frequency	1090.0	MHz.
5. F_1 Pulse Width	0.45	us.
6. F_2 Pulse Width	0.45	us.
7. Sensitivity	Normal 76.0 /Low 70.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.04	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.4 / 2.5	us.
14. Mode A Decode Accuracy	7.2 / 8.4	us.
15. Mode C Decode Accuracy	20.4 / 21.5	us.

* DATE 03-01-85

TRANSPONDER TYPE COLLINS 621A SERIAL NUMBER 1864 POSITION NUMBER 2

AIRCRAFT TYPE B-727 NUMBER N-77

* NOTE: verified 3/11/85
This transponder set as close to 9 dB (SLS) as possible without component change for flight test profile of 03/19/85.

DYNAMIC RANGE	NORMAL	SLS DITCH TO MIN
30	4.6	7.2
40	4.2	6.6
50	4.8	7.9
60	5.2	8.0
70	3.8	5.5

TRANSPONDER CALIBRATION VERIFICATION

DATE 03-12-85

AIRCRAFT NUMBER: N-77

TYPE: B-727

LOCATION: HONOLULU FIFO

[XX] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: COLLINS 621A

SERIAL NUMBER: 1864

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-75.8 dBm
LO	N/A	-69.7 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	-69.7 dBm

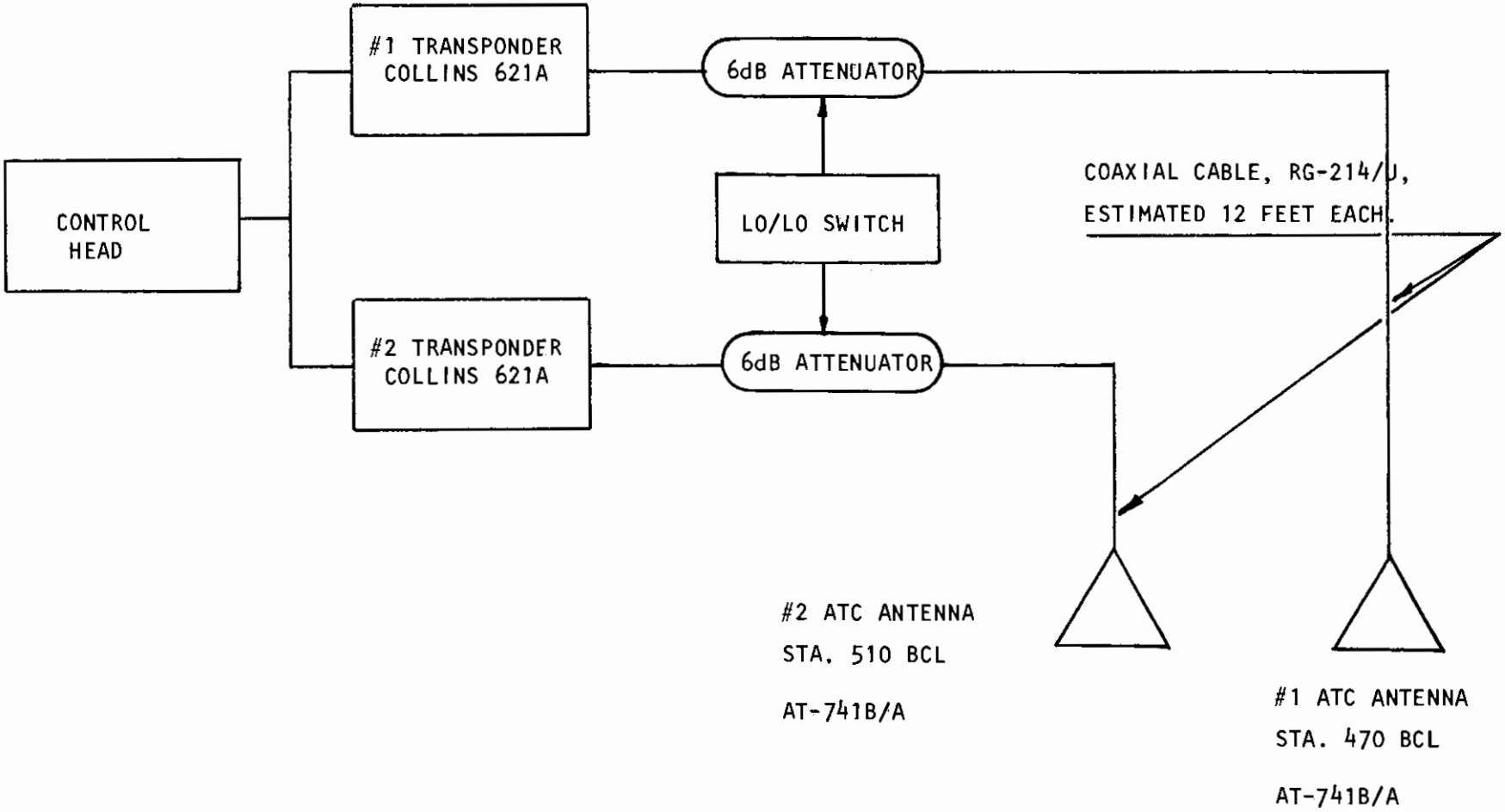
TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	655 WATTS
LO/LO (FAA SABRE-80 ONLY)	N/A	130 WATTS

REMARKS:

#2 TRANSPONDER

TRANSPONDER CONFIGURATION

B-727



B-727 ANTENNA LOCATION AND RAMP CALIBRATION

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/29/84

C-130H, U.S. AIR FORCE RESERVES

DOBBINS AFB., GEORGIA

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	93.0	us.
2. Suppression Time	30.0	us
3. Reply Power	Normal 950 /Low 950	Watts
4. Frequency	1089.1	MHz.
5. F_1 Pulse Width	0.5	us.
6. F_2 Pulse Width	0.5	us.
7. Sensitivity	Normal -77.2 /Low -63.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.01	us.
10. Mode A Delay	3.2	us.
11. Mode C Delay	3.2	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.7/2.3	us.
14. Mode A Decode Accuracy	7.5/8.6	us.
15. Mode C Decode Accuracy	20.5/21.7	us.

C-130H
AF-81-0626
Transponder: RT-859A/APX-72 S/N 4143

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/29/84

AIRCRAFT NUMBER: AF-81-0626

[X] PRIMARY AIRCRAFT

TYPE: C-130H

[ ] BACK-UP AIRCRAFT 2/

LOCATION: Dobbins A.F.B., Georgia 1/

TRANSPONDER TYPE: RT-859A/APX-72

SERIAL NUMBER: 4143

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-77.2 dBm	-74.5 dBm
LO	-63.0 dBm	-59.2 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	825 watts	615 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

1/ 94th Consolidated Aircraft Maintenance Squadron, U.S.A.F. Reserves.

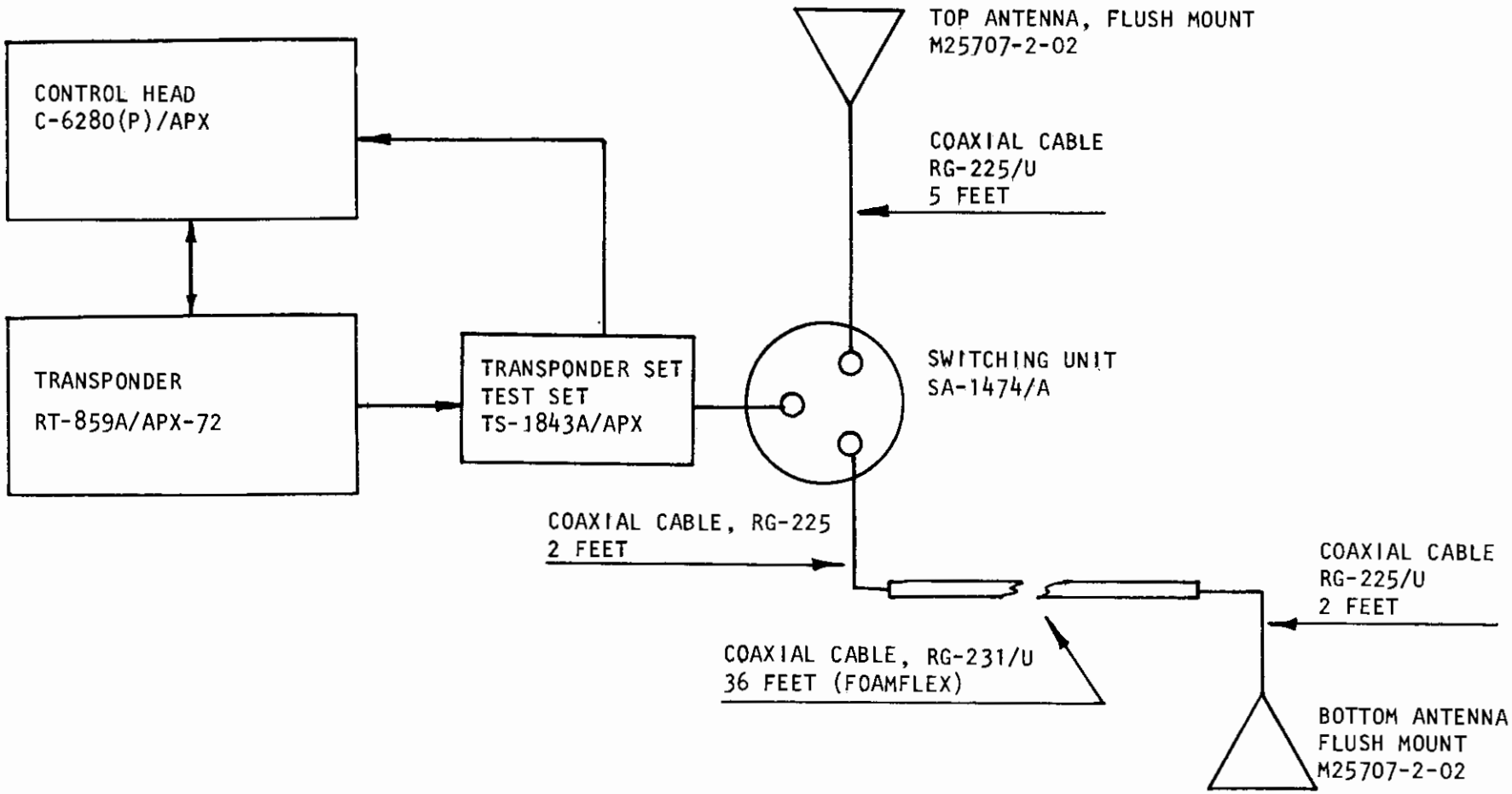
2/ Back-up aircraft not available.

TRANSPONDER CONFIGURATION

C-130H

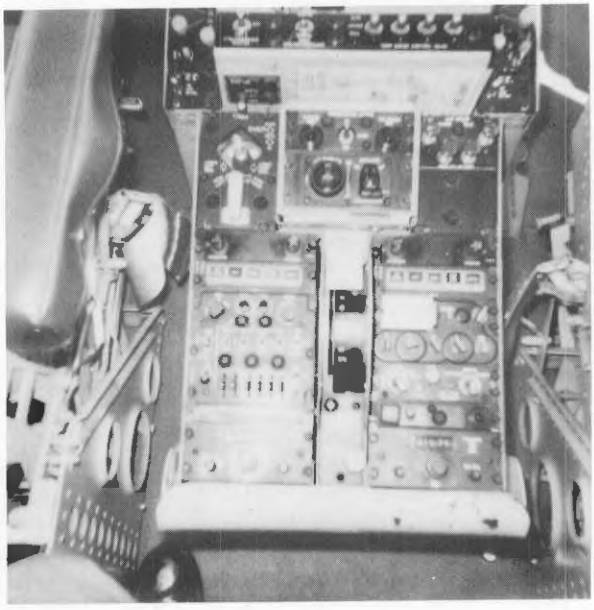
TRANSPONDER CONFIGURATION

C-130H



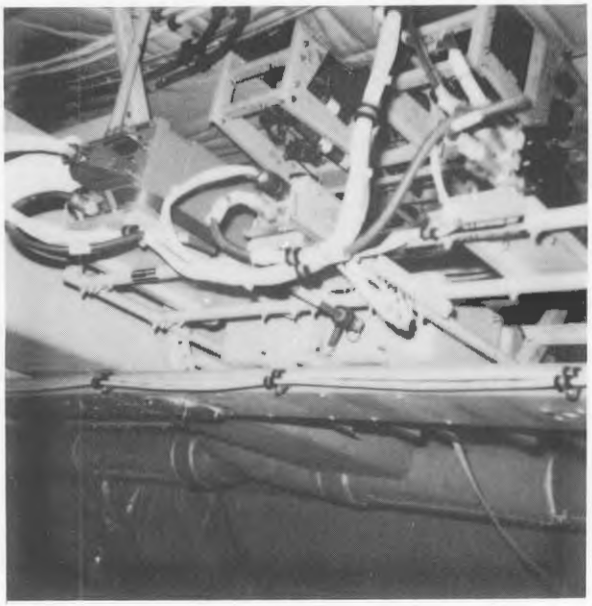
C-130H

1. Top antenna location. (Flush Mount)
2. Bottom antenna location. (Flush Mount)
3. Control Head.



1. Technician using ladder to reach transponder.
2. Overhead equipment racks.
3. Equipment:
   a. APX-72 Transponder
   b. TS-1843A Test Set
   c. SA-1474A Switching Unit

   Circled: top antenna connection



TRANSPONDER SYSTEM ANALYSIS

C-130H

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [ ] Air Carrier [ ] Military [XXX] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: Packard-Bell

Model: AN/UPM-137A (S/N A655)

Calibration Frequency: 90 days

Last Calibration Date: September 10,1984

Calibration Within Limits? yes [XXX] no [ ]

3. TRANSPONDER.

Manufacturer: Hazeltine

Model: RT-859A/APX-72

Serial Number: 4143

TSO'd? yes [XXX] no [ ]

Class 1B - 2B: _____

Class 1A - 2A: (Military Specifications)

Calibration Instructions (Obtain Copy)? yes [XX] not available [ ]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [XX] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XX] no [ ]

Approved Aircraft Inspection Program? yes [XX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XXX] frequency: Demand

Scheduled Inspection in Aircraft? yes [ ] no [XXX] frequency: Demand

5. AIRCRAFT.

Type: C-130H

Number of Transponders Installed: 1

Date Transponder System Installed: 1981

Coax. Type: RG-225/U & RG-231/U (See Transponder Configuration Diagram)

Antenna Type: Flush Mount, type M25707-2-02

Antenna Checked Periodically?	**yes**	[ ]	**no**	[XXX]	1/
Coaxial Cable Tested Periodically?	**yes**	[ ]	**no**	[XXX]	
Transponder in Aircraft Systems Check Performed?	**yes**	[ ]	**no**	[XXX]	

Frequency: Periodically NO **Demand** YES 1/

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1089.1 MHz.

Transponder Power Output: 950 watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): xx

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response ≤ 1%): 0.K

P_2 Pulse Amplitude 9db < P_1 Pulse Amplitude (Response ≥ 90%): 0.K.

Receiver Sensitivity Verification by use of Test Set:

		normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	top ant.	-77.2	-63.0
	bottom ant.	-74.5	-59.2
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):		-77.2	-63.0

1/ These parameters are constantly monitored by the Transponder Set Test Set, TS-1843A, and failures or out-of-tolerance conditions are annunciated on the control head on every preflight and/or each time the test is initiated from the control head.

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: Yes

Form: Yes

Disposition of Records: Yes

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984). 1/

Number of Pilot Complaints: 2

Number of Correlating Bench Check Verifications: 1

Mean Time Between Removals (MTBR): Insufficient data

Confirmed Failure Rate of MTBR: Insufficient data

8. COMMENTS.

1/ Records were available only for a 90-day period preceding November 1, 1984.

CALIBRATION PROCEDURES

AN/APX-72

Table 4-44. Complete Alignment and Adjustment Procedures Using AN/UPM-137 (Cont)

STEP	PROCEDURE	REMARKS
4. Ditch length adjustments (RT-859/ APX-72)	a. Ensure C-6280(P)/APX (AN/APM-239) MASTER switch is in STBY. Remove cables between ANT. J5 (receiver-transmitter) and RF IN/OUT on AN/UPM-137. Connect the 10-dB attenuator to ANT. J5 and a cable between the attenuator and SIG GEN IN/OUT.	
	b. Set AUX ATTEN +3-60 dB dial to 0 and adjust OUTPUT ATTEN 0-100 dBm control to obtain -27 dBm at ANT. J5. Connect oscilloscope Channel A probe to A1TP4.	
	c. Adjust A1R10 to obtain trapezoidal waveform with base line equal to 13.5 μs. Disconnect probe from A1TP4.	See waveform at TP4 of figure 6-4.
4A. Wide pulse detector adjustments (RT-859A/ APX-72)	a. Setup AN/UPM-137 using the preliminary and starting procedures in paragraphs 4-12.a and 4-12.b, page 4-46, establishing an output level 3 dB above MTL. Ensure that AUX-ATTEN-13-60 dB is set to 0.	
	b. Set MODE 1 switch of AN/UPM-137 to MODE 1 (off) and MODE C switch to ON (up). Set M1-TEST/ON/OUT switch of AN/APM-239 to OUT and MC-TEST/ON/OUT switch to ON. The C-6280(P)/APX MASTER switch should be set to STANDBY.	
	c. Remove cable from AUX MOD IN and connect to CHAN B VIDEO IN of AN/UPM-137 oscilloscope. Set CHAN B 75Ω switch to IN.	

Table 4-44. Complete Alignment and Adjustment Procedures Using AN/UPM-137 (Cont)

STEP	PROCEDURE	REMARKS
4A. Wide pulse detector adjustments (RT-859A/ APX-72) (Cont)	d. Adjust the CHAL/TAG WIDTH control on the AN/UPM-137 for 1.4 μs pulse width. Reconnect cable to AUX MOD IN. Assure that the electronic counter is connected to SUPPRESSION OUT jack on AN/APM-239.	
	e. Adjust A1R10 until electronic counter indicates an average of 10 counts per second. Note: Adjust A1R10 cw to reduce the count.	
	f. Rotate the OUTPUT ATTEN on the AN/UPM-137 from 3 dB to 50 dB above MTL. If electronic counter indicates higher than an average ten counts, readjust A1R10.	
5. Side lobe suppression adjustments for transponders equipped with AR3, Part No. 4023409-0501, or 4023409-0502	a. Ensure C-6280(P)/APX (AN/APM-239) MASTER switch is in STBY.	
	b. Connect CHAN B VIDEO IN of oscilloscope to VIDEO OUT on rf generator. Connect CHAL/TAG VAR AMP OUT of SIS generator to MAIN MOD IN of rf generator. Adjust AUX ATTEN +3-60 dB dial to 0 dB. Set the CHAL/TAG switch to SLS OUT and the SLS POSN control to NORM. Connect SLS OUT to AUX MOD IN. Verify that SLS pulse is present and equal in amplitude to the interrogation pulses on oscilloscope Channel B. Adjust AUX ATTEN +3-60 dB dial if necessary to obtain equality then increase dial reading by 9 dB.	

Table 4-44. Complete Alignment and Adjustment Procedures Using AN/UPM-137 (Cont)

STEP	PROCEDURE	REMARKS
5. Side lobe suppression adjustments (Cont)	c. Adjust OUTPUT ATTEN 0-100 dBm control to obtain -64 dBm at ANT. J5 of receiver-transmitter. Connect CHAN A VIDEO IN of oscilloscope to A1TP2. Adjust A1R6 until ISLS pulse appears intermittently at A1TP2, then readjust until ISLS pulse disappears. Sweep OUTPUT ATTEN 0-100 dBm dial from 3 dB to 50 dB above MTL (77.5 dBm). If ISLS pulse reappears intermittently from 6 to 50 dB below MTL, repeat adjustments until ISLS does not appear in this range. Disconnect probe from A1TP2.	
	d. Setup the equipment as directed in step 3.a, page 4-290. The AUX ATTEN and OUTPUT ATTEN should be set for a -77.5 dBm signal at ATN. J5. On the C-6280(P)/APX (AN/APM-239), set the M2-TEST/ON/OUT switch to ON and all other modes to OFF. On the SIS generator of the AN/UPM-137, set the CHAL/TAG CODER MODE 2 switch to ON and all other mode switches to off. Adjust A1R25 until counter indicates an average of 450 counts.	90% replies
	e. Set C-6280(P)/APX MASTER to STBY. Repeat steps 4.a. and 5.b. and c. and adjust A1R6 only if required. If A1R6, requires adjustment, repeat step 5.d. adjusting A1R25 only if required. If A1R25 requires adjustment, repeat complete cycle until no further adjustments are required.	

Table 4-44. Complete Alignment and Adjustment Procedures Using AN/UPM-137 (Cont)

STEP	PROCEDURE	REMARKS
5. Side lobe suppression adjustments (Cont)	f. Restore equipment connections as stated in step 3.a.	
5A. Side Lobe Suppression Adjustments for transponders equipped with AR3, Part No. 4023409-0503	a. Ensure that C-6280(P)/APX (AN/APM-239) MASTER switch is in STBY.	
	b. Connect CHAN B VIDEO IN of oscilloscope to VIDEO OUT on rf generator. Connect CHAL/TAG VAR AMP OUT of SLS generator to MAIN MOD IN of rf generator. Adjust AUX ATTEN +3-60 dB dial to 0 dB. Set the CHAL/TAG switch to SLS OUT and the SLS POSN control to NORM. Connect SLS OUT to AUX MOD IN. Verify that SLS pulse is present and equal in amplitude to the interrogation pulses on oscilloscope Channel B. Verify that the width of all pulses is 0.8 microsecond. Adjust AUX ATTEN +3-60 dB dial if necessary to obtain equal amplitudes, and then increase dial reading by 9 dB. Connect electronic counter to SUPPRESSION OUT jack on AN/APM-239.	
	c. Sweep OUTPUT ATTEN 0-100 dBm control from 3 dB to 50 dB below minimum triggering level (MTL) (77.5 dBm). Verify that the electronic counter reads 500 (full firing) for levels from 6 dB to 50 dB below MTL. If misfiring occurs, adjust A1R6 slightly to obtain full firing.	

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
1					LCL-~~918 TA~~ 94 CAM 60-2 11 Je75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST / AN-APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.

PRELIMINARY SETTINGS AN/APM 239

1. POWER SWITCH — ON
2. SET AC AND DC LEVELS USING CONTROLS
3. MODE C ENCODER SIMULATOR:
   a. ALL SWITCHES — OFF
   b. TEST CONDITION — VOLTS
   c. ALTITUDE DIGITIZER — OUT
4. MODE 4 — N/A
5. X PULSE — OFF

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP					2
				6. AC/DC	AC/DC			
				7. CONTROL BOX				
				a. MODE 4	ALL OFF			
				b. MASTER	OFF			
				c. RAD TEST	OUT			
				d. MODE SWITCHES	ALL ON			
				e. (IDENT/MIC)	OUT			
				f. MODE ONE	CODE 73			
				g. MODE 3/A	CODE 7777			
				h. MODE 2 (RT)	CODE 7777			

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
3					LCL-~~918 T~~ 94 CAM ·60-2 1	NE75

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
				FUNCTIONAL TEST AN/APX/72			

PRELIMINARY SETTINGS AN/UPM-137

a. SIS GENERATOR:

1. SUPPRESSOR N/A

2. PRF

a. RANGE MULT X100

b. MULT 1-11 5.0

3. SIF CODER 1 N/A

4. SIf CODER 2 N/A

5. TRIGGERS

a. DLY RANGE MULT OFF

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP					4
				6. MIXED VIDEO				
				a. MIXED VID SEL	TAG RESET			
				b. VAR AMP	MAX CW			
				7. CHAL/TAG CODER				
				a. MODE REPEAT	1			
				b. SWITCHES	MODE 2 ON			
				8. CHAL/TAG RESET SUBST				
				a. SELECT	OFF			
				9. SIDELOBE SUPPRESSION				
				a. SLS WIDTH	NORM			
				SLS POSN	RM			

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
5					LCL-~~918~~ TA 60-2 11 ~~June~~ 75 94 CAM	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX-72 — INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
				10. CHAL/TAG RESET VIDEO			
				a. CHAL/TAG — SLS OUT			
				b. CHAL/TAG WIDTH — NORM			
				c. CHAL/TAG VAR AMPL — MAX ON			
				B. RF SIGNAL GENERATOR			
				1. TRANSMITTER:			
				a. XMTR FREQ — XTAL			
				b. CW SORCE — INTL 1030 MHZ			
				2. VIDEO — N/A			

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP					6

3. RF	N/A
4. AUX ATTEN	NEG 25 DBM
5. OUTPUT ATTN	ØDBM
C. INTERROGATOR SIGNAL SIMULATOR	
1. PRF COUNTER	
a. METER SELECTOR	X1000
2. TRANSMITTER	N/A
3. SYSTEM SIMULATOR	N/A (EXCEPT FOR PRF)

PRELIMINARY CABLE CONNECTIONS AND SETTINGS

1. OPEN AND SEPARATE R/T UNIT ON EXTENDER CABLES, AFTER DEPRESSURING.
2. R/T UNIT POWER PLUG CONNECTED TO POWER PLUG ON APM
2.

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH ROR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
7					LCL-~~918~~ ~~TAC~~ 94 CAM 30-2 11 ne 75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX-72 — INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.

3. R/T UNIT ANTENNA CONNECTED TO RF IN/OUT OF RF SIGNAL GENERATOR.

4. APM-239 EXTERNAL SUPPRESSION OUT JACK CONNECTED TO SCOPE CHANNEL B.

   a. EXT TRIG ON SIS PRF TO AUX TRIG IN ON APM-239

5. UPM-137

   a. RF SIGN GEN, SIG GEN IN OUT JACK CONNECTED TO LOW 20dB JACK.

   b. RF SIG GEN, VIDEO OUT JACK CONNECTED TO SCOPE CHANNEL A.

   c. RF SIG GEN, AUX MOD IN JACK CONNECTED TO SLS OUT JACK ON SLS.

CARD NO.	WORK AREA(S)	TYPE MECH ROR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP					8

d. USING A TEE CONNECTOR, CONNECT CHAL/TAG VAR AMPL JACK (SIS) TO MAIN MOD IN JACK (RF SIG GEN) AND PRF COUNTER IN JACK (ISS). TURN ON UPM 137 AND LET WARM FOR AT LEAST 15 MINUTES BEFORE CHECKING OUT APX-72.

e. ADJUST PRF MULTI-11 (SIS) FOR 500 PRF METER (ISS).

f. SIS GENERATOR O TRIG JACK CONNECTED TO EXT SYNC IN JACK ON SCOPE.

6. REMOVE COVER OFF RF HEAD BY REMOVING 3 SCREWS.

7. MASTER SWITCH ON CONTROL BOX TO NORM.

8. USING EXT SYNC (DC POS, SET UP SCORE SO THAT B CHANNEL HAS THE EXTERNAL SUPPRESSION PULSE AND A CHANNEL HAS THE INTERROGATION PULSES AND THE REPLY PULSE TRAIN.

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH R	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
9					LCL-~~918 T~~ 94 CAM 60-2 1 ne75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
				FUNCTIONAL TEST AN APX 72			

BENCH CHECK

A. PRECHEGK

VOLTAGE LEVEL ADJUSTMENTS

1. USING THE FLUKE DIFFERENTIAL VOLTMETER, CONNECT POSITIVE LEAD TO GROUND AND NEGATIVE (GROUNDING JUMPER ON METER DISCONNECTED) LEAD TO AR3TP3. ADJUST AR3R76 FOR VOLTAGE READING OF -4.5 VDC±.025 VDC.

2. CONNECT NEGATIVE LEAD OF DIFFERENTIAL VOLTMETER TO GROUND AND POSITIVE LEAD TO AR3TP2. ADJUST AR3R73 FOR VOLTAGE READING OF 4.5±.025 VOLTS.

3. TURN MASTER CONTROL ON C6280 TO OFF & RE-INSTALL RF COVER. PUT MASTER CONTROL TO NORM.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72 INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP				10

1. RECEIVER SENSITIVITY TEST (NORMAL)

a. ROTATE 0-100 DBM DIAL UNTIL SUPPRESSION PULSE FLASHES OVER (MINIMUM TRIGGERING LEVEL).

b. DBM DIAL PLUS-POWER PROBE CALIBRATION CHART (LOW) PLUS CABLE EQUAL RECEIVER SENSITIVITY.

c. [redacted]

d. IF RECEIVER SENSITIVITY IS LOW, TURN MASTER SWITCH TO STBY MODE C SWITCH OF UPM 137 TO ON AND ALL THE REST TO OFF POSITION. CONNECT CHAN A VIDEO IN OF OSCILLOSOPE TO A1TP6 ON RT 859/APX 72.

(1) ADJUST A8R6 NORMAL SENSITIVITY ON RF HEAD FOR MAXIMUM ALPLITUDE OF THE PULSE AT A1TP6.

(2) KEEP THE 0-100 DBM DIAL SET [illegible] MTL A[illegible] MEAS[illegible]E FROM ENTER OF BASE LINE NOISE TO C[illegible]ER OF [illegible]E PEAK

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
11					LCL-~~918TAC~~ 94 CAM 30-2 11 June 75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX -72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.

(2 con't). PULSE NOISE. IF A MAXIMUM AMPLITUDE IS LESS THAN 0.9 VOLT MINIMUM, RT859 (A)/APX 72 IS DEFECTIVE. IF OK, MEASURE VOLTAGE DIFFERENCE BETWEEN PEAK OF THE UPPER AND LOWER LEVEL OF BASE LINE NOISE. SHOULD BE A MINIMUM OF 0.2 VOLTS. IF LESS, IT INDICATES A BAD RT 859.

e. REMOVE PROBE FROM A1TP6 and connect to A1TP2. ADJUST TIME BASE ON OSCILLOSCOPE TO OBSERVE TWO INTERROGATIONS, ADJUST A1R22 CLOCKWISE UNTIL CIRCUIT BEGINS TO TRIGGER ON NOISE, THEN TURN A1R22 COUNTERCLOCKWISE SLIGHTLY UNTIL NO TRIGGERING ON NOISE IS OBSERVED.

f. IF NORMAL SENSITIVITY IS STILL LOW SET C-6280 (P) APX (APM239) MASTER TO NORM, MC-TEST/ON/OUT SWITCH TO ON. 0-100 DBM DIAL TO MTL. ADJUST A1R25 SLOWLY CLOCKWISE (KEEPING IN MIND ORIGINAL STARTING POINT) AND SEE IF MISFIRE ACROSS SUPPRESSION GATE STOPS. IF SO, INCREASE 0-DBM DIAL

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP					12

UNTIL MISFIRING TAKES PLACE AGAIN. REPEAT THIS PROCESS UNTIL A DBM OF -77.5 IS AT J5 ANTENNA JACK. REMOVE PROBE FROM RT AND OSCILLOSCOPE AND RECONNECT VIDEO OUT CABLE TO CHANNEL A.

[redacted]

a. SET THE C-6280 (P)/APX ON APM 239 MASTER SWITCH TO LOW. SET MODE C SWITCHES ON THE C-6280 AND UPM 137 TO ON AND ALL OTHERS TO OFF. [redacted] J5.

b. [redacted] E.

c. CONTROL C6280 TO NORMAL.

3. TRANSMITTER POWER TEST AND ADJUSTMENT

a. ADJUST F1 PULSE, USING 0-100 DBM DIAL, FOR VOLTAGE RE ING FROM DEMODULATOR CALIBR ION CI T FOR 90 MC.

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
13					LCL918-~~TAG~~ 30-2 11June75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX-72 INSPECTION REQUIREMENTS	POWER	SERVICE	CARD NO.

b. ADJUST F2 PULSE AS IN THE PREVIOUS STEP.

c. SET 0-100 DBM DIAL HALFWAY BETWEEN EACH READING.

d. (27) PLUS (DBM DIAL)PLUS (POWER PROBE CALIBRATION) CHART, LOW EQUALS TRANSMITTER POWER FROM CONVERSION CHART DBM TO WATTS

[redacted].

f. IF LOW, TURN MASTER TO OFF AND TAKE COVER OFF RF HEAD BY REMOVING 3 SCREWS. TURN MASTER TO NORM, ADJUST AR2 C1 FOR MAXIMUM PULSE HEIGHT. IF STILL LOW, CHECK FILAMENT VOLTAGES OF 6.3VDC. IF VOLTAGES ARE OK, RF ASSEMBLY IS BAD.

4. SIDEBODE SUPPRESSION ADJUSTMENTS

a. INSURE C-6280 (P)(ONAPM-239) MASTER SWITCH IS IN STBY

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST / AN/APX-72 — INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP				14

b. CONNECT CHAN B VIDEO IN OF OSCILLOSCOPE TO VIDEO OUT OF RF GENERATOR. CONNECT CHAL/TAG VAR AMP OUT OF SIS GENERATOR TO MAIN MOD IN OF RF GENERATOR. ADJUST AUX ATTEN +3-60DB DIAL TO ODB. SET THE CHAL/TAG SWITCH TO SLS OUT AND THE SLS POSN CONTROL TO NORM. CONNECT SLS OUT TO AUX MOD IN. VERIFY THAT SLS PULSE IS PRESENT AND EQUAL IN AMPLITUDE TO THE INTERROGATION PULSES ON OSCILLOSCOPE CHANNEL B. ADJUST AUX ATTAN +3-60DB DIAL, IF NECESSARY, TO OBTAIN EQUALITY THEN SET DIAL 9DB HIGHER.

c. ADJUST OUTPUT ATTEN 0-100 DBM CONTROL TO OBTAIN -64 DBM AT ANT J5 OF RT-859. CONNECT CHAN A VIDEO IN OF OSCILLOSCOPE TO A1TP2. ADJUST A1R6 UNTIL X SLS PULSE APPEARS INTERMITTENTLY AT A1TP2, THEN READJUST UNTIL X SLS PULSE JUST DISAPPEARS. SWEEP OUTPUT ATTEN 0-100 DBM DIAL FROM 3DB TO 50DB BELOW MTL (77.5 DBM AT ANT J5 OF RT 859) IF X SLS PULSE REAPPEARS INTERMITTENTLY FORM 6 TO 50 DBM BELOW MTL REPEAT ADJUSTMENTS UNTIL X SLS DOES NOT APPEAR IN THIS RANGE.

PREVIOUS EDITION WILL BE USED.

AFTO FORM JUN 70 26

AIRCRAFT INSPECTION WORK CARD

CARD NO.	WORK AREA(S)	TYPE MECH ROR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
15					LCL918TAG-3-2 11 June 75 94 CAM	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX-72 — INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.

5. PULSE CHARACTERISTICS TEST

a. INTERROGATE ON EACH MODE AND CHECK FOR PROPER CODE TRAIN.

b. CONTROL BOX MASTER SWITCH TO ~~EMER~~ EMERG.

c. INTERROGATE ON EACH MODE AND CHECK FOR PROPER CODE TRAINS.

d. CONTROL BOX MASTER SWITCH TO NORM.

e. SELECT IP AND RELEASE.

f. INTERROGATE ON EACH MODE AND CHECK FOR PROPER CODE TRAINS FOR THIRTY SECONDS.

g. INTERROGATE ON MODE 2 ONLY.

CARD NO.	WORK AREA(S)	TYPE MECH ROR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72 INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP				16

h. INSERT X PULSE ON APM-239.

i. CHECK FOR X PULSE IN ITS PROPER POSITION.

j. REMOVE X PULSE.

k. ADJUST F1 PULSE TO MEASURE THE WIDTH OF THE PULSE.

l. PULSE WIDTH SHOULD BE .45 MICRO SEC AT THE 50% AMPLITUDE POINTS.

6. AUTOMATIC OVERLOAD TEST

a. PUT +3-60DM DIAL TO 20.

b. ADJUST 0-100 DBM DIAL 3 DB DOWN FROM MINIMUM TRIGGERRING LEVEL.

c. PRF METER SELECT (ISS) TO X10,000.

d. REDUCE MULT 1-11 ON SIS PR[illegible] D 0.

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
17					LCL ~~918TAG~~ 94 CAM 0-2 11 75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	FUNCTIONAL TEST AN/APX-72 — INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.

e. SET SIS PRF RANGE MULT TO 1000.

f. ADJUST PRF (SIS) UNTIL SUPPRESSION PULSE STARTS TO MISFIRE ACROSS OPEN SPACE.

g. PRF SHOULD BE 1200 PLUS OR MINUS 100.

7. RECEIVER FREQUENCY TEST

a. DISCONNECT CABLE FROM O TRIG JACK (SIS) AND CONNECT TO SWEEP SYNC OUT JACK (RF SIG GEN)

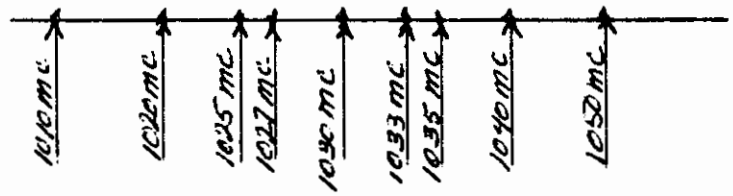
b. CONNECT CABLE FROM SWEEP FREQ MARKS JACK (RF SIG GEN) TO SCOPE FREQ MARKS IN.

c. XMTR FREQ SWITCH (RF SIG GEN) TO SWEEP.

d. USING EXT POS SYNC ADJUST CHANNEL A FOR WAVE FOR SHOWN

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72 INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP				18



e. CONNECT 1 TO 1 PROBE TO TP6 A1 BOARD.

f. INCREASE PRF TO 5,000.

g. ADJUST VERTICAL LEVEL FOR PRESENTATION.

h. ADJUST 0-100 DBM DIAL FOR 6 DB BELOW MINIMUM TRIGGERING LEVEL.

i. MAXIMUM BELL SHOULD BE 1030 MC PLUS OR MINUS 1.5 MC.

AFTO FORM JUN 70 26 AIRCRAFT INSPECTION WORK CARD PREVIOUS EDITION WILL BE USED.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD
19					LCL ~~918TAC~~ 94 CAM 0-2 11 . 75	

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY: SYS	SUB-SYS AND COMP	INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
				FUNCTIONAL TEST AN/APX-72			

j. BAND WIDTH OF BELL SHOULD BE NO LESS THAN 7 MC. IF NOT WITHIN LIMITS, ADJUST Z1C1 AND AR1C3 ALTERNATELY FOR THE BEST OBTAINABLE WAVEFORM ABOUT 1030 MHZ. OBTAIN BEST COMPROMISE BETWEEN PEAK RESPONSE AND WAVEFORM SYMMETRY. SHOULD ADJUSTMENT OF Z1C1 AND AR1C3 NOT PROVIDE PEAK RESPONSE AT 1030 MHZ, LOOSEN LOCK NUTS AND ADJUST Z1C2, Z1C3, AR1C1, AR1C2 AND AR1C3 IN GIVEN ORDER FOR PEAK RESPONSE. THEN RE-ADJUST Z1C1 AND AR1C3 ALTERNATELY FOR THE BEST OBTAINABLE WAVEFORM ABOUT 1030 MHZ.

k. ROTATE 0-100 DBM DIAL TO 0.

l. REMOVE 1 TO 1 PROBE FORM TP6 AND SCOPE A CHANNEL.

8. TRANSMITTER FREQUENCY TEST

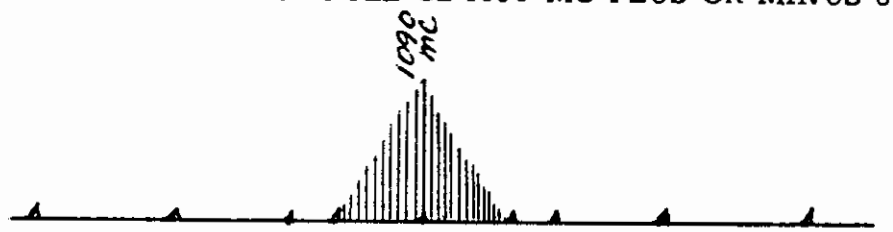
a. CONNECT CABLE FROM FREQ PROBE JACK (RF SIG GEN) TO SCOPE A CHANNEL.

CARD NO.	WORK AREA(S)	TYPE MECH RQR	MECH NO.	CARD TIME	PUBLICATION NUMBER AND DATE	CHANGE RECORD

MAN MINUTES	WORK AREA	WORK UNIT CODE FOR DISCREPANCY		FUNCTIONAL TEST AN/APX-72 INSPECTION REQUIREMENTS	ELEC POWER	SERVICE	CARD NO.
		SYS	SUB-SYS AND COMP				20

b. ADJUST VERTICAL LEVEL AND 0-100 DBM DIAL FOR PRESENTATION.

c. CENTER OF BELL SHOULD BE 1090 MC PLUS OR MINUS 3 MC.



d. IF NOT WITHIN LINITS, ADJUST Z2C1 TO CENTER FREQUENCY SPECTRUM AT 1090 MHZ.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/27/84

F-4D, GEORGIA AIR NATIONAL GUARD

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	125.0	us.
2. Suppression Time	27.2	us
3. Reply Power	Normal 825 /Low 825	Watts
4. Frequency	1090.0	MHz.
5. F_1 Pulse Width	0.45	us.
6. F_2 Pulse Width	0.45	us.
7. Sensitivity	Normal -73.0 /Low -57.2	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.0	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.0/2.3	us.
14. Mode A Decode Accuracy	7.4/8.45	us.
15. Mode C Decode Accuracy	20.4/21.45	us.

PRIMARY AIRCRAFT

F4D
AF-66-7588
KY-532B/ASQ S/N 61

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/27/84

AIRCRAFT NUMBER: AF-66-7588

[X] PRIMARY AIRCRAFT

TYPE: F4D

[ ] BACK-UP AIRCRAFT

LOCATION: Dobbins A.F.B. 1/

TRANSPONDER TYPE: KY-532B/ASQ

SERIAL NUMBER: 61

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-70.1 dBm	N/A
LO	-54.0 dBm	N/A
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	550 watts	N/A
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

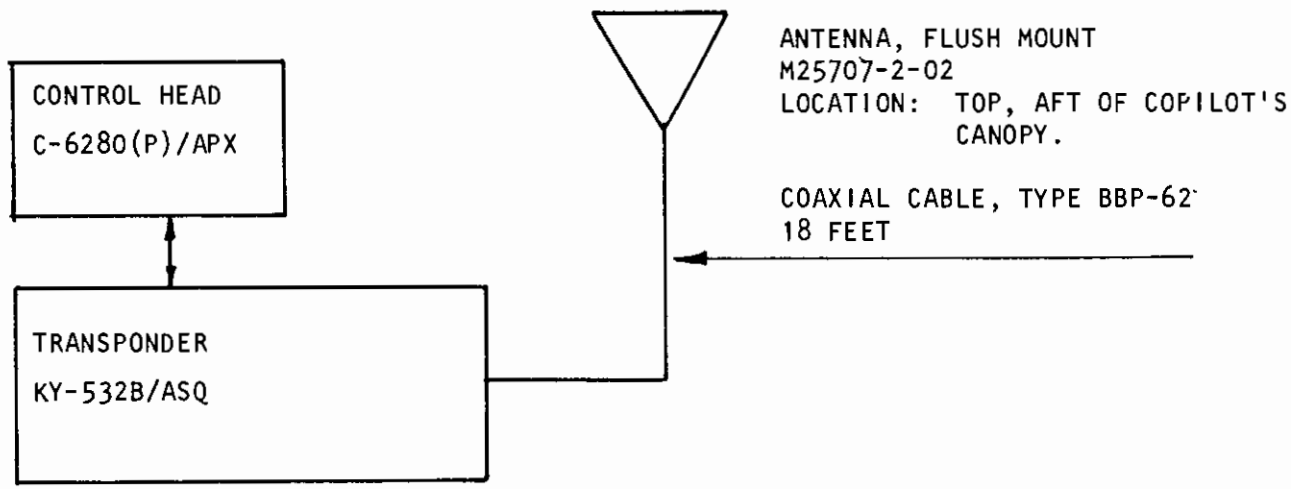
1/ 116th Tactical Fighter Wing, Georgia Air National Guard.

TRANSPONDER CONFIGURATION

F-4D

GEORGIA AIR NATIONAL GUARD

TRANSPONDER CONFIGURATION
F-4D

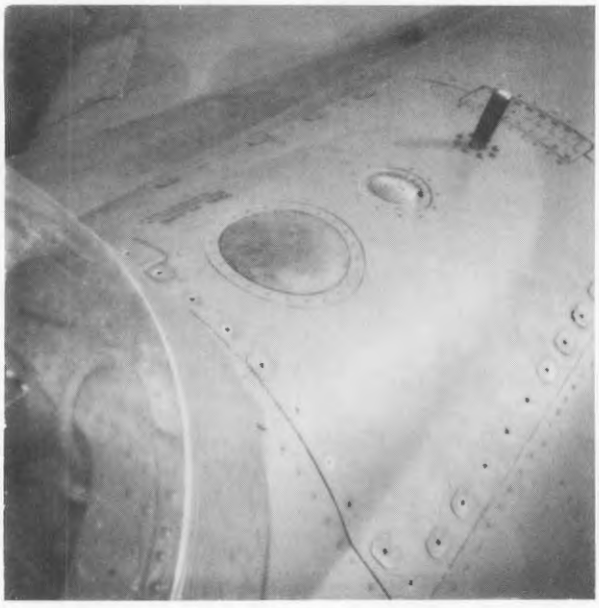


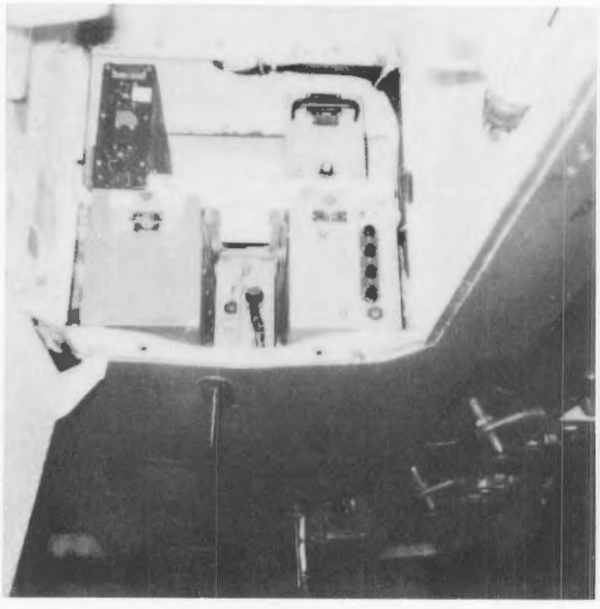
F-4D AF-66-7588

1. Removing test equipment from van.
2. Transporting test equipment to aircraft.
3. Elevating test equipment.
4. Testing transponder.

F-4D AF-66-7588

1. Flush mount antenna, looking aft.
2. Flush mount antenna, looking forward.
3. Gaining access to antenna.
4. Transponder mounted up-side-down in nose wheel well.





TRANSPONDER SYSTEM ANALYSIS

F-4D

GEORGIA AIR NATIONAL GUARD

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [ ] Air Carrier [ ] Military [XX] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: Packard-Bell

Model: AN/UPM-137A

Calibration Frequency: 90 days

Last Calibration Date: 28 September 1984

Calibration Within Limits? yes [XX] no [ ]

3. TRANSPONDER.

Manufacturer: Collins

Model: KY-532B/ASQ

Serial Number: 61

TSO'd? yes [XX] no [ ]

Class 1B - 2B: _____

Class 1A - 2A: (Military Specifications)

Calibration Instructions (Obtain Copy)? yes [XX] not available [ ]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [XX] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XX] no [ ]

Approved Aircraft Inspection Program? yes [XX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XX] frequency: Demand

Scheduled Inspection in Aircraft? yes [ ] no [XX] frequency: Demand

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

AIRCRAFT.

Type: F4D

Number of Transponders Installed: 1

Date Transponder System Installed: 1966

Coax. Type: BBP-62 (RG-225)

Antenna Type: Flush mount P/N M25707-2-02

Antenna Checked Periodically? yes [ ] no [X]

Coaxial Cable Tested Periodically? yes [ ] no [X]

Transponder in Aircraft Systems Check Performed? yes [ ] no [X]

Frequency: Periodically No Demand Yes

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1090.0 MHz.

Transponder Power Output: 825 watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): X

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response $\leq$ 1%): O.K.

P_2 Pulse Amplitude 9db $<$ P_1 Pulse Amplitude (Response $\geq$ 90%): O.K.

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	-70.1	-54.0
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):	N/A	N/A

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73 ± 4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference ($\leq$1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: Yes

Form: Yes

Disposition of Records: Yes

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: (11 R/T Units) 33 total complaints

Number of Correlsting Bench Check Verifications: 32

Mean Time Between Removals (MTBR): Insufficient data

Confirmed Failure Rate of MTBR: Insufficient data

8. COMMENTS.

CALIBRATION PROCEDURES

KY-532B/ASQ

AVIONICS

Control No 108

18 APR 1984

LCL 116TFW-014

KY-532B CHECKOUT AND

ALIGNMENT PROCEDURES

REVIEWED BY: _____ DATE: 18 Apr 84

APPROVED BY: _____ DATE: 18 Apr 84

OPR: MAAC

4 April 1984

TEST EQUIPMENT REQUIRED

1. ASM-86 Distribution Box
2. Frequency Counter 5328A
3. Digital Voltmeter
4. PSM-6 Multimeter
5. UPM-137 Test Set

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

This checksheet is a complete alignment. However, it is meant to be used in conjunction with the T.O. Page and paragraph references are given for this purpose. All references are from T.O. 12P4-2ASQ-102-2.

STANDARD TEST EQUIPMENT SETTINGS T.O. page 6-33 table 6-11

OS-208

Channel A & B set to 1 volt/div on A and 2 volt/div on B.

75 ohm switches to Out

Sync to Ext DC-

Time/Div to 10 usec/div

Sweep Delay to 4.80 X4

SM-559

PRF Meter to X1000

Xmtr Freq to Xtal

SG-865

Suppressor Width to Center

PRF Range to X100

PRF Mult to 5.0

SIF 1 CODER

Function to N

Width to Center

Subst pulse sel to Off

SIF 2 CODER

Trig Sel to Int

Width to Center

Trig Delay to Center

Subst Pulse Sel to Off

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

STANDARD TEST EQUIPMENT SETTINGS Continued

SG-865 Continued

CHAL/TAG CODER

Mode Repeat to 1

Mode 1 to down

Mode 2 to down

Mode 3 to up

Mode C to down

Mode 4 to down

NOTE: Always maintain all Mode switches down except the one in use

SLS WIDTH to Norm

SLS POSN to Norm

Trig Delay to Off

Trig Mult to 1.0

Mixed Video Sel to Tag Reset

Var Ampl to Center

Chal/Tag Reset Subst Sel to Off

Chal/Tag SLS to Out

Chal/Tag Width to Norm

SG-866

Aux Atten to 10 db

Output Atten to 10db

Xmtr Freq to Xtal

Xmtr CW Source to Intl 1030

NOTE: Some settings are not included as they are not normally moved. If in doubt refer to the T.O. page 6-33 Table 6-11.

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

Use standard cable connections on page 6-37, fig 6-7 of T.O. 12P4-2ASQ-102-2.

1. POWER SUPPLY T.O. page 6-35 para 4 thru 8 and para 11a

   Use a digital voltmeter to make the following checks and adjustments:

   A5J1-----pos 12 VDC-----adjust A5R4

   A5J2-----neg 12 VDC-----adjust A5R9

   A5J4-----pos 18 VDC-----no adjustment

   A5J3-----6.3 VAC--------no adjustment

   F-1 & F-2-----115 ± 5 VAC

   KIT-1A plug pin 15-----115 VAC

   MASTER switch to OFF. Pin 15 should read 0 VAC. If not, replace K-1.

2. SENSITIVITY CHECKOUT T.O. page 6-36 table 6-12

   A. MASTER t[redacted]. Observe interrogation pulses on scope. (see T.O. page 6-38 fig 6-8)

   B. Adjust CHAL/TAG WIDTH for .8 usec at the half power point. OUTPUT ATTEN to 30 db. PRF for 500 pps on Counter.

   C. Slowly increase OUTPUT ATTEN until Counter res[redacted].

   D. Calculate MTL (minimum triggering level) as follows:

ADD	Output Atten	--.-
	Power Probe Atten	--.-
	RF Cable Loss	0.9
	Total	[redacted]

Lo Sens?

NOTE: MTL represents the receiver sensitivity. If it is incorrect proceed to Freq Converter and IF Amp alignments.

3. FREQUENCY CONVERTER ALIGNMENT T.O. page 6-111 para 6-50

   A. Disconnect P-3 from IF Amp. OUTPUT ATTEN to 100 db. Digital voltmeter to A1J1 (DC scale). PSM-6 to A1J2 (neg 100 uamp special scale).

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

3. FREQ CONV ALIGNMENT Continued

B. Adjust A1C7 for a peak on voltmeter (normally C7 slug will be about 1/8 inch from top and volts will be 4-10).

C. Adjust A1Z1-1 and A1Z1-2 for a peak on PSM-6. (C7 may need repeaking) Peak A1R6 for first peak on PSM-6. Then adjust A1R3 for 25 uamps.

NOTE: These adjustments will interact and may need to be repeated. The ultimate goal is to have C7, Z1-1 and Z1-2 peaked with the PSM-6 reading 25 ± 1 uamps and the voltmeter reading 4-12 volts. At this point return to Step 2. If MTL has degraded, then Freq Conv alignment is wrong.

D. Remove A5F2 from Power Supply. Connect cables as on page 6-113A of T.O. Disconnect PSM-6 and voltmeter. OUTPUT ATTEN to 0 db. SG-866 XMTR FREQ switch to SWEEP. SWEEP DELAY to X400 on scope.

E. Adjust scope to observe waveform as on page 6-41A. Adjust A1Z2-1, A1Z2-2 and A1Z2-3 for correct waveform.

F. Return to Step 2 and determine MTL. If still incorrect, proceed to IF Amp alignment.

4. IF AMPLIFIER ALIGNMENT T.O. page 6-112 table 6-48, table 6-49

A. Perform step 3D above. Connect P-3 to IF Amp. Connect scope Chan A to J1 on IF Amp. Adjust OUTPUT ATTEN so IF bell is .1 volts amplitude. fig 1 of this book. If display is incorrect, proceed with IF alignment.

B. Replace IF Amp cover with mock-up alignment cover. Use all the screws. Using a non-metallic tuning tool, adjust C-14, C-16, C-18, C-20, C-22 and C-24 for correct bandpass waveform. (see fig 1 of this book)

C. Replace original IF Amp cover. Return to the following connections: MAIN MOD to HIGH LEVEL, EXT SYNC to 0 TRIG OUT. XMTR FREQ switch to XTAL. SWEEP DELAY to X4. Observe a single interrogation pulse. (see fig 2 this book). OUTPUT ATTEN to 70.5 db. MASTER to NORM.

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

4. IF AMPLIFIER ALIGNMENT Continued

C. (continued) Adjust A2R9 HIGH SENS for a .1 volt spike.

D. MASTER to LOW. OUTPUT ATTEN to 52 db. Adjust A2R4 LOW SENS for a .1 volt spike.

E. MASTER to NORM. OUTPUT ATTEN to 53 db. Adjust A2R28 LOG LIM for a .34 volt spike.

F. OUTPUT ATTEN to 33 db. Adjust A2R25 LOG LIM for a .63 volt spike.

G. OUTPUT ATTEN to 18 db. Adjust A2R20 LOG LIM for a .85 volt spike.

NOTE: R9, R4, R28, R25 and R20 will interact. Check and repeat adjustments as necessary. At this point MTL should be correct. Check step 2 again.

5. DECODER BOARD ALIGNMENTS T.O. page 6-116 table 6-50

A. Return to standard settings and cable connections. Install A5F2. Set to M-4. PRF to 500 pps. Counter to SYNC TRIG.

B. Observe first M-4 interrogation pulse. Adjust CHAL/TAG WIDTH for .4 usec at the half power point.

C. OUTPUT ATTEN to 50.5 db. Adjust A7A1R75 (TB-1 board) for 450 pps nominal. WIDTH to .2 usec. Counter reads 0.

D. Set for M-2. Counter to SUPPR OUT. WIDTH to .7 usec.

E. Adjust A7A1R16 for 450 pps nominal. WIDTH to .3 usec. Counter reads 0.

F. WIDTH to .8 usec. SLS OUT to AUX MOD IN. AUX ATTEN to 4.5 db. Adjust SLS WIDTH for .8 usec on P-2. OUTPUT ATTEN to 29 db.

G. Adjust A7A1R41 until Counter just reads 0. AUX ATTEN to 5 db. Counter should read 450 pps nominal.

H. Disconnect SLS OUT. OUTPUT ATTEN to 49.5 db. WIDTH to 1.3 usec. Adjust A7A1R12 until Counter just reads 0. WIDTH to 1.1 usec. Counter should read 450 pps nominal.

I. WIDTH to .8 usec. OUTPUT ATTEN to 43.5 db. Connect scope Chan B to

5. DECODER BOARD ALIGNMENTS Continued

I. (continued) collector of A7A2Q17 (TB-2 board). Sync to internal + . SWEEP DELAY to OFF. Observe two pos pulses on scope.

J. MAIN MOD to MOD OVERRIDE. Do not re-sync scope. Adjust A7A2R38 CW until trigger pulses are generated, then CCW for just no pulses.

K. MAIN MOD to HIGH LEVEL. Set to M-4. Counter to O TRIG. Set PRF to 3000 pps. OUTPUT ATTEN to 20.5 db.

L. Counter to SYNC TRIG. Adjust A7A2R28 until Counter reads 2200 pps.

M. Set for M-2, code 7777. Counter to O TRIG. Set PRF to 5000 pps. Counter to SUPPR OUT. OUTPUT ATTEN to 20.5 db.

N. Adjust A6R67 until Counter reads 1700 pps.

O. Set for M-1. Counter to SUPPRESSOR OUT (UPM-137). Set PRF to 3000 pps. Counter to SUPPR OUT. OUTPUT ATTEN to 50.5 db.

P. Adjust A6R83 until Counter reads 2900 pps.

Q. Return to standard settings and connections. PRF to 500 pps. Set to M-3. Connect SLS OUT to AUX MOD IN. AUX ATTEN to 0 db. OUTPUT ATTEN to 44.5 db. Scope Chan A to 2 volts/div and 1usec/div. VAR TIME CW to cal. SWEEP DELAY to X4. Observe interrogation pulses on scope. Adjust SLS WIDTH for .8 usec on P-2. Adjust SLS POSN until P-2 is 2 usec from leading edge of P-1.

R. Using a T-connector, connect Counter to O TRIG. Set PRF to 11000 pps. Counter to A6J7. Adjust A6R57 until Counter reads 5500 pps.

S. Return to standard settings and connections. Set to M-4. OUTPUT ATTEN to 20.5 db. Scope Chan A to M-4 AUDIO. M-4 AUDIO switch to ON. Scope to 50 usec/div, .5 volts/div. 75 ohms in.

T. Adjust A11R15 for a M-4 audio pulse of 3 volts amplitude. Return to standard settings and connections.

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

6. TRANSMITTER FREQUENCY AND POWER T.O. page 6-119 table 6-51

A. Connections as per T.O. page 6-50. Set for M-2, code 7777. SWEEP DELAY to X400. .2 msec/div. 10 volts/div. OUTPUT ATTEN to 10 db. XMTR FREQ to SWEEP. 75 ohms to OUT. PRF to X1000.

B. Observe waveform similar to that on T.O. page 6-52. Vary PRF for optimum display.

C. Adjust XMTR FREQ (front of KY) to center freq.

D. Return to standard settings and connections. Set for M-2 SELF TEST. Code 7777. Connect RF cable to 400A wattmeter with 50 ohm termination. MASTER to NORM. Power should be [redacted] watts with [redacted] [redacted]m. Adjust screw on xmtr tube cavity inside RF assy.

CAUTION: HIGH VOLTAGES ARE EXPOSED WHEN RF ASSY IS OPENED.

7. SELF TEST ALIGNMENT T.O. page 6-120A table 6-52

A. Standard settings and connections. OUTPUT ATTEN to 100 db. Set to M-2 SELF TEST. Scope to A7A1J2 (TB-1). Use Chan B for J2. SWEEP DELAY to OFF. Turn A3R7 fully CW.

B. Digital voltmeter to A3J1 (+ DC). Adjust A3C8 for peak. Disconnect voltmeter.

C. Observe self test pulses on scope Chan B. Adjust A3C14 for peak, then A3Z1 for peak.

D. OUTPUT ATTEN to 42 db. Adjust A3R7 until self test pulses are same amplitude as interrogation pulses.

E. Connect scope to A3J4. (display on T.O. page 6-68) Adjust A3Z2 and A3Z3 for maximum amplitude.

F. Perform steps 6A & B above. Adjust xmtr freq to first mark off center. Adjust A3R17 for steady self test lite. MASTER to LOW. Lite should go out. Reset xmtr freq to center.

KY-532B CHECKOUT AND ALIGNMENT PROCEDURES

8. CODER BOARD ALIGNMENTS T.O. page 6-123 table 6-53

A. Standard settings and connections. OUTPUT ATTEN to 10 db. PRF to 500 pps. View first xmtr pulse (see T.O. page 6-38).

B. Adjust A8R44 for pulse width of .45 usec at half power point.

C. Set for M-3. Turn CALIBRATORS XTAL MARK switch to 1.45 usec. Observe markers and pulse train on scope. Observe that leading edges of pulses and markers are spaced the same. Turn on IP switch. Observe that it will also align with the markers. If not, adjust A10C28.

END OF ALIGNMENT

Check M-1, M-2, M-3 and M-C pulse trains for missing pulses or intermittant pulses. Check EMER and IP trains for proper displays. Use KIT-1A and APM-123 for proper operation in all modes. Pressurize unit if it is to be installed in aircraft.

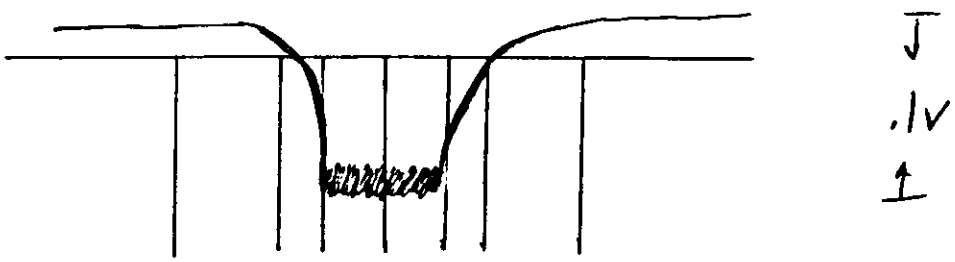


fig 1

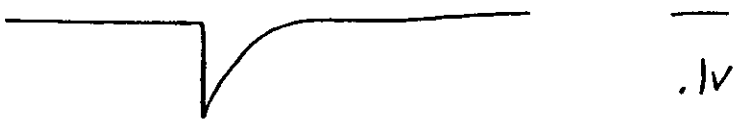


fig 2

Table 6-50. Decoder Board Alignment (Cont)

STEP	PROCEDURE	REMARKS
2. (Cont)	e. On decoder board no 2 A7A1 (TB1) (figure 6-19), adjust potentiometer A7A1R16 (SIF SENS).	Adjust to 450 Electronic counter reads 450 to 500.
	f. On SG-865/UPM-137, adjust CHAL/TAG, WIDTH control for a pulse width of 0.3 μs.	Electronic counter does not read.
	NOTE If step 2f is not obtained, repeat steps 2e and 2f until proper readings are obtained.	
3	a. **On SG-865/UPM-137, adjust CHAL/TAG WIDTH control for a pulse width of 0.8 us.**	
	[redacted]	
	[redacted]	Electronic counter reads 0.
	[redacted]	Electronic counter reads 450 to 500. (AC Input)
	NOTE If step 3e is not obtained, repeat steps 3d and 3e until proper readings are obtained.	
4	a. On **SG-865/UPM-137,** disconnect cable from VIDEO, AUX MOD IN jack and SG-865/UPM-137 SIDELOBE SUPPRESSION, SLS OUT jack.	
	b. On SG-866/UPM-137, increase OUTPUT ATTEN dial until electronic counter reads 450; then decrease dial setting by 1 dB.	
	c. On SG-865/UPM-137, adjust CHAL/TAG WIDTH control for a pulse width of 1.3 μs.	
	d. On decoder board no 2 A7A1 (TB1) (figure 6-19), adjust potentiometer A7A1R12 (WP REJ).	Electronic counter does not read.
	e. On SG-865/UPM-137, adjust CHAL/TAG WIDTH control for a pulse width of 1.1 μs.	Electronic counter reads 450 to 500.
	NOTE If step 4e is not obtained, repeat steps 4d and 4e until proper readings are obtained.	

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/28/84

KC-135, ROBINS A.F.B., GEORGIA

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading
1. Dead Time	122.0 us.
2. Suppression Time	33.0 us
3. Reply Power	Normal 900 /Low 900 Watts
4. Frequency	1090.0 MHz.
5. F_1 Pulse Width	0.55 us.
6. F_2 Pulse Width	0.55 us.
7. Sensitivity	Normal -76.8 /Low -64.0 dBm.
8. Delay Time Difference	0.0 us.
9. Reply Jitter	0.0 us.
10. Mode A Delay	3.0 us.
11. Mode C Delay	3.0 us.
12. F_1 - F_2 Pulse Spacing	20.3 us.
13. Side Lobe Suppression Decode Accuracy	1.7/2.5 us.
14. Mode A Decode Accuracy	7.4/8.2 us.
15. Mode C Decode Accuracy	20.1/21.2 us.

PRIMARY AIRCRAFT

KC-135
AF-60-0330
RT-728A/APX-64 S/N 3822

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/28/84

AIRCRAFT NUMBER: AF-60-0330

[X] PRIMARY AIRCRAFT

TYPE: KC-135

[ ] BACK-UP AIRCRAFT

LOCATION: Robins A.F.B., Georgia 1/

TRANSPONDER TYPE: RT-728A/APX-64(V)

SERIAL NUMBER: 3822

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-74.2 dBm	-74.2 dBm
LO	-62.4 dBm	-62.4 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	560 watts	560 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

1/ 19th AREFW/MAM, Strategic Air Command:

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

11/30/84

KC-135, ROBINS A.F.B., GEORGIA

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	129.0	us.
2. Suppression Time	35.0	us
3. Reply Power	Normal 660 /Low 660	Watts
4. Frequency	1089.5	MHz.
5. F_1 Pulse Width	0.50	us.
6. F_2 Pulse Width	0.50	us.
7. Sensitivity	Normal -77.2 /Low -65.2	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.0	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.6/2.4	us.
14. Mode A Decode Accuracy	7.6/8.4	us.
15. Mode C Decode Accuracy	20.3/21.4	us.

BACK-UP AIRCRAFT (This aircraft also was flown in the Flight Test Profile on November 30, 1984)

KC-135
AF-56-3634
RT-728A/APX-64 S/N 0057

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 11/28/84

AIRCRAFT NUMBER: AF-56-3634

TYPE: KC-135

LOCATION: Robins A.F.B., Georgia 2/

[ ] PRIMARY AIRCRAFT

[XX] BACK-UP AIRCRAFT 1/

TRANSPONDER TYPE: RT-728A/APX-64(V)

SERIAL NUMBER: 0057

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-76.5 dBm	-76.0 dBm
LO	-63.5 dBm	-63.5 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	525 watts	525 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

1/ This back-up aircraft was also flown in the Flight Test Profile on November 30, 1984.

2/ 19th AREFW/MAM, Strategic Air Command

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

12/18/84

KC-135, ROBINS A.F.B., GEORGIA

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading
1. Dead Time	110.0 us.
2. Suppression Time	36.0 us
3. Reply Power	Normal 1120 /Low 1120 Watts
4. Frequency	1090.0 MHz.
5. F_1 Pulse Width	0.42 us.
6. F_2 Pulse Width	0.42 us.
7. Sensitivity	Normal -76.2 /Low -67.3 dBm.
8. Delay Time Difference	0.0 us.
9. Reply Jitter	0.0 us.
10. Mode A Delay	3.2 us.
11. Mode C Delay	3.2 us.
12. F_1 - F_2 Pulse Spacing	20.3 us.
13. Side Lobe Suppression Decode Accuracy	1.5/2.5 us.
14. Mode A Decode Accuracy	7.55/8.5 us.
15. Mode C Decode Accuracy	20.2/21.8 us.

12/18/84

KC-135 AF-59-1449
RT-728A/APX-64 S/N 496
Receiver side lobe suppression set for 5 dB.

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 12/18/84

AIRCRAFT NUMBER: AF-59-1449

[XX] PRIMARY AIRCRAFT

TYPE: KC-135

[ ] BACK-UP AIRCRAFT

LOCATION: Robins A.F.B., Georgia

TRANSPONDER TYPE: RT-728A/APX-64

SERIAL NUMBER: 496

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-74.5 dBm	-74.5 dBm
LO	-63.5 dBm	-63.5 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	825 watts	825 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

1. Receiver side lobe suppression set at 5 dB.

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	122.0	us.
2. Suppression Time	33.0	us
3. Reply Power	Normal 900 /Low 900	Watts
4. Frequency	1090.0	MHz.
5. F_1 Pulse Width	0.55	us.
6. F_2 Pulse Width	0.55	us.
7. Sensitivity	Normal -78.4 /Low -64.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.0	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.7/2.5	us.
14. Mode A Decode Accuracy	7.4/8.2	us.
15. Mode C Decode Accuracy	20.1/21.2	us.

12/18/84

KC-135 AF-59-1449
RT-728A/APX-64 S/N 3822
Receiver side lobe suppression set for 9 dB.

TRANSPONDER CALIBRATION VERIFICATION - FAA AND MILITARY AIRCRAFT ONLY

DATE 12/18/84

AIRCRAFT NUMBER: AF-59-1449

[X] PRIMARY AIRCRAFT

TYPE: KC-135

[ ] BACK-UP AIRCRAFT

LOCATION: Robins A.F.B., Georgia

TRANSPONDER TYPE: RT-728A/APX-64

SERIAL NUMBER: 3822

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	-74.8 dBm	-74.8 dBm
LO	-64.0 dBm	-64,0 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

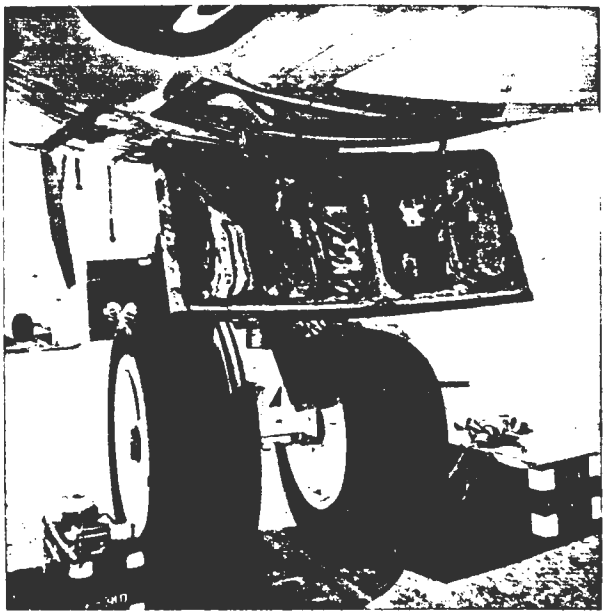
TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	650 watts	650 watts
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS: (All test aircraft transponders will be tested to the full range of parameters specified by the Manufacturer, FAA, or Military Specifications. See Appendix 2.)

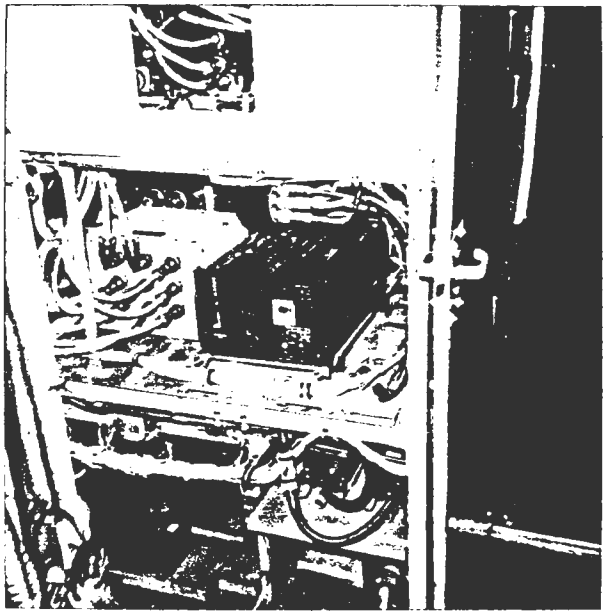
1. Receiver side lobe suppression set for 9 dB.

TRANSPONDER CONFIGURATION

KC-135



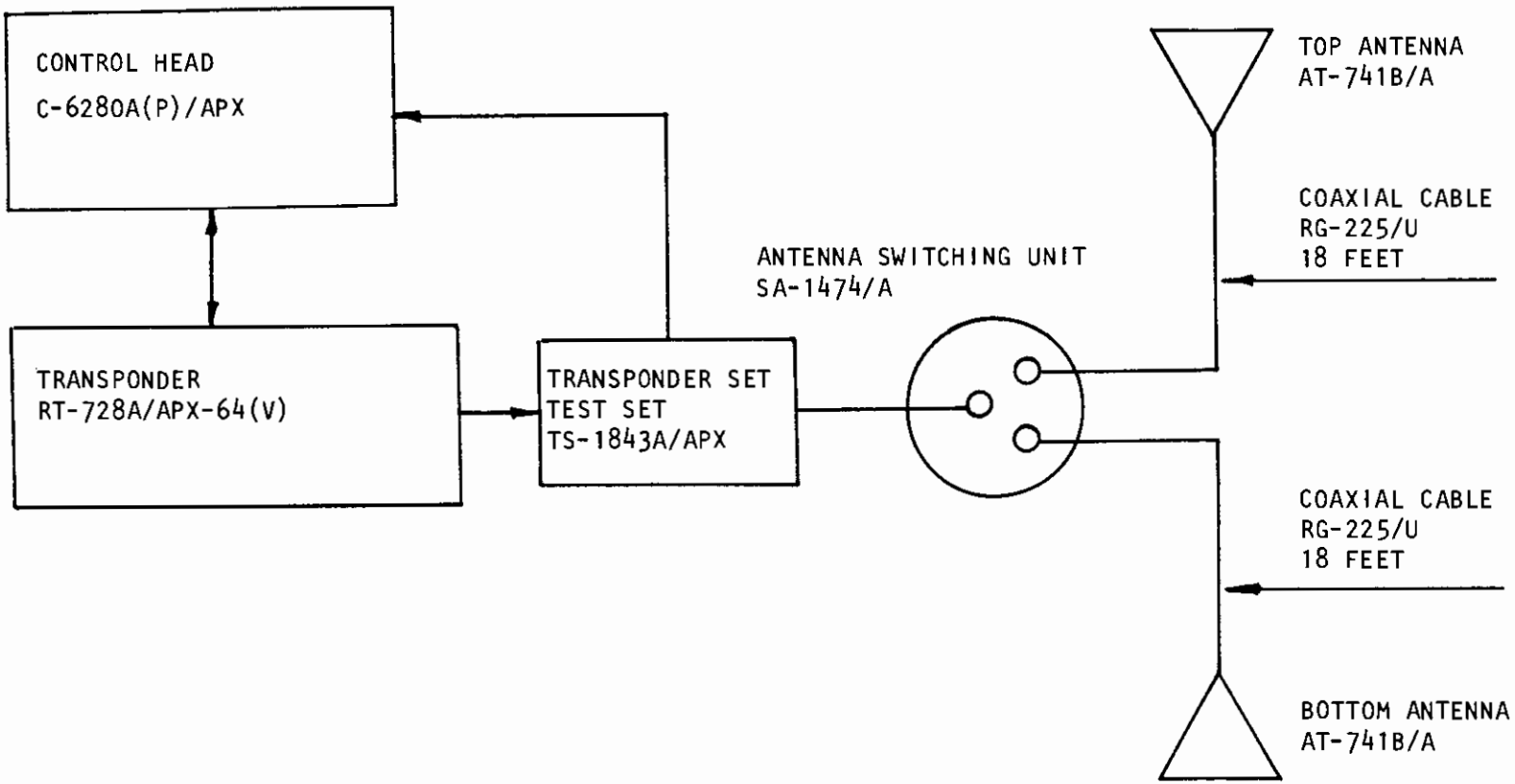
EC-135J BOTTOM ATC ANTENNA LOCATION



EQUIPMENT LOCATION

TEST EQUIPMENT

TRANSPONDER CONFIGURATION
KC-135



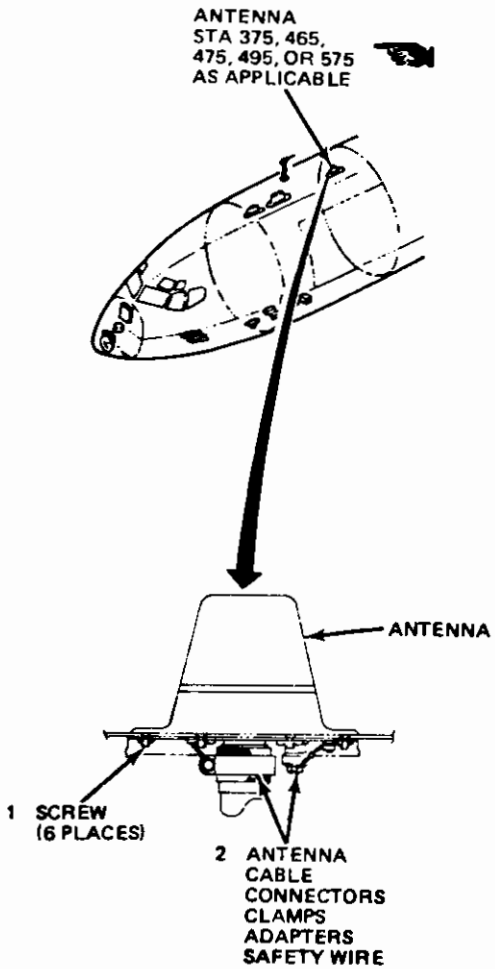


Figure 13-19-2

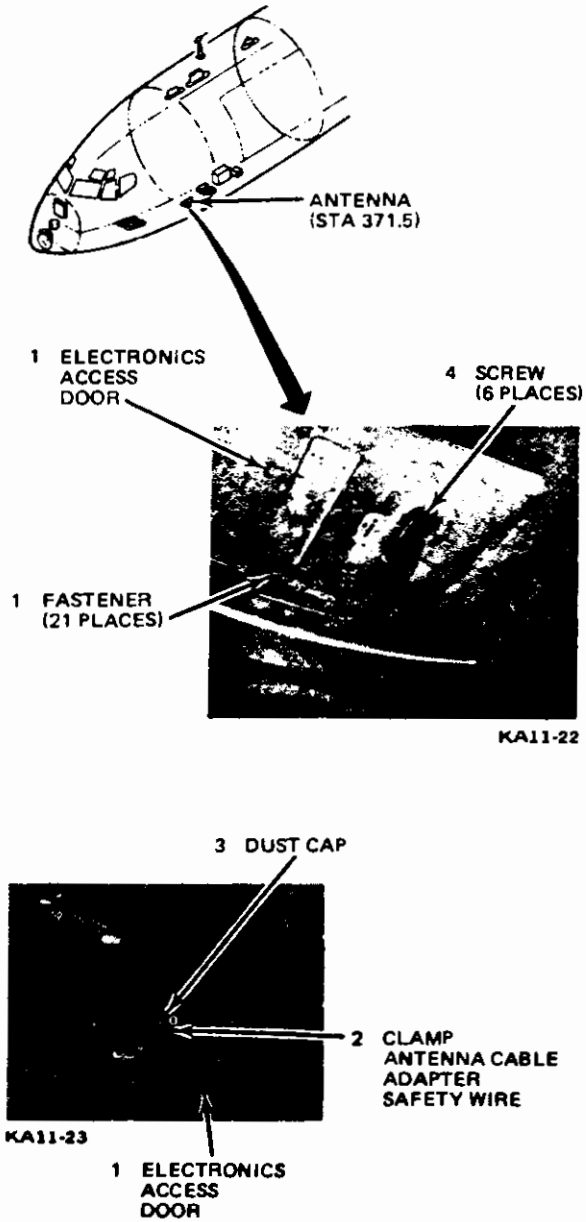


Figure 13-19-1

Transponder antenna location, KC-135 aircraft.
Photographs were not permitted at Robins A. F. B. SAC BASE.

EQUIPMENT SPECIFICATIONS

RT-728A/APX-64

a. Equipment Nomenclature:	Radio Receiver-Transmitter RT-727/APX-64(V)
	Radio Receiver-Transmitter RT-728/APX-64(V)
	Radio Receiver-Transmitter RT-731/APX-64(V)
	Mounting Base MT-3092/APX-46(V)
	Mounting MT-3495/APX-64(V)
	Mounting Adapter MX-6941/APX-64(V)
b. Equipment Weight:	
RT-727/APX-64(V)	27.3 lb (max)
RT-728/APX-64(V)	29 lb (max)
RT-731/APX-64(V)	31 lb (max)
MT-3092/APX-46(V)	3.75 lb
MT-3495/APX-64(V)	1.4 lb (max)
MX-6941/APX-64(V)	1.3 lb (max)
c. Over-all Dimensions:	
RT-727/APX-64(V) with MT-3495/APX-64(V) and MX-6941/APX-64(V)	
Height	12.59 in.
Width	11.62 in.
Length	8.26 in.
RT-728/APX-64(V) with MT-3092/APX-46(V)	
Height	8.58 in.
Width	11.13 in.
Length	19.31 in.
RT-731/APX-64(V)	
Height	7.76 in.
Width	10.12 in.
Length	21.10 in.
d. Input Power Requirements:	
Ac	115 volts, 320 to 480 cps, single phase; 80 watts at 0.2 percent duty cycle
Dc	26.5 volts, 10 watts
e. High Voltage Circuit Protection:	1 amp, 115 vac circuit breaker
f. Operating Temperature Ranges:	−55°C to +95°C continuous, +125°C intermittent at sea level
g. Operating Altitude Ranges:	0 (sea level) to 100,000 feet

h. Receiver Characteristics:	
Frequency	1030 mc
Frequency Stability	±1.5 mc
Frequency Control	Crystal
Intermediate Frequency	59.5 mc
Bandwidth	7.0 to 9.0 mc at points 6 db from maximum response
Normal Sensitivity	−78 dbm
Low Sensitivity	−66 dbm
Spurious Response	Response to signals below 1010 mc and above 1050 mc at least 70 db below response at desired frequency of 1030 mc.
Suppression Input:	
Amplitude	15 to 70 volts
Duration	1.5 to 250 μsec
Polarity	Positive
Input Resistance	2200 ohms
Rise Time	At least 10 volts/μsec
Decay Time	Peak amplitude to 1.0 volt within 10 μsec
Recovery Time	Sensitivity returns to within 3 db of normal in no more than 15 μsec after the suppression pulse falls to 1 volt.
i. Transmitter Characteristics:	
Frequency	1090 mc
Frequency Stability	±3 mc
Power Output	29 dbw at a duty cycle of 0.2 percent (−6 dbw min under any service condition at 1 percent)
Output Pulse:	
Width	0.45 ± 0.1 μsec
Rise Time	0.05 to 0.1 μsec
Decay Time	0.05 to 0.2 μsec
j. Interrogation Code:	
Mode 1	2 pulses spaced 3 ± 0.1 μsec
Mode 2	2 pulses spaced 5 ± 0.1 μsec
Mode 3/A	2 pulses spaced 8 ± 0.1 μsec
Test Mode	2 pulses spaced 6.5 ± 0.1 μsec
Mode C	2 pulses spaced 21.0 ± 0.1 μsec

Figure 1-14. Leading Particulars (Sheet 1 of 3)

Mode 4	4 sync pulses followed by a vacant pulse position, followed by as many as 32 pulses. The spacing from the leading edge of any pulse to the leading edge of the succeeding pulse is 2 ± 0.1 μsec. An anti-interference interrogation (AII) pulse is inserted between any consecutive vacant pulse spaces. The spacing of the AII pulses is 1 ± 0.15 microsecond in odd multiples from the leading edge of the fourth sync pulse. Recognition-of-interference action is accomplished by sensing the lack of pulses in the Mode 4 interrogation.
k. Interrogation Pulse:	
Characteristics of Modes 1, 2, 3/A, C and Test:	
Pulse Width	0.8 ± 0.1 μsec
Rise Time	Between 0.05 and 0.1 μsec
Decay Time	Between 0.05 and 0.2 μsec
Mode 4:	
Pulse Width	0.5 ± 0.1 μsec
Rise Time	Between 0.05 and 0.1 μsec
Decay Time	Between 0.05 and 0.2 μsec
l. Automatic Overload Control:	
Modes 1, 2, 3/A, C, Test, I/P, Emergency (Modes 1 and 3/A).	1200 replies/sec
Emergency (Mode 2)	800 replies/sec
m. Reply Pulses:	
Mode 1	Zero to five information and two framing pulses spaced 20.3 ± 0.05 μsec apart
Mode 2	Zero to 12 information and two framing pulses spaced 20.3 ± 0.05 μsec apart
Mode 3/A	Zero to 12 information and two framing pulses spaced 20.3 ± 0.05 μsec apart
Mode C	Zero to 11 information pulse positions, two framing pulses spaced 20.3 ± 0.05 μsec and the I/P pulse
Test Mode	Zero to 12 information and two framing pulses spaced 20.3 ± 0.05 μsec apart
Emergency	
Modes 1 or 2	Selected code appears in the first pulse train followed by three sets of framing pulses, each framing pulse spaced 24.65 ± 0.10, 44.95 ± 0.15, 49.30 ± 0.20, 69.60 ± 0.25, 73.95 ± 0.30, and 94.25 ± 0.35 μsec from the first framing pulse of the first train.
Mode 3/A	Code 7700 appears in the first pulse train followed by three sets of framing pulses as above.
I/P	
Mode 1	Selected code appears twice, the second reply train spaced 24.65 ± 0.1 μsec between the leading edges of the first framing pulses
Mode 2 or Mode 3/A	Selected code appears in the first pulse train followed by a single pulse spaced 24.65 ± 0.1 μsec from the first framing pulse.
n. Auxiliary Trigger:	
Pulse Width	0.3 to 1.5 μsec
Amplitude	15 to 30 volts across 90 ± 10 ohms
Rise Time	0.1 μsec or less
Decay Time	0.2 μsec or less
Polarity	Positive
o. Suppression Output:	
Polarity	Positive
Amplitude	20 volts min, 50 volts max with a 300-ohm load resistor in parallel with 1850-μμf capacitor.
Start Time	Pulse reaches 20 volts minimum by the time an r-f output pulse has reached 10 percent of its amplitude.

Figure 1-14. Leading Particulars (Sheet 2 of 3)

Stop Time	Suppression output is less than 5 volts, 5 μsec after the last r-f framing pulse of the reply train has fallen to 50 percent amplitude. (The first framing pulse is always followed by a second framing pulse for the purpose of this requirement.) Suppression output is also less than 5 volts, 5 μsec after each r-f output pulse (resulting from the auxiliary trigger or Mode 4 input) has fallen to 50 percent amplitude.
p. Interrogation Side-Lobe Suppression Control:	
Pulse Width	0.8 ± 0.1 μsec for Modes 1, 2, 3/A, C, or Test; 0.5 ± 0.1 μsec for Mode 4.
Pulse Position	2.0 ± 0.15 μsec after the first pulse of a Mode 1, 2, 3/A, C, or Test interrogation, or 8.0 ± 0.15 μsec after the first pulse of a Mode 4 interrogation.
Rise Time	Between 0.05 and 0.1 μsec
Decay Time	Between 0.05 and 0.2 μsec
Pulse Frequency	1030 ± 0.2 mc
q. Mode 4 Reply Input:	
Pulse Width	0.3 to 0.7 μsec
Amplitude	3 to 6.5 volts across 90 ± 10 ohms
Rise Time	0.1 μsec or less
Decay Time	0.25 μsec or less
Polarity	Positive
r. Mode 4 Disparity Input:	
Duration	0.3 to 1.0 μsec
Amplitude	3 to 6.5 volts across 90 ± 10 ohms
Rise Time	0.15 microsecond max
Decay Time	0.5 microsecond max
Polarity	Positive
s. Mode 4 Trigger:	
Duration	0.5 to 3 μsec
Amplitude	1.5 to 25 volts across 90 ± 10 ohms
Rise Time	0.1 μsec or less
Decay Time	1.0 μsec or less
Polarity	Positive
t. Mode 4 Video:	
Duration	0.4 to 0.6 μsec
Amplitude	1.5 to 5 volts across 90 ± 10 ohms
Rise Time	0.1 μsec max
Decay Time	0.2 μsec max
Polarity	Positive
u. Mode 4 Computer Reset Trigger:	
Duration	0.3 to 10 μsec
Amplitude	6 to 10 volts across 1000 ohms ±10%
Rise Time	0.25 μsec max
Decay Time	5.0 μsec max
Polarity	Positive

Figure 1-14. Leading Particulars (Sheet 3 of 3)

QUANTITY	TYPE OR PART NO.	REFERENCE DESIGNATION	FUNCTION
1	910629	A7Q1	Modulator driver
2	910623	A1Q1	Oscillator
		A1Q2	Doubler

Figure 1-15. Transistor Complement, RF Module A1 and Transmitter Module A7

(USAF) T.O. 12P4-2APX-192
(NAVY) NAVAIR 16-35TS1843-1
(ARMY) TM 11-6625-1646-25

TECHNICAL MANUAL

ORGANIZATIONAL/INTERMEDIATE MAINTENANCE
WITH
DEPOT OVERHAUL INSTRUCTIONS
AND
ILLUSTRATED PARTS BREAKDOWN

TRANSPONDER SET TEST SET
TS-1843A/APX
(P/N 01A233750-21-11,-12)

(STEWART-WARNER)

(F33657-68-C-1265)

(F33657-71-C-0752)

This publication replaces Interim T. O. 12P4-2APX-192 dated 15 November 1969.

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARIES
OF THE AIR FORCE, NAVY AND ARMY

AIR FORCE - 20 November 1972 - 6400

15 FEBRUARY 1972

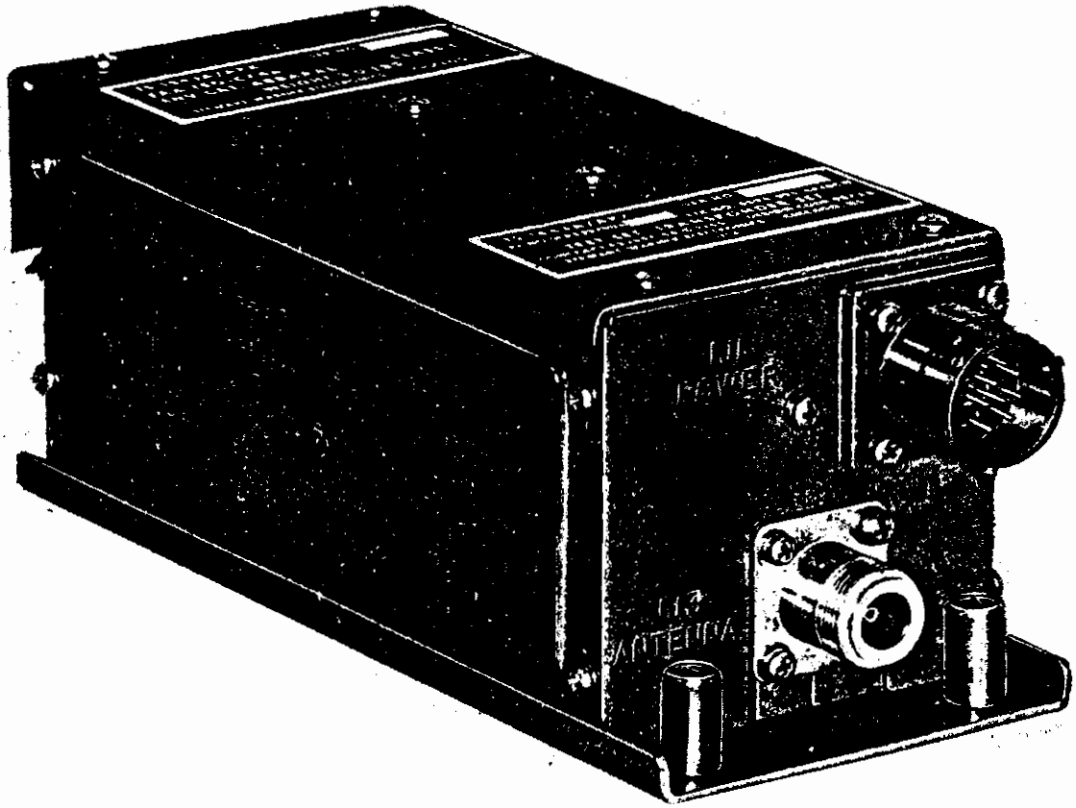


Figure 1-1. Test Set, Transponder Set TS-1843A/APX and Mounting MT-3513A/APX

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. GENERAL.

1-2. This technical manual consists of instructions and procedures for use by experienced personnel in the performance of intermediate maintenance and depot overhaul of Test Set, Transponder Set TS-1843A/APX manufactured by Stewart-Warner Electronics under contracts F33657-68-C-1265 and F33657-71-C-0752 (figure 1-1). An illustrated parts breakdown is also provided in this manual.

1-3. PURPOSE OF EQUIPMENT.

1-4. The TS-1843A is designed to be used with an airborne SIF/IFF transponder system. The Test Set evaluates the performance characteristics of the transponder system and provides a go, no-go indication. The Test Set operates in either of two modes: monitor or test.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The TS-1843A is comprised of four major assemblies: mode generator assembly (A2), comparator-decoder assembly (A4), and power supply and reply evaluator assembly (A3), all of which plug-in to the main frame assembly (A1). The overall dimensions of the TS-1843A are approximately 7-55/64 by 3 by 3-3/64 in.; weight is approximately 2 lb. 8 oz. Located on the ends of the main frame assembly are two R-F connectors, a power and control connector, and three service adjustments. The service adjustments are located under an access cover (figure 1-2). The R-F connectors are utilized to connect the test set in a direct line between the antenna system and the Receiver-Transmitter. The power and control connector serve as a means of connection from the Transponder Set Control unit and primary power source to the test set. The test set is enclosed by four plates which are mounted directly to the main frame assembly. The test set is secured to the aircraft by a mount assembly (MT-3513A/APX). The mount assembly measures approximately 7-25/64 by 3-1/4 in. and weighs approximately 0.8 oz. The test set is so designed that by removing and rotating the bottom plate 180° and remounting the plate, the test set can be secured to the mount assembly in the opposite direction.

1-7. GENERAL PRINCIPLES OF OPERATION.

1-8. GO, NO-GO CHECK. The TS-1843A evaluates the following characteristics of the transponder on a go, no-go basis.

a. Receiver sensitivity
b. Receiver frequency
c. Decoding
d. Reply frequency
e. Reply-code bracket-pulse spacing

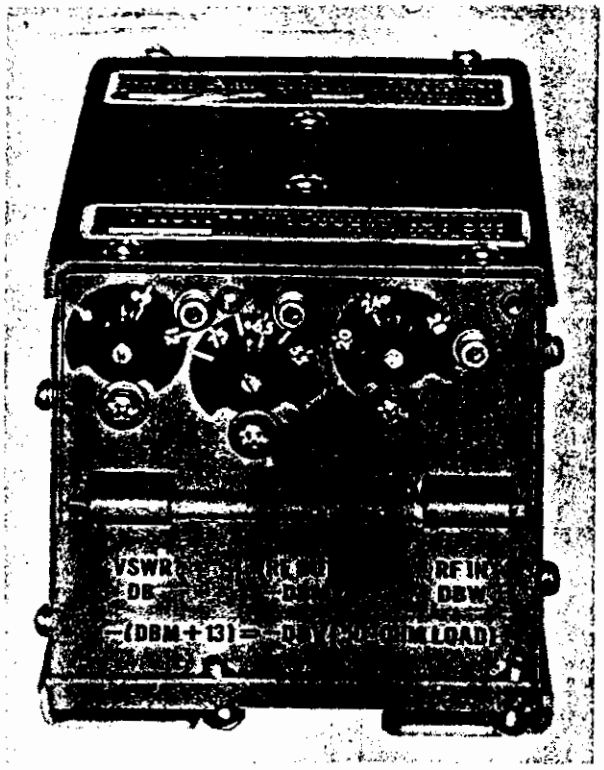


Figure 1-2. Test Set Transponder Set TS-1843A/APX (Rear View), Service Adjustments

f. Reply peak-pulse power
g. Antenna VSWR
h. Reply rate (per cent)

The above characteristics must be within a specified set of limits to achieve a go condition. If any one or more of these characteristics fail to fall within the specified limits, a no-go condition will result. In the test function a go condition is indicated by an illuminated indicator lamp located on the associated Transponder Set Control. In the monitor function, a go indication is determined by the indicator lamp illuminating for a minimum of two seconds and then extinguishing. This process will be repeated as long as there is a proper input being applied to the test set. A no-go condition is indicated by failure of the indicator lamp to illuminate.

1-9. IN-FLIGHT FUNCTION. The TS-1843A provides the following dual functions while in flight.

a. Test Function. The test set, when functioning as an in-flight tester, generates R-F interrogation pulse pairs upon activation of momentary contact switches

on the associated Transponder Set Control (MODE 1, 2, 3/A or C in TEST position). These interrogation pulses are routed to the transponder, which in turn will reply if the receiver frequency, sensitivity, and decoding are proper. The test set will receive the transponder reply and proceed to analyze the reply for proper bracket pulse spacing, frequency, power, reply rate and antenna VSWR. If the transponder reply is within the desired tolerances, a go indication is given. An improper reply will give a no-go indication.

b. Monitor Function. The test set, when functioning as a monitoring device, analyzes the transponder replies to interrogations transmitted by external interrogators. The transponder replies are analyzed for proper bracket pulse spacing, frequency, power and antenna VSWR. The evaluation of the transponder is indicated by a GO, NO-GO indication.

1-10. INSTALLATION.

1-11. The installation instructions for the TS-1843A (figure 1-3) are not specified, due to the inconsistency in the type of aircraft that the test set is to be installed in. The variety of associated transponders that can be used with the test set also greatly affect the installation instructions. For detailed installation instructions, reference can be made to the specific aircraft and transponder manuals.

1-12. LEADING PARTICULARS.

1-13. The leading particulars pertinent to the test set are listed in table 1-1.

1-14. SEMICONDUCTOR COMPLEMENT.

1-15. A list of the semiconductors used in the test set, along with their respective reference designation, part number, and function, are listed in table 1-2.

1-16. INDEXES OF PUBLICATIONS (ARMY).

1-17. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

1-18. Refer to the latest issue of DA Pam 310-7 to determine whether there are modification work orders (MWOs) pertaining to the equipment.

1-19. FORM AND RECORDS (ARMY).

1-20. REPORTS OF MAINTENANCE AND UNSATISFACTORY EQUIPMENT. Use equipment forms and records in accordance with instructions in TM38-750.

1-21. REPORT OF PACKAGING AND HANDLING DEFICIENCIES (ARMY). Fill out and forward DD Form 6 (Reporting of Packaging and Handling Deficiencies) as prescribed in AR 700-58.

1-22. DISCREPANCY IN SHIPMENT REPORT (DISREP) (SF 361) (ARMY). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38.

1-23. REPORTING OF IMPROVEMENTS FOR EQUIPMENT MANUALS (ARMY). Reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028. DA Form 2028 will be forwarded direct to Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-ME-NMP-AN, Fort Monmouth, New Jersey 07703.

Table 1-1. Leading Particulars

ITEM		CHARACTERISTICS	TOLERANCE
Interrogation Output			
Frequency		1030 MHz	±0.5 MHz
Modes 1		2 pulses spaced 3 usec	±0.1 usec
2		2 pulses spaced 5 usec	±0.1 usec
3/A		2 pulses spaced 8 usec	±0.1 usec
C		2 pulses spaced 21 usec	±0.1 usec
Output level		-54 to -81 dbm (-67 to -94 dbv)	±2 db
Rate		400 pps	±50 pps
Reply Analyzer			
Frequency	GO	1090 MHz	±3.0 MHz
	NO-GO	1090 MHz	±4.0 MHz
Bracket Spacing	GO	20.3 usec	±0.15 usec
	NO-GO	20.3 usec	±0.3 usec
Power	GO	20 to 28 dbw	+2 dbw or greater than control setting (RF IN, figure 1-2)
	NO-GO	20 to 28 dbw	-2 dbw or less of control setting (RF IN, figure 1-2)

Table 1-1. Leading Particulars (Continued)

ITEM	CHARACTERISTICS	TOLERANCE
Antenna System VSWR		
GO	Dial set at 6	±1.5 db
	Dial set at 9	±1.5 db
	Dial set at 12	±2.0 db
NO-GO	Dial set at 6	7.5 db or greater
	Dial set at 9	10.5 db or greater
	Dial set at 12	14.0 db or greater
Primary Power	Nominal: 27.5 vdc Limits: 21 to 29 vdc	15 W max.
Secondary Power	+11.7 vdc	±0.3 V
	+ 5.1 vdc	±0.3 V
Weight		
TS-1843A/APX	2 lb. 12 oz.	
MT-3513A/APX	8 oz.	
Dimensions		
TS-1843A/APX	Height: 3 in. Width: 3-3/64 in. Length: 7-61/64 in.	
MT-3513A/APX	7-25/64 by 3-1/4 in. overall	
Service Conditions		
Altitude	100,000 ft.	
Temperature		
Operating	-54°C to +95°C	
Operating with Degradation of Performance	+95°C to +125°C	
Non-operating	-64°C to +150°C	
Humidity	100 percent	
Vibration	MIL-R-5400G Curve IV	

Table 1-2. Semiconductor Complement

REFERENCE DESIGNATION	PART NUMBER	FUNCTION
Main Frame Assembly A1		
A1A1CR1	5082-2800	VSWR Detector
A1A2CR1	5082-2800	Power Detector
A1A3CR1	5082-2800	Frequency Detector
A1A4CR1	5082-0112	Varactor Multiplier
A1A4CR2	MA-47041	Pin Modulator
A1A5CR1	1N914	Gate Input
A1A5Q1	2N706	Oscillator
A2Q1	2N4231	Series DC Regulator
A4A1CR1	1N914	Diode OR Circuit
A4A1CR2	1N914	Diode OR Circuit
A4A1CR3	1N914	Diode OR Circuit
A4A1CR4	1N914	Diode OR Circuit
A4A1CR5	1N914	Diode OR Circuit
A4A2CR1	1N914	Limiting Switch

TRANSPONDER SYSTEM ANALYSIS

KC-135

ROBINS A.F.B., GEORGIA

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [ ] Air Carrier [ ] Military [XX] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: PACKARD-BELL

Model: AN/UPM-137A

Calibration Frequency: 90 days

Last Calibration Date: September 11, 1984

Calibration Within Limits? yes [XX] no [ ]

3. TRANSPONDER.

Manufacturer: HAZELTINE

Model: RT-728A/APX-64(V)

Serial Number: 3822 (primary) 0057 (back-up aircraft)

TSO'd? yes [XX] no [ ]

Class 1B - 2B: _____

Class 1A - 2A: Military specifications

Calibration Instructions (Obtain Copy)? yes [ ] not available [XX]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [XX] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XXX] no [ ]

Approved Aircraft Inspection Program? yes [XXX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XX] frequency: Demand

Scheduled Inspection in Aircraft? yes [ ] no [XX] frequency: Demand

5. AIRCRAFT.

Type: KC-135

Number of Transponders Installed: 1

Date Transponder System Installed: 1960

Coax. Type: RG-225U

Antenna Type: AT-741B/A

Antenna Checked Periodically? yes [ ] no [XX]

Coaxial Cable Tested Periodically? yes [ ] no [XX]

Transponder in Aircraft Systems Check Performed? yes [ ] no [XX]

1/

Frequency: Periodically NO Demand YES

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): 1090.0

Transponder Power Output: 560 Watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec):

Class 1A & 2A (230-1200 Interrogations/Sec): X

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response ≤ 1%): O.K.

P_2 Pulse Amplitude 9db < P_1 Pulse Amplitude (Response ≥ 90%): NO 2/

Receiver Sensitivity Verification by use of Test Set:

	normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm):	-74.2	-62.4
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):	-76.8	-64.0

1/ These parameters are constantly monitored by the Transponder Set Test Set, TS-1843A, and failures or out-of-tolerance conditions are annunciated on the control head on every preflight and/or each time the test is initiated from the control head.

2/ APX-64 transponders adjusted at 9dB did not perform satisfactory during the flight test profiles flown.

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: Yes

Form: Yes

Disposition of Records: Yes

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: 20

Number of Correlating Bench Check Verifications: 14

Mean Time Between Removals (MTBR): Insufficient data

Confirmed Failure Rate of MTBR: Insufficient data

8. COMMENTS.

TRANSPONDER CALIBRATION VERIFICATION

FLIGHT TEST PROFILE

03/14/85

EC-135J HICKAM AFB, HONOLULU, HAWAII

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	N/A	us.
2. Suppression Time	35.0	us
3. Reply Power	Normal 1000 /Low 1000	Watts
4. Frequency	1090.1	MHz.
5. F_1 Pulse Width	0.5	us.
6. F_2 Pulse Width	0.5	us.
7. Sensitivity	Normal -78.0 /Low -66.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.0	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.5/2.5	us.
14. Mode A Decode Accuracy	7.5/8.5	us.
15. Mode C Decode Accuracy	20,5/21.6	us.

* DATE 03/13/85

TRANSPONDER TYPE RT-728A/APX-64 SERIAL NUMBER 3491 POSITION NUMBER 5 dB

AIRCRAFT TYPE EC-135J NUMBER 63-8055

* Unit calibrated at Robins AFB, and shipped to Honolulu. Calibration verified on bench check at Hickam AFB on this date.

DYNAMIC RANGE: 30-- 9.5
40-- 5.0
50-- 6.0
60-- 5.0
70-- 7.0

TRANSPONDER CALIBRATION VERIFICATION

DATE 03/13/85

AIRCRAFT NUMBER: 63-8055

TYPE: EC-135J

LOCATION: HICKAM AFB., HONOLULU, HAWAII

[X] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: RT-728A/APX-64

SERIAL NUMBER: 3491

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-80.9 dBm
LO	N/A	-66.7 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	450 WATTS
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

REMARKS:

SLS SET AT 5 dB.

15th AMS SQUADRON
Hickam A.F.B.
HONOLULU, HAWAII

FAA AND MILITARY AIRCRAFT

TRANSPONDER PERFORMANCE TEST DATA

(MEASURED AT TRANSPONDER)

Characteristic	Test Reading	
1. Dead Time	N/A	us.
2. Suppression Time	35.0	us
3. Reply Power	Normal 631.0 /Low 631.0	Watts
4. Frequency	1089.5	MHz.
5. F_1 Pulse Width	0.50	us.
6. F_2 Pulse Width	0.50	us.
7. Sensitivity	Normal -78.0 /Low -67.0	dBm.
8. Delay Time Difference	0.0	us.
9. Reply Jitter	0.0	us.
10. Mode A Delay	3.0	us.
11. Mode C Delay	3.0	us.
12. F_1 - F_2 Pulse Spacing	20.3	us.
13. Side Lobe Suppression Decode Accuracy	1.5/2.8	us.
14. Mode A Decode Accuracy	7.7/8.55	us.
15. Mode C Decode Accuracy	20.5/21.6	us.

* DATE 03/13/85

TRANSPONDER TYPE RT-728A/APX-64 SERIAL NUMBER 4492 ROSITION NUMBER 9 dB

AIRCRAFT TYPE EC-135J NUMBER 63-8055

* Unit calibrated at Robins AFB, and shipped to Honolulu. Calibration verified on bench check at Hickam AFB on this date.

DYNAMIC RANGE AS FOUND ON CHECK:		RESET DYNAMIC RANGE FOR 9.0 dB at -40dBm	
	30--8.0		30--9.0
	40--8.0		40--9.0
	50--12.0		50--12.0
	60--7.0		60--7.0
	70--6.5		70--7.0

TRANSPONDER CALIBRATION VERIFICATION

DATE 03/13/85

AIRCRAFT NUMBER: 63-8055

TYPE: EC-135J

LOCATION: HICKAM AFB, HONOLULU, HAWAII

[X] PRIMARY AIRCRAFT

[ ] BACK-UP AIRCRAFT

TRANSPONDER TYPE: RT-728A/APX-64

SERIAL NUMBER: 4492

RECEIVER SENSITIVITY	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	-79.9 dBm
LO	N/A	-69.0 dBm
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

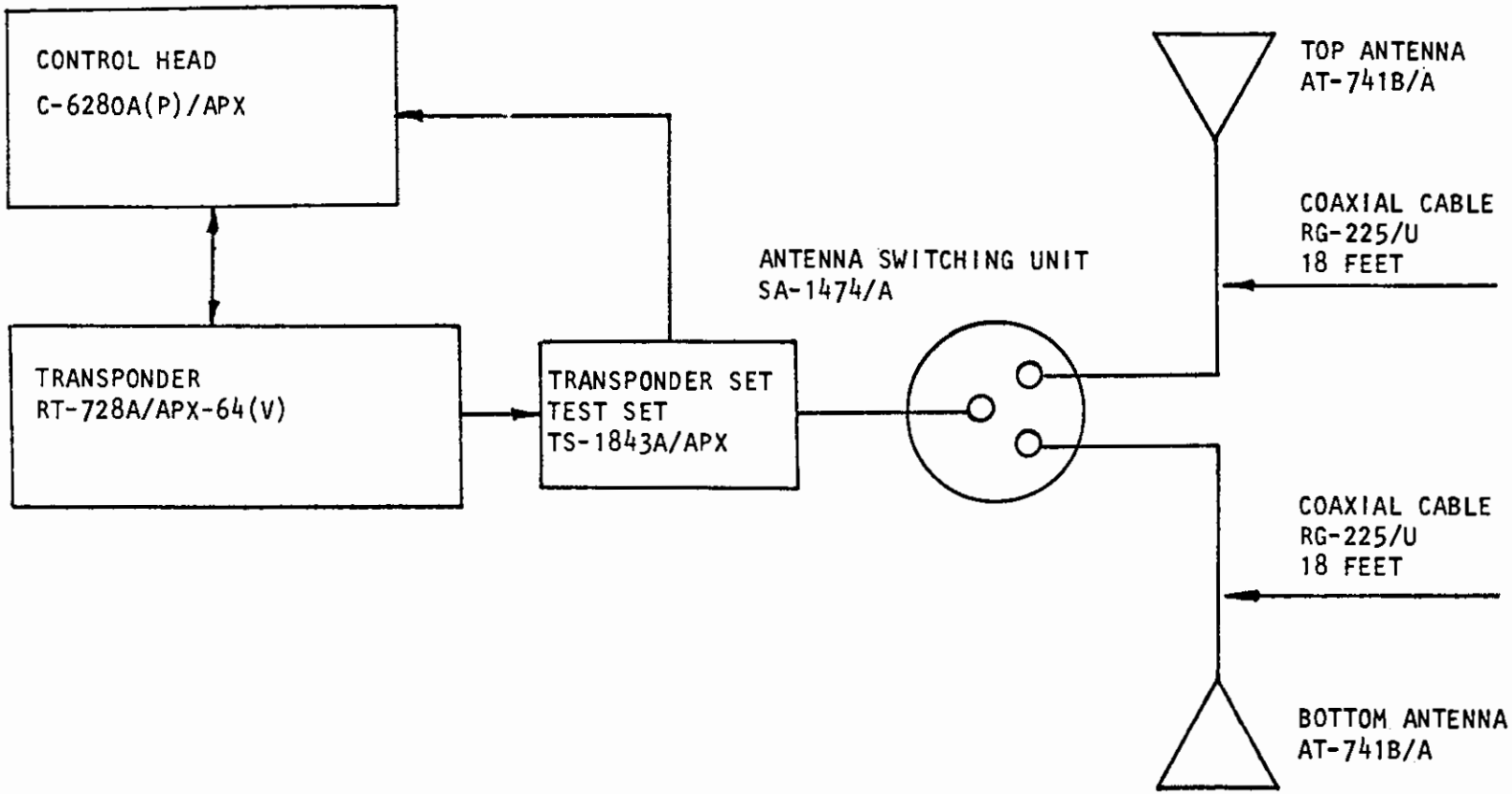
TRANSMITTER POWER	MEASURED AT	
	TOP ANTENNA	BOTTOM ANTENNA
NORMAL	N/A	350 WATTS
LO/LO (FAA SABRE-80 ONLY)	N/A	N/A

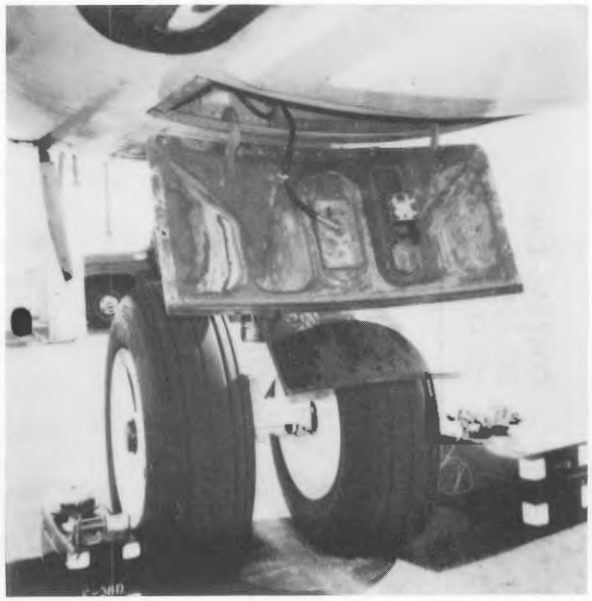
REMARKS:

SLS SET AT 9 dB.

15th AMS SQUADRON
HICKAM A.F.B.
HONOLULU, HAWAII

TRANSPONDER CONFIGURATION
EC-135 J





EC-135J BOTTOM ATC ANTENNA LOCATION

EQUIPMENT LOCATION

TEST EQUIPMENT

TRANSPONDER SYSTEM ANALYSIS

1. ORGANIZATION.

FAA [ ] Air Carrier [ ] Military [XXX] Air Taxi [ ] General Aviation [ ]

2. TEST EQUIPMENT.

Manufacturer: PACKARD-BELL

Model: AN/UPM-137A

Calibration Frequency: 90 DAYS

Last Calibration Date: JANUARY 15, 1985

Calibration Within Limits? yes [XXX] no [ ]

3. TRANSPONDER.

Manufacturer: HAZELTINE

Model: RT-728A/APX-64

Serial Number: 3491 (set @ 5 dB SLS); 4492 (set @ 9 dB SLS)

TSO'd? yes [XX] no [ ]

Class 1B - 2B:

Class 1A - 2A: Military Specifications

Calibration Instructions (Obtain Copy)? yes [ ] not available [XXX]

Calibration Instructions in Consonance with Appendix F, Part 43? yes [XXX] no [ ]

4. MAINTENANCE PROGRAM.

Continuous Airworthiness Maintenance Program? yes [XXX] no [ ]

Approved Aircraft Inspection Program? yes [XXX] no [ ]

Scheduled Bench Maintenance? yes [ ] no [XX] frequency: Demand

Scheduled Inspection in Aircraft? yes [ ] no [XX] frequency: Demand

5. AIRCRAFT.

Type: EC-135J

Number of Transponders Installed: 1 1

Date Transponder System Installed: 1963

Coax. Type: RG-225U

Antenna Type: AT-741B/A

Antenna Checked Periodically? yes [ ] no [XX]

Coaxial Cable Tested Periodically? yes [ ] no [XX] 2/

Transponder in Aircraft Systems Check Performed? yes [ ] no [XX]

Frequency: Periodically NO Demand YES

6. TRANSPONDER TEST.

Reference Appendix F of Part 43 --

Reply Radio Frequency (1090 ± 3MHz): O.K. 5dB SLS= 1090.1 9dB SLS= 1089.5

Transponder Power Output: 5dB SLS=450 Watts 9dB SLS=350 Watts

Suppression, Mode 3/A:

Class 1B & 2B (230-1000 Interrogations/Sec): _____

Class 1A & 2A (230-1200 Interrogations/Sec): X

Transponder Interrogation Response:

P_2 Pulse Amplitude Equals P_1 Pulse Amplitude (Response ≤ 1%): O.K.

P_2 Pulse Amplitude 9db < P_1 Pulse Amplitude (Response ≥ 90%): NO 3/

Receiver Sensitivity Verification by use of Test Set:

		normal	low
Connected to the Antenna end of Transmission Line (-73±4dbm)	5dB	-80 dBm	-66.7 dBm
	9dB	-79.9dBm	-69.0 dBm
Connected to the Transponder Antenna Terminal with Transmission Line Loss Correction (-73±4dbm):		N/A	N/A

1/ Two transponders were used in test profile: one adjusted to SLS=5dB; one SLS=9dB

2/ These parameters constantly monitored by test set TS-1843A. See note on KC-135.

3/ APX-64 Transponders set at 9dB had probability of detection of 62.39% at 100 miles from antenna, and 40.54% within 50 miles of antenna on flight test profile flown in Hawaii.

TRANSPONDER SYSTEM ANALYSIS (CONTINUED)

Receiver Sensitivity Verification Using a Radiated Signal (-73±4dbm): N/A

Mode 3/A and Mode C Receiver Sensitivity Difference (≤1db): No difference

Record:

Complied with Provisions of FAR 43.9 as to:

Content: YES

Form: YES

Disposition of Records: YES

7. RECORDS (NOVEMBER 1, 1983 - NOVEMBER 1, 1984).

Number of Pilot Complaints: 7

Number of Correlating Bench Check Verifications: 3

Mean Time Between Removals (MTBR): Insufficient data

Confirmed Failure Rate of MTBR: Insufficient data

8. COMMENTS.

PREPARED 84 NOV 02 — AIMS SYSTEM CONFIGURATION INFORMATION — AS OF 84 NOV 02 FCN UC011-04P

- - - - - - A I R B O R N E - - - - - -

- - A I M S - - SYSTEM	NUMBER	SERV CODE	MDS	QTY	MDS	QTY	MDS	QTY	MDS	QTY	MDS	QTY	MDS	QTY	MDS	QTY	MDS	QTY
PP-4460/APX-65		USAF	OEC130H	1	OGC130P	1	OHC130H	1	OHC130N	1	OWC130H	1						
RT&1063B-APX10		USAF	OOF015A	1														
RT-1063B/APX101		USAF	A010A	1	B001	1	C012	1	E003A	1	F015A	1	F015B	1	F015C	1	F015D	1
			F016A	1	F016B	1												
RT-1157/APX100		ARMY	AH001S	1														
		USAF	HH0600	1														
		NAVY	AV008B	1	F/A018A	1	TFA018A	1										
RT-1284/APX100		ARMY	C012A	1	C012C	1	C012D	1	RC012D	1	RC012E	1						
RT-1285A/APX100		ARMY	CH047D	1	OH058C	1												
RT-1286A/APX100		ARMY	AH064	1	EH060A	1	UH060A	1										
RT-319C/APX-65		USAF	JC130H	1	OEC130H	1	OHC130H	1	OHC130N	1	OHC130P	1	OWC130H	1				
RT-727A/APX-64		USAF	T038A	1	CH003E	1	HH003E	1										
RT-728A/APX-64		USAF	B052D	1	B052G	1	B052H	1	C135A	1	C135B	1	C135C	1	F111A	1	F111D	1
			F111E	1	F111F	1	0002	1	CH053B	1	CH053C	1	DC130H	1	EC135A	1	EC135C	1
			EC135G	1	EC135H	1	EC135J	1	EC135K	1	EC135L	1	EC135N	1	EC135P	1	FB111	1
			HC130H	1	HC130N	1	HC130P	1	HH053B	1	HH053C	1	JC130H	1	KC135A	1	KC135Q	1
			NC135A	1	RC135A	1	RC135D	1	RC135M	1	RC135S	1	RC135T	1	RC135U	1	RC135V	1
			VC135B	1	WC130H	1	WC135B	1	OV010A	1	NKC135A	1						
		NAVY	A004F	1	A007A	1	A007B	1	C002A	1	F111B	1	T002B	1	T002C	1	CH053	1
			CH053A	1	CH053D	1	EA004F	1	RH053D	1	TA004F	1	TA004J	1	OV010	1	OV010A	1
RT-731A/APX-64		USAF	C005A	1	C141A	1	C141B	1	VC137B	1	VC137C	1						

APPENDIX 8

INVENTORY OF APX-64 TRANSPONDER EQUIPPED AIRCRAFT

te technical note techn

ATCRBS Data from Atlanta, Georgia, Spring 1985

Leo J. Wapelhorst

December 1985

DOT/FAA/CT-TN85/38

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U.S. Department of Transportation
Federal Aviation Administration

Technical Center
Atlantic City Airport, N.J. 08405

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/38	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ATCRBS DATA FROM ATLANTA, GEORGIA - SPRING 1985		5. Report Date
		6. Performing Organization Code ACT-150
7. Author(s) Leo J. Wapelhorst		8. Performing Organization Report No. DOT/FAA/CT-TN85/38
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. T10-2B
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Avaition Administration Program Engineering and Maintenance Service Washington, D.C. 20590		13. Type of Report and Period Covered Technical Note
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The Mobile Transponder Performance Analyzer (MTPA) was used to collect data on general aviation aircraft transponders in the Atlanta, Georgia, area. The data were collected at three different airports (Fulton County, Peachtree/DeKalb, and McCollum) in the Atlanta area. The data were collected at a distance of 250 to 400 feet from the taxiway being used by the aircraft. The pilots were asked to hold their position on the taxiway while the tests were conducted.

Data were collected which describe the interrogation decoding characteristics of the transponders as well as their reply characteristics. A total of 24 parameters were checked during the test which required approximately 1 minute per transponder. Altitude data reported by the transponders were also compared to that received from a calibrated altimeter which is a part of the MTPA.

The most frequently failed parameter was the requirement to reply at 90 percent rate during the side-lobe suppression (SLS) decoding accuracy test when the P2 pulse is outside the prescribed limits for suppression.

17. Key Words ATCRBS MTPA		18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 118	22. Price

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

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EXECUTIVE SUMMARY

The Mobile Transponder Performance Analyzer (MTPA) was used to collect data on general aviation aircraft transponders in the Atlanta, Georgia, area. The data were collected at three different airports (Fulton County, Peachtree/DeKalb, and McCollum) in the Atlanta area. The data were collected on 154 transponders at a distance of 250 to 400 feet from the taxiway being used by the aircraft. The pilots were asked to hold their position on the taxiway while the tests were conducted.

Data were collected which describe the interrogation decoding characteristics of the transponders as well as their reply characteristics. A total of 24 parameters were checked during the test which required approximately 1 minute per transponder. Altitude data reported by the transponders was also compared to that received from a calibrated altimeter which is a part of the MTPA.

The most frequently failed parameter was the requirement to reply at 90 percent rate during the side-lobe suppression (SLS) decoding accuracy test when the P2 pulse is outside the prescribed limits for suppression. Only 41 percent of the transponders tested passed this test compared to 65 percent when these data were collected on general aviation transponders at Philadelphia in 1983.

Seven transponders out of the 154 tested passed all 24 parameters tested. Five additional transponders passed all parameters, but replied with "brackets only" to the Mode C interrogations and were failed by MTPA for that parameter. Thus, approximately 7 percent of the transponders passed all tests for which they were equipped. An additional 38 failed to reply at a 90 percent rate during the SLS decoding accuracy test and/or were "brackets only" as their only problem. Another 43 failed one other parameter (in addition to the previous ones), 24 failed two others, and 49 failed three or more additional parameters.

INTRODUCTION

OBJECTIVE.

The objective of this project was to collect data describing the performance of transponders of general aviation aircraft based in the Atlanta, Georgia, area. Of special interest were the side-lobe suppression (SLS) characteristics and the accuracy of the transponder reported altitude data.

BACKGROUND.

The Federal Aviation Administration (FAA) Technical Center was requested to provide support to the Headquarters FAA Air Traffic Control Radar Beacon System (ATCRBS) Analysis Team in the investigation of transponder related problems in the Atlanta, Georgia, area. The problems reported by the operational air traffic controller personnel were target dropout, excessive coasting, and erroneous altitude data.

The implementation and operation of the Traffic Collision Alert System (TCAS) is dependent on the accuracy, reliability, and integrity of the transponder reported altitude data from TCAS intruder aircraft. The air traffic control (ATC) ground-based system normally interrogates the aircraft for their 4096 code identity and Mode C altitude for use in the ATC system. The TCAS interrogates the transponders for Mode C altitude for use in the airborne TCAS logic to develop commands for evasive maneuvers. Importance of accurate, reliable altitude information cannot be overemphasized for the safe operation of the TCAS.

The Mobile Transponder Performance Analyzer (MTPA) was used to collect large volumes of data in a relatively short period of time in an operational environment.

The MTPA is a system designed and fabricated at the FAA Technical Center to analyze performance characteristics of all known types of aircraft surveillance transponders. The system is mounted in a bus which has its own engine generator for system power requirements. The system is fully software controlled. It includes a PDP-11/34 computer with peripherals, two low power programmable transmitters, and receiving and decoding hardware so that the format and protocol changes necessary can be implemented without hardware modifications. Digitally controlled phase shift keying (DPSK) modulators, pin diode modulators, and variable attenuators are used for control of the radio frequency (RF) interrogations. The maximum RF power for interrogation is approximately one watt. A parabolic dish antenna with approximately a 10-degree beamwidth is mounted to the side of the bus for ramp testing. The system will operate at any distance of up to 200 meters from the aircraft being tested.

The transponder parameters are comprised of two basic categories. One set contains the transponders waveform and signal characteristics such

as power, sensitivity, pulse amplitude, pulse width, pulse frequency, spacing, etc. The second set is message content and response to certain stimuli. These functions are primarily for Mode S transponders, but the suppression tests and the Mode C altitude data fall into this category for all transponders.

The MTPA software resides in both computer random access memory (RAM) and on disk. Required routines are overlayed in memory as necessary. Software control is broken down into sets and sequences of tests to provide maximum flexibility for operator control, interaction, and test time. On-line recording of data is done on disk; a real-time summary of test results is provided. A hard copy of this summary is provided if requested.

When not performing tests, the MTPA runs in an "idle" loop in which it continuously interrogates at a low pulse repetition frequency (PRF). When a candidate for testing arrives and is solidly responding to the idle loop interrogations (monitored by an A scope presentation), the tests can begin. Tests are nominally conducted at an interrogation signal of -47 decibels above 1 milliwatt (dBm) (at the approximate aircraft antenna position). If interference exists from other aircraft the interrogation signal power can be reduced from the keyboard in 1 decibel (dB) steps until the interference disappears prior to starting the test.

RELATED PROJECTS/DOCUMENTATION.

1. "ATCRBS Transponder Data from Dayton, Ohio Airshow - 1983," DOT/FAA/CT-TN83/53.
2. "Mobile Transponder Performance Analyzer Volume 1, System Description," DOT/FAA/CT-TN83/05.
3. "ATCRBS Transponder Data from Initial Field test of MTPA," DOT/FAA/CT-TN83/04
4. "Summary of Transponder Data for Atlanta, Georgia, Area," FAA-CT-80-39.
5. "Summary of Transponder Data June 1977 through August 1978," FAA-RD-79-56.
6. "U.S. National Standard for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon System Characteristics," FAA Order 1010.51A.

MTPA FIELD CALIBRATION.

The MTPA has previously been calibrated for the bench mode of operation. The only difference in ramp operation are the path losses (transmit and receive) and the time difference for the RF signal to travel to and from the transponder.

This translation is easily accomplished by a two-step process. A transponder is first connected to the calibrated laboratory cable and tested so that its power, sensitivity, and delay characteristics are known. This "calibrated" transponder is then placed in a vehicle with

an antenna mounted on its roof and driven down the taxiway to be used during the tests. Continuous power, sensitivity, and delay measurements are made on the transponder during this trip. As delay characteristics of most transponders vary with received signal strength, the interrogation signal is varied across the antenna pattern in order to maintain a -50 dBm signal at the vehicle antenna. (This is only possible since the transponder output characteristics are known; i.e., if the reply power is 60 dB down from that achieved on the calibrated cable, the path loss would be known and power of the next interrogation would be adjusted so that approximately -50 dBm would be seen at the transponder on the next interrogation.)

The MTPA antenna pattern also has a vertical component which must be considered. The RF coupling is significantly better at 5 feet (the approximate height of the roof of the car) than it is at 1 foot The system contains a lookup table with offset values as a function of antenna height and distance. Prior to the test, the operator enters the approximate antenna height of the aircraft under test (i.e., 3 feet); the transmit power is automatically increased by the offset value so that a level of -47 dBm is achieved at the aircraft's antenna. (The measured sensitivity will also be offset by this value.) A power level of -47 dBm was used so that the majority of the tests would be conducted at a level of approximately -50 dBm. (The aircraft was normally stopped at a position where the power was down approximately 3 dBm from that at the nose of the beam.)

Measurement accuracy of power and sensitivity is normally about plus or minus 3 dB using the above techniques. At times, however, reflections and landing gear sheilding make this figure difficult to achieve.

DATA COLLECTION

Data were collected at three airports in the Atlanta, Georgia, area (Fulton County, Peachtree/DeKalb, and McCollum) The same test scenario was used at each of the airports.

As communications were available with the pilots of the aircraft under test, the planes were stopped during the conduction of the tests. The planes were taxied into position on a taxiway (approximately 400 feet away from the bus) so they were in a position approximately 3 to 6 dB down from the nose of the MTPA interrogation pattern. They were instructed to have their transponder and altimeter on as they taxied into position. The test scenario was then run while the pilot held this position. He was then instructed to taxi past a cone which designated the opposite edge of the interrogation beam. Continuous power, sensitivity (Modes A and C), and delay measurements were made as he taxied past. The maximum power and sensitivity values achieved and the minimum delay value achieved were saved as the true parameters for the transponder.

Each of the three sites presented its own data collection problem. Figure 1 shows the site plan of the Fulton County Airport with the MTPA bus position. Reflections from the Administration Building across the taxiway area were a minor problem, but this site was preferable to one further to the left where the taxiway dropped off to a level 3 to 4 feet below the bus. The taxiway used for data collection was approximately 250 feet from the MTPA bus.

Figure 2 shows the site plan of the Peachtree/DeKalb Airport with the selected site for data collection. The taxiway distance was about 400 feet from the bus. The problem here was interference from planes taking off and landing on the runway directly in our interrogation beam. Power reduction of interrogation signals was an effective means of minimizing the problem.

Figure 3 is the site plan of the McCollum Airport showing the site of the MTPA bus during data collection. Planes parked around the periphery of the taxiways caused reflection problems when parked parallel to the taxiway. The problem was solved by turning the bus so that the antenna pattern was centered at the intersection of the two taxiways shown. This caused a slight error in the delay data (only a few nanoseconds) if the tests were allowed to continue past the intersection.

TEST SCENARIO.

The test scenario selected for use required approximately 1 minute for completion. Since SLS amplitude and altitude data characteristics were of special interest, two separate tests for each parameter were included. Table 1 lists the tests in the order they were conducted.

The system was calibrated each morning prior to start of data collection. A run was also made each morning to verify the antenna pattern prior to the start of data collection. A set of data on our "standard" transponder was also collected at the start and finish of data collection each day in order to verify the stability of the system. A sample calibration run and antenna pattern run from Peachtree/DeKalb Airport is included in appendix A. Also included is the first run from the calibrated transponder after the calibration process.

3-18-85 ATLANTA - CHARLIE BROWN (FULTON COUNTY) AIRPORT

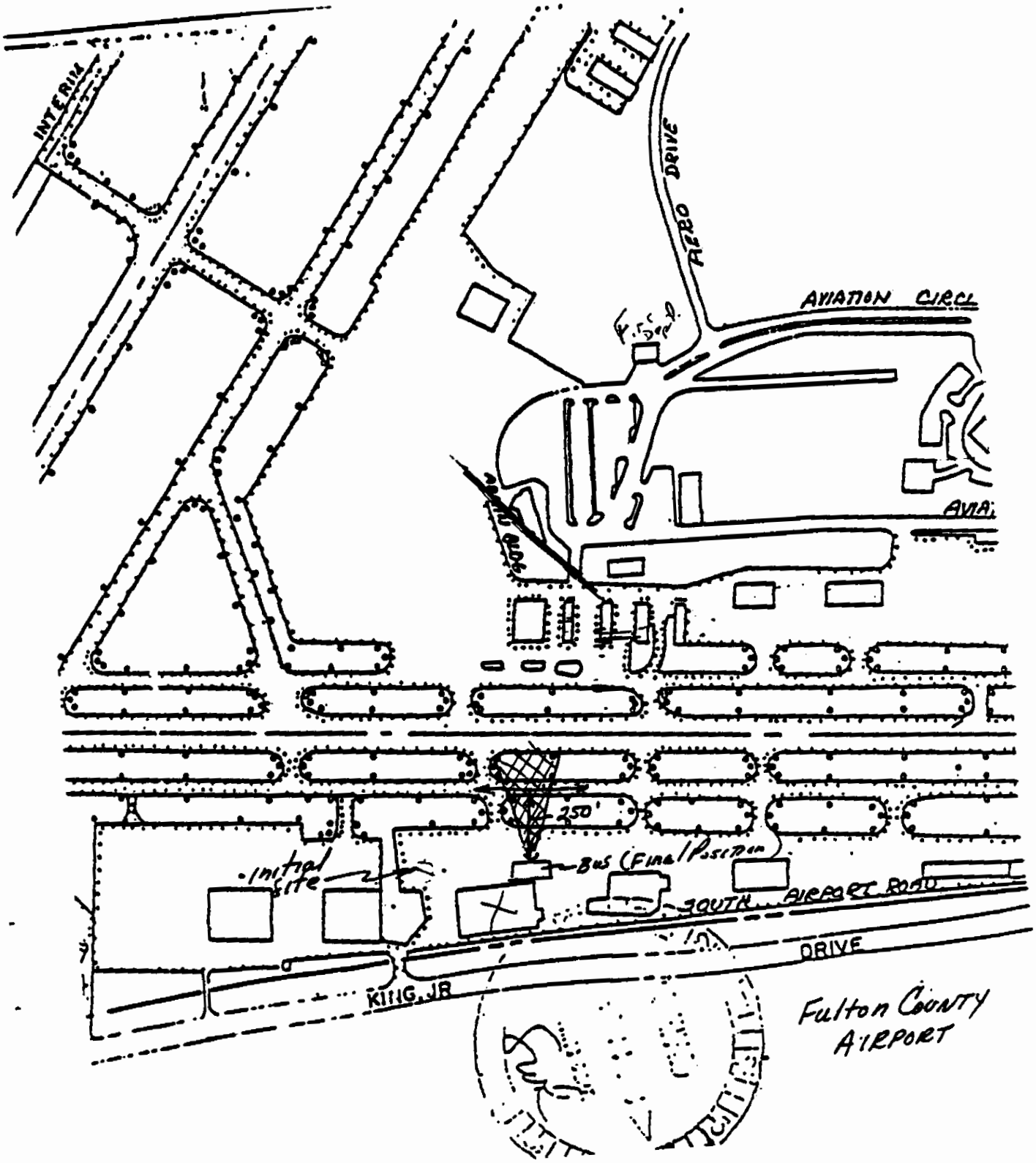

FIGURE 1. DATA COLLECTION SITE PLAN - FULTON COUNTY AIRPORT

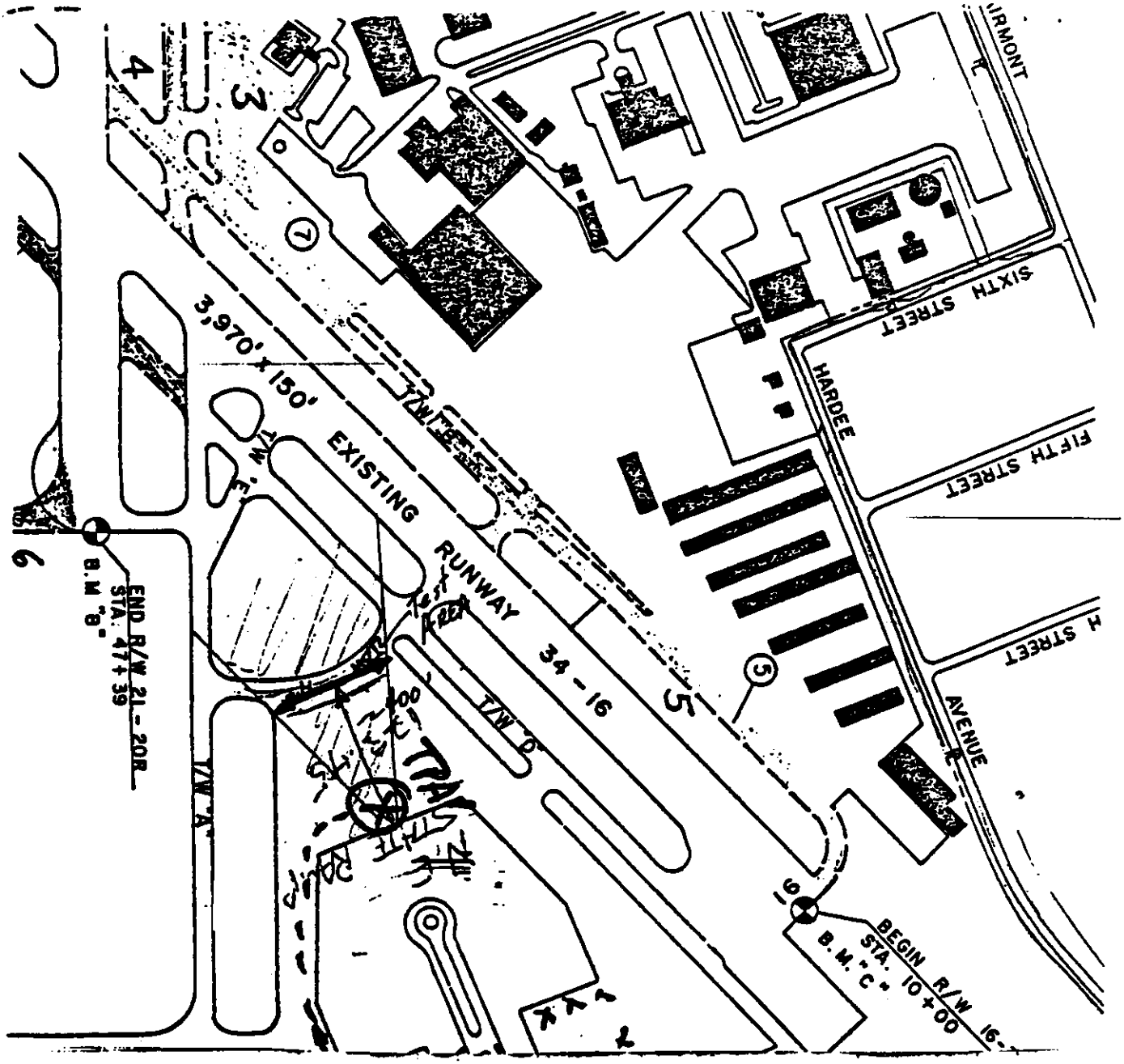

FIGURE 2. DATA COLLECTION SITE PLAN - PEACHTREE/DEKALB AIRPORT

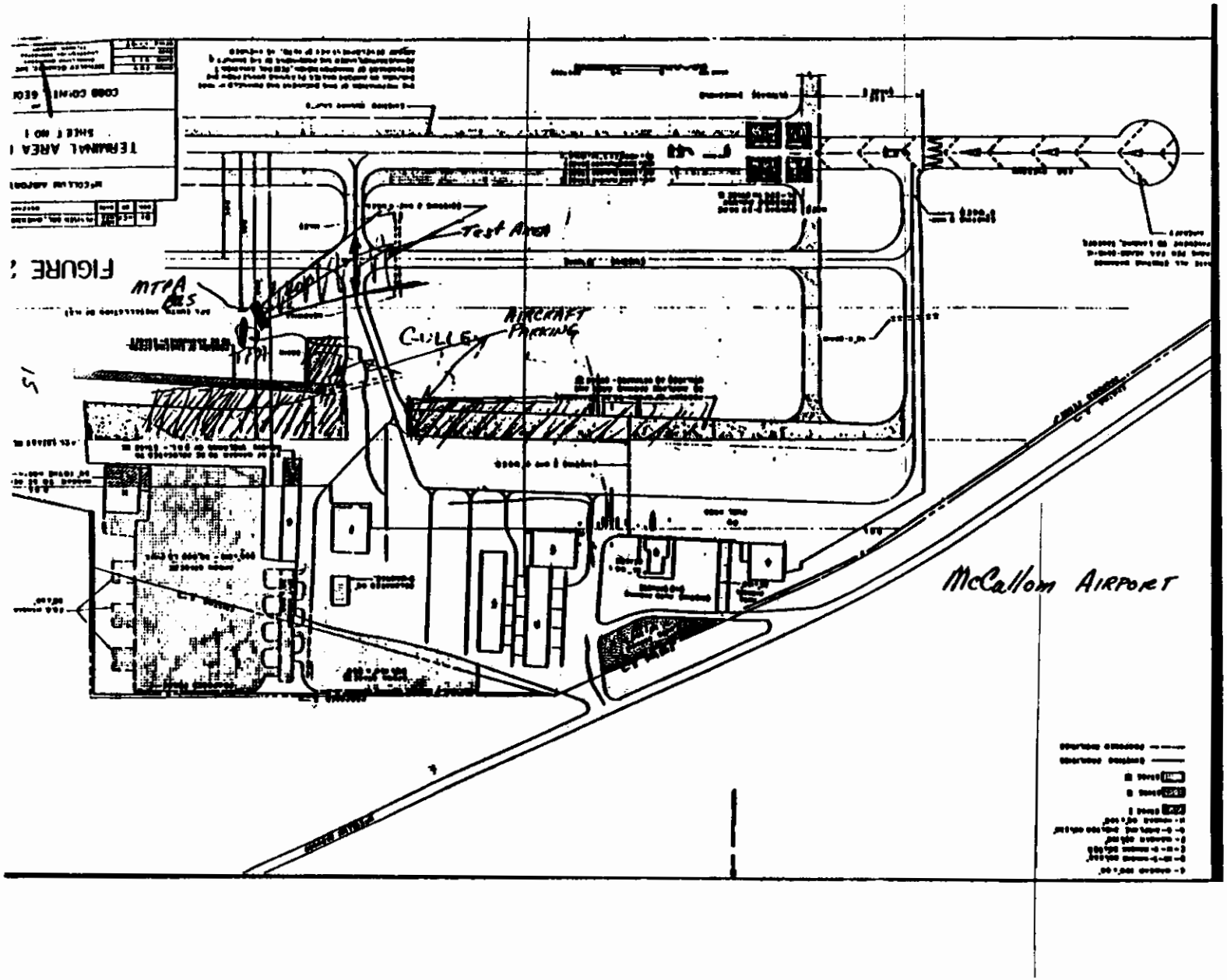

FIGURE 3. DATA COLLECTION SITE PLAN - MCCOLLUM AIRPORT

TABLE 1. TEST SEQUENCE FOR THE ATLANTA TESTS (ATL1)

Test Sequence No	MTPA Test No.	MTPA Test Description	Test Duration (sec)
1	2	Reply Characteristics	0.5
2	3	Mode Acceptance--Spacing	4.0
3	4	Mode Acceptance--Pulse Width	2.0
4	99	Altitude Comparison	0.5
5	15	SLS AMP Characteristics -50,-60 dBm	3.0
6	6	Dead Time	1.5
7	7	Supression Time	1.0
8	8	Reply Rate Limiting	4.0
9	12	SLS Mode Acceptance -- Spacing	10.0
10	13	SLS Mode Acceptance -- Pulse Width	10.0
11	14	Mode A and Mode C Sensitivity	1.0
12	5	SLS AMP Char ~-40 to -75 dBm (3 dB steps)	16.0
13	99	Altitude Comparison	0.5
14 to ??	14	Mode A and Mode C Sensitivity	1.0

TEST RESULTS.

Tests were conducted on a total of 154 different aircraft transponders. Some were tested more than once, but the results were included only once in these data. There were cases when all tests were not successfully completed (the transponder may have been turned off by the pilot prior to completion or interference from another plane invalidated the data from a particular test). In these cases the data are not included in the summaries. The results of each particular test are summarized below as a group.

REPLY CHARACTERISTICS. This test, which is MTPA test No. 2, makes 100 interrogations and measures the characteristics of the replies. This test produced data on the following parameters for 154 transponders:

1. Reply Frequency. Figure 4 shows the distribution of the reply frequencies from the 154 samples. The frequencies range from approximately 1086 to 1096 megahertz (MHz) with approximately 9 percent outside the limits of 1087-1093 MHz.

2. Bracket Spacing. Figure 5 shows the distribution of F1-F2 bracket spacing for the 154 samples. The times varied from 20.12 to 20.55 microseconds (μs) with six transponders or approximately 3 percent outside the allowed range of 20.2 to 20.4 μs.

3. Pulse Width. Figure 6 shows the pulse width distribution from the 154 transponders. Variations from 0.35 to 0.625 μs were found with 5 percent outside the limits of 0.35 to 0.55 μs.

4. Code Pulse Offset. Figure 7 shows the code pulse offset variations from the 840 code pulse samples from the 154 transponders. Figure 8 shows the maximum code pulse offset (the deviation from the nominal position of the code pulse which is the furthest from its prescribed position). The specified tolerance is plus or minus 100 nanoseconds (ns) with eight transponders or approximately 5 percent falling outside this limit.

5. Reply Jitter. Figure 9 shows the distribution of reply jitter for the Atlanta sample. No planes fell outside the prescribed limits of plus or minus 100 ns.

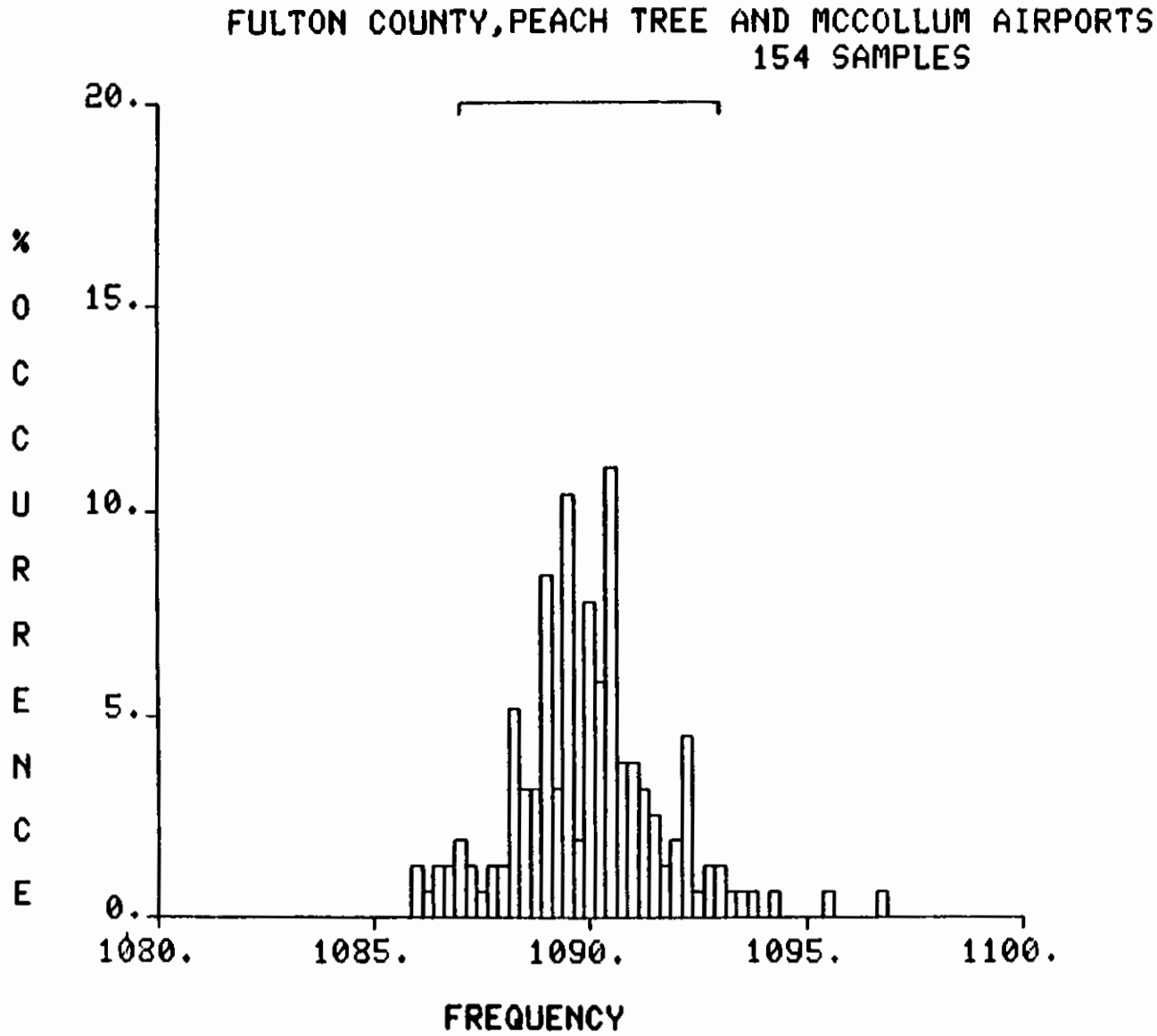

FIGURE 4. FREQUENCY DISTRIBUTION - ATLANTA SAMPLE

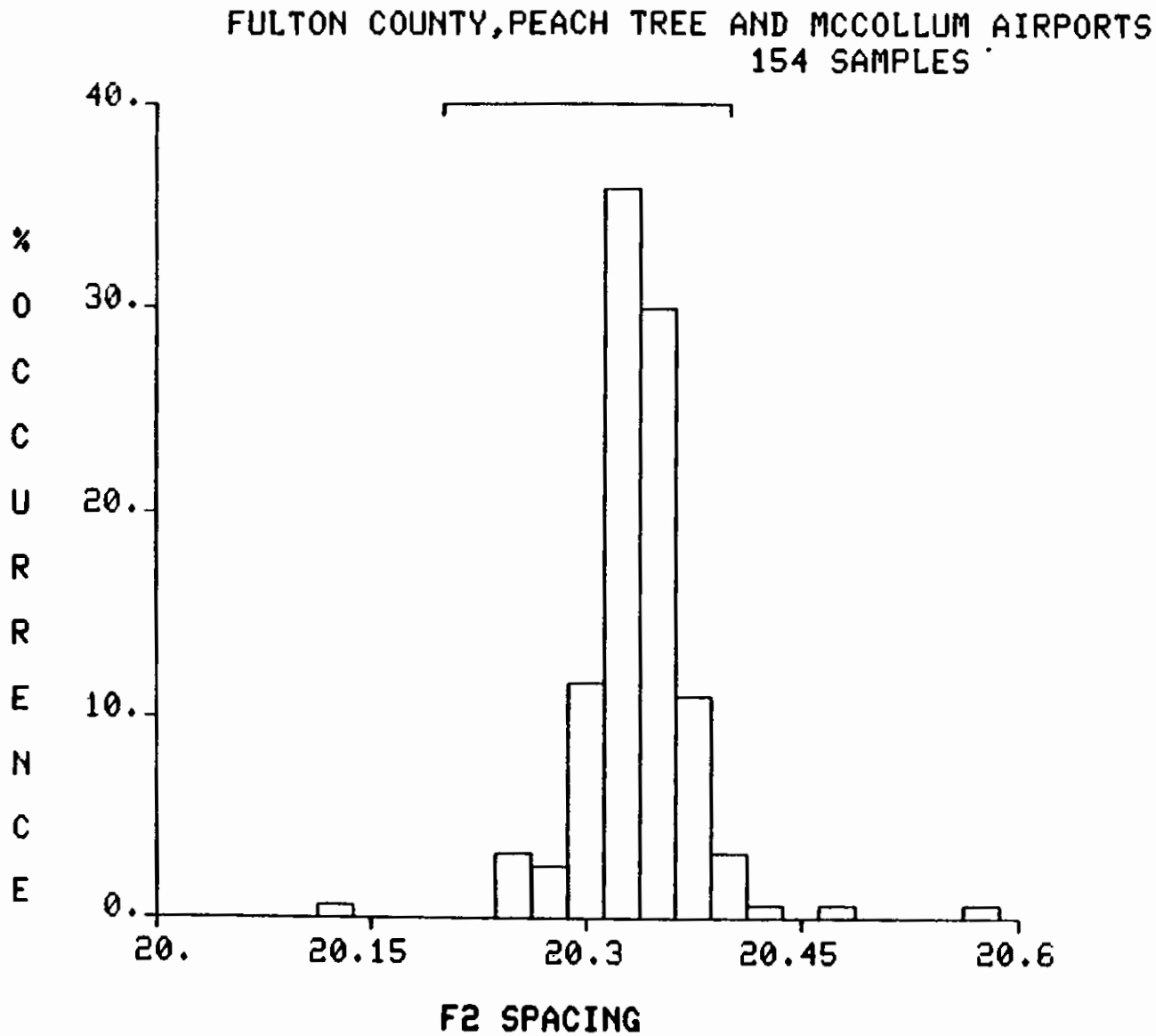

FIGURE 5. BRACKET SPACING DISTRIBUTION - ATLANTA SAMPLE

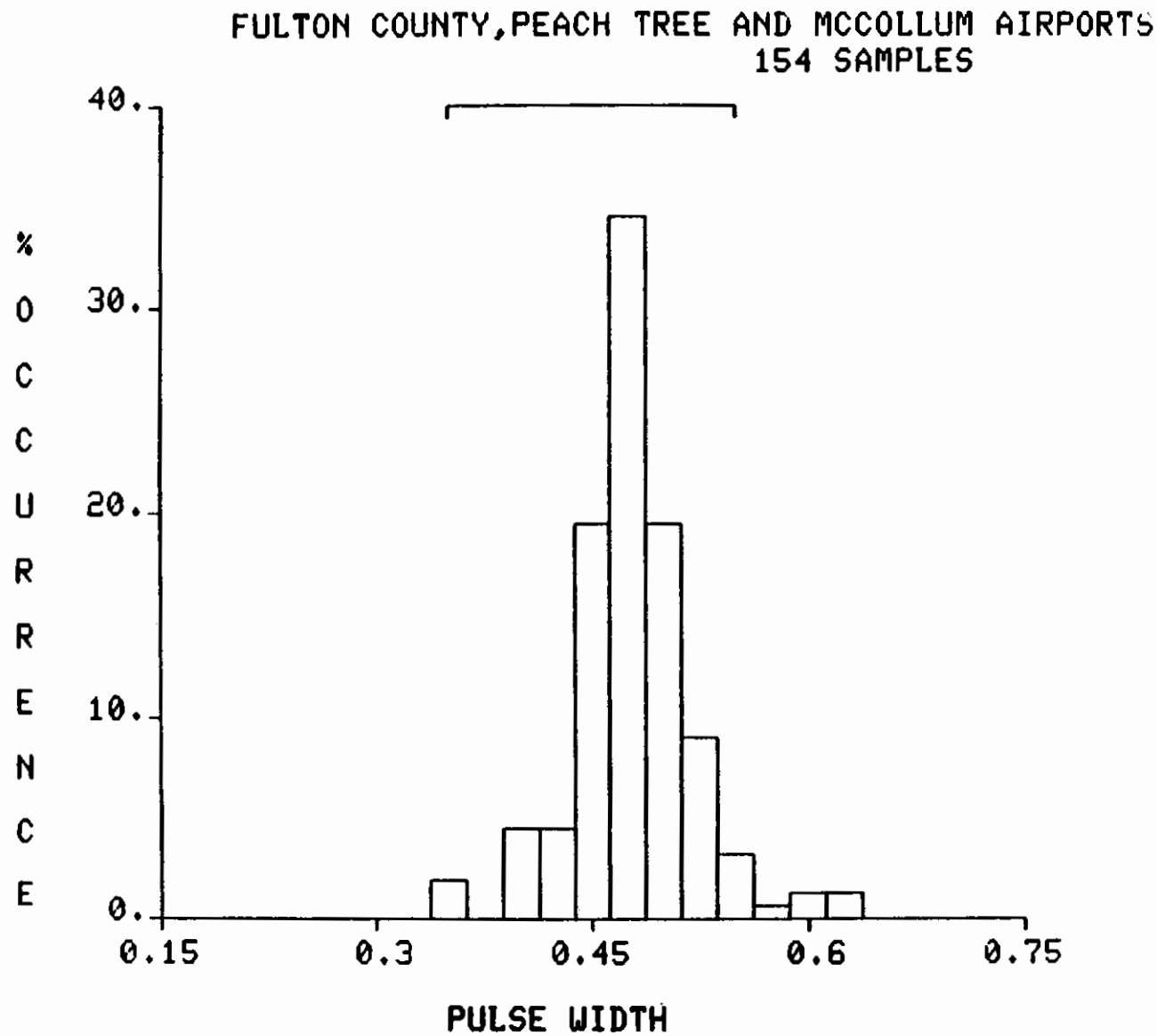

FIGURE 6. PULSE WIDTH DISTRIBUTION - ATLANTA SAMPLE

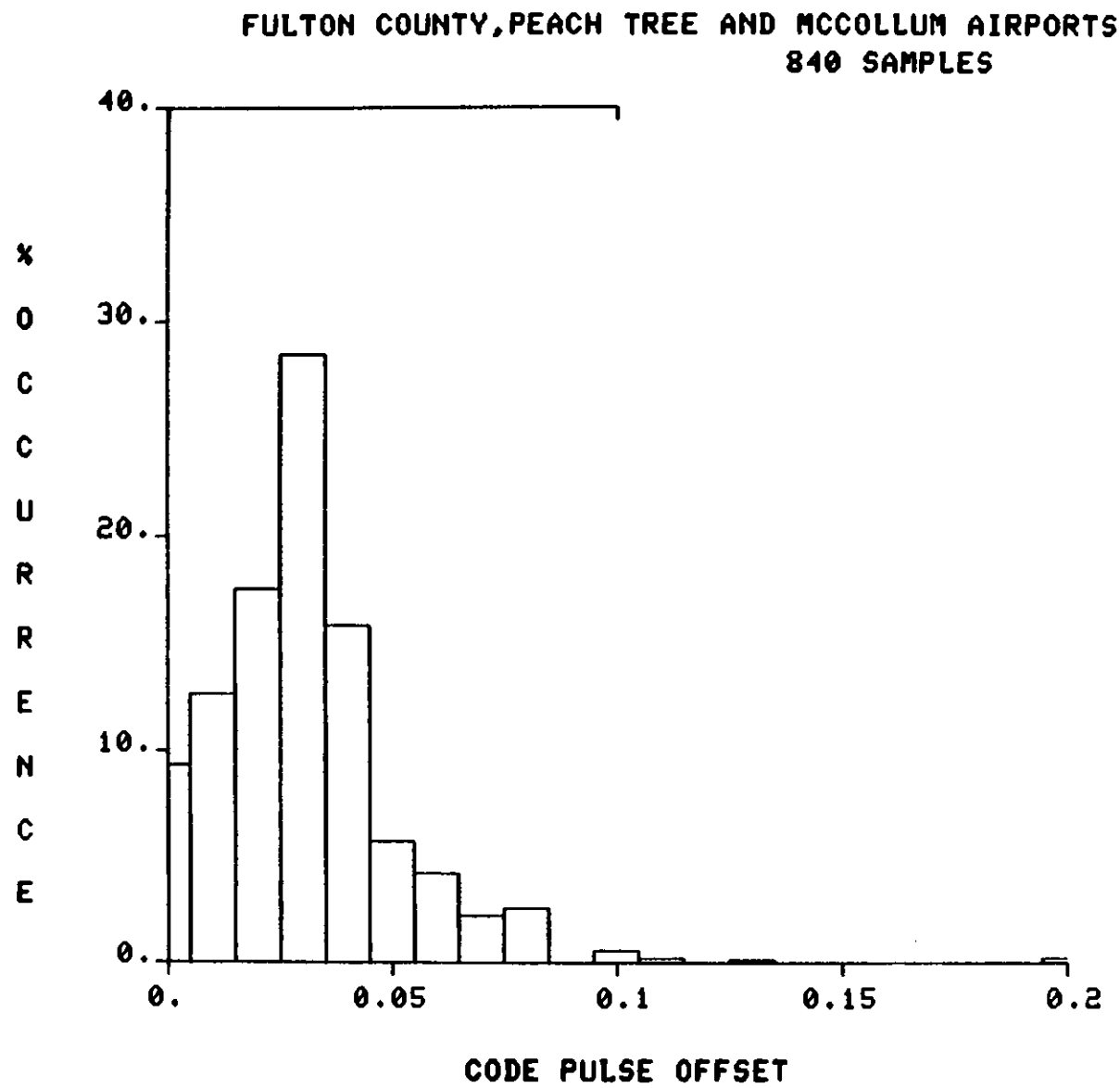

FIGURE 7. CODE PULSE OFFSET DISTRIBUTION - ATLANTA SAMPLE

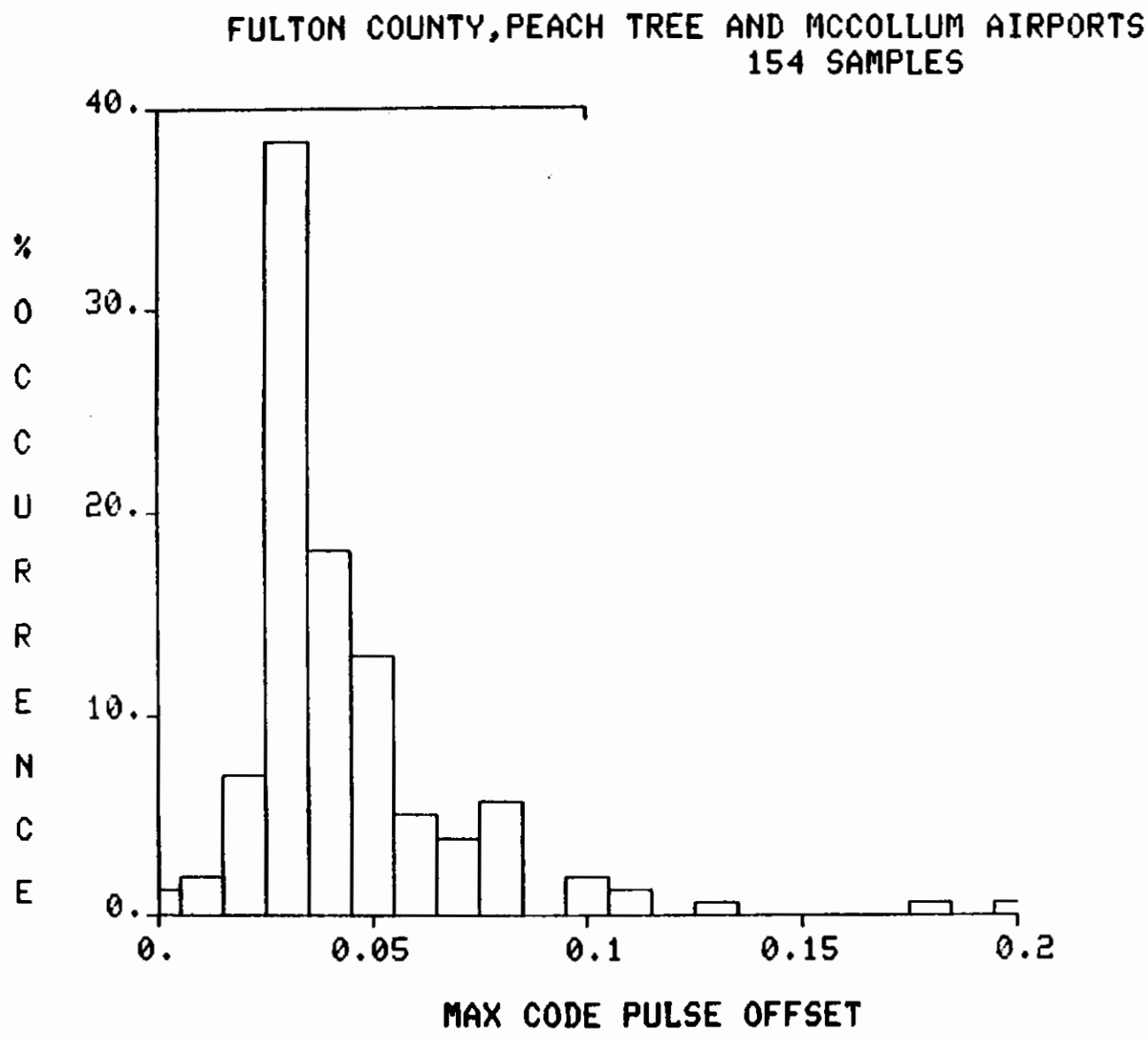

FIGURE 8. MAXIMUM CODE PULSE OFFSET DISTRIBUTION - ATLANTA SAMPLE

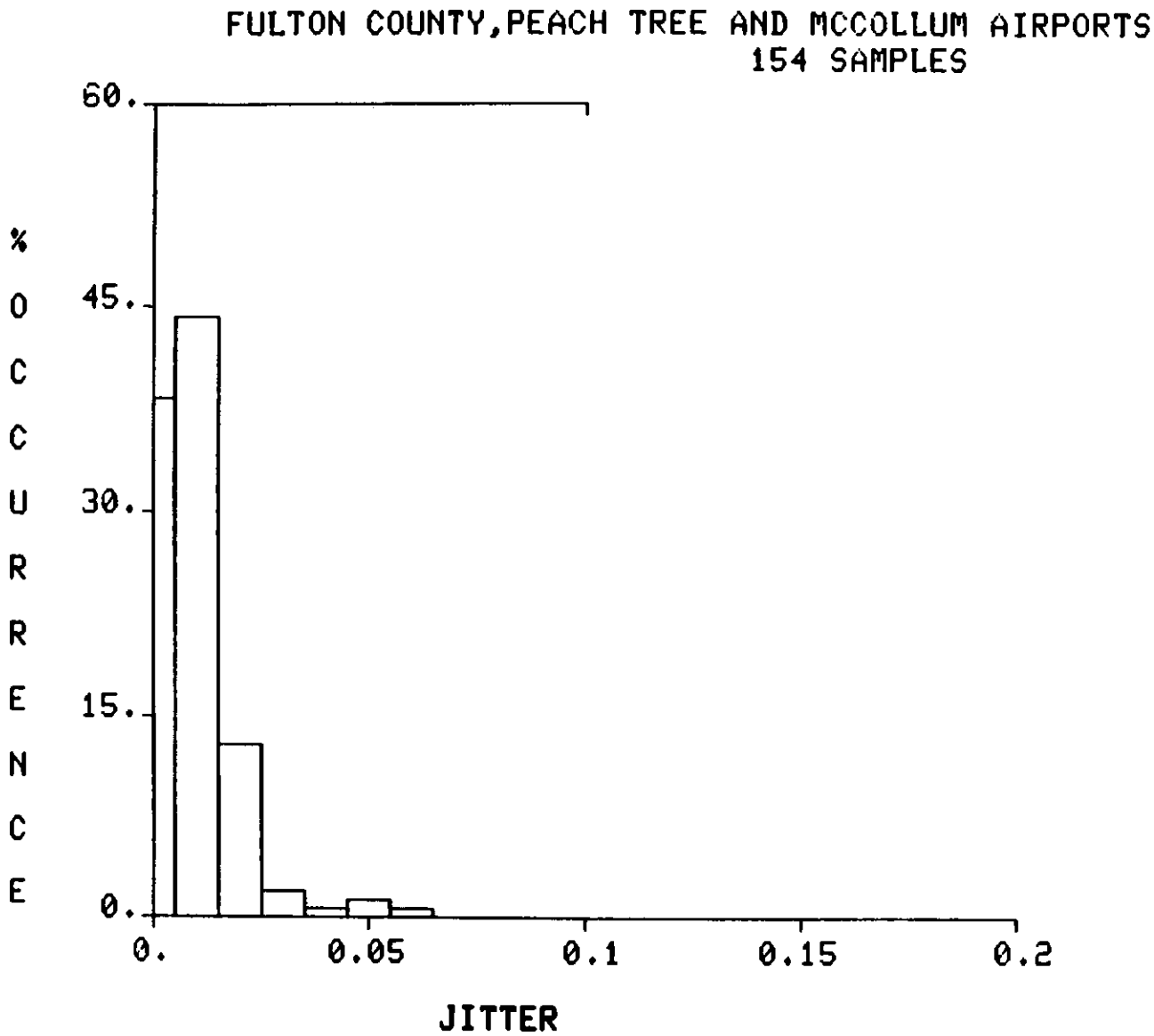

FIGURE 9. JITTER DISTRIBUTION - ATLANTA SAMPLE

MODE ACCEPTANCE -- PULSE SPACING. This test varies the spacing between P1 and P3 of the mode interrogation pulses to ascertain the acceptance/rejection characteristics of the transponder. Twenty interrogations are made in 50 ns increments from the nominal Mode A and Mode C spacings minus 800 ns to nominal plus 800 ns. The reply rates for the group of interrogations at each point are saved. Figure 10 shows an analysis of the 154 samples from Atlanta. The shaded in portion of the figure shows the defined area of the specification. Samples falling in this area are out of tolerance. For example, the interrogations spaced at 7 µs resulted in 153 transponders not replying at all and one which replied at a 90 percent rate. Eight transponders or approximately 5 percent failed to meet the specified tolerances.

Figure 11 shows the data from the Mode C acceptance pulse spacing portion of the test. Thirteen transponders or approximately 8 percent fell outside the allowable area. The data from all those transponders that failed were examined further to see why they had failed. In almost all cases, the acceptance zone was merely skewed from the nominal spacing. Figure 12 shows an example of the detailed data from one of the samples that failed. The acceptance zones appear to be centered at approximately 8.4 and 21.5 µs rather than the nominal of 8.0 and 21 0 µs. Seven were skewed so badly that they did not respond at the nominal spacing.

The reply delay difference data was also gathered from the mode acceptance (pulse spacing) test. The allowable delay difference is 200 ns. Figure 13 shows the distribution of differences in delay for the Atlanta data. Seven planes or about 5 percent failed to meet this criteria Only 147 samples are included because the remainder did not respond to Mode C at the nominal interrogation characteristics.

MODE ACCEPTANCE -- PULSE WIDTH. Figure 14 shows the reply rates of the Atlanta sample as a function of pulse width. All samples which fell into the shaded area were investigated further by examining the individual tests. In general, the cause was a single data point in the shaded (out of tolerance) area of the data plot. The nominal (0.8 µs) point was compared to the results of the pulse position test which used the same interrogation parameters. After this analysis two transponders or approximately 1 percent were out of specified limits.

FULTON COUNTY,PEACH TREE AND MCCOLLUM AIRPORTS

154 POINTS - REPLY RATE (%) VS PULSE SPACING (USEC) MODE A

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
6.800	153	1	*																		
6.850	154		*																		
6.900	154		*																		
6.950	152	2	*																		
7.000	153		*																1		
			**********																		
7.050	142	8	2	1																1	
7.100	115	11	13	8	1	3	2														1
7.150	103	4	7	6	7	6	6	1	7	2	3										2
7.200	101	1	1	2	3	3	12	5	9	6	2	5		1							3
7.250	95	3			2	2	1	5	3	3	4	3	10	8	4	2	1	1		2	5
7.300	86	3						2	1	5	3	6	8	9	5	3	3	5	1	6	8
7.350	62	7	2	5		2		2		1	2	1	1	2	12	7	8	5	7	3	25
7.400	44	5	7	4	4	2	1	1	2	3	1	3	2		3	1	1	4	6	9	51
7.450	32	5	1	3	2	2	4	5	2	1	1	1	1	1		5	3	1	5	3	76
7.500	15	3	1	2	1	2	2	3	1	4	2	2	3	3	2	2	2	1	3	6	94
7.550	10	1	2	2		1		1	1		2	7	2	2	9	2	2	4	2	6	98
7.600	11								2	1	3	1	1	2		4	5	4	2	6	112
7.650	7	1		1	1						1		3	1		3	3	1	4	7	121
7.700	6	1									1	1				1		1	1	13	129
7.750	5														1	2	1	1		10	134
	**********																				
7.800	3	1									1	1						*	2	6	140
7.850	2											1		1	1		1	*	1	5	142
7.900	1															1		2*	3	9	138
7.950							1				2					1		1*		11	138
8.000										1			1			1	1	*	1	7	142
8.050											1	1				1		1*		10	140
8.100											1						1	1*		11	140
8.150											1				2	2	2	*		11	136
8.200	1	1										1					1	1*	2	6	141
	**********																				
8.250	2						1				1		1				1	2	1	8	137
8.300	3	1								1	1		1			2	1		3	12	129
8.350	7	1			1						2			2			2		1	8	130
8.400	12								1			1	1		1	2		2	5	8	121
8.450	14							1		3		2		3	2	2	7	3	8	5	104
8.500	16	2		1	2	1		2	1	1	2	3	1	9	2	2	3	4	3	5	94
8.550	31	2	1	1			3	2	3	2	4	3	5	2	3	3	6	1	14	13	55
8.600	36	4	2	1	3		3	1	4	4	6	4	7	2	5	9	7	8	8	7	33
8.650	53	4	4	3	4	4	3	3	1	4	6	6	4	9	6	9	3	1	2	1	24
8.700	66	10	4	4	2	1	3	2	9	10	8	5	5	3				2	3	2	15
8.750	88	3	1	4	3	7	3	11	7	5	3	2	2	1		1		2		1	10
8.800	95	4	10	1	9	10	5	2	3	4	1	1			1			1	1		6
8.850	113	12	10	3	4	3	1	1					1				1			1	4
8.900	141	2	4		1				1					1					1		3
8.950	147	2	1			1														1	2
	**********																				
9.000	149	1	1*			1															2
9.050	153	1	*																		
9.100	151	3	*																		
9.150	152	2	*																		
9.200	150	4	*																		

must reply less than 10%

must reply greater than 90%

must reply less than 10%

FIGURE 10. MODE ACCEPTANCE (PULSE SPACING) DISTRIBUTION, MODE A - ATLANTA SAMPLE

FULTON COUNTY,PEACH TREE AND MCCOLLUM AIRPORTS

154 POINTS - REPLY RATE (%) VS PULSE SPACING (USEC) MODE C

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
19.800	152	1	*																		1
19.850	150	1	1*					1													1
19.900	151	1	*	1																	1
19.950	150	1	*			1															2
20.000	149	2	*							1										1	1
			**********																		
20.050	146	2	1		1																4
20.100	128	11	6	3			1						1					1		1	2
20.150	105	8	7	8	9	4	5		1								1				6
20.200	92	6	8	3	5	10	9	6		2	5									1	7
20.250	92	4	2	1	1	4	5	3	4	7	6	7	4	3	2						9
20.300	90	3	1		1	1	2	4	2	6	6	7	11	2	5	1	2		1		9
20.350	66	5	3	5	2		1	1		4	3	3	9	5	8	5	6	3	3	6	16
20.400	48	4	10	2	1	4	1		2	1	1	3	1	1	5	8	7	13	6	6	30
20.450	42	3	1	1	5		2	3	4	2	1	2	2	2		3	1	3	8	14	55
20.500	27	2	2	1	1	2	2	3	4	3	3	2	3	4	1	1	2	3	2	11	75
20.550	20	1	1	2	1	1		1	4	1	2	3	4	1	5	2	1	3	4	8	89
20.600	13				1				1	3		1	2	4	2	2	2	4	6	7	106
20.650	11									2			1	3	1	2	4		3	15	112
20.700	9			1											1	1	1	3	3	8	127
20.750	9				1								1		1			2	1	9	130
			**********																		
20.800	9								1		1		1	1				*	2	9	130
20.850	5									1	1	1			1	1		1*	1	13	129
20.900	6										2	1			1			1*		6	137
20.950	6										2		1				1	1*	1	6	136
21.000	6										1					1		*	1	13	132
21.050	5	1									1	1			1		1	*	2	13	129
21.100	6										1					1	1	*	1	10	134
21.150	6										1				1			1*		9	136
21.200	7										1	1			2			*	2	11	130
			**********																		
21.250	6		1									1		1	1		2		2	12	128
21.300	8												1	1					2	10	132
21.350	8		1		1						2				1		1		7	12	121
21.400	14			1			1					2				1	4			14	117
21.450	18			1	1						3	1	1	2	1	3	5	6	4	8	100
21.500	21	2			1	1		1			5		3	4	6	2	1	3	2	12	90
21.550	29	2		1			1	2	1	2	4	3	4	6	4	3	1	1	2	9	79
21.600	39	2	2	1	1		5	4	3	4	4	4	2	2			4	11	5	11	50
21.650	47	3	3	4	7	3	5	1	1	2	1	3	2	6	4	7	6	5	7	3	34
21.700	56	9	1	3	2	5	2	2		2	10	5	6	10	2	5	4	3	1	2	24
21.750	78	5	2	1	2	1	1	5	7	8	3	5	8	4	1	1		1		1	20
21.800	81	7	2	3	4	8	10	3	2	6	4	2	2		3				1		16
21.850	91	9	6	5	10	5	8	3	2	2									1	2	10
21.900	108	11	12	5			4		1			1						1	1		10
21.950	132	6	4	1	1			1										1			8
			**********																		
22.000	146		1*													1					6
22.050	145	2	*	1															1		5
22.100	146	2	1*																	1	4
22.150	147	2	*																	1	4
22.200	148		1*														1				4

must reply less than 10%

must reply greater than 90%

must reply less than 10%

FIGURE 11. MODE ACCEPTANCE (PULSE SPACING) DISTRIBUTION, MODE C - ATLANTA SAMPLE

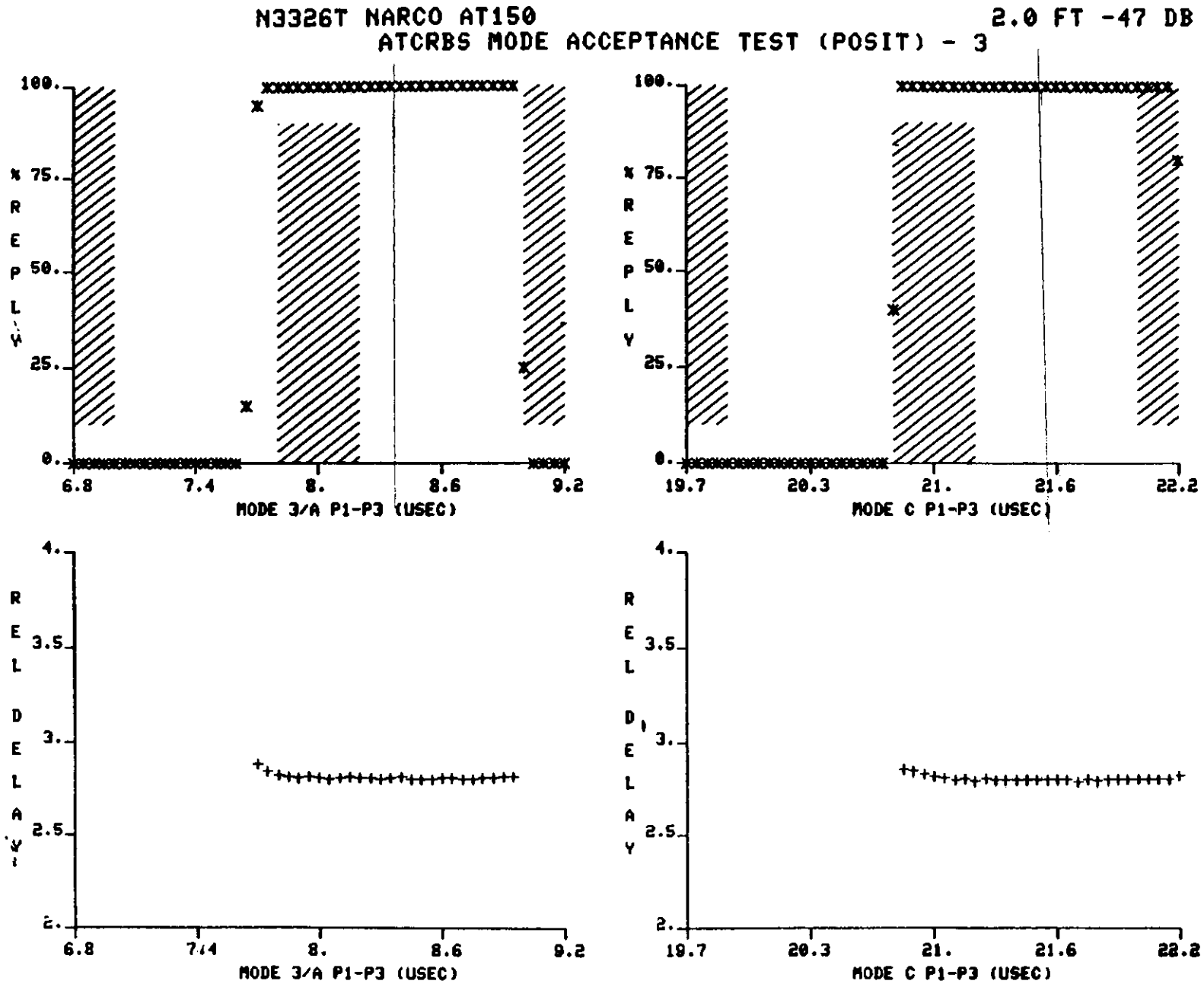

FIGURE 12. INDIVIDUAL SAMPLE - MODE ACCEPTANCE - ATLANTA SAMPLE

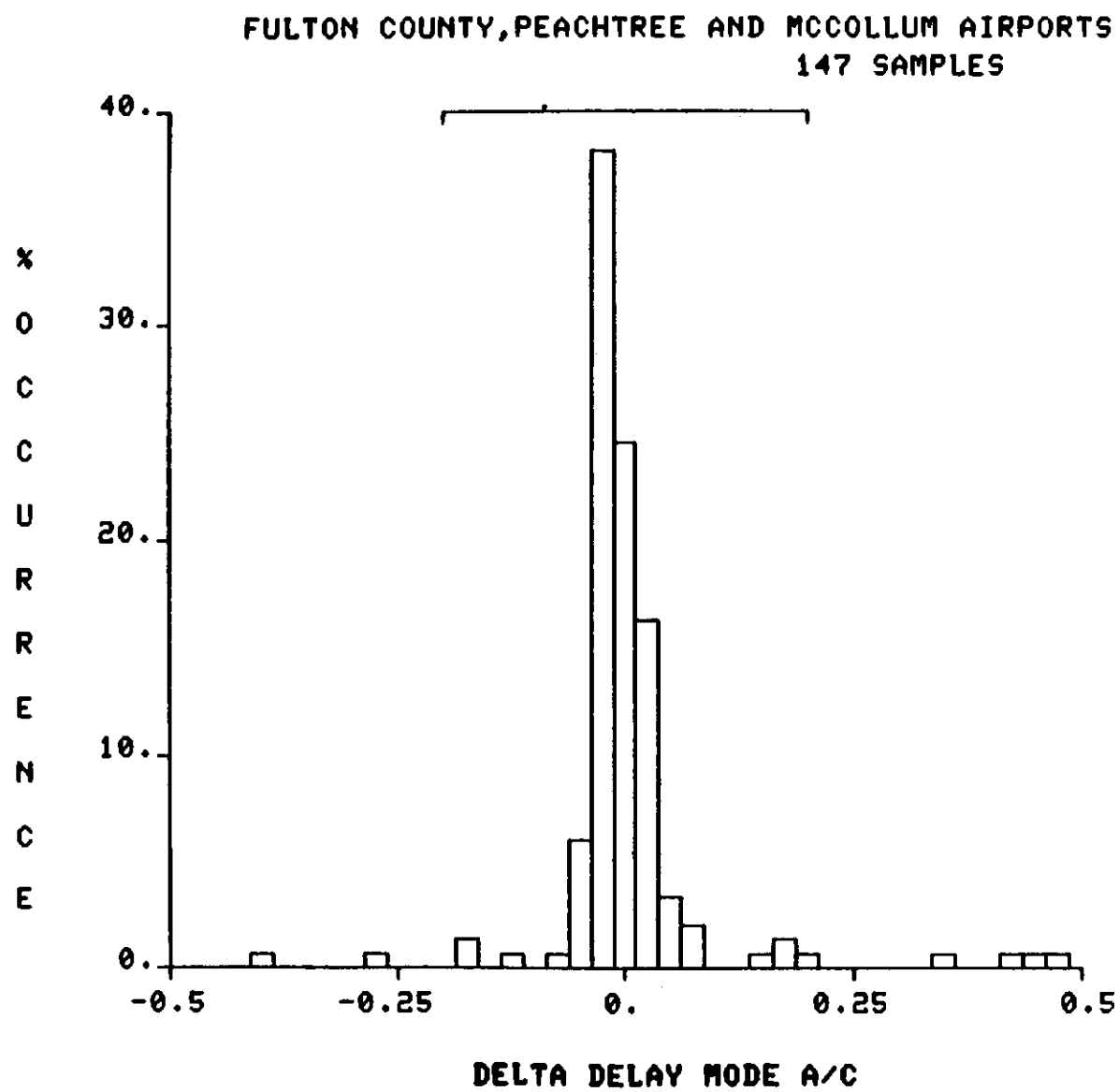

FIGURE 13. REPLY DELAY DIFFERENCE (MODE A TO MODE C) - ATLANTA SAMPLE

FULTON COUNTY,PEACH TREE AND MCCOLLUM AIRPORTS

154 POINTS - REPLY RATE (%) VS PULSE WIDTH (USEC) MODE A

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0.300	24	1			1			1			1	2		1					1	6	116
0.325	22		1				1	1		2		1		1	1				1	6	117
0.350	22										1			2			1		2	15	111
0.375	20		1					1			1		1					1	2	4	123
0.400	15	2		1					1			1		1		1			1	3	128
0.425	9		1	1	1			1				1	1		1					4	134
0.450	6	2							1		1	2			1		1		1	7	132
0.475	6				1				1	1	1	1		1			2	1		9	130
0.500	5				1						2		1	1		1	1	2		10	130
0.525	4	1		1								1	1				2	1	1	12	130
0.550	2			1				1		1			1	1			2		1	9	135
0.575	2							1			1	1		1		1		1		7	139
0.600	1							1			2	2		1		1		1	2	5	138
0.625											1	1		1		1	1			11	138
0.650													1	1		1	1	1	1	7	141
0.675												1	1	1				1		5	145
**********																					
0.700												2	1	1				1*	1	6	142
0.725								1				1					2	*		4	146
0.750											1		1			1		1*	1	9	140
0.775										1					2	1	1	*		7	142
0.800										1	2						2	**		5	142
0.825														1	1		1	1*	1	7	142
0.850							1										1	2*	1	6	143
0.875										1							1	1*	1	8	142
0.900												1			1	1		*	3	9	139
**********																					
0.925									1					1	1			1		9	141
0.950											1		1					1	1	6	144
0.975							1											2		5	146
1.000												1				1	1		1	7	143
1.025							1				1						2	1		8	141
1.050								1			1						1		3	8	140
1.075												1	1	1		1		2		5	143
1.100					1			1			1							1	2	5	143
1.125						1				1				1		1			3	6	141
1.150		1							1						1			1	2	8	140
1.175	1										1		1				2	1	2	3	143
1.200	1										2	1	1	2					1	7	139
1.225	1									1					1				1	10	140
1.250	1								1							1		2	1	8	140
1.275	1									1			1			1			2	8	140
1.300	2				1						1							2	1	5	142
1.325	3									1	2	1	1					1	1	9	135
1.350	4									1	3	1	1					1		5	138
1.375	4		1								1								2	10	136
1.400	7									1	1	1		1			1	1		6	135
1.425	7										1	1		1					1	7	136
1.450	7										2	1	1					2		7	134
1.475	7										1		1	1	1	1		1		7	134
1.500	7										1				1	1		1	1	6	136

must reply >90%

FIGURE 14. MODE ACCEPTANCE (PULSE WIDTH) DISTRIBUTION - ATLANTA SAMPLE

DEAD TIME. This test determines how long a transponder is "dead" after responding to an ATCRBS interrogation. An interrogation is made to solicit an ATCRBS reply. A second interrogation is then moved in time from 20 to 140 μs after the first. The reply rate to the second interrogation is used to determine dead time parameter of the transponder. It must reply at a 90 percent rate no later than 125 μs following the end of the first reply. Eighteen transponders originally appeared to fail this criteria. They were investigated individually to get a better idea of their characteristics. It was found that the dead time data was affected by two other circumstances: (1) triggering of the reply rate mechanism of the transponder, and (2) RF coupling between MTPA and the transponder which could not maintain the 90 percent threshold. Most transponders raise their receiver threshold in order to reduce the amount of interrogations they see when the reply rate exceeds a certain amount. When the dead time test was conducted, two interrogations were made on the same interrogation sequence which is repeated at a 500 hertz (Hz) rate, giving an effective rate of 1000 interrogations per second. If this triggered the reply rate limiting circuitry, the receiver threshold was increased. If the coupling was marginal (for whatever the reason, i.e., shielding, poor sensitivity, etc.), it may no longer be possible to retain the 90 percent reply rate for the duration of the test. In the real ATC environment, the transponder does not receive more than about 50 interrogations from the same interrogator in a burst. Thus, the situation created with the dead time test was not a realistic one in which to measure dead time (it measured the effect of two parameters at once). Figure 15 is a plot of the dead time characteristics of a single sample showing the effect of the reply rate limiting on the output of this test. The reply rate limiting test of all samples which exhibited this characteristic were examined. If the reply rate was less than 100 percent during this test and if it were 100 percent during the preceding test, it was assumed to be in reply rate limiting. It was then assumed the dead time to be the point at which the transponder first replied at a 90 percent rate. Applying this criteria, only one plane failed to respond within the limits of the dead time specification. The distribution of the data is shown in figure 16. Reply delay data were not used from this test as the reply rate limiting action of the transponders also affected the reply delay.

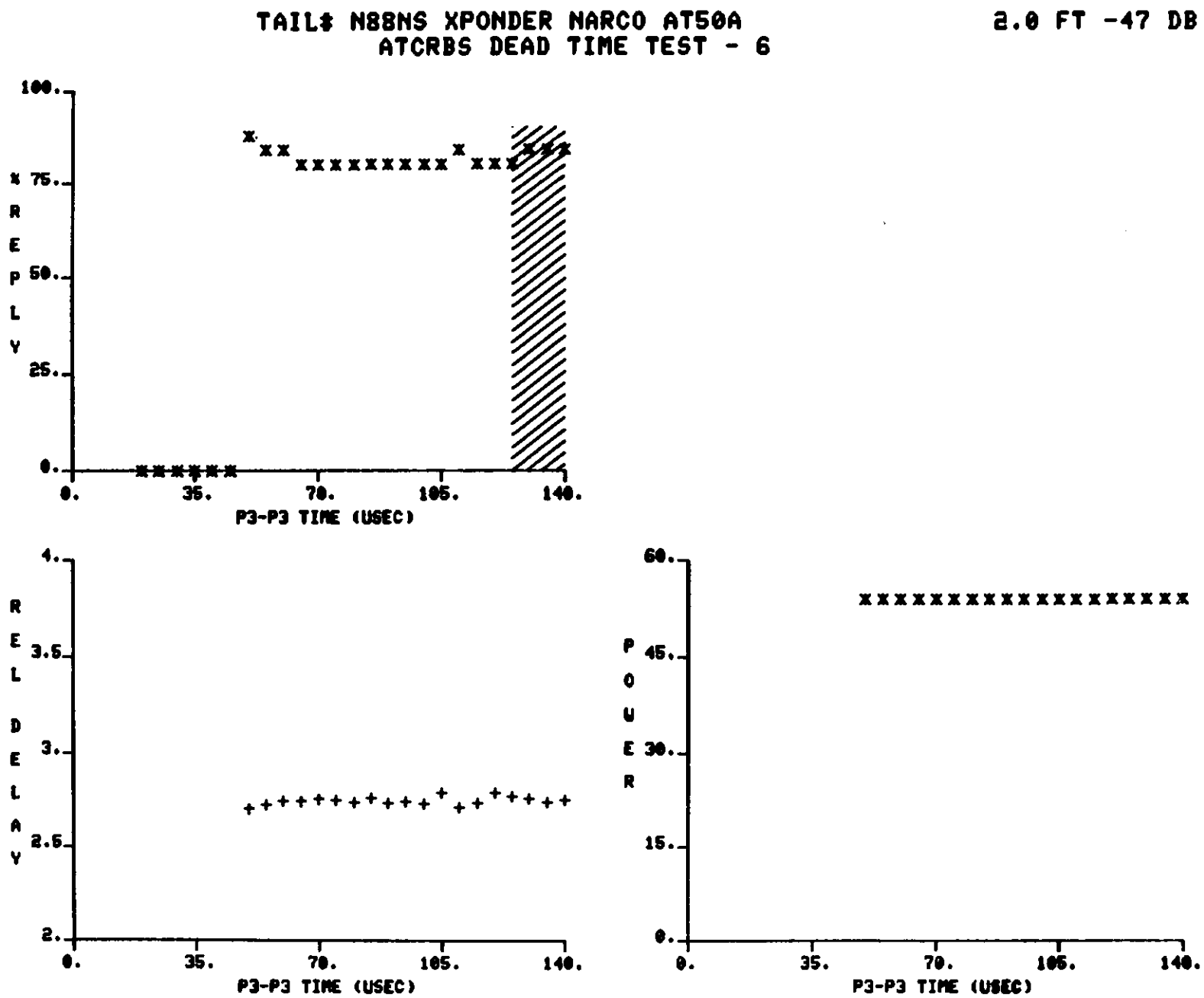

FIGURE 15. INDIVIDUAL SAMPLE - DEAD TIME TEST

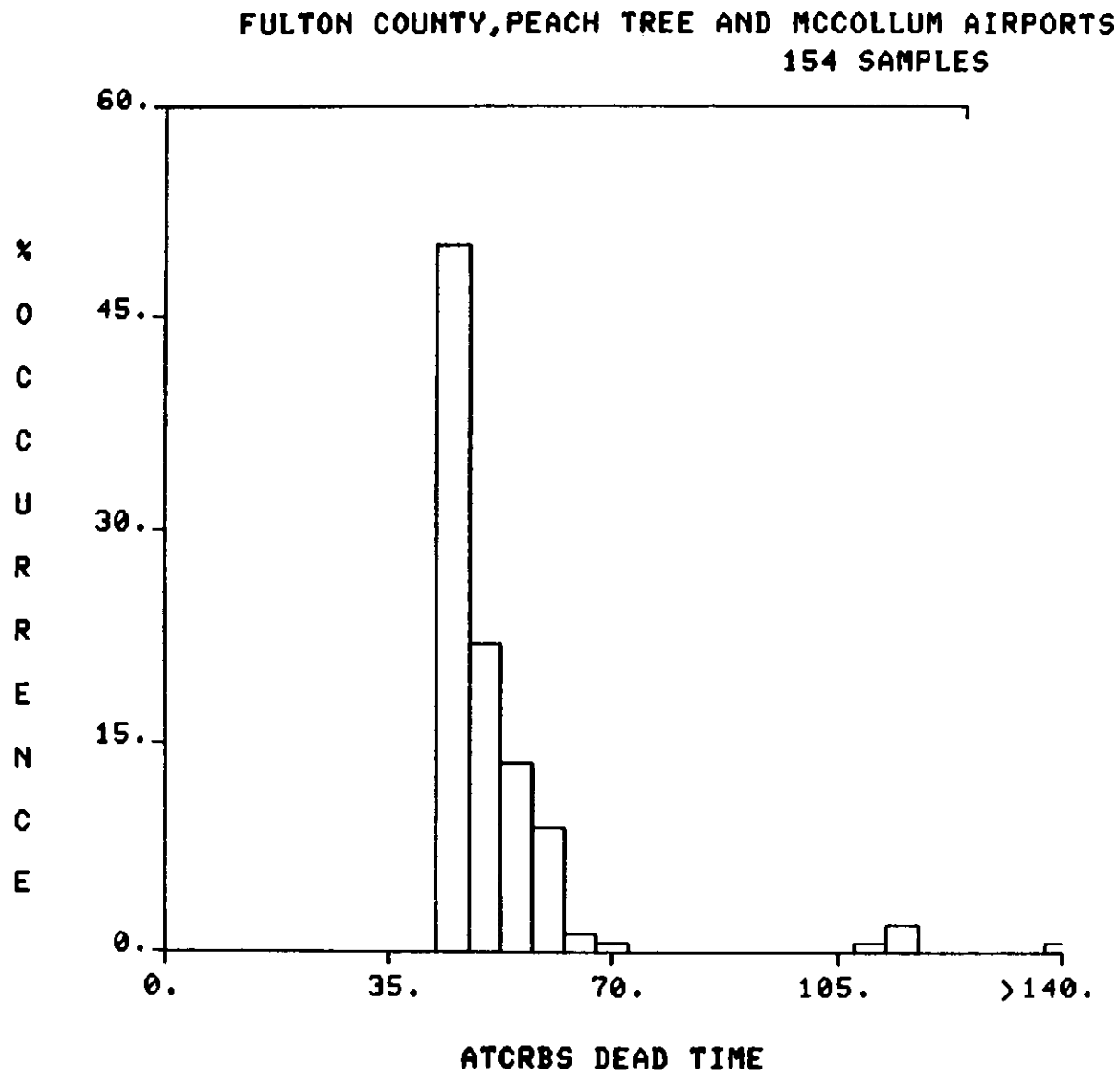

FIGURE 16. DEAD TIME DISTRIBUTION - ATLANTA SAMPLE

ATCRBS SUPPRESSION TIME. The suppression time test is essentially the same as the dead time test except the first interrogation consists only of a suppression pair (P1 and P2) and, thus, requires no reply. The second interrogation is moved away from the first to see how long the suppression period (initiated by the first interrogation) lasts. The reply rate to the second interrogation is used to determine the suppression time. Figure 17 shows the distribution of suppression times. Twenty-two transponders, or approximately 14 percent, fell outside the limits of 25 to 45 µs.

SLS CHARACTERISTICS--PULSE SPACING. This test makes 100 interrogations at each point. A Mode A interrogation is used with a P2 pulse 3 dB higher than P1 and P3. The spacing between P1 and P2 is then varied in 50 ns increments from 1.2 to 2.8 µs. This was the most frequently failed test in the sample from Atlanta. The results are broken into two areas: (1) the area where the transponder should reply less than 1 percent (the suppression area--1.8 to 2.2 µs), and (2) the area where it should reply at greater than a 90 percent rate (see figure 18). Eighteen (approximately 11 percent) failed the first category while 91 (approximately 59 percent) failed the second. Detailed investigation of the test results showed that the SLS acceptance region was too wide or skewed from nominal in almost all cases. Figure 19 is a sample showing the response of one sample to the variation in the SLS.

SLS CHARACTERISTICS--PULSE WIDTH. This test makes 100 interrogations at each point in order to check the pulse width acceptance characteristics of the transponder. Nominal pulse positions and widths are used for all pulses of the interrogations with the exception of the P2 pulse (its position is nominal but the width is variable). The P2 pulse is set to be 3 dB greater than P1 and P3. Widths from 300 ns to 1.5 µs are used. Figure 20 shows the results of this test. A total of five transponders (approximately 3 percent) failed to suppress as a function of width, although four of these failed to suppress altogether.

SLS AMPLITUDE/DYNAMIC RANGE CHARACTERISTICS. Two versions of this test were conducted during each run as these parameters were of special interest. One test was run at only a power level of -50 and -60 dBm (MTPA test 15) while varying the P1/P2 power ratio. The other (MTPA test 5) was run throughout the entire dynamic range capability attainable at the transponder (normally the range was from -75 to approximately -39 dBm).

Test 5 was performed in the following sequence: the power level of P1 and P3 were set to -75 dBm. Sets of interrogations (100 per point) were then made where the ratio of P1 (and P3) to P2 was 15, 12, and 9 dB (P1 and P3 are greater than P2), to which the transponder should reply at least 90 percent. Interrogations were then made at ratios of 6 and 3 dB, where the performance is unspecified, and at ratios of 0, -3, and -6 dB where the transponder must reply less than 1 percent

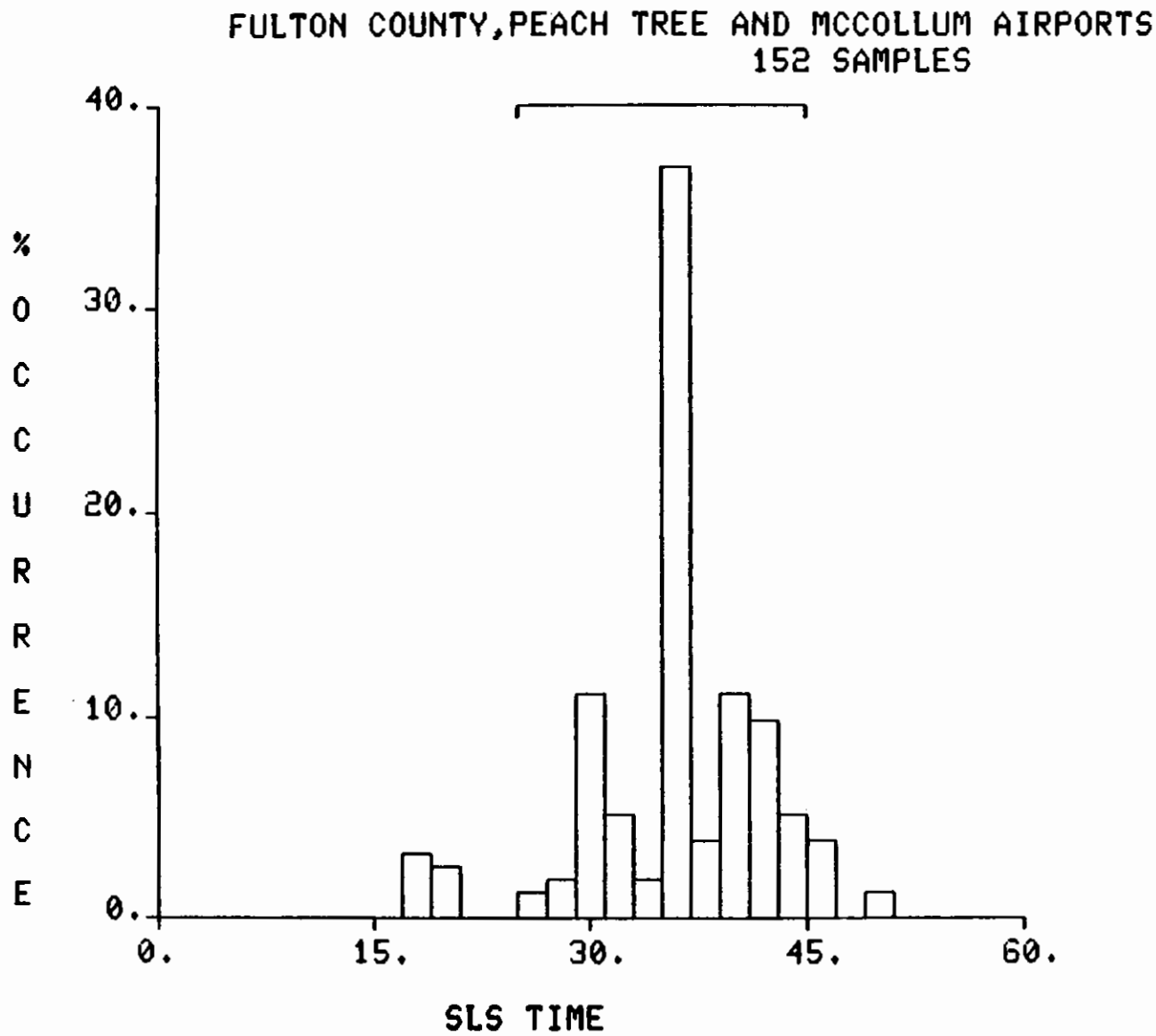

FIGURE 17. SLS SUPPRESSION TIME DISTRIBUTION - ATLANTA SAMPLE

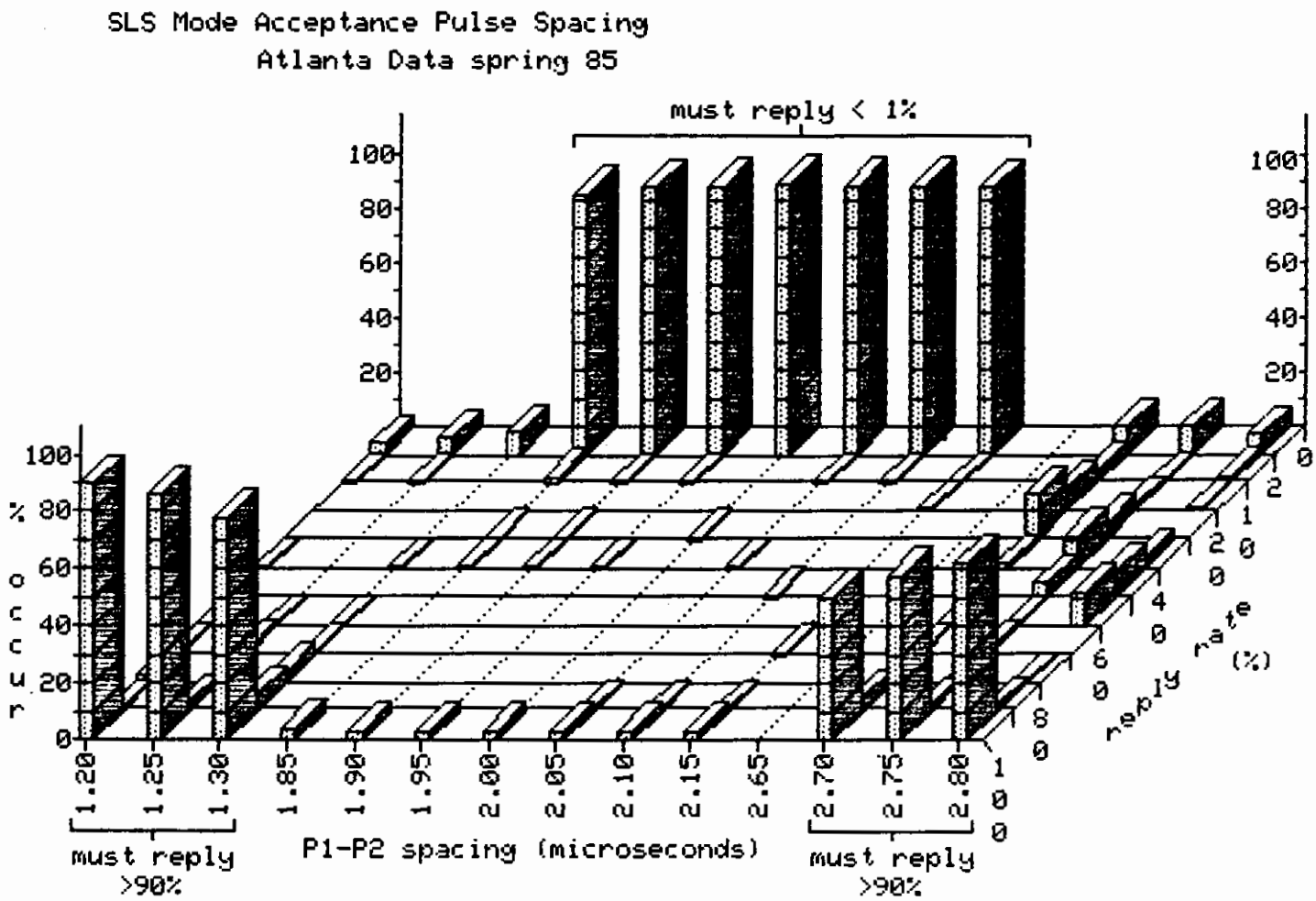

FIGURE 18. SLS MODE ACCEPTANCE (PULSE POSITION) DISTRIBUTION - ATLANTA SAMPLE

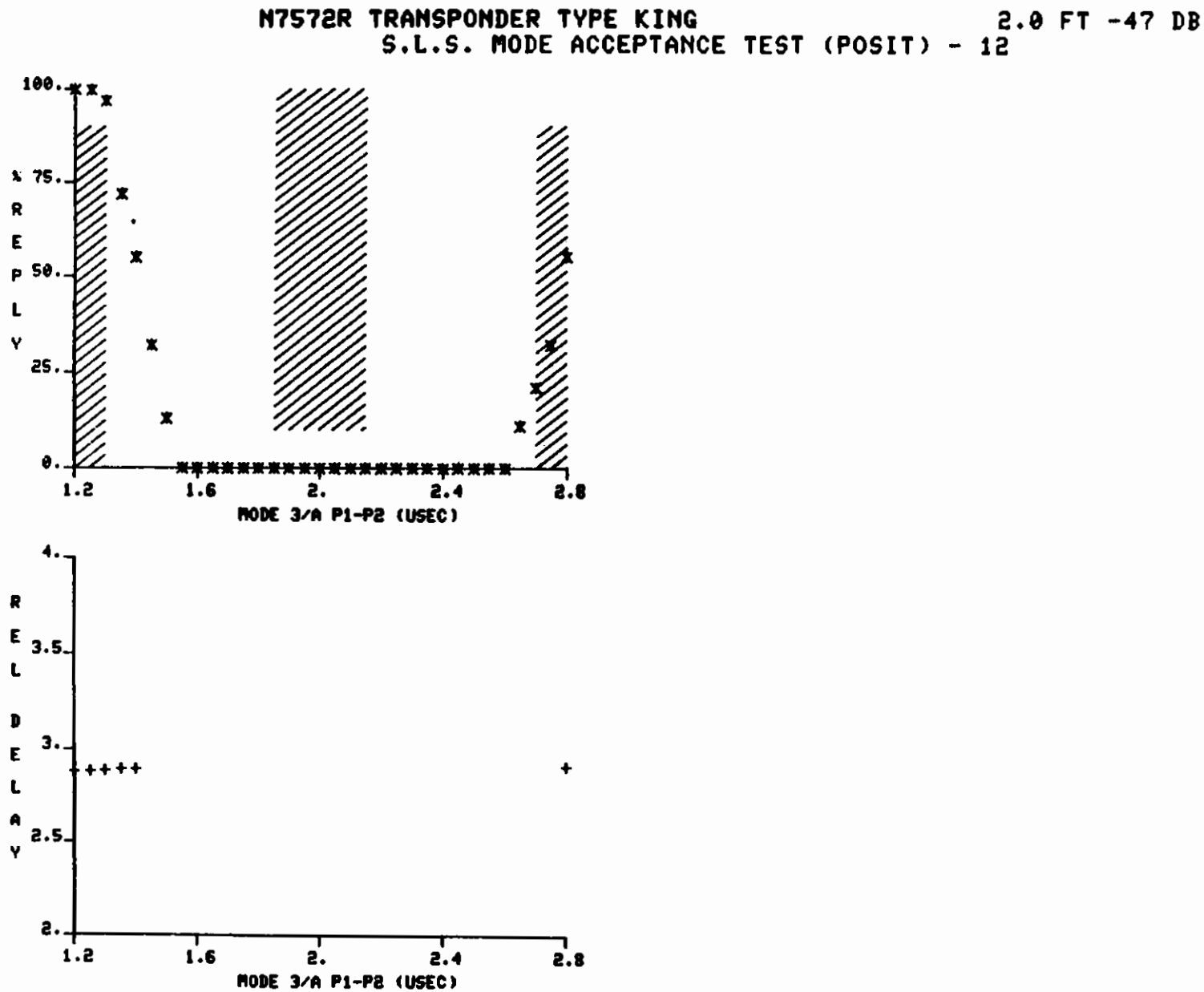

FIGURE 19. INDIVIDUAL SAMPLE - SLS MODE ACCEPTANCE (PULSE POSITION)

FULTON COUNTY,PEACH TREE AND MCCOLLUM AIRPORTS

154 POINTS - REPLY RATE (%) VS PULSE WIDTH (USEC) SLS - MODE A

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0.300	21	1	2	3	2	1		2		2	1	1	1			4	1	4	4	7	97
0.325	36	5	1	1	3		1	3	1		1	2	4	4	2	2	3	5	3	12	65
0.350	67	4	1	1	2	2		2	1	1	1	2	2	1		4	1	1	1	7	53
0.375	82	8	2	1	1	1			1			3		1	1	2	2	3	1	5	40
0.400	99	4	1	1	1	3	2	1	2		1		1	1	2	3			1	3	28
0.425	117	3	2	2	2	2		1					1			2			1		21
0.450	131	2			1	1		2										1			16
0.475	137	1					1						1		1			1	1	1	10
0.500	140	3	1	1												1	1		1		6
0.525	144	2					1										1				6
0.550	147											1								1	5
0.575	146	1							1											1	5
0.600	147								1												6
0.625	146	1				1										1				1	4
0.650	146	2			1											1					4
0.675	146	2						1										1			4
0.700	146*	2								1									1		4
0.725	148*								1												5
0.750	147*	1							1											1	4
0.775	148*		1																1		4
0.800	148*					1													1		4
0.825	146*	2			1															1	4
0.850	146*	2					1										1				4
0.875	148*					1											1				4
0.900	147*	1		1											1						4
0.925	146		1	1	1									1							4
0.950	147	1						1							1						4
0.975	148						1							1							4
1.000	147	1				1									1						4
1.025	147	1									1						1				4
1.050	147		1		1										1						4
1.075	146	1		1		1									1						4
1.100	147	1					1						1								4
1.125	148								1					1							4
1.150	148									1						1					4
1.175	146	2							1								1				4
1.200	147		1								1					1					4
1.225	143	3		1		1	1									1					4
1.250	144	1	1			1				1					1		1				4
1.275	145	1		1										1			1				5
1.300	144	1				1	1				1										6
1.325	144	1			1							1				1					6
1.350	143	1				1				1											8
1.375	144					1						1								1	7
1.400	143					1	1						1								8
1.425	136	6					1		1												10
1.450	142							1					1							1	9
1.475	142							1					1								10
1.500	142						1					1									10

FIGURE 20. SLS MODE ACCEPTANCE (PULSE WIDTH) DISTRIBUTION - ATLANTA SAMPLE

(suppress). The reply ratio at each point is saved. The power of the group is then increased by 3 dB (-72 dBm) and the process repeated. This is done at 3 dB increments until the maximum power output capability of MTPA is reached.

Test 15 performed the groups of interrogations only at -50 and -60 dBm. Figure 21 is a summary of the data from test 15. It shows that at an interrogation level of -60 dBm, only 116 transponders responded at a rate greater than 90 percent, while at -50 dBm, 149 reached this level. Since the transponders had not reached minimum triggering threshold (MTL) which is defined as the signal level which produces a 90 percent reply rate, the specification cannot be applied. It was used, however, in conjunction with test 5 where MTL can be determined.

The transponder producing the data for figure 22 (the results of an individual test 5) shows definite SLS problems. At a P1-P2 ratio of +9 dB the reply probability drops, as confirmed by test 15 (see figure 23) which was run at -50 and -60 dBm. The analysis program searches the "must reply" area (see figure 22) of each individual test 5 for a reply rate of at least 90 percent. This defines the MTL level for this transponder (-54 dBm for this case). Data from this column (MTL), -51, -48, -45, and -42 dBm (MTL + 9 dB), are then saved for the test 5 data base. This procedure is used on each transponder sample until the data for all the transponders has been standardized to these four levels referenced to MTL. Figures 24, 25, 26, and 27 are plots of the SLS amplitude characteristics from the Atlanta sample at MTL, MTL + 3, MTL + 6, and MTL + 9 dB, respectively. The "reply rate" axis is not completely linear on these plots. The first row contains reply rates of 0 and 1 percent (in order to separately show the suppression area of the specification). The remaining rows are 2 to 10, 11 to 20, 21 to 30 percent, etc. Thus, at a P1-P2 ratio of -6 dB, 91 percent of the transponders replied at a rate of 1 percent or less, 3 percent replied at a rate of 2 to 10 percent, 1 percent replied 10 to 20 percent, 1 percent replied 30 to 40 percent, 1 percent at 80 to 90 percent, and 3 percent replied at 90 to 100 percent.

The "must suppress" characteristics apply at all signal levels at MTL +3 dB and above. Failures of the specification are indicated by an "x" on figures 25, 26, and 27. A total of 10 transponders failed this specification with 4 of those failing to suppress at all.

Figure 27 is a plot of the data from all the SLS amplitude characteristic tests at a level of MTL + 9 dB for each transponder. Only 141 samples passed the threshold of MTL + 9 dB (poor sensitivity or shielding of the antenna caused a reduction of dynamic range of the MTPA interrogations). The maximum signal capability (at the antenna of the aircraft under test) varied from site to site, but was normally in the area of -39 dBm.

FULTON COUNTY,PEACH TREE AND MCCOLLUM AIRPORTS

154 POINTS - REPLY RATE (%) VS P1 - P2 AMPLITUDE S.L.S. P1 @ -60 DBM

	0	> 1	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
15	16	2	1	1			1	1		2	1	1	4	1	2	2	3	1	5	8	102
12	17	2		1		1		1		1	2	1		1	3	3	3	2	4	9	103
9	17	2	1			1		1			3	1	2	1	2	1	3	3	4	9	103
6	19	4	2	1		2		1		5		4	6	2	5	3	6	4	6	13	71
3	79	14	6	4	3	3	3	4	4	3	4	3	5	3	2	2	3	2	2	1	4
0	134	11	1	2	1			1												1	3
-3	145	3	2																1		3
-6	145	5																	1		3

must reply ≥90%

must reply less than 1%

154 POINTS - REPLY RATE (%) VS P1 - P2 AMPLITUDE S.L.S. P1 @ -50 DBM

	0	> 1	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
15											1	1		2	1	2		2		13	132
12		1										2			1		1		1	7	141
9	2							1			1		1		1	1	2	1	1	7	136
6	11	3	2			2			2	3		4		3	2	4	4	1	3	12	98
3	78	20	5	5	6	3	1	1	2		3	3	2	1	1	1	2	1	2	4	13
0	145	2	1	1						1											4
-3	149											1									4
-6	150	1									1										2

Must reply ≥ 90%

Must reply less than 1%

FIGURE 21. MTPA TEST 15 DISTRIBUTION - ATLANTA SAMPLE

N15101 KING KT78
SIDE LOBE SUPPRESSION TEST - 5

2.0 FT -47 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	0	0	0	0	0	81	88	91	94	100	100	100	0	0	0	0	0	0
12	0	0	0	0	0	80	87	91	94	100	100	98	0	0	0	0	0	0
9	0	0	0	0	0	79	87	91	82	92	60	47	0	0	0	0	0	0
6	0	0	0	0	0	81	88	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

must reply at least 90%

MTL

FIGURE 22. INDIVIDUAL SAMPLE (MTPA TEST 5) - N15101

N15101 KING KT78 2.0 FT -47 DB
SIDE LOBE SUPPRESSION TEST - 15

P1-P2	P1 LEVEL (-DBM) 60	50
15	78	96
12	81	98
9	78	37
6	81	0
3	78	0
0	0	0
-3	0	0
-6	0	0

FIGURE 23. INDIVIDUAL SAMPLE (MTPA TEST 15) - N15101

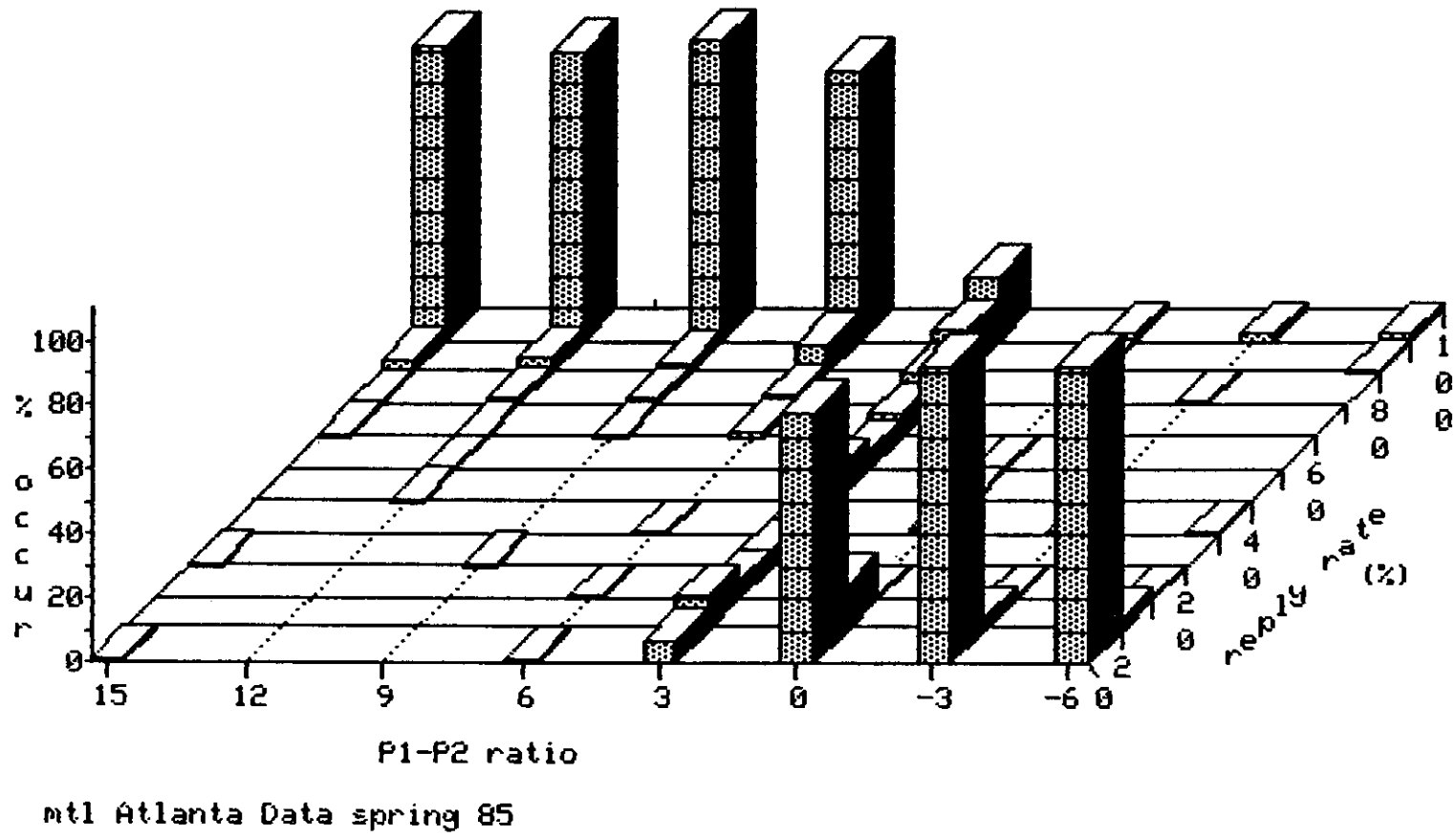

FIGURE 24. SLA AMPLITUDE CHARACTERISTICS DISTRIBUTION (MTL) - ATLANTA SAMPLE

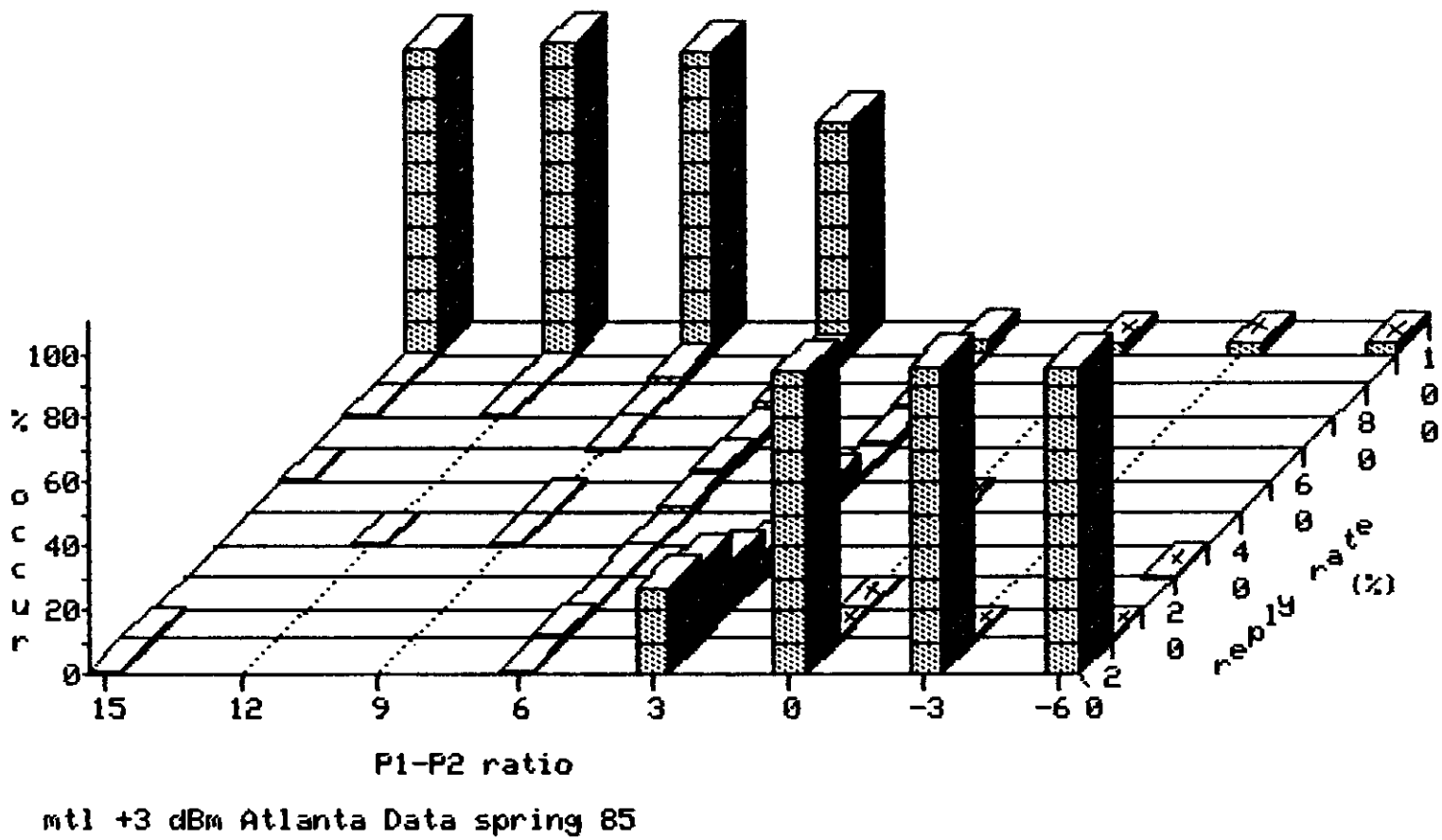

FIGURE 25. SLS AMPLITUDE CHARACTERISTICS DISTRIBUTION (MTL + 3 dB) - ATLANTA SAMPLE

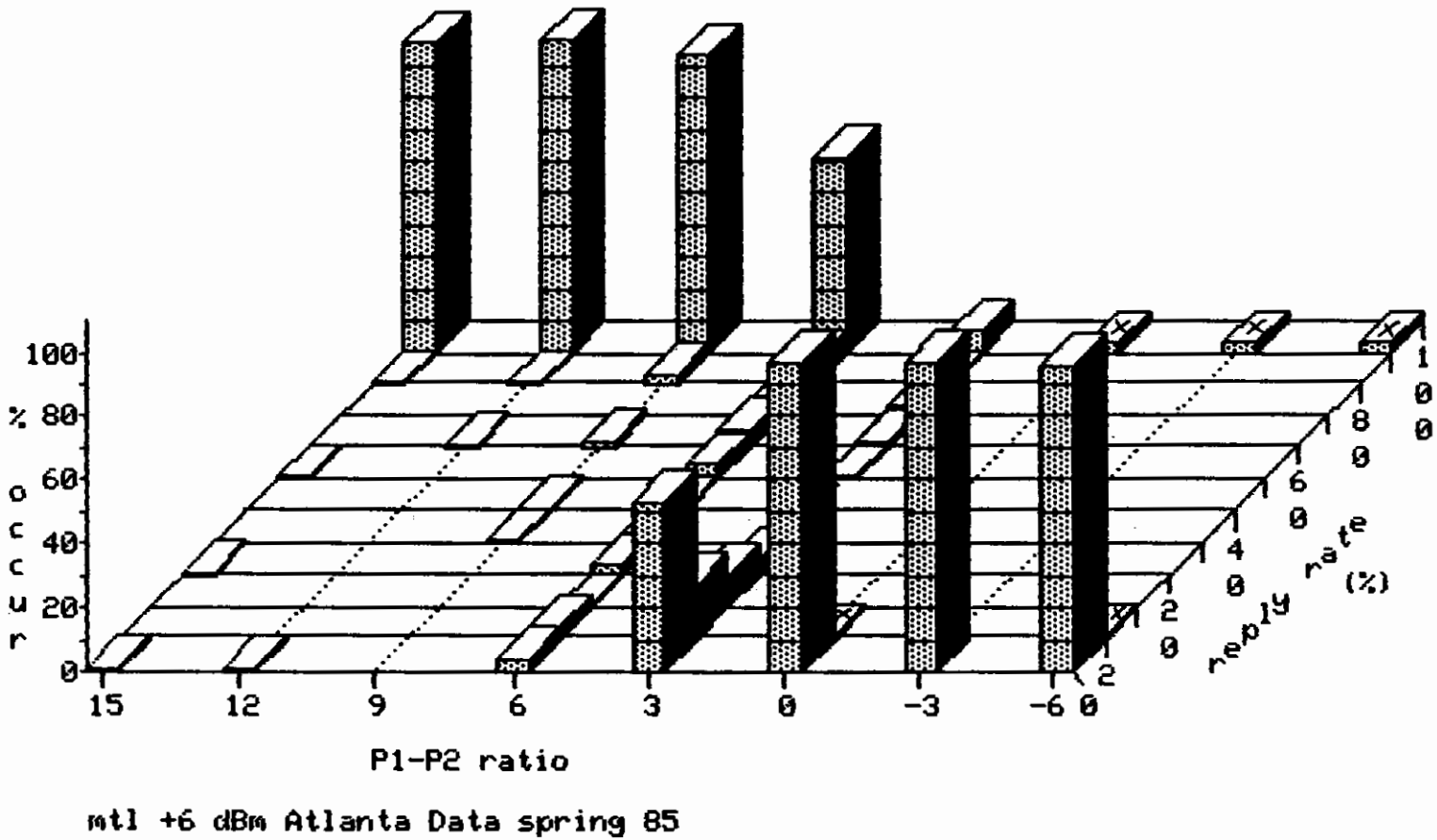

FIGURE 26. SLS AMPLITUDE CHARACTERISTICS DISTRIBUTION (MTL +6 dB) - ATLANTA SAMPLE

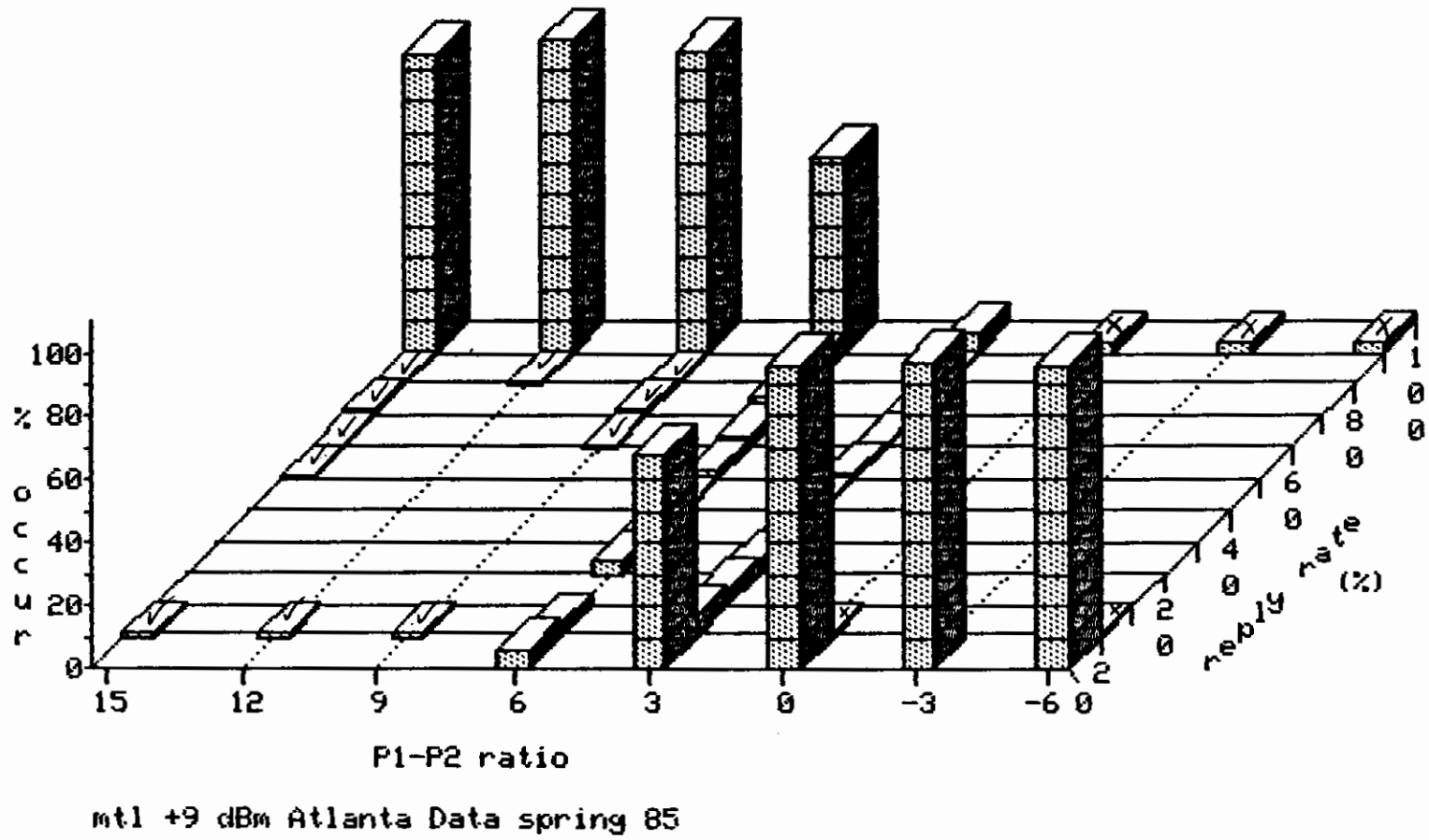

FIGURE 27. SLS AMPLITUDE CHARACTERISTICS DISTRIBUTION (MTL + 9 dB) - ATLANTA SAMPLE

The "must reply" area of the SLS specification applies when the signal level reaches MTL + 9 dB, so that the P2 pulse (if present) would be above the receiver noise. Failures to reply at a 90 percent rate or greater are indicated by a "check" on figure 27. A total of 12 transponders failed this criteria.

Figures 28, 29, and 30 are typical examples of transponders which failed to pass "must reply" portion of the SLS amplitude characteristics test. Normally, there was a "hole" of some sort in the pattern (see circled areas on the plots).

ALTITUDE COMPARISON. In this test (MTPA test No. 99) Mode S interrogations are made to our MTPA transponder in order to get the proper Mode C altitude data from our calibrated altimeter. These data are then compared to that received from the transponder being tested. The differences in these data are stored as the result of test No. 99. Figure 31 shows the distribution of data from the standard altitude for the Atlanta sample. Test 99 was run twice for each transponder. The number of samples is odd, because one transponder was switched from "no altitude" to "altitude on" between the two tests. The data were analyzed in more detail by selecting one or the other of the tests and using that for the characteristic of the transponder being tested. It shows that 107 tests (approximately 38 percent) replied to Mode C interrogations with "brackets only" or no altitude data. Of the remainder which did reply with altitude information, 27 (~9 percent) replied at a rate less than 90 percent. Ten (~5 percent) replied with altitude data outside the tolerance of plus or minus 125 feet. One replied with an error of 1,000 feet, and when the results were discussed with the pilot, he confirmed that he had been told by the ATC personnel that his altitude was erroneous.

POWER, SENSITIVITY, AND DELAY DATA. These parameters are checked by analysis of the reply data from all the other tests. The power and sensitivity are checked for the maximum value achieved, while the reply delay is checked for a minimum.

1. Reply Delay Data. The former algorithm used for determination of delay data (merely a search for the minimum value) was modified because of the large number of transponders whose delay varied widely as a function of other parameters. Figure 32 shows a typical example where delay is a function of interrogation pulse spacing. This transponder obviously does its timing off the P1 pulse and the delay is set to the nominal value of 3.0 µs at the middle of the interrogation acceptance window. As can also be seen from these data, this particular transponder had the interrogation acceptance window offset from the nominal interrogation spacing (8.0 and 21.0 µs for Modes A and C, respectively). In fact, this transponder did not respond at all at the nominal 21.0 µs Mode C spacing.

In order to get reply data which would be meaningful in the search for ATC system problems, the following change was made to the algorithm

N543GA TRANS #1 KING 76
SIDE LOBE SUPPRESSION TEST - 5

3.0 FT -47 DB

P1 LEVEL (-DBM)

P1-P2	75 (MTL)	72	69	66 (MTL+9)	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	91	100	100	100	100	100	100	100	100	100	100	100	100	0	0	0	0	0
12	91	100	100	100	100	100	100	100	15	1	98	100	100	0	0	0	0	0
9	90	100	100	100	100	100	9	0	0	0	0	97	100	0	0	0	0	0
6	92	99	89	97	87	0	0	0	0	0	0	0	0	0	0	0	0	0
3	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 28. INDIVIDUAL SAMPLE (MTPA TEST 5) - N543GA

4553F NARCO AT150
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -50 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
					MTL			MTL+9										
15	0	0	0	31	99	100	100	100	100	0	0	0	0	0	0	0	0	0
12	0	0	0	31	48	31	0	8	11	0	0	0	0	0	0	0	0	0
9	0	0	0	34	94	44	33	96	100	0	0	0	0	0	0	0	0	0
6	0	0	0	37	100	41	33	95	66	0	0	0	0	0	0	0	0	0
3	0	0	0	30	16	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 29. INDIVIDUAL SAMPLE (MTPA TEST 5) - N4553F

N15101 KING KT78 LETTER
SIDE LOBE SUPPRESSION TEST - 5

2.0 FT -47 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66 (MTL)	63	60	57 (MTL+9)	54	51	48	45	42	39	36	33	30	27	24
15	0	66	87	90	93	100	100	100	100	100	100	100	0	0	0	0	0	0
12	0	69	87	89	93	100	100	100	100	100	100	0	0	0	0	0	0	0
9	0	65	86	90	88	94	100	100	0	0	0	0	0	0	0	0	0	0
6	0	72	86	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	67	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 30. INDIVIDUAL SAMPLE (MTPA TEST 5) - N15101

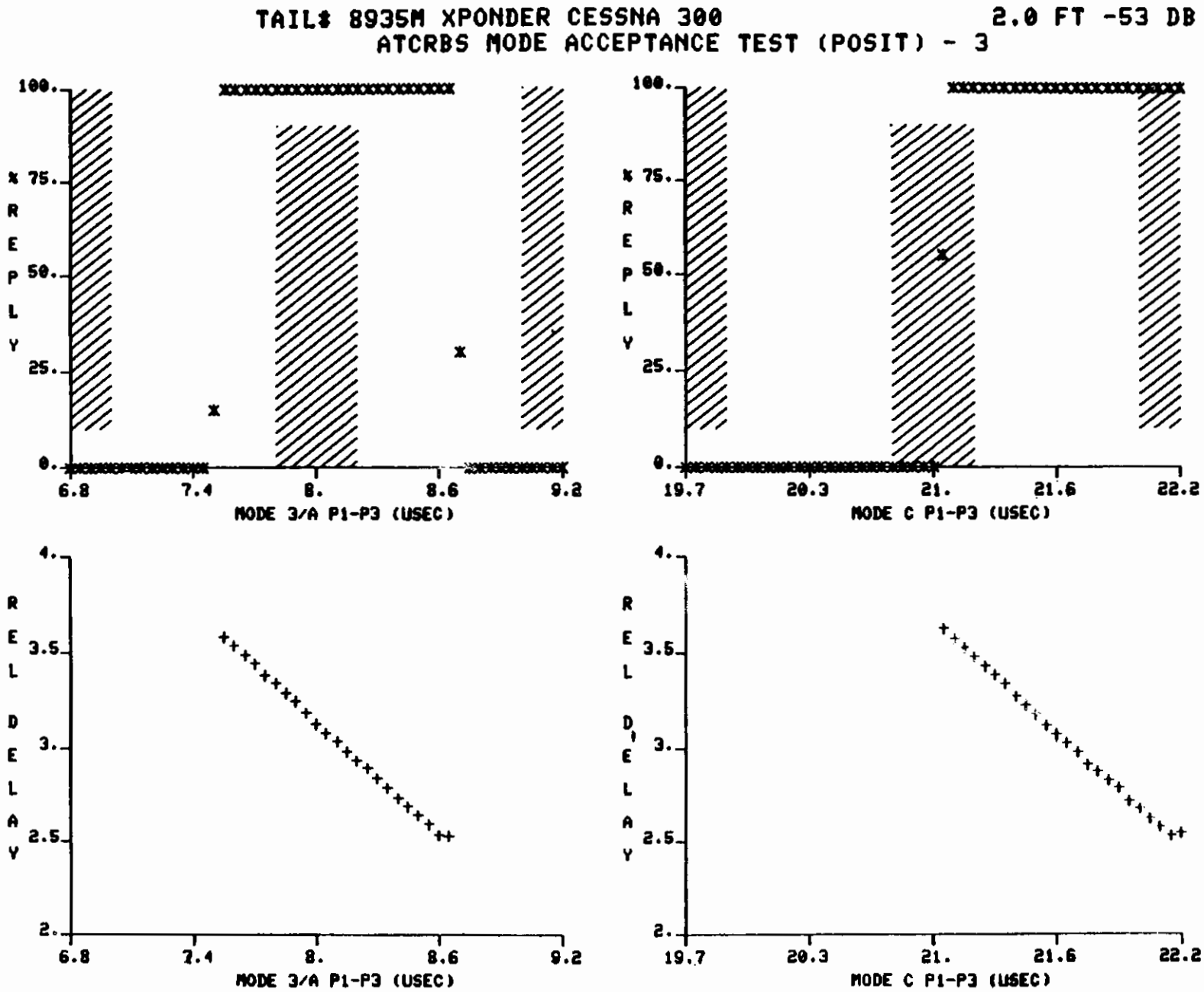

FIGURE 31. ALTITUDE ERROR DISTRIBUTION - ATLANTA SAMPLE

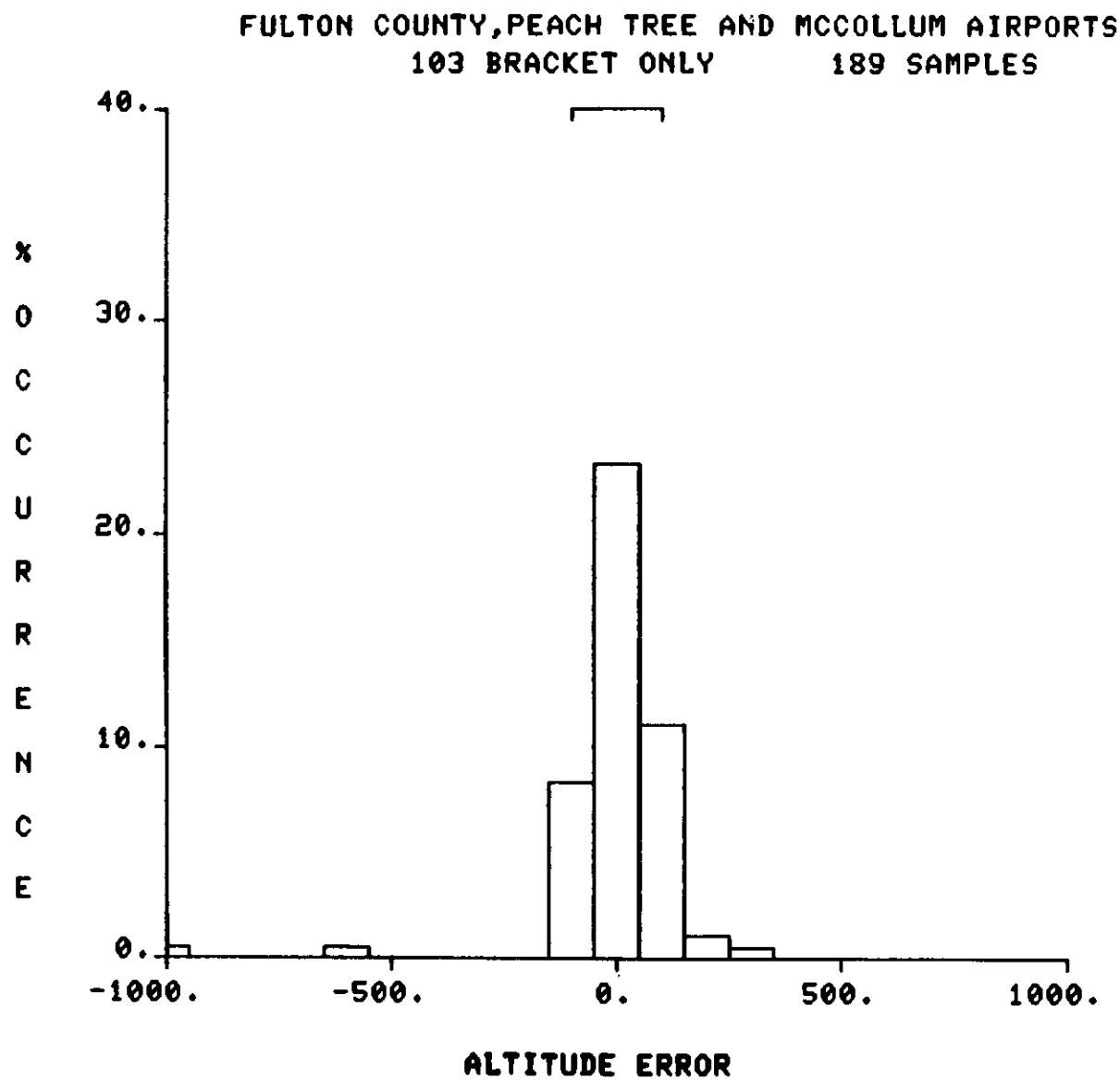

FIGURE 32. INDIVIDUAL SAMPLE - MODE ACCEPTANCE - N8935M

which determined the delay data for our sample. Since the interrogators' pulse characteristics are tightly controlled, the assumption was made that the interrogators were always at the nominal position for all variables during a particular test. Thus, even though a test varied a parameter on both sides of nominal (as all of them do), the delay data from that test was only used when the variable was at the nominal value. The new set of delay values (one from each test taken when the variable is at nominal) was then searched for the minimum. This value was used as the reply delay data for each transponder. Figure 33 shows the distribution of delay data for the Atlanta sample. Nine transponders, or approximately 5 percent, were outside the limits of 2.5 to 3.5 µs.

2. Reply Power Data. Figure 34 shows the distribution of reply power data from the 154 samples. After applying a 3 dB allowance for measurement error due primarily to the reflection environment discussed previously, 33 transponders (approximately 21 percent) fell outside the allowable limits. Most of the failures were on the high side of the specification. Almost all of the military planes tested fell into this category.

3. Sensitivity Data. Sensitivity tests (MTPA test No. 14) were run continuously as the aircraft taxied past the nose of the interrogation beam after the remainder of the tests had been completed. The results of each test (successive approximation search for the Modes A and C sensitivity value) were then examined and the highest value achieved was used as the sensitivity of that transponder. The reply power of each group was also used as an input to the power analysis above. Figures 35 and 36 show the distribution of sensitivity for Modes A and C, respectively. After allowing a plus and minus tolerance for measurement error, 39 transponders (~25 percent) failed to meet the sensitivity requirements for Mode A sensitivity. Only 147 samples are included in the Mode C sample as the remainder did not reply at nominal interrogation characteristics (investigation of more detailed data showed that the transponders did answer at other than nominal spacing (see figure 32 for example). Thirty-nine or 27 percent of the transponders failed to meet the Mode C sensitivity criteria.

REPLY RATE LIMITING. The reply rate limiting test consists of making interrogations at four different PRF's and recording the reply rates to those interrogations. The PRF's are 1,000, 1,400, 1,700, and 2,000 interrogations per second. The transponders should respond to at least 90 percent of the interrogations to a rate of at least 1,000 interrogations per second. (Transponders of aircraft designed to operate above 1,500 feet must respond at least 90 percent to a rate of 1,200 per second.) Figure 37 is a plot of the reply rate data from Atlanta. As shown, 10 percent failed to respond at least 90 percent at 1,000 interrogations per second. Approximately 5 percent showed no reply rate limiting at all at rates up to 2,000 interrogations per second.

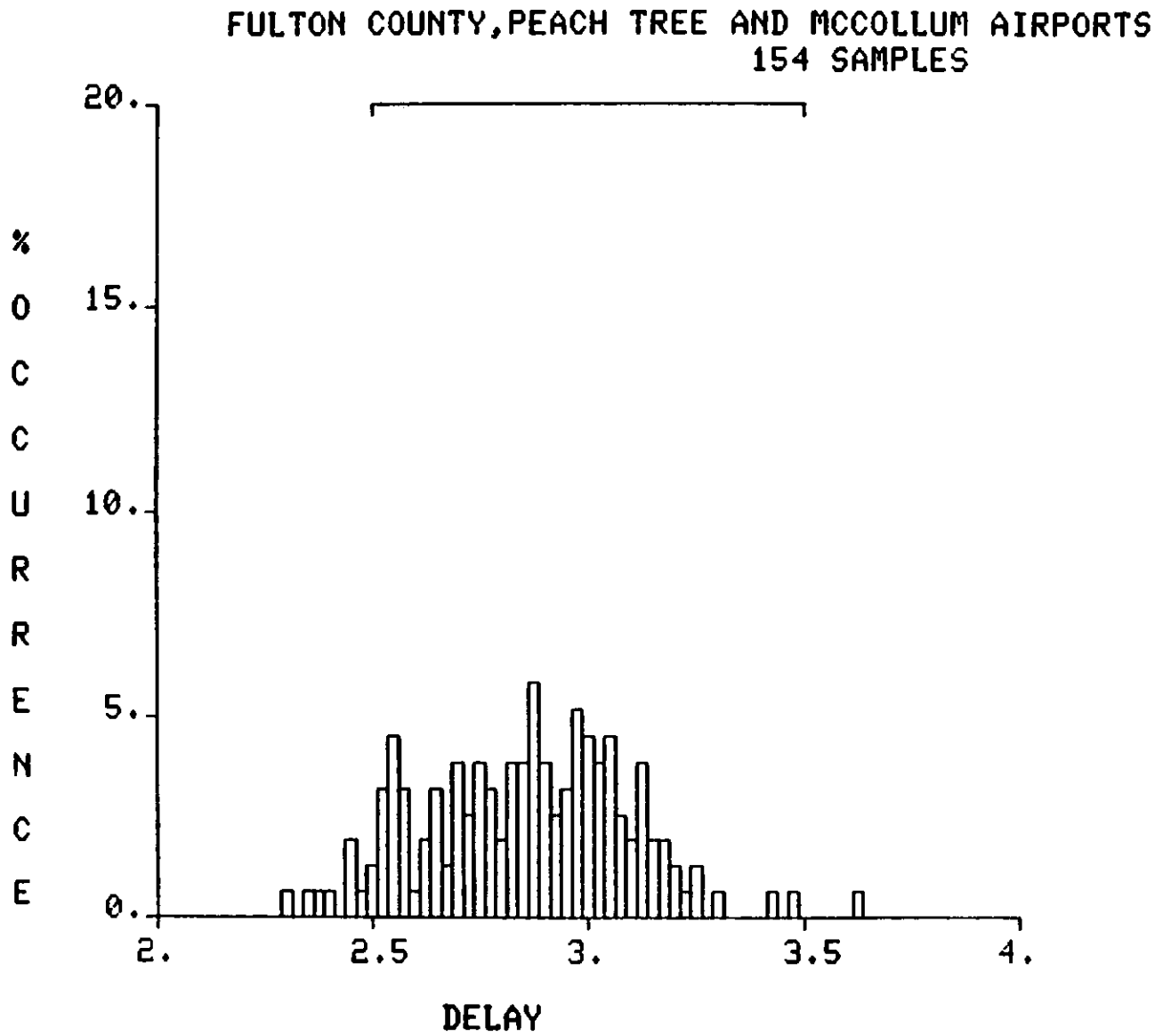

FIGURE 33. REPLY DELAY DISTRIBUTION - ATLANTA SAMPLE

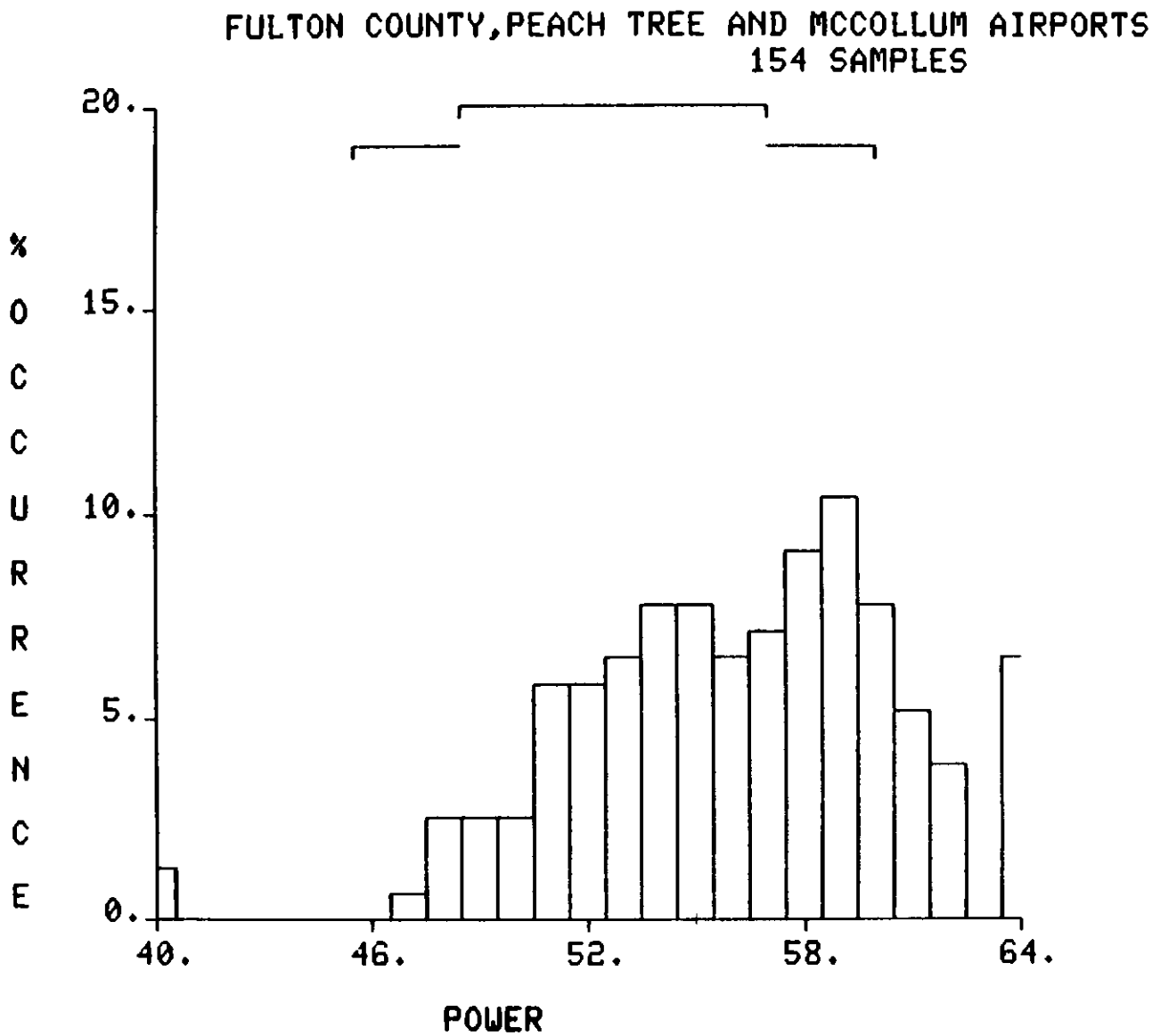

FIGURE 34. REPLY POWER DISTRIBUTION - ATLANTA SAMPLE

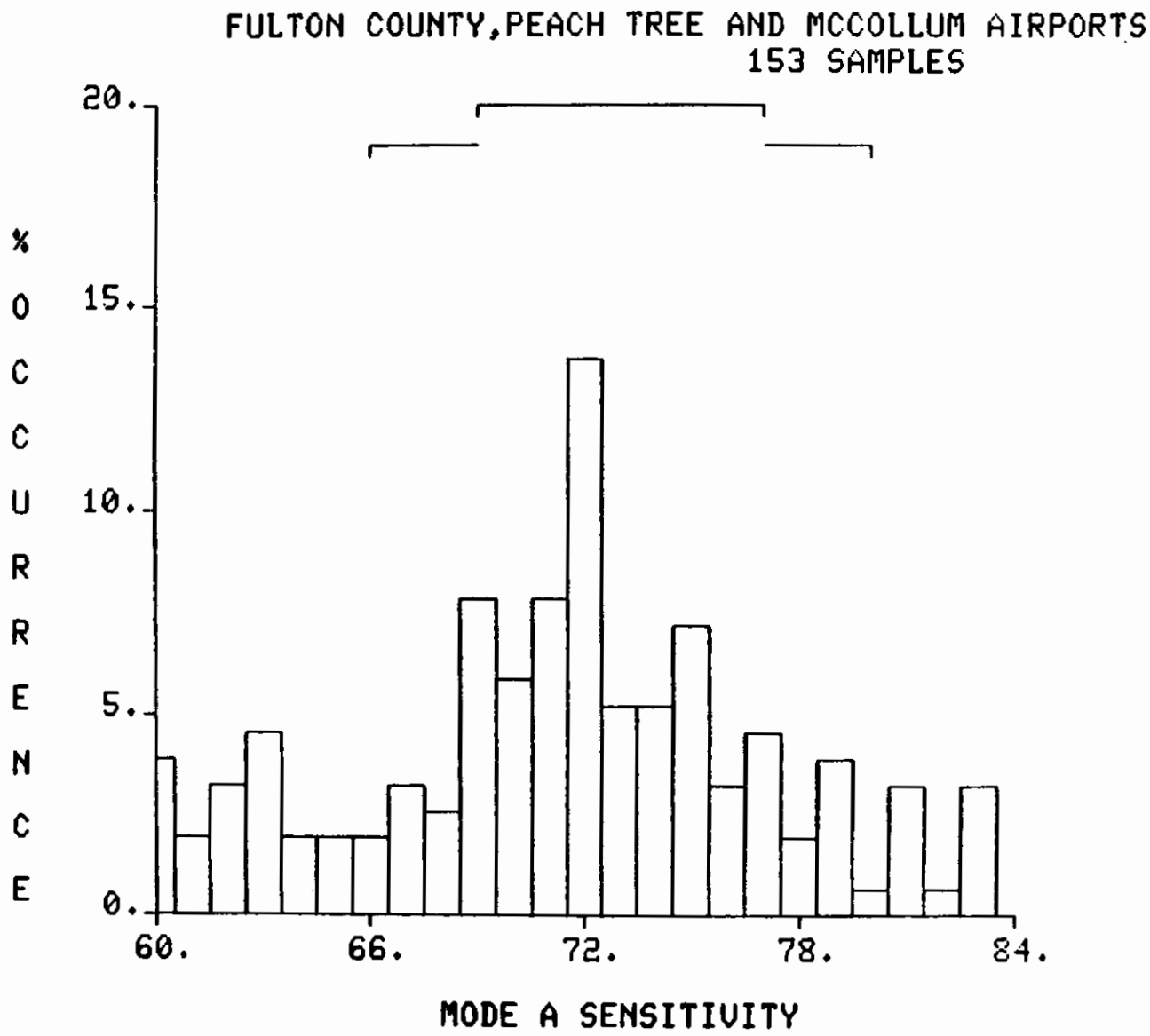

FIGURE 35. MODE A SENSITIVITY DISTRIBUTION - ATLANTA SAMPLE

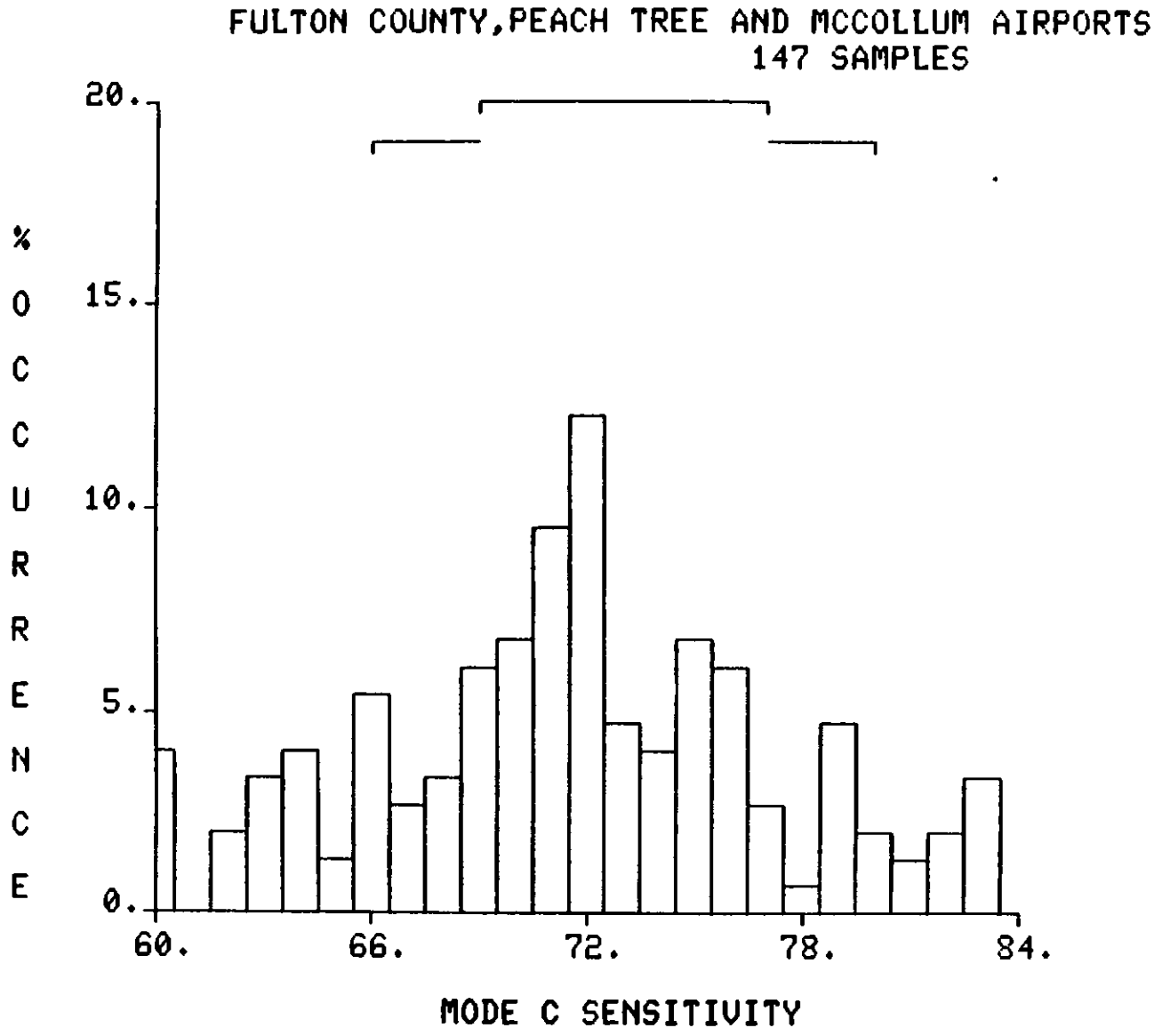

FIGURE 36. MODE C SENSITIVITY DISTRIBUTION - ATLANTA SAMPLE

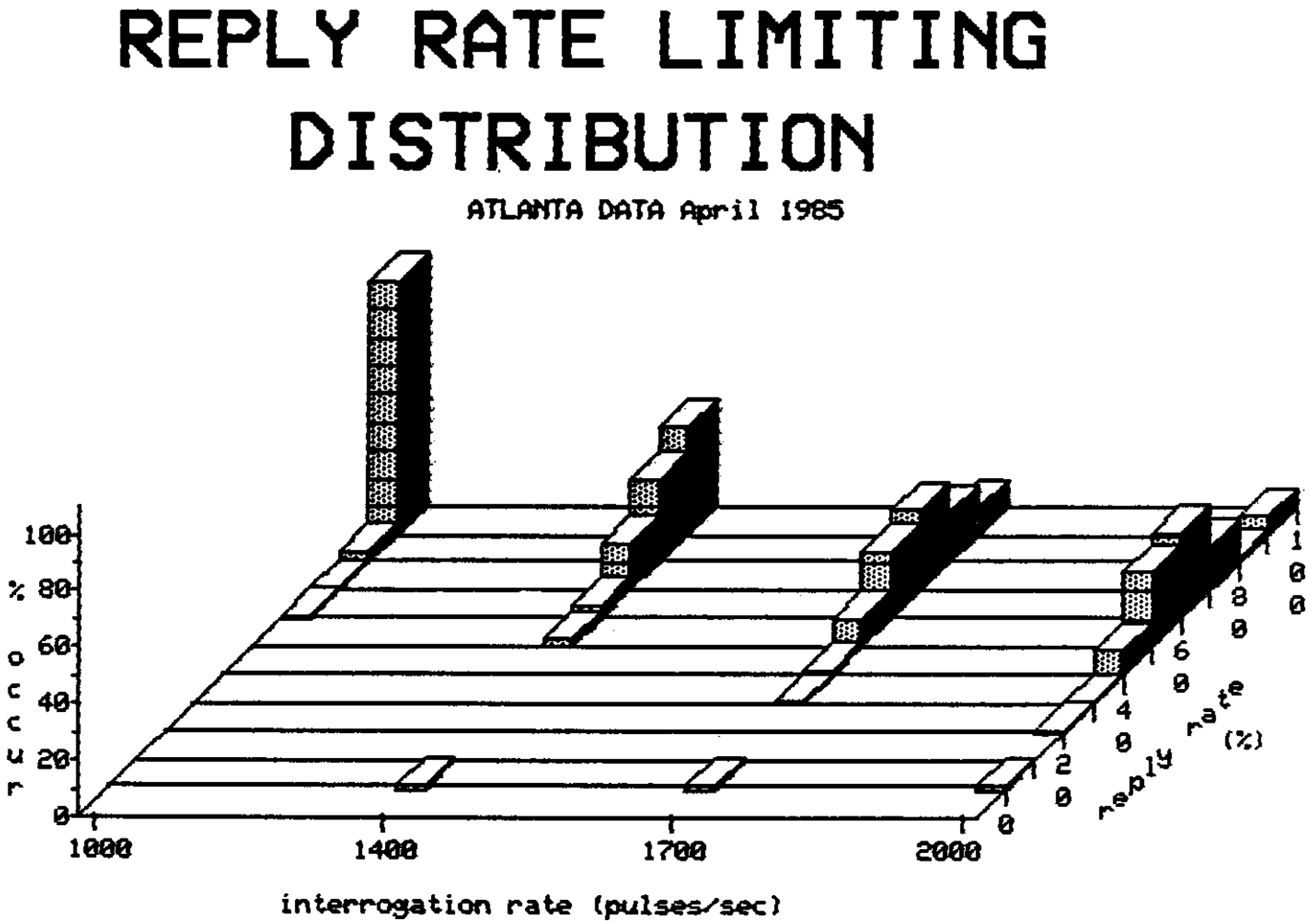

FIGURE 37. REPLY RATE LIMITING DISTRIBUTION - ATLANTA SAMPLE

```
                                                                                                                                  FIGURES
                                                                                                                                  FBP   D   99-A        SS   99-99A
                                                                                                                                  J KD  E A 99991 SS D S LL S 99991   AC
                                                                                                                                  IWFL  I C HH GT LL E U SS I HH GT MF
                                                                                                                                 FTTT  AC  C 00BR  SS A P 19 S 00BR  EDSS
                                                                                                                                 RTD D  D   BBRFD     D P 0   BBRFD IWFE
                                                                                                                                 EETSF PPT P FE YF 9       PP P FE YF AEHH
                                                                                                                                 ORHPF SSF W SCOCF 01 T T SS W SCOCF YESS
DL1:CB19DG.001 BEECHCRAFT TWIN                                                                   5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB19DG.002 E                                                                                 5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 2
DL1:CB21DA.002 N5782Q MOONEY                                                                     5.0 FT -47 DB ||||*||||||||||||||||||||||||||||||||||||||| 3
DL1:CB22DC.002 D18017 LEFT TO  RIGHT ARMY                                                        5.0 FT -47 DB ||||||||||||||*00||||||||||||*||||||*00||||| 2
DL1:CB22DF.002 N8NF                                                                              5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB23DA.002 N7572R TRANSPONDER TYPE KING                                                      2.0 FT -47 DB *||||||||||||*0000||||||||||*||||*0000||||| 3
DL1:CB23DC.001 N7141A 300 CESSNA L TO R                                                          5.0 FT -47 DB ||||||||||||||*00||*||||*|*||*||||*00||||| 5
DL1:CB23DD.002 N3089A                                                                            2.5 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB23DE.003 N45429S0SSSSSSS                                                                   5.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||| 2
DL1:CB24DA.001 N16AK FAA CLUB                                                                    5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||** 3
DL1:CB24DB.002 N6512K                                                                            2.0 FT -47 DB ||||*||||||||||*00||||||||||*||||||*00||||| 3
DL1:CB25DA.001 N704YB NARCO AT 150                                                               5.0 FT -47 DB ||||||||||||||||*00||||||||||*||||||*00||||| 2
DL1:CB25DB.002 N316JC                                                                            5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB25DB.011 N551BD COMPLETE TEST                                                              2.0 FT -47 DB *||||||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB25DE.001 N5430A TRANS #1 KING 76                                                           3.0 FT -47 DB ||||||||||||||||||*||||||||||||||||||||||||| 2
DL1:CB25DE.002 N5436A TRANS #2 DID NOT ROLL THROUGH                                              5.0 FT -47 DB ||||||||*||||||||||||||||||||||||||||||||||| 1
DL1:CB25DF.007 20324 ARMY HELICOPTER                                                             4.0 FT -47 DB ||||||||||||||||||||||||||*||||||||||||||||| 2
DL1:CB25DG.001 18023 KING KT76A                                                                  4.0 FT -47 DB ||||||||||||||*|*||||||*||*||||*|*||||||||| 5
DL1:CB25DG.002 N2893A TDR 950 COLLINS                                                            2.0 FT -47 DB ||*||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB25DG.003 N63 COLLINS 621A 1ST TRANS.                                                       3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB25DG.004 N63 COLLINS 621A 2ND TRANSPONDER                                                  3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB26DB.002 18075 ARMY TRANSPONDER TYPE KING KT76A                                            3.0 FT -47 DB ||***||||||||||||||||||||||||||*||||||||||||| 5
DL1:CB26DC.007 N19 1ST XPONDER TDR 90                                                            3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||*** 3
DL1:CB26DC.008 N19 2ND XPONDER TDR 90                                                            3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||*** 3
DL1:CB26DD.002 22266 ARMY COLLINS APX101                                                         3.0 FT -47 DB ||||||||||||||*00||||||||||||||||||||||||*** 4
DL1:CB26DD.005 N15101 KING KT78                                                                  2.0 FT -47 DB ||||||*|*||||||||||||||||||||||||||||||||||| 3
DL1:CB26DE.003 N38NR HELICOPTER ON WAGON                                                         3.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB27DB.001 016826 ARMY HELICOPTER                                                            5.0 FT -47 DB ||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB27DB.002 N3020 KT76A L-R                                                                   2.5 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||| 1
DL1:CB27DB.003 21510 ARMY HELICOPTER                                                             2.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||*|| 2
DL1:CB27DB.006 N4355T NARCO AT150 ATO                                                            2.0 FT -47 DB ||||||||||||||||*00||||||||||*||||||*00||||| 2
DL1:CB28DB.001 N47UC COLLINS TDR90 #1                                                            2.5 FT -47 DB ||||||||||||||*0000||||||||||*||||*0000||*||| 3
DL1:CB28DB.002 N47UC COLLINS TDR 90 #2                                                           5.0 FT -47 DB ||||||||||||||*0000||||||||||*||||*0000||||| 2
DL1:CB29DA.003 N62 #1 FAA                                                                        2.5 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||*** 3
DL1:CB29DA.004 N62 #2 FAA 621A COLLINS                                                           2.5 FT -47 DB ||||||||||||||||||||*||||*|*||*||||||||||*|| 5
DL1:CB29DB.001 N101RS NARCO AT50A                                                                2.5 FT -47 DB ||||||||||||||||||*00||||||||||*||||||*00||||** 4
DL1:CB29DC.001 N3838L NARCO AT                                                                   2.0 FT -47 DB ||***||||||||||||||||||||||||||||||||||||||*** 7
DL1:CB30DA.001 N1428E 300X TDR                                                                   5.0 FT -47 DB ||||||||||||||*00||*||||||*||||||*00||||** 5
DL1:CB30DC.001 22560 APX100 ARMY                                                                 5.0 FT -47 DB ||||||*||||||||||||||||||||||*||||||||||||*** 5
DL1:CB30DD.001 N80489 ARC 300 TRANS.                                                             4.0 FT -47 DB ||||||||||||||||||*00||||||||||||||||*00||||** 3
DL1:CB30DF.001 N46176 RT-359A                                                                    2.5 FT -47 DB ||||*||||||||||*00||||||||||||||||*00||||||| 3
DL1:CB30DE.002 N4629S KT76A                                                                      2.5 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB30DF.001 22251 APX44 BOTTOM ANT.                                                           5.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||*** 4
DL1:CB30DF.003 22251 APX44 TOPANT. ROLL                                                          8.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:CB30DG.002 N2310R KING 76A                                                                   2.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||| 1
DL1:FT2DA .001 24K HD POWER SEN. #1                                                              1.5 FT -49 DB ||||||||||||||*0000||||||||||*||||*0000||||** 5
DL1:FT2DA .002 N6024K#2                                                                          1.5 FT -49 DB *||||||*||*||*0000|*||||*|*||||*0000||||||| 9
DL1:FT2DB .001 N1932N KINGKT76                                                                   2.0 FT -47 DB ||*||||||*||||||||||||||||||||||||||||||||||| 2
DL1:FT2DB .003 N4341V 2ND TIME INTERFERENCE ON #2 ALT TEST                                       2.5 FT -47 DB *||||||||||||||||||||||||||||**|*||||||||||| 5
DL1:FT2DB .005 N735 KC SECOND TRY CESSNA 300 TRANSPONDER                                         2.0 FT -47 DB ||||||||||||||||*00||*||||*|**|*||||*00||||| 6
DL1:FT2DB .006 N53540 CESSNA                                                                     2.0 FT -54 DB ||||||||||||||*0000||||||||||*||||*0000||||** 5
```

FIGURE 38. ATLANTA INDIVIDUAL TEST DATA SUMMARY - (SHEET 1 OF 3)

```
                                                                                  PBF   D   99999          SS   99999
                                                                                  J LU  F A 99999L SS D S LL S 99999L    AC
                                                                                  TWEL  L C NN GT LL E U SS L NN GT NF
                                                                                 FTTT  AC  C DDRK  SS A F 19 S DDRK  EDSS
                                                                                 RTD D  D   DDREO     D F  0   DDREO LHFE
                                                                                 EFTSF PPI P EE YT Y      FF F EE YF AENN
                                                                                 DRHPF SSF W SCDCF 01 T T SS W SCDCF YRSS
DL1:PT2DC .001 3841Y KING                                                  2.0 FT -52 DB ||||||||||||||||*00||||||||||||*||||||*00||||||  3
DL1:PT2DC .002 N12356 BETA 5000 TRANSPONDER                                2.0 FT -52 DB ||||||*||||||||||*00||||||||||||||||||*00||||||  2
DL1:PT2DC .003 N18994 KING TRANSPONDER                                     2.0 FT -47 DB ||||||||||||||||||*||||||||||*||||||||*||||||  2
DL1:PT2DC .004 N6489D  KING KT76A                                          2.0 FT -47 DB *||||||||||||||||||||||||||||*||||||||||||||  3
DL1:PT2DC .006 9625V TAXIING AWAY                                          5.0 FT -47 DB *||||||||||||||||*00||||||||||*||||||||||||||  3
DL1:PT3DA .001 8233S COLLINS                                               2.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||  5
DL1:PT3DA .002 N5443V CESSNA 300 XPONDER                                   2.0 FT -51 DB ||||||||||||||||||||||||||||||*||||||||||||||  1
DL1:PT3DA .005 4015L NARCO AT-150                                          2.0 FT -55 DB ||||||*0||||*000||||||||||*||||*00||||||||  4
DL1:PT3DB .001 N4669G RT300 TRANSPONDER                                    2.0 FT -48 DB ||||||||||||||||||||||||||*||||||||||||||||  1
DL1:PT3DB .002 475JM COLLINS                                               5.0 FT -47 DB ||||||||||||||||||||||||||||*||||||||||||||||  1
DL1:PT3DB .003 475JM COLLINS TDR90 SECOND TRANSPONDER                      5.0 FT -52 DB ||*||||||||||||||||||||||||||||||||||||||||||  1
DL1:PT3DB .004 2340M XPONDER 1                                             3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT3DB .005 234AM XPONDER 2 COLLINS                                     3.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT3DC .001 4553F NARCO AT150                                           1.5 FT -50 DB ||||||||||||||*00||||||||||*||||||*00||||||  2
DL1:PT3DC .003 777AT WILCOKS B14R #1 XPONDER                               2.5 FT -47 DB ||||||||*||||||||||||||||*||||*||||||||||||*  4
DL1:PT3DD .001 9695U NARCO AT58 XPONDER                                    2.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||||  1
DL1:PT4DA .001 NN15101 KING KT78                                           5.0 FT -52 DB ||||||||*||||*0000||||||||||*||||*0000||||||  3
DL1:PT4DA .002 SESSNA 400 XPONDER 4835G TAIL#                              2.0 FT -50 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT4DA .004 TAIL# 820BA TEST2                                           2.0 FT -47 DB *||||||||||||||||||||||||||||||||||||||||||  2
DL1:PT4DA .006 TAIL# 6555Y TEST2 XPONDER KING 76A                          2.5 FT -50 DB ||||||||||||||||||||||||||||||*||||||||||||||  1
DL1:PT4DA .007 TAIL# 6458J XPONDER COLLINS 950                             2.0 FT -47 DB *||||||||||||||*00||||||||||||||||||*00||||||  2
DL1:PT4DA .008 TAIL# 2036G XPONDER COLLINS 950                             2.5 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT4DA .009 TAIL# 704PF XPONDER SESSNA 300                              2.0 FT -47 DB ||||||||||||||*00||||||||||*||||||*00||||||  2
DL1:PT4DA .010 TAIL# 736LFXPONDER KING AT76A                               2.0 FT -47 DB ||||||||||||||||||||||||||||*||||||||||||||  2
DL1:PT4DA .012 N8HL KING KT78                                              1.5 FT -54 DB ||||||*0||||*000||||||||||||||||*0000||||||*  5
DL1:PT4DA .013 TAIL# 3874H KING XPONDER                                    1.5 FT -60 DB ||||||||||||||||||||||||||||*||||||||||||***  5
DL1:PT5DA .002 TAIL#K5019J XPONDER KT76A                                   2.5 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||||  1
DL1:PT5DA .004 TAIL#8341F XPONDER KING                                     2.0 FT -47 DB ||||||||||||||||*||||||||||*||||||||*||||||  2
DL1:PT5DA .005 TAIL# N15361 XPONDER KING KT78                              2.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||||  1
DL1:PT5DB .001 TAIL# N45EE XPONDER KING KT75R                              2.5 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT5DB .002 TAIL# 6569M PONDER CESSNA 300                               2.0 FT -50 DB ||||||||||||||||||||||||||||*||||||||||||||  1
DL1:PT5DB .004 TAIL# N4302Y XPONDER NARCO AT50A                            2.0 FT -47 DB ||||||||||||||||||*||*||*||*||||||||||||||  4
DL1:PT5DB .005 TAIL# 4355W                                                 2.0 FT -47 DB ||||||||||||||||*00||||||||||||||||||*00||||||  1
DL1:PT5DB .006 TAIL# 80173 XPONDER KING KT76                               2.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||||  2
DL1:PT5DB .007 TAIL# N94186 XPONDER CESSNA 300                             2.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||||  1
DL1:PT5DB .008 TAIL#53319P XPONDER CESSNA 300                              2.0 FT -47 DB ||||||||||||||*00||||||||||*||||||*00||||||  3
DL1:PT6DA .001 TAIL# 620JM XPONDER KING KT76A                              2.0 FT -53 DB ||||||||||||||||||||||||||||*||||||||||||*||  2
DL1:PT6DA .002 TAIL# N139C XPONDER KING KT 76A                             2.5 FT -51 DB ||||||||||||||*00||||||||||||*||||||*00||||||  2
DL1:PT6DA .003 TAIL#421CW XPONDER1                                         2.5 FT -47 DB ||||||||||||||||||||||||||||*||||||||||||||  1
DL1:PT6DA .004 TAIL#421CW XPONDER2                                         2.5 FT -47 DB |||*||||||||||||||||||||||||*||||||||||||||*  4
DL1:PT6DA .006 TAIL#57259 XPONDER KING KT76A TEST2                         1.5 FT -48 DB ||||||||||||||||||||||||||||*||||||||||||*||  2
DL1:PT6DA .007 TAIL#28967 XPONDER COLLINS TDR950                           2.0 FT -47 DB ||||||||||||||*00||||||||||||||||||*00||||||  1
DL1:PT6DA .008 TAIL# N88NS XPONDER NARCO AT50A                             2.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||**  3
DL1:PT6DA .010 TAIL# 343BE XPONDER CESSNA 300 TEST2                        2.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT6DA .011 TAIL# 57620 XPONDER NARCO AT50A                             2.0 FT -47 DB *||||||*||||||*00||||||||||*||||||*00||||||*  6
DL1:PT6DA .012 TAIL# 3035L XPONDER KING KT78A                              2.0 FT -49 DB ||||||||||||||||*||||||||||*||||||||*||||||  2
DL1:PT6DA .013 TAIL# 8935M XPONDER CESSNA 300                              2.0 FT -53 DB ||||*||*0||||*000||||||||||*||||*0000||||||*  5
DL1:PT6DA .014 TAIL# 56408 XPONDER NARCO AT150                             2.0 FT -54 DB *||||||||||||||||||||||||||||||||||||||||||  1
DL1:PT6DA .015 TAIL# 201CW XPONDER KING 76A                                2.0 FT -47 DB ||||||||||||||||||||||||||||||*||||||||||||**  3
DL1:PT6DA .016 TAIL# 4008T XPONDER KING                                    2.0 FT -47 DB ||||||||||||||||||||||||||||||||||||||||||||  0
DL1:PT7DA .001 TAIL#88430 XPONDER AT50A                                    2.0 FT -47 DB *||||||||||||||*00||||||||||||||||||*00||||||  2
```

FIGURE 38. ATLANTA INDIVIDUAL TEST DATA SUMMARY - (SHEET 2 OF 3)

```
                                                                                 PBP    D    99999            SS    9999A
                                                                                J NU    E A 9999L SS D S LL S 9999L    AC
                                                                                IWEL    L C HH GT LL I U SS I HH GT UF
                                                                               FTIT  AC  C OOBR  SI A P 19 S OOBR  EDBS
                                                                               RTD O   D    DBEFO     U P  G   DBEFO IHEE
                                                                               EFTSF PPI F FE YF ?       FF P FE YF AEHN
                                                                               ORHPF SSF W SCOCF OI T T SS W SCOCF YRSS
DL1:F170A .002 TAIL#N98321 XPONDER KING                            2.0 FT -47 DB II*IIIIIIIIIIII*00IIIIIIIIIIIIIIIIIII*00IIII  2
DL1:MC9DA .001 TAIL#40760 XPONDER KING KT76A                       2.0 FT -47 DB IIIIIIIIIIIIIII*IIIIIIIIIIII*IIIIIIIIIIII*II  4
DL1:MC9DA .002 TAIL#28847 XPONDER NARCO AT150                      2.0 FT -47 DB IIIIIIIIIIIIIII*00IIIIIIIIII*IIIIIIIII*IIIII  3
DL1:MC9DB .001 TAIL#N94709 XPONDER KING 78A                        2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  1
DL1:MC9DC .001 TAIL#79482 XPONDER BETA 5000                        2.0 FT -44 DB IIIIII**0IIII*000I*IIIIIIII**IIII*000III**II  9
DL1:MC9DD .001 TAIL#140739 XPONDER BENDIX TEST2                    2.0 FT -44 DB IIIIIIIIIIIIIIII*0I*IIIIIIIIIIIIIIII*60II*II  3
DL1:G     .001 N97150 NARCO AT50A                                  5.0 FT -37 DB IIIIIII*IIIIIIII*00IIIIIIIIIIIIIIIIII*00II**  4
DL1:G     .002 N82585 KING KT76                                    2.0 FT -44 DB IIIIIIIIIIIIIIIIIIIIIIIIIII**IIIIIIIIIIII*II  3
DL1:G     .003 N8282Z KING KT76A                                   2.0 FT -44 DB IIIIIIIIIIIIIIII*00*IIIIIIII*IIIIIII*00IIIII  3
DL1:G     .004 N8274T CESSNA 300                                   2.0 FT -44 DB IIIIIIIIIIIIIIIIIIIIIIIIII*II*III*I*IIIIIIII  4
DL1:G     .005 N6453H KING KT76A INTERFERENCE                      2.0 FT -44 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  1
DL1:G     .006 N757MC CESSNA 300                                   2.0 FT -53 DB IIIIIIIIIIIIIIII*00IIIIII*II*IIIIIII*60IIIII  3
DL1:MC10DA.001 TAIL#9350N                                          2.0 FT -47 DB IIIIII*IIIIIIIII*00IIIIIIIII*IIIIIIII*00IIII  3
DL1:MC10DA.003 TAIL#6340P XPONDER CESSNA 300                       2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIII*IIIIIIIIII*00IIIII  2
DL1:MC10DA.004 TAIL#6228C XPONDER KING KT76A                       2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIII**IIIIIIIIIIIII**  4
DL1:MC10DA.005 TAIL#94445 XPONDER CESSNA                           2.0 FT -47 DB IIIIIII*IIIIIIII*00IIIIIIIIIIIIIIIIII*00IIII  2
DL1:MC10DA.006 TAIL#4937N XPONDER CESSNA 300                       2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIII*II*IIIIIII*00IIIII  3
DL1:MC10DA.007 TAIL#8219Y SHIELDING PROB.                          2.0 FT -44 DB IIIIIIIIIIIIIIIIIIIIII*IIIII**IIIIIIIIII*I*I  6
DL1:MC10DB.001 N734WR RT 359A FUEL TRUCK & HELI.                   2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIII*IIIIIIIIII*00IIIII  2
DL1:MC10DB.004 N221AM HELICOPTER 3RD TRY                           3.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIII**  3
DL1:MC10DB.005 N2791T KING KT76A #1 TRANS.                         2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIII**IIIIIIIIIIIIIII  2
DL1:MC10DB.006 H2791T REGENCY #2 TRANS.                            2.0 FT -47 DB *IIIIIIIIIIIIIII*00IIIIIIIIIIIIIIIIII*00IIII  2
DL1:MC10DB.007 TAIL#2777Y XPONDER KING KT76                        2.0 FT -47 DB IIIIIII**IIIIIII*00IIIIIIIIIIIIIIIIII*00IIII  3
DL1:MC11DA.001 N7026P NARCO AT50A                                  2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIIIIII*IIIIIII*00I*III  3
DL1:MC11DA.002 TAIL#8876X XPONDER KING KT76A                       2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIII*IIIIII*IIIIIIIIIIIII**  4
DL1:MC11DA.003 TAIL#8961U                                          2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIIIIII*IIIIIII*00II*II  3
DL1:MC11DA.004 TAIL#65740 XPONDER CESSNA 300                       2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIII*I*IIIIIIIIIIIII**  4
DL1:MC11DA.005 N44979 NARCO                                        2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIII*II  2
DL1:MC11DA.006 N92658 KING KT78                                    2.0 FT -47 DB IIIIIII**IIIII**0IIIIIIIIIII*IIIIII***0I*II*  8
DL1:MC12DA.001 N6707M                                              2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIII*IIIIIIIIII*00III**  4
DL1:MC12DA.002 N5555Y PASSED BEAM                                  2.0 FT -47 DB IIII*II*0IIII*000*IIIIIIIIII*IIII*000III**II  8
DL1:MC12DA.003 N990AR KING KT76A #2                                2.5 FT -47 DB *IIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  2
DL1:MC12DA.004 N990AR TRANS. #1                                    2.5 FT -47 DB IIIIIIIIIIIIIIIIIIIII*IIIIII*IIIIIIIIIIIII**  4
DL1:MC12DA.005 TAIL#53890 XPONDER CESSNA 300                       2.0 FT -47 DB III**I*I0*II***0*IIIII*II*IIIIII***0IIIIIIII 10
DL1:MC12DA.006 TAIL#64136 XPONDER CESSNA300 INTEFERENCE SEN.       2.0 FT -47 DB II*IIIIIIIIIIIII*00IIIIIIIII*IIIIIII*00III**  5
DL1:MC12DA.007 TAIL#538MC COLLINS 1                                2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIII*III  2
DL1:MC12DA.008 TAIL#538MC COLLINS 2                                2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIII*IIIIII*IIIIIIIIIIIII**  4
DL1:MC12DA.010 TAIL#507MC HELI. COLLINS                            3.0 FT -47 DB IIIIIIIIIIIIIIII*00*IIIIIIIIIIIIIIII*00*IIII  3
DL1:MC12DA.011 N39494 KING 78 NO SENS.                             5.0 FT -47 DB IIIIIIII0IIIIII*00IIIIIIIIII*IIIIIII*00III**  4
DL1:MC12DA.012 TAIL#7026P NARCO AT50                               2.0 FT -47 DB IIIIIIIIIIIIIIII*00*IIIIIIII*IIIIIII*00II*II  4
DL1:MC12DA.013 N2524Y                                              2.0 FT -47 DB IIIIII**0III*000*IIIIIIIIIIIIIIIIIII*000I*I*  6
DL1:MC12DB.001 N555FC KT76A                                        2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  1
DL1:MC13DA.001 TAIL#52806 XPONDER R235A                            2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIIIIII*IIIIIIII*00II**  4
DL1:MC13DA.002 TAIL#81177 XPONDER KING KT76A                       2.0 FT -51 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  1
DL1:MC13DA.004 TAIL#4621R COLLINS                                  2.0 FT -47 DB *IIIIIIIIIIIIIII*00IIIIIIIIIIIIIIIIII*00I*II  3
DL1:MC13DA.005 TAIL#3598J NARCO AT150                              2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIIIIII*IIIIIIIIIIIIIII  1
DL1:MC13DA.007 TAIL#6344V CESSNA 300 TES2                          2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIII*III*IIIIIIIIIIIIII*I  3
DL1:MC13DA.008 TAIL#47850 KING KT76A                               2.0 FT -47 DB *IIIIIIIIIIIIIII*00IIIIIIIII*IIIIIII*00IIIII  3
DL1:MC13DB.001 N5345T KING INC. TEST                               2.0 FT -47 DB IIIIIIIIIIIIIIIIIIIIIIIII*II*IIIIII*000III**  5
DL1:MC13DC.001 TAIL#5581W NARCO AT150                              2.0 FT -50 DB IIIIIIIIIIIIIIII*00IIIIIIIIIIIIIIIII*00I*I*I  3
DL1:MC13DC.002 N26076 KING KT76                                    2.0 FT -47 DB IIIIIIIIIIIIIIII*00IIIIIIIII*IIIIIII*00IIIII  2
```

FIGURE 38. ATLANTA INDIVIDUAL TEST DATA SUMMARY - (SHEET 3 OF 3)

ANALYSIS OF THE FAILURES AND THEIR EFFECT ON THE ATC SYSTEM.

A program was written to examine all the data collected for the entire sample and output a summary sheet containing the parameter(s) failed, if any, for each of the transponders. The summary output of this program is shown in figure 38. An "*" indicates a failure of the parameter at the top of the column (i.e., the first entry "Beechcraft twin" failed to reply at least 90 percent to the SLS pulse spacing test at all required points). A "0" indicates that, for some reason, the parameter was not tested. As an example, aircraft "D18017" was not tested for altitude characteristics as it replied "brackets only" to the altitude test. These data were then used in order to examine each of the failures in an effort to determine the effect on the ATC system. The failures will be discussed by parameter.

1. Frequency. Approximately 9 percent of the transponders tested fell outside the allowable limits of 1087 to 1093 MHz. As the reply pulse frequency deviates from the center frequency (1090 MHz), the receiver output begins to show distortion in both amplitude and pulse shape. Within the receiver bandwidth (the FAA ground sites are normally 1086 to 1094 MHz), the distortion is not significant. The pulse will be attenuated approximately 2.5 dB and stretched to about 550 ns, compared to an input pulse at 1090 MHz which would produce the proper pulse width of 450 ns. As the frequency deviation reaches beyond approximately 4.7 MHz, however, the distortion of the output pulse becomes severe. Beyond this point, in addition to more attenuation, the pulse splits into a pulse pair approaching a limit of 1/bandwidth of the receiver or approximately 0.125 ns. The one sample encountered at a frequency of 1096.8 would almost surely not survive the thresholding process of the digitizers as the video output of the receiver would be attenuated by approximately 15 dB and each pulse would appear as a pulse pair approximately 250 ns wide.

The pilot of this plane had received a letter from the FAA indicating a potential problem with his transponder. The data from his complete test is furnished as appendix B. This transponder never reached a 90 percent reply rate in any of the tests. If this transponder uses the transmitter frequency source as the local oscillator for its receiver (as many designs do), the problem of pulse distortion would occur in its receiver and could account for the overall poor performance because of only this one (frequency) parameter.

The receiver of the MTPA system has a bandwidth of 20 MHz, so the distortion due to the MTPA receiver of the off frequency signal is negligible.

2. Bracket Spacing. The ground system bracket detectors are normally set to accept bracket pairs spaced at 20.1 to 20.4 µs in order to accommodate out of tolerance transponders. As a result of this widened acceptance zone, of the six transponders out of the specified limits only one would have probably not been detected as its spacing was 20.55 µs.

3. Pulse Width. Most of the ground systems contain "pseudo-lead edge" logic, which inserts extra lead edges into the code determination logic when the input pulse exceeds a certain value. The assumption is that a wide pulse is really the result of the overlapping of code pulses from two ATCRBS replies, so one lead edge is inserted at the true lead edge of the wide pulse and the second is inserted at a point 400 to 500 ns before the trailing edge. This enables the decoder to resolve code problems in a "garble or overlapping" situation. This parameter is normally site dependent, but a normal value is approximately 600 ns. Some of the transponders with wide output pulses would probably trigger this pseudo-lead edge mechanism and may result in the declaration of two targets where only one really exists (split targets).

4. Code Pulse offset Transponders which failed this specification would probably be detected with the wrong code. Depending on the sampling point of the code pulses on each reply, the correct code could occasionally be decoded, but the validity of the code data would be low.

One transponder replied with the wrong code during the test. At that time we were not requesting the pilot to reply a specific code. The problem came to light during the discussion of the test results with the pilot. After that time the pilots were requested to reply with code 5777. In this way we could at least ascertain if most code bits worked (if the bit were always "on" we still would not know it).

5. Mode Acceptance--Pulse Spacing. The transponders which failed this parameter will perform at a level which depends on the accuracy of the interrogator timing. Even if the transmitters are exactly at the nominal spacing, seven transponders would not reply to Mode C interrogations. In addition to the loss of altitude data, the probability of detecting the target at all would suffer if the detection algorithm uses the Mode C data.

6. Dead Time/Suppression Time. If the dead or suppression time is excessive, the reply probability will be degraded as the system tries to interrogate a transponder which has just been suppressed or replied to another interrogation. Although 14 percent failed the suppression time, the majority failed by 4 µs or less.

7. SLS Acceptance--Pulse Spacing. Since this test was the most frequently failed (only 41 percent passed), it deserves special consideration. This compares with 65 to 70 percent (in the area where 90 percent replies are required) as measured in the Philadelphia sample taken in 1983. As stated previously, the acceptance area of the transponder was usually too wide or skewed to one side or the other. Most of the transponders still suppressed when the P1-P2 spacing was 2.8 µs. If there is any Mode 1 activity, these transponders would see this interrogation as a suppression pair and suppress. It is also possible that some other RF activity with a pulse width of approximately 3 µs (a rise time of about 100 ns or less

is also required) produces a pulse pair in the receiver output of the transponders because of the off frequency characteristics of a bandwidth limited receiver. If this signal were an omnidirectional radiating pattern, the suppression time of this group of transponders would be greatly increased, which would cause a drop in the probability of a reply when interrogated by the ATC system.

8. SLS Amplitude Characteristics. The primary problem here appeared to be small ranges of signals where the transponders did not respond at a 90 percent rate when required (especially at a P1/P2 ratio of 9 dB). This could lead to spotty coverage as those signal levels are encountered during the flight. Those which did not suppress at all would probably result in "ring around" targets when near the interrogator in range.

9. Altitude Comparison. Approximately 38 percent of the transponders were not "altitude equipped" as they replied with only brackets to Mode C interrogations. The 5 percent with altitude errors present a serious problem to both TCAS and the ATC system.

10. Reply Delay Data. Since so many transponders' reply data were a function of the interrogation pulse spacing, it is important that these pulses be maintained at their nominal value (this is especially true for the TCAS interrogators) to avoid range errors.

11. Sensitivity and Power. Failure of these two parameters will result in a reduction of the range of coverage from the ATC interrogator, or in an increased loss of replies when the aircraft is in the process of making a turn.

The remaining parameter measurements compare reasonably well with those collected previously. Thus, if the Atlanta area is experiencing more problems than normally encountered, it may well be the activation of the more easily triggered suppression mechanism of the transponders based there.

RECOMMENDATION

In general, the failure rates of the transponders tested in Atlanta are comparable with those previously tested (i.e., Philadelphia and Dayton) with one exception. That is the susceptibility of the Atlanta-based transponders to suppression initiation. Only 41 percent passed the SLS pulse spacing tests compared to a 65 to 70 percent pass rate at Philadelphia. (This is the only data available on this parameter.)

If the ATCRBS problem is more severe at Atlanta, the parameter discussed above is a candidate as the possible cause as it is the only one significantly different from the previous data.

It is important to say that the tests only show a vulnerability to suppression initiation. The main problem is suppression action as a result of interrogations which should not be recognized as a suppression pair. In order to cause a problem for the ATC system, something in the environment must initiate a suppression by some interrogation.

This can be either a pulse pair within the bandwidth of the transponder receiver (1030+BW) or a single pulse with a fast rise time outside the bandwidth of the receiver (i.e., a 2.8 µs pulse with a fast rise time at a frequency of 1020 MHz will exit the receiver as a pulse pair at 2.8 µs). The majority of the Atlanta transponders could then be suppressed by the single pulse.

The fact that the transponders are illegally suppressed could, therefore, make them available a lower percentage of the time to reply to interrogations from an ATC system.

It is recommended that the environment be investigated to determine if interference of the type decribed above exists in the Atlanta area.

SUMMARY

A total of 154 different transponders were checked at three different general aviation airports in the Atlanta, Georgia, area. The planes were stopped at one edge of the MTPA interrogation where the tests were conducted. The pilots were then instructed to taxi across the interrogation pattern while power, sensitivity, and reply delay measurements were made.

Figure 39 gives a summary of the testing of the Atlanta sample. As indicated, the most failed parameter was the requirement to reply at a 90 percent rate in the SLS pulse spacing test, where 59 percent of the transponders failed to comply. This compares to a 35 percent failure rate at Philadelphia, the only other site where data on this parameter were collected.

Seven transponders out of the 154 tested passed all 24 parameters tested. Five additional transponders passed all parameters, but replied with "brackets only" to the Mode C interrogations and were failed by MTPA for that parameter. Thus, approximately 7 percent of the transponders passed all tests for which they were equipped. An additional 38 failed to reply at a 90 percent rate during the SLS decoding accuracy test as their only problem and/or replied with "brackets only" to Mode C. Another 43 failed one other parameter (in addition to the previous ones), 24 failed two others, and 49 failed three or more additional parameters.

ALL PARAMETERS MEASURED AT MTL UNLESS OTHERWISE STATED
TEST 2 MUST REPLY GREATER THAN 5%.

FREQUENCY	15	OUT OF	154	= %	9
JITTER	0	OUT OF	154	= %	0
PULSE WIDTH	8	OUT OF	154	= %	5
BRACKET SPACING	6	OUT OF	154	= %	3
PULSE POSITION OFFSET	8	OUT OF	154	= %	5
MODE A PULSE SPACING	8	OUT OF	154	= %	5
MODE C PULSE SPACING	13	OUT OF	154	= %	8

TEST 3 MUST REPLY GREATER THAN 50% BOTH MODES TO MEASURE DELAY DIFFERENCE

DELAY DIFFERENCE A-C	7	OUT OF	146	= %	4
MODE ACCEPTANCE PULSE WIDTH	2	OUT OF	154	= %	1
DEAD TIME	1	OUT OF	154	= %	0
SUPPRESSION TIME	22	OUT OF	154	= %	14
SLS PULSE SPACING <1%	18	OUT OF	154	= %	11
SLS PULSE SPACING >90%	91	OUT OF	154	= %	59
SLS PULSE WIDTH	5	OUT OF	154	= %	3
SLS DYNAMIC RANGE >90%	16	OUT OF	154	= %	10
SLS DYNAMIC RANGE <1%	9	OUT OF	154	= %	5
INSUFFICIENT MODE S REPLIES	8	OUT OF	307	= %	2
MODE C REPLIES <90%	27	OUT OF	299	= %	9
BRACKETS ONLY	107	OUT OF	280	= %	38
GREY CODE VALID <90%	13	OUT OF	180	= %	7
ALTIMETER OFFSET	10	OUT OF	171	= %	5
REPLY DELAY	9	OUT OF	154	= %	5
REPLY POWER	33	OUT OF	154	= %	21
MODE A SENSITIVITY	39	OUT OF	154	= %	25
MODE C SENSITIVITY	39	OUT OF	154	= %	25

This data is taken from test 15 where the transponder is not necessarily sufficiently above MTL to apply the spec. The true data is taken from test 5 where MTL is known:

22 = Total failures ≈ 14%
12 - failed to meet the 90% portion
6 - failed to meet the 1% portion
4 - failed to suppress at all

This is not a failure! The Mode S Transponder was inadvertently left off during the test and thus no calibrated altitude data was available.

PASSED ALL PARAMETERS 7 = 4%
PASSED ALL OR FAILED BRACKETS ONLY 12 = 7%
PASSED ALL OR FAILED BO AND/OR SLS90 PS 38 = 24%
FAILED ONLY 1 OTHER PARAMETER 43 = 27%
FAILED 2 OTHER PARAMETERS 24 = 15%
FAILED 3 OR MORE OTHER PARAMETERS 49 = 31%

FIGURE 39. ATLANTA OVERALL TEST DATA SUMMARY

APPENDIX A

MTPA CALIBRATION DATA FROM PEACHTREE/DEKALB AIRPORT

LIST OF ILLUSTRATIONS

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A-5	Sample Antenna Pattern Plot (Sensitivity Corrected by Power)	A-6
A-6	Sample Antenna Pattern Plot (Reply Delay)	A-7
A-7	Sample Test Summary Sheet (Calibration Vehicle)	A-8

Figure A-1 is a copy of the screen after the calibration process has been completed. It shows a history of the events during the run. The name of the MTPA program is "COUPLE." The name of the calibration file for the day is "PT2." The sensitivity, power, and delay data were collected twice on the calibrated cable to check for repeatability prior to moving the transponder to the car for the calibration run on the ramp. Function "2" (Transponder in Remote Location) was then selected and the car was positioned at one of the edges of the interrogation pattern. Data were then collected as the car was driven through the pattern to the opposite side. The couple program searched these data looking for the maximum power, sensitivity, and the minimum delay. (The arrows in the left hand column indicate that one of these parameters was updated during that set of tests.) When the power and sensitivity have both decreased by 10 dB from the maximum value achieved during the run, the file is then closed by selecting function "3" and entering the approximate distance for use in the vertical offset table selection.

Figures A-2 through A-6 are the data from the pattern run after calibration. The values of power, sensitivity, and delay which would be used as the true parameters for that transponder are circled on figure A-2. When compared to those from the calibrated cable (see figure A-1), it is seen that the sensitivity and delay values are very close but the power is off by about 1.4 dB. The plot of the power data (figure A-3) shows a dip where the maximum should have occurred. This could have been caused by a number of reasons (reflections, interference, etc.), but is well within our tolerance.

Figure A-7 is the summary sheet of the complete set of tests (File-name=ATL1) run on the calibrated transponder. The arrows on the left side indicate parameters which are out of the specified limits. The arrows beside "Mode S reply rate" merely mean that the transponder in MTPA which supplies the calibrated value for the Mode C code was turned off during this run. The delay data are also low (3.167 rather than 3.182) when compared to the bench value. This is a result of selecting the lowest value of delay which occurs during any test. (Some of the tests affect the delay.)

```
R COUPLE

M. T. P. A. COUPLING PROGRAM

ENTER CALIBRATION FILENAME  *PT2

1 - TRANSPONDER ON CALIBRATED CABLE
2 - TRANSPONDER IN REMOTE LOCATION
3 - DATA COLLECTION COMPLETE

     ENTER  FUNCTION    1
CAL SEN *-77. POW * 57.9 DEL * 3.185

1 - TRANSPONDER ON CALIBRATED CABLE
2 - TRANSPONDER IN REMOTE LOCATION
3 - DATA COLLECTION COMPLETE

     ENTER  FUNCTION    1
CAL SEN *-77. POW * 57.7 DEL * 3.182

1 - TRANSPONDER ON CALIBRATED CABLE
2 - TRANSPONDER IN REMOTE LOCATION
3 - DATA COLLECTION COMPLETE

     ENTER  FUNCTION    2
EXTRACT DATA  (N*0)

PAUSE --   <CR>  WHEN  READY

->      SEN *-49. POW * 46.2 DEL * 4.121
->      SEN *-51. POW * 48.1 DEL * 4.120STOP --
->      SEN *-53. POW * 49.5 DEL * 4.114
->      SEN *-54. POW * 51.3 DEL * 4.109.
->      SEN *-55. POW * 52.4 DEL * 4.107
->      SEN *-56. POW * 52.6 DEL * 4.104
->      SEN *-56. POW * 53.0 DEL * 4.106
->      SEN *-57. POW * 53.3 DEL * 4.103
->      SEN *-57. POW * 53.5 DEL * 4.104
->      SEN *-57. POW * 53.5 DEL * 4.103
->      SEN *-58. POW * 53.5 DEL * 4.102
->      SEN *-58. POW * 53.7 DEL * 4.100
->      SEN *-58. POW * 54.5 DEL * 4.099
->      SEN *-58. POW * 54.5 DEL * 4.104
->      SEN *-58. POW * 54.6 DEL * 4.102
->      SEN *-58. POW * 55.0 DEL * 4.104
->      SEN *-58. POW * 54.6 DEL * 4.103
->      SEN *-58. POW * 54.1 DEL * 4.105
        SEN *-57. POW * 54.5 DEL * 4.108
        SEN *-57. POW * 54.2 DEL * 4.109
        SEN *-56. POW * 53.5 DEL * 4.111
        SEN *-56. POW * 53.0 DEL * 4.113
        SEN *-55. POW * 51.9 DEL * 4.112
        SEN *-54. POW * 51.2 DEL * 4.118
        SEN *-52. POW * 49.8 DEL * 4.120
        SEN *-51. POW * 49.0 DEL * 4.128
        SEN *-50. POW * 48.0 DEL * 4.131
        SEN *-49. POW * 47.5 DEL * 4.133
        SEN *-48. POW * 46.7 DEL * 4.135
        SEN *-46. POW * 45.5 DEL * 4.140
REMOTE SEN *-58. POW * 55.0 DEL * 4.099

1 - TRANSPONDER ON CALIBRATED CABLE
2 - TRANSPONDER IN REMOTE LOCATION
3 - DATA COLLECTION COMPLETE

     ENTER  FUNCTION    3
ENTER DISTANCE  (100->800)   400
```

on calibrated cable

on calibrated cable

prompt selection

2 + selection

Calibration Run

Calibration run

Final Selection

400 + for use in lookup table selection

FIGURE A-1. SAMPLE FIELD CALIBRATION DATA RUN

```
ENTER DATA FILE NAME      *PATPT2
 1 SEN= 54. POWER= 37.0 DELAY=  3.293
 2 SEN= 54. POWER= 36.9 DELAY=  3.294
 3 SEN= 54. POWER= 37.0 DELAY=  3.294
 4 SEN= 54. POWER= 37.0 DELAY=  3.292
 5 SEN= 54. POWER= 37.0 DELAY=  3.295
 6 SEN= 54. POWER= 37.0 DELAY=  3.293
 7 SEN= 54. POWER= 37.0 DELAY=  3.294
 8 SEN= 54. POWER= 37.0 DELAY=  3.293
 9 SEN= 54. POWER= 36.9 DELAY=  3.294
10 SEN= 54. POWER= 37.0 DELAY=  3.302
11 SEN= 53. POWER= 37.0 DELAY=  3.303
12 SEN= 53. POWER= 35.7 DELAY=  3.300
13 SEN= 53. POWER= 34.3 DELAY=  3.297
14 SEN= 54. POWER= 33.7 DELAY=  3.285
15 SEN= 55. POWER= 35.7 DELAY=  3.256
16 SEN= 59. POWER= 39.7 DELAY=  3.240
17 SEN= 61. POWER= 42.8 DELAY=  3.228
18 SEN= 63. POWER= 45.2 DELAY=  3.212
19 SEN= 67. POWER= 46.6 DELAY=  3.206
20 SEN= 68. POWER= 48.1 DELAY=  3.202
21 SEN= 70. POWER= 49.8 DELAY=  3.197
22 SEN= 71. POWER= 51.5 DELAY=  3.195
23 SEN= 72. POWER= 52.3 DELAY=  3.194
24 SEN= 73. POWER= 53.3 DELAY=  3.194
25 SEN= 74. POWER= 53.7 DELAY=  3.189
26 SEN= 74. POWER= 54.5 DELAY=  3.191
27 SEN= 75. POWER= 55.0 DELAY=  3.189
28 SEN= 75. POWER= 55.5 DELAY=  3.188
29 SEN= 76. POWER= 55.8 DELAY=  3.187
30 SEN= 76. POWER= 56.3 DELAY=  3.186
31 SEN= 76. POWER= 56.4 DELAY=  3.186
32 SEN= 76. POWER= 56.2 DELAY=  3.184
33 SEN= 77. POWER= 55.7 DELAY=  3.182
34 SEN= 76. POWER= 55.7 DELAY=  3.185
35 SEN= 76. POWER= 56.4 DELAY=  3.181
36 SEN= 75. POWER= 56.3 DELAY=  3.180
37 SEN= 74. POWER= 55.5 DELAY=  3.181
38 SEN= 74. POWER= 55.2 DELAY=  3.182
39 SEN= 74. POWER= 54.5 DELAY=  3.179
40 SEN= 73. POWER= 53.9 DELAY=  3.186
41 SEN= 72. POWER= 53.5 DELAY=  3.182
42 SEN= 72. POWER= 52.3 DELAY=  3.181
43 SEN= 71. POWER= 51.2 DELAY=  3.184
44 SEN= 70. POWER= 49.8 DELAY=  3.193
45 SEN= 68. POWER= 48.7 DELAY=  3.193
46 SEN= 67. POWER= 47.3 DELAY=  3.194
47 SEN= 66. POWER= 45.7 DELAY=  3.199
48 SEN= 64. POWER= 44.6 DELAY=  3.205
49 SEN= 62. POWER= 41.4 DELAY=  3.215
50 SEN= 60. POWER= 38.6 DELAY=  3.225
51 SEN= 58. POWER= 36.9 DELAY=  3.236
52 SEN= 58. POWER= 35.9 DELAY=  3.239
53 SEN= 57. POWER= 35.3 DELAY=  3.246
54 SEN= 57. POWER= 34.9 DELAY=  3.250
```

FIGURE A-2. SAMPLE ANTENNA PATTERN RUN

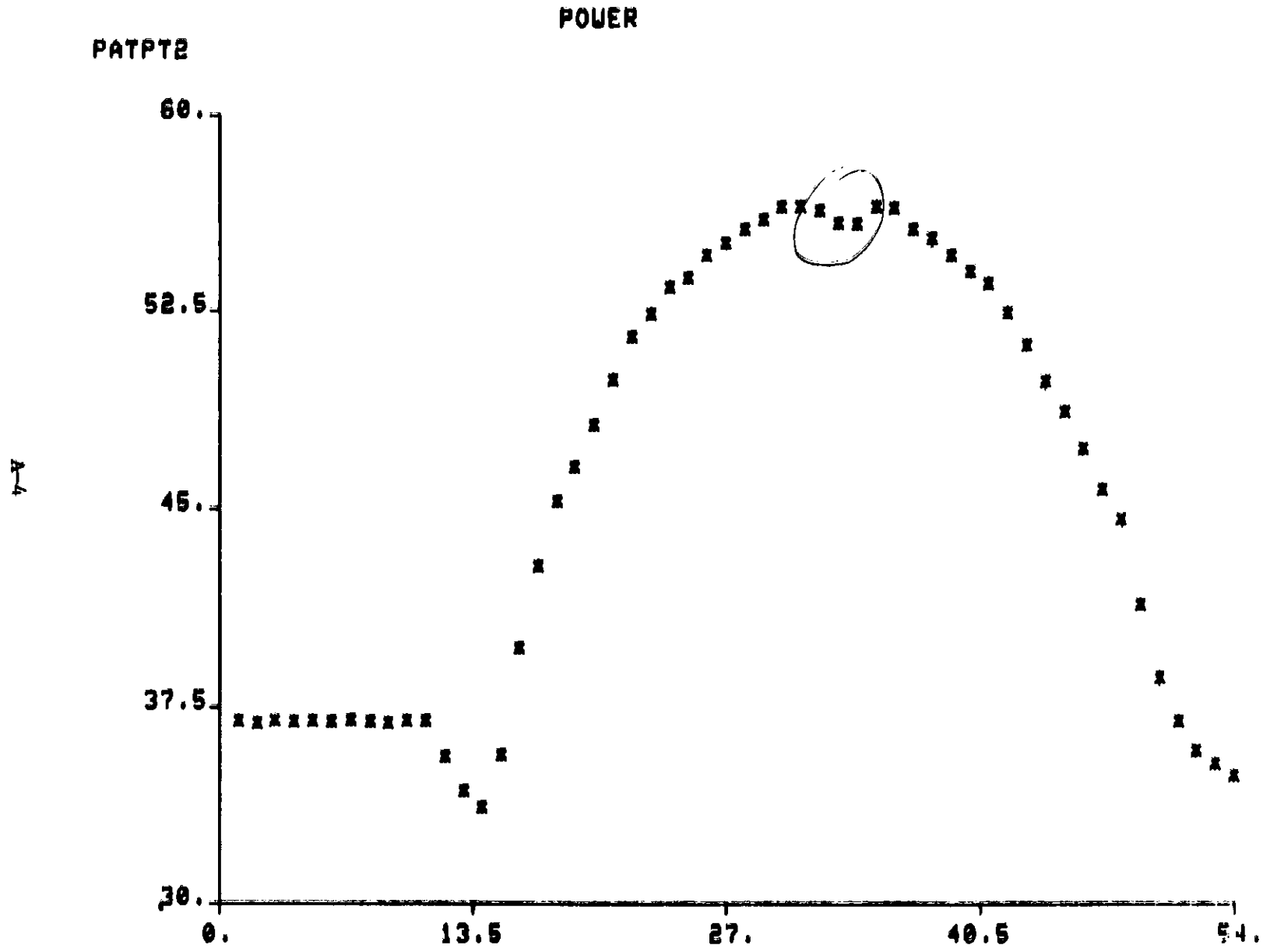


FIGURE A-3. SAMPLE ANTENNA PATTERN PLOT (POWER)

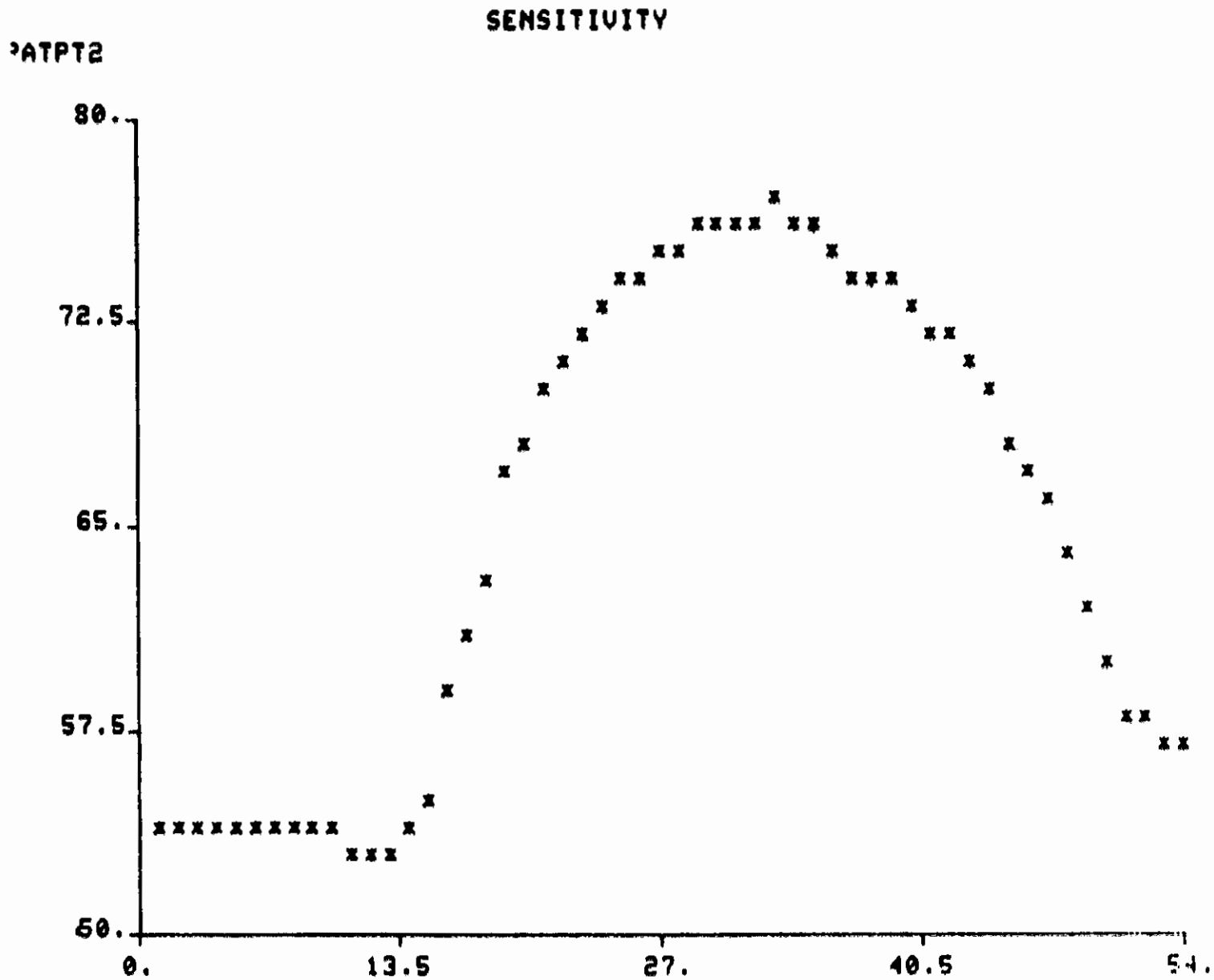


FIGURE A-4. SAMPLE ANTENNA PATTERN PLOT (SENSITIVITY)

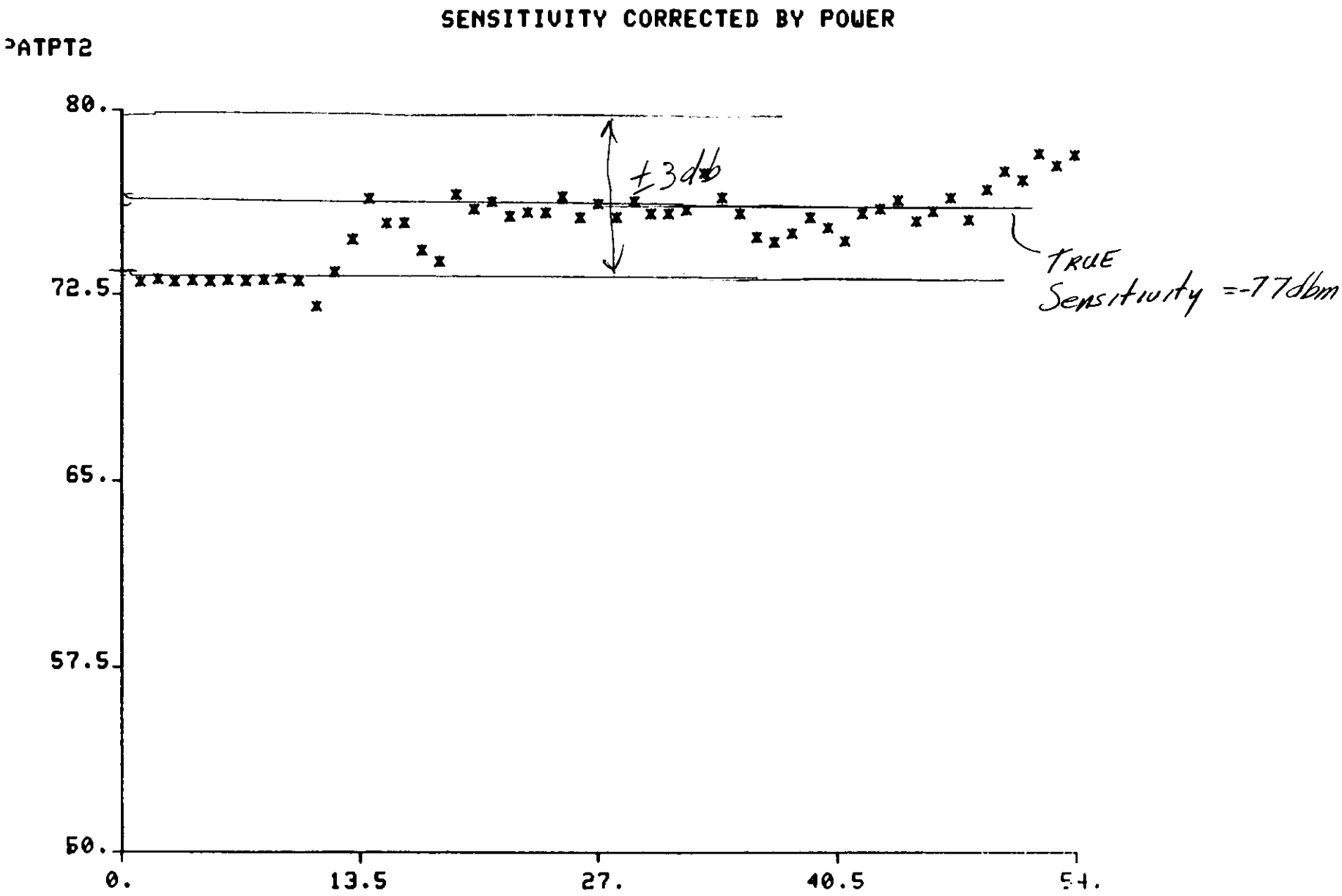


FIGURE A-5. SAMPLE ANTENNA PATTERN PLOT (SENSITIVITY CORRECTED BY POWER)

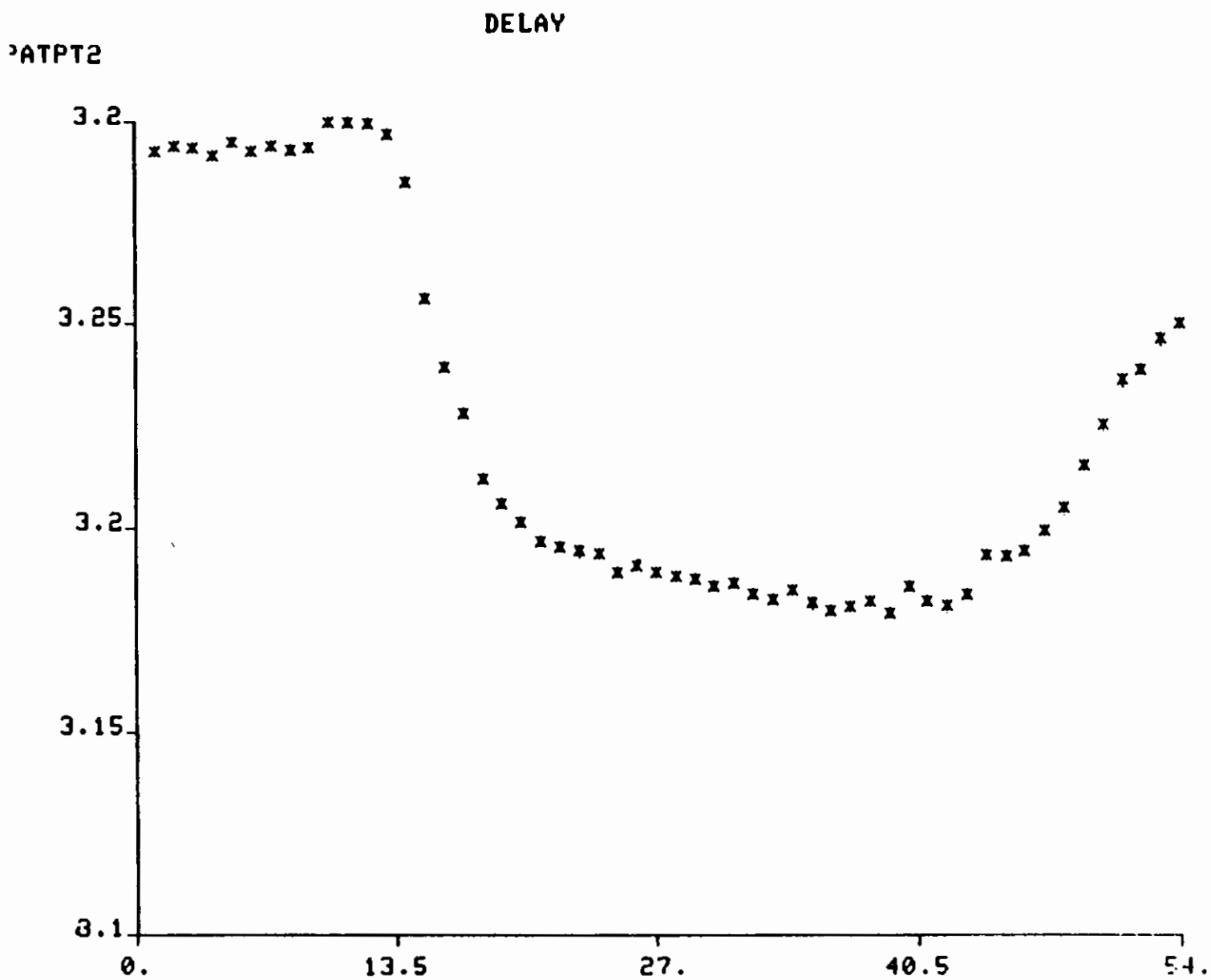


FIGURE A-6. SAMPLE ANTENNA PATTERN PLOT (REPLY DELAY)

F. A. A. TECHNICAL CENTER TRANSPONDER SUMMARY

THIS TEST DOES NOT PRECLUDE TRANSPONDER CERTIFICATION

PTSHK1 5.0 FT -47 DB

PTD2 .001 02-APR-85 08:09:32

```
   CODE                          5252
   FREQUENCY                     1090.5 MHZ                          1090 +/- 3
   JITTER                          0.018 USEC                       NTE .100 USEC
   PULSE WIDTH                     0.452 USEC                       .450 +/- .100 USEC
   BRACKET SPACING                20.310 USEC                       20.300 +/- .100 USEC
   MAX CODE PULSE OFFSET           0.010 USEC                       NTE .100 USEC
   MODE A ACCEPTANCE (PS)          7.75  ->   8.40   USEC           <7.8 -> >8.2 USEC
   MODE C ACCEPTANCE (PS)         20.75  ->  21.40   USEC           <20.8 -> 21.2 USEC
   DELAY DIFFERENCE (MODE A-C) (US)    0.007                       NTE .200 USEC
   ATCRBS ACCEPTANCE (PW)          0.425 ->   0.925  USEC
-> MODE S REPLY RATE               0.0 %
   P1-P2 RATIO (REP >= 90%) @ -50 DBM 15 ** 12 **  9 ** ** **  >=9
   P1-P2 RATIO (REP <=  1%) @ -50 DBM ** -6 ** -3 **  0  6  3  <=0
-> DEAD TIME                     130.0  USEC                       NTE 125.0 USEC
   SUPPRESSION TIME               26.0  USEC                       35.0 +/- 10 USEC
   REPLY RATE (1000)             100  %
   REPLY RATE (1400)              68  %
   REPLY RATE (1700)              50  %
   REPLY RATE (2000)              49  %
   S.L.S. ACCEPTANCE (PS) ( <  1% )  1.75  ->   2.30  USEC  <1.85 -> >2.15 USEC
   S.L.S. ACCEPTANCE (PW)          0.300 ->   1.500  USEC
-> MODE S REPLY RATE               0.0 %
   REPLY DELAY                     3.167  USEC                     3.000 +/- .500 USEC
   REPLY POWER                    56.5  DBM                        45.5 - 60 DBM
   MODE A SENSITIVITY            -77    DBM                        66-80 DBM
   MODE C SENSITIVITY            -77    DBM                        66-80 DBM
```

FIGURE A-7. SAMPLE TEST SUMMARY SHEET (CALIBRATION VEHICLE)

APPENDIX B

ANALYSIS OF TRANSPONDERS OF N6024*

APPENDIX B - LIST OF ILLUSTRATIONS

Figure		Page
B-1	Test Matrix Transponder (2 Sheets)	B-3
B-2	Test Summary Sheet - Transponder (2 Sheets)	B-5
B-3	MTPA Test 2 Summary Sheet (1) (2 Sheets)	B-7
B-4	MTPA Test 2 Summary Sheet (2) (2 Sheets)	B-9
B-5	MTPA Test 3 Summary Sheet (2 Sheets)	B-11
B-6	MTPA Test 4 Summary Sheet (2 Sheets)	B-13
B-7	MTPA Test 99 Summary Sheet (1st run) (2 Sheets)	B-15
B-8	MTPA Test 15 Summary Sheet (2 Sheets)	B-17
B-9	MTPA Test 15 Summary Sheet (Delay) (2 Sheets)	B-19
B-10	MTPA Test 15 Summary Sheet (Power) (2 Sheets)	B-21
B-11	MTPA Test 6 Summary Sheet (2 Sheets)	B-23
B-12	MTPA Test 7 Summary Sheet (2 Sheets)	B-25
B-13	MTPA Test 9 Summary Sheet (2 Sheets)	B-27
B-14	MTPA Test 12 Summary Sheet (2 Sheets)	B-29
B-15	MTPA Test 13 Summary Sheet (2 Sheets)	B-31
B-16	MTPA Test 14 Summary Sheet (2 Sheets)	B-33
B-17	MTPA Test 5 Summary Sheet (2 Sheets)	B-35
B-18	MTPA Test 5 Summary Sheet (Delay) (2 Sheets)	B-37
B-19	MTPA Test 5 Summary Sheet (Power) (2 Sheets)	B-39
B-20	MTPA Test 99 Summary Sheet (2nd run) (2 Sheets)	B-41

This aircraft had two transponders which were checked by the MTPA. The summary data from each test is included as this appendix. Accurate power and sensitivity data were not taken on transponder No. 1 so that the second transponder could be checked. Power and sensitivity data were taken on the second transponder after completion of the remainder of the tests.

The figures for transponder No. 1 are all labeled "sheet 1." The companion figures for transponder No. 2 are labeled "sheet 2." Figure B-1 is the test matrice for the two transponders. Figure B-2 is the summary.

Transponder No. 1 shows only two problems: (1) it has no reply rate limiting, and (2) it did not reply to the Mode C interrogations of the altitude tests. This is somewhat puzzling, as it answered 100 percent to the interrogations of the Mode C acceptance spacing test (see figure B-5). The interrogations of the altitude test are nominal spacing and the same interrogation power as those of test 3.

Transponder No. 2, however, failed many parameters (see figure B-2). The fact that the frequency is so far off could explain why many of the other parameters failed. If the transmit frequency is used as the local oscillator, the interrogation signals from MTPA would be approximately 6.9 MHz from the center frequency of the transponders' receiver. This would certainly result in attenuation and distortion of the interrogation signals. The reply rate on most of the tests is less than 100 percent, as is evidenced by any of the test figures for transponder No. 2. Apparently, there was much antenna sheilding during the tests as the power readings gathered during test 15 show a reply power of 26.5 dBm, test 2 shows 27 or 28 dBm, and the true power was 51.5 dBm. Thus, the signals were between 20 and 25 dB down from the maximum during the tests. The reply power of transponder no. 2 was also about 4 dB lower than that of transponder no. 1 according to figures B-3 and B-10.

The summaries of the sensitivity tests with the reply power above 40 dBm are listed in the following table:

TABLE B-1 ATCRBS SENSITIVITY TEST RESULTS

MATRIX NO.	A SENS	A DEL.	C SENS	C DEL.	POWER (A)	POWER (C)
71	-58	2.661	-59	2.662	40	43
72	-64	2.638	-62	2.646	45	47
73	-62	2.617	-66	2.628	49	51
74	-68	2.603	-68	2.616	51	51
75	-69	2.599	-68	2.618	51	51
76	-68	2.606	-67	2.622	50	50
77	-67	2.611	-66	2.631	49	47
78	-65	2.615	-65	2.632	47	46
79	-64	2.618	-65	2.638	46	47
80	-64	2.621	-64	2.641	46	47
81	-63	2.630	-62	2.646	47	45
82	-63	2.634	-63	2.654	44	43
83	-64	2.639	-63	2.661	43	43
84	-62	2.646	-62	2.665	42	42
85	-62	2.659	-62	2.679	41	40

As indicated, the nose of the interrogation beam was crossed by the plane at approximately the time tests 73 to 75 were being conducted. Since the interrogation power was set to -49 dBm for the tests conducted while the aircraft was stationary, and the aircraft antenna was approximately 20 dB down from the nose, the majority of the tests were conducted at or near the MTL of the transponders. This makes the data of some of the tests somewhat questionable (all tests which require a 90 percent reply rate, i.e., dead time, suppression time), but all reply characteristic type tests are valid.

24K NO POWER SEN. #1 1.5 FT -49 DB

02-APR-85 08:51:46

TEST MATRIX

		1	2	3	4	5	6	7	8	9
		2	3	4	99	15	6	7	8	12
10	13	14	5	99	14	14	14	14	14	14
20	14	14	14	14	14	14	14	14	14	14
30	14	14	14	14	14	14	14	14	14	14
40	14	14	14	14	14	14	14	14	14	14
50	14	14	14	14	14	14	14	14	14	14
60	14	14	14	14	14	14	14	14	14	14
70	14	14	14	14	14	14	14	14	14	14
80	14	14	14	14	14	14	14	14	14	14
90	14	14	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	

FIGURE B-1. TEST MATRIX TRANSPONDER (SHEET 1 OF 2)

N6024K82 1.5 FT -49 DB

02-APR-85 08:54:27

TEST MATRIX

		1	2	3	4	5	6	7	8	9
		2	3	4	99	15	6	7	8	12
10	13	14	5	99	14	14	14	14	14	14
20	14	14	14	14	14	14	14	14	14	14
30	14	14	14	14	14	14	14	14	14	14
40	14	14	14	14	14	14	14	14	14	14
50	14	14	14	14	14	14	14	14	14	14
60	14	14	14	14	14	14	14	14	14	14
70	14	14	14	14	14	14	14	14	14	14
80	14	14	14	14	14	14	14	14	14	14
90	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	

FIGURE B-1. TEST MATRIX TRANSPONDER (SHEET 2 OF 2)

F. A. A. TECHNICAL CENTER TRANSPONDER SUMMARY

THIS TEST DOES NOT PRECLUDE TRANSPONDER CERTIFICATION

24K NO POWER SEN. #1 1.5 FT -49 DB

PT2DA .001 02-APR-85 08:51:46

```
   CODE                          1200
   FREQUENCY                     1090.8 MHZ                          1090 +/- 3
   JITTER                           0.020 USEC                      NTE .100 USEC
   PULSE WIDTH                      0.397 USEC                      .450 +/- .100 USEC
   BRACKET SPACING                 20.310 USEC                      20.300 +/- .100 USEC
   MAX CODE PULSE OFFSET            0.006 USEC                      NTE .100 USEC
   MODE A ACCEPTANCE (PS)           7.70  ->   8.45   USEC          <7.8 -> >8.2 USEC
   MODE C ACCEPTANCE (PS)          20.75  ->  21.40   USEC          <20.8 -> 21.2 USEC
   DELAY DIFFERENCE (MODE A-C) (US)    0.024                        NTE .200 USEC
   ATCRBS ACCEPTANCE (PW)           0.525 ->   1.500  USEC
-> MODE C REPLY RATE                0.0 %
   P1-P2 RATIO (REP >= 90%) @ -50 DBM 15 ** 12 **  9 **  6 **  >=9
   P1-P2 RATIO (REP <=  1%) @ -50 DBM ** -6 ** -3 **  0 ** **  <=0
   DEAD TIME                       45.0  USEC                      NTE 125.0 USEC
   SUPPRESSION TIME                38.0  USEC                      35.0 +/- 10 USEC
   REPLY RATE (1000)               99  %
   REPLY RATE (1400)              100  %
   REPLY RATE (1700)               99  %
   REPLY RATE (2000)               99  %
   S.L.S. ACCEPTANCE (PS) ( <  1% )  1.80  ->   2.40  USEC  <1.85 -> >2.15 USEC
   S.L.S. ACCEPTANCE (PW)           0.350 ->   1.500  USEC
-> MODE C REPLY RATE                0.0 %
   REPLY DELAY                      2.819  USEC                     3.000 +/- .500 USEC
-> REPLY POWER                     31.0  DBM                        48.5 - 57 DBM
```

no limiting

not tested

FIGURE B-2. TEST SUMMARY SHEET - TRANSPCNDER (SHEET 1 OF 2)

F. A. A. TECHNICAL CENTER TRANSPONDER SUMMARY

THIS TEST DOES NOT PRECLUDE TRANSPONDER CERTIFICATION

N6024K#2 1.5 FT -49 DB

PT2DA .002 02-APR-85 08:54:27

```
   CODE                          1200
-> FREQUENCY                     1096.9 MHZ                          1090 +/- 3
   JITTER                          0.062 USEC                       NTE .100 USEC
   PULSE WIDTH                     0.362 USEC                       .450 +/- .100 USEC
   BRACKET SPACING                20.255 USEC                       20.300 +/- .100 USEC
   MAX CODE PULSE OFFSET          -0.040 USEC                       NTE .100 USEC
   MODE A ACCEPTANCE (PS)          7.80  ->   8.20   USEC           <7.8 -> >8.2 USEC
-> MODE C ACCEPTANCE (PS)         20.80  ->  20.95   USEC           <20.8 -> 21.2 USEC
   DELAY DIFFERENCE (MODE A-C) (US)    0.027                        NTE .200 USEC
-> ATCRBS ACCEPTANCE (PW)          0.750 ->   1.500  USEC
-> MODE C REPLY RATE               0.0 %
-> P1-P2 RATIO (REP >= 90%) @ -50 DBM ** ** ** ** ** ** ** **  >=9
-> P1-P2 RATIO (REP <=  1%) @ -50 DBM ** -6 ** -3 ** ** ** **  <=0
-> DEAD TIME                     140.0  USEC                       NTE 125.0 USEC
-> SUPPRESSION TIME               50.0  USEC                       35.0 +/- 10 USEC
   REPLY RATE (1000)              81  %
   REPLY RATE (1400)              56  %
   REPLY RATE (1700)              45  %
   REPLY RATE (2000)              37  %
-> S.L.S. ACCEPTANCE (PS) ( <  1% )  1.95  ->   2.40  USEC  <1.85 -> >2.15 USEC
   S.L.S. ACCEPTANCE (PW)          0.300 ->   1.500  USEC
-> MODE C REPLY RATE               0.0 %
   REPLY DELAY                     2.599  USEC                      3.000 +/- .500 USEC
   REPLY POWER                    51.5  DBM                         48.5 - 57 DBM
   MODE A SENSITIVITY            -69    DBM                         69-77 DBM
   MODE C SENSITIVITY            -70    DBM                         69-77 DBM
```

FIGURE B-2. TEST SUMMARY SHEET - TRANSPONDER (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB
ATCRBS REPLY TEST - 2

PULSE	POSITION	POWER
1 - F1	0.000	0.0
2 - C1	0.000	0.0
3 - A1	0.006	30.9
4 - C2	0.000	0.0
5 - A2	0.000	0.0
6 - C4	0.000	0.0
7 - A4	0.000	0.0
8 - B1	0.000	0.0
9 - D1	0.000	0.0
10 - B2	0.001	31.0
11 - D2	0.000	0.0
12 - B4	0.000	0.0
13 - D4	0.000	0.0
14 - F2	0.010	31.0

CODE = 1200

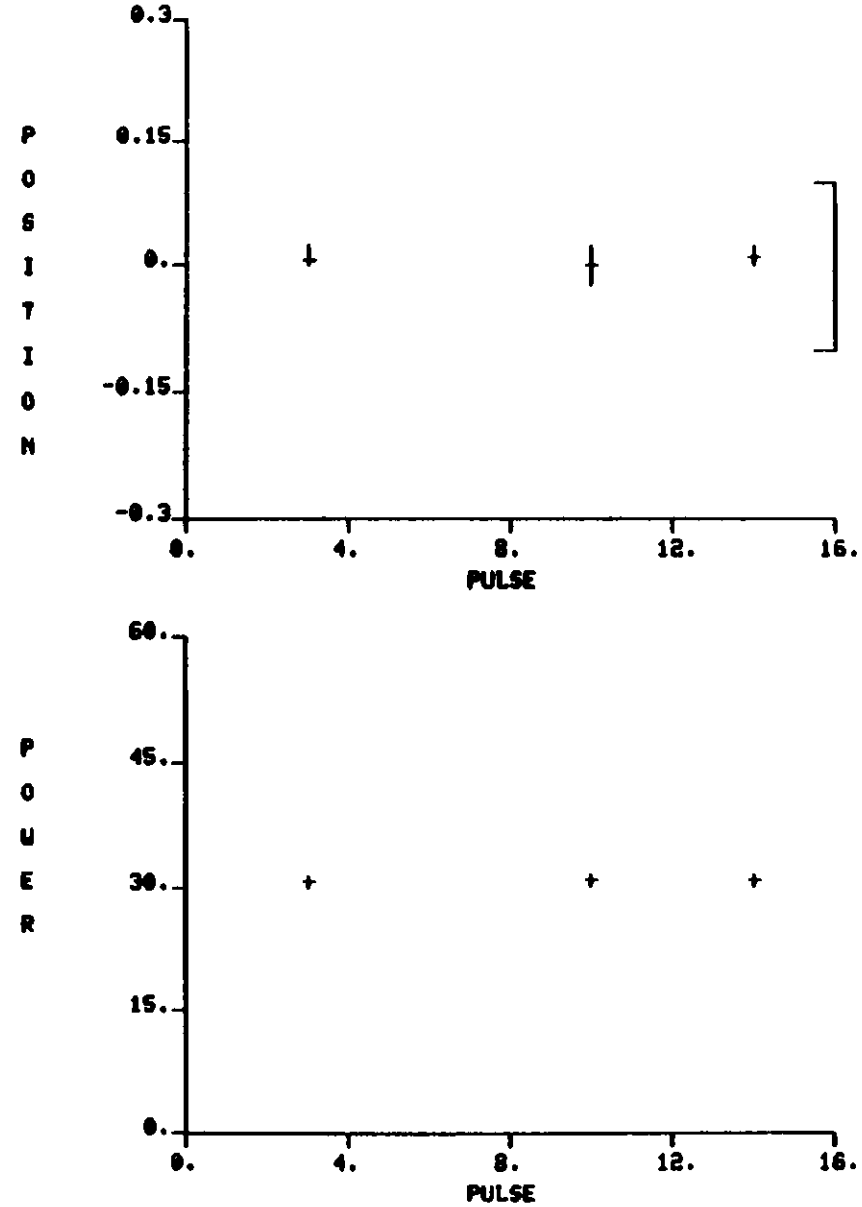


FIGURE B-3. MTPA TEST 2 SUMMARY SHEET (1) (SHEET 1 OF 2)

N6024K#2 1.5 FT -49 DB

ATCRBS REPLY TEST - 2

PULSE	POSITION	POWER
1 - F1	0.000	0.0
2 - C1	0.000	0.0
3 - A1	-0.012	28.0
4 - C2	0.000	0.0
5 - A2	0.000	0.0
6 - C4	0.000	0.0
7 - A4	0.000	0.0
8 - B1	0.000	0.0
9 - D1	0.000	0.0
10 - B2	-0.040	27.2
11 - D2	0.000	0.0
12 - B4	0.000	0.0
13 - D4	0.000	0.0
14 - F2	-0.045	27.4

CODE = 1200

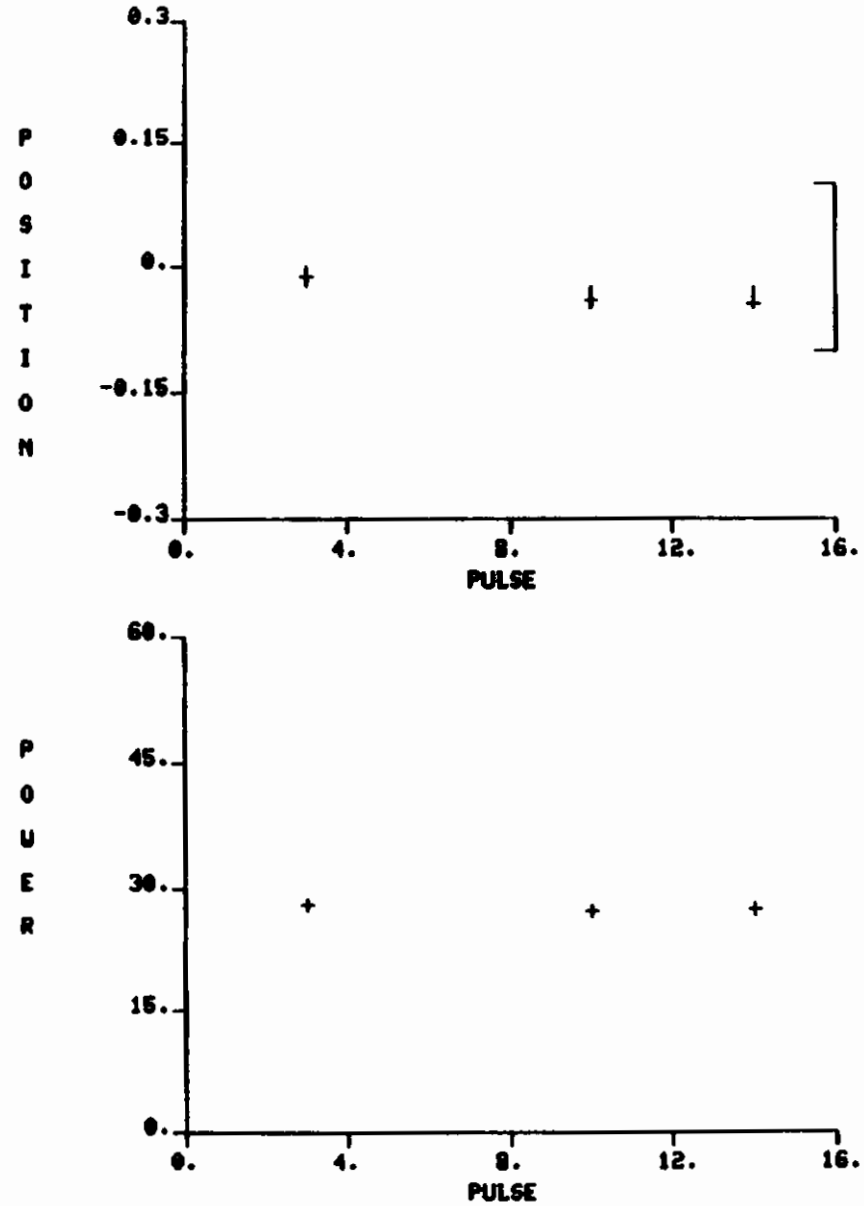


FIGURE B-3. MTPA TEST 2 SUMMARY SHEET (1) (SHEET 2 OF 2)

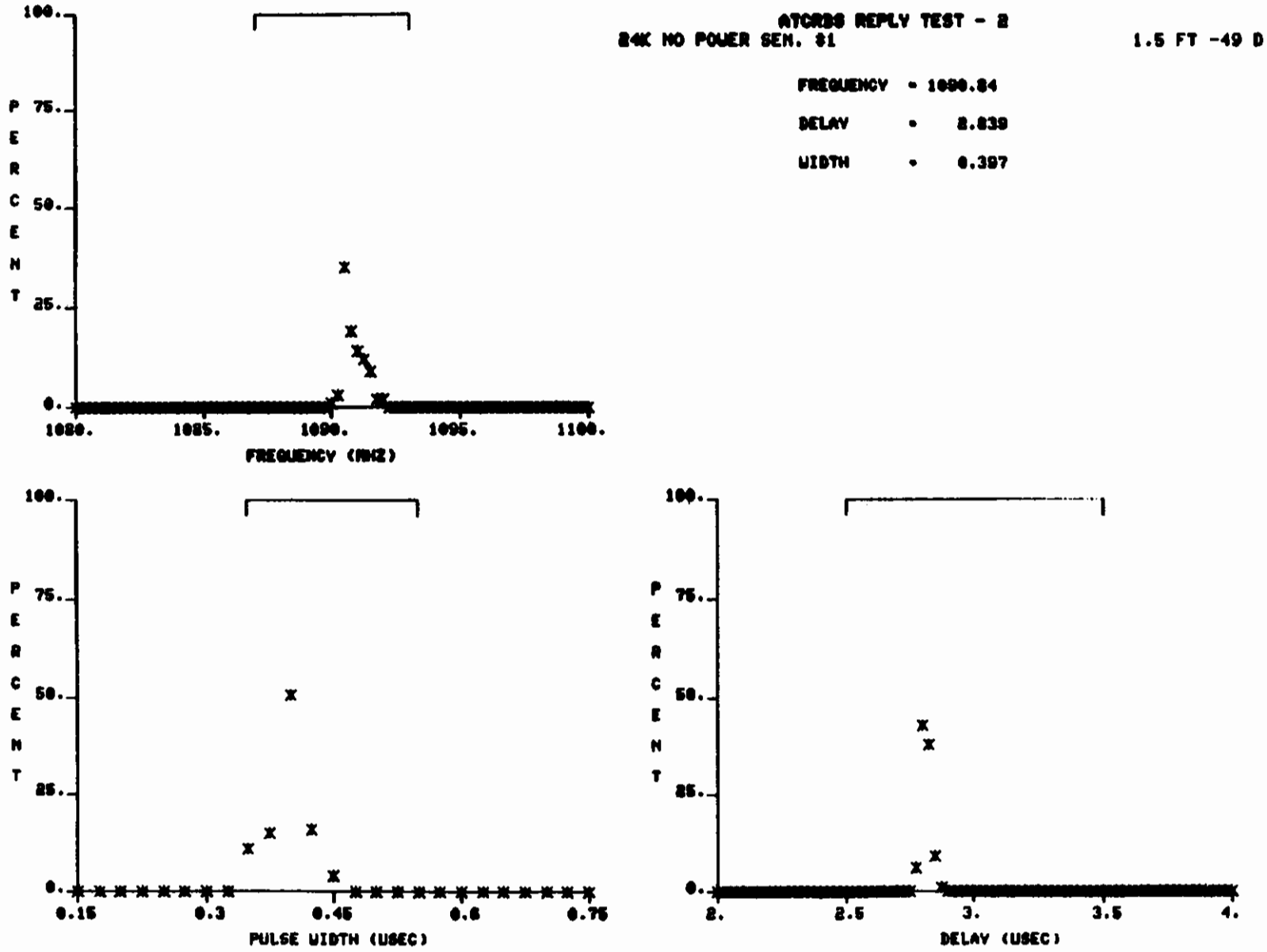


FIGURE B-4. MTPA TEST 2 SUMMARY SHEET (2) (SHEET 1 OF 2)

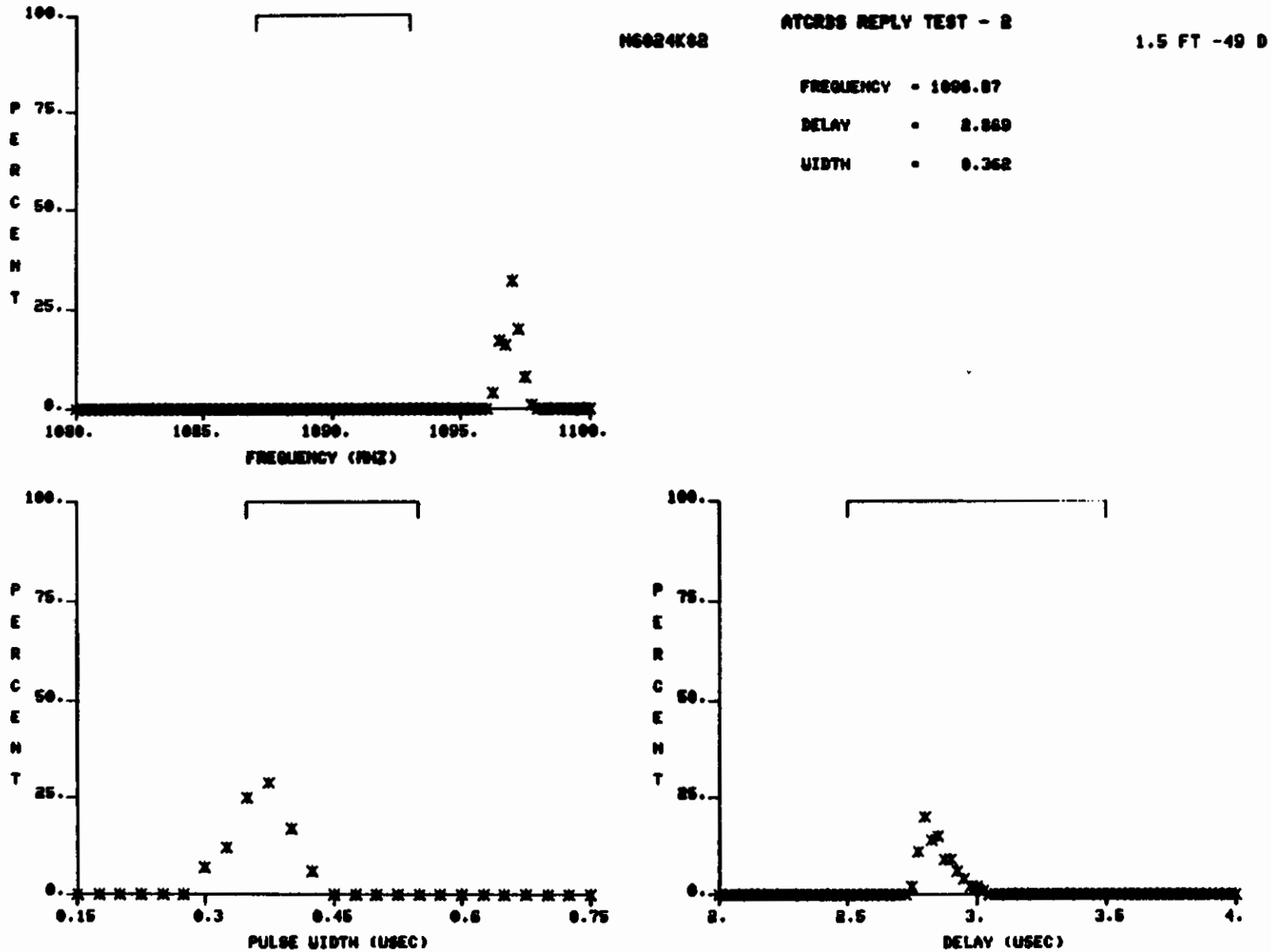


FIGURE B-4. MTPA TEST 2 SUMMARY SHEET (2) (SHEET 2 OF 2)

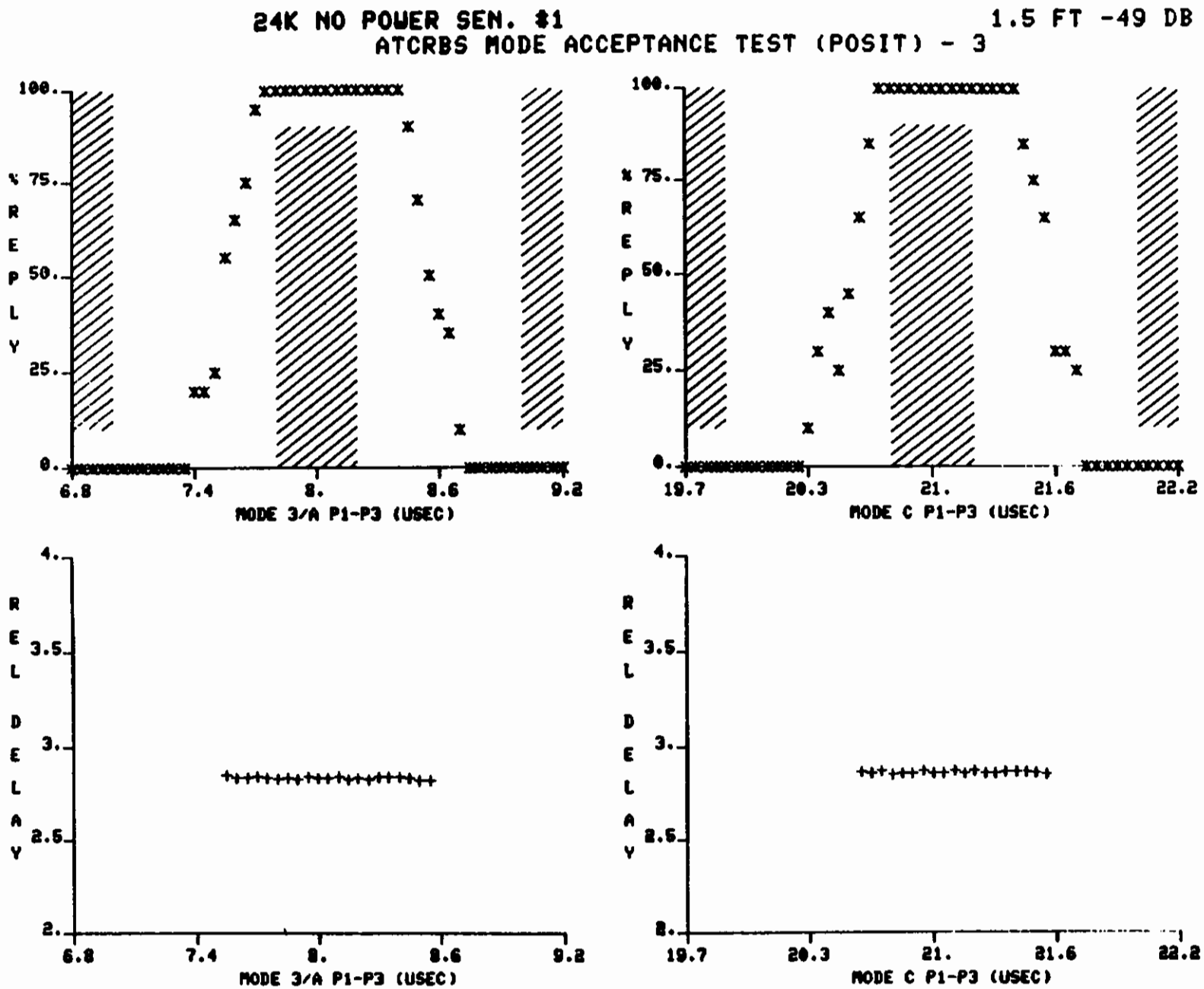


FIGURE B-5. MTPA TEST 3 SUMMARY SHEET (SHEET 1 OF 2)

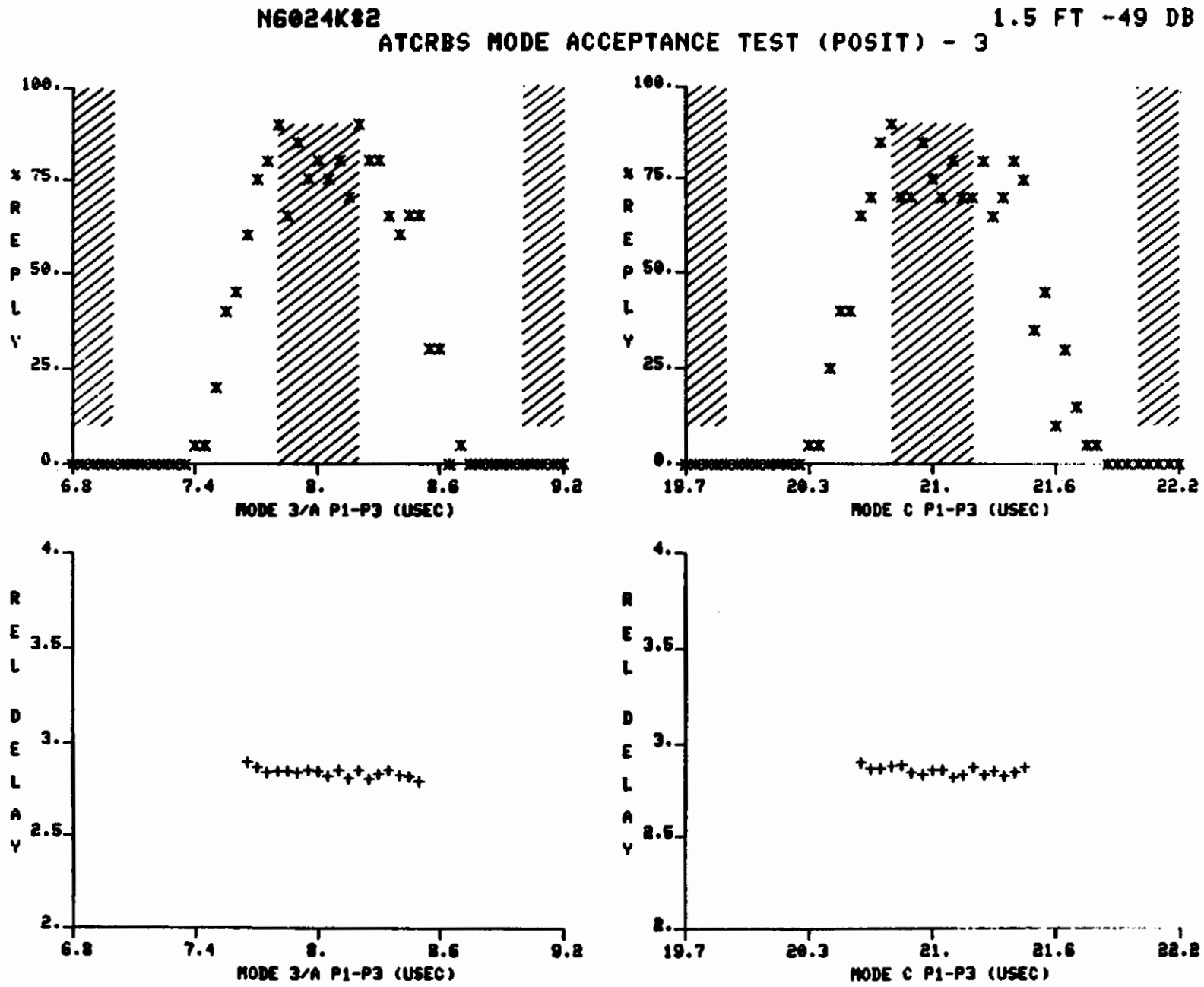


FIGURE B-5. MTPA TEST 3 SUMMARY SHEET (SHEET 2 OF 2)

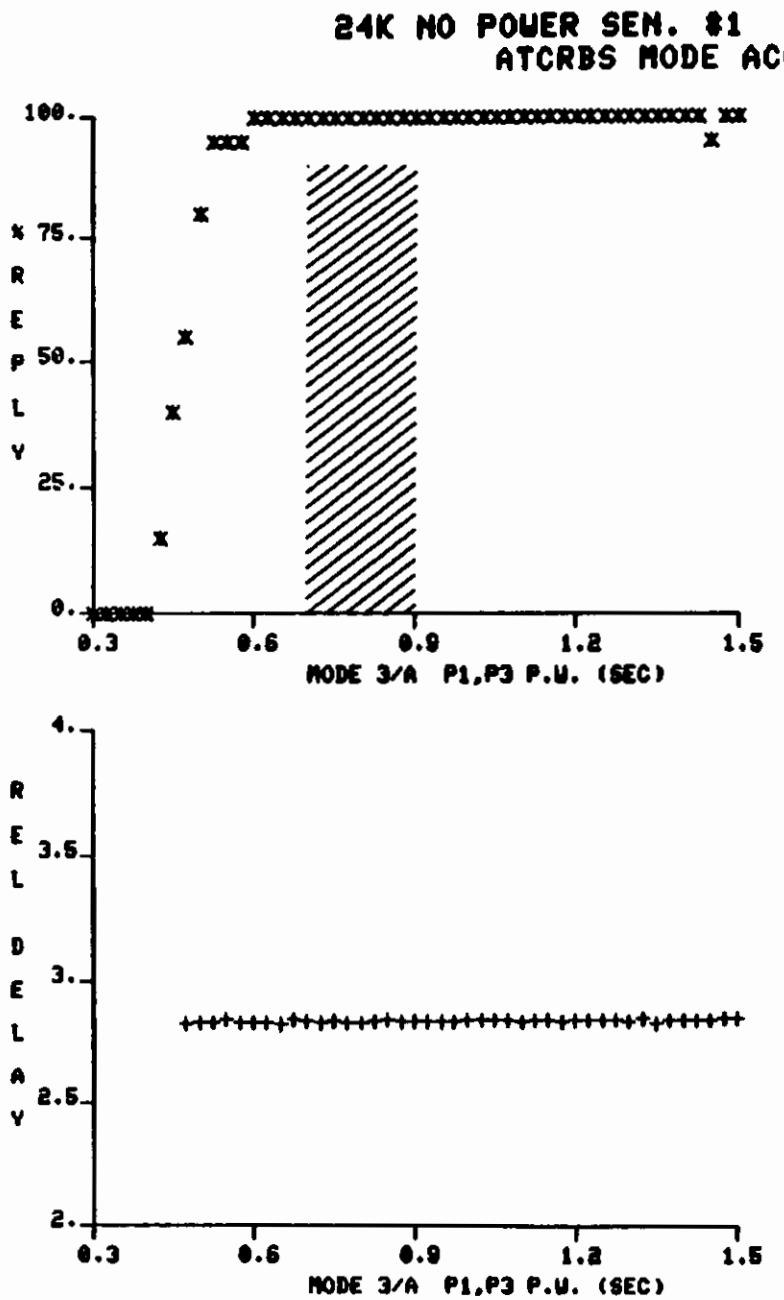


FIGURE B-6. MTPA TEST 4 SUMMARY SHEET (SHEET 1 OF 2)

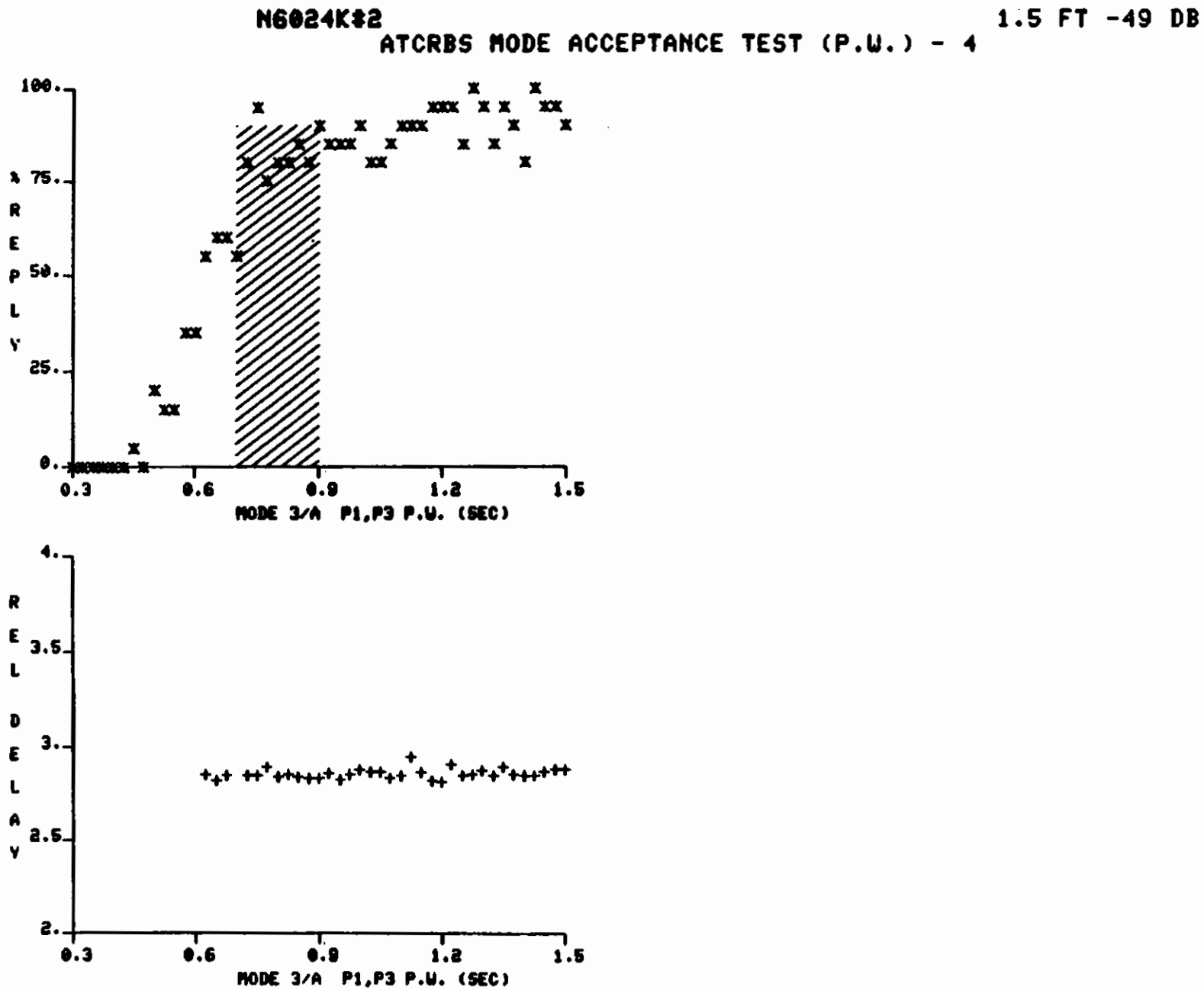
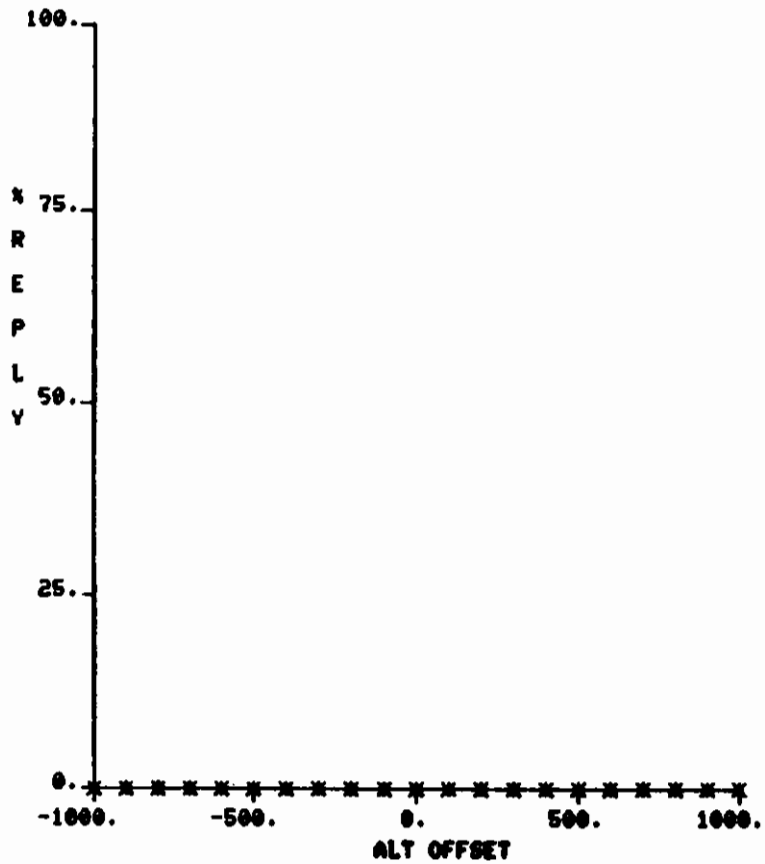


FIGURE B-6. MTPA TEST 4 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB

MODE C ALTITUDE VERIFICATION - 99

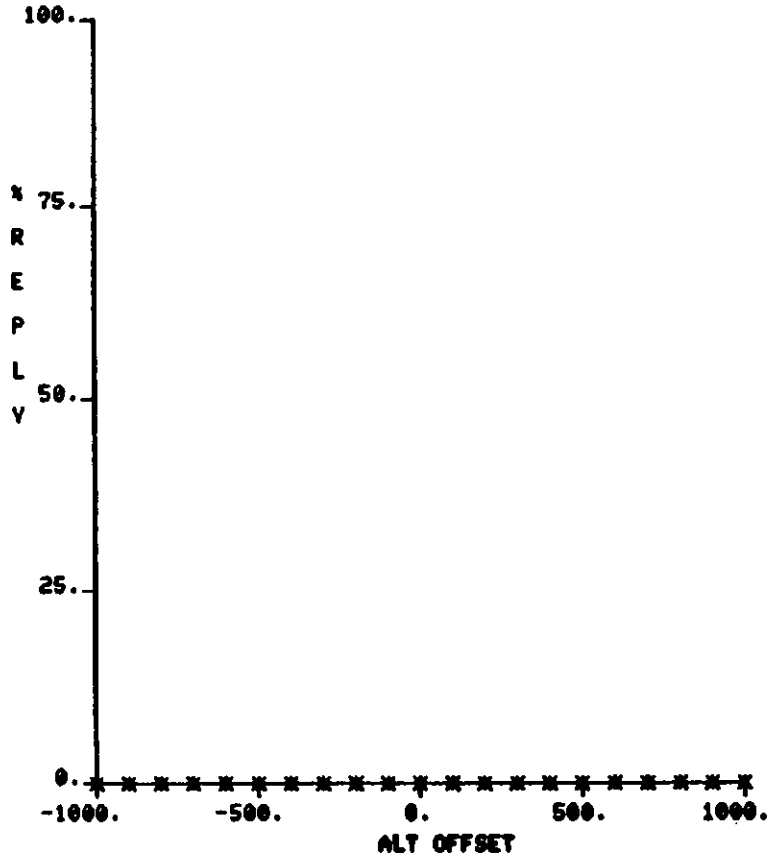


STANDARD TRANSPONDER =	900. FEET	100.	% VALID REPLY
TEST TRANSPONDER =	0. FEET	0.	% VALID REPLY
	0. REPLY	0.	% BRACKET REPLY

FIGURE B-7. MTPA TEST 99 SUMMARY SHEET (1st RUN) (SHEET 1 OF 2)

N6024K#2 1.5 FT -49 DB

MODE C ALTITUDE VERIFICATION - 99



STANDARD TRANSPONDER = 900. FEET 100. % VALID REPLY

TEST TRANSPONDER = 0. FEET 0. % VALID REPLY

0. REPLY 0. % BRACKET REPLY

FIGURE B-7. MTPA TEST 99 SUMMARY SHEET (1st RUN) (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB
SIDE LOBE SUPPRESSION TEST - 15

P1-P2	P1 LEVEL (-DBM) 60	50
15	0	100
12	0	100
9	0	100
6	0	99
3	0	31
0	0	0
-3	0	0
-6	0	0

FIGURE B-8. MTPA TEST 15 SUMMARY SHEET (SHEET 1 OF 2)

N6024K#2
SIDE LOBE SUPPRESSION TEST - 15

1.5 FT -49 DB

P1-P2	P1 LEVEL (-DBM) 60	50
15	0	53
12	0	53
9	0	58
6	0	57
3	0	53
0	0	13
-3	0	0
-6	0	0

FIGURE B-8. MTPA TEST 15 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1
SIDE LOBE SUPPRESSION TEST - 15

1.5 FT -49 DB

P1-P2 \ P1 LEVEL (-DBM)	60	50
15	2850	
12	2850	
9	2850	
6	2875	
3		
0		
-3		
-6		

FIGURE B-9. MTPA TEST 15 SUMMARY SHEET (DELAY) (SHEET 1 OF 2)

N6024K#2
SIDE LOBE SUPPRESSION TEST - 15

1.5 FT -49 DB

P1-P2	P1 LEVEL (-DBM) 60	50
15	2900	
12	2900	
9	2875	
6	2900	
3	2900	
0		
-3		
-6		

FIGURE B-9. MTPA TEST 15 SUMMARY SHEET (DELAY) (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB
SIDE LOBE SUPPRESSION TEST - 15

P1-P2 \ P1 LEVEL (-DBM)	60	50
15		30.5
12		30.5
9		30.5
6		30.5
3		
0		
-3		
-6		

FIGURE B-10. MTPA TEST 15 SUMMARY SHEET (POWER) (SHEET 1 OF 2)

N6024K#2
SIDE LOBE SUPPRESSION TEST - 15

1.5 FT -49 DB

P1-P2 \ P1 LEVEL (-DBM)	60	50
15		26.5
12		26.5
9		26.5
6		26.5
3		26.5
0		
-3		
-6		

FIGURE B-10. MTPA TEST 15 SUMMARY SHEET (POWER) (SHEET 2 OF 2)

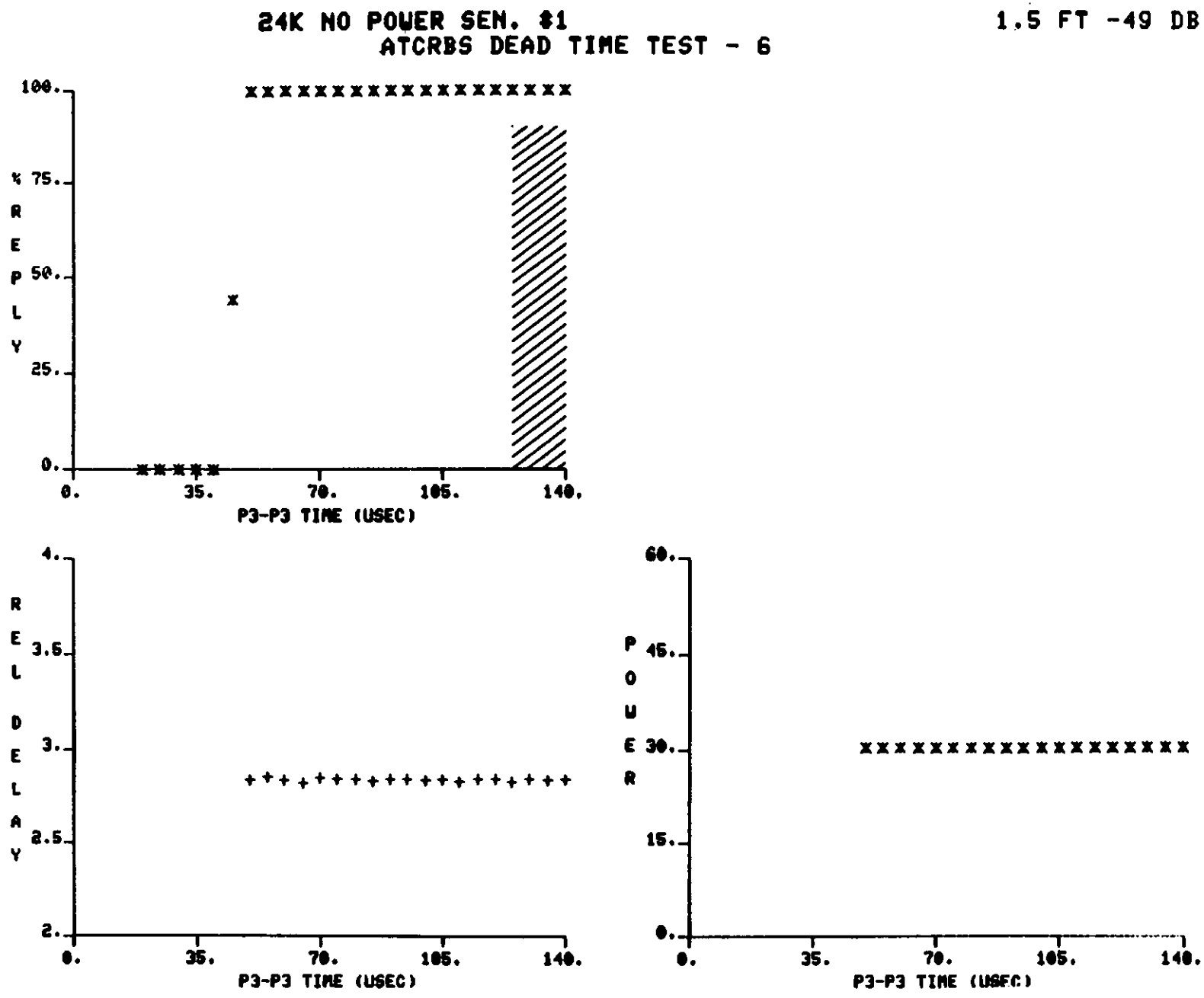


FIGURE B-11. MTPA TEST 6 SUMMARY SHEET (SHEET 1 OF 2)

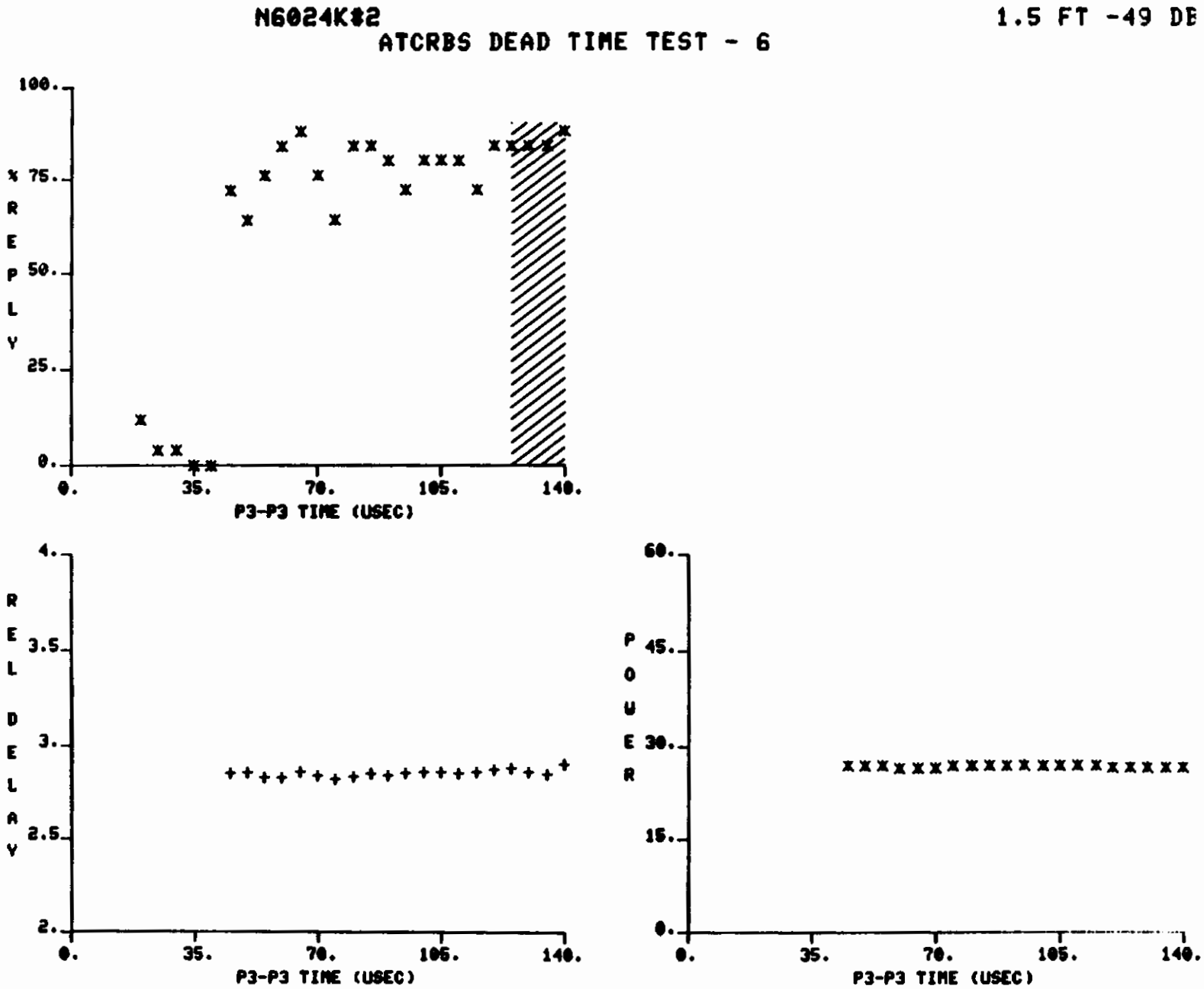


FIGURE B-11. MTPA TEST 6 SUMMARY SHEET (SHEET 2 OF 2)

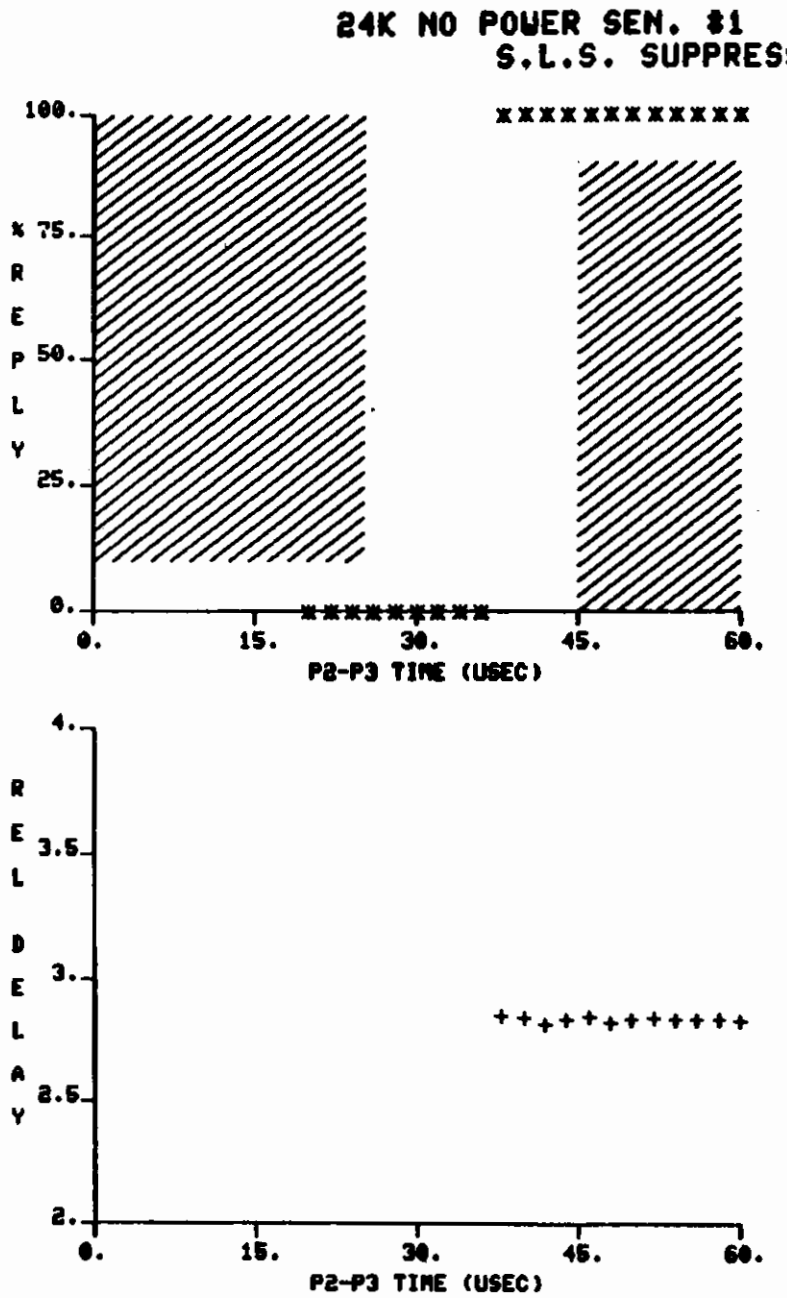


FIGURE B-12. MTPA TEST 7 SUMMARY SHEET (SHEET 1 OF 2)

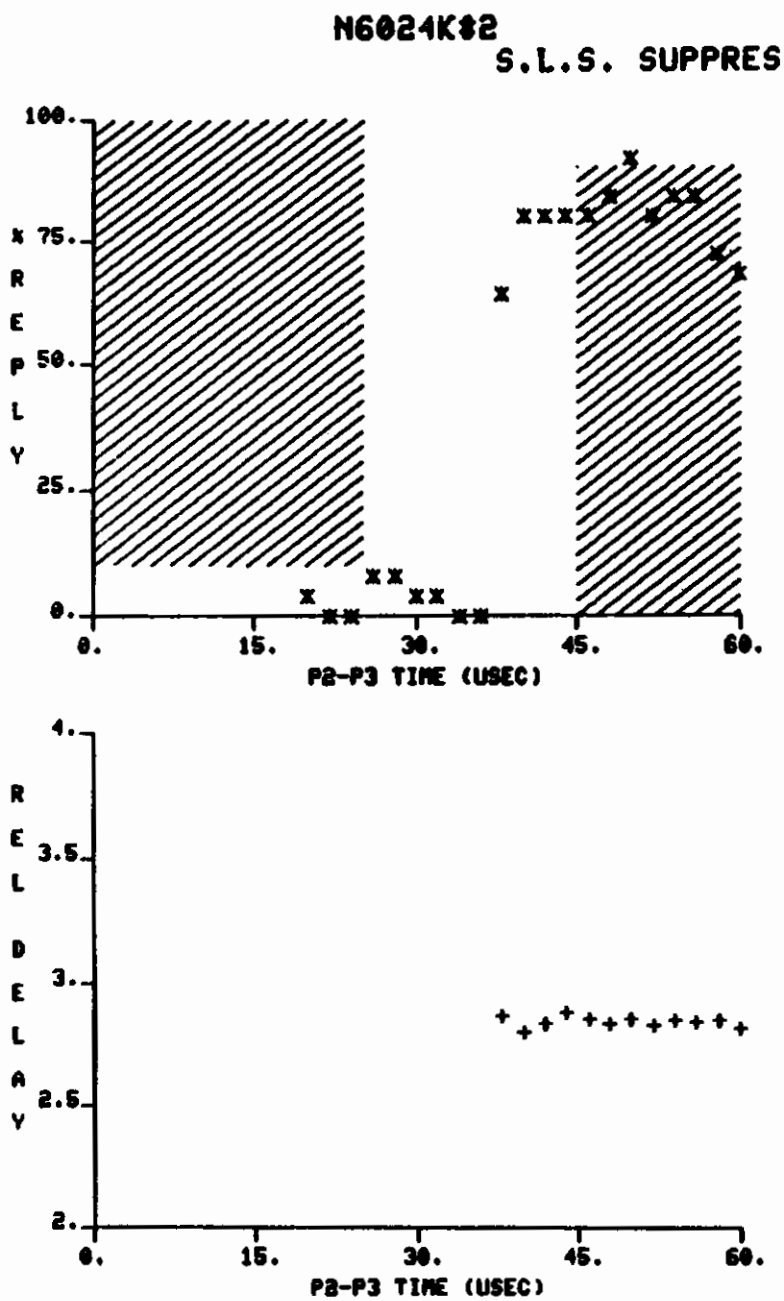


FIGURE B-12. MTPA TEST 7 SUMMARY SHEET (SHEET 2 OF 2)

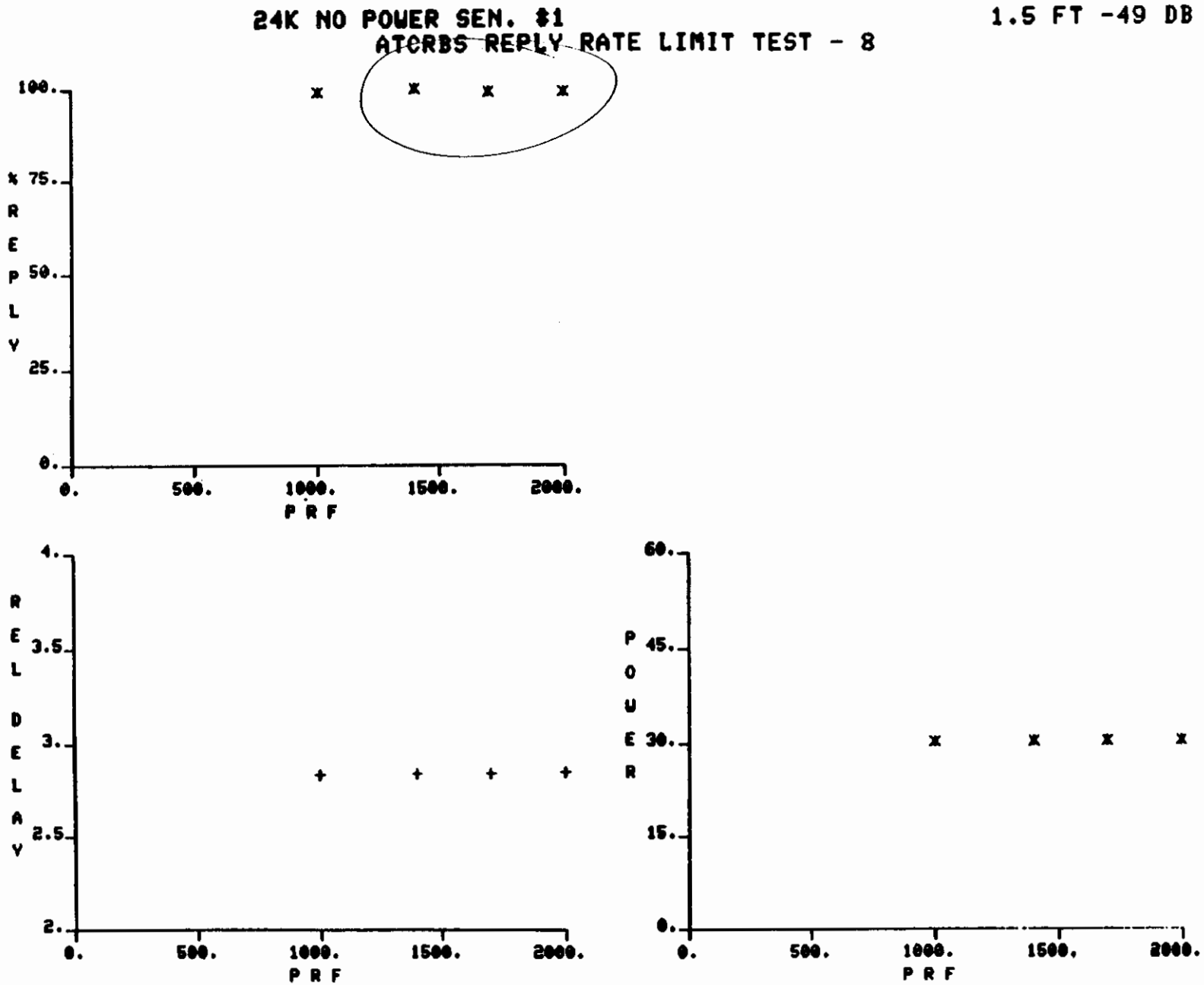


FIGURE B-13. MTPA TEST 8 SUMMARY SHEET (SHEET 1 OF 2)

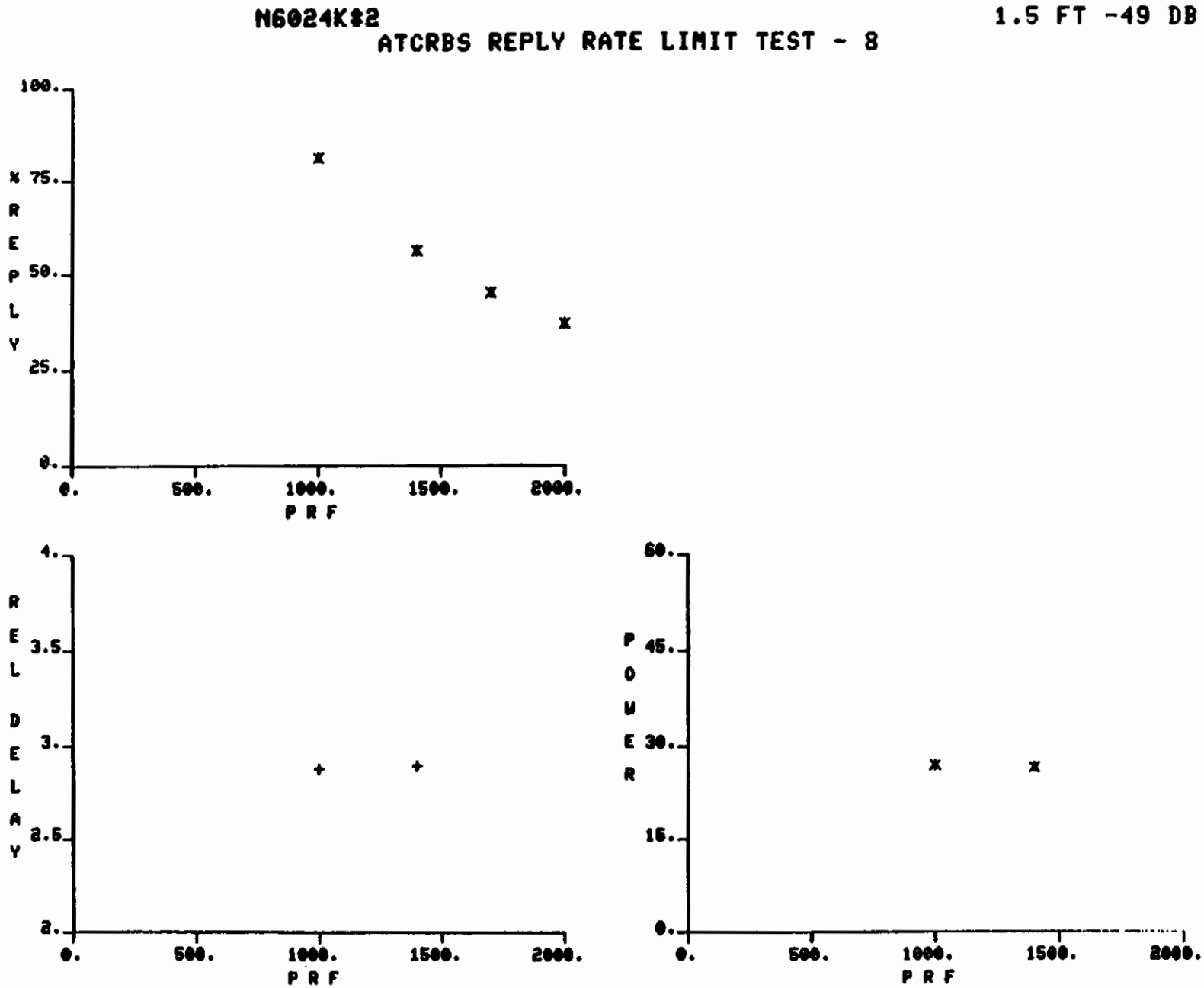
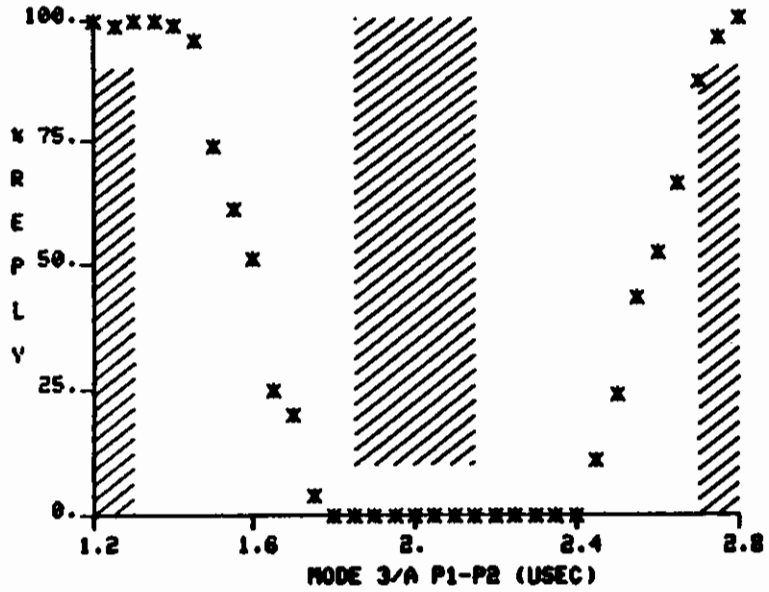


FIGURE B-13. MTPA TEST 8 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB
S.L.S. MODE ACCEPTANCE TEST (POSIT) - 12



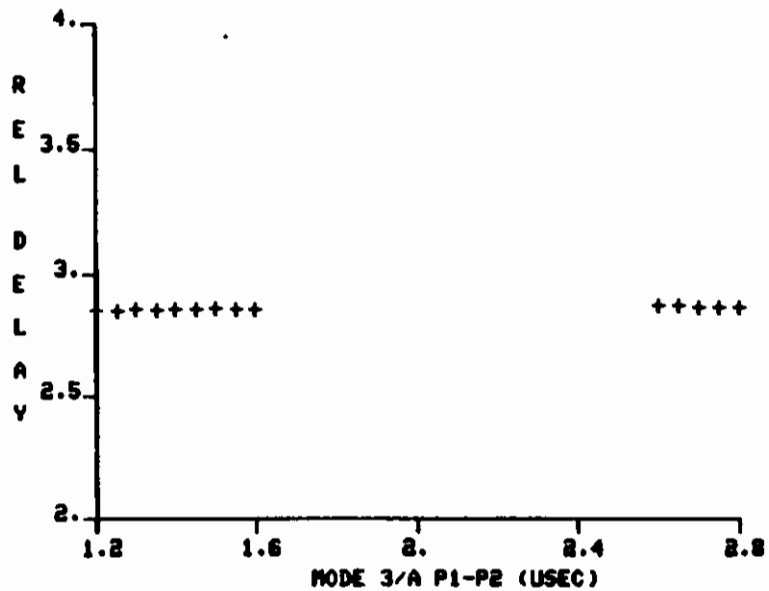


FIGURE B-14. MTPA TEST 12 SUMMARY SHEET (SHEET 1 OF 2)

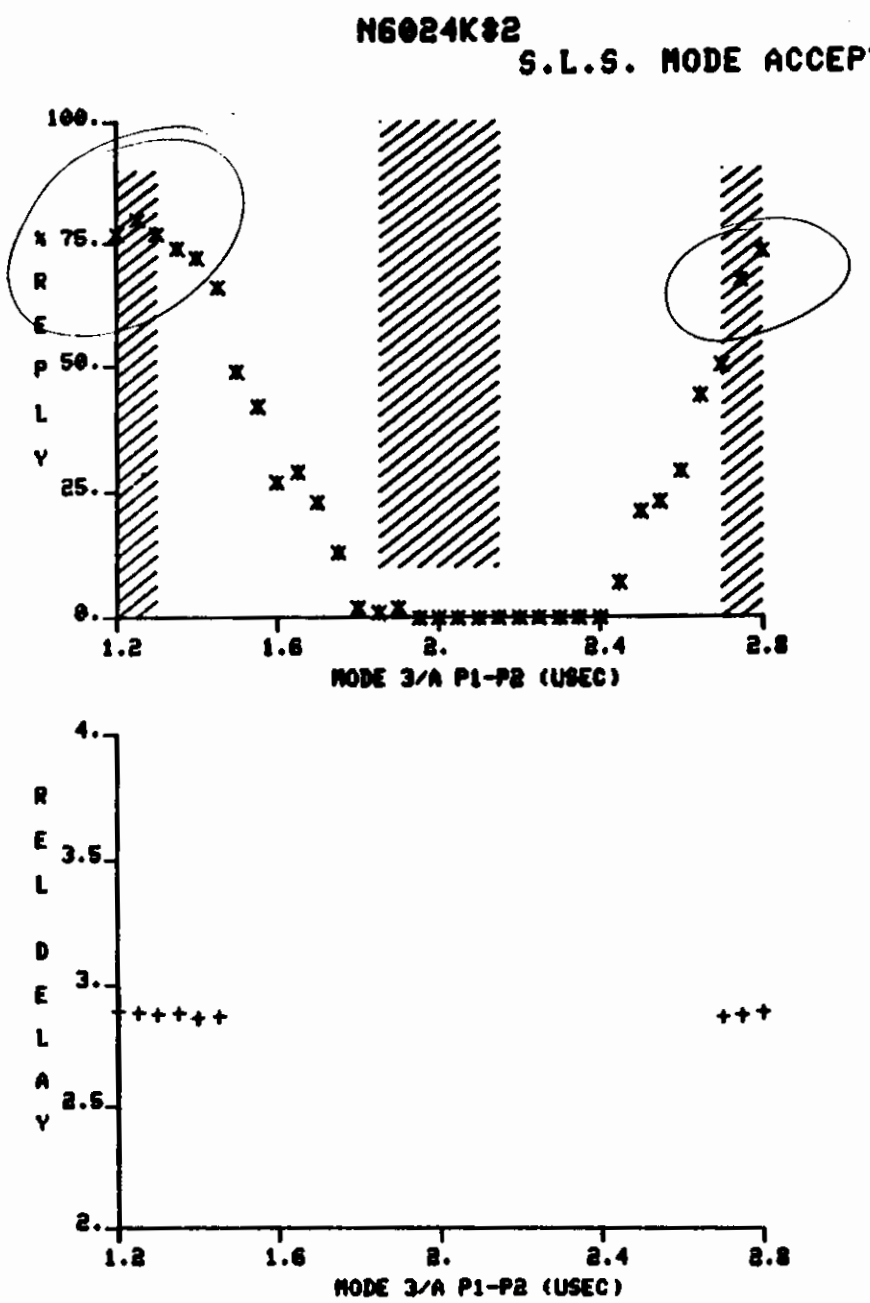


FIGURE B-14. MTPA TEST 12 SUMMARY SHEET (SHEET 2 OF 2)

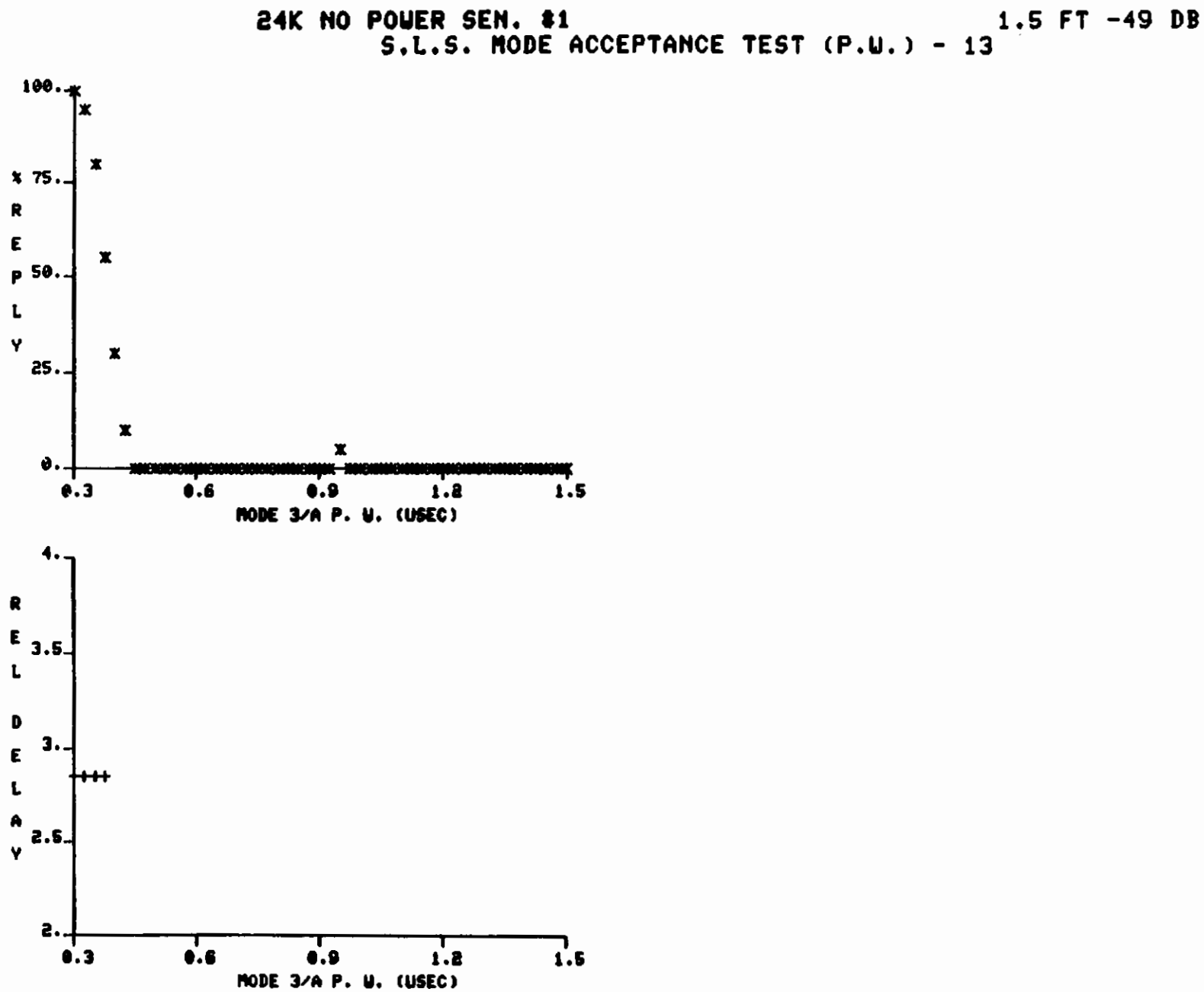


FIGURE B-15. MTPA TEST 13 SUMMARY SHEET (SHEET 1 OF 2)

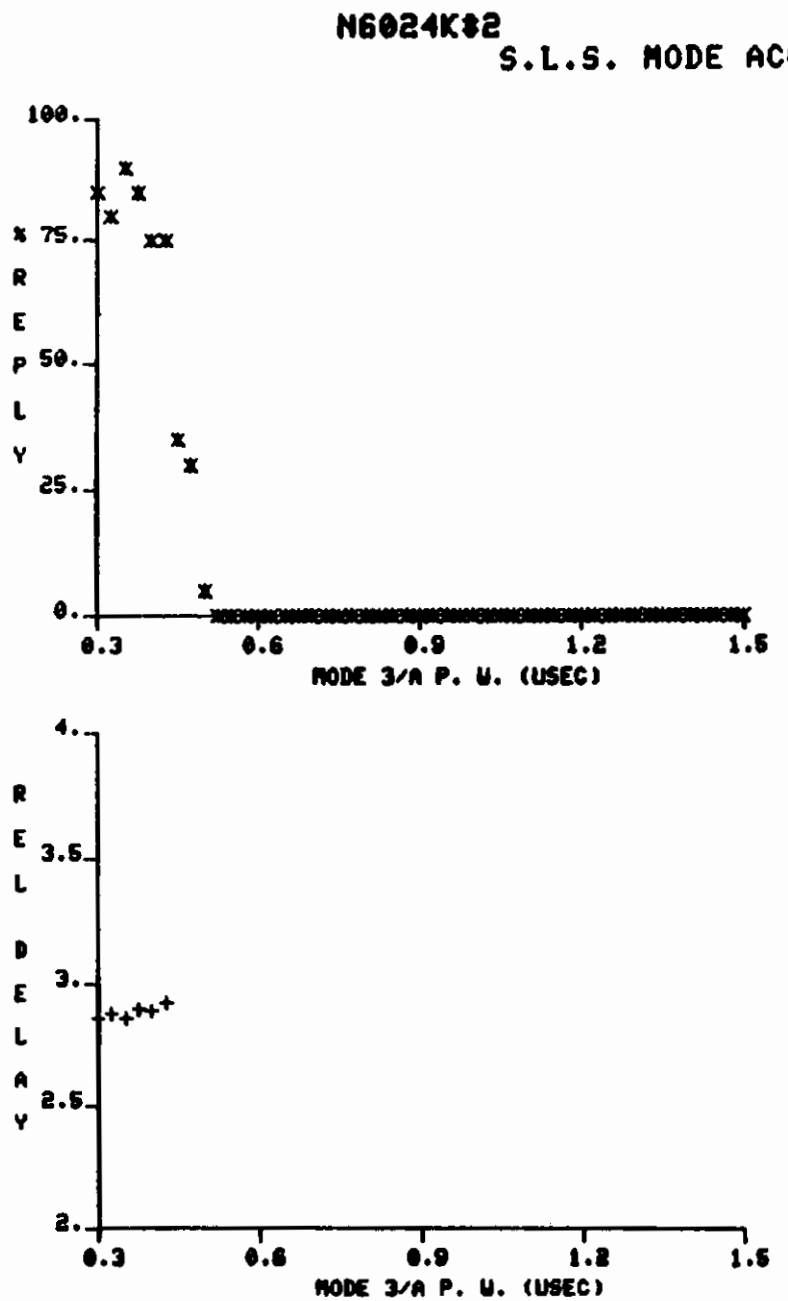


FIGURE B-15. MTPA TEST 13 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB

ATCRBS SENSITIVITY TEST - 14

	SENSITIVITY	POWER	DELAY
MODEA	0	0	2.855
MODEC	0	0	2.878

never reached 90% reply rate

this program filters all power readings below +40dbm

FIGURE B-16. MTPA TEST 14 SUMMARY SHEET (SHEET 1 OF 2)

N6024K#2 1.5 FT -49 DB

ATCRBS SENSITIVITY TEST - 14

	SENSITIVITY	POWER	DELAY
MODEA	0	0	2.867
MODEC	0	0	2.853

never reached 90% reply rate

this program filters all power readings below +40dbm

FIGURE B-16. MTPA TEST 14 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	0	0	0	0	0	0	0	24	100	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	5	99	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	11	99	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	11	99	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	10	77	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE B-17. MTPA TEST 5 SUMMARY SHEET (SHEET 1 OF 2)

N6024K#2
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	0	0	0	0	0	0	0	1	39	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE B-17. MTPA TEST 5 SUMMARY SHEET (SHEET 2 OF 2)

24K NO POWER SEN. #1
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15								2896										
12								2909										
9								2904										
6								2911										
3								2918										
0																		
-3																		
-6																		

FIGURE B-18. MTPA TEST 5 SUMMARY SHEET (DELAY) (SHEET 1 OF 2)

N6024K$2
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15																		
12																		
9																		
6																		
3																		
0																		
-3																		
-6																		

FIGURE B-18. MTPA TEST 5 SUMMARY SHEET (DELAY) (SHEET 2 OF 2)

24K NO POWER SEN. #1
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15									30.5									
12									31.0									
9									31.0									
6									31.0									
3									30.5									
0																		
-3																		
-6																		

FIGURE B-19. MTPA TEST 5 SUMMARY SHEET (POWER) (SHEET 1 OF 2)

N6024K#2
SIDE LOBE SUPPRESSION TEST - 5

1.5 FT -49 DB

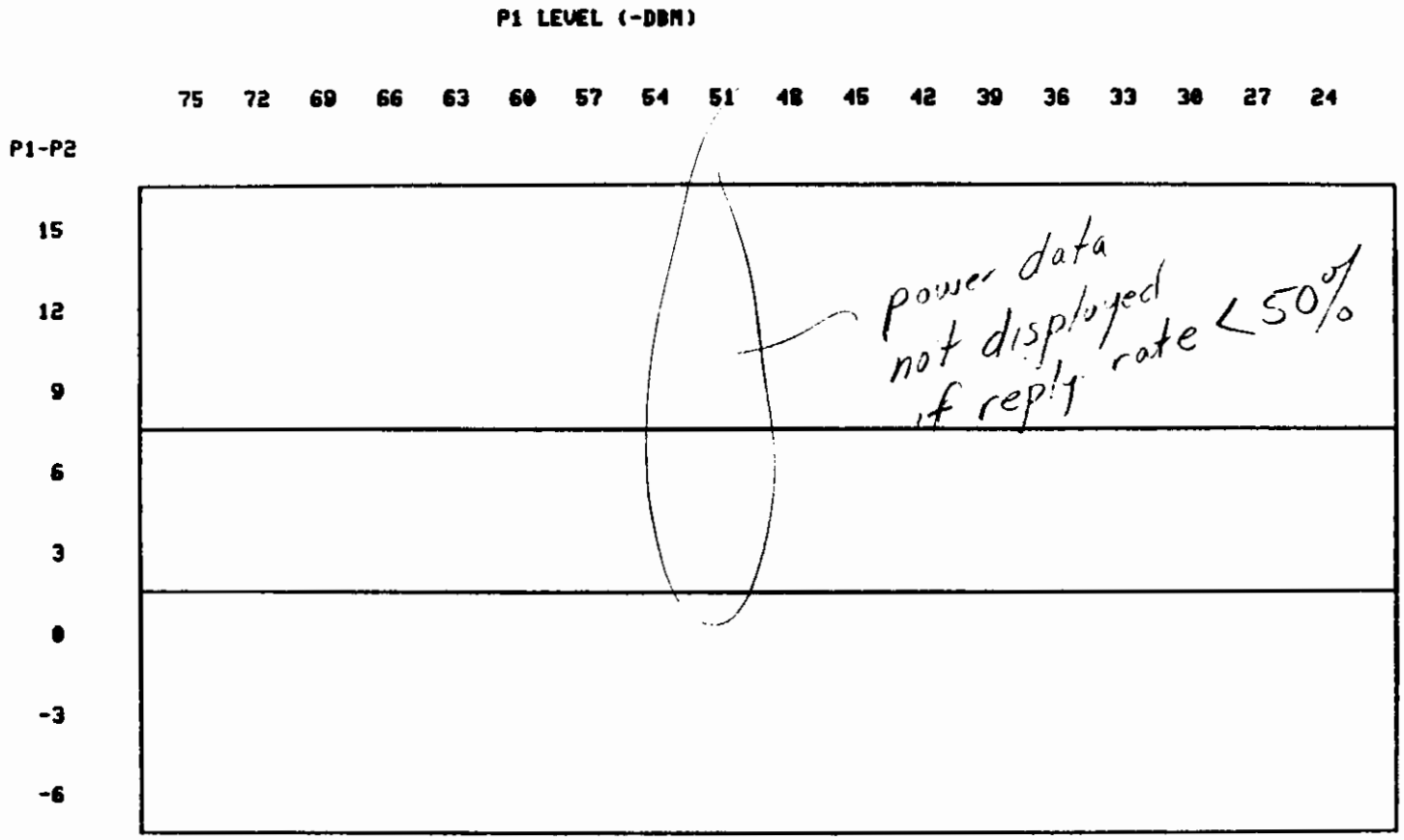
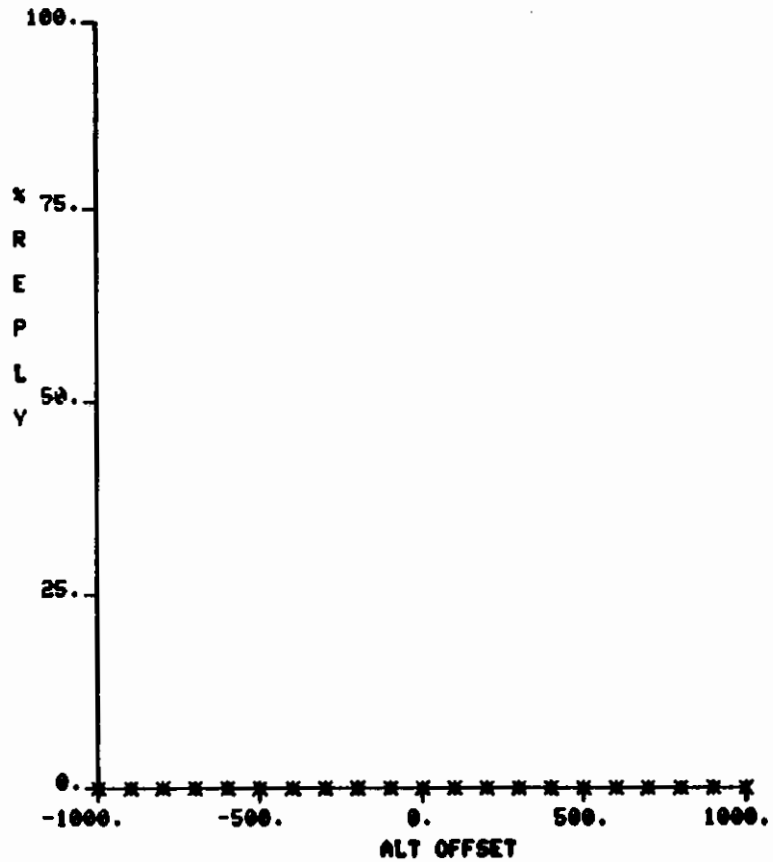


FIGURE B-19. MTPA TEST 5 SUMMARY SHEET (POWER) (SHEET 2 OF 2)

N6024K#2 1.5 FT -49 DB

MODE C ALTITUDE VERIFICATION - 99



STANDARD TRANSPONDER = 900. FEET 100. % VALID REPLY

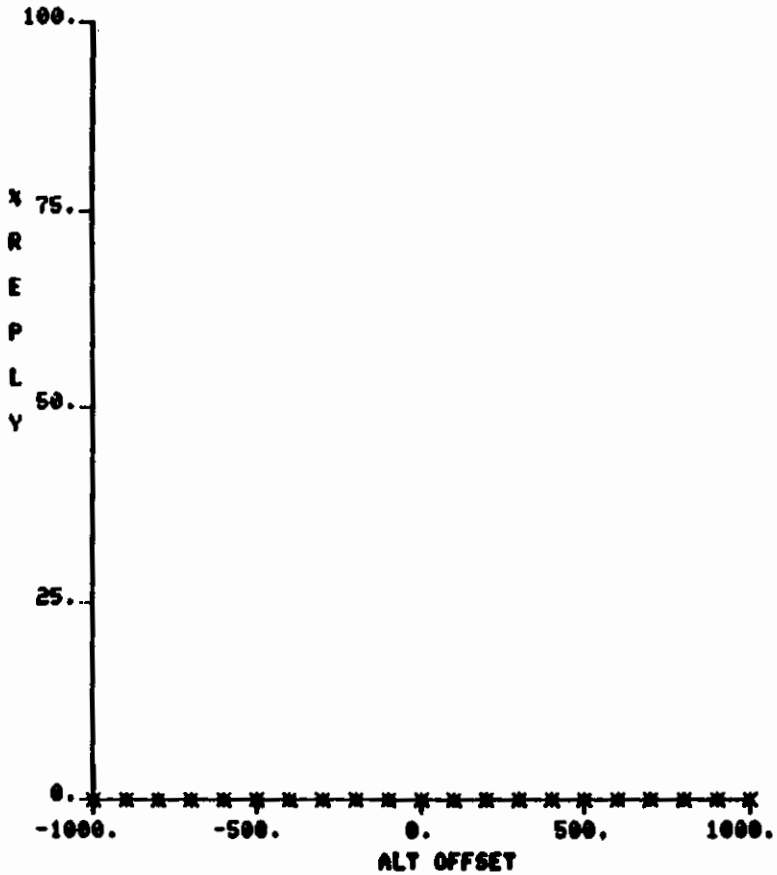
TEST TRANSPONDER = 0. FEET 0. % VALID REPLY

0. REPLY 0. % BRACKET REPLY

FIGURE B-20. MTPA TEST 99 SUMMARY SHEET (2nd RUN) (SHEET 1 OF 2)

24K NO POWER SEN. #1 1.5 FT -49 DB

MODE C ALTITUDE VERIFICATION - 99



STANDARD TRANSPONDER = 900. FEET 100. % VALID REPLY

TEST TRANSPONDER = 0. FEET 0. % VALID REPLY

0. REPLY 0. % BRACKET REPLY

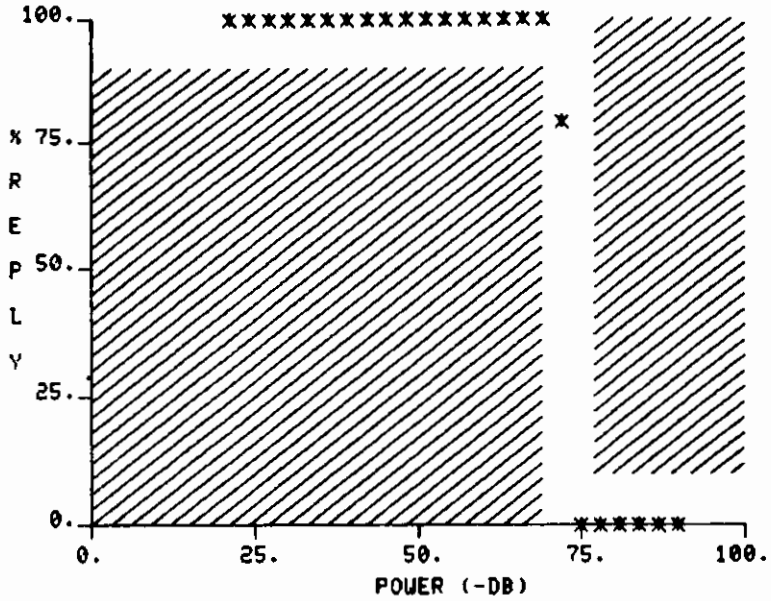
FIGURE B-20. MTPA TEST 99 SUMMARY SHEET (2nd RUN) (SHEET 2 OF 2)

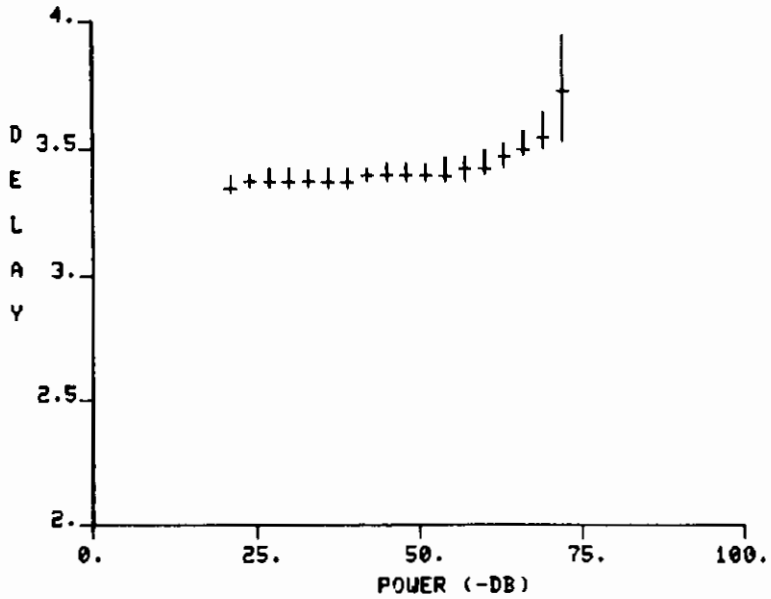
APPENDIX 9A

NEW MANUFACTURED TRANSPONDER TEST RESULTS

KING KT76A SER # 47422 18-MAR-86
ATCRBS DYNAMIC RANGE TEST - 1

SENSITIVITY = -70 DBM

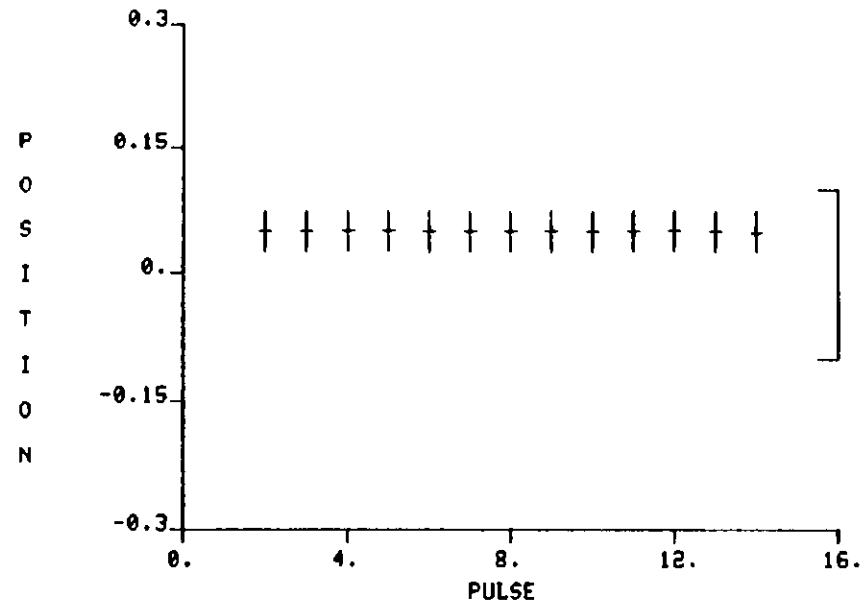


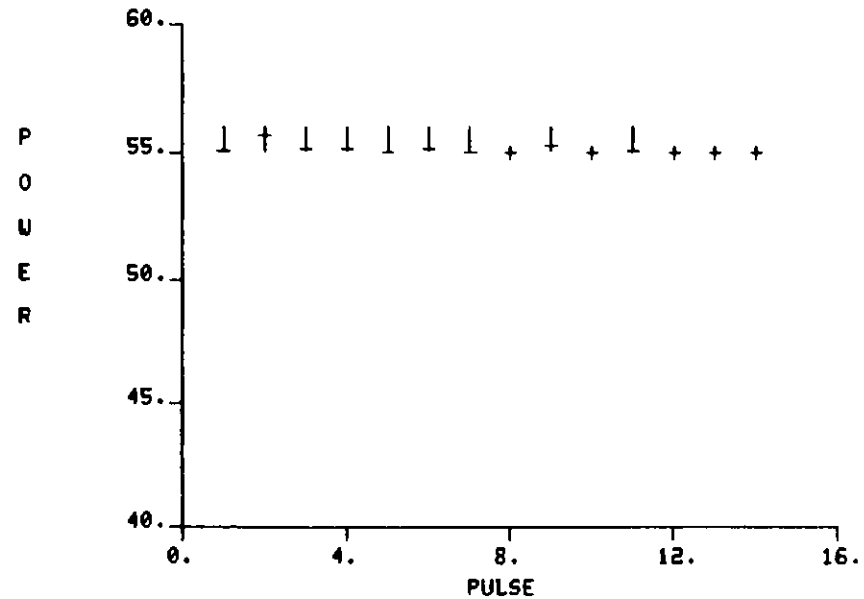


KING KT76A SER # 47422 18-MAR-86
ATCRBS REPLY TEST - 2

PULSE	POSITION	POWER
1 - F1	0.000	55.0
2 - C1	0.050	55.7
3 - A1	0.050	55.1
4 - C2	0.050	55.2
5 - A2	0.050	55.0
6 - C4	0.051	55.1
7 - A4	0.050	55.0
8 - B1	0.050	55.0
9 - D1	0.051	55.3
10 - B2	0.050	55.0
11 - D2	0.050	55.1
12 - B4	0.050	55.0
13 - D4	0.050	55.0
14 - F2	0.049	55.0

CODE = 7777





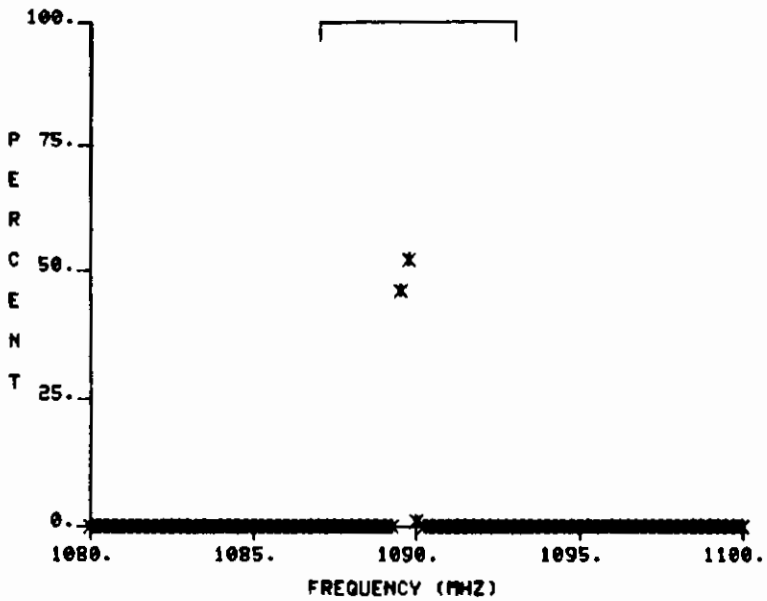
ATCRBS REPLY TEST - 2

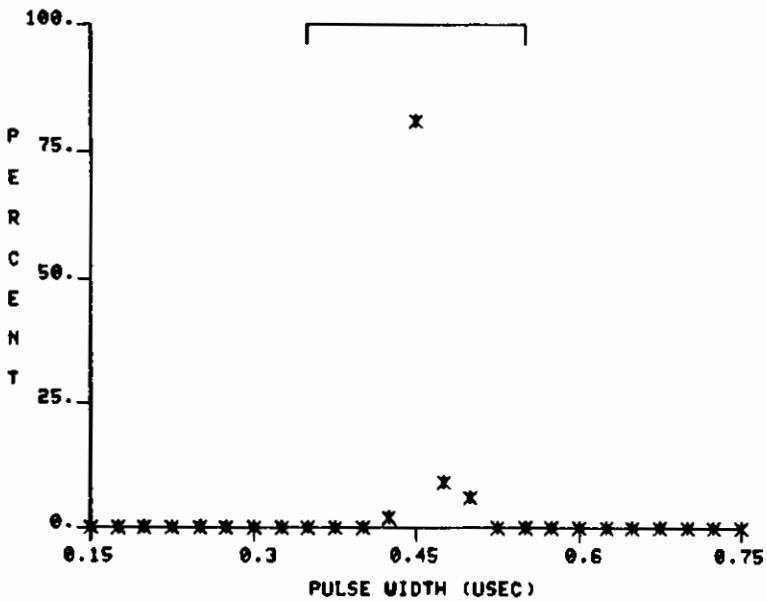
FREQUENCY = 1089.63

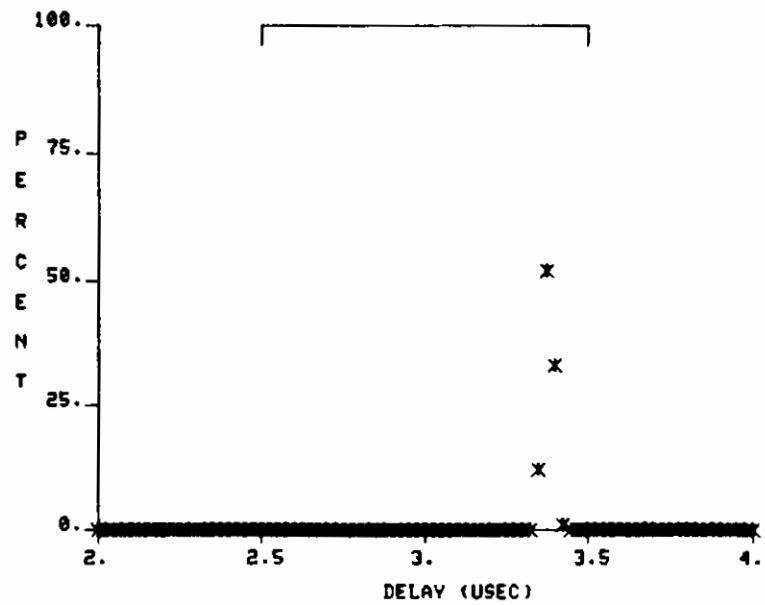
DELAY = 3.406

WIDTH = 0.455

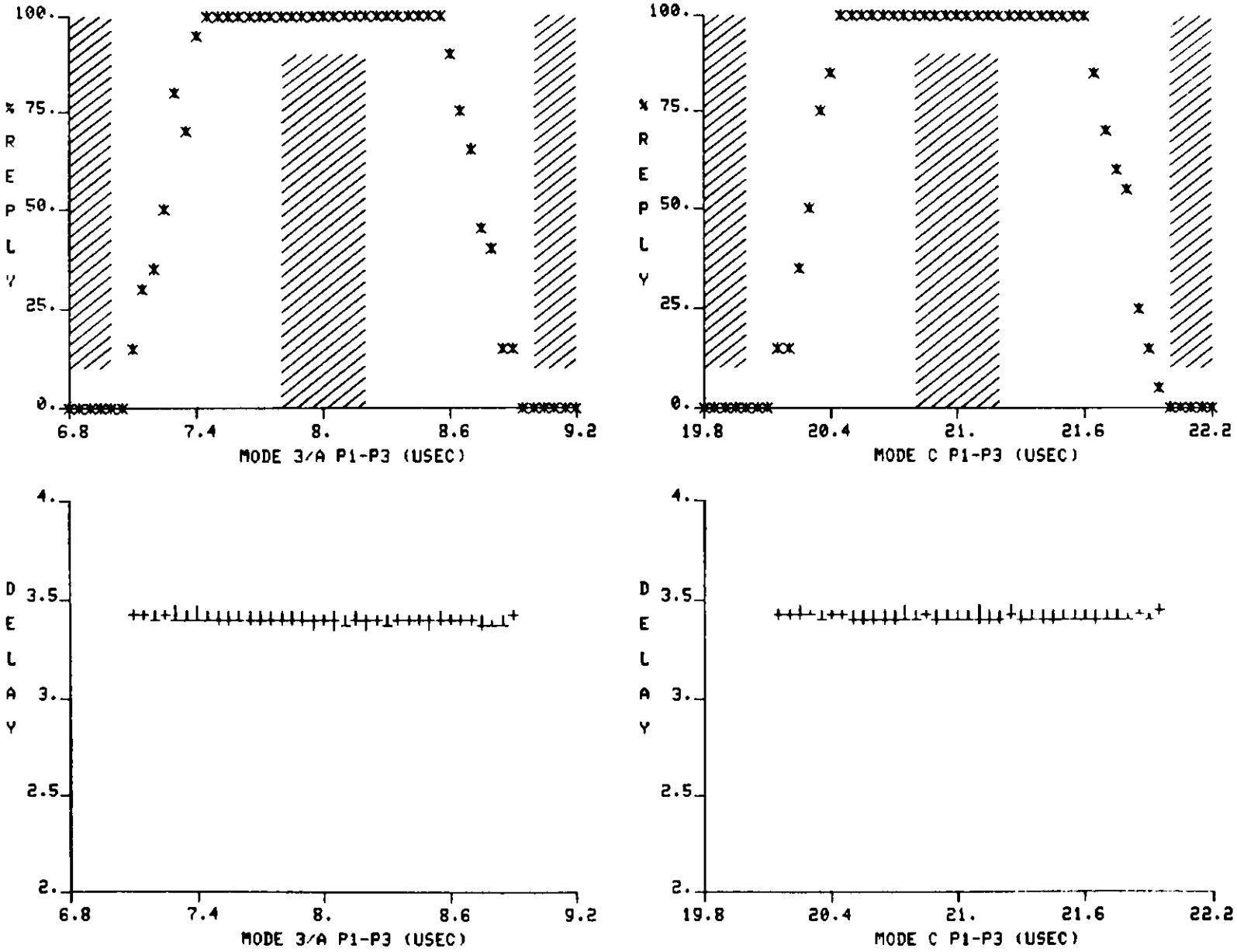
KING KT76A SER # 47422 18-MAR-86



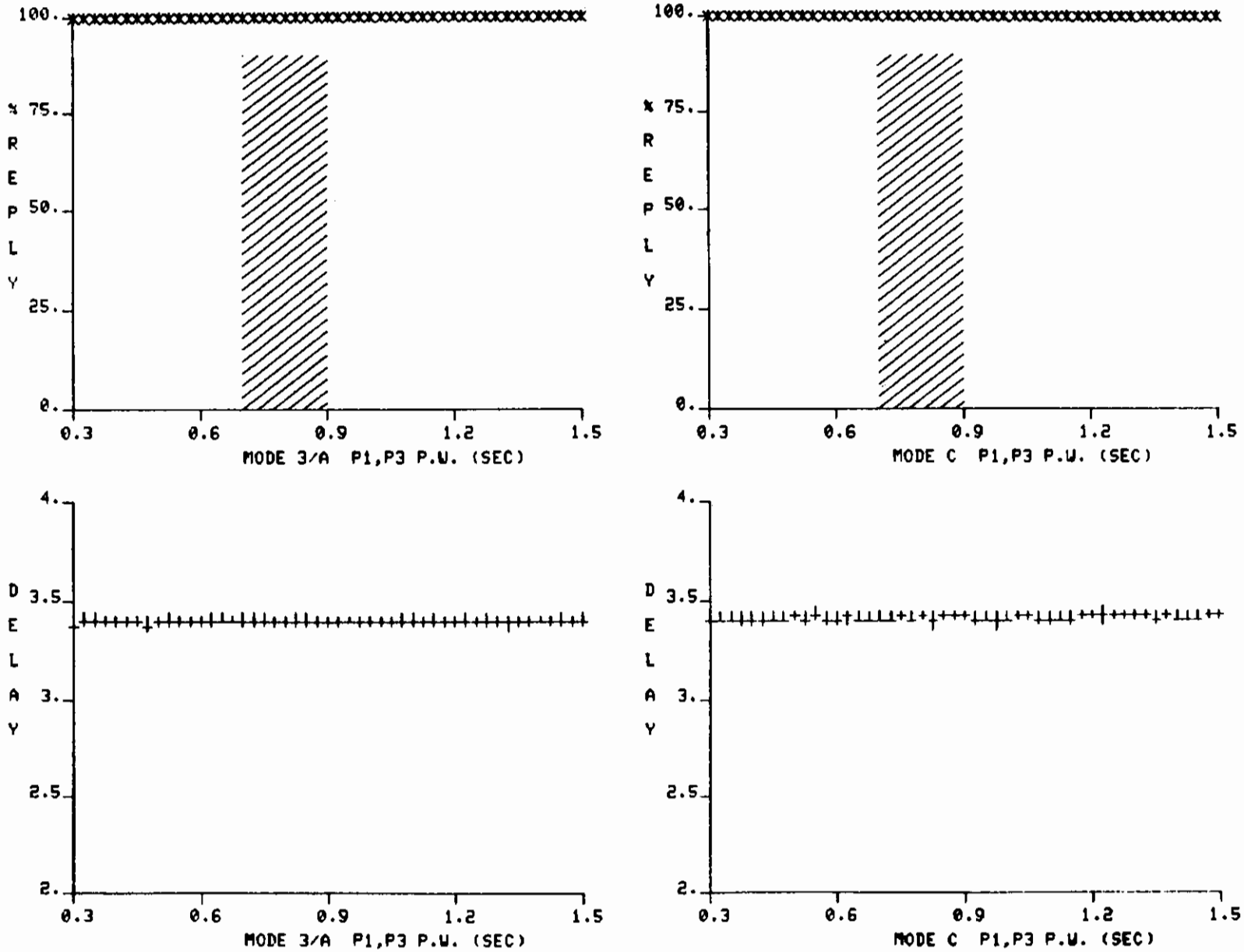




KING KT76A SER # 47422 18-MAR-86
ATCRBS MODE ACCEPTANCE TEST (POSIT) - 3



KING KT76A SER # 47422 18-MAR-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 4



KING KT76A SER # 47422 18-MAR-86
SIDE LOBE SUPPRESSION TEST - 5

P1 LEVEL (-DBM)

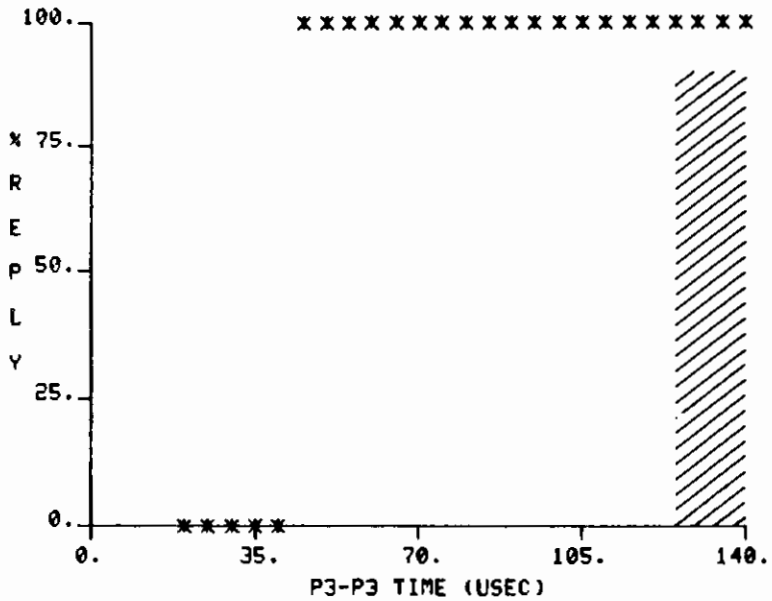
P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	0	73	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
12	0	73	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	0	74	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6	0	73	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
3	0	80	79	85	40	1	2	35	100	100	100	100	72	0	0	0	55	1
0	0	19	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

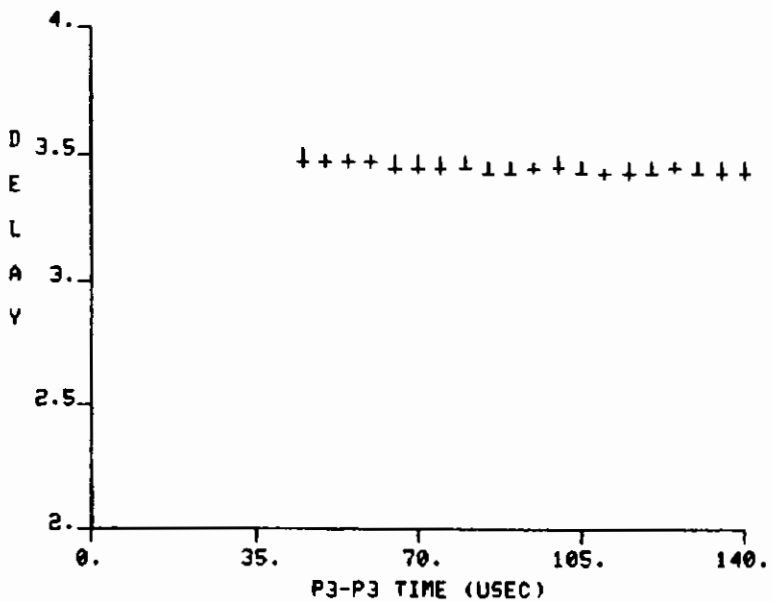
KING KT76A SER # 47422 18-MAR-86
SIDE LOBE SUPPRESSION TEST - 5

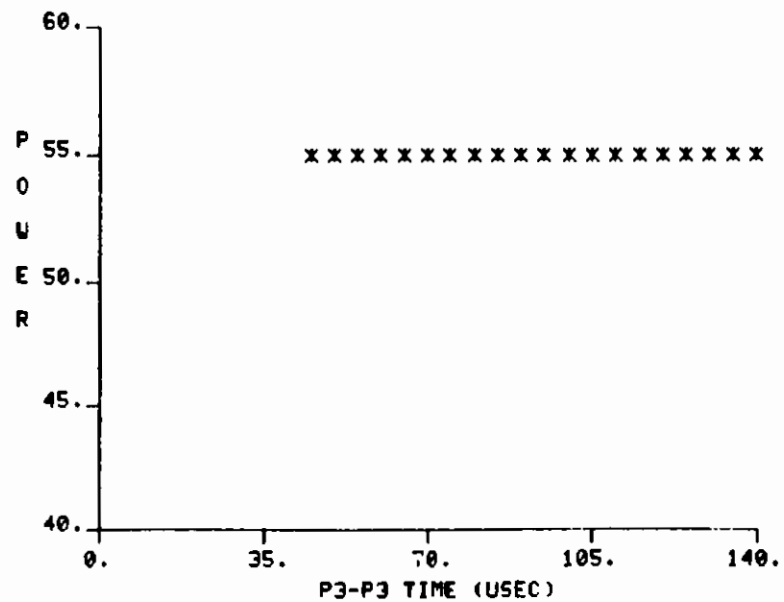
P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15		3750	3525	3500	3450	3425	3425	3400	3400	3400	3400	3400	3400	3375	3375	3375	3375	3375
12		3725	3550	3500	3475	3450	3425	3425	3400	3400	3400	3400	3400	3375	3375	3375	3375	3375
9		3700	3550	3500	3475	3450	3425	3400	3400	3400	3400	3400	3400	3375	3375	3375	3375	3375
6		3725	3550	3500	3450	3450	3425	3400	3400	3400	3400	3400	3400	3400	3400	3375	3375	3375
3		3700	3550	3500	3475	3425	3425	3425	3400	3400	3400	3400	3400				3400	3400
0		3700	3550															
-3																		
-6																		

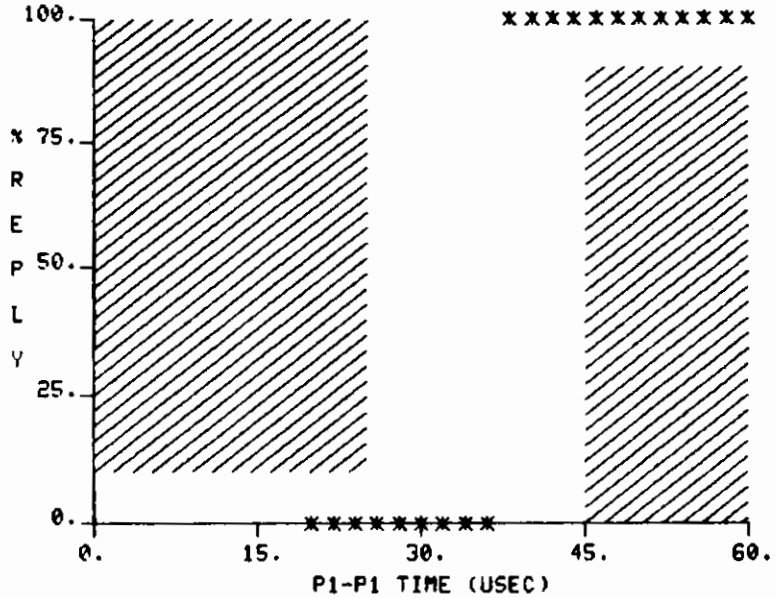
KING KT76A SER # 47422 18-MAR-86
ATCRBS DEAD TIME TEST - 6

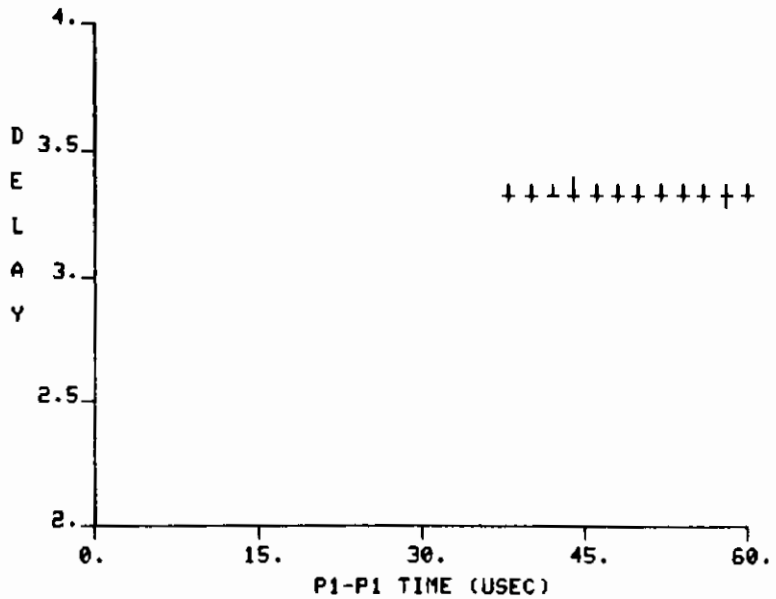




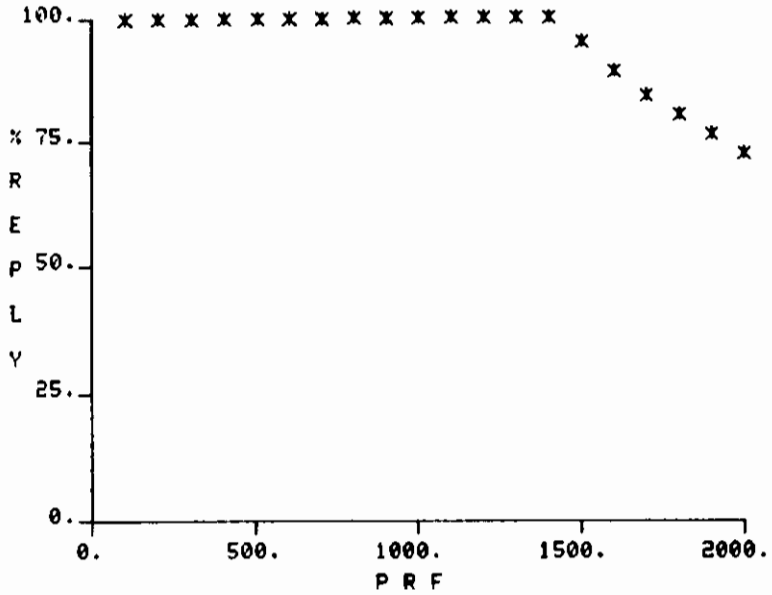


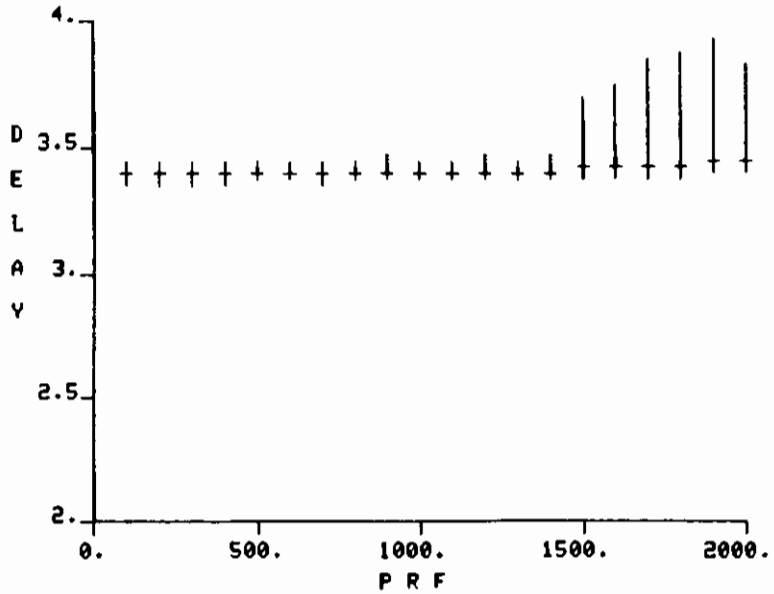
KING KT-76A S/N 47422 3-18-86
S.L.S. SUPPRESSION TEST - 7

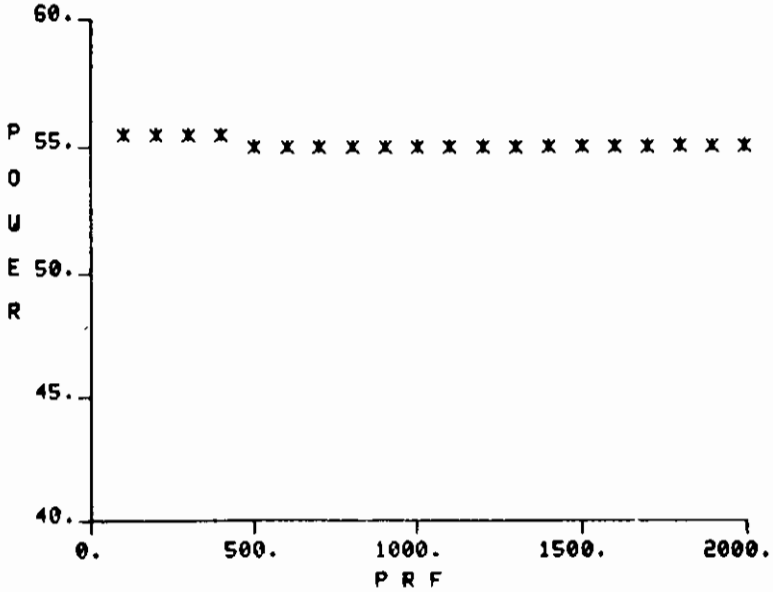




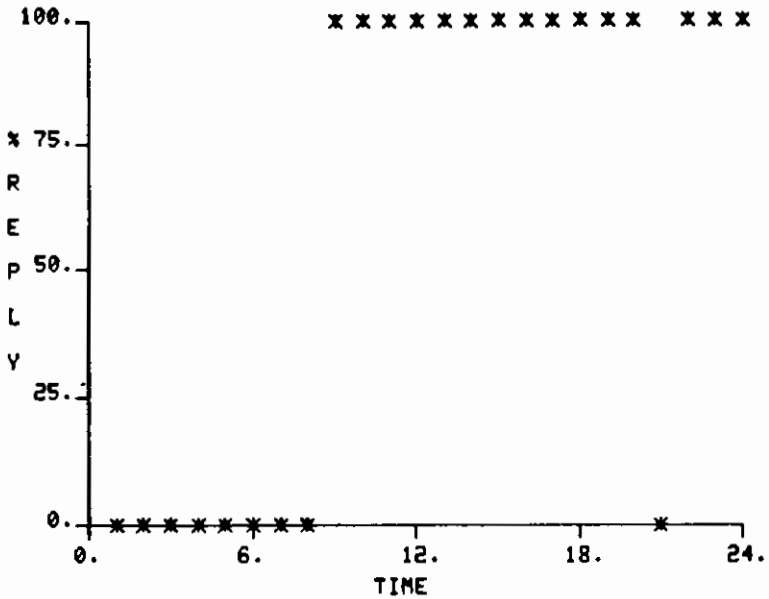
KING KT76A SER # 47422 18-MAR-86
ATCRBS REPLY RATE LIMIT TEST - 8

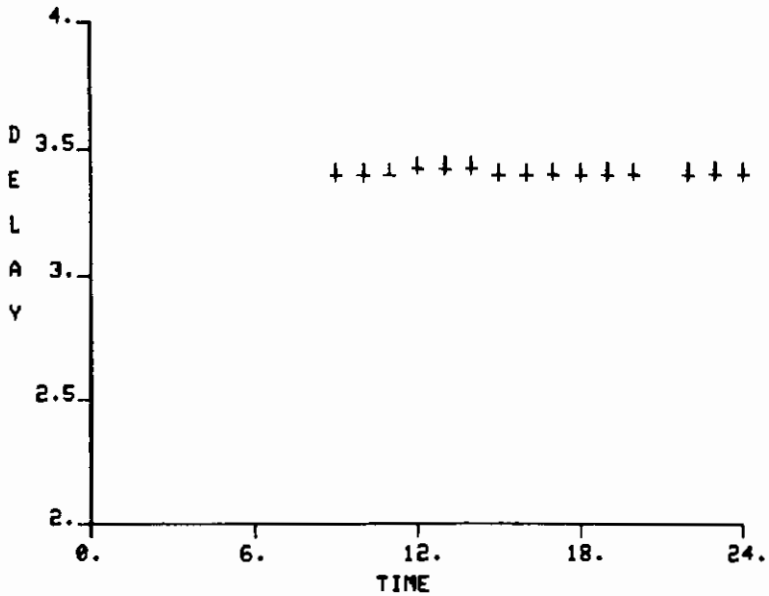




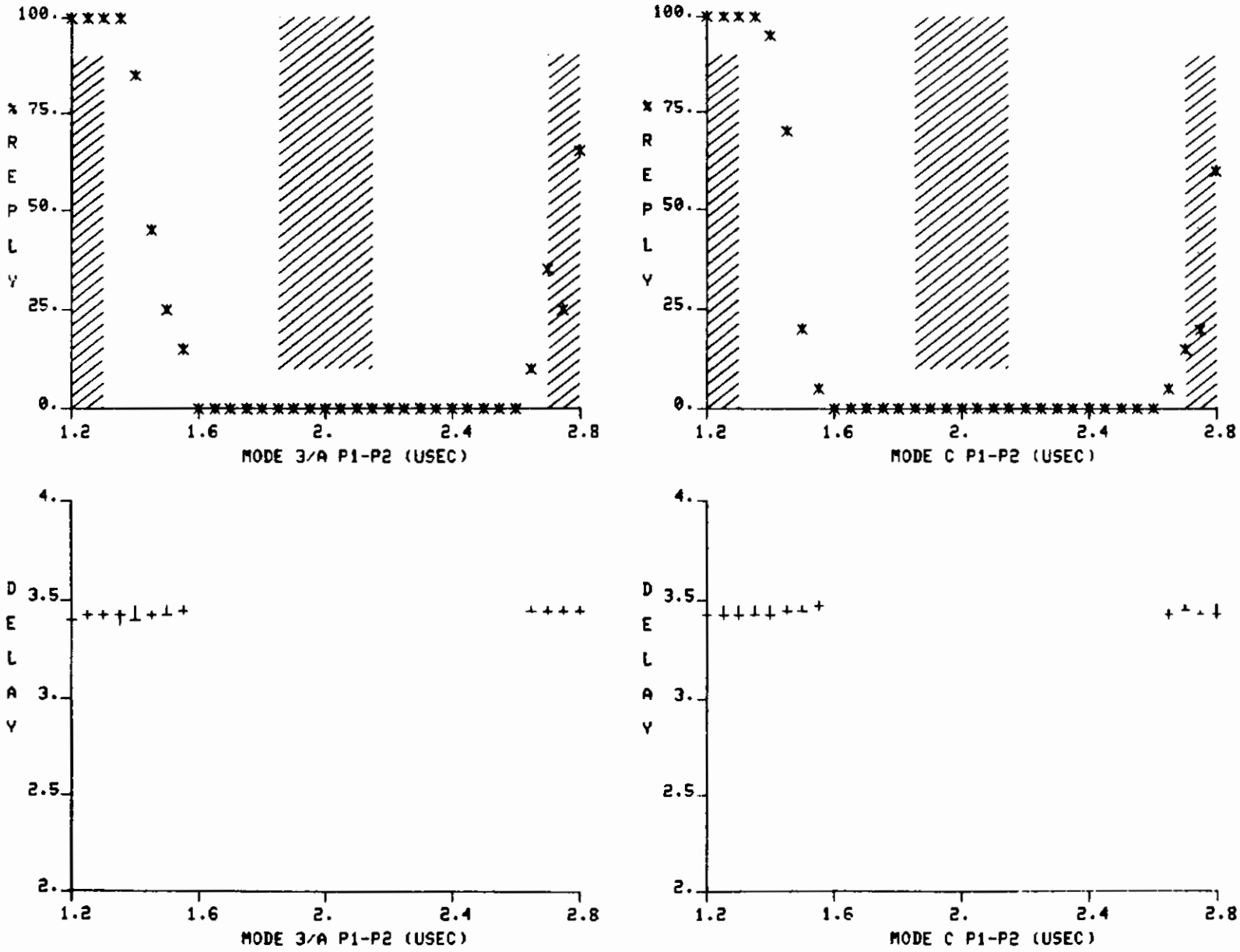


KING KT76A SER # 47422 18-MAR-86
ATCRBS ECHO SUPPRESSION TEST - 10

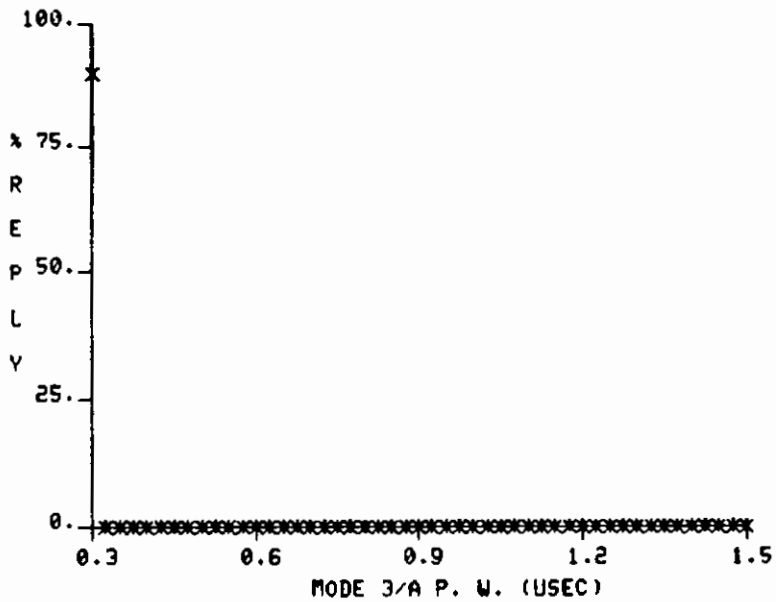


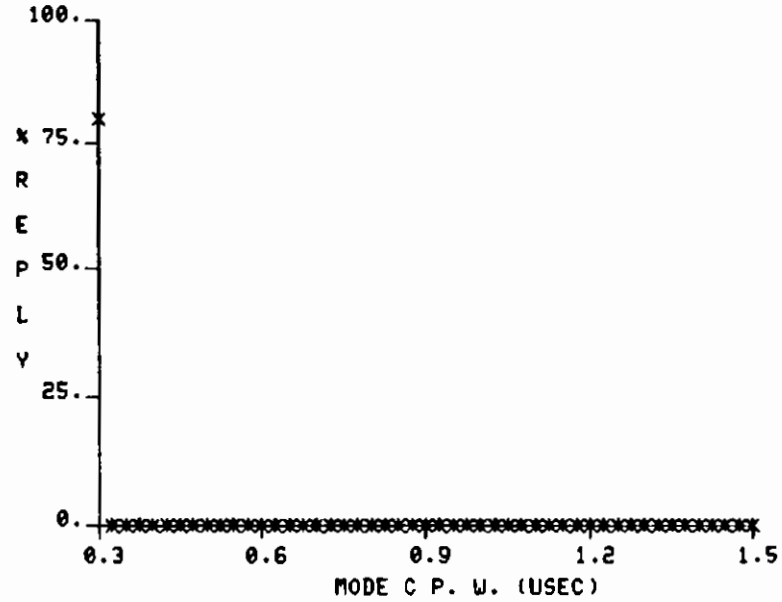


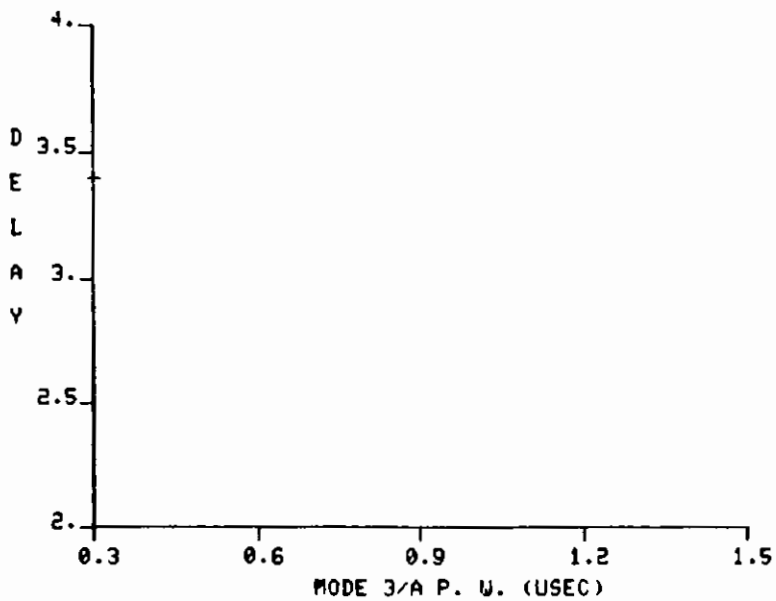
KING KT76A SER # 47422 18-MAR-86
S.L.S. MODE ACCEPTANCE TEST (POSIT) - 12

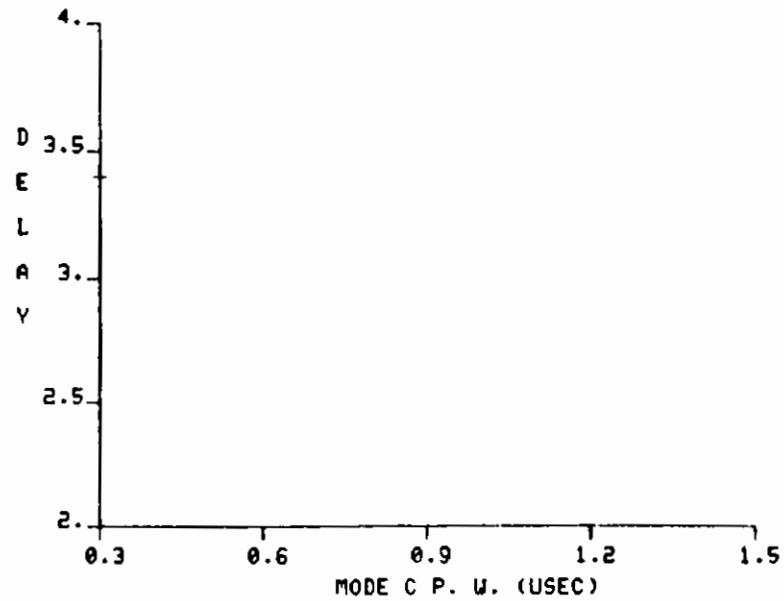


KING KT76A SER # 47422 18-MAR-86
S.L.S. MODE ACCEPTANCE TEST (P.W.) - 13









KING KT76A SER # 47422 18-MAR-86

ATCRBS SENSITIVITY TEST - 14

MODE A

SENSITIVITY = -71 DBM

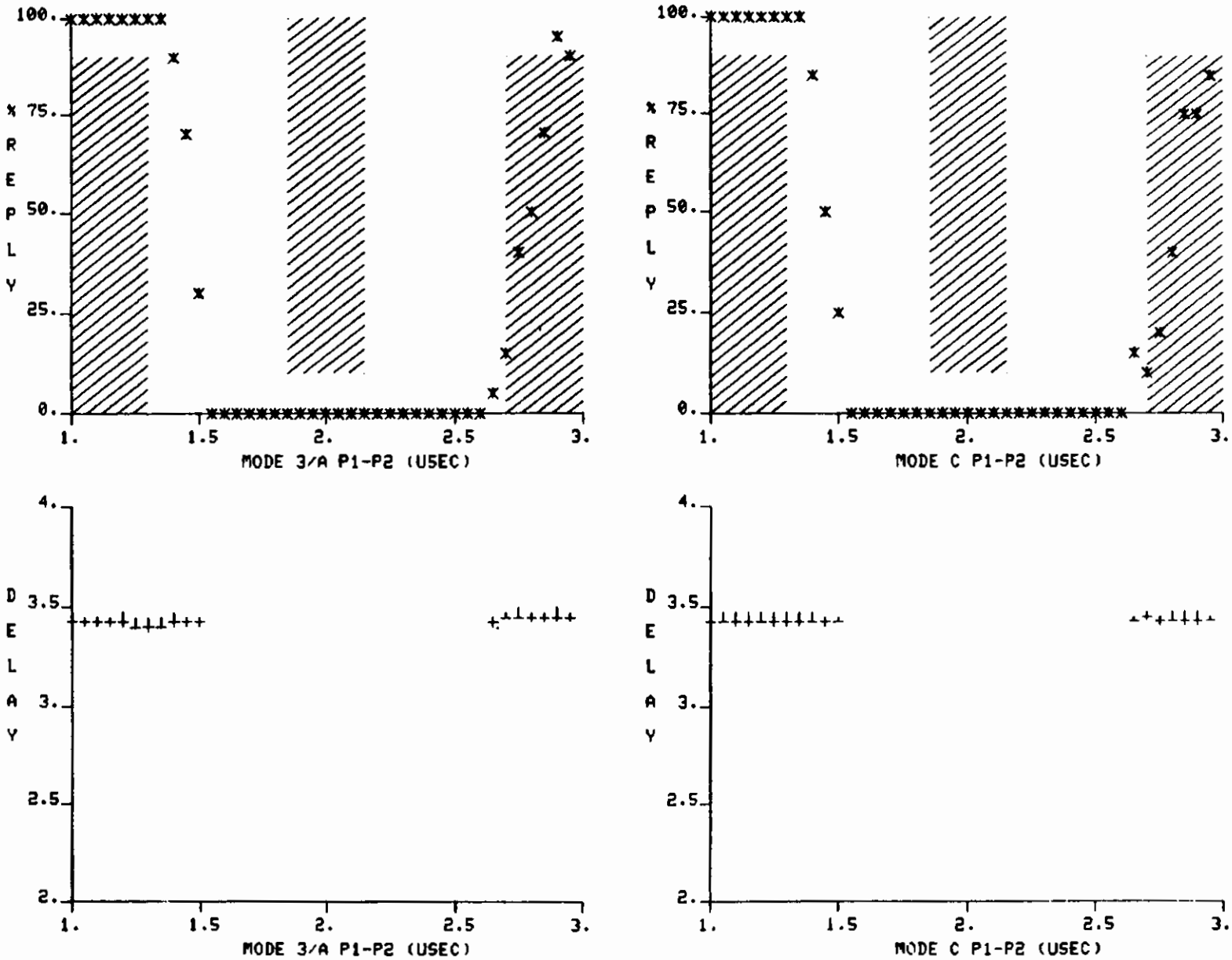
PERCENT RESPONSE AT -81 DBM = 0.0

MODE C

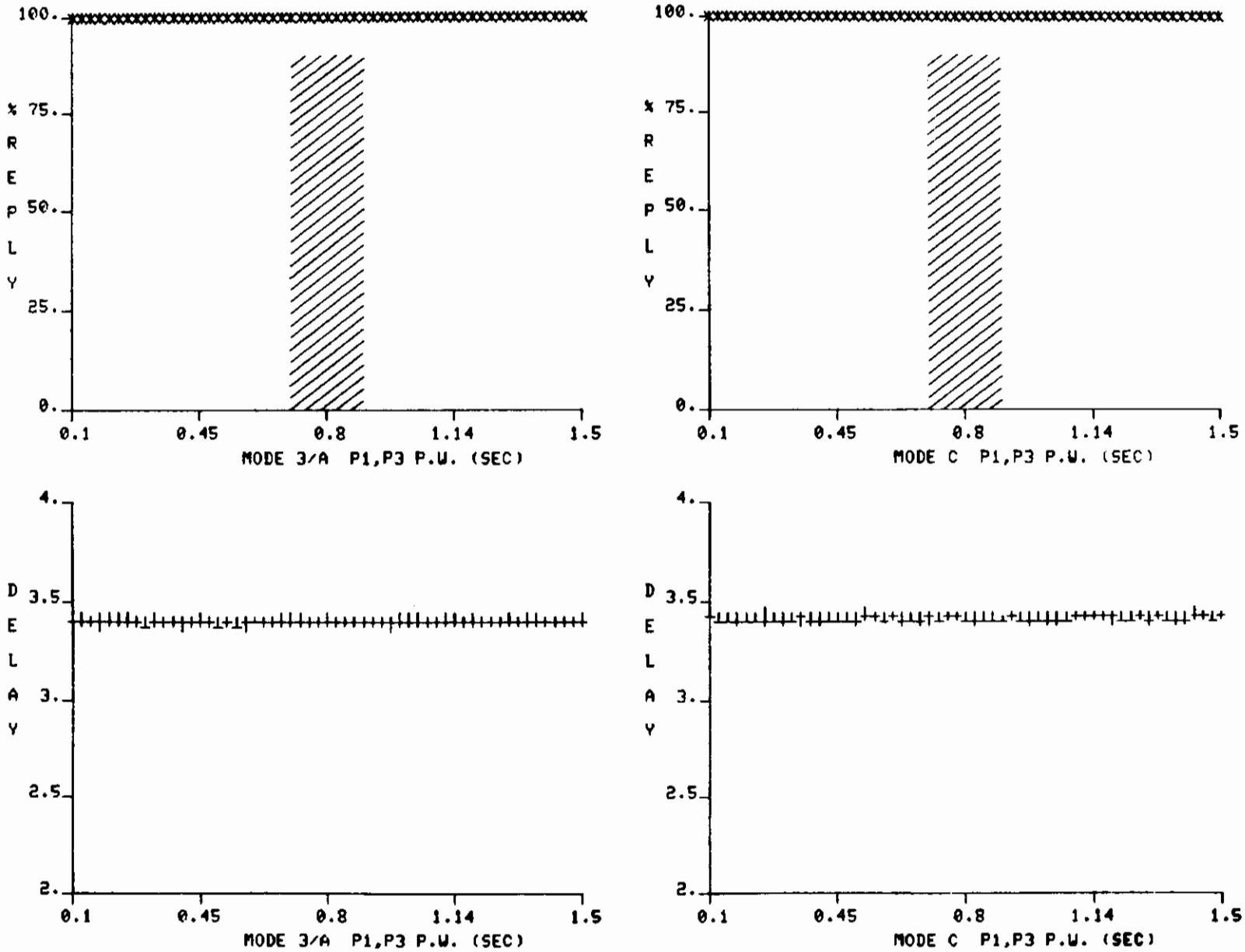
SENSITIVITY = -71 DBM

PERCENT RESPONSE AT -81 DBM = 0.0

KING KT76A SER # 47422 18-MAR-86
S.L.S. MODE ACCEPTANCE TEST (POSIT) - 16

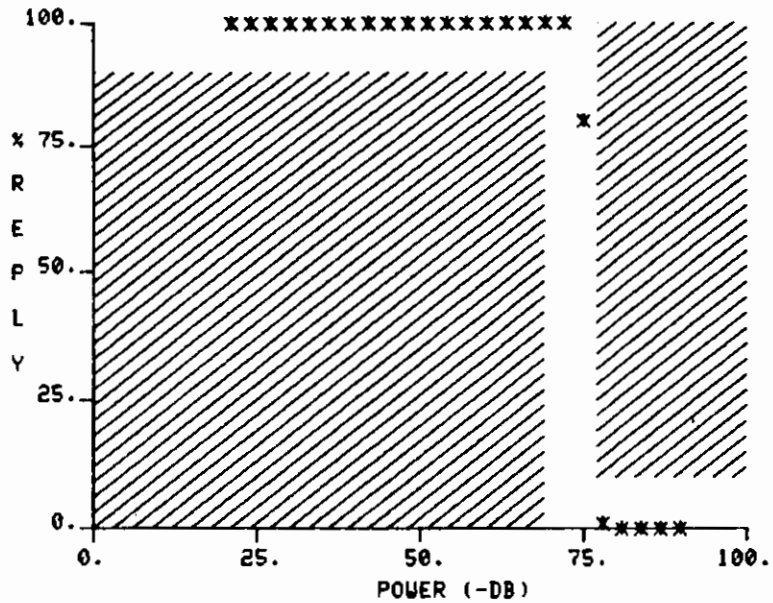


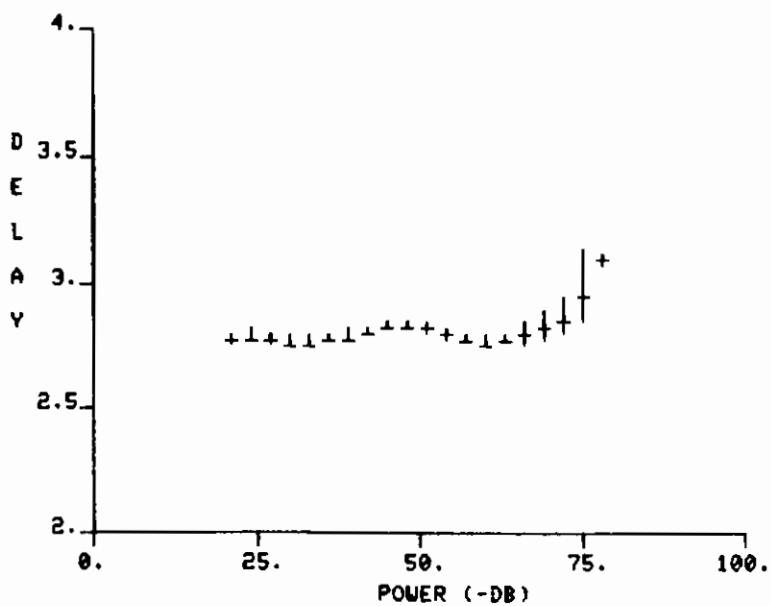
KING KT76A SER # 47422 18-MAR-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 17



SPERRY RT-459A S/N 11599 3-18-86
ATCRBS DYNAMIC RANGE TEST - 1

SENSITIVITY = -73 DBM

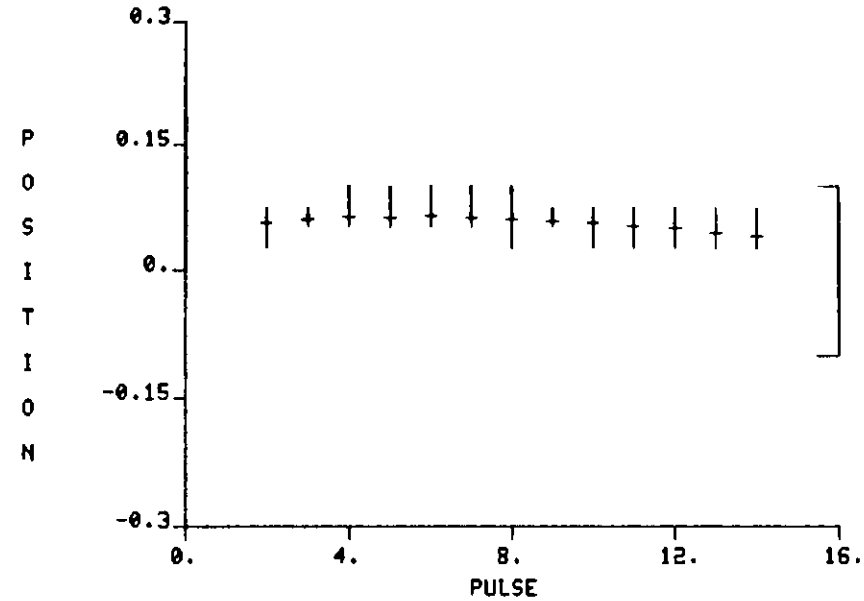


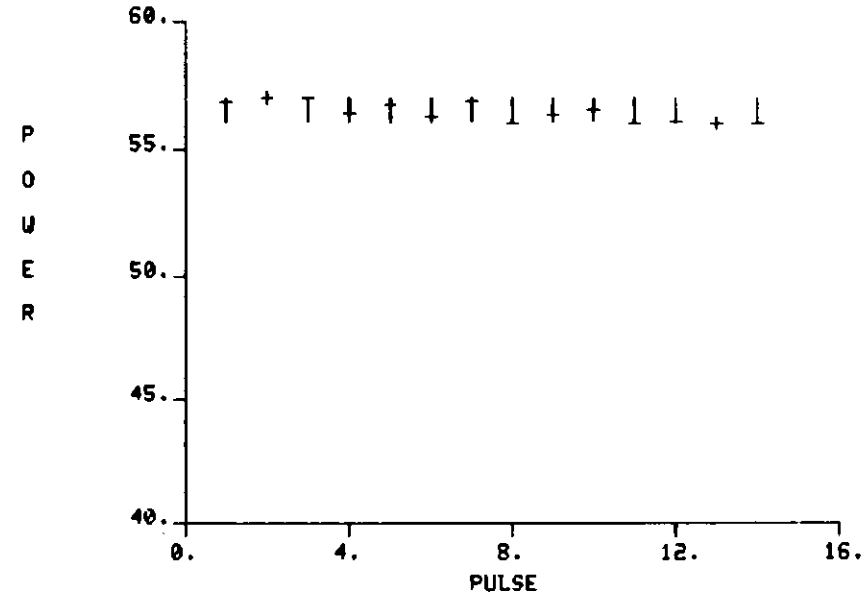


SPERRY RT-459A S/N 11599 3-18-86
ATCRBS REPLY TEST - 2

PULSE	POSITION	POWER
1 - F1	0.000	56.9
2 - C1	0.057	57.0
3 - A1	0.060	57.0
4 - C2	0.061	56.4
5 - A2	0.063	56.7
6 - C4	0.063	56.3
7 - A4	0.063	56.9
8 - B1	0.059	56.0
9 - D1	0.059	56.3
10 - B2	0.056	56.5
11 - D2	0.052	56.0
12 - B4	0.049	56.1
13 - D4	0.045	56.0
14 - F2	0.039	56.0

CODE = 7777





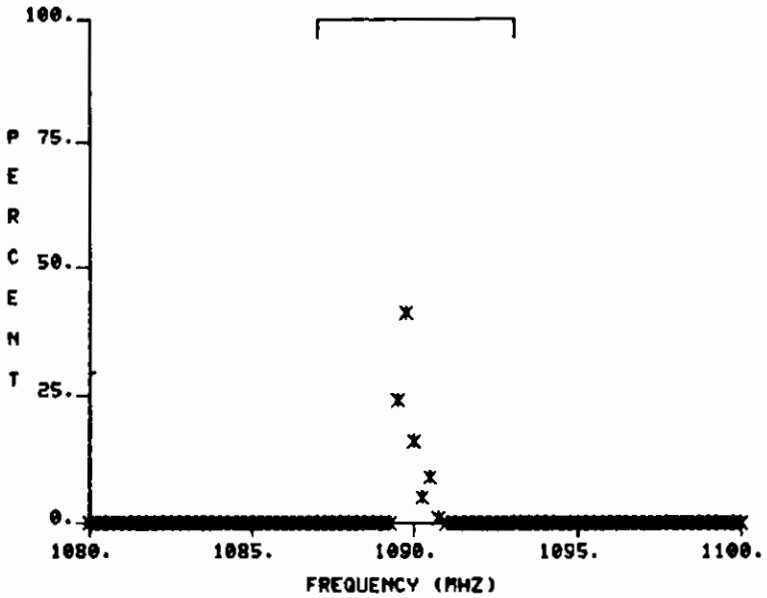
ATCRBS REPLY TEST - 2

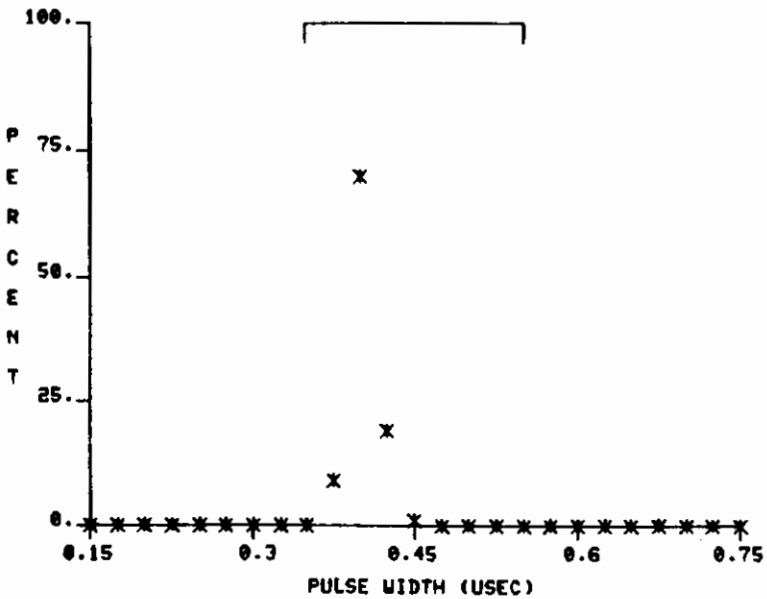
FREQUENCY - 1089.80

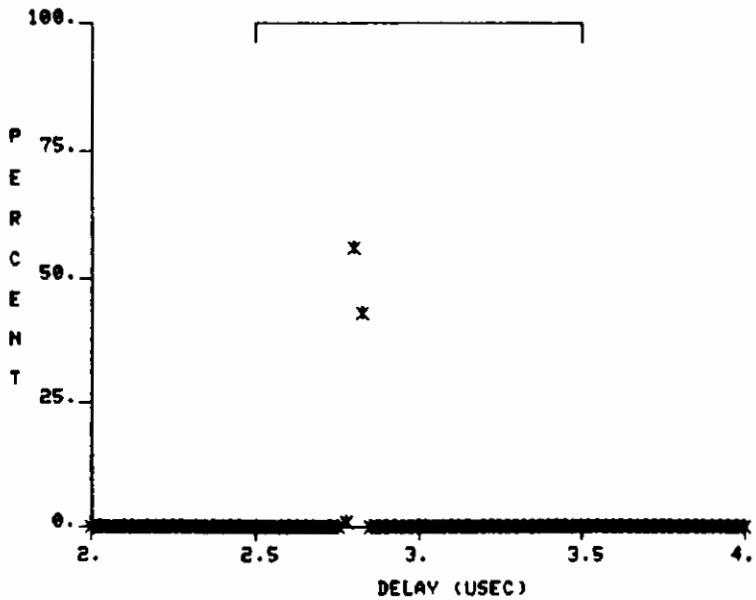
DELAY - 2.836

WIDTH - 0.402

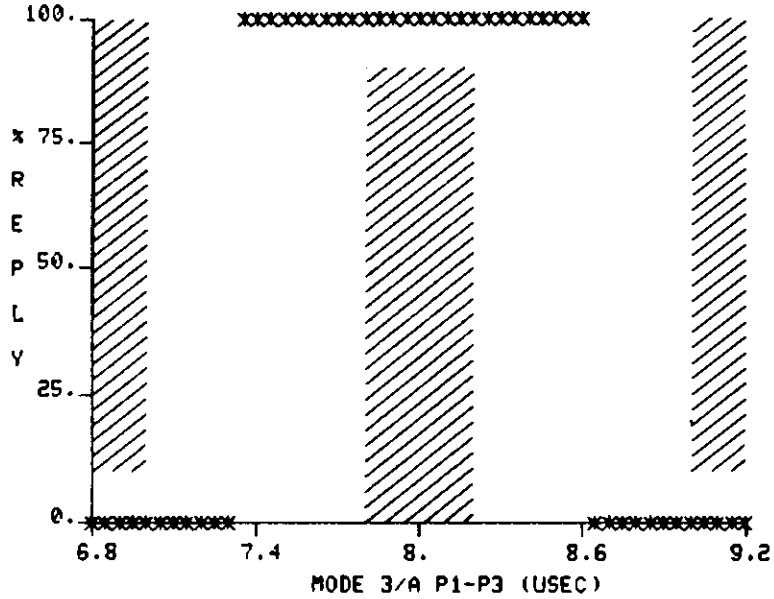
SPERRY RT-459A S/N 11599 3-18-86

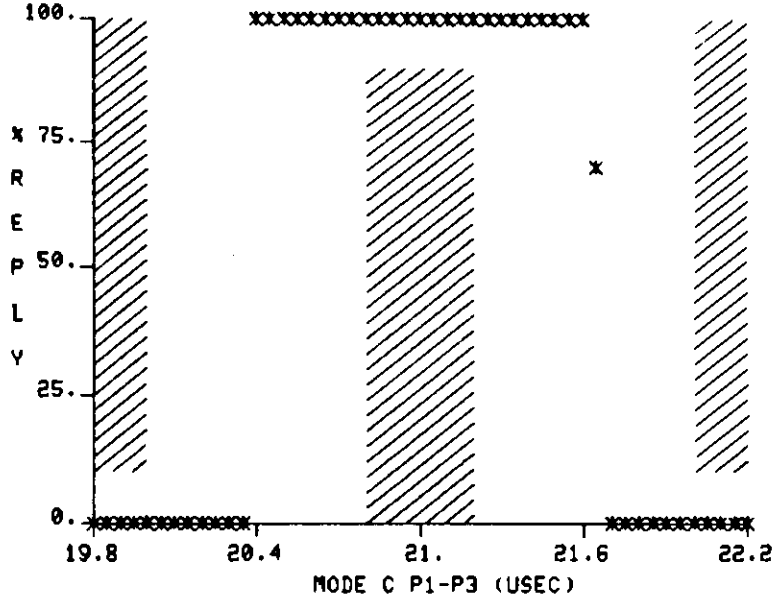


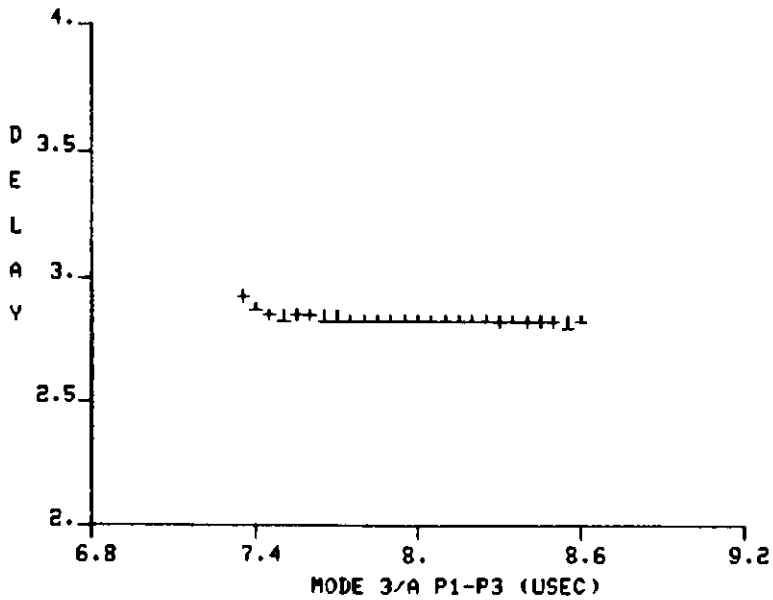


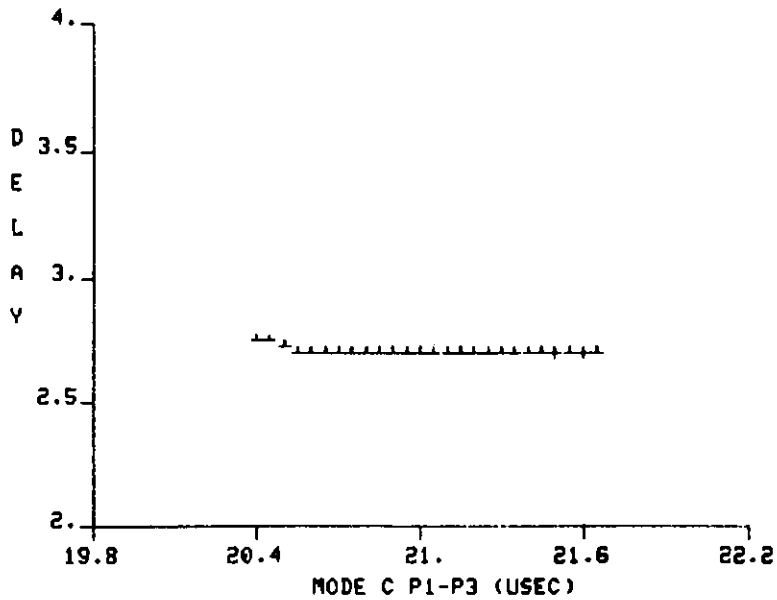


SPERRY RT-459A S/N 11599 3-18-86
ATCRBS MODE ACCEPTANCE TEST (POSIT) - 3









SPERRY RT-459A S/N 11599 3-18-86
SIDE LOBE SUPPRESSION TEST - 5

P1 LEVEL (-DBM)

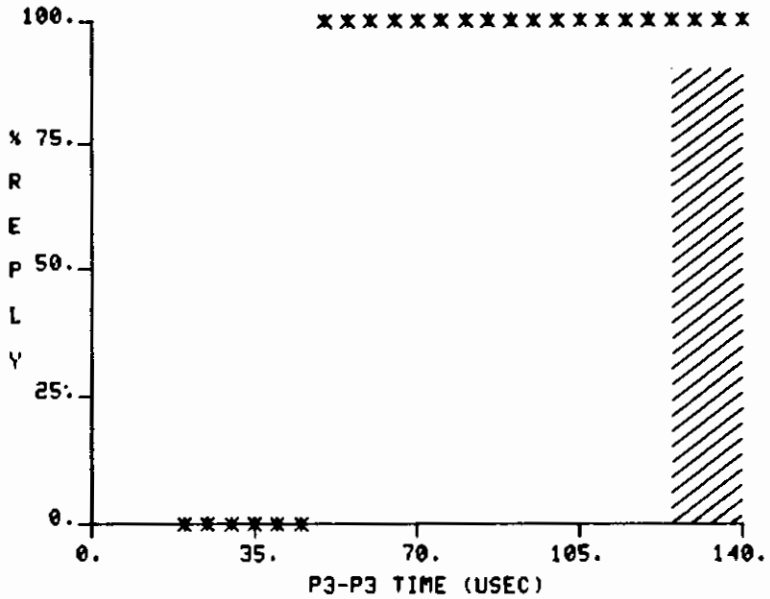
P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	82	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
12	85	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6	85	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
3	84	46	66	92	90	100	100	100	100	100	100	0	0	0	0	100	100	0
0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

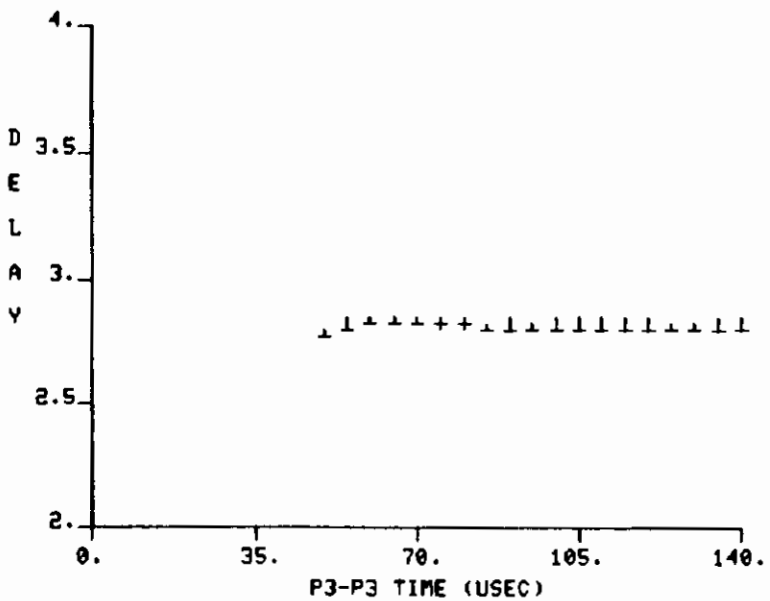
SPERRY RT-459A S/N 11599 3-18-86
SIDE LOBE SUPPRESSION TEST - 5

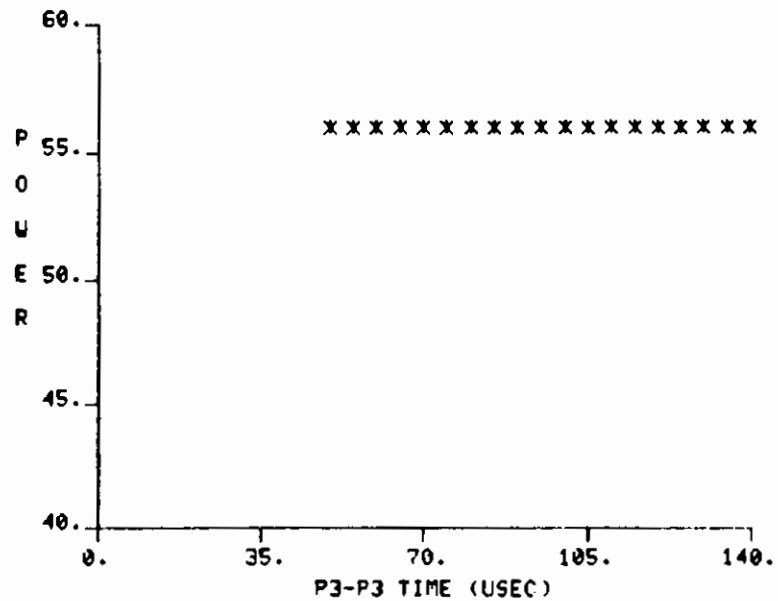
P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	2950	2850	2825	2800	2775	2750	2775	2800	2825	2825	2825	2800	2800	2775	2775	2775	2775	2800
12	2925	2850	2825	2800	2775	2750	2775	2800	2825	2825	2825	2800	2800	2775	2775	2775	2775	2800
9	2925	2850	2825	2800	2775	2750	2775	2800	2825	2825	2825	2800	2800	2775	2775	2775	2775	2800
6	2950	2875	2825	2800	2775	2750	2775	2800	2825	2825	2825	2825	2800	2800	2775	2775	2775	2800
3	2950	2875	2825	2800	2775	2750	2775	2825	2825	2825	2850					2800	2800	
0	3000																	
-3	3025																	
-6																		

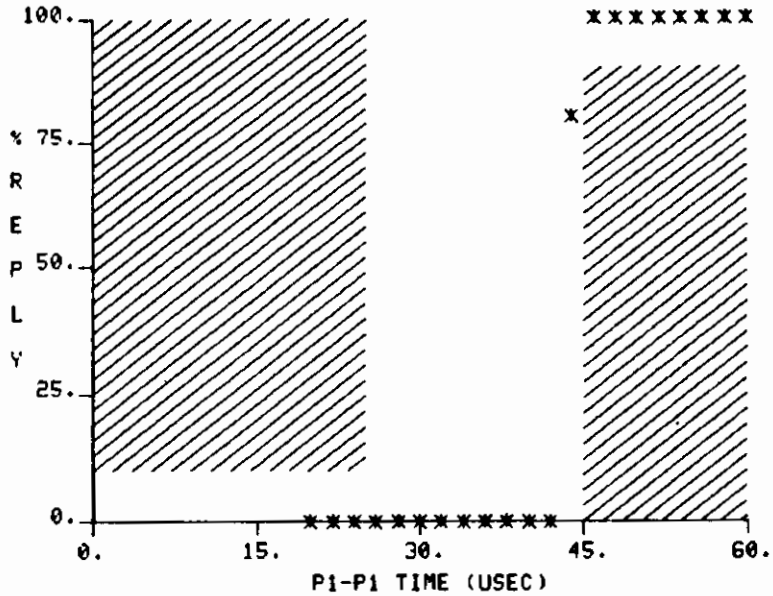
SPERRY RT-459A S/N 11599 3-18-86
ATCRBS DEAD TIME TEST - 6

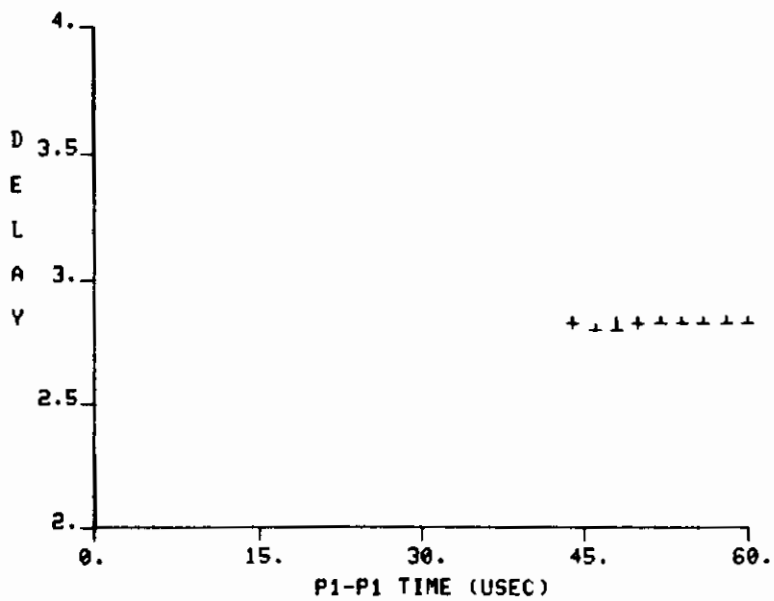




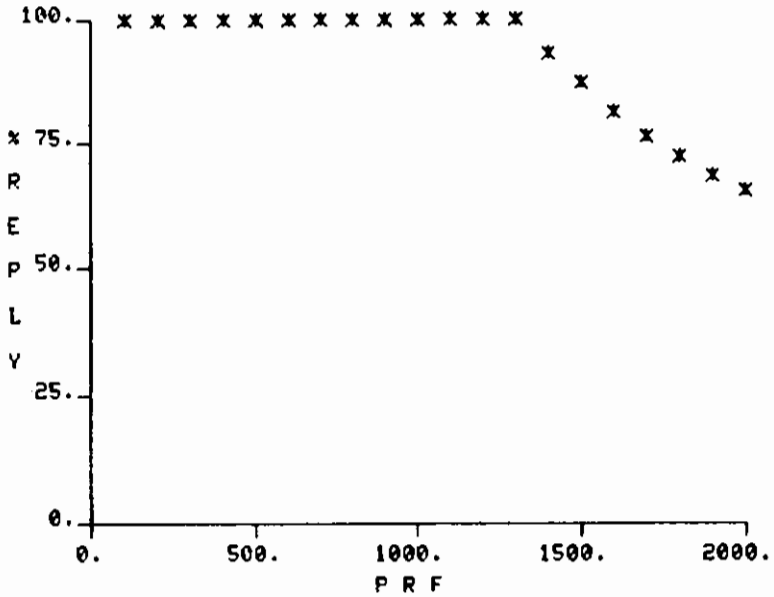


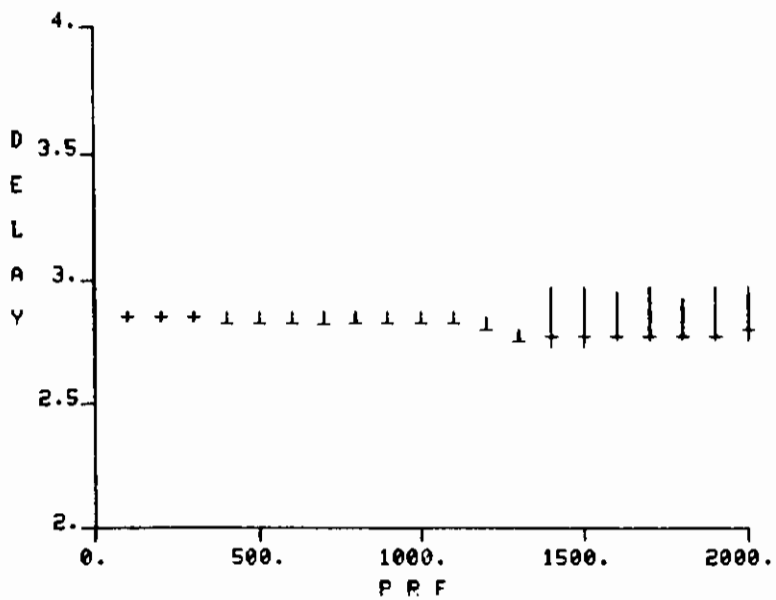
SPERRY RT-459A S/N 11599 3-18-86
S.L.S. SUPPRESSION TEST - 7

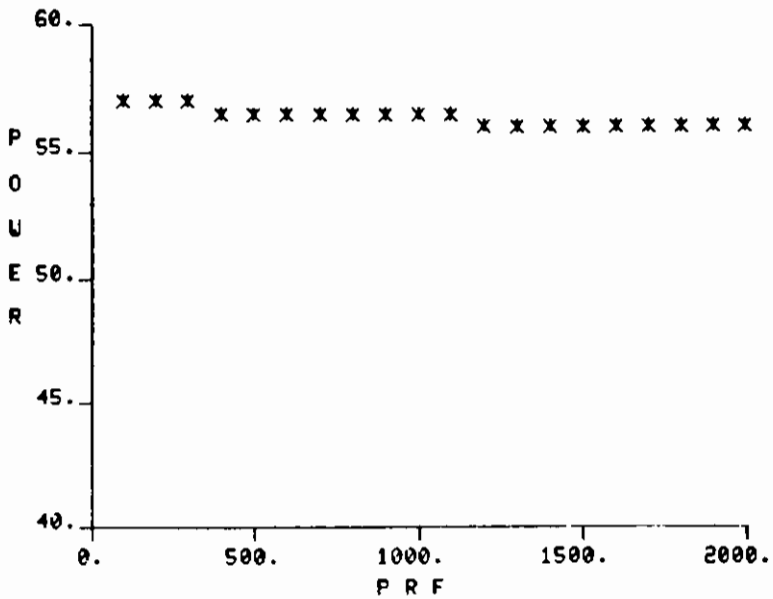




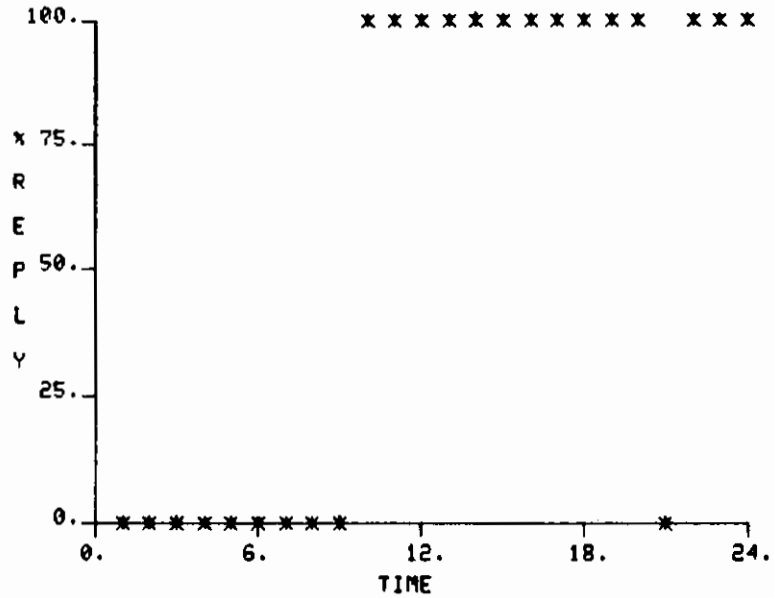
SPERRY RT-459A S/N 11599 3-18-86
ATCRBS REPLY RATE LIMIT TEST - 8

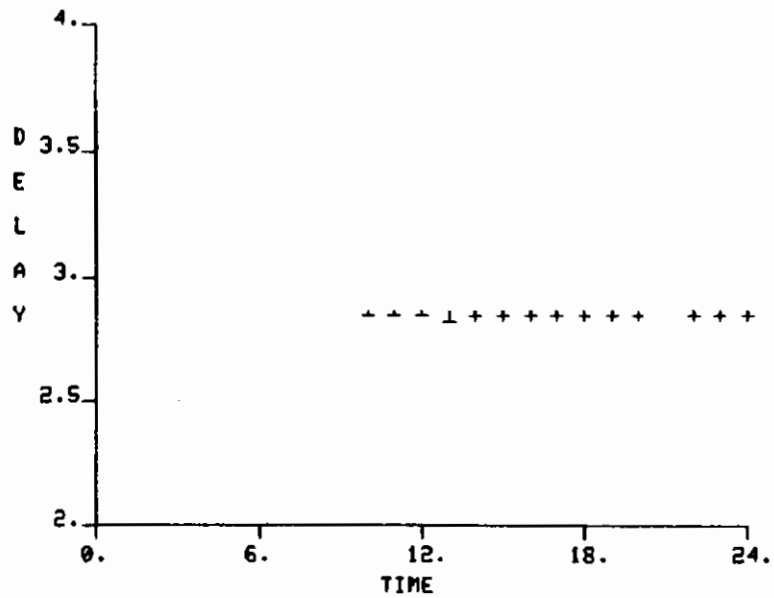




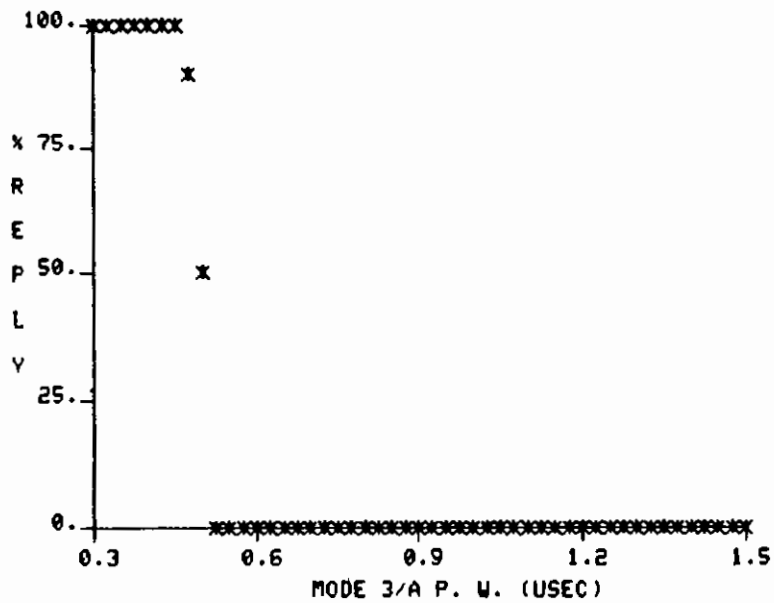


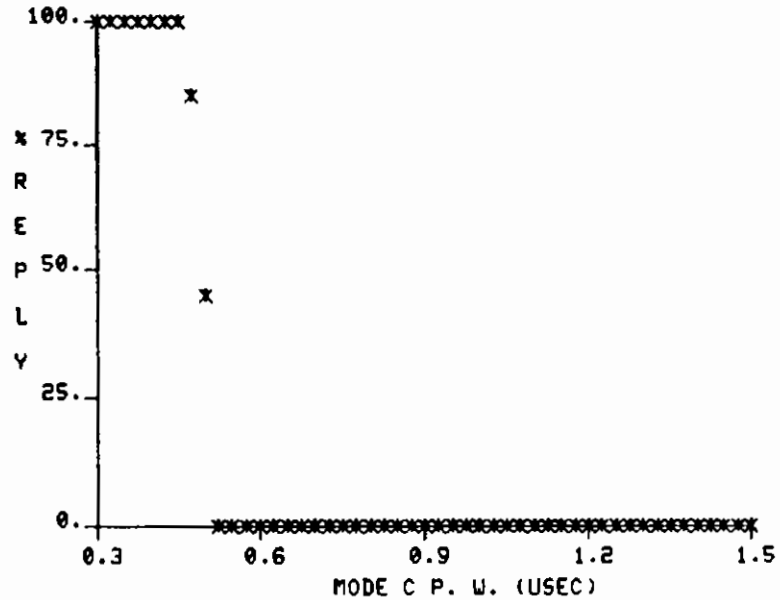
SPERRY RT-459A S/N 11599 3-18-86
ATCRBS ECHO SUPPRESSION TEST - 10

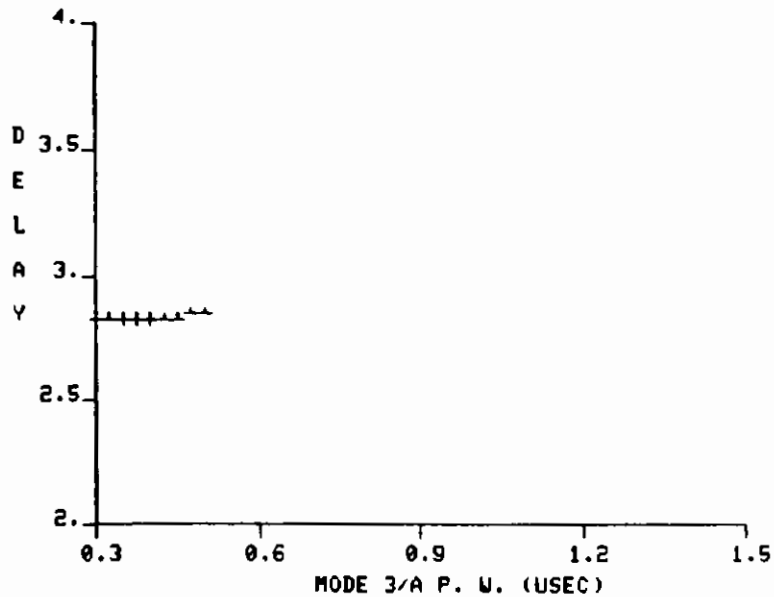


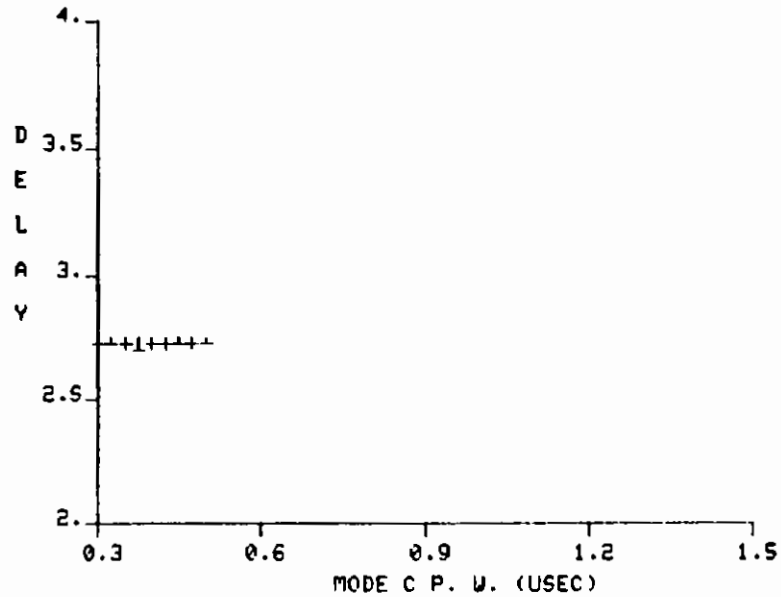


SPERRY RT-459A S/N 11599 3-18-86
S.L.S. MODE ACCEPTANCE TEST (P.W.) - 13









SPERRY RT-459A S/N 11599 3-18-86

ATCRBS SENSITIVITY TEST - 14

MODE A

SENSITIVITY = -74 DBM

PERCENT RESPONSE AT -81 DBM = 0.0

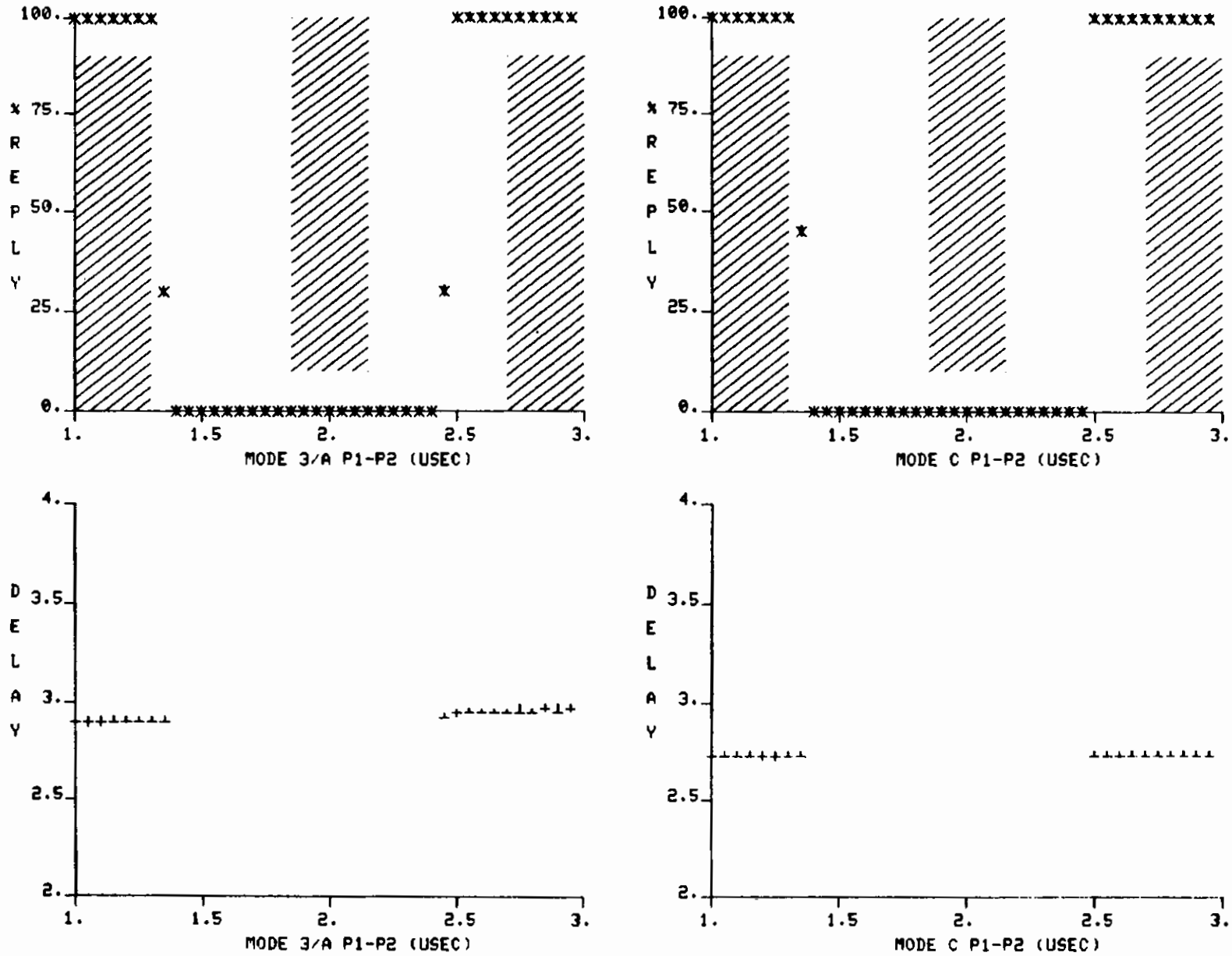
MODE C

SENSITIVITY = -74 DBM

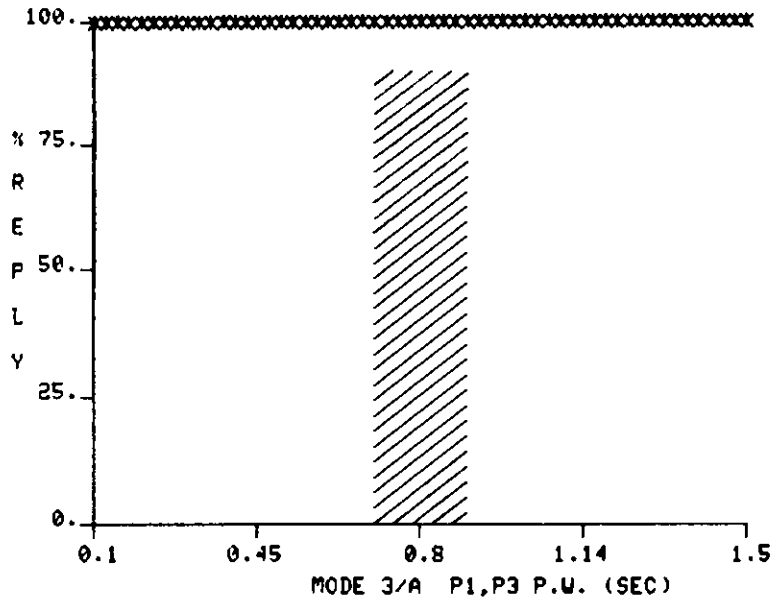
PERCENT RESPONSE AT -81 DBM = 0.0

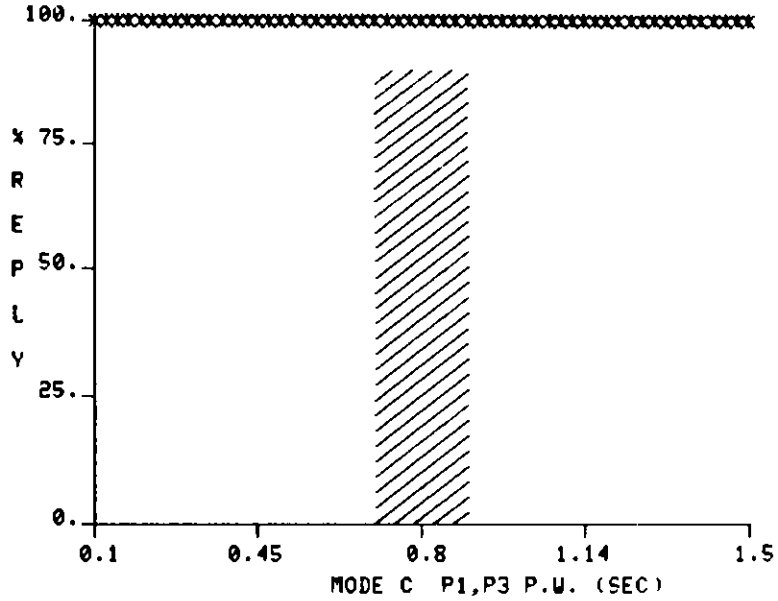
SPERRY RT-459A S/N 11599 3-18-86

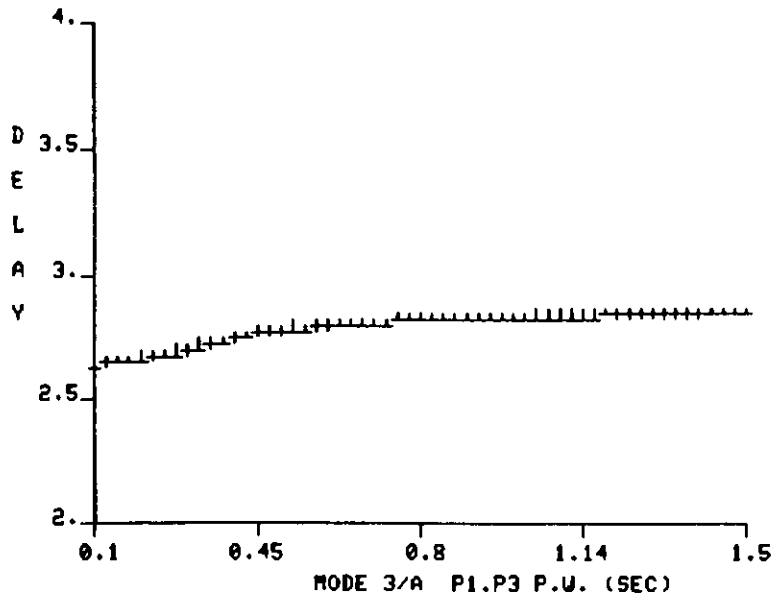
S.L.S. MODE ACCEPTANCE TEST (POSIT) - 16

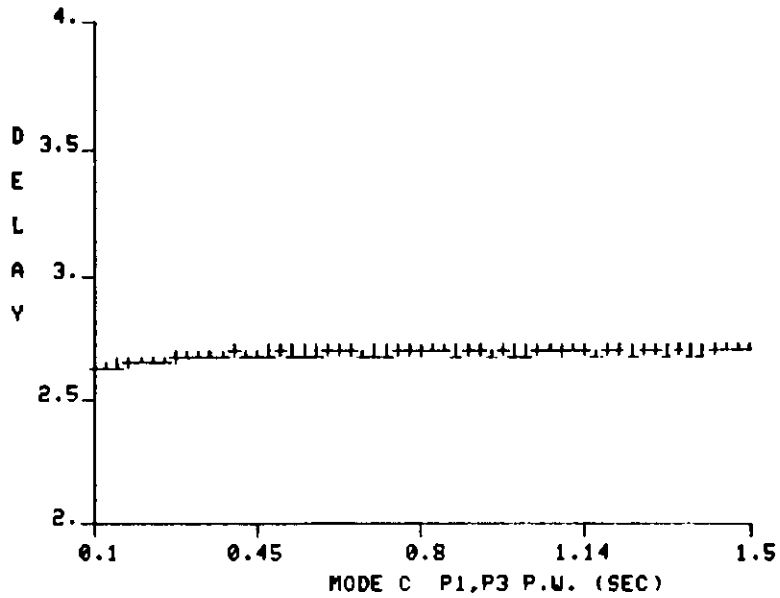


SPERRY RT-459A S/N 11599 3-18-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 17

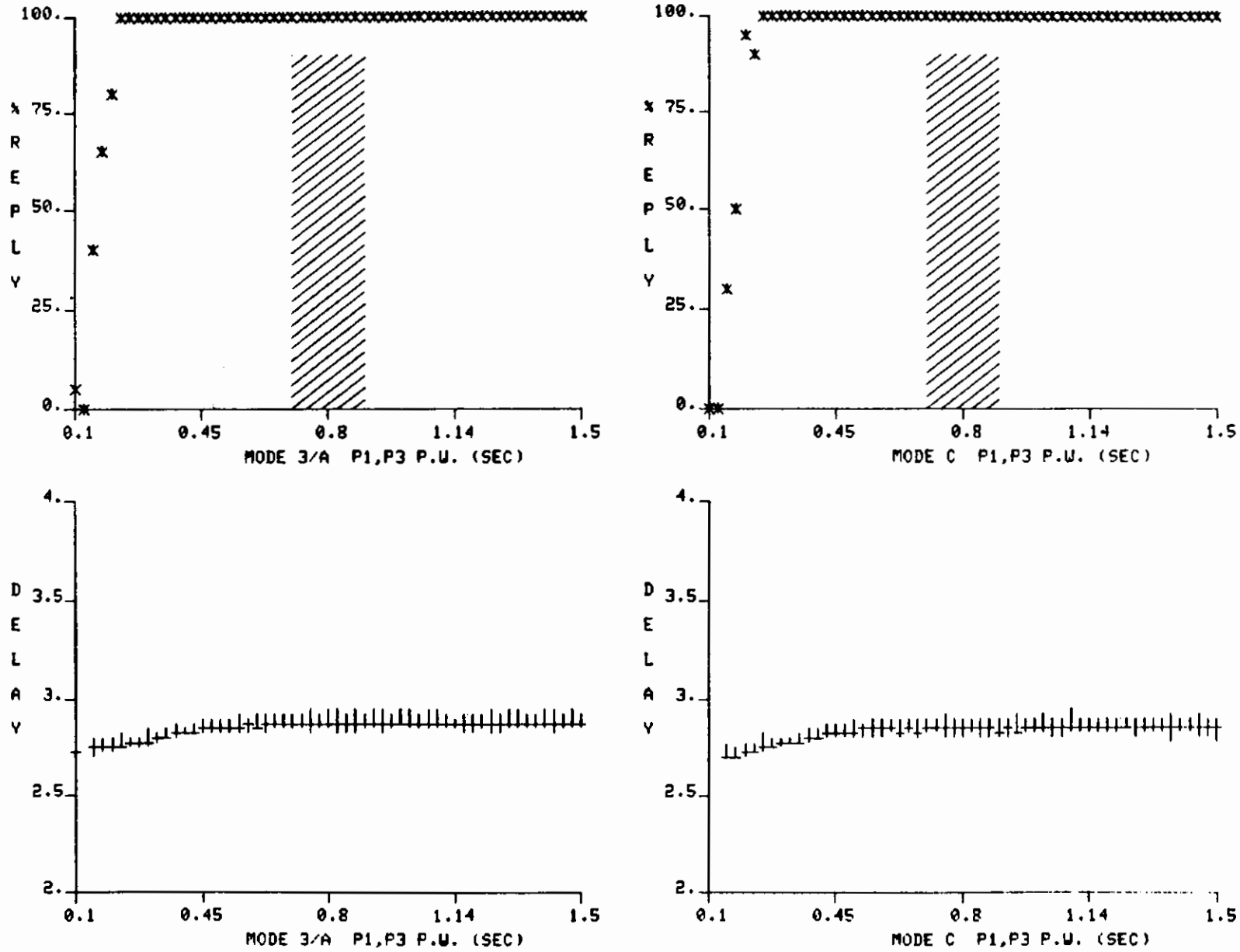






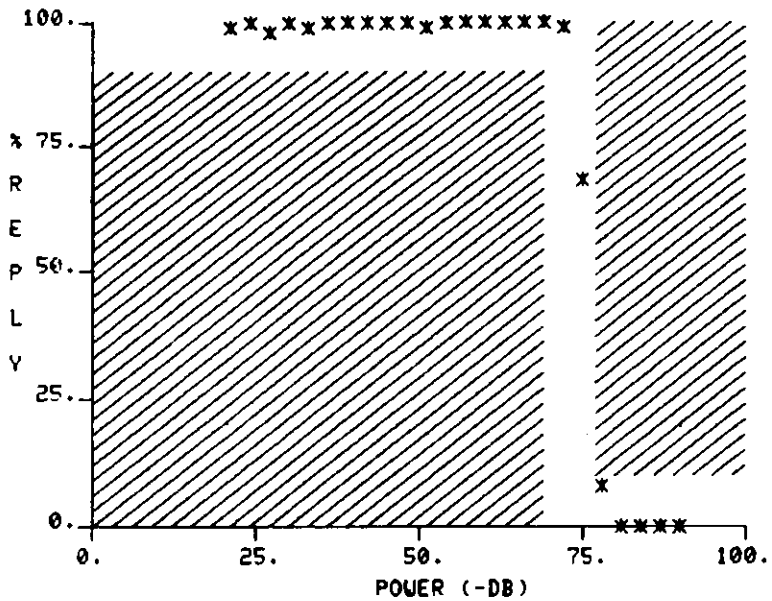


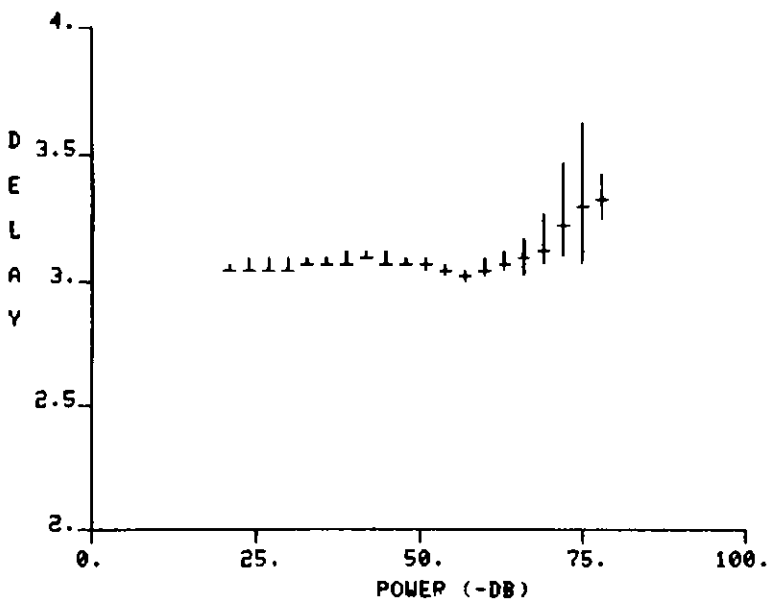
SPERRY RT-459A. S/N 11599 3-18-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 17



NARCO AT-150 S/N 28728 3-18-86
ATCRBS DYNAMIC RANGE TEST - 1

SENSITIVITY = -73 DBM

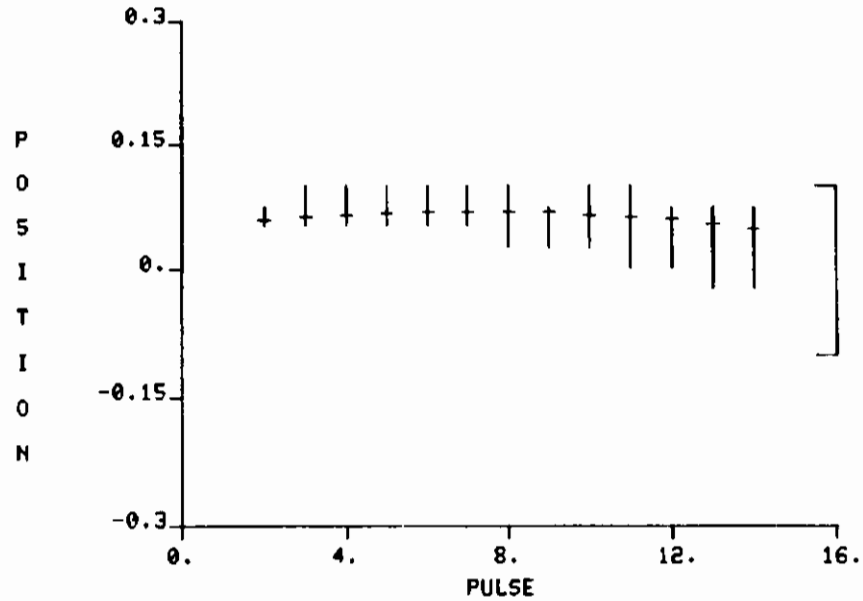


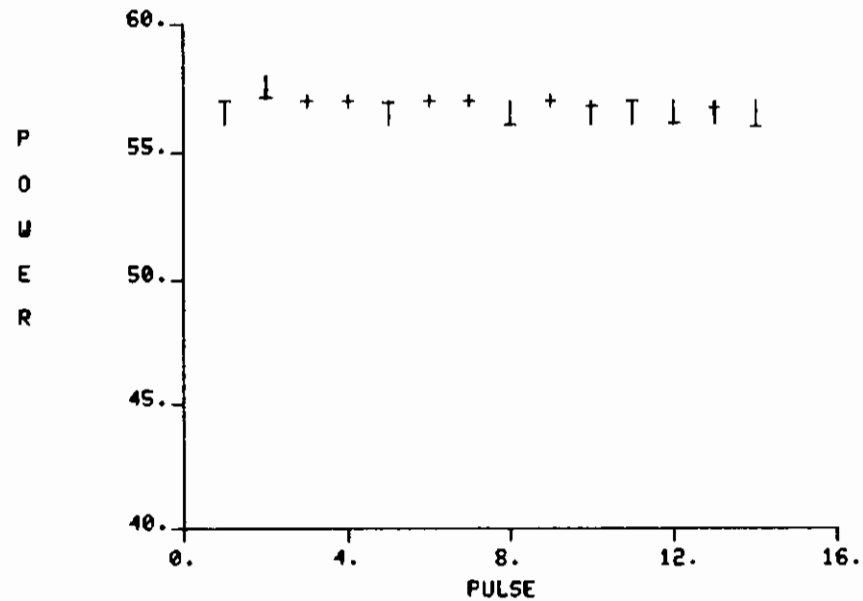


NARCO AT-150 S/N 28728 3-18-86
ATCRBS REPLY TEST - 2

PULSE	POSITION	POWER
1 - F1	0.000	57.0
2 - C1	0.059	57.1
3 - A1	0.062	57.0
4 - C2	0.065	57.0
5 - A2	0.066	57.0
6 - C4	0.067	57.0
7 - A4	0.069	57.0
8 - B1	0.068	56.1
9 - D1	0.068	57.0
10 - B2	0.065	56.8
11 - D2	0.062	57.0
12 - B4	0.059	56.1
13 - D4	0.054	56.7
14 - F2	0.048	56.0

CODE = 7777





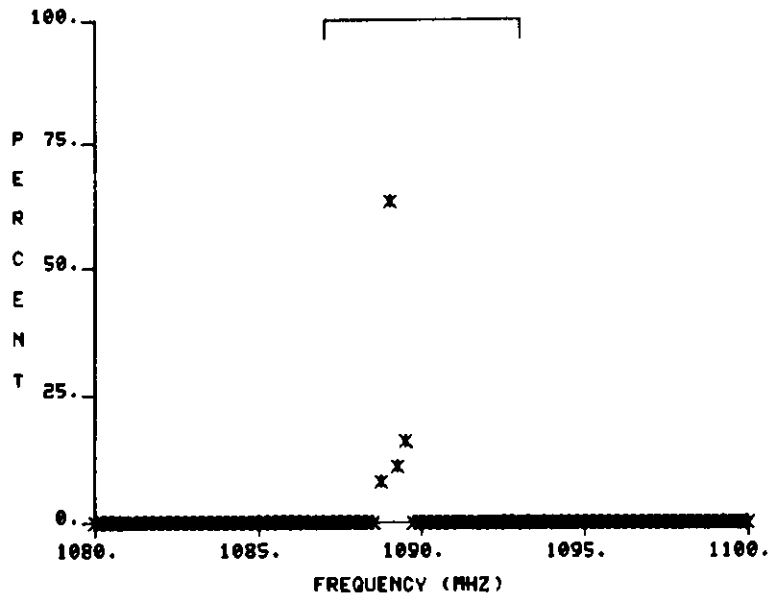
ATCRBS REPLY TEST - 2

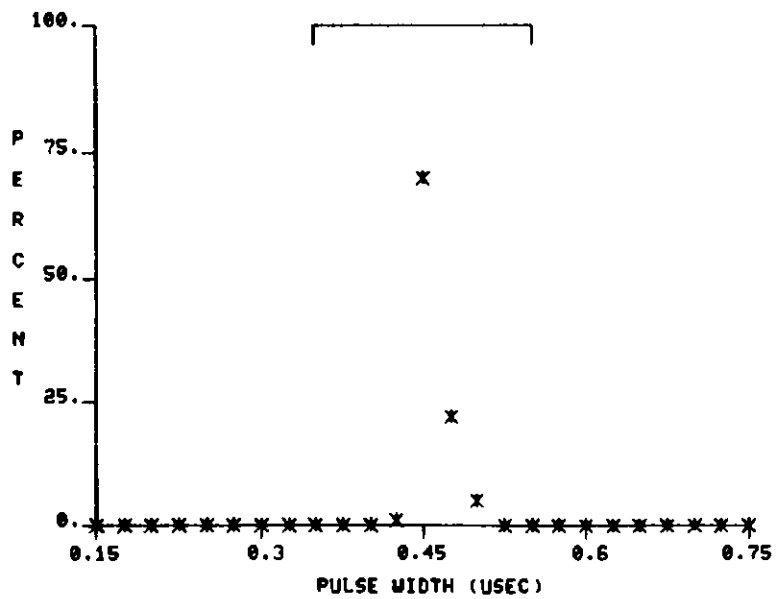
FREQUENCY = 1089.05

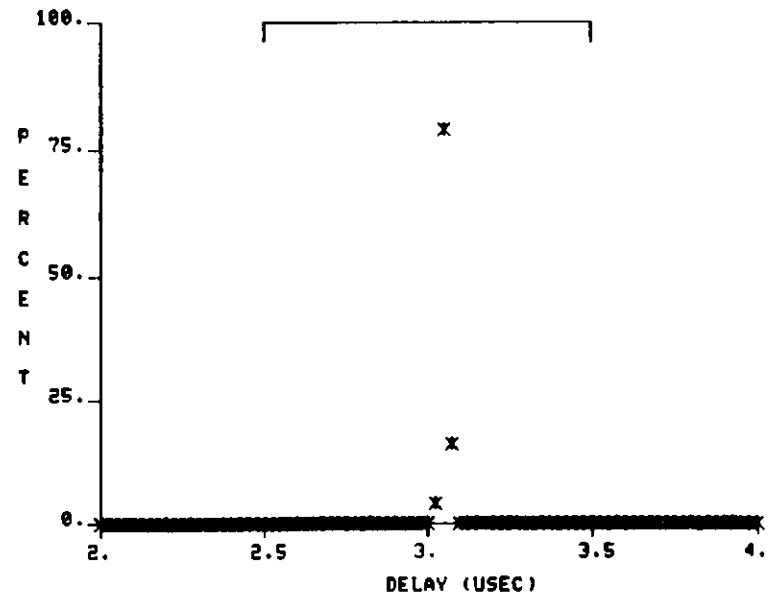
DELAY = 3.078

WIDTH = 0.458

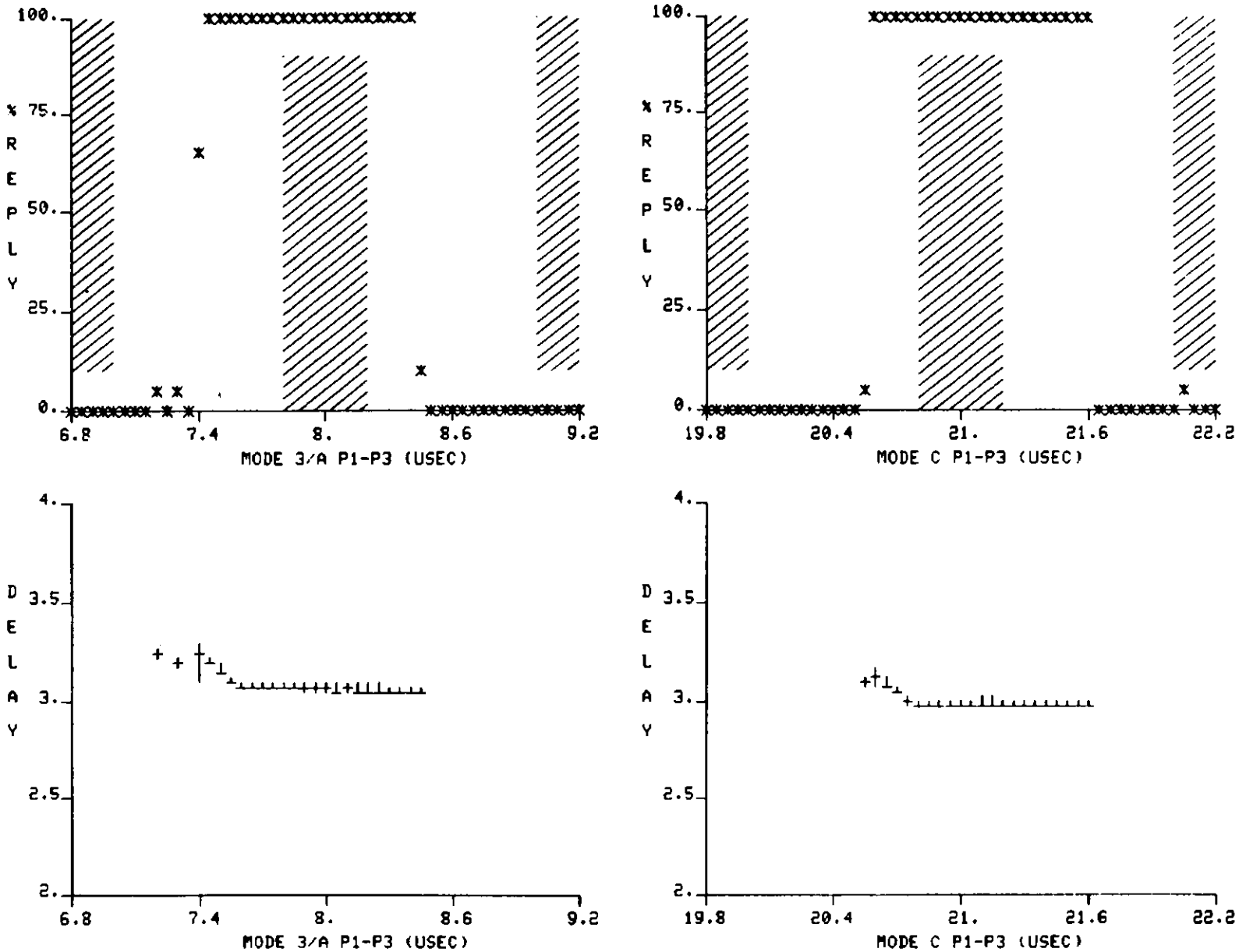
NARCO AT-150 S/N 28728 3-18-86







NARCO AT-150 S/N 28728 3-18-86
ATCRBS MODE ACCEPTANCE TEST (POSIT) - 3



NARCO AT-150 S/N 28728 3-18-86
SIDE LOBE SUPPRESSION TEST - 5

P1 LEVEL (-DBM)

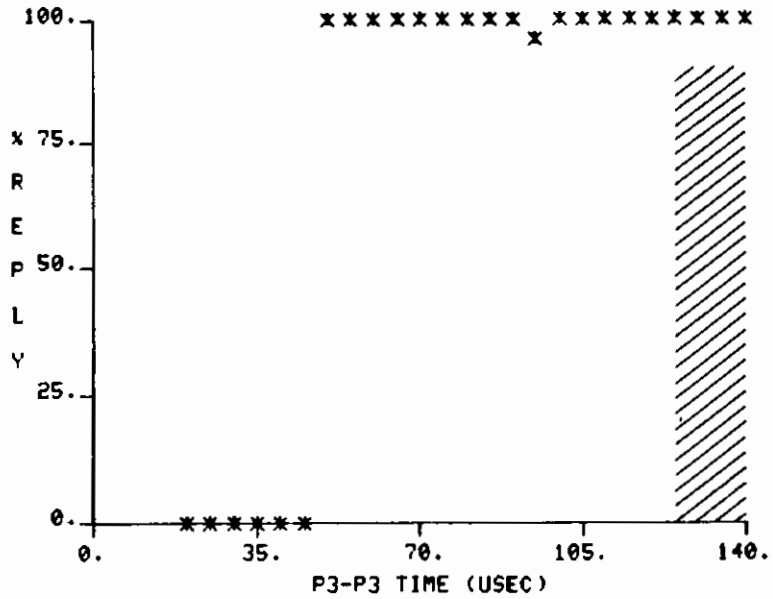
P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	54	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99
12	51	100	100	100	99	100	100	100	100	100	99	100	100	100	99	100	99	100
9	58	99	100	100	99	99	100	100	100	100	100	100	100	100	100	99	100	100
6	64	96	90	90	100	100	100	100	100	100	100	100	100	100	100	99	100	100
3	66	56	19	37	49	98	100	100	100	100	100	99	98	100	0	100	100	100
0	28	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

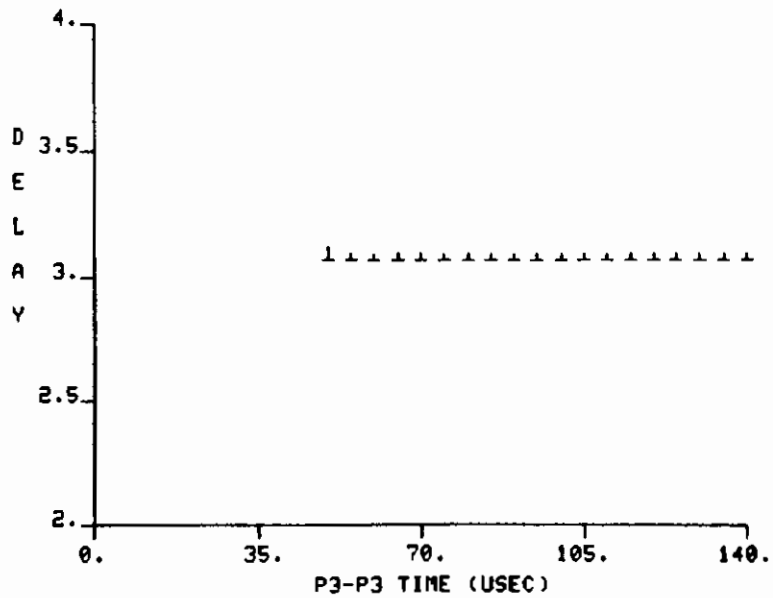
NARCO AT-150 S/N 28728 3-18-86
SIDE LOBE SUPPRESSION TEST - 5

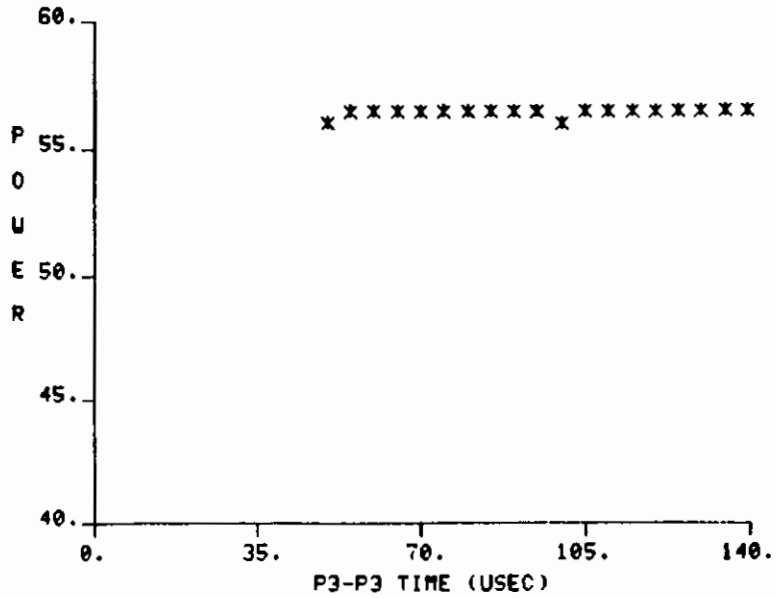
P1 LEVEL (-DBM)

P1-P2	75	72	69	66	63	60	57	54	51	48	45	42	39	36	33	30	27	24
15	3300	3225	3150	3100	3075	3050	3025	3050	3050	3075	3075	3100	3075	3075	3075	3050	3050	3050
12	3325	3225	3150	3100	3075	3050	3025	3050	3050	3075	3075	3100	3075	3075	3075	3050	3050	3050
9	3325	3225	3150	3100	3075	3050	3025	3050	3050	3075	3075	3100	3100	3075	3075	3050	3050	3050
6	3325	3225	3150	3100	3075	3050	3025	3050	3050	3075	3075	3100	3075	3075	3075	3050	3050	3050
3	3325	3225	3150	3100	3075	3050	3025	3050	3075	3075	3100	3100	3100	3100		3075	3050	3050
0	3325	3300	3175															
-3																		
-6																		

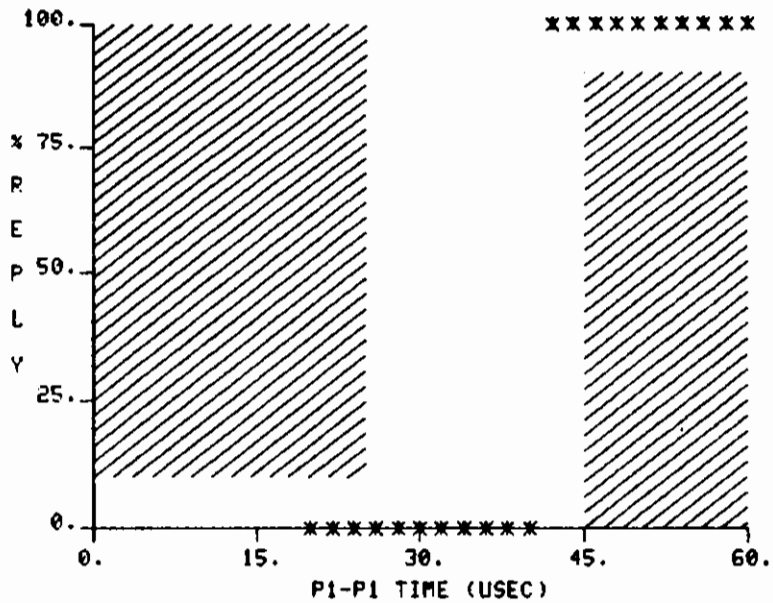
NARCO AT-150 S/N 28728 3-18-86
ATCRBS DEAD TIME TEST - 6

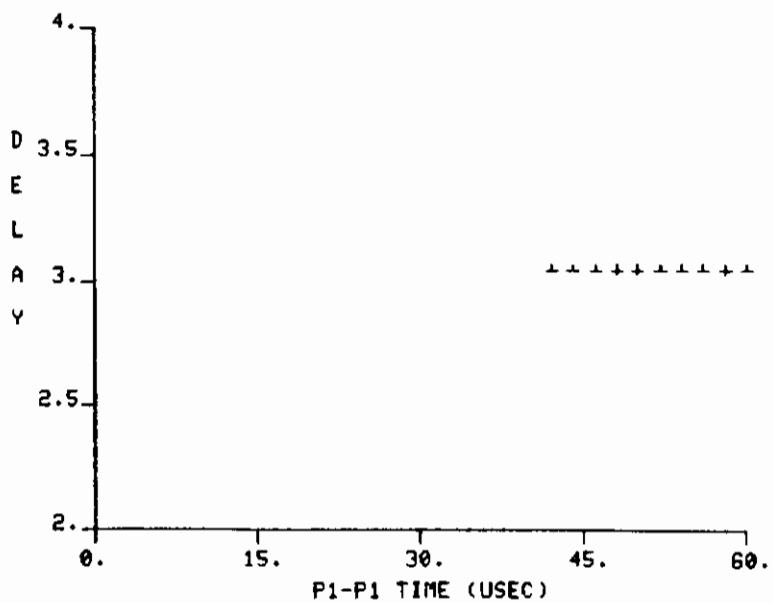




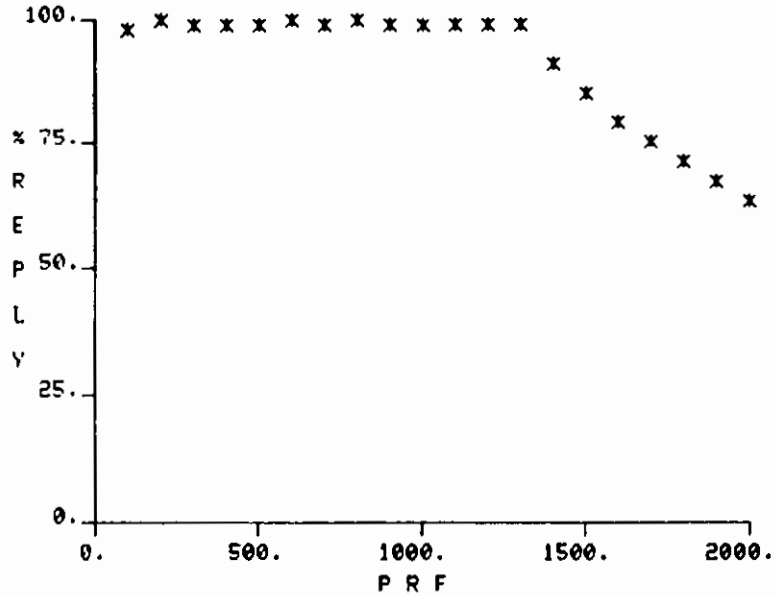


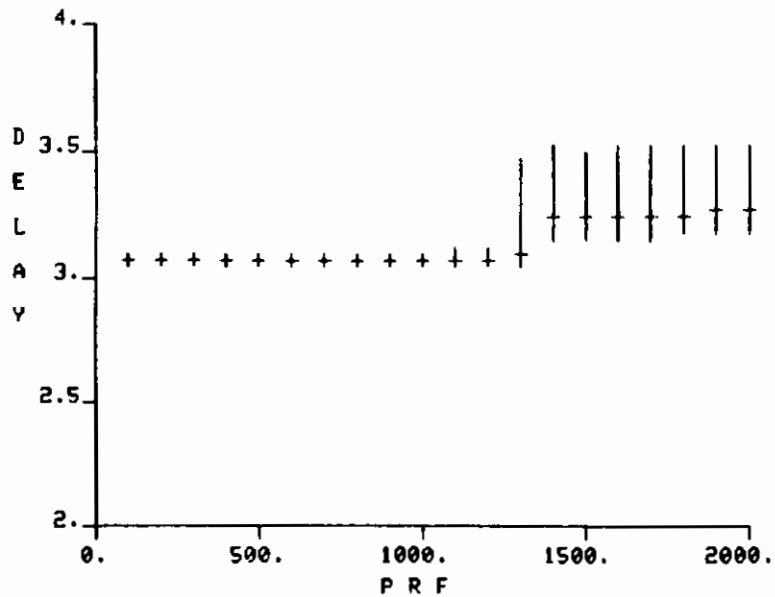
NARCO AT-150 S/N 28728 3-18-86
S.L.S. SUPPRESSION TEST - 7

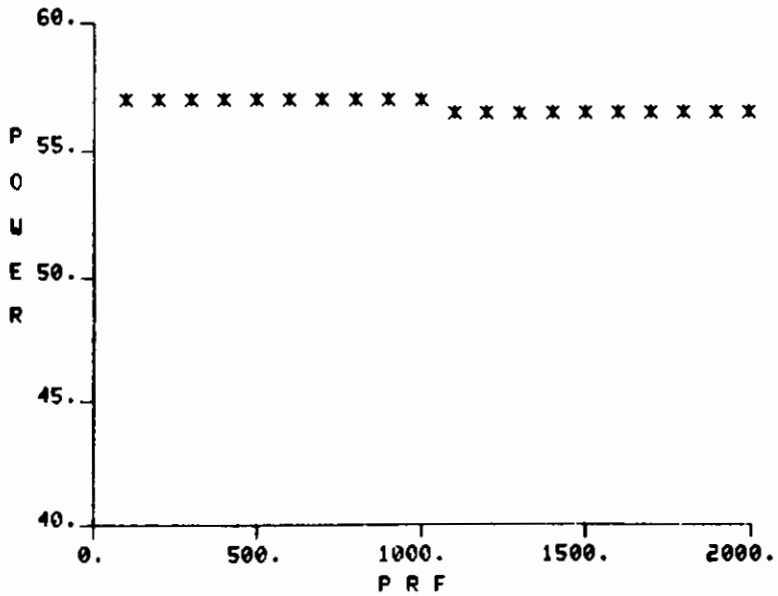




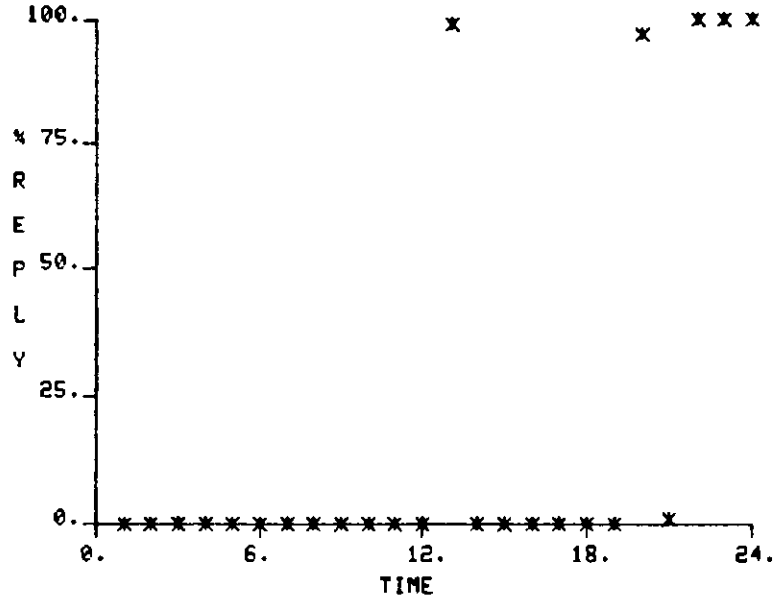
NARCO AT-150 S/N 28728 3-18-86
ATCRBS REPLY RATE LIMIT TEST - 3

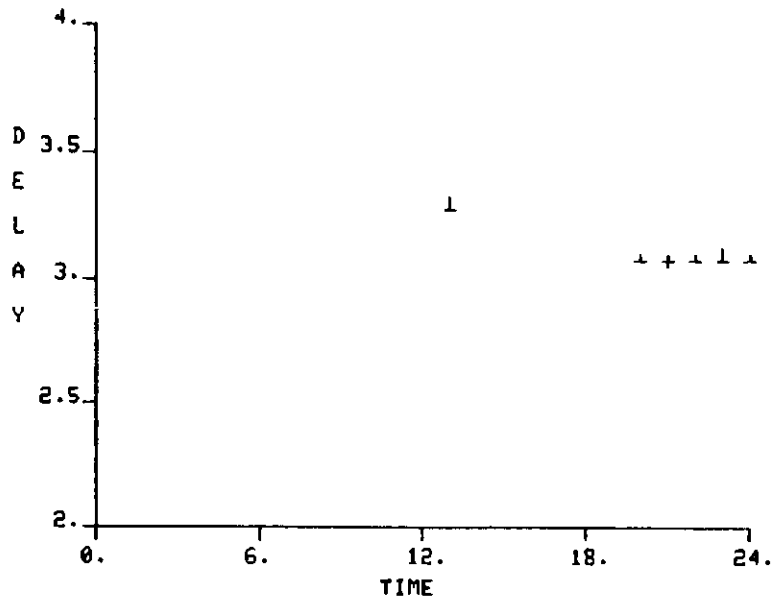




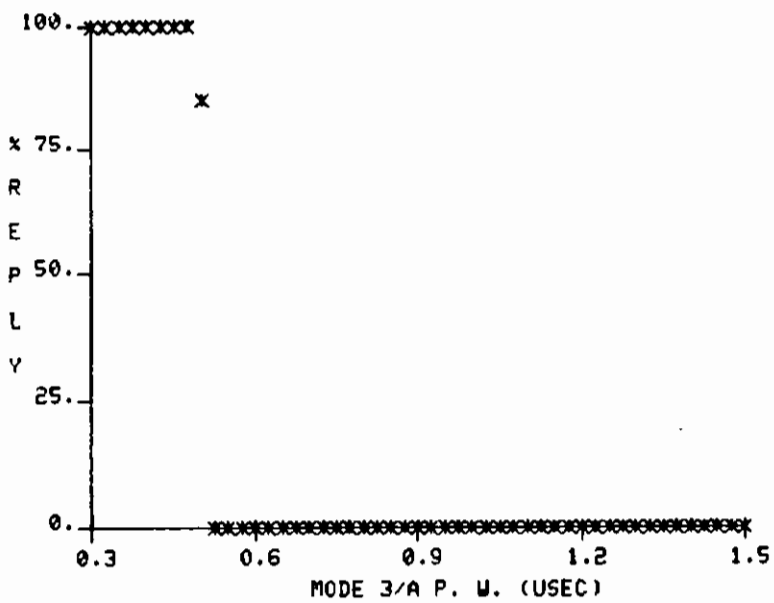


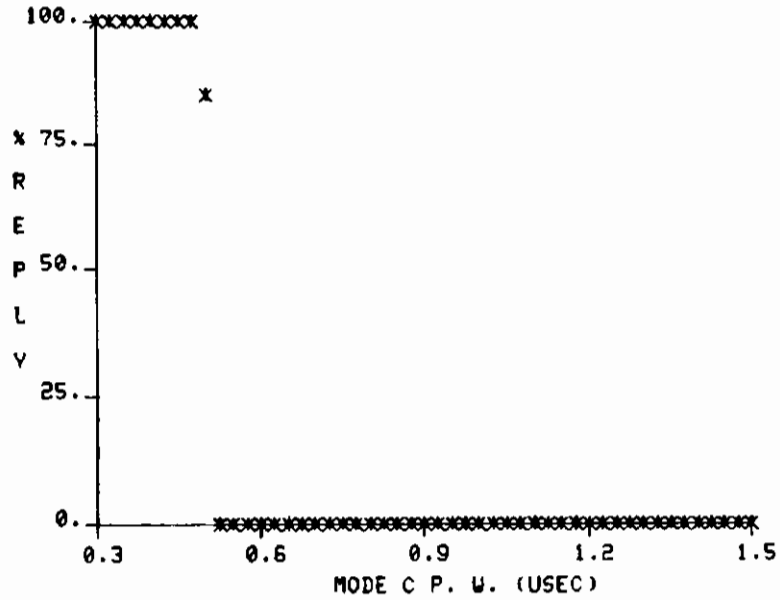
NARCO AT-150 S/N 28728 3-18-86
ATCRBS ECHO SUPPRESSION TEST - 10

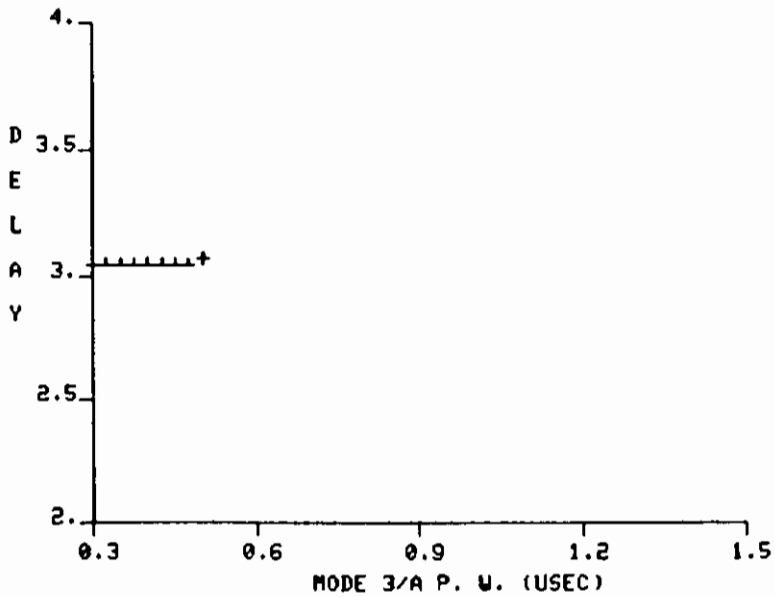


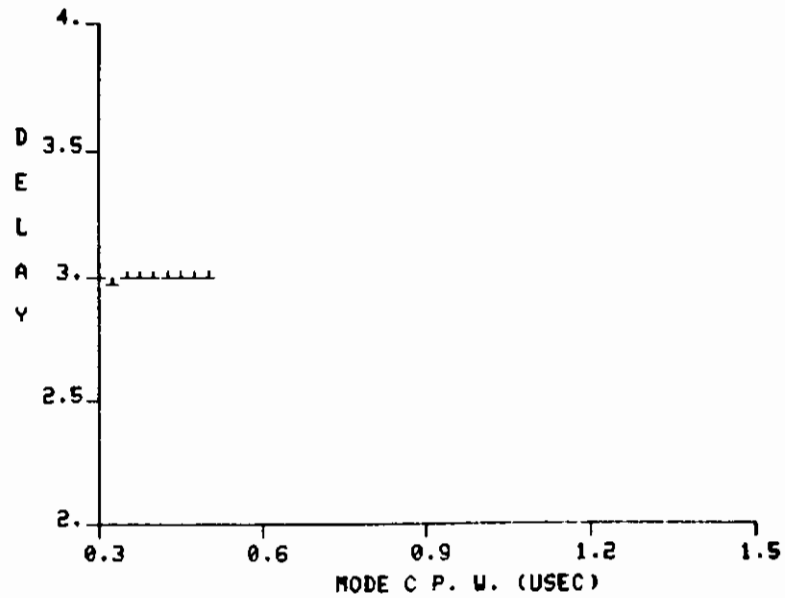


NARCO AT-150 S/N 28728 3-18-86
S.L.S. MODE ACCEPTANCE TEST (P.W.) - 13









NARCO AT-150 S/N 28728 3-18-86

ATCRBS SENSITIVITY TEST - 14

MODE A

SENSITIVITY = -73 DBM

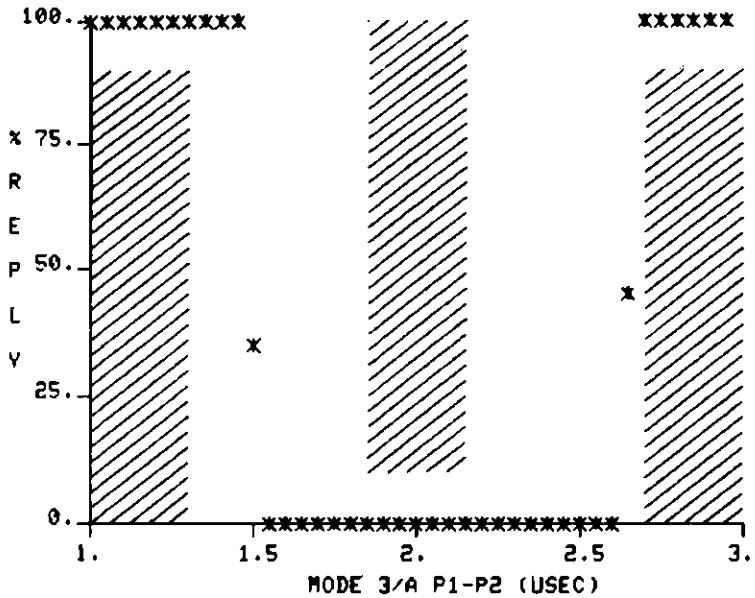
PERCENT RESPONSE AT -81 DBM = 1.0

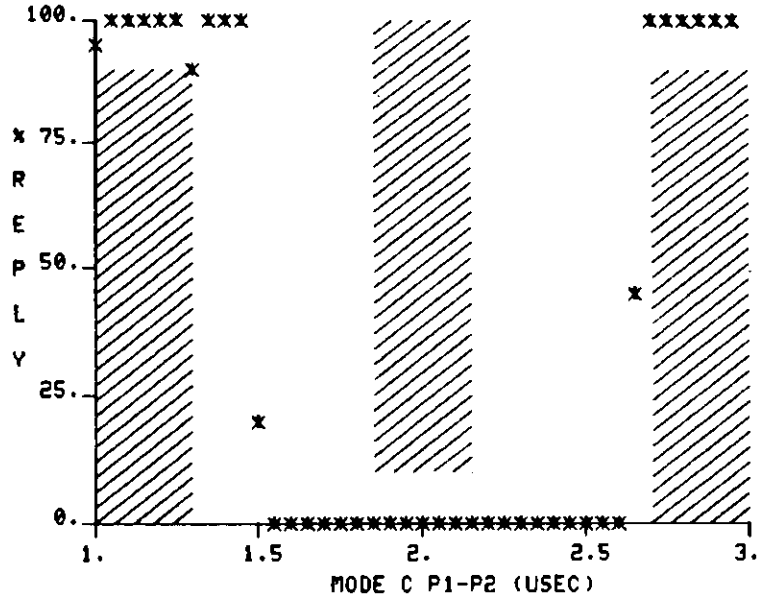
MODE C

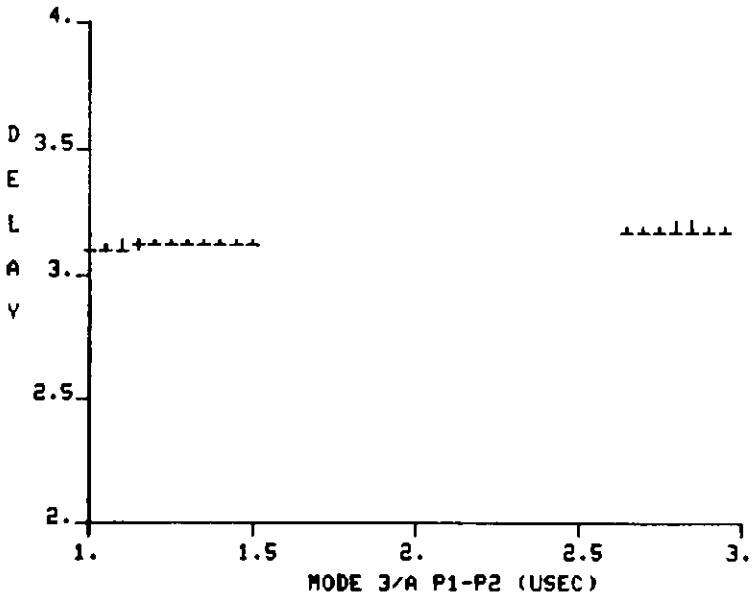
SENSITIVITY = -73 DBM

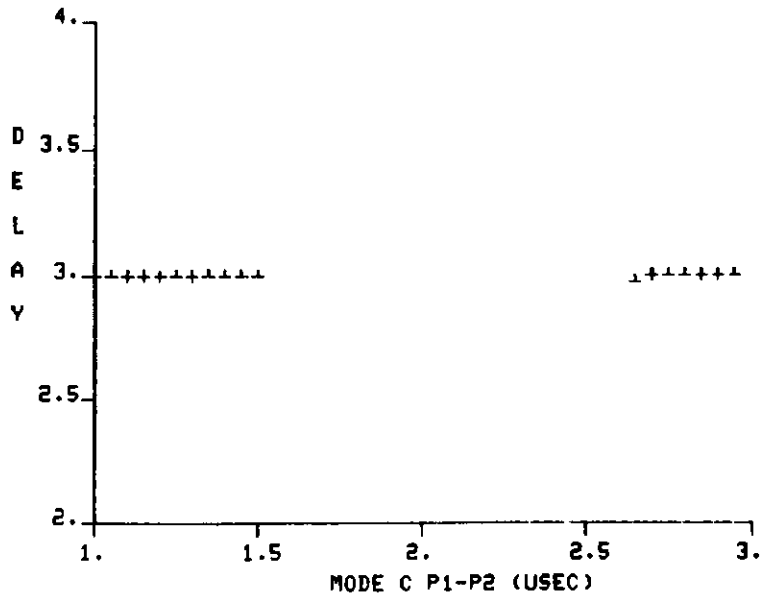
PERCENT RESPONSE AT -81 DBM = 0.0

NARCO AT-150 S/N 28728 3-18-86
S.L.S. MODE ACCEPTANCE TEST (POSIT) - 16

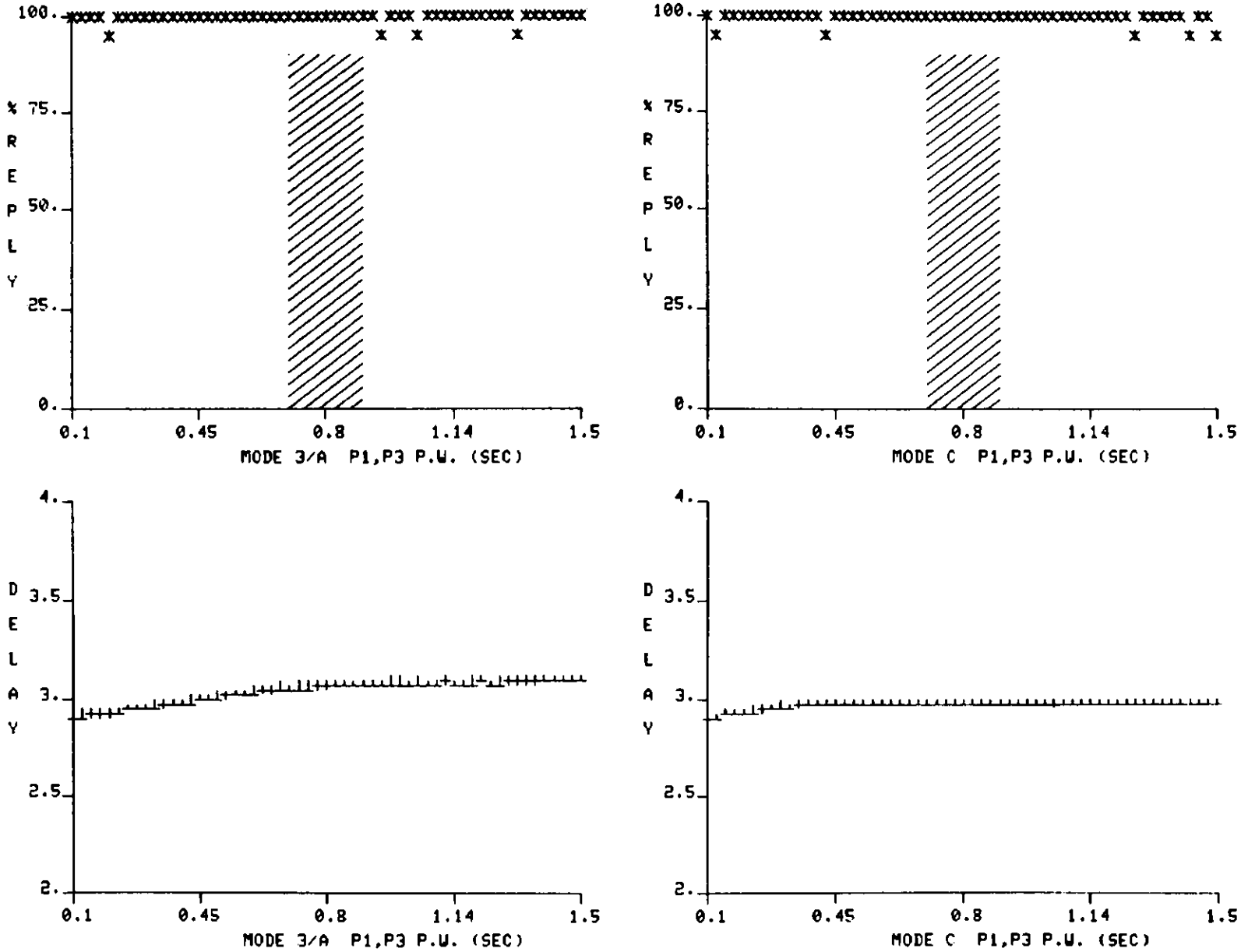




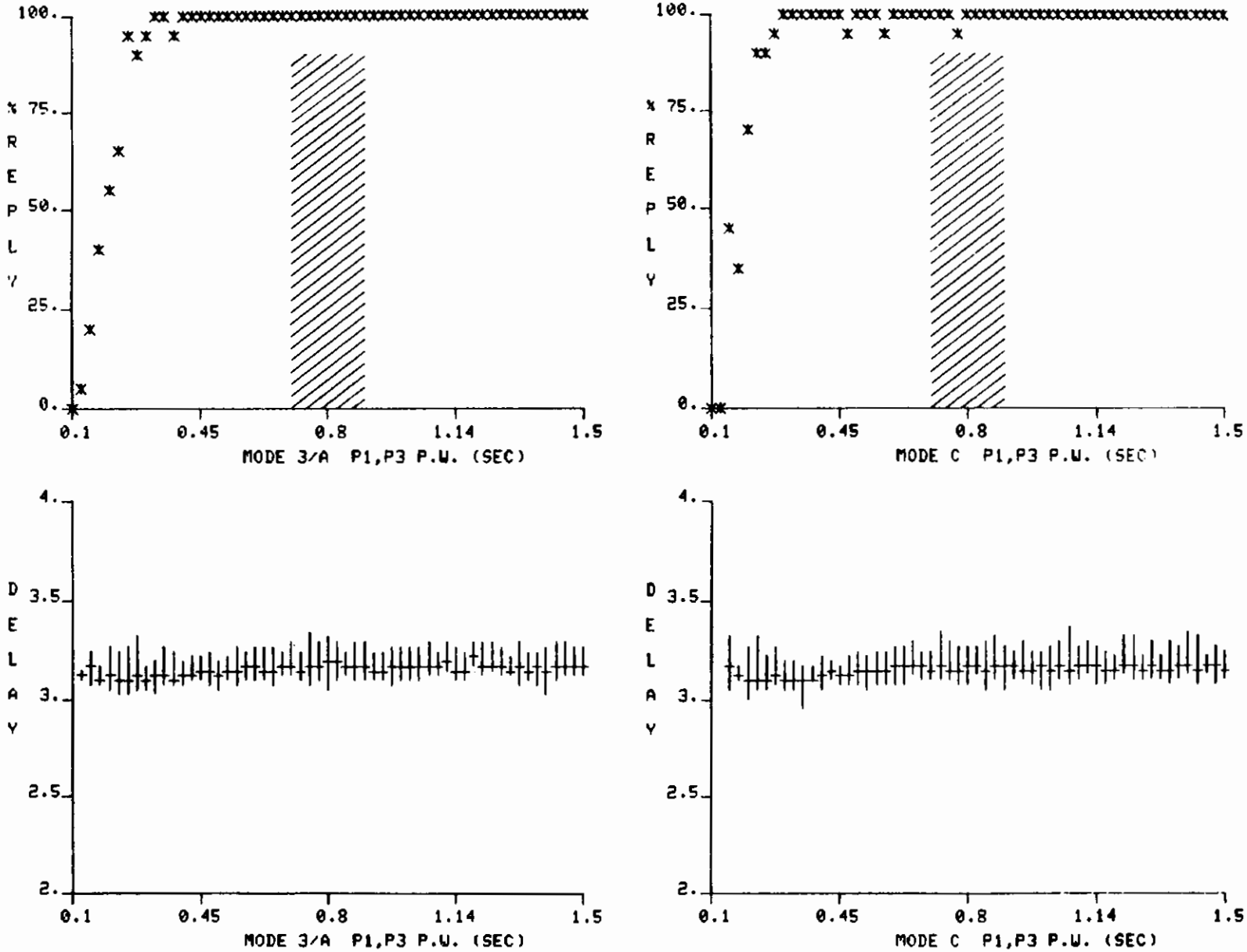




NARCO AT-150 S/N 28728 3-18-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 17



NARCO AT-150 S/N 28728 3-18-86
ATCRBS MODE ACCEPTANCE TEST (P.W.) - 17



SUMMARY OF TRANSPONDER PERFORMANCE REPORTS 1975 - 1985

1. Summary of Transponder Data, June 1975 through August 1976: June 1977, Interim Report; George R. Hetrich; Report No. FAA-RD-77-74.

2. Summary of Transponder Data, June 1977 through August 1978: August 1979, Interim Report; Max Greenberg; Report No. FAA-RD-79-56.

3. Transponder Performance Analyzer (TPA): October 1979, Final Report; Carl Hazelwood; Report No. FAA-RD-79-54.

4. Beacon and Transponder Study for the Atlanta Terminal Area, November 8, 1979 to January 10, 1980; Willard Kyrk, ASO-432.

5. Summary of Transponder Data for Atlanta, Georgia, area; Final Report, October 1980; Max Greenberg; Report No. FAA-CT-80-39.

6. Detection of Military Aircraft in an Air Traffic Control Radar Beacon (ATCRBS) Environment: Final Report, December 1980; Carl Hazelwood; Report No. FAA-CT-80-37.

7. ATCRBS Transponder Data from Initial Field Test of MTPA: October 1983; Leo Wapelhorst, John Zvanya, Mark Schoenthal; Report No. DOT/FAA/CT-TN83/04.

8. ATCRBS Transponder Data from Dayton, Ohio, Airshow - 1983: March 1984; Leo Wapelhorst, Mark Schoenthal; Report No. DOT/FAA/CT-TN 83/53.

APPENDIX 10

APPENDIX 11

GLOSSARY

GLOSSARY

AGL: Above Ground Level; Altitude expressed in feet measured above ground level.

ARTCC: Air Route Traffic Control Center; A facility established to provide air traffic control service to aircraft operating on an Instrument Flight Rule flight plan within controlled air space and principally during the en route phase of flight.

ARTS: Automated Radar Terminal System; Computer-aided radar display sub-systems capable of associating alpha-numeric data with radar returns.

ASO: FAA Southern Region headquartered in Atlanta, Georgia.

ASR: Airport Surveillance Radar; Radar providing position of aircraft by azimuth and range data. It is designed for range coverage up to 60 nautical miles and is used by terminal air traffic control.

ATCBI: Air Traffic Control Beacon Interrogator; That part of the Air Traffic Control Radar Beacon System located on the ground that interrogates the airborne transponder and receives the reply.

ATCRBS: Air Traffic Control Radar Beacon System; A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver/transmitter (transponder). Radio pulses transmitted from the searching transmitter/receiver (interrogator) site are received in the cooperative equipment and used to trigger a distinctive transmission from the transponder. This latter transmission rather than a reflected signal (primary radar) is then received back at the transmitter/receiver site.

ATCT: Airport Traffic Control Tower; A central operations facility in the terminal air traffic control system consisting of a tower cab structure, including an associated Instrument Flight Rule room if radar equipped, using air/ground communications and/or radar, visual signaling, and other devices to provide safe and expeditious movement of terminal air traffic.

CD RECORDING: Common Digitizer Recording; A recording of the common digitizer system processed data.

COASTING: A tracking mode which provides predicted track position when radar data is lost or unreliable. The last available velocity information is used to maintain track position prediction.

COMDIG: Common Digitizer Reduction Program; A multi-function multi-task program used to analyze the Common Digitizer data.

CONE OF SILENCE: Airspace above a radar facility in which no interrogations are received due to the antenna pattern.

DARC: Direct Access Radar Channel; A back-up display processor for the IBM 9020 System.

DOD AIMS PROGRAM MANAGER: Department of Defense Air Traffic Control Radar Beacon Identification Friend or Foe Mark 12 Systems Program Manager.

EARTS: En Route Automated Radar Tracking System; A UNIVAC en route air traffic control flight data/radar processor computer.

FAA: Federal Aviation Administation.

FAR: Federal Aviation Regulations; Any rule, standard, procedure, or system characteristic promulgated by the FAA to which adherence is recognized as necessary in the interest of the safety, regularity, or efficiency of air navigation.

FLIGHT LEVEL: A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each is slated in three digits representing hundreds of feet. For example, flight level 330 represents a barametric altimeter indication of 33,000 feet; flight level 350, an indication of 35,000 feet.

IBM 9020: International Business Machine Model 9020 Computer; The en route air traffic control flight data/radar processor computer.

LRR: Long Range Radar; A radar used in the en route system.

MSL: Mean Sea Level; Altitude expressed in feet measured from mean sea level.

MTPA: Mobile Transponder Performance Analyzer; A system designed and fabricated at the FAA Technical Center to analyze performance characteristics of aircraft transponders.

MULTIPLOT: An IBM 9020 based system which provids an output tape containing a scan-by-scan plot of up to 50 selected beacon codes for up to twelve radar sites.

NADIF: NAFEC Dipole Integrated Feed; A type of radar antenna developed by the National Aviation Facilities Experimental Center (now called the FAA Technical Center) in which the secondary radar uses the primary radar antenna.

NAFEC: National Aviation Facilities Experimental Center (now called the FAA Technical Center); located in Pleasantville, New Jersey, where research and experimental testing is conducted and aviation equipment and procedures are evaluated.

NAS: National Airspace System; The common network of U.S. Airspace, navigational aids, communications facilities and equipment, air traffic control equipment and facilities, aeronautical charts and information, rules, regulations, and procedures, technical information, and FAA personnel and material. Included are system components shared jointly with the military. In addition to all designated airspace, the system includes the following components: air navigation facilities, and airports.

NAS: Naval Air Station.

NM: Nautical Mile; A measure of lineal distance equal to one minute of a great circle at the equator.

RADAR: Radio Detection and Ranging; A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth and/or elevation of objects in the path of the transmitted pulses.

RADAR BEACON (SECONDARY RADAR): A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver transmitter (transponder). Radio pulses transmitted from the searching transmitter/receiver (interrogator) site are received in the cooperative equipment and used to trigger a diatinctive transmission from the transponder. This latter transmission, rather than a reflected signal (primary radar) is then received back at the transmitter/receiver site.

RAPCON: Radar Approach Control; A joint-use air traffic control facility, located at a U.S. Air Force Base, utilizing surveillance and precision approach radar equipment in conjunction with air/ground communication equipment providing for the safe and expeditious movement of air traffic within the controlled airspace of that facility.

RML: Radar Microwave Link; A method of transmitting radar and beacon data to a remote indicator site by microwave equipment.

SLS: Side Lobe Suppression; A technique of preventing transponder replies to side lobe interrogations of radar beacons.

TO: Technical Order; Publications covering the operation, maintenance, repair and overhaul of equipment.

TPX: A military designation for a type of display processor.

TRACON: Terminal Radar Approach Control; A terminal air traffic control facility collocated with an air traffic control tower. It uses radar data acquisition and air/ground communication equipment to provide approach and departure traffic control services under Instrument Flight Ruleconditions.

TSO: Technical Standard Order; Regulations covering the technical standards of a product.

VORTAC: A collocated VHF Omnidirectional Range (VOR) and Tactical Air Navigation (TACAN); A radio navigational facility providing bearing and slant-range distance information in the en route electronic navigation system.