Target Data Extractor Model 2000d Test and Evaluation Final Report

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William P. Conklin
Thomas D. Bratton

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16. Abstract

This report provides the final results of Test and Evaluation (T&E) of the Target Data Extractor Model 2000d (TDX-2000d). T&E of the TDX-2000d was conducted at the Federal Aviation Administration (FAA) William J. Hughes Technical Center with radar/beacon data provided by the Airport Surveillance Radar Model 8 (ASR-8) radar and Army Navy/General Use Pulsed Identification Model 27 (AN/UPX-27) beacon systems. Testing was conducted in limited radar clutter and weather conditions from June 20, 1997, through December 18, 1998.

Further performance testing of the TDX-2000d was conducted in heavy radar clutter and weather conditions at Dobbins Air Force Base (AFB), Atlanta, GA, during July and August 1998. The Army Navy/General Pulsed Navigation Model 20 (AN/GPN-20) radar and Air Traffic Control Beacon Interrogator Model 4 (ATCBI-4) beacon systems. Other tests were performed to verify solutions to discrepancies from September 1998, to the present.

Several problem areas have been indentified during testing. A total of 56 Test Discrepancy Reports (TDRs) were written to describe integration, performance, and operational problems. Discrepancies were classified as either critical, moderate, or minor; 24 critical (2 remain open), 15 moderate (2 remain open), and 17 minor (2 remain open). Plans are in place to close all open TDRs by the third quarter of 2000.

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EXECUTIVE SUMMARY

This report provides the final results of Test and Evaluation (T&E) of the Target Data Extractor Model 2000d (TDX-2000d). T&E of the TDX-2000d was conducted at the Federal Aviation Administration (FAA) William J. Hughes Technical Center with radar/beacon data provided by the Airport Surveillance Radar Model 8 (ASR-8) radar and Army Navy/General Use Pulsed Identification Model 27 (AN/UPX-27) beacon systems. Testing was conducted in limited radar clutter and weather conditions from June 20, 1997, through December 18, 1998. Further performance testing of the TDX-2000d was conducted in heavy radar clutter and weather conditions at Dobbins Air Force Base (AFB), Atlanta, GA., during July and August 1998. The TDX-2000d at Dobbins AFB receives radar/beacon data from the Army Navy/General Pulsed Navigation Model 20 (AN/GPN-20) radar and Air Traffic Control Beacon Interrogator Model 4 (ATCBI-4) beacon systems. Other tests were performed to verify solutions to discrepancies from September 1998, to the present. Twenty-nine discrepancies have been evaluated and closed during that period.

Successful preliminary tests performed on Standard Terminal Automation Replacement System (STARS).

Results from the T&E program indicate that the TDX-2000d successfully validated the following performance measures (requirements):

a. Interface to Automated Radar Terminal System Model IIA (ARTS-IIA) including electrical characteristics and communication protocols.

b. Detects and reports aircraft throughout the coverage volume.

c. Primary detection with false alarm control provided the site is carefully optimized. Primary detection in clutter is equal to or better than other digitizers in the National Airspace System (NAS) such as Common Digitizer Model 2D (CD-2D) or Surveillance Receiver and Processor (SRAP); Primary detection in light to moderate precipitation, in operating modes of Linear Polarization (LP) or Circular Polarization (CP), is a limitation of the radar (ASR-8, AN\GPN-20) not the TDX-2000d.

d. Control of beacon false target reports.

e. Acceptable, limited weather data to the end user.

f. Beacon azimuth resolution and range resolution.

g. Primary range resolution.

h. Primary and secondary positional accuracy.

i. Beacon detection using different beacon systems and in conditions of low and high target densities.

j. Performance and statistical information to the operator; provides maintenance data to the properly trained technician.

Results from the T&E program indicates that the TDX-2000d did not successfully validate the following performance measures (requirements):

a. Throughput time of 2.5 seconds that exceeds the required delay of 2.2 seconds, however, the performance measure of 2.2 seconds does not accurately reflect the allocated throughput delay for the system as configured. Measured delay includes video reconstitution and redigitization to

accommodate the Palm Springs configuration. Subsequent ARTS-IIE/IIIE tests will evaluate the 2.2 second requirement.

b. Primary azimuth resolution that exceeds the performance measure by two Azimuth Change Pulses (ACPs) or 6 percent of the requirement.

Several problem areas have been identified during testing. A total of 56 Test Discrepancy Reports (TDRs) were written to describe integration, performance, and operational problems. Discrepancies were classified as either Critical, Moderate, or Minor; 24 Critical (2 remain open), 15 Moderate (2 remain open), and 17 Minor (2 remain open). Plans are in place to close all open TDRs by the third quarter of 2000.

1. PURPOSE.

Test and Evaluation (T&E) was conducted in accordance with the Target Data Extractor Model 2000d (TDX-2000d) Test Plan. T&E is used to verify that the TDX-2000d is operationally suitable and effective and can meet operational requirements when integrated as part of the National Airspace System (NAS) system.

2. SCOPE.

This report discusses the final results of T&E of the TDX-2000d at the Federal Aviation Administration (FAA) William J. Hughes Technical Center, from June 20, 1997, through December 18, 1998, and at Dobbins Air Force Base (AFB), during the July-August 1998 timeframe. This test effort was performed in support of the Interim Digitizer Program and was not considered a complete NAS System Test or NAS Operational Test and Evaluation (OT&E) program. There were no evaluations conducted by air traffic controllers.

3. BACKGROUND.

With the procurement and implementation of new digital automation equipment (i.e., Standard Terminal Automation Replacement System (STARS)), terminal radar systems will be required to provide a digital surveillance output. Several terminal radar systems operating in the NAS provide only analog data. These systems include Airport Surveillance Radar Model 8 (ASR-8) and their co-located beacon systems.

The decision was made to replace these older radar systems with the new digital Airport Surveillance Radar Model 11 (ASR-11). However, the ASR-11 may not be in place before STARS is installed at the impacted sites. To mitigate the potential risk, methods for providing a digital surveillance output from the ASR-8 to support the STARS interface were investigated. A potential solution was to use the TDX-2000d. The TDX-2000d will accept analog radar and beacon video inputs and output digital messages to STARS. This would be used until the ASR-11 was integrated into NAS.

Several regions have purchased the TDX-2000d and/or Automated Radar Terminal System (ARTS) Interface Unit (AIU), and are integrating it with their existing automation equipment (e.g., ARTS-IIA). The system can provide an alternate method for remoting radar and beacon data. Microwave links and video compression techniques are currently used to provide that function. The potential benefits of using this approach include lower operational costs and improved radar performance. The TDX-2000d and AIU require national certification before they can be used in NAS.

The TDX-2000d must serve as a radar data extractor, beacon data extractor, weather data extractor, and formatter. The extractor must perform target detection, range and azimuth centroiding, and resolution of closely spaced aircraft while maintaining a low false report rate. The extractor must also merge radar and beacon reports associated with the same target.

Tests are needed to verify the TDX-2000d and AIU provide adequate performance and can be properly integrated into NAS. These tests will also aid in the determination of the operational effectiveness, suitability, supportability, and maintainability of the system. The test results will provide information needed for development of NAS certification procedures for the TDX-2000d and AIU.

The TDX-2000d system performance testing was conducted with limited radar clutter and weather conditions at the Technical Center, from June 20, 1997, to March 30, 1999. The TDX-2000d system performance testing was also conducted with heavy radar clutter and moderate weather conditions at Dobbins AFB, Atlanta, GA, from July through September 1998.

4. T&E DESCRIPTION.

This report section describes the final results of T&E of the TDX-2000d conducted at the Technical Center and at Dobbins AFB. The system performance testing was conducted through a series of tests as described in the Integration Test, section 4.1. The reliability, maintainability, and availability of the TDX-2000d system will be conducted through a series of tests as described in the Operational Test, section 4.2. The test configuration used for all tests at the Technical Center is depicted in figure 4-1. The test configuration used for tests at the Dobbins AFB is depicted in figure 4-2.

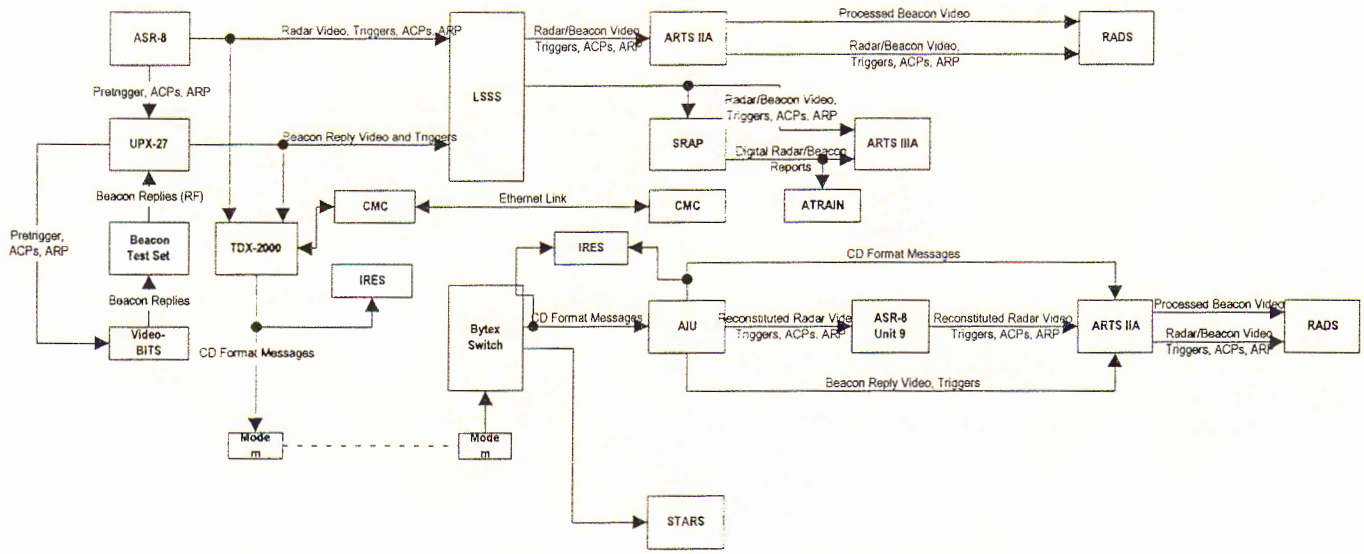

FIGURE 4-1. TECHNICAL CENTER TEST CONFIGURATION

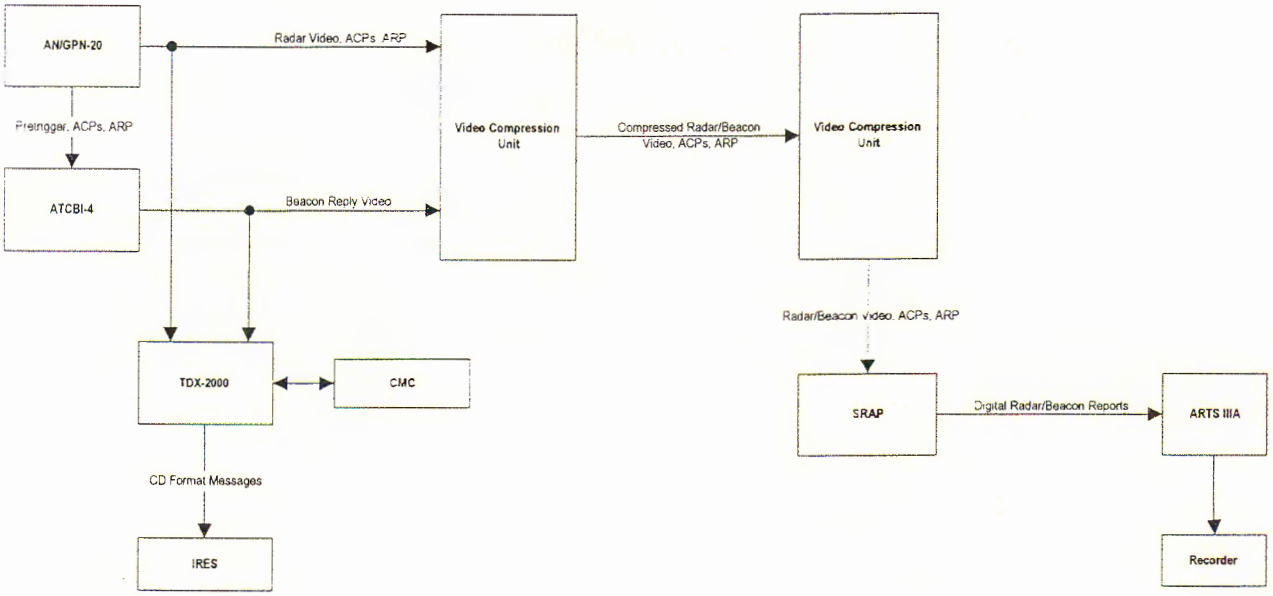

FIGURE 4-2. DOBBINS AFB TEST CONFIGURATION

Throughout the conduct of T&E, various test failures or system problems were encountered. Test Discrepancy Reports (TDRs) were developed to track and identify each test failure or system problem discovered. These reports identify the test in progress, TDX-2000d software build in use, criticality of the problem, a description of the problem/failure, and recommended course of action.

Appendix A provides a summary table of the 56 TDRs written by ACT-310 during testing at the Technical Center and at Dobbins AFB. Included in this table is the TDR number, the date the TDR was developed, a brief description, the criticality of the problem, and the closure status.

The TDRs were classified as Critical, Moderate, or Minor. Critical discrepancies describe problems which prevent the TDX-2000d from operating successfully in the NAS. Moderate discrepancies describe problems which primarily affect user ability to maintain or troubleshoot the radar. Minor discrepancies describe annoyances which may result in increased work for the user. In summarizing the test discrepancies, there were: 24 Critical (2 remain open), 15 Moderate (2 remain open), and 17 Minor (2 remain open).

Appendix B lists the Integrated Radar Evaluation System (IRES) test tool programs used during data reduction and analysis. Appendix C lists the Radar Beacon Analysis Tool (RBAT) programs used during data reduction and analysis.

System software changed several times during the test period. Software upgrades were made, primarily, to correct discrepancies. Initial software configuration was; TDX-2000d version 1.0, Control and Maintenance Monitor (CMC) version 1.0. The current software version for the TDX-2000d is 3.5 and the CMC is currently operating with version 3.5. One significant software change was adopted in December 1998. This TDX-2000d and CMC revision included a solution to improve primary azimuth resolution. Regression tests were

conducted to verify improvement. The current version of software standardized the FAA and Air Force configurations in all areas where practical.

4.1 INTEGRATION TESTS.

This section describes the final results of TDX-2000d system integration T&E. The integration tests were conducted at the Technical Center, from June 20, 1997, to March 30, 1999, and at Dobbins AFB, from July through September, 1998. Integration tests are used to verify that the TDX-2000d system end-to-end performance provides suitable system coverage, target detection, search and beacon surveillance data, and weather data to the end user in the NAS. Other tests were performed to verify solutions to discrepancies from September 1998, to the present. Twenty-nine discrepancies have been evaluated and closed during that period.

4.1.1 TDX-2000d to AIU.

4.1.1.1 User Port Operation.

4.1.1.1.1 Criteria.

Verify that the TDX-2000d user ports can be configured to support user requirements. Verify that the clock and data electrical characteristics, and timing are in compliance with EIA-RS-232 and EIA-RS-422 standards at varying signal rates. (Reference: Performances Measures; Paragraph 8. Paragraph 3.a.(5). Physical Interfaces, Critical Operational Issues (COI) COI 6.0 NAS Interoperability).

4.1.1.1.2 System Configuration.

Pulse characteristic measurements were made at the Universal Input/Output (UNIO) output ports and at the Signal Distribution Unit (SDU) front panel monitor jacks. UNIO output ports provide surveillance and weather messages to the modems and the SDU monitor jacks allow maintenance personnel to view and record surveillance data. Data and clock signal characteristics measured include: voltage, pulse width, rise time, fall time, data transition, and polarity. These measurements were performed for the RS-232 and RS-422 standards operating at various baud rates.

UNIO board #1 (surveillance) is configured for normal clock and data polarity at a baud rate of 9600, RS-232 protocol. UNIO board #2 (weather) is configured for normal clock polarity and inverted data polarity at a baud rate of 9600, RS-232 protocol. SDU monitor jacks are not configurable, but provide surveillance data at the selected baud rate in RS-422 and RS-232 protocols.

Pulse characteristics were measured using a Hewlett Packard Model 54510A Digitizing Oscilloscope. Channel one of the oscilloscope was used to measure data signal characteristics (i.e., voltage, pulse widths, rise times, fall times) while channel two of the oscilloscope measured clock signal characteristics. The two channels were compared to ensure that data levels transitioned on the correct edge of the clock and that setup and hold times were being observed. Measurements were repeated for RS-232 protocol at various baud rates.

Action was taken at the UNIO configuration menu to switch baud rates and polarity for six available user ports (J14 through J19) at the rear distribution panel. The SDU monitor door was lowered to access the monitor jacks (J42 through J45).

4.1.1.1.3 Results.

The TDX-2000d provides sufficient flexibility to configure the communications ports to support FAA requirements. Up to four ports can be configured for one individual user including dedicated ports for weather, sector marks, and surveillance data. Switching user protocols from RS-232 to RS-422 requires an Integrated Circuit (IC) replacement on the UNIO board. A spare user port is not provided for manual or automatic switching.

Oscilloscope measurements indicate that clock and data voltages, pulse widths, and rise and fall times were in compliance with EIA-RS-232 and RS-422 standards at the various baud rates. Data transitioned on the correct edge of the clock.

Monitor jacks, at the SDU front panel, provided surveillance data including; beacon, radar, status, sector marks, and Real-Time Quality Control (RTQC). Weather data is not provided at the monitor jacks. This problem is described in TDR ACT025 listed in appendix A.

4.1.1.2 Data Format Verification.

4.1.1.2.1 Criteria.

Verify that the TDX-2000d reliably and accurately transmits all expected message types to the AIU in correct ASR-9 Common Digitizer (CD) format. Verify that the TDX-2000d consistently reports beacon and search RTQC and status messages to the AIU each scan. Verify that the TDX-2000d can detect, process, and report civil and military beacon emergencies in the proper format. Verify that changes in the TDX-2000d status are detected and accurately reported in the status messages sent to the AIU and on the local and remote Control and Maintenance Console (CMC). (Reference: Performances Measures; Paragraph 8. Paragraph 3.a.(5). Physical Interfaces, Critical Operational Issues (COI) COI 6.0 NAS Interoperability).

4.1.1.2.2 System Configuration.

Data were collected at output ports of the SDU patch panel. The TDX-2000d UNIO boards were configured to output ASR-9 CD format messages. Data sources included targets of opportunity and beacon test targets.

Target of opportunity data were recorded to verify that the TDX-2000d outputs each message type in the correct format. The message types include: search, beacon, sector mark, status, and weather messages. The data were analyzed to ensure that the beacon RTQC, search RTQC, and status message are correctly output on each scan.

To exercise TDX-2000d status message bits, faults were injected or configuration changes were made to the TDX-2000d while data were recorded with Real-Time Aircraft Display System (RTADS). Front panel and status menu indications were observed for corresponding changes in alarm or status. Recorded data were analyzed to ensure the correct fault or status bit changes were reported.

Beacon test targets were injected into the Army Navy/general Use Pulsed Identification Model 27 (AN/UPX-27) at Radio Frequency (RF) to verify that bits in the beacon message operate properly and that the TDX-2000d properly processes beacon emergencies. Targets were injected at various ranges and azimuths. Mode 3/A and Mode 2 codes were chosen to exercise all bits in the beacon message. Target altitudes were varied to test the Mode C field in the message. Invalid Mode C altitudes were injected to verify the TDX-2000d

properly reports illegal altitudes. The beacon test scenarios used for this test are listed in table 4.1.1.2.2-1.

TABLE 4.1.1.2.2-1. BEACON TEST TARGET SCENARIOS

Scenario	Description
DETECT06.SET	12 individual targets with range movement. All runlengths = 31 ACPs. Replies to Modes 3/A, 2, C interrogations. No azimuth movement. Round Reliability = 100%.

Target	Start Range (nm)	Start Azim. (deg)	Range Movement (nm/hr)	M3 Code	MC Code
1	5	5	700	7776	5320
2	10	30	625	7775	1420
3	15	60	565	7773	5320
4	20	90	505	7767	1420
5	25	120	445	7757	5320
6	30	150	385	7737	1420
7	35	180	325	7677	5320
8	40	210	265	7577	1420
9	45	240	205	7377	5320
10	50	270	145	6777	1420
11	55	300	085	5777	5320
12	55	330	025	3777	1420

DETECT08.SET

Same as DETECT06.SET, except all heights and height rates as listed:

Target	Start Altitude	Altitude Rate
1	5k	17 ft/sec
2	10k	"
3	15k	"
4	20k	"
5	25k	"
6	30k	"
7	35k	"
8	40k	"
9	45k	"
10	50k	"
11	55k	"
12	60k	"

MC0000.SET	Sixteen spokes with ten targets per spoke. All Mode C codes = 0000.
INVAL_MC.SET	Sixteen spokes with ten targets per spoke. Mode C codes are invalid. (i.e., ABCD = 0001, 0051 or 0071).

The MC0000.SET and INVAL_MC.SET scenarios were injected to test the TDX-2000d detection and reporting of Mode C replies containing only brackets and Mode C reported altitudes that are outside the allowable range of values.

In addition, civil and military emergency replies were injected into the AN/UPX-27. Four scenarios tested TDX-2000d beacon emergency processing and reporting. The four scenarios and a description of each are listed in table 4.1.1.2.2-2.

EMNOMC01.SET was designed to test the ability of the TDX-2000d to process civilian emergency replies (7500, 7600, or 7700 Mode 3/A codes). The remaining three scenarios (EMNOMC02.SET - EMNOMC04.SET) were designed to test military emergency processing. A military transponder sends four replies in succession to denote an emergency. The F1 bracket pulse of each of the three trailing replies is positioned in the SPI position of the preceding reply.

TABLE 4.1.1.2.2-2. BEACON EMERGENCY PROCESSING SCENARIOS

Scenario	Description
EMNOMC01.SET	4 of each (7500, 7600, 7700) emergency target. Start range = 30 nm. Range movement varies from 700 to 150 nm/hr. Runlengths vary from 40 to 25.
EMNOMC02.SET	3 military emergency targets. First target set contains 4 replies with only brackets in replies 2 - 4. Second target set has 2nd reply missing. Third target set has 3rd reply missing.
EMNOMC03.SET	3 military emergency targets with nominal min and max spacing (up to 300 ns error). Each target set contains 4 replies.
EMNOMC04.SET	3 military emergency targets. Same as EMER002.SET except same code in all four replies for each target set.

4.1.1.2.3 Results.

The TDX-2000d transmits messages that are compatible with the ASR-9 CD format. The TDX-2000d outputs all message types to the FAA end user with the exception of several bit positions in the search and status messages. See table 4.1.1.2.3-1 to identify the search message bits that are hard coded and see table 4.1.1.2.3-2 to identify the status message bits that are active.

TABLE 4.1.1.2.3-1. SEARCH MESSAGE HARD CODED BITS

FIELD	MSG.BITS	DESCRIPTION
4	40 - 41	Quality of the search target (ASR-9 definition). Hard coded to decimal 3. 40 41 1 1
4	42 - 44	Confidence of the search target (ASR-9 definition). Hard coded to decimal 4. 42 43 44 1 0 0
4	45 - 46	Target tracking eligibility (ASR-9 definition). Hard coded to decimal 2. 45 46 1 0
4	47 - 49	Target ARTS IIIA quality (ASR-9 definition). Hard coded to decimal 7. 47 48 49 1 1 1
4	50	(ASR-9 definition) Set to decimal 0.

TABLE 4.1.1.2.3-2. STATUS MESSAGE ACTIVE BITS

FIELD	MSG BITS	DESCRIPTION
2	19, 20, 22, 25	19 1 Indicates TDX #1 (A) is on line. 0 Indicates TDX #2 (B) is on line. 20 1 Indicates a fault in TDX #1 (A). 22 1 Indicates a fault in TDX #2 (B). 25 1 Indicates a fault in the weather processor.
3	34, 35	34 1 If UNIO board #1 transmit FIFO exceeds 90% depth on any channel. 35 1 If UNIO board #2 transmit FIFO exceeds 90% depth on any channel.

Inspection of RTADS data recorded when DETECT06.SET and DETECT08.SET scenarios were injected, showed that detected targets reported the expected range, azimuth, Mode 3/A, and Mode C codes.

The MC0000.SET and INVAL_MC.SET scenarios results showed that when targets with 0000 Mode C codes (brackets only) were injected, the TDX-2000d reported

-1,200-foot altitude. When targets with invalid Mode C altitudes (D1 bit set and C1, C2, and C4 bits = 000, 101, or 111) were injected, the TDX-2000d reported -1,200-foot altitude.

A flight test recording was randomly selected during T&E and examined for missing or dropped RTQC, status, or sector mark messages. The recorded file, RUN018 (2/2/98), showed no missing radar or beacon RTQCs, status, or sector mark messages in 1,330 scans. However, other recorded files indicate occasional missing RTQC's. TDX-2000d RTQCs are not protected from real traffic affects. False alarms and crossing traffic in the close vicinity of the RTQC's position can cause a message ID or a position change which results in an undeclared RTQC. This problem was described in TDR ACT038 listed in appendix A.

During the initial phase of T&E, the TDX-2000d failed to detect a military emergency situation and report a 7700 code in position of the first reply. Instead, code transformation did not occur; an emergency was not detected when either the second or third (but not both) reply is missing in the set of four reply pulse trains, and emergency replies were not being output in the proper format. These problems were described in TDRs ACT017, ACT018, and ACT019 listed in appendix A.

After changes were made to the TDX-2000d software to correct the military emergency detection problems, the tests were repeated during T&E regression. The TDX-2000d successfully reported a 7700 code for each beacon emergency scenario injected.

All status bits listed in table 4.1.1.2.3-2 were demonstrated to operate properly. The remaining 30 bits, excluding header (field 1) and parity bits of the status message, are inactive and were not tested during T&E.

4.1.1.3 Degraded Operations.

4.1.1.3.1 Criteria.

Verify that the TDX-2000d can detect a modem failure and redirect data transmission over remaining, operating modem channels. Verify that priority messages (i.e., beacon emergency, status, RTQCs) are output during overload conditions. Verify that TDX-2000d graceful degradation functionality operates correctly during overload conditions.
(Reference: Performances Measures; Paragraph 8. Paragraph 3.a.(5). Physical Interfaces, Critical Operational Issues (COI) COI 6.0 NAS Interoperability).

4.1.1.3.2 System Configuration.

Radar targets of opportunity data and the beacon civil emergency test scenario EMNOMC01.SET, listed in table 4.1.1.2.2-2, were used to verify that the TDX-2000d can detect; faulty or unterminated serial ports, route data to the remaining operational channels, prioritize messages, and recover from an overload condition.

Clock and data signals to the TDX-2000d were interrupted and then restored to simulate modem failures. Data were recorded using RTADS. TDX-2000d status log messages, and front panel indications were monitored for configuration changes and faults.

Data output buffers were overloaded to simulate a degraded condition. A degraded condition is controlled by range reduction. The range reduction process stops processing or outputting surveillance targets beyond a specified range until processor loading is reduced and the degraded condition clears;

processing range is reduced in increments determined by an adjustable parameter.

Data was recorded and analyzed to determine if priority messages (e.g., beacon emergencies) are output with failed modem ports.

4.1.1.3.3 Results.

No fault or error indications were observed on the front panel or in the status log as clock and data line were interrupted and restored at the three modem ports. Data collected and analyzed at the input to the modem indicates that surveillance messages are not prioritized. However, any message may be redirected to an available surveillance channel without regard to message type. Surveillance channels (modem ports) are channels #1 and #2 in the Technical Center configuration. Channel #3 is designated for weather data only and will not reconfigure with surveillance messages from other channels.

Loss of data at the modem inputs is not detected by the TDX-2000d. Loss of clock at the input to the TDX-2000d is detected in the surveillance channels (channels #1 and #2). Sector marks and surveillance data is routed to the alarm-free channel when clock is missing from the modem system.

Overload conditions were observed on several occasions due to inversion (anomalous propagation (AP)) in the area causing degraded operation of the TDX-2000d. The TDX-2000d successfully initiated range reduction to reduce processor loading and fully recovered from this degraded condition when the AP dissipated.

The Technical Center configuration places the RTQCs at ranges of 47 to 51 nautical miles (nmi). Invoking range reduction during an overload condition will eliminate RTQC messages since these test targets are not prioritized or protected. This problem is described in TDR ACT038 and is listed in appendix A.

4.1.1.4 Modem to Modem Interface.

4.1.1.4.1 Criteria.

Verify that the modems provide for the transmission of TDX-2000d digital messages to the AIU with a low transmission error rate.
(Reference: Performances Measures; Paragraph 8. Paragraph 3.a.(5). Physical Interfaces, Critical Operational Issues (COI) COI 6.0 NAS Interoperability).

4.1.1.4.2 System Configuration.

The communications between the TDX-2000d and the AIU was tested to ensure that data is transmitted across the fiber-optic backbone satisfactorily. A RS-232 to fiber-optic I/O card was used to transmit TDX-2000d data to the AIU. The configuration and strapping of the I/O card was verified by monitoring front panel indications.

Local and remote loopback tests were performed to verify backbone operation, line quality, and data integrity. During these tests, the transmit and receive I/O card looped data through the local and remote cards and compared the transmitted and received data.

In addition, to internal diagnostics, data was recorded at the input to the local optic I/O card at the SDU patch panel and at the output of the remote optic I/O card located in the Terminal Laboratory Bytex switch simultaneously. The recorded files were compared to verify that both files contain the same information.

4.1.1.4.3 Results.

Diagnostics tests of the fiber logic and optic I/O cards showed that no frame sync or retransmission errors were detected from the local and remote I/O cards. Loopback tests performed from the local to remote and remote to local units indicated good data integrity.

Data recorded at the input to the local optic I/O card at the SDU patch panel and at the output of the remote optic I/O card contained identical beacon, radar, RTQC, and status message counts. The fiber optic communication path from local to remote sites operated trouble free. A high quality telephone line interconnection using standard modems was not tested.

4.1.2 TDX/AIU to ARTS-IIA.

This test section ensures that the TDX/AIU accurately and reliably transmitted reconstituted beacon reply video and digital messages to the ARTS-IIA and provided suitable reconstituted video for air traffic controller displays.

4.1.2.1 Data Format Verification.

4.1.2.1.1 Criteria.

This test ensures that the AIU reliably transmits all expected message types to the ARTS-IIA with the correct bit formatting and with sufficient redundancy. The AIU should output messages in the correct CD format to the ARTS-IIA Mode S/ASR-9 Line Adapter (MALA) board interface. The AIU should consistently report beacon RTQCs, status messages, and sector marks to the MALA board on each scan. The AIU should consistently report emergency replies in the proper format. The changes in the AIU status should be detected and reported in the status messages sent to the MALA. There should be sufficient redundancy in the AIU to reconfigure the standby channel to on-line when a failure is encountered.

4.1.2.1.2 Configuration.

The AIU MALA was connected to the MALA interface of the ARTS-IIA. The AIU was configured to output CD format messages as defined in the Interface Control Document (ICD) Item SE007-4 for the ASR-9 Surveillance and Communications Interface Processor (SCIP) to Terminal Computer. Data sources included targets of opportunity and beacon test targets.

Beacon test targets were injected into the AN/UPX-27 at the RF port to verify that the AIU properly reports beacon replies and emergency replies. Test target scenarios were generated using VideoBITS. Targets were tested with various ranges and azimuths.

There were several recordings conducted with the AIU and the ARTS-IIA systems. RUN115, recorded on June 4, 1998, contains a scenario with four Mode 3A targets including a 7700 emergency target. Data was recorded at input of the AIU with the MX6A record board and the RTADS record program. Data was also recorded using the existing ARTS-IIA recording unit. RUN148, recorded on September 11, 1998, contains data from the AIU MALA output port. This recording was done to examine all required message type output of the AIU.

IRES PLOTSCAN and COUNTPCS programs were used to verify that the AIU reported Beacon Real-Time Quality Control (BRTQC) and status messages per scan. The SHOWPCS program was used to verify that injected beacon replies produced CD messages with the correct range, azimuth, codes, and emergency bits set. Additonal information about these IRES programs can be found in appendix B.

4.1.2.1.3 Results.

Table 4.1.2.1.3-1 contains a data extraction listing of the ARTS-IIA system. Table 4.1.2.1.3-2 contains AIU output data. The ARTS-IIA data extraction indicates that the MALA interface provides all surveillance information to ARTS-IIA I the correct format. The ARTS-IIA received beacon code with the appropriate positional information provided by the AIU. The ARTS-IIA data also contains the appropriate emergency code and BRTQC data as compared to table 4.1.2.1.3-2.

TABLE 4.1.2.1.3-1. RUN115 - ARTS-IIA DATA EXTRACTION

RANGE	ACP	DEG	BEACON	ALT	SOURCE
29.625	0261	023	1111-3	+0004-3	MALA 1
29.625	1284	112	2222-3	+0004-3	MALA 1
47.875	2047	180	7777-3	+0839-3	MALA 1
29.625	2308	202	3333-3	+0004-3	MALA 1
29.625	3333	292	7700-3	+0004-3	MALA 1

TABLE 4.1.2.1.3-2. RUN115 - AIU OUTPUT DATA

RANGE	AZIMUTH	ALTITUDE	ATCRBS
29.656	22.939	400	1111
29.656	112.852	400	2222
29.656	202.676	400	3333
29.656	292.676	400	7700
47.9	179.9	83900	7777

The data observed from RUN148 showed that the AIU MALA output does not provide status messages. The system configuration changes could not be tested with the missing status messages. This problem has been noted in TDR ACT050. No MALA boards have been or are anticipated to be distributed to the field. Additionally, the missing status messages did not affect the processing of surveillance data in the MALA board. Therefore, a test team consensus closed the TDR. The AIU consistently reports BRTQCs and sector marks to the MALA board on each scan.

The AIU had sufficient redundancy to manually reconfigure the standby channel to on-line when a failure was encountered.

4.1.2.2 Video Characteristics.

4.1.2.2.1 Criteria.

This test ensures that the AIU converts surveillance digital target reports and weather contour digital reports into analog video signals that are in an accurate and suitable form for ATC Planned Position Indicator (PPI) displays. The AIU should generate correlated search, uncorrelated search, beacon reply code, and weather video signals with proper electrical characteristics. The AIU should generate radar pre-triggers, beacon pre-triggers and mode-pair triggers with proper electrical and timing characteristics. The AIU should generate Azimuth Change Pulse (ACP) and Azimuth Reference Pulse (ARP) signals

with proper electrical characteristics for time alignment of radar, beacon, and weather videos.

Sufficient target range and azimuth extent adjustments should exist for both radar and beacon video so that the actual position of the target on the display is contained within the reconstituted video symbol. The AIU should provide video, azimuth data, and trigger alignment adjustments so that system data processing delays are properly compensated. Correlated radar targets, uncorrelated radar targets, beacon targets, merged targets, and weather level outputs should be at the correct range and azimuth and can be distinguished on PPI displays.

4.1.2.2.2 Configuration.

Characteristics of the video signals were measured at the output of the AIU. The characteristics measured include: amplitude, pulse width, rise time, fall time, overshoot/undershoot, pulse timing, and pulse jitter. An Hewlett Packard Model 54510A (HP)-54510A digital oscilloscope was used to measure video electrical and timing characteristics.

Beacon test targets were injected into the AN/UPX-27 at the RF port to verify that the AIU properly provides the video electrical and timing characteristics to the ARTS-IIA. Test target scenarios were generated using VideoBITS.

AIU variable site parameters were analyzed to determine if sufficient adjustments exist to provide an accurate reconstituted video presentation on PPI displays. The PPI displays were monitored to see if targets are reported in the correct position and can be resolved.

4.1.2.2.3 Results.

Oscilloscope measurements indicate that video and trigger voltages, pulse widths, and rise and fall times were within the signal characteristics stated in the AIU Operations and Maintenance Manual, paragraph 3.3.2. Signal levels were sufficient to drive one set of PPI displays. Data protocol to the ARTS-IIA MALA interface was satisfactory and the supplied cables and connectors were suitable for interconnection up to 50 feet separation of AIU and ARTS-IIA equipment.

The AIU provides sufficient flexibility to configure the system to support ARTS-IIA requirements. The AIU had range and azimuth extent adjustments for both radar and beacon video. The AIU provided video, azimuth data, and trigger alignment adjustments so that system data processing delays were properly compensated. Correlated radar targets, uncorrelated radar targets, beacon targets, merged targets, and weather level outputs were at the correct range and azimuth as distinguished on PPI displays.

4.1.3 TDX-2000d to STARS.

4.1.3.1 Criteria.

Verify that the TDX-2000d reliably and accurately transmits all expected message types to the STARS in the correct format. Verify that the TDX-2000d consistently reports beacon and search RTQC and status messages to the STARS each scan. Verify that the TDX-2000d can detect, process, and report civil and military beacon emergencies in the proper format.

4.1.3.2 System Configuration.

Data was collected at output ports of the SDU to verify the TDX-2000d outputs messages in the correct format. Data was also collected with the STARS data

extraction tools. The TDX-2000d UNIO boards will be configured to output ASR-9 CD format messages. Data sources include targets of opportunity, search test targets, and beacon test targets. Figure 4-1 illustrates setup details; additionally, data for modem ports 1 and 2 were configured inverted and modem port 3 was configured normal at the UNIO configuration menu.

Target of opportunity data was recorded to verify that the TDX outputs each message type in the correct format. The message types include: search, beacon, sector mark, and weather messages. The data were also analyzed to ensure that the beacon RTQC, search RTQC, and status message output is correct on each scan.

Beacon test targets were injected into the AN/UPX-27 at RF to verify that bits in the beacon message operate properly and that STARS properly processes beacon emergencies. Targets were injected at various ranges and azimuths. Mode 3/A and Mode 2 codes were chosen to exercise all bits in the beacon message. Target altitudes were varied to test the Mode C field in the message. Invalid Mode C altitudes were also injected to verify the TDX properly reports illegal altitudes. In addition, civil and military emergency replies were injected into the AN/UPX-27 to test the ability of the TDX to process these replies.

To exercise TDX status message bits, configuration changes were made and/or faults were injected into the TDX while data is recorded at STARS. These configuration changes should be reflected in the status message detected by STARS.

Several tests were performed on October 5 and 6, 1998, to verify integration and interface requirements. STARS was operating at the Full Service Level (FSL) software version 5.0.0. STARS Continious Data Recorder (CDR) was used to collect data and the STARS Data Reduction and Analysis (DR&A) tool was used for data evaluation.

The STARS system including hardware, software, and DR&A were under test and not officially accepted by the FAA at the time of the tests.

Table 4.1.3.2-1 is a description of test target scenarios used to verify that STARS receives and processes all types of message formats.

TABLE 4.1.3.2-1. STARS TEST TARGET SCENARIOS

Scenario	Description
BMALA.SET	10 spoke targets spaced 35 degrees apart at 30 nmi, 1kft alt. Different codes, no movement. R/L 32 acps
B4TARG.SET	4 targets spaced 90 degrees apart with codes; 1111, 2222, 3333, 4444; at 30 nmi, no movement.
EMNOMC02.SET	3 military emergency targets. First target set contains 4 replies with only brackets in replies 2 - 4. Second target set has 2nd reply missing. Third target set has 3rd reply missing.
BDXCAP.SET	240 spoke targets with a start range = 14nmi, at 5 nmi increments. Code 1234, 10kft, R/L 32acps
RDXCAP.SET	240 spoke targets with a start range = 13nmi, at 5 nmi increments. Fi pulse only, set to .8 usec to simulate radar targets. One ring of targets reinforce.
DETECT006.SET	12 individual targets with range movement. All runlengths = 31 ACPs. Replies to Modes 3/A, 2, C interrogations. No azimuth movement. Round Reliability = 76%.

Target	Start Range (nmi)	Start Azim. (deg)	Range Movement (nmi/hr)	M3 Code	M2 Code	MC Code
1	30	5	600	7776	0001	5230
2	50	30	550	7775	0002	2546
3	70	60	500	7773	0004	5230
4	90	90	450	7767	0010	2546
5	110	120	400	7757	0020	5230
6	130	150	350	7737	0040	2546
7	150	180	300	7677	0100	5230
8	170	210	250	7577	0200	2546
9	190	240	200	7377	0400	5230
10	210	270	150	6777	1000	2546
11	230	300	100	5777	2000	5230
12	240	330	50	3777	4000	2546

WXTEST.SET	A weather test pattern wedge with several levels, movemet at 90 degrees from 15 to 60 mni.
INVAL_MC.SET	Sixteen spokes with ten targets per spoke. Mode C codes are invalid. (i.e. ABCD = 0001, 0051 or 0071).

4.1.3.3 Results.

RUN202 recorded 25 scans of the BMALA.SET scenario at the output of the TDX-2000d, ACY202TM.TRA, and simultaneously, at the STARS CDR, LST202ST.CDR. The two recorded files were compared using the IRES and STARS DR&A to compile the messages in tabular form. A representative example of one (1) scan of TDX-2000d and STARS data is shown in tables 4.1.3.3-1 and 4.1.3.3-2, respectively. The tables' total message count is identical except for a status message that

is not reported in the STARS data. The STARS system ignores the ASR-9 CD status message.

STARS or the DR&A function interprets sector marks as search uncorrelated (SU) RTQC due to the similarity of the S-RTQC and sector mark messages in the CD-2 (enroute) and ASR-9 CD (terminal) message protocols.

However, STARS properly interpreted, displayed, and recorded surveillance messages. Beacon code, range, azimuth, and altitude were correct. RTQCs messages were correctly identified and range and azimuth information was correct.

TABLE 4.1.3.3-1. RUN202 TDX OUTPUT, ONE SCAN

ID	RNG NMs	AZ ACPs	ALT/HT FT	CODE 3/A	TIME HH:MM:SS.ss
S-RTQC	50.0	2048			13:24:20.80
S-RTQC	50.0	2048			13:24:20.80
B-RTQC	47.9	2047	83900_3	7777_3	13:24:20.90
Sector	0.0	2176			13:24:20.90
Sector	0.0	2304			13:24:21.10
Sector	0.0	2432			13:24:21.20
BO	29.7	2020	1000_3	5555_3	13:24:21.20
Sector	0.0	2560			13:24:21.40
Sector	0.0	2688			13:24:21.60
Sector	0.0	2816			13:24:21.70
BO	29.7	2419	1000_3	6666_3	13:24:21.80
Sector	0.0	2944			13:24:21.80
Sector	0.0	3072			13:24:22.00
Sector	0.0	3200			13:24:22.10
BO	29.7	2817	1000_3	1234_3	13:24:22.20
Sector	0.0	3328			13:24:22.30
Sector	0.0	3456			13:24:22.40
BO	29.7	3216	1000_3	2345_3	13:24:22.50
Sector	0.0	3584			13:24:22.50
Sector	0.0	3712			13:24:22.80
Sector	0.0	3840			13:24:22.90
Sector	0.0	3968			13:24:23.00
BO	29.7	3613	1000_3	3456_3	13:24:23.10
Sector	0.0	0			13:24:23.10
Sector	0.0	128			13:24:23.30
Sector	0.0	256			13:24:23.40
Status	0C0 002 000 000				13:24:23.50
BO	29.7	4011	1000_3	4567_3	13:24:23.50
Sector	0.0	384			13:24:23.60
Sector	0.0	512			13:24:23.70
Sector	0.0	640			13:24:23.90
Sector	0.0	768			13:24:24.10
Sector	0.0	896			13:24:24.20
BO	29.7	427	1000_3	1111_3	13:24:24.20
Sector	0.0	1024			13:24:24.40
Sector	0.0	1152			13:24:24.50
BO	29.7	825	1000_3	2222_3	13:24:24.60
Sector	0.0	1280			13:24:24.60
Sector	0.0	1408			13:24:24.80
Sector	0.0	1536			13:24:24.90
Sector	0.0	1664			13:24:25.10
BO	29.7	1224	1000_3	3333_3	13:24:25.10
RO	54.3	1343			13:24:25.20
Sector	0.0	1792			13:24:25.20
Sector	0.0	1920			13:24:25.40
Sector	0.0	2048			13:24:25.50
BO	29.7	1622	1000_3	4444_3	13:24:25.50

TABLE 4.1.3.3-2. RUN202 STARS OUTPUT, ONE SCAN

Time	Beacon Type	Range Code	Azimuth (NM)	Flight (ACP)	Radar Level	Radar Number	Sector
17:24:19.577	SU -RTQC		49.98	2048		1	17
17:24:19.577	SC -RTQC		49.98	2048		1	17
17:24:19.577	MD3A-RTQC	7777	47.92	2047	839	1	16
17:24:19.637	SU -RTQC		0.00	2176		1	18
17:24:19.807	SU -RTQC		0.00	2304		1	19
17:24:19.919	MD3A-ONLY	5555	29.66	2020	10	1	16
17:24:19.978	SU -RTQC		0.00	2432		1	20
17:24:20.057	SU -RTQC		0.00	2560		1	21
17:24:20.227	SU -RTQC		0.00	2688		1	22
17:24:20.388	SU -RTQC		0.00	2816		1	23
17:24:20.437	MD3A-ONLY	6666	29.66	2419	10	1	19
17:24:20.558	SU -RTQC		0.00	2944		1	24
17:24:20.677	SU -RTQC		0.00	3072		1	25
17:24:20.868	SU -RTQC		0.00	3200		1	26
17:24:20.977	MD3A-ONLY	1234	29.66	2817	10	1	23
17:24:20.977	SU -RTQC		0.00	3328		1	27
17:24:21.118	SU -RTQC		0.00	3456		1	28
17:24:21.279	MD3A-ONLY	2345	29.66	3216	10	1	26
17:24:21.337	SU -RTQC		0.00	3584		1	29
17:24:21.458	SU -RTQC		0.00	3712		1	30
17:24:21.539	SU -RTQC		0.00	3840		1	31
17:24:21.693	SU -RTQC		0.00	3968		1	32
17:24:21.797	MD3A-ONLY	3456	29.66	3613	10	1	29
17:24:21.857	SU -RTQC		0.00	0		1	1
17:24:21.968	SU -RTQC		0.00	128		1	2
17:24:22.178	SU -RTQC		0.00	256		1	3
17:24:22.242	MD3A-ONLY	4567	29.66	4011	10	1	32
17:24:22.298	SU -RTQC		0.00	384		1	4
17:24:22.398	SU -RTQC		0.00	512		1	5
17:24:22.608	SU -RTQC		0.00	640		1	6
17:24:22.748	SU -RTQC		0.00	768		1	7
17:24:22.928	SU -RTQC		0.00	896		1	8
17:24:22.987	MD3A-ONLY	1111	29.66	427	10	1	4
17:24:23.038	SU -RTQC		0.00	1024		1	9
17:24:23.157	SU -RTQC		0.00	1152		1	10
17:24:23.280	MD3A-ONLY	2222	29.66	825	10	1	7
17:24:23.338	SU -RTQC		0.00	1280		1	11
17:24:23.467	SU -RTQC		0.00	1408		1	12
17:24:23.598	SU -RTQC		0.00	1536		1	13
17:24:23.807	SU -RTQC		0.00	1664		1	14
17:24:23.868	MD3A-ONLY	3333	29.66	1224	10	1	10
17:24:23.927	SU		54.28	1343		1	11
17:24:23.988	SU -RTQC		0.00	1792		1	15
17:24:24.087	SU -RTQC		0.00	1920		1	16
17:24:24.268	SU -RTQC		0.00	2048		1	17
17:24:24.268	MD3A-ONLY	4444	29.66	1622	10	1	13

Table 4.1.3.3-3 lists the message counts, in tabular form, for one scan of data. The messages listed in the table are representative of the entire contents of each recording.

TABLE 4.1.3.3-3. SUMMARY OF ONE SCAN OF MESSAGES

One Scan of Surveillance Data							
Run	B-RTQC	S-RTQC	Valid Bcn Only	Radar Correla te	Radar Un-Correlat e	Re-Inforce d	Sector Mark
202 TDX	1	2	10	N/A	1	N/A	32
202 STARS	1	2	10	N/A	1	N/A	32
204 TDX	1	2	3	N/A	N/A	N/A	32
204 STARS	1	2	3	N/A	N/A	N/A	32
205 TDX	1	2	114	N/A	N/A	N/A	32
205 STARS	1	2	114	N/A	N/A	N/A	32
207 TDX	1	2	205	142	208	52	32
207 STARS	1	2	205	142	208	52	32
209 TDX	1	2	10	N/A	N/A	N/A	32
209 STARS	1	2	10	N/A	N/A	N/A	32

RUN204 recorded 25 scans of the EMNOMC02.SET scenario at the output of the TDX-2000d, ACY204TM.TRA, and simultaneously, at the STARS CDR, LST204ST.CDR. Analyzing and comparing the contents of the two recorded files indicate that STARS properly displayed and recorded the emergency targets as 7700 beacon codes at the proper range and azimuth.

RUN205 recorded 25 scans of the INVAL_MC.SET scenario at the output of the TDX-2000d, ACY205TM.TRA, and simultaneously, at the STARS CDR, LST205ST.CDR. Analyzing and comparing the contents of the TWO recorded files indicate that STARS properly recorded the invalid Mode C messages, that were Mode 3/A validated, at the proper range and azimuth and reported the altitude as -1,200 feet.

RUN207 recorded 25 scans of the BDXCAP.SET in combination with RDXCAP.SET scenarios at the output of the TDX-2000d, ACY207TM.TRA, and simultaneously, at the STARS CDR, LST207ST.CDR. The BDXCAP and RDXCAP scenarios produced a capacity pattern with some beacon targets that were reinforced with radar. Analyzing and comparing the contents of the two recorded files indicate that STARS properly recorded and displayed all surveillance messages including reinforced. Approximately 711 messages per scan were recorded at the output of the TDX and were input to STARS. The STARS system displayed targets normally with this capacity scenario.

RUN209 recorded 25 scans of the DETECT006.MD2 scenario at the output of the TDX-2000d, ACY209TM.TRA, and simultaneously, at the STARS CDR, LST209ST.CDR. Analyzing and comparing the contents of the two recorded files indicate that STARS recognized the validated Mode 3/A and Mode 2 codes generated by the TDX-2000d. STARS interpreted Mode 2 codes with bits reordered in Octal format (e.g., A_1, A_2, A_4, B_1, B_2, B_4, etc.)

Two tests were performed to verify status message content and operation. RUN210 exercised the FIFO overflow bit and RUN211 tested status bits that indicate the on-line and fault condition of the TDX-2000d. STARS DR&A did not provide a means to capture or analyze the status message. The content, function, and use of the status message in STARS could not be determined.

Weather test targets generated from the WXTEST.SET scenario of RUN208 was displayed on the STARS monitors at the correct location. The path of the moving weather cell was observed to start and end at the correct location on the monitors. STARS DR&A did not provide a means to capture or analyze the weather message. A comparison could not be made of the spatial, temporal composition, or levels of the weather cells recorded by STARS.

In summary, the TDX-2000d provides an adequate interface to STARS for surveillance data. Target reports are presented on the STARS displays at their proper range and azimuth. Weather data is detected and displayed in STARS; however, the content and accuracy of the weather messages could not be confirmed. Results are preliminary since STARS has not been accepted or certified by the FAA at the time of the test.

4.1.4 TDX/AIU to Power Subsystem.

Criteria

Verify that the TDX-2000d and AIU provide a means for maintaining any critical data necessary to restore the system to normal operation in an acceptable time following restoration of power when a power loss occurs. Verify that the restoration of normal operation is automatic and that all operational programs, fixed and dynamic maps, and site adjustable parameters are preserved.

System Configuration

The TDX-2000d is equipped with an American Power Conversion (APC) Model 3000 VA Uninterruptable Power Supply (UPS) that provides battery backup for both target extractors, SDU, and CMC. The Technical Center configuration included an additional power load of two Personal Computers (PCs) and one oscilloscope. The AIU cabinet does not contain an UPS or other power backup systems.

Tests were performed to determine the impact that power interruptions have on both the TDX-2000d and AIU. Tests were also conducted to determine how long the UPS can maintain TDX-2000d operation. Power was interrupted to the equipment for a short term (i.e., less than 15 seconds), and for a long term (i.e., greater than 15 seconds). Following restoration of power, the amount of time needed to restore normal operation was noted. Any alarms that remain in the system after recovery were also recorded.

Data was recorded at the output ports of the TDX-2000d and the input ports of the AIU during the power interruptions. This data was analyzed to determine if any false reports were output to the user. The data was also analyzed to determine the amount of time the TDX-2000d and AIU required to restore operation and output data to the user.

Results

The TDX-2000d successfully recovered from short term power failures due to the UPS supplying power to the cabinet. No loss of critical data was recorded during short-term power loss and no false reports were recorded or observed. Long-term power loss tests were also successful. The UPS maintained adequate

power to the TDX-2000d cabinet for a period in excess of 24 minutes. No false reports or alarms were observed and no loss of data were recorded.

Surveillance video and triggers to the ARTS-IIA were missing for a period of approximately 56 seconds during short- and long-term power loss tests of the AIU. This is the amount of time required for the individual AIU to reset after power is restored. No battery backup is provided for the AIU cabinet; therefore, video and MALA data are not generated until the AIU is fully restored. All AIU adjustable parameters were restored to their optimized values and the AIU recovered alarm free.

4.1.5 System Coverage.

4.1.5.1 Criteria.

Verify that the TDX-2000d detects and reports radar and beacon targets from 0.5 to 55 nmi and through 360° in azimuth. Verify that the elevation reporting coverage is from 0 to 30° and that the beacon altitude coverage extends to 20,000 feet Above Ground Level (AGL). (Reference: Performances Measures; Paragraph 8. Paragraph 3.a.(1).(a) Detection Volume, Critical Operational Issues (COI) COI 1. Coverage).

4.1.5.2 System Configuration.

Target of opportunity data and test targets were used for coverage analysis at the Technical Center. The data were collected at the SDU output ports using an MX-6A record board and RTADS record software. Targets of opportunity data were also collected at the output of the Surveillance Receiver and Processor (SRAP) which used normal and Moving Target Indicator (MTI) video from the ASR-8 site. Targets of opportunity data were also collected at the AN/GPN-20 radar at Dobbins AFB, Georgia.

4.1.5.2.1 Configuration at the Technical Center.

Targets of opportunity, RUN052, were recorded on March 3, 1998. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. Simultaneously, data was collected at the output of the SRAP which supplies surveillance messages to the ARTS-III automation system. See figure 4-1 for setup and configuration details.

Additional tests were performed to verify search sensitivity at ranges less than 1.5 nmi. A test target scenario was recorded on June 9, 1998, and on October 9, 1998, as RUN117 and RUN156, respectively. The scenario consists of three test targets injected at the channel A incident port of the ASR-8 using VideoBITS test tool. This test scenario generated targets that began at a range of 4 nmi and were advanced through 0 nmi using a range rate of 100 nmi/hour. Targets were adjusted to approximately +10 dB above Minimum Discernable Signal (MDS). RUN117 is a surveillance data recording with an older version of software. RUN156 is a surveillance data recording with the new version of software; both recordings were generated using an identical scenario.

Site parameters were optimized with the cooperation of the contractor during the beginning of T&E. The TDX-2000d was not reoptimized for the conduct of this test; however, new software was installed to improve search sensitivity at ranges less than 1.5 nmi. The software update addresses the problem described in TDR ACT043 listed in appendix A.

Coverage analysis for RUN052 was performed using IRES. The data was first converted to PCS-2 format using COPYCD. The data was then sorted into range

and azimuth order for each scan using the PREPPCS program. The data was then tracked using TRACK, an alpha-beta tracker in IRES. The QUALIFY program then compared the resultant tracks to a predetermined set of criteria (e.g., minimum track age, minimum distance traveled, percent beacon, etc.) to determine the status of each track (true, false, or unknown).

The FILTER program separated the track data into true and false track files. The true track file was then used for coverage analysis.

The true track data was plotted using the PLOTPCS and PLOTRHI programs. PLOTPCS presents a PPI plot of range versus azimuth. These plots present the minimum and maximum range of coverage at all azimuth angles. PLOTRHI plots reports in a range versus elevation format. The radar antenna height and 3/4 earth curvature are taken into account. The plot shows areas of reduced search detection by the lower reinforcement rate.

Coverage analysis for injected test targets, RUN117 and RUN156, were converted to PCS-2 format using COPYCD. FILTER was used to extract 34 scans of the total scans recorded and the data was filtered to include ranges from 0 to 5 nmi. Also, TDX-2000d data was filtered to include only Radar Only (RO) and Radar Correlated (RC) reports to match the messages reported by the SRAP. COUNTPCS was used to count the number of RO and RC reports for TDX-2000d and SRAP.

4.1.5.2.2 Configuration at Dobbins AFB.

Targets of opportunity, RUN513, were recorded on July 27, 1998. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. See figure 4-2 for setup and configuration details.

Coverage analysis for RUN513 was performed using IRES. The data was reduced and analyzed with the same techniques described in paragraph 4.1.5.2.1.

4.1.5.3 Results.

4.1.5.3.1 Technical Center Results.

Figure 4.1.5.3.1-1 presents a PLOTPCS plot (400 scans) of the true tracks during RUN052. Tracks represent search reinforced beacon reports, beacon only reports, and radar only reports. From the figure, the TDX-2000d provides very good range coverage for primary and secondary targets from 0 to 360° in azimuth at ranges from 1.5 nmi to 60 nmi.

Figure 4.1.5.3.1-2 shows a Range Height Indicator (RHI) plot for RUN052. The plot shows that the TDX-2000d provides good search and beacon detection at altitudes within its coverage extent. The tracks also show that the TDX-2000d provides coverage from 0° elevation angle through 30°.

Figure 4.1.5.3.1-3 is a plot of RUN117 (34 scans) collected at the TDX-2000d using a test target scenario with an older version of software. Figure 4.1.5.3.1-4 shows the RUN156 plot (34 scans) with the new version of software using the same test target scenario. The new software includes an improvement to search sensitivity at close in ranges. The new software increased RC target detection by greater than 20 percent at ranges less than 5 nmi as can been seen in figure 4.1.5.3.1-4.

Overall reinforcement rate for the Technical Center TDX-2000d system is 92.5 percent and the overall reinforcement rate for the Technical Center SRAP is

80.7 percent using RUN052 data. Reinforcement rate was calculated using the RBAT and IRES COUNTPCS programs.

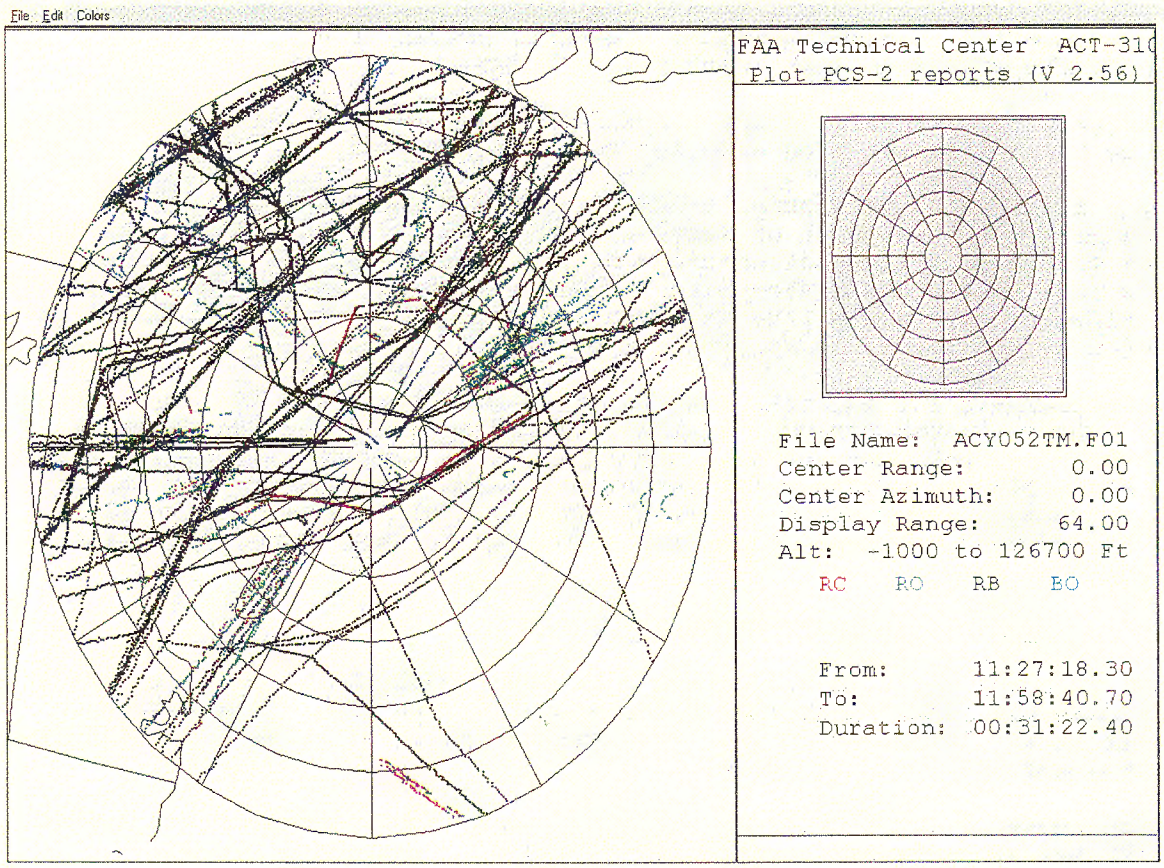

FIGURE 4.1.5.3.1-1. RANGE, AZIMUTH COVERAGE AT THE TECHNICAL CENTER

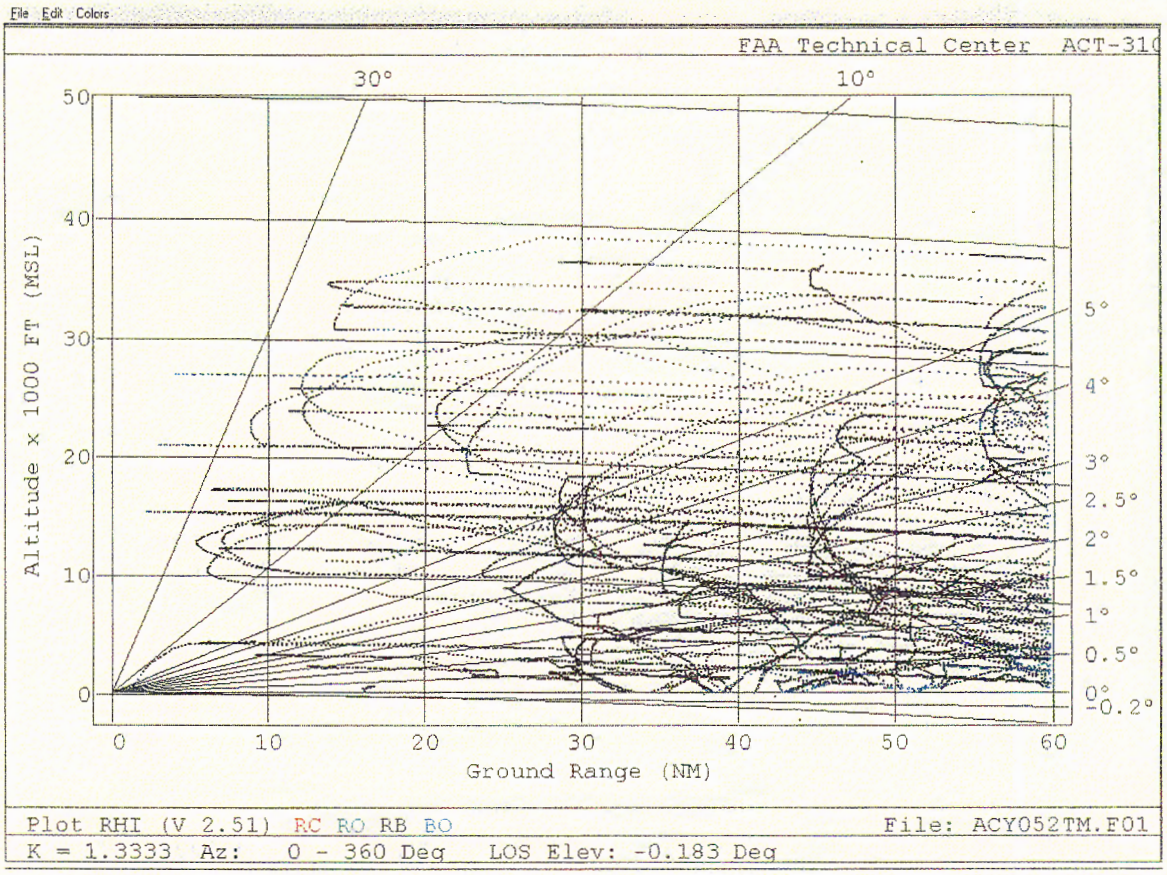

FIGURE 4.1.5.3.1-2. ELEVATION COVERAGE AT THE TECHNICAL CENTER

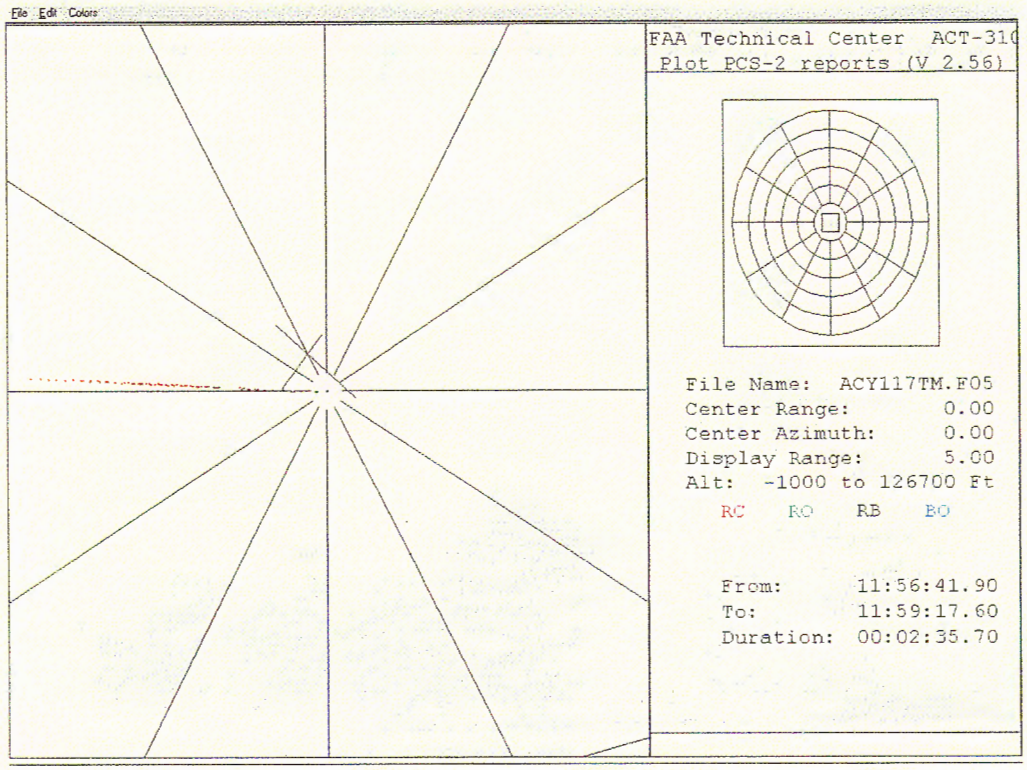

FIGURE 4.1.5.3.1-3. TDX-2000d COVERAGE, OLD S/W, RANGE LESS THAN 5 NMI

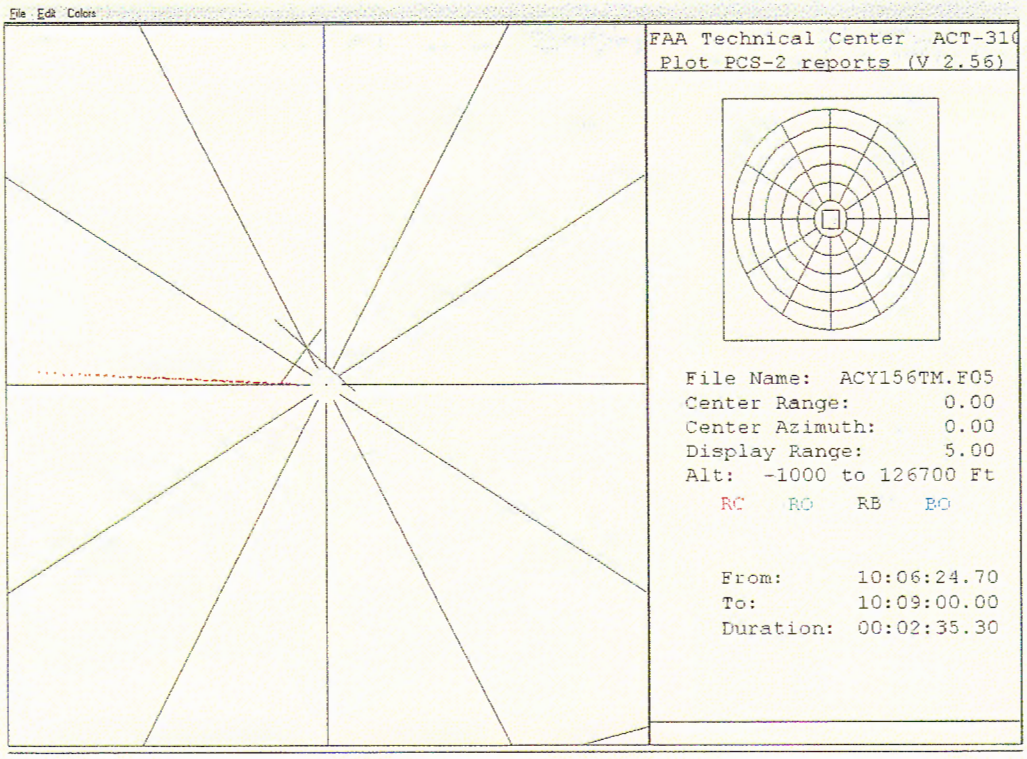

FIGURE 4.1.5.3.1-4. TDX-2000d COVERAGE, NEW S/W, RANGE LESS THAN 5 NMI

4.1.5.3.2 Dobbins AFB Results.

Figure 4.1.5.3.2-1 presents a PLOTPCS plot (400 scans) of the true tracks during RUN513. Tracks represent search reinforced beacon reports, beacon only reports, and radar correlated reports. From the figure, the TDX-2000d provides very good range coverage for primary and secondary targets from 0 to 360° in azimuth at ranges from 1.5 nmi to 60 nmi.

RC report, shown as red in the diagram, were excessive at ranges less than 10 nmi. due to ineffective map thresholds. Generally, all map thresholds, at the Dobbins facility, should be reviewed and reoptimized. Beacon Only (BO) reports shown as blue in the diagram are reports that were not reinforced. Frequently, these aircraft were identified as low altitude aircraft associated with terrain screening in the quadrants adjacent to zero degrees.

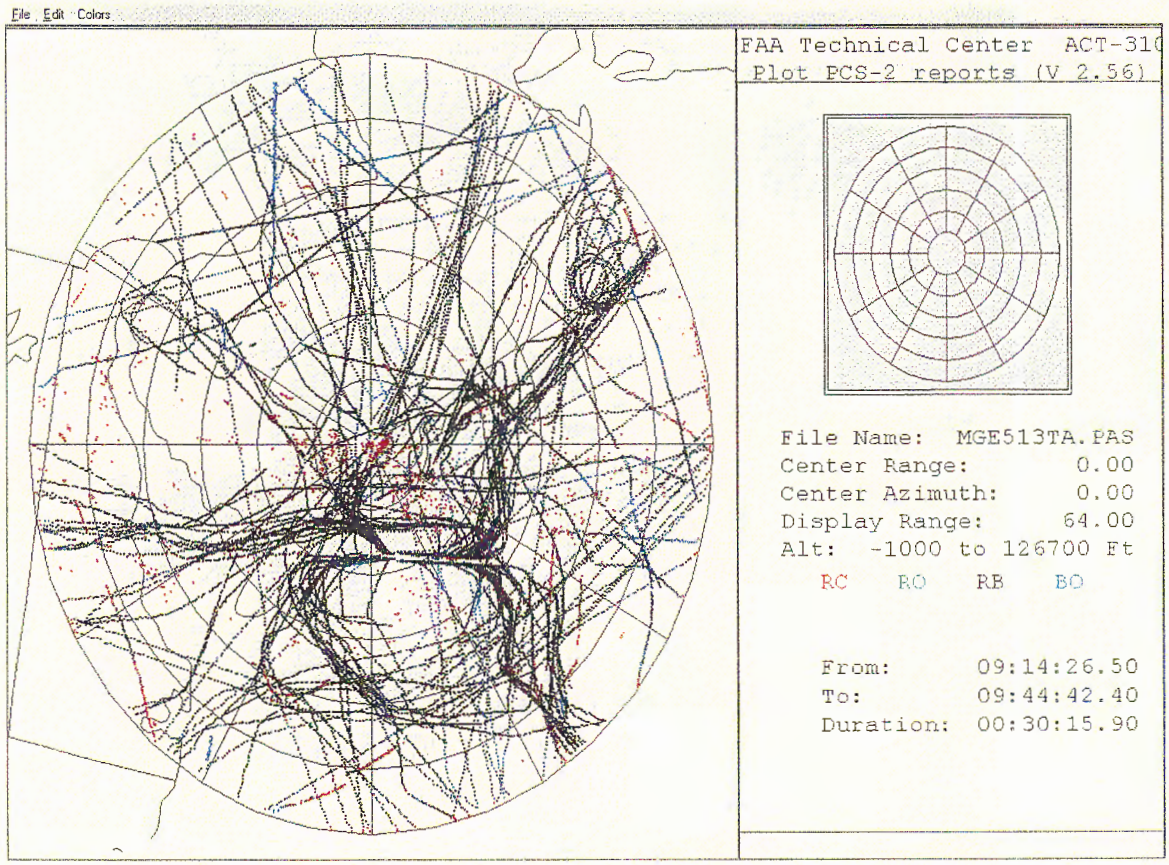

FIGURE 4.1.5.3.2-1. RANGE AZIMUTH COVERAGE AT DOBBINS AFB

Figure 4.1.5.3.2-2 shows a RHI plot for RUN513. The plot shows that the TDX-2000d provides good search and beacon detection at altitudes within its coverage extent. The tracks also show that the TDX-2000d provides coverage from 0° elevation angle through 30°.

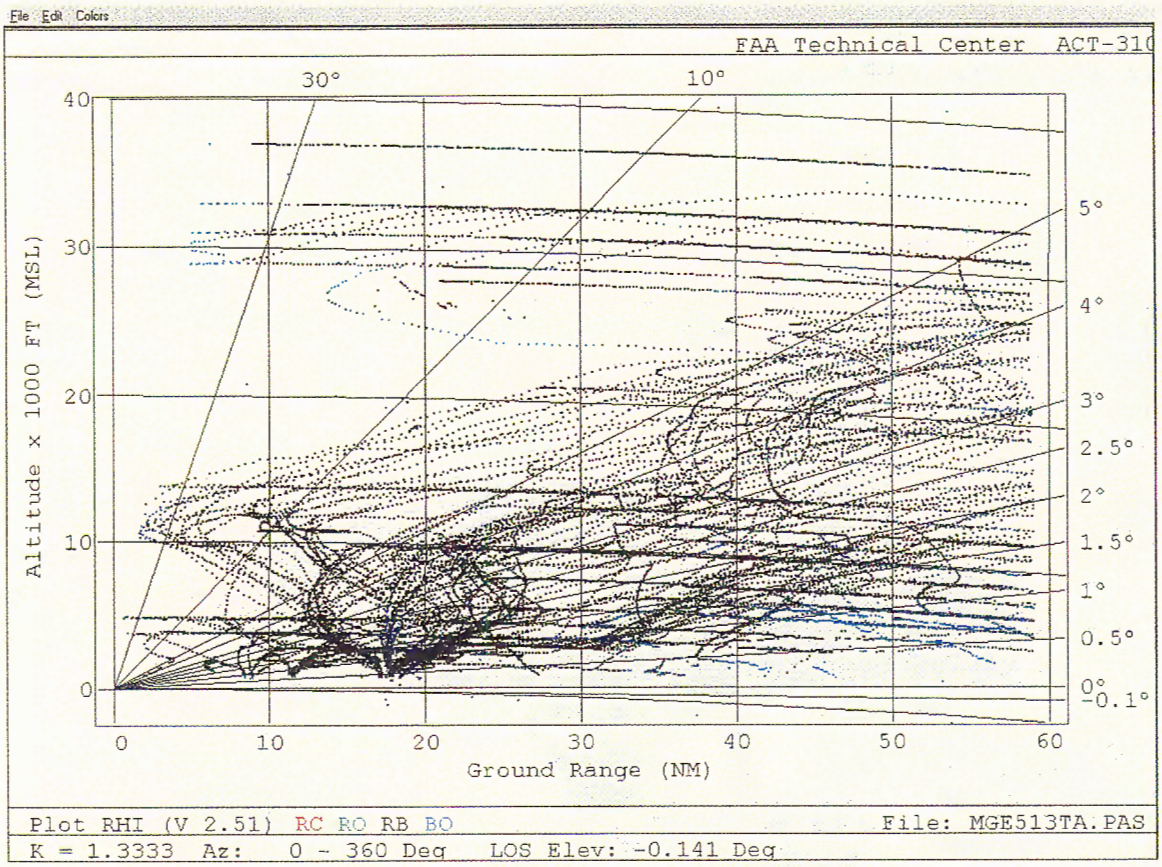

FIGURE 4.1.5.3.2-2. ELEVATION COVERAGE AT DOBBINS AFB

In summary, the TDX-2000d effectively detects and reports aircraft throughout the coverage volume.

4.1.6 Primary Target Detection.

4.1.6.1 Criteria.

Verify that the digitized TDX-2000d can detect a small RCS aircraft at least 80 percent of the time at distances from 0.5 to 55 nmi. (Reference: Performances Measures; Paragraph 3.a.(1).(g) Probability of Detection). Determine the detection performance of the TDX-2000d with a small RCS aircraft flying over areas of strong clutter (i.e., mountains, sea, and roads) and/or in areas of light precipitation. (Reference: Performances Measures; Paragraph 3.a.(1).(g) Probability of Detection.)

4.1.6.2 System Configuration.

Dedicated flight tests were used for detection analysis. The data was collected at the Technical Center TDX-2000d SDU and Common Digitizer Model 2D (CD-2D) output ports using a MX-6A record board and RTADS and Radar Recording and Analysis Program (RRAP) record software. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. Data was also recorded at the output of the CD-2D. The CD-2D was not fully optimized for the conduct of T&E. The CD-2D is not co-located with the ASR-8; this prevented the complete setup and calibration of the CD-2D.

TDX-2000d site parameters were optimized with the cooperation of the contractor at the beginning of T&E. The TDX-2000d was not re-optimized for the conduct of this test. The ASR-8 mode of operation was Linear Polarization (LP) and Circular Polarization, Communications Processor (CP) for the conduct of these tests. The TDX-2000d adjustable parameters will be set to provide no association (reinforcement) of radar and beacon to monitor and collect individual radar and beacon reports.

Additional primary detection tests were conducted at Dobbins AFB, GA. The data was collected at the Dobbins radar site TDX-2000d SDU output ports using a MX-6A record board and RTADS and RRAP record software. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. The AN/GPN-20 mode of operation was LP and CP for the conduct of these tests. The TDX-2000d adjustable parameters will be set to provide no association (reinforcement) of radar and beacon to monitor and collect individual radar and beacon reports.

The primary detection tests are divided into three parts:

- Clear Environment

For the clear environment detection test the small RCS aircraft will fly radially between two fixed points in range with respect to the radar antenna.

- Terrain Clutter

For the terrain clutter environment detection test the small RCS aircraft will fly radially starting at the radar antenna out to a range beyond the clutter area. Aircraft will also fly in an arc pattern. Arc pattern will consist of legs that begin at a range over clutter and extend in an arc through clutter areas.

- Light Precipitation

For the light precipitation detection test, the small RCS aircraft will fly radially starting at a specified range associated with light areas of rain to a point beyond weather detection and return. Atmospheric ducting conditions will require the aircraft to fly radially to a point beyond the area of ducting and return.

Primary detection analysis was performed using IRES. The data was first converted in IRES PCS format using COPYCD. The data was then sorted into range and azimuth order for each scan using the PREPPCS program. SELECT, an alpha-beta tracker in IRES, was used to isolate the test aircraft and FILTER was used to eliminate turns. The PLOTPD program displays percentage of detection histograms of the single test aircraft. The histograms show how well the track was detected from zero to maximum range while traveling inbound and outbound. An Excel spread sheet was used to combine RUN018 and RUN019 for display of percent detection at different altitudes. PLOTPCS and BLIPSCAN programs were also used to present and analyze data.

4.1.6.3 Results; Clear Environment.

Flights at the Technical Center were performed over several days. RUN015, RUN017, through RUN019, RUN076, and RUN100 were collected on January 30; February 02, 03; April 24, and May 14, 1998. Aircraft were flown at approximately constant velocity and altitude during all test flights. RUN018 and RUN019 were flown in a stair step pattern from a low altitude to higher altitudes for each leg of the flight. RUN076 was flown from 10 nmi to 55 nmi

on a 218° radial at an altitude of 10.2 Thousands of Feet (Kft). RUN100 was flown from 10 nmi to 60 nmi on a 218° radial at an altitude of 10.2 Kft.

Several detection flights were conducted in a clear environment at Dobbins AFB, GA. RUN503 and RUN504 were collected on July 21, 1998. Aircraft were flown at approximately constant velocity and altitude during all test flights. RUN503 and RUN504 were flown on the 85° radial, from 15 nmi to 55 nmi at an altitude of 12.3 Kft with the AN/GPN-20 operating in LP for RUN503 and in CP for RUN504.

4.1.6.3.1 Technical Center.

Test flights were flown using a small Radar Cross Section (RCS) single engine aircraft (Glastar) from 0 to 10 nmi at different altitudes on the 218° radial. Figure 4.1.6.3.1-1 shows the combined results from RUN018 and RUN019. Correlated reports, shown in red, drop to 79.5 percent detection at 4000 feet but remain well above the required 80 percent detection at all other altitudes for correlated and radar (uncorrelated) reports.

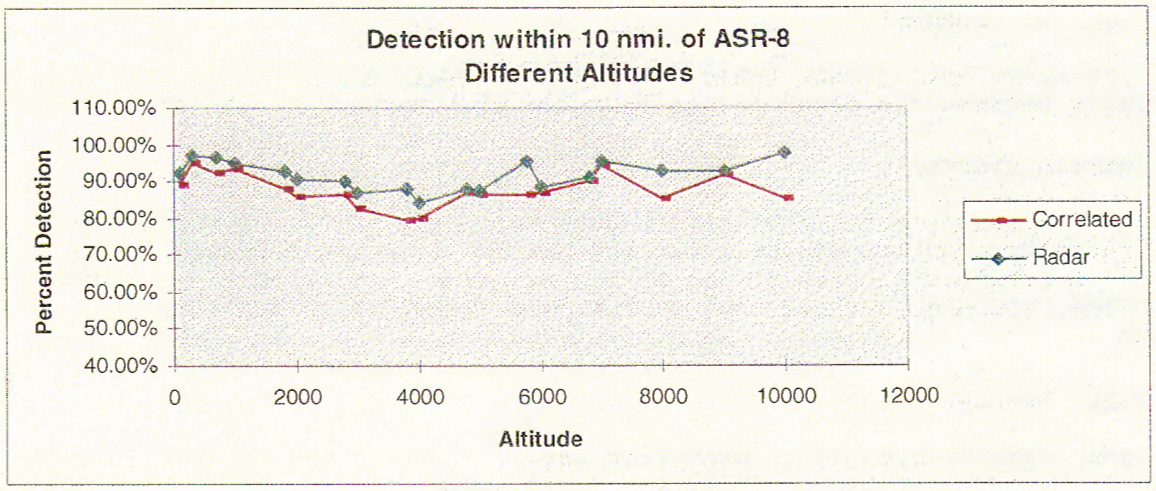

FIGURE 4.1.6.3.1-1. SMALL RCS AIRCRAFT DIFFERENT ALTITUDES (LP)

Flights providing data for percent detection were flown using a small RCS single engine aircraft (Cherokee 172). Figure 4.1.6.3.1-2 presents a smoothed inbound/outbound radar histogram from RUN076. Radar detection for the Cherokee 172 is above 80 percent detection from less than 10 nmi to 52.8 nmi as shown in the shaded area. The ASR-8 was operating in LP.

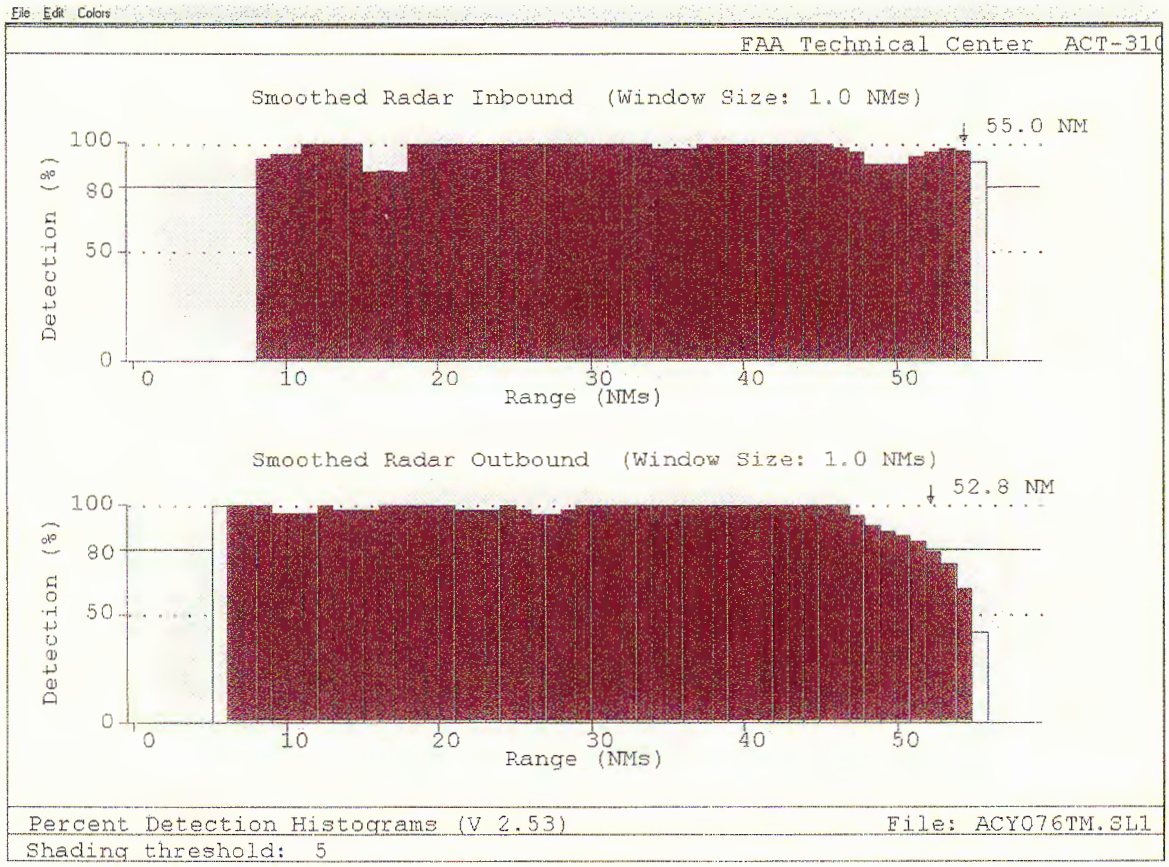

FIGURE 4.1.6.3.1-2. SMALL RCS DETECTION (LP)

Additional detection flights were flown using the Cherokee 172 from 10 to 60 nmi on the 218° radial. Figure 4.1.6.3.1-3 presents a smoothed inbound/outbound radar histogram from RUN100. Radar detection for the Cherokee is above 80 percent detection from less than 12 nmi to 47.0 nmi as shown in the shaded area. The ASR-8 was operating in CP.

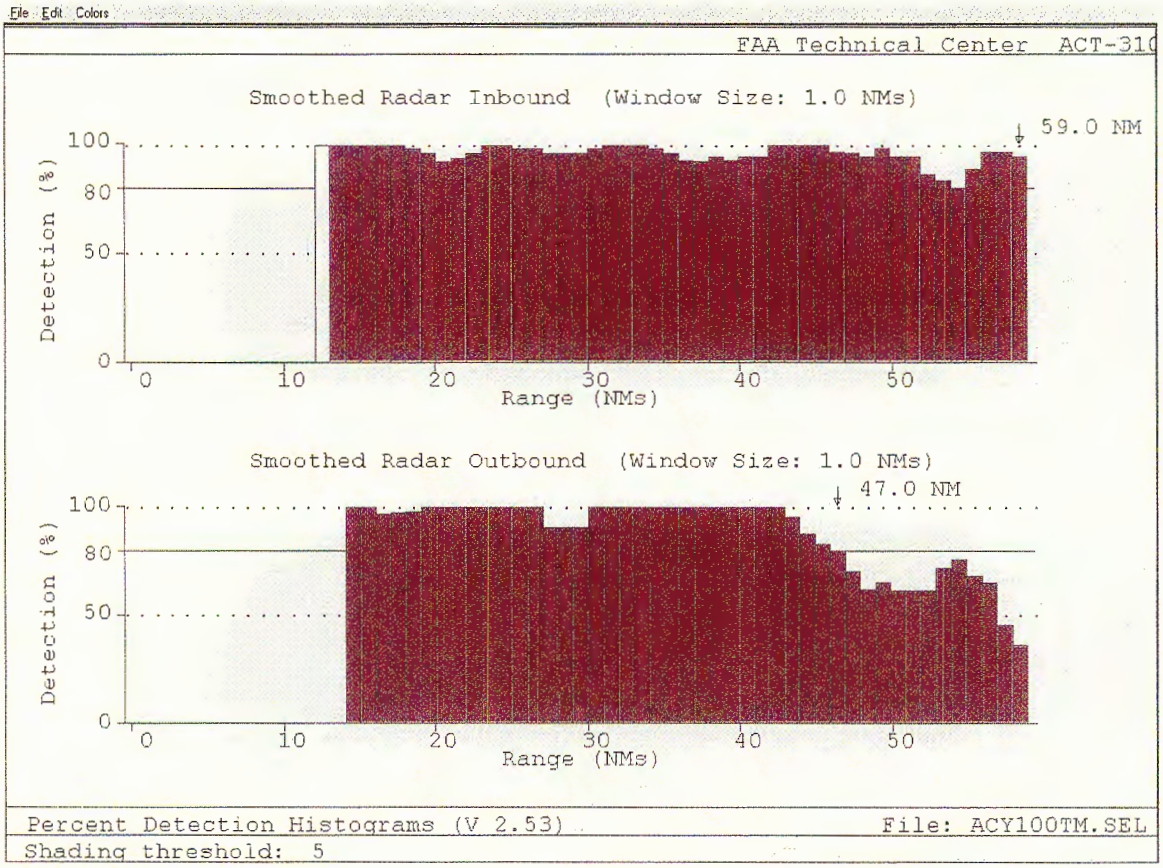

FIGURE 4.1.6.3.1-3. SMALL RCS DETECTION (CP)

4.1.6.3.2 Dobbins.

Detection flights were conducted in a clear environment using a small RCS single engine aircraft (Mooney) from 15 to 55 nmi on the 85° radial. Figure 4.1.6.3.2-1 presents a smoothed inbound/outbound radar histogram from RUN503 recorded at the output of the TDX-2000d. Radar detection for the Mooney is above 80 percent detection from less than 17 nmi to 42.1 nmi as shown in the shaded area. The AN/GPN-20 was operating in LP.

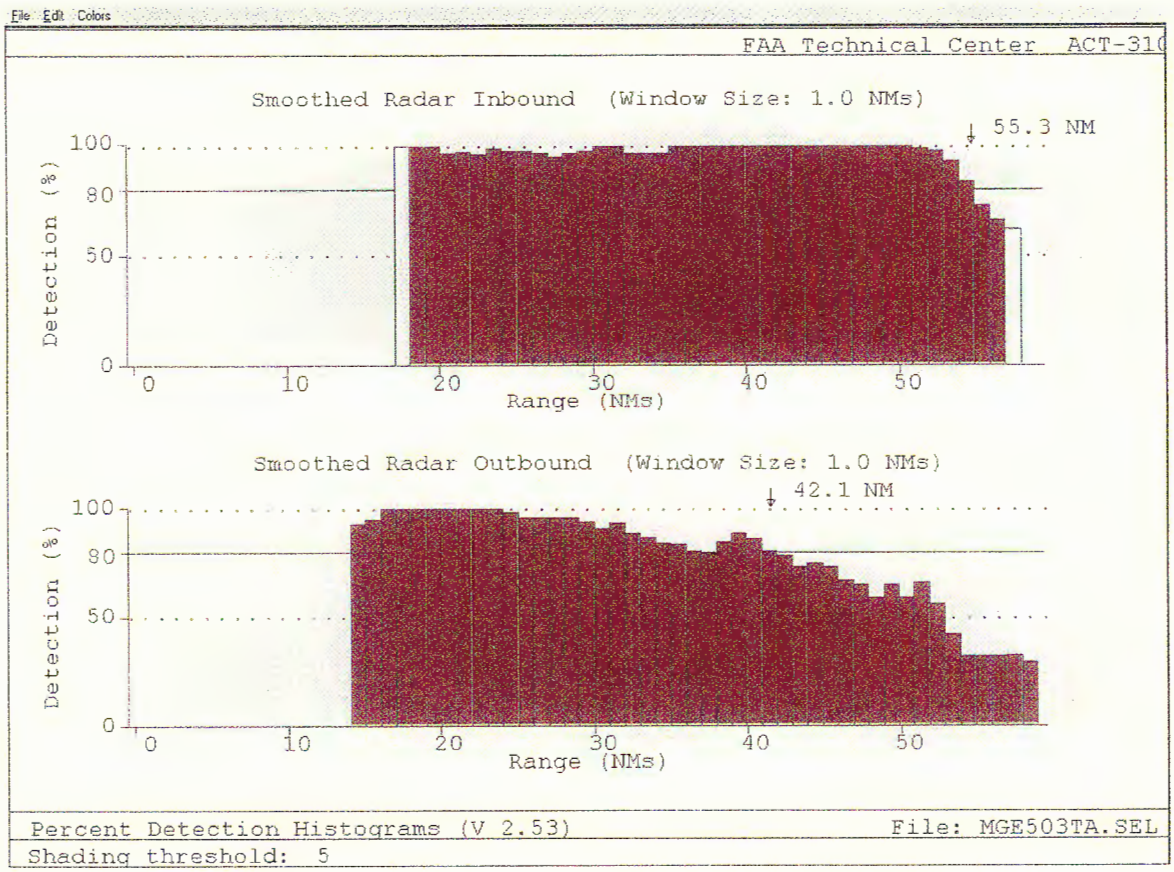

FIGURE 4.1.6.3.2-1. SMALL RCS DETECTION (LP)

Additional detection flights were flown using the Mooney from 15 to 60 nmi on the 85° radial. Figure 4.1.6.3.2-2 presents a smoothed inbound/outbound radar histogram from RUN504 recorded at the output of the TDX-2000d. Radar detection for the Mooney is above 50 percent detection from less than 25 nmi to 45.0 nmi as shown in the shaded area. The AN/GPN-20 was operating in CP.

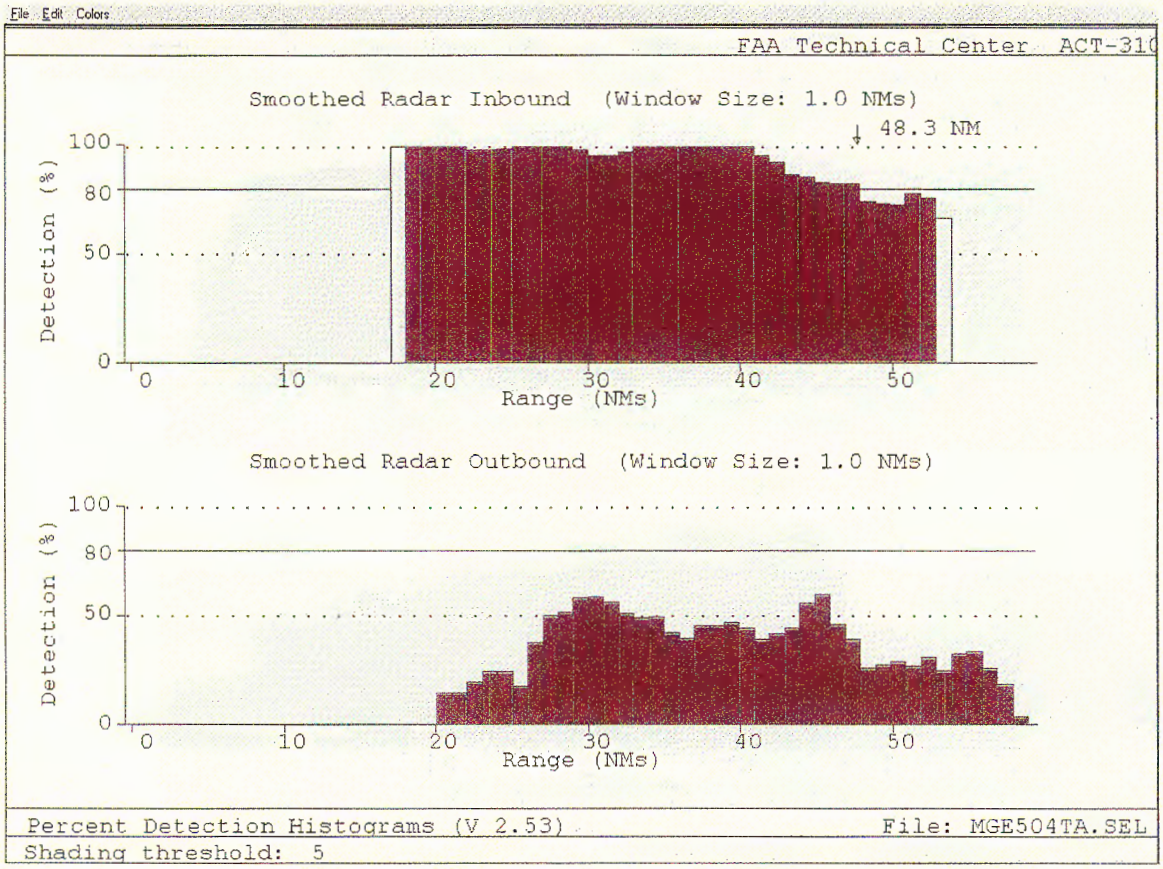

FIGURE 4.1.6.3.2-2. SMALL RCS DETECTION (CP)

Simultaneously, surveillance data was collected at the Atlanta Terminal Radar Approach CONtrol (TRACON) ARTS-III using the CDR. ARTS-III data was reduced and filtered using the CDR Editor for ARTS-IIIA, version 1.3. Figure 4.1.6.3.2-3 presents a smoothed inbound/outbound radar histogram from RUN503 from the Atlanta TRACON. Radar detection for the Mooney is above 50 percent detection from less than 20 nmi to 40.0 nmi as shown in the shaded area. The AN/GPN-20 was operating in LP.

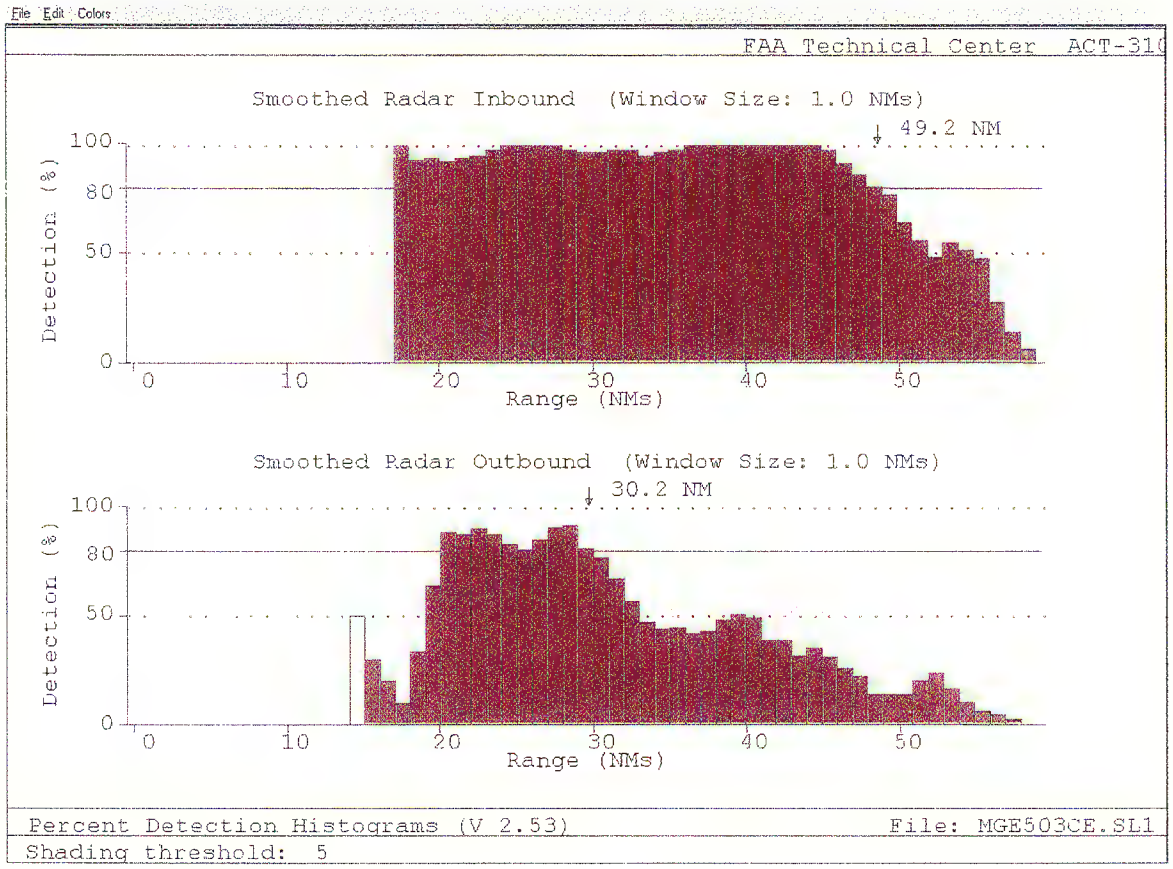

FIGURE 4.1.6.3.2-3. ARTS III SMALL RCS DETECTION (LP)

Surveillance data was also collected at the Atlanta TRACON ARTS-III with the Army Navy/General Pulsed Navigation Model 20 (AN/GPN-20) operating in CP. Figure 4.1.6.3.2-4 shows a smoothed inbound/outbound radar histogram from RUN504 from the Atlanta TRACON. Radar detection for the Mooney is above 50 percent detection from less than 20 nmi to 30.0 nmi as shown in the shaded area.

Comparing TDX-2000d detection (figure 4.1.6.3.2-1) and ARTS-IIIA Surveillance Receiver and Processor (SRAP) detection (figure 4.1.6.3.2-3) of a small Radar Cross Section (RCS) aircraft, with the radar operating in LP, shows that the TDX-2000d detects primary targets moderately better than the ARTS-IIIA.

Similarly, the comparison of TDX-2000d detection (figure 4.1.6.3.2 2) and ARTS-IIIA (SRAP) detection (figure 4.1.6.3.2-4), with the radar operating in CP, shows that the TDX-2000d detects primary targets better than the ARTS-IIIA. However, overall outbound detection of both digitizers was very poor.

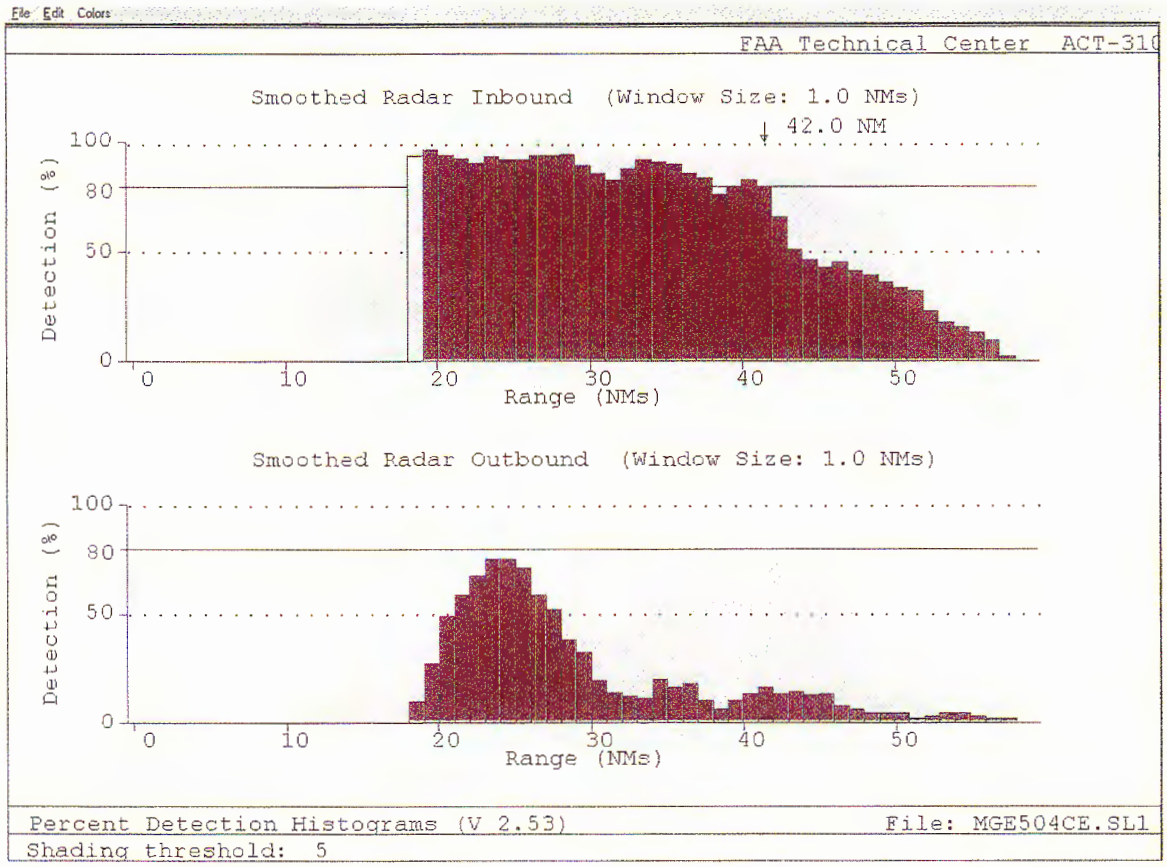

FIGURE 4.1.6.3.2-4. ARTS III SMALL RCS DETECTION (CP)

4.1.6.4 Results; Terrain Clutter.

Two test flights were performed in light clutter in the vicinity of the Technical Center. RUN015 and RUN017 consisted of a semi-arc pattern from 90 to 175 at 8.5 nmi in range at an altitude of 5.6 Kft. A Glastar single engine aircraft was used for the test. Data were simultaneously recorded at the output of the TDX-2000d and the CD-2D. The ASR-8 was operating in LP.

Three test flights were performed in moderate to heavy clutter in the vicinity of Atlanta, GA. RUN505 are inbound and outbound radials at 330^0, from 0 to 20 nmi, at an altitude of 5.5 Kft. RUN509 consisted of a semi-arc pattern from 60 to 140 at 9.4 nmi in range at an altitude of 3.5 Kft. RUN520 consisted of a semi-arc pattern from 60 to 140 at 9.1 nmi in range at an altitude of 5.9 Kft. This arc was flown over clutter (city) in a pattern that presented the TDX-2000d with very good tangential opportunities.

A Mooney single engine aircraft was used for the three tests. Data was simultaneously recorded at the output of the TDX-2000d and the Atlanta ARTS-III TRACON for RUN505 and RUN509. The AN/GPN-20 was operating in LP.

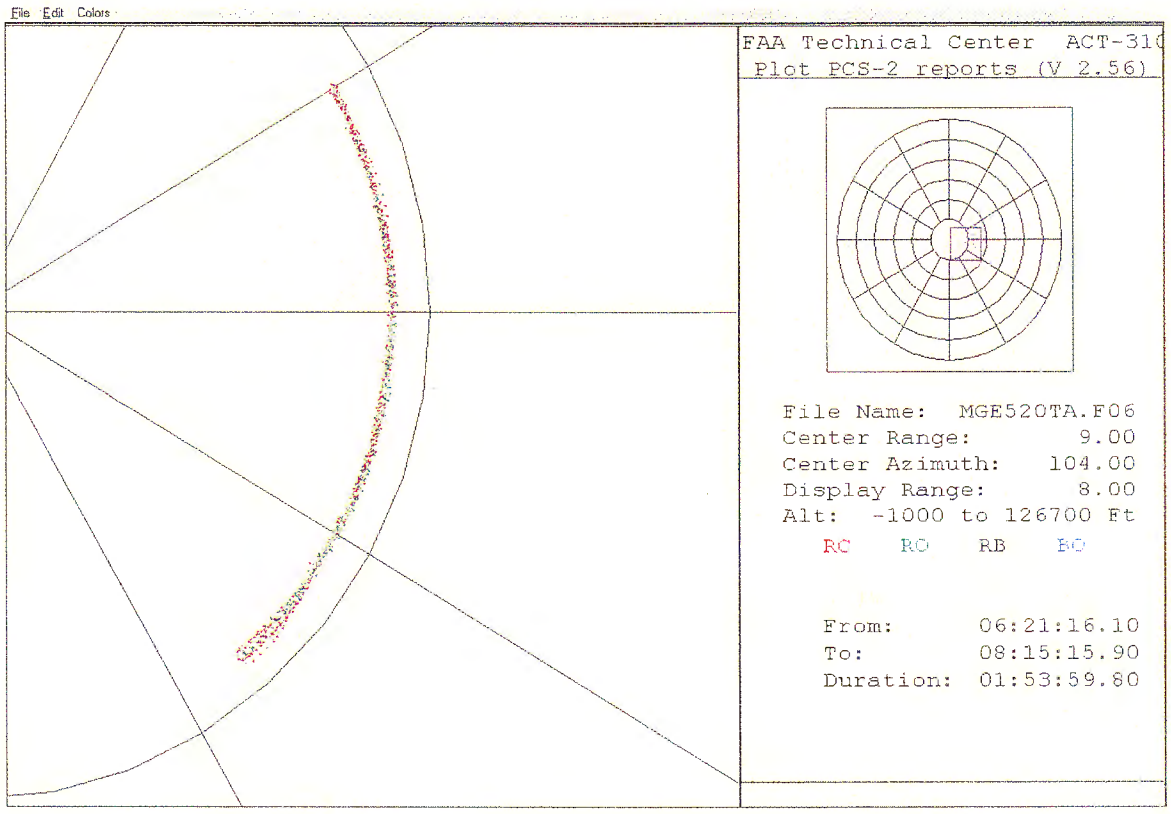

FIGURE 4.1.6.4.2-1. HEAVY CLUTTER, ARCS TANGENT TO THE RADAR

4.1.6.5 Results; Light Precipitation.

Two test flights were performed in light to moderate precipitation in the vicinity north of Atlanta, GA. RUN506 consisted of inbound and outbound radials into and through regions of rain at altitudes of 5.3 Kft to 6.3 Kft from 20 to 60 nmi. RUN511 consisted of inbound and outbound radials into and through regions of rain at altitudes of 3.8 Kft to 5.8 Kft from 20 to 60 nmi. A KingAir dual engine aircraft was used for both tests. Data was simultaneously recorded at the output of the TDX-2000d and the Atlanta ARTS-III TRACON. The AN/GPN-20 was operating in LP.

4.1.6.5.1 Dobbins.

A blipscan of each recording was performed. Data was filtered to match primary radar data with each file in time and position. Table 4.1.6.5.1-1 lists the blipscan data from each system.

TABLE 4.1.6.5.1-1. PRIMARY BLIPSCAN IN WEATHER

	RADAR HITS	RADAR AGE	BLIP SCAN
RUN506 TDX	961	1,849	52.0%
RUN506 ARTS	810	1,841	44.0%
RUN511 TDX	493	1,544	31.9%
RUN511 ARTS	396	1,514	26.2%

In summary, the TDX-2000d provides acceptable primary detection with adequate false alarm control provided the site is carefully optimized. Primary

4.1.6.4.1 Technical Center.

A blipscan (number of primary reports (hits) divided by the number of opportunities (age)) of each recording was performed. Data was filtered to match primary radar data with each recording in time and position. Table 4.1.6.4.1-1 lists the blipscan (detection) data from each digitizer.

TABLE 4.1.6.4.1-1. PRIMARY BLIPSCAN IN CLUTTER

	RADAR HITS	RADAR AGE	BLIP SCAN
RUN015 TDX	1,279	1,356	94.3%
RUN015 CD-2D	853	1,355	63.0%
RUN017 TDX	1,129	1,176	96.0%
RUN017 CD-2D	887	1,175	75.4%

4.1.6.4.2 Dobbins.

A blipscan of each recording was performed. Data was filtered to match primary radar data with each recording in time and position.
Table 4.1.6.4.2-1 lists the blipscan data from each system. RUN520 was an analysis emphasizing tangential detection in heavy clutter. Therefore, turns and any RO and RC reports that did not closely match the beacon position were filtered (removed) from this recording. ARTS data was not available for RUN520.

TABLE 4.1.6.4.2-1. PRIMARY BLIPSCAN IN CLUTTER

	RADAR HITS	RADAR AGE	BLIP SCAN
RUN505 TDX	1,537	1,787	86.0%
RUN505 ARTS	1,442	1,787	80.7%
RUN509 TDX	785	907	86.5%
RUN509 ARTS	714	907	78.7%
RUN520 TDX	642	852	73.2%

Figure 4.1.6.4.2-1 presents a plot (RUN520) of the six north and south legs of the Mooney aircraft. The plot was magnified in range to show the arc in detail. BO, RO, and RC reports are shown in color; however, colors of the reports may change due to overlapping reports.

detection in clutter is equal or better than other digitizers in the NAS (CD-2D, SRAP). Primary detection in light to moderate precipitation, in operating modes of LP or CP, is a limitation of the radar (ASR-8, AN\GPN-20) not the TDX-2000d.

4.1.7 Primary False Alarm Rate.

4.1.7.1 Criteria.

Verify that the TDX-2000d minimizes false target declarations from clutter types including ground, weather, road and surface traffic, birds, second time around clutter, second time around targets, interference, sea clutter, and anomalous propagation. (Reference: Performances Measures; Paragraph 8. Critical Operational Issues (COI) COI 2. False Alarm Rate). Verify that the TDX-2000d clutter mapping recognizes areas of strong clutter (land, weather, etc.) and automatically adapts to the environmental conditions in these designated areas. (Reference: Performances Measures; Paragraph 8. Critical Operational Issues (COI) COI 2. False Alarm Rate).

4.1.7.2 System Configuration.

Targets of opportunity were used for false alarm analysis. The data was collected at the SDU output ports using a MX-6A record board and RTADS record software. Site parameters were optimized with the cooperation of the contractor during T&E. The TDX-2000d was reoptimized for the conduct of this test.

False alarm analysis data, RUN055, RUN056, RUN077, and RUN306 were collected on March 10, April 29, 1998, and May 10, 1999, at the Technical Center. False alarm analysis data, RUN509, RUN515, and RUN516 were collected on July 24, July 29, and July 30, 1998, at Dobbins AFB. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. Recordings were performed with the correlation function of the TDX enabled. The data was analyzed to determine the false alarm rate of the TDX-2000d.

The data was analyzed using the IRES Track Quality Assessment (TQA) programs. The data was first converted to IRES PCS format using COPYCD program. FILTER was used to select several hundred scans of data. PREPPCS was performed to place the reports in range/azimuth order. TRACK was used to track all surveillance reports in the prepared file. Tracks are initiated on any eligible radar or beacon report.

The QUALIFY program was used to compare the resultant tracks to a predetermined set of criteria (e.g., minimum track age, minimum distance traveled, percent beacon) to determine the status of each track. The PLOTTQA track editor program was used to verify that the true and false status assigned to the tracks by QUALIFY is correct. Also, unknown tracks can be manually reclassified as true or false after further study using PLOTTQA. The COUNTTRK program produces true and false report counts.

4.1.7.3 Technical Center Results.

Table 4.1.7.3-1 presents RUN055, RUN056, RUN077, and RUN306 results from the COUNTTRK program. Two tracks from each run were manually reclassified from false to true tracks. These reclassified tracks were located at the position for existing Permanent Echoes (PE) and are not considered false reports. After reclassifying the PE tracks, the false report rate for each sample is 5.4 for RUN 055, 4.8 for RUN 056, and 5.3 for RUN 077 false correlated reports per scan. The average rate was calculated by summing the False, Unknown,

Single Hits, and Not Eligible RC reports and dividing by the total scans in the file.

False alarm recording RUN306 was made following the reoptimization of the TDX-2000d at the Technical Center. RUN306 reflects an effort to reduce false targets and improve target detection throughout the coverage volume. The analysis of RUN306 yields a reduction in false alarms as seen in the table.

TABLE 4.1.7.3-1. PRIMARY CORRELATED FALSE ALARMS, TECHNICAL CENTER

	FALSE	UNKNOWN	SINGLE HITS	NOT ELIGIBLE	TOTAL	AVERAGE RATE	SCANS
RUN055 RC's	632	253	51	156	1092	5.4	201
RUN056 RC's	734	486	72	141	1433	4.8	301
RUN077 RC's	636	303	35	100	1074	5.3	201
RUN306 RC's	395	326	74	88	883	4.4	200

Data analysis and observations were used to evaluate sets of different Threshold, RVT, and Clutter maps. The test team determined, with contractor support, that new map thresholds for clutter control and target detection were necessary. The TDX-2000d false report rate was improved by desensitizing the threshold maps to better eliminate the local clutter and road traffic at ranges from 0 nmi to 10 nmi. A range azimuth plot of RUN306 shown in figure 4.1.7.3-1 shows few false targets (shown in red) at ranges less than 10 nmi for the 200 scan interval. The plot was magnified in range to show detail.

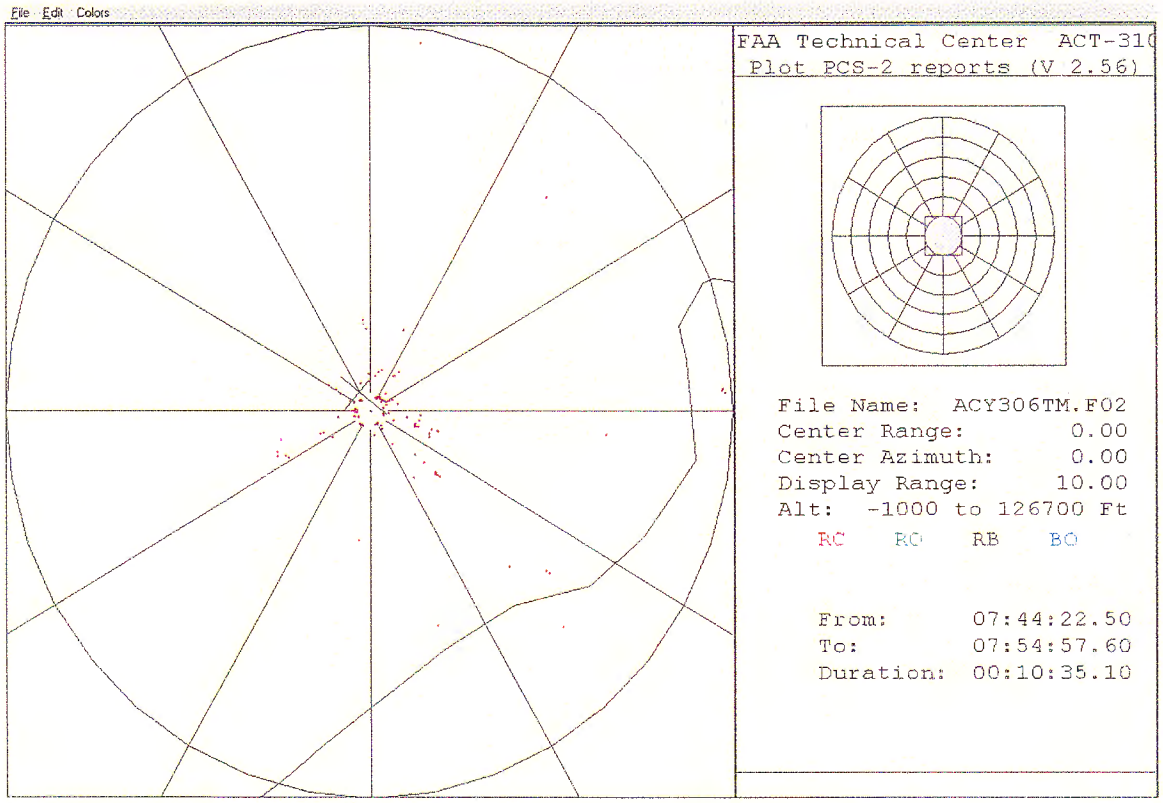

FIGURE 4.1.7.3-1. RUN306 FALSE CORRELATED REPORTS - 200 SCANS

4.1.7.4 Dobbins AFB Results.

Table 4.1.7.4-1 presents RUN509, RUN515, and RUN516 results from the COUNTTRK program. Two tracks from each run were manually reclassified from false to true tracks. These reclassified tracks were located at the position for existing PE and are not considered false reports. After reclassifying the PE tracks the false report rate is 15.0 for RUN 509, 11.0 for RUN 515, and 11.7 for RUN 516 false correlated reports per scan. The average rate was calculated by summing the False, Unknown, Single Hits, and Not Eligible RC reports and dividing by the total scans in the file.

TABLE 4.1.7.4-1. PRIMARY CORRELATED FALSE ALARMS, DOBBINS AFB

	FALSE	UNKNOWN	SINGLE HITS	NOT ELIGIBLE	TOTAL	AVERAGE RATE	SCANS
RUN509 RC's	1362	335	105	1186	2998	15.0	200
RUN515 RC's	1040	84	52	1025	2201	11.0	200
RUN516 RC's	1271	100	53	917	2341	11.7	201

The TDX-2000d false report rate at Dobbins is as much as three times the rate at the Technical Center. Many false reports were identified at ranges less than 10 nmi. A range azimuth plot of RUN 516 shown in figure 4.1.7.4-1 illustrates the excessive RC (shown in red) false targets. The plot was magnified in range to show detail.

In summary, the false alarm rate can be controlled by carefully adapting site parameters and tailoring threshold maps to the local environment. Re-examine the site optimization and adaptation at Dobbins AFB, GA, to effective control primary false alarms.

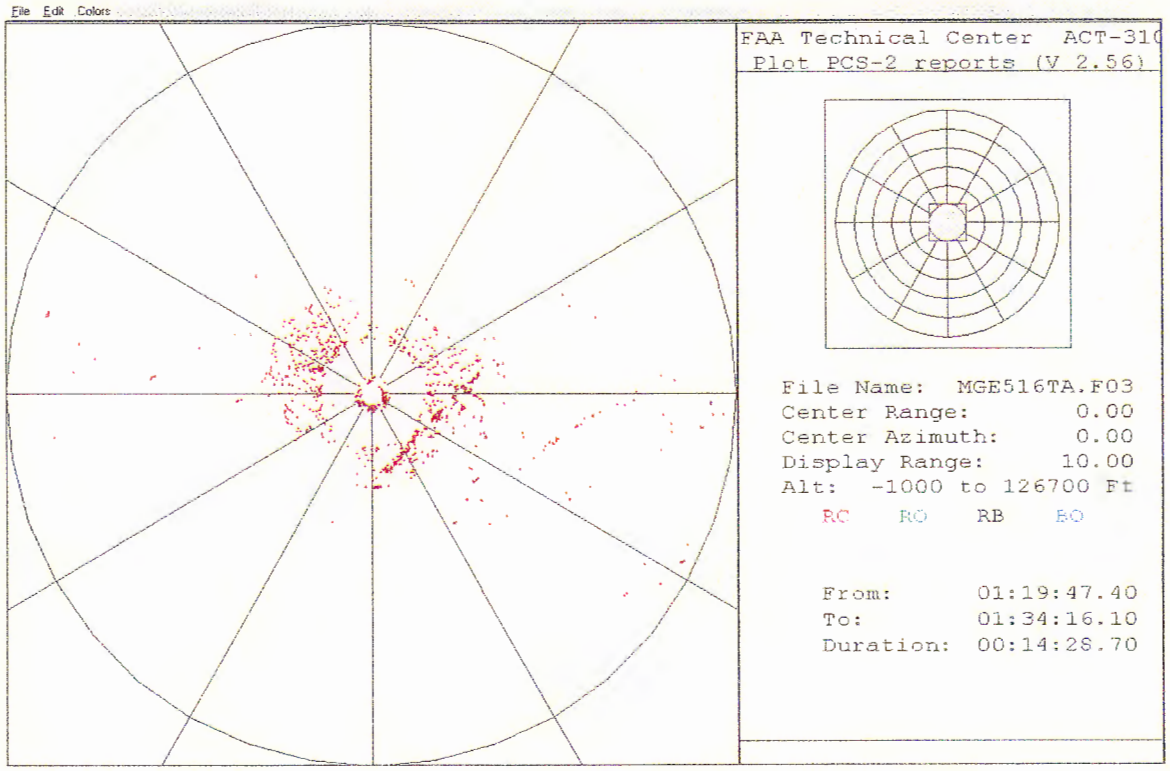

FIGURE 4.1.7.4-1. RUN516 FALSE CORRELATED REPORTS - 201 SCANS

4.1.8 Primary Range and Azimuth Resolution.

4.1.8.1 Criteria.

Verify that the TDX-2000d resolves with an 80 percent probability, two unequal sized Swerling 1 targets separated by 0.16 nmi in range, at the same azimuth, and resolves at the same range and separated in azimuth by 2.8° at any point in the coverage volume. (Reference: Performances Measures; Paragraph 3.a.(1).(e) Range Resolution, (f) Azimuth Resolution.)

4.1.8.2 System Configuration.

Dedicated flight tests, conducted at the Technical Center, were used for the primary range and azimuth resolution analysis. The data was collected at the SDU output ports using an MX-6A record board and RTADS record software.

Range resolution flight test data, RUN010 and RUN011 were performed on January 14 and 21, 1998. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem.

Site parameters were optimized with the cooperation of the system contractor. The ASR-8 mode of operation was LP for the conduct of this test. The TDX-2000d adjustable parameters were set to provide no association of radar and beacon to monitor and collect individual radar and beacon reports.

Range resolution tests were performed by simultaneously flying two aircraft of dissimilar RCS in closely spaced flight patterns. The holding pattern was performed in a clear environment, at an altitude of 12,500 feet, from 25 nmi to 55 nmi at a 50° radial from the radar site. The aircraft flew in a tail chase configuration maintaining a nominal range separation of 1/8 nmi.

Range test required that the AN/UPX-27 be configured to prevent interference between the beacon replies of the closely spaced aircraft. One test aircraft set its beacon transponder to reply on Mode 3/A, while the other aircraft transponder was set to respond to Mode B. Since each test aircraft will respond to only one mode of interrogation, beacon code garbling between the aircraft is eliminated.

The AN/UPX-27 was configured for a one-to-one interlace pattern of Mode 3/A and Mode B. To decode the Mode B beacon replies, the Mode B beacon triggers from the AN/UPX-27 were converted to Mode 3/A mode triggers using a dual channel pulse generator. By converting the Mode B beacon replies to Mode 3/A, the Mode B codes are processed by the TDX-2000d as Mode 3/A codes and placed in the Mode 3/A field of the beacon message.

Azimuth resolution flight test data, RUN177 and RUN178 were both performed on December 18, 1998. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. Simultaneously, data was also recorded at the output of the SRAP and CD-2D digitizers in the Technical Center automation laboratory for selected resolution tests.

Site parameters were reoptimized with the cooperation of the system contractor for the conduct of the azimuth resolution test. The ASR-8 mode of operation was LP for the conduct of this test. The TDX-2000d adjustable parameters was set to provide no association of radar and beacon to monitor and collect individual radar and beacon reports.

Azimuth resolution tests were performed by simultaneously flying two aircraft in closely space flight patterns. The flight pattern was performed with a

lateral separation of 2° to 4.5° and zero nmi range separation. Flights were performed in a clear environment, at an altitude of 10,500 feet, from 20 nmi to 55 nmi, at a 218° radial from the radar site.

Range and azimuth resolution analysis were performed using IRES. The data was first converted in IRES Personal Computer Surveillance (PCS) format using COPYCD. The data was then sorted into range and azimuth order for each scan using the PREPPCS program. SELECT, an alpha-beta tracker in IRES, was used to isolate the test aircraft and FILTER was used to eliminate turns. The COPYLLA program reformats the Global Positioning System (GPS) ASCII latitude, longitude, and altitude position data into PCS reference reports. This reformat includes a coordinate transform to the position of the radar antenna.

Next, the tracked target reports were merged with the GPS data by the MERGEPCS program. The percent resolution was computed based on the GPS reported separation and the existence of one (no resolution) or two (targets resolved) radar reports. The PLOTRES program presents resolution results in the form of radar detection histograms. The histogram show how often both aircraft were seen and at what separation.

Range resolution analysis was performed for RUN010 and RUN011. Azimuth resolution analysis was performed for RUN177 and RUN178. Individual test data, associated with range or azimuth tests, were combined to provide additional samples at or near the specified performance measure (requirement). GPS was used as a source of truth to determine the actual separation of the two aircraft.

4.1.8.3 Results.

Figure 4.1.8.3-1 presents the results of the primary range resolution analysis performed on the range resolution flight test data. Range samples were bounded from 0 to 10 Azimuth Change Pulse (ACP). The data indicates that the two aircraft resolved 80 percent of the time at a range separation of 10/64 nmi or 0.156 nmi.

Figure 4.1.8.3-2 shows the results of the primary azimuth resolution analysis performed on the azimuth resolution flight test data. Azimuth samples were bounded from 0 to 14/64 nmi. The data shows that the two aircraft resolved 80 percent of the time at an azimuth separation of 34 azimuth (ACPs) or 2.99°. This problem was described in TDR ACT052 and is listed in appendix A.

In summary, the TDX-2000d provides adequate primary range resolution, but provides a primary azimuth resolution that was outside of the requirement by at least two ACPs or 0.2°.

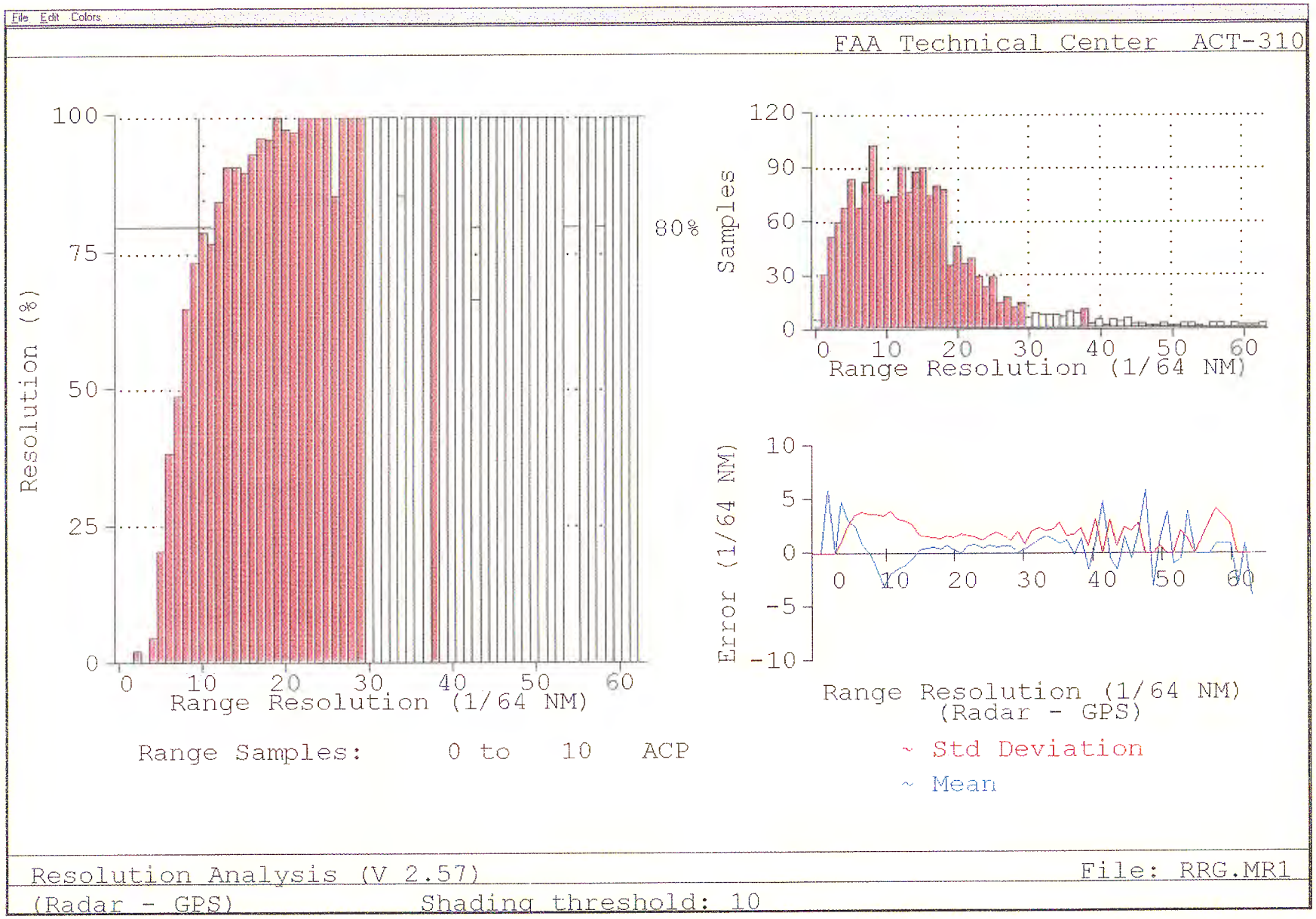

FIGURE 4.1.8.3-1. PRIMARY RANGE RESOLUTION

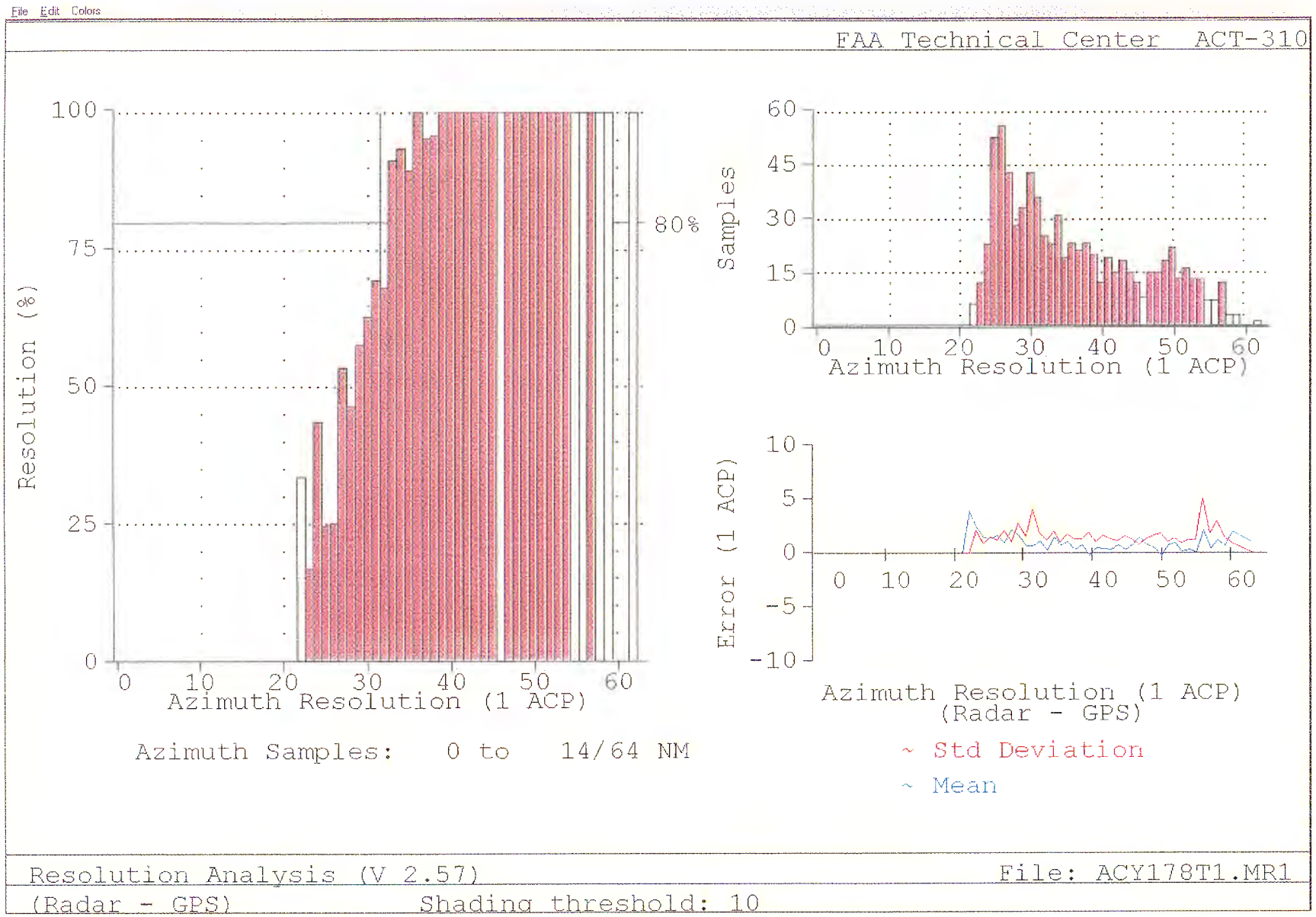

FIGURE 4.1.8.3-2. PRIMARY AZIMUTH RESOLUTION

4.1.9 Primary Positional Accuracy.

4.1.9.1 Criteria.

This test evaluates the TDX-2000d Search Processor and Plot EXtractor's (SPLEX) ability to accurately provide primary positional data. The TDX-2000d should provide single scan primary range and azimuth surveillance information that is accurate to 380 feet root mean square (rms) (1/16 nmi) and 0.264°, respectively, within the entire detection envelope. (Reference: Performances Measures; Paragraph 3.a.(1).(c) Range Accuracy, (d) Azimuth Accuracy, Paragraph 8. Critical Operational Issues (COI) COI 3. Coverage.)

4.1.9.2 Configuration.

Primary positional accuracy was evaluated through analysis of dedicated flight test data. Data was collected at the TDX-2000d SDU output port using an MX-6A record board and RRAP record software. Positional accuracy flight test data, RUN172, was collected on December 14, 1998, at the Technical Center. ASHTEC GPS receiver data, aboard the aircraft and at the ASR-8 radar site, was simultaneously collected during the flight test.

Site parameters were optimized with the cooperation of the TDX-2000d system contractor. The TDX-2000d adjustable parameters were set to provide no association of radar and beacon, to monitor and collect individual radar and beacon reports.

Positional accuracy tests were conducted by flying an aircraft in a single radial pattern. The holding pattern was performed in a clear environment, at an altitude of 11,000 feet, from 25 nmi to 55 nmi at a 218° radial from the radar site.

Positional accuracy analysis was performed using IRES. The data was first converted in PCS format using COPYCD. The target reports were then sorted into range and azimuth order for each scan using the PREPPCS program. SELECT, an alpha-beta tracker in IRES, was used to isolate the test aircraft and FILTER was used to eliminate turns. The COPYLLA program reformats the GPS ASCII latitude, longitude, and altitude position data into PCS reference reports. This reformat includes a coordinate transform to the position of the radar antenna.

Next, the tracked target reports were merged with the GPS data by the MERGEPCS program. The primary range and azimuth collimation was computed based on the GPS reported position and the radar reported position. The IRES COLRB program presents accuracy results in the form of number of hits per primary range or azimuth position histograms. The histogram show how the primary reported position compares to GPS reported position.

4.1.9.3 Results.

Figure 4.1.9.3-1 presents a histogram showing the primary azimuth accuracy. The azimuth mean error was -0.63 ACPs, as shown in the diagram, and is computed in degrees as:

$$360°/4096 \text{ ACPs} * -0.63 \text{ ACPs} = -0.055°.$$

The azimuth standard deviation was 2.402 ACPs and is computed in degrees as:

$$360°/4096 \text{ ACPs} * 2.402 \text{ ACPs} = 0.211°.$$

Figure 4.1.9.3-2 contains a histogram showing the primary range accuracy. The range mean error was 2.06 64ths nmi, as shown in the diagram, and is computed in feet as:

$$2.06 \text{ 64ths}/64 = 0.032 \text{ nmi} * 6080 \text{ feet} = 195 \text{ feet rms}.$$

The range standard deviation was 2.684 64ths nmi and is computed in feet as:

$$2.684 \text{ 64ths}/64 = 0.042 \text{ nmi} * 6080 \text{ feet} = 255 \text{ feet}.$$

In summary, the TDX-2000d provides suitable range and azimuth positional accuracy.

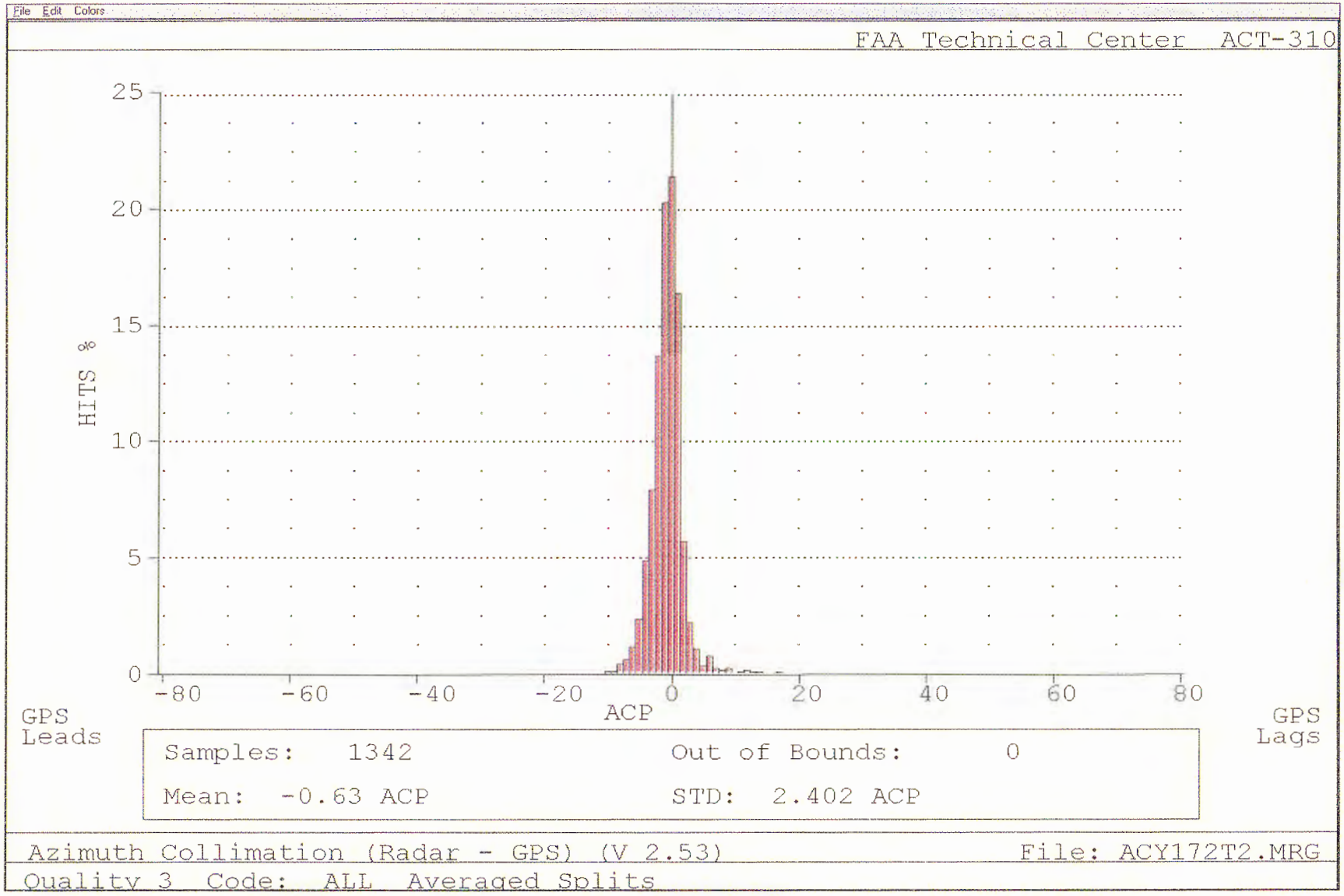

FIGURE 4.1.9.3-1. TDX PRIMARY AZIMUTH ACCURACY

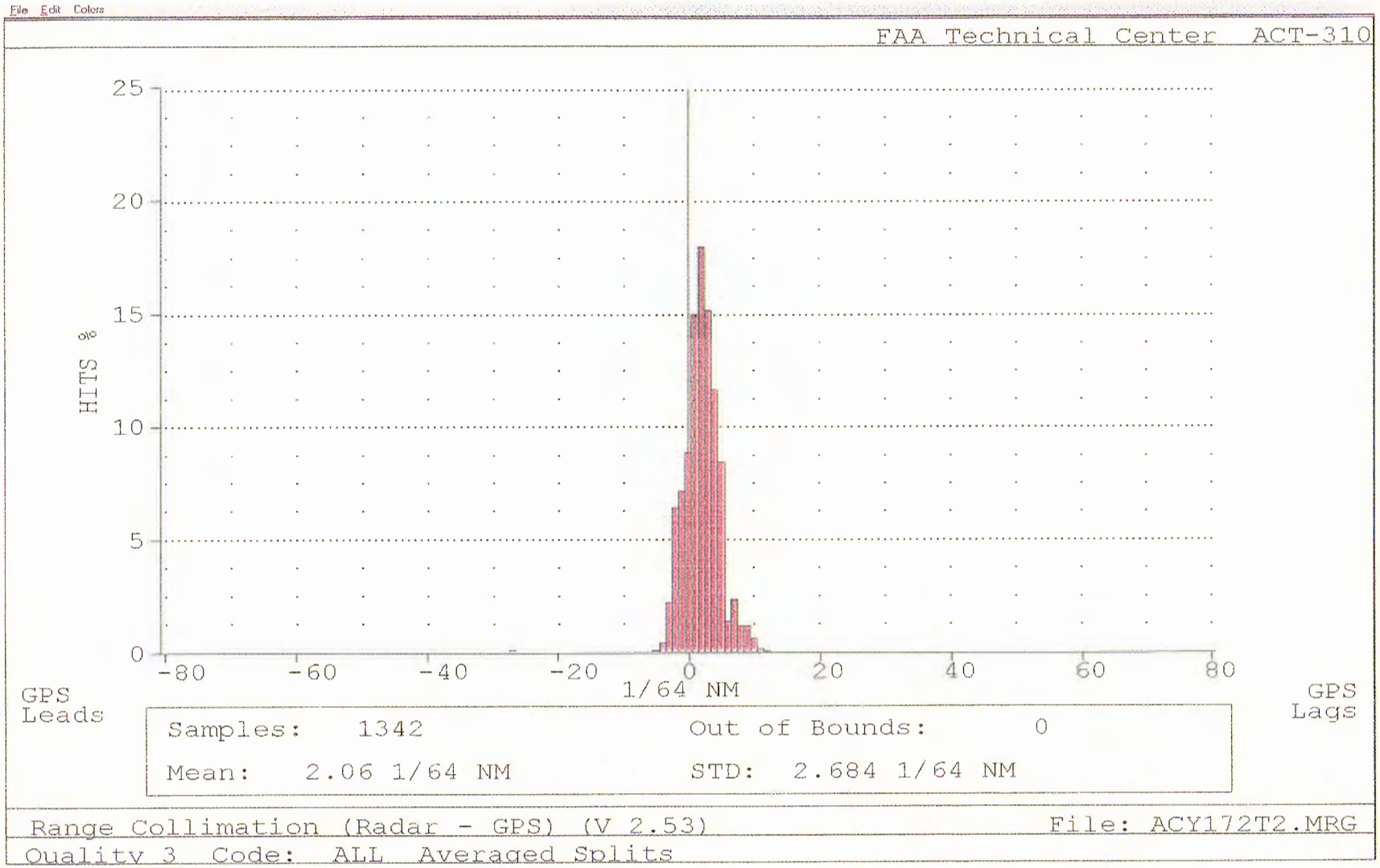

FIGURE 4.1.9.3-2. TDX PRIMARY RANGE ACCURACY

4.1.10 Weather Detection and Processing.

4.1.10.1 Criteria.

This test evaluates that the performance of the TDX-2000d WEather PROcessor (WEPRO) and Weather EXtractor (WEX) accurately provides acceptable weather data to the user for air traffic advisories. TDX-2000d should provide weather contours that are comparable to weather contours from a reference source. (Reference: Performances Measures; Paragraph 3.a.(3). Weather Detection and Resolution, Paragraph 8. Critical Operational Issues (COI) COI 9. Weather Detection and Display.)

4.1.10.2 Configuration.

The TDX-2000d weather processor was evaluated at the Technical Center in light to moderate weather conditions, and at Dobbins AFB in light to heavy weather conditions, through analysis of weather data collected from the TDX-2000d and NEX generation RADar (NEXRAD) data. Data was collected at the TDX-2000d, SDU output port using an MX-6A record board, and RTADS or RRAP record software.

Site parameters were optimized with the cooperation of the TDX-2000d system contractor. The TDX-2000d was not reoptimized for performance in atmospheric ducting or precipitation. The ASR-8 and AN/GPN-20 radar modes of operation were set to LP for conduct of this test at the Technical Center and at Dobbins AFB, respectively.

The Technical Center data used in the analysis was collected from RUN118, RUN119, and RUN120 on June 12, 1998. The test data was collected in one-half hour intervals to obtain various contours and levels of weather data. The Fort Dix, New Jersey, NEXRAD weather data was recorded simultaneously with the recordings of the Technical Center TDX-2000d weather data.

The Dobbins AFB data used in the analysis was collected from RUN506, RUN511, and RUN514 on July 22, July 24, and July 27, 1998. The test data was collected in one-half hour intervals to obtain various contours and levels of weather data. The Atlanta, Georgia, NEXRAD weather data was recorded simultaneously with the recordings of the Dobbins AFB TDX-2000d weather data.

The weather data was recorded to be viewed in real-time, printed, or played back at a later date to verify weather cell location and presentation of the TDX-2000d weather.

The IRES COPYCD program was used to convert the TDX-2000d and NEXRAD formats into PCS-2 format. The Fort Dix NEXRAD data was transposed in range and azimuth to the ASR-8 radar site for comparison to the TDX-2000d weather data. The Atlanta NEXRAD file was not available to the user. PLOTWX was used to prepare the weather files for plotting. SHOWPLOT was used to alternately display the TDX-2000d and NEXRAD plotter files for visual comparison. Also, the test team members compared real-time weather presentations of TDX-2000d and NEXRAD to verify weather processor performance and presentation.

4.1.10.3 Results.

The Technical Center TDX-2000d weather data presentations were compared to the Fort Dix NEXRAD weather data. The Fort Dix NEXRAD is located approximately 30 nmi northeast of the ASR-8 radar site. Site location differences were factored into the observations of weather intensity, contours, and position. There were five sets of weather data recorded which had similar weather presentations. Only one set of weather data was used as the best example. The weather conditions in the sample contain light to moderate rain throughout the

coverage area. Figure 4.1.10.3-1 presents TDX-2000d weather data recorded with the ASR-8 radar system in LP. Figure 4.1.10.3-2 contains the corresponding recorded NEXRAD weather data transposed to the ASR-8 radar site. The TDX-2000d presentation of weather contours and cell locations closely approximate that of the NEXRAD weather file.

Figures 4.1.10.3-3 is the NEXRAD weather image which was captured and saved during the TDX-2000d data recording. This NEXRAD image is centered at Fort Dix and not scaled or transposed to the ASR-8 site. The contours of this NEXRAD weather image generally match the TDX-2000d presentation of weather intensity and contour.

The Dobbins AFB TDX-2000d weather data presentations were also compared to a NEXRAD weather source, obtained from the Atlanta NEXRAD weather station. The Atlanta NEXRAD is located approximately 35 nmi south of the AN/GPN-20 radar site. Site location differences were factored into the observations of weather intensity, contours, and position. There were six sets of weather data recorded which had similar weather presentations. Only one set of weather data was used as the best example. The weather condition in the example contains light to heavy rain throughout the coverage area. Figure 4.1.10.3-4 presents TDX-2000d weather data recorded with the AN/GPN-20 radar system in LP. Figure 4.1.10.3-5 is the corresponding NEXRAD weather image which was captured and saved during the TDX-2000d data recordings. The TDX-2000d presentation of weather intensities, contours, and cell locations represent that of the NEXRAD weather image.

In summary, weather data is delivered to the user in a timely manner and presents weather images throughout the coverage area. TDX-2000d weather intensity and contour approximate NEXRAD weather presentations.

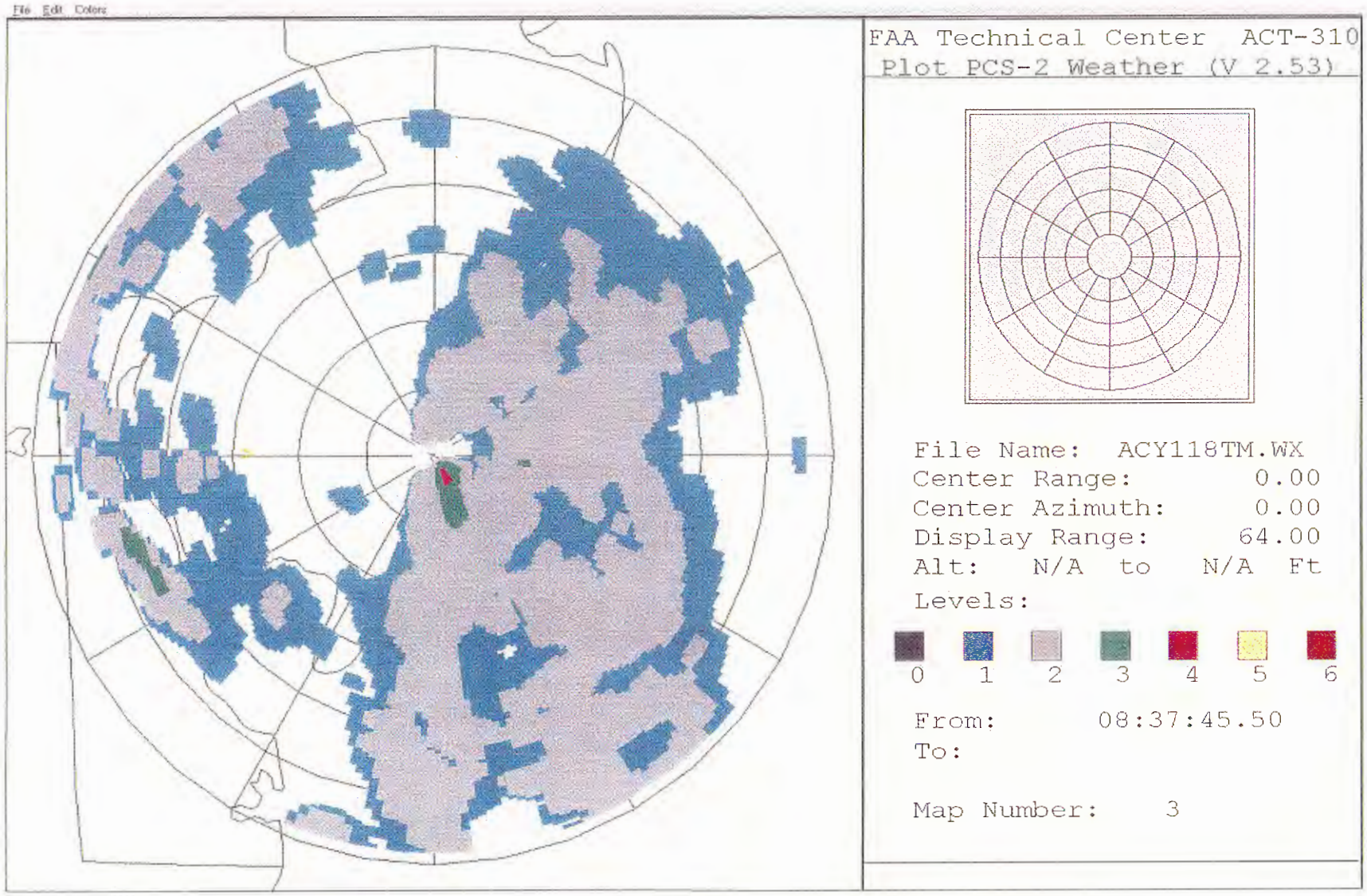

FIGURE 4.1.10.3-1. TDX WEATHER MAP - FAA TECHNICAL CENTER 08:38

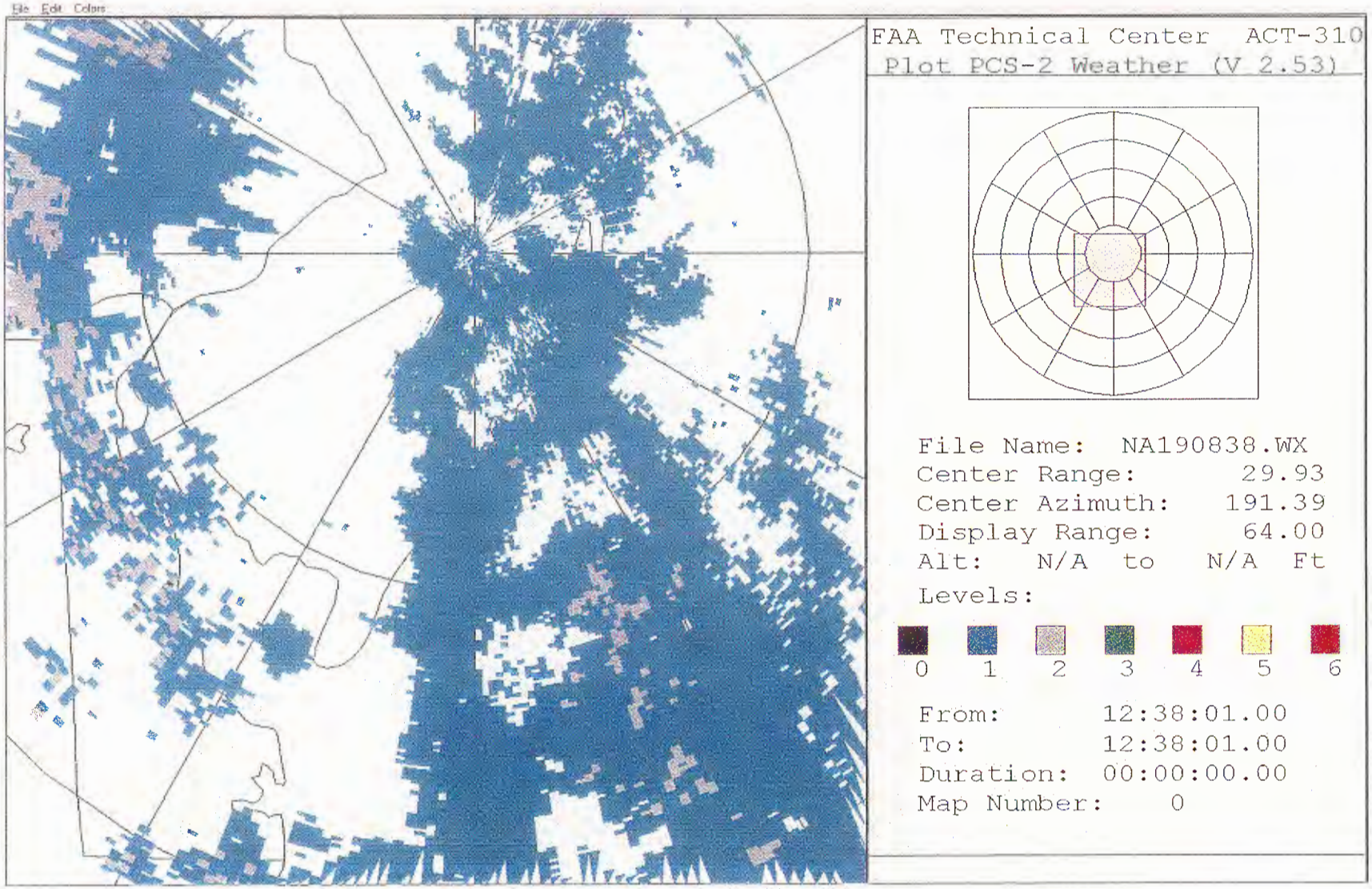

FIGURE 4.1.10.3-2. NEXRAD PCS WEATHER MAP - FAA TECHNICAL CENTER 08:38

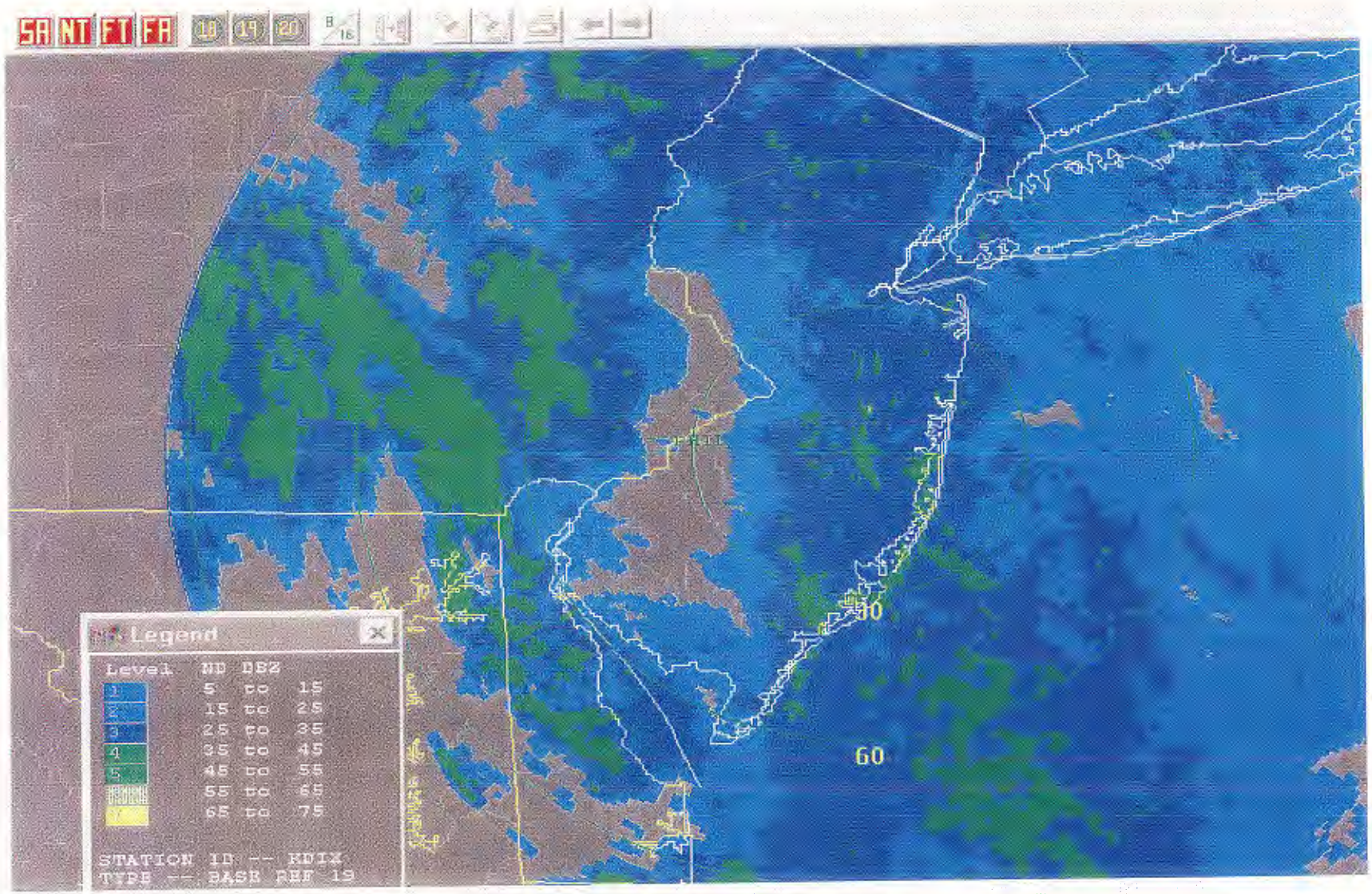

FIGURE 4.1.10.3-3. NEXRAD WEATHER MAP - FORT DIX, NJ 08:38

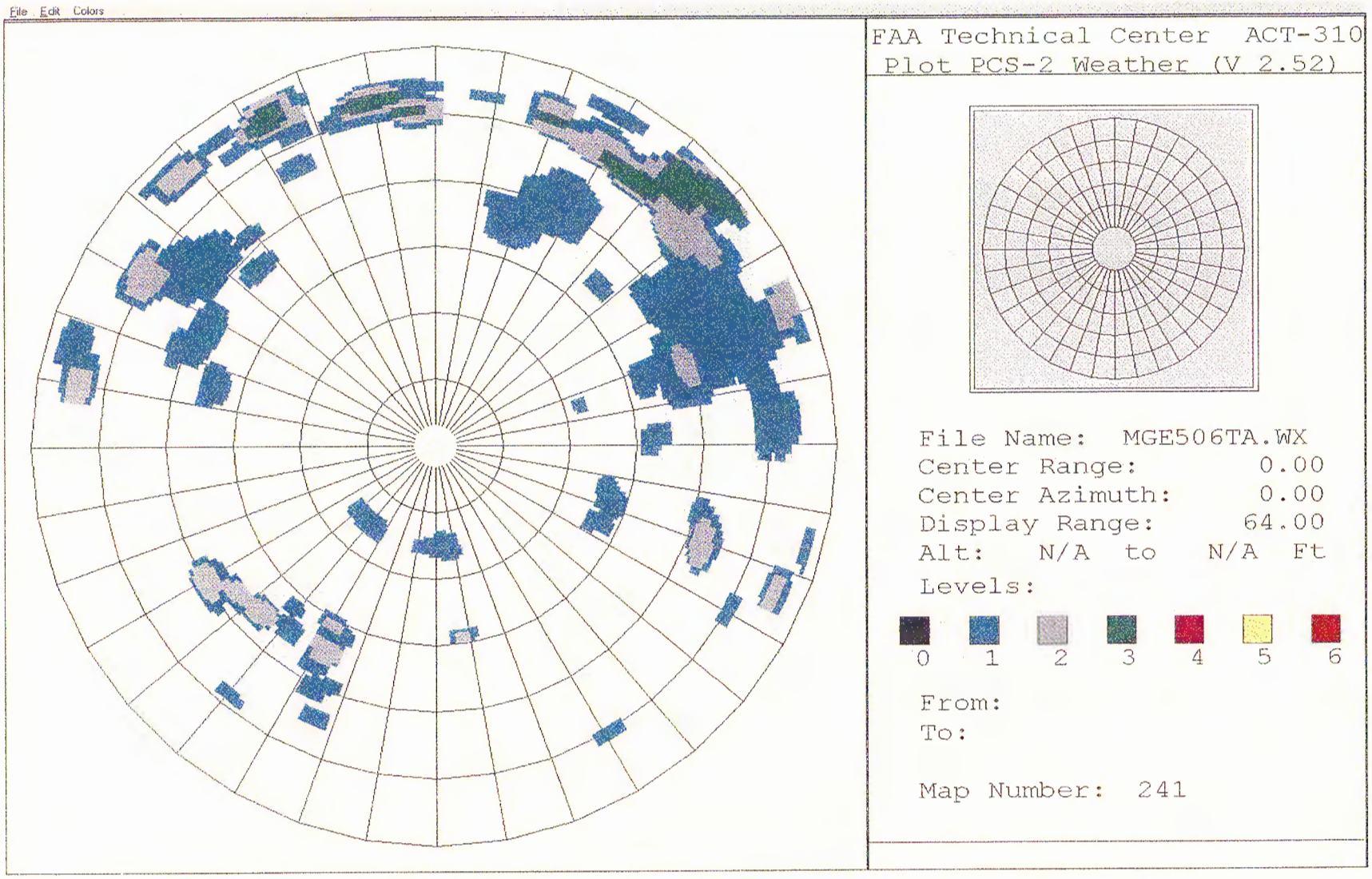

FIGURE 4.1.10.3-4. TDX WEATHER MAP - DOBBINS AFB 15:35

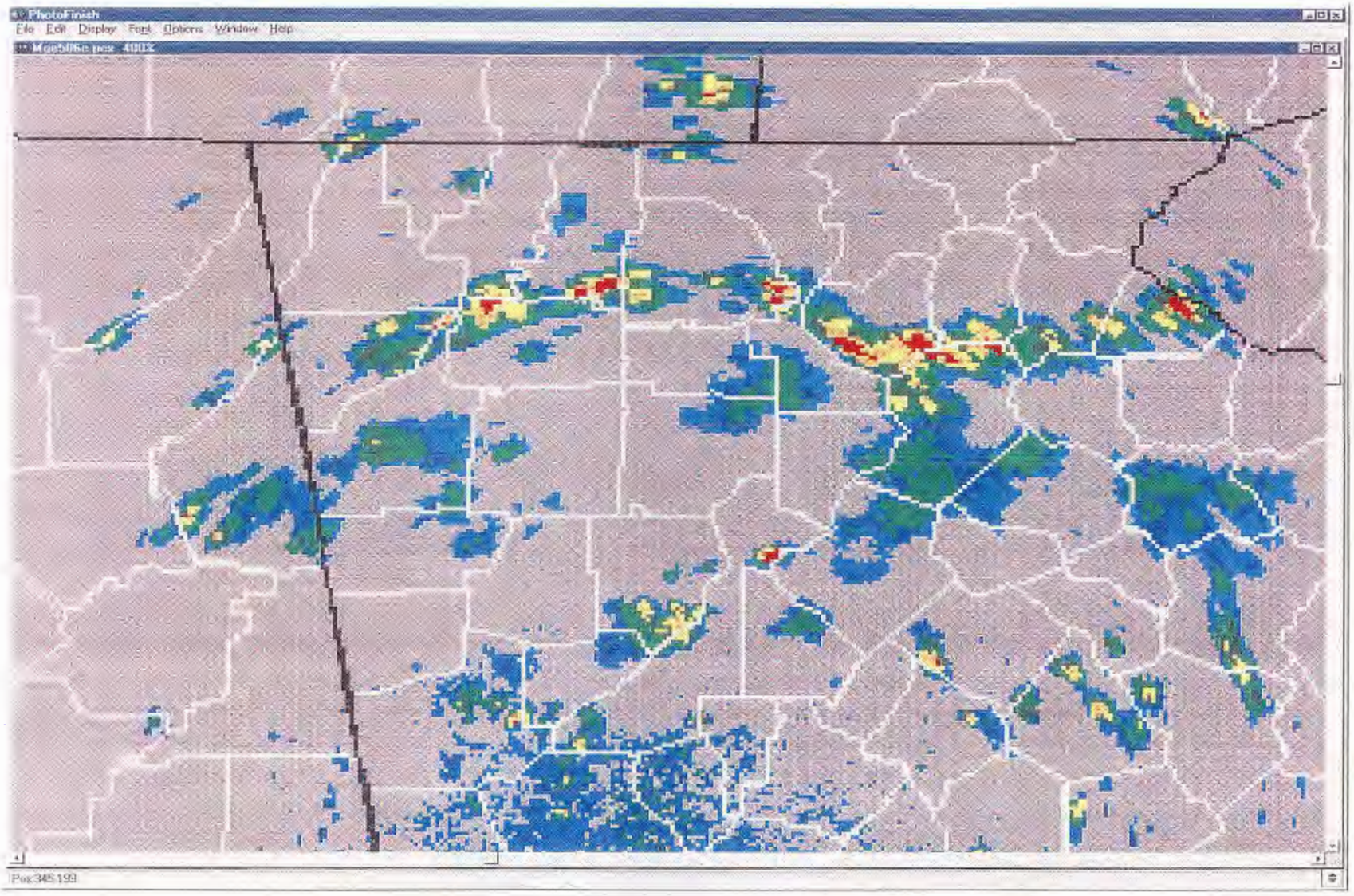

FIGURE 4.1.10.3-5. NEXRAD WEATHER MAP - ATLANTA, GA 15:35

4.1.11 Beacon Target Detection.

4.1.11.1 Criteria.

Verify that the detection performance of the TDX-2000d beacon processor meets or exceeds the performance of existing SRAP beacon processor. (Reference: Performances Measures; Paragraph 3.a.(2).(b) Probability of Detection.)

Verify that the beacon probability of detection, for targets with a round reliability of 0.75, is 99.5 percent (Reference: Performances Measures; Paragraph 3.a.(2).(b) Probability of Detection) based on the following conditions:

a. Three-fourths of the modes responding (e.g., Modes 3/A, C, 3/A responding from a 3/A, C, 3/A, C interlace pattern).

b. In a steady state condition of 10,000 False Replies Unsynchronous In Time (FRUIT) replies per second.

4.1.11.2 System Configuration.

Dedicated flight tests and beacon target scenarios were used for detection analysis. The data were collected at the SDU output ports using a MX-6A record board and RTADS and RRAP record software. Site parameters were optimized with the cooperation of the contractor at the Technical Center and at Dobbins AFB. The TDX-2000d adjustable parameters will be set to provide no association of radar and beacon to monitor and collect individual radar and beacon reports.

Flight test data, RUN018, was collected on February 3, 1998, from the Technical Center. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem. The flight test was flown approximately +/-10 nmi from the ASR-8 radar site. The aircraft flew in a climbing stairstep pattern starting at 500 feet and incrementing 1000 feet on each leg.

Flight test data, RUN100, was collected on May 14, 1998, from the Technical Center. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. Aircraft was flown at approximately constant velocity and altitude during all test flights. RUN100 was flown with the ASR-8 in CP. The test flight was flown from 5 nmi to 60 nmi on a 218° radial at an altitude of 10,400 feet. The beacon detection test used similar flight scenarios described for the primary detection tests of paragraph 4.1.6.

Scenario RUN137 was collected on August 10, 1998, at the Technical Center. This scenario was used to verify Probability of detection (Pd) of beacon targets in a steady state condition of 10,000 FRUIT replies per second. The FRUIT scenario was injected at the input to the AN/UPX-27 beacon system using the VideoBITS test tool. The FRUIT scenario was run in conjunction with targets of opportunity.

An additional beacon target capacity scenario was collected on August 11, 1998, at the Technical Center. This scenario, RUN139, was used to verify the beacon Pd for targets with a round reliability of 0.75 and in a steady state condition of 10,000 FRUIT replies per second. A capacity scenario of 360 beacon targets was injected at the input to the AN/UPX-27 beacon system using the VideoBITS test tool. The beacon antenna was disconnected during RUN139.

Flight test data, recorded as RUN519, were collected and included targets of opportunity which can be used to identify additional problems with beacon coverage or performance in areas of screening, holes, or dropouts.

4.1.11.3 Results.

Figure 4.1.11.3-1 shows smoothed inbound/outbound beacon histogram from RUN100 using the single engine Cherokee aircraft. Beacon detection shown in the red shaded area is well above 80 percent from less than 10 nmi to 59 nmi. The lack of inbound samples, shown in the top histogram, are attributed to transponder antenna screening.

Figure 4.1.11.3-2 shows detection results, in the shaded area, from RUN018 using the single engine Glastar aircraft in a stairstep pattern. The samples in this recording supplement the data in figure 4.1.11.3-1. The poor inbound detection from minimum range to 9 nmi is due to transponder antenna screening as shown in the top histogram.

Figure 4.1.11.3-3 shows detection results from RUN519 using the small RCS Mooney aircraft. The inbound and outbound samples, shown in the shaded areas of the histogram, maintain detection well above 80 percent from minimum range to 59 nmi.

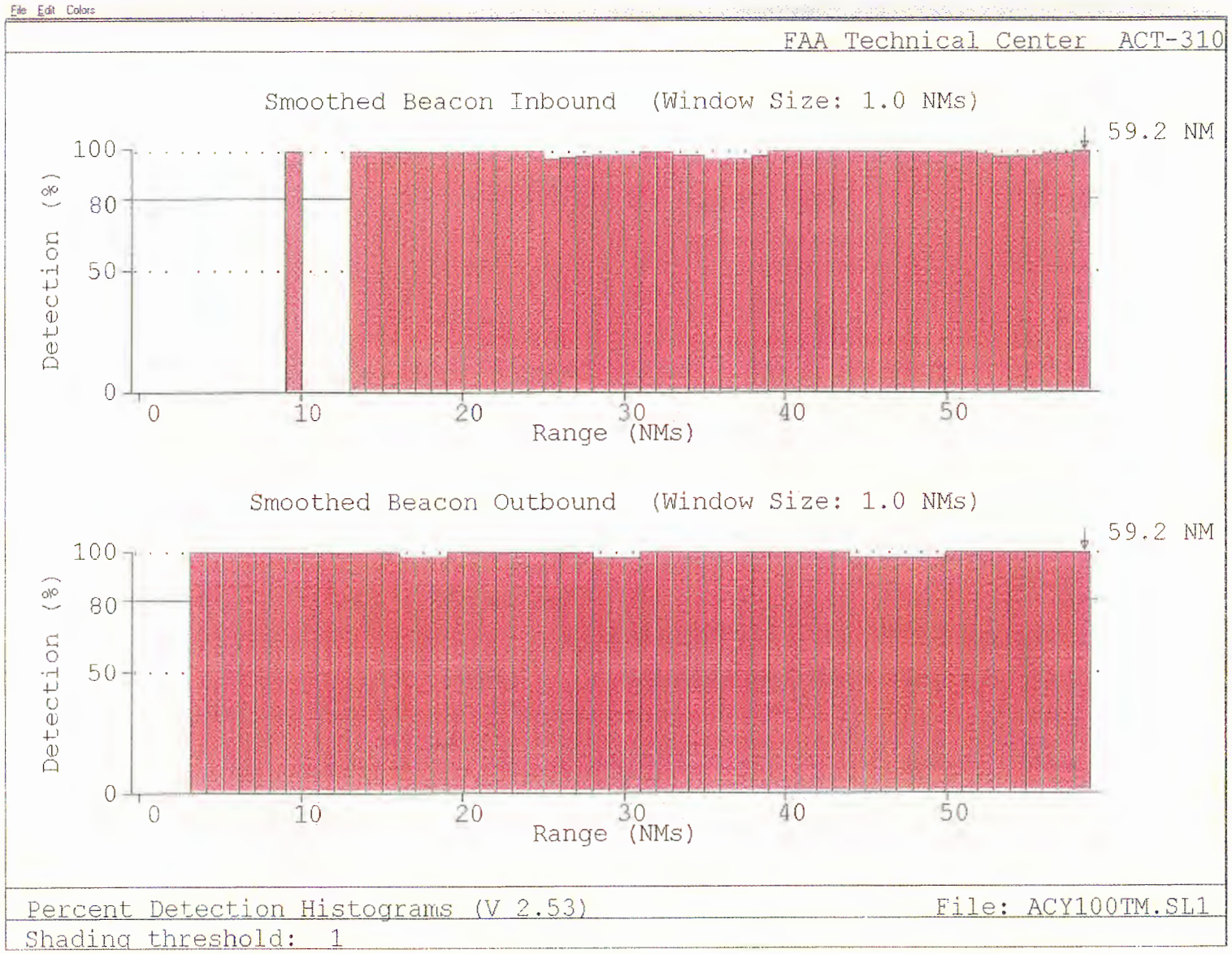

FIGURE 4.1.11.3-1. BEACON TARGET DETECTION (TECHNICAL CENTER)

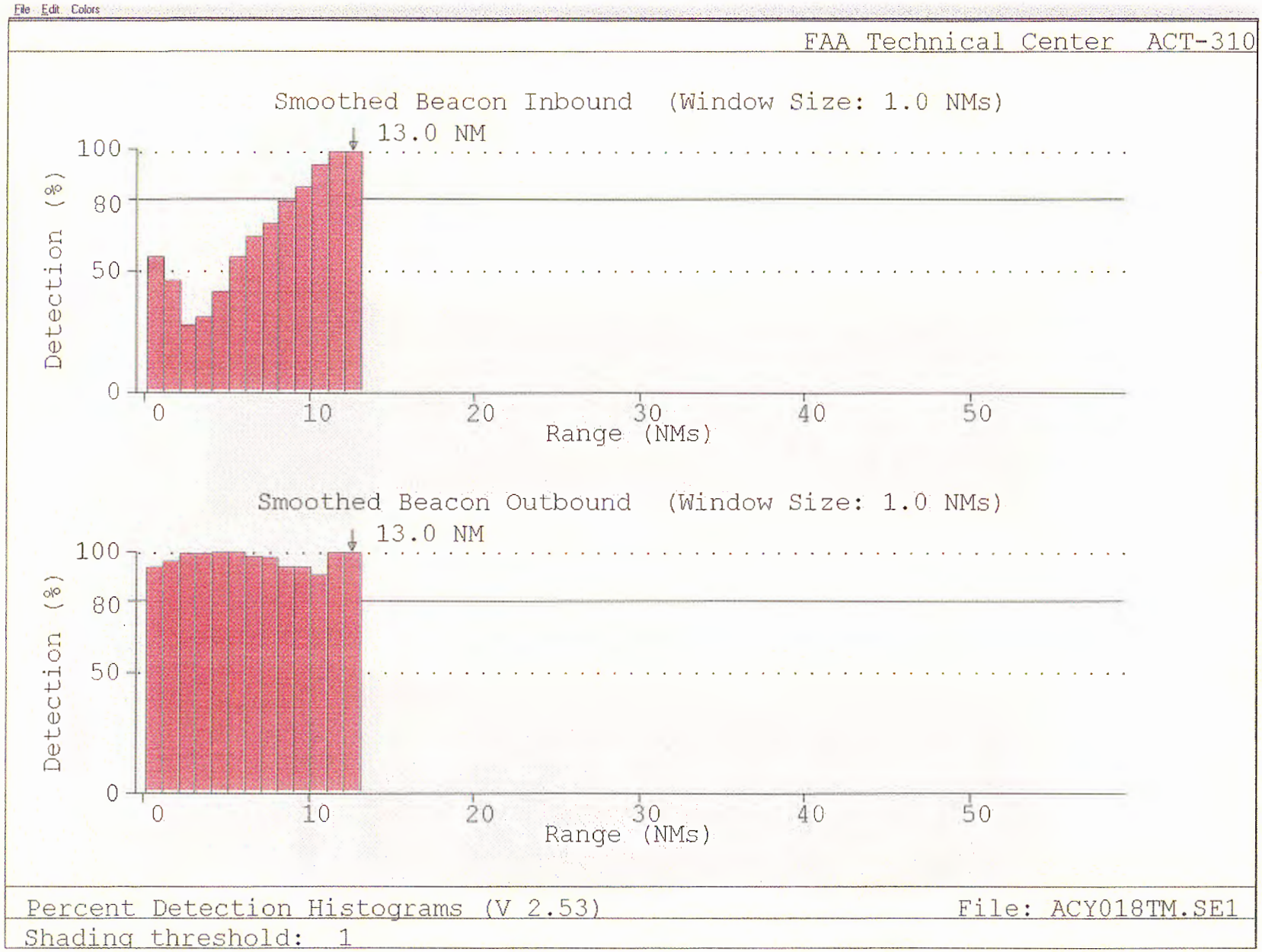

FIGURE 4.1.11.3-2. BEACON TARGET DETECTION (TECHNICAL CENTER)

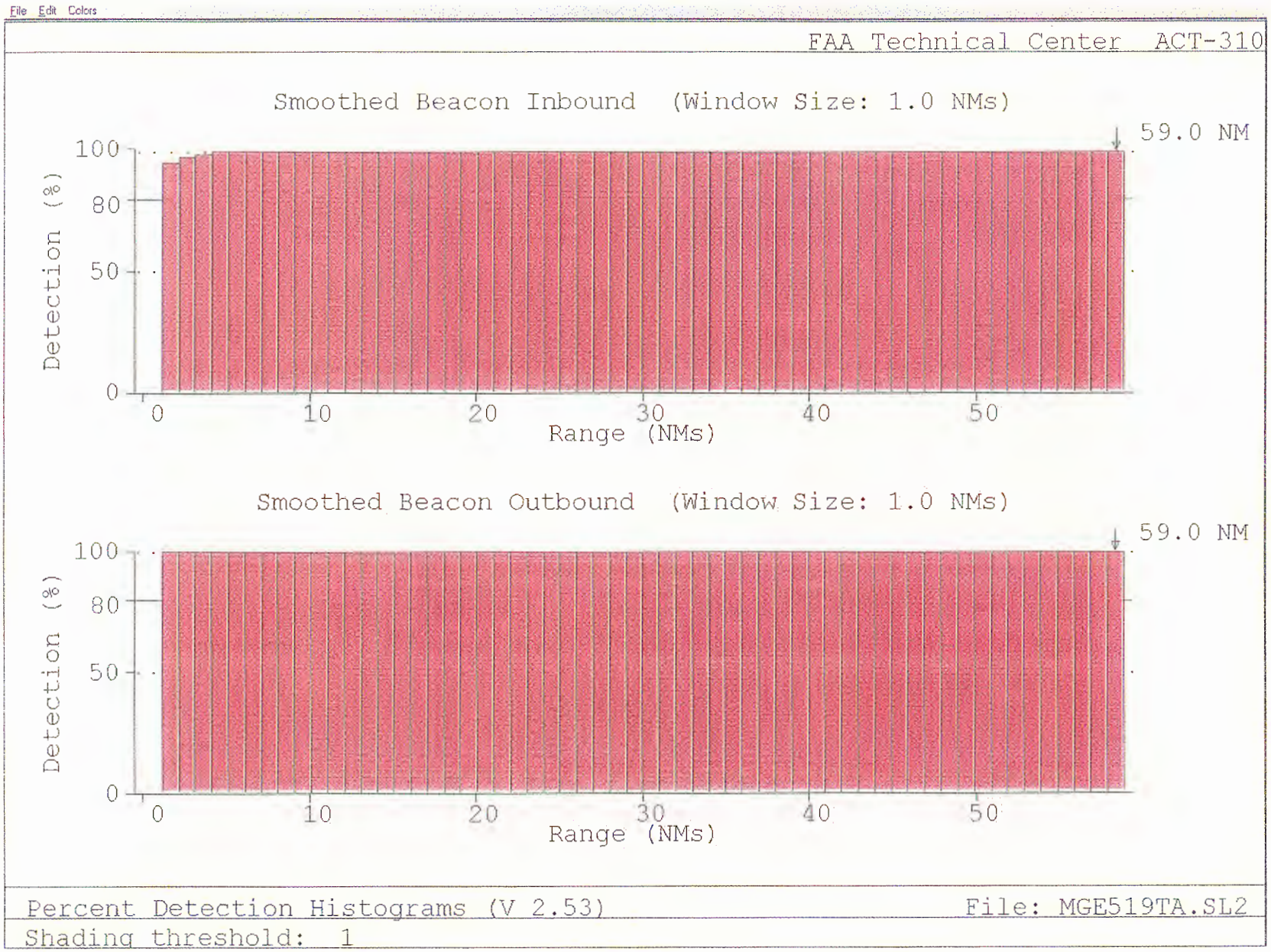

FIGURE 4.1.11.3-3. BEACON TARGET DETECTION (DOBBINS AFB)

Table 4.1.11.3-1 contains a Surveillance Analysis output of 200 scans of data from RUN100. The beacon Pd for discrete targets was 99.35 percent. The beacon Pd for nondiscrete targets was 97.43 percent. Table 4.1.11.3-2 contains a Surveillance Analysis output of 200 scans of data from RUN137. The beacon Pd for discrete targets in a steady state condition of 10K FRUIT was 98.95 percent. The beacon Pd for nondiscrete targets in a steady state condition of 10,000 FRUIT was 94.68 percent.

Table 4.1.11.3-3 contains a Surveillance Analysis output of 115 scans of data from RUN139. The beacon Pd for targets with a round reliability of 0.75 and in a steady state condition of 10K FRUIT was 99.6 percent. Table 4.1.11.3-4 contains a Surveillance Analysis output of 200 scans of data from RUN519. The beacon Pd for discrete targets was 99.33 percent. The beacon Pd for nondiscrete targets was 97.27 percent.

In summary, the TDX-2000d provides good beacon detection using different beacon systems and in conditions of low and high target densities.

TABLE 4.1.11.3-1. SURVEILLANCE ANALYSIS - RUN100

RUN100 - Targets of Opportunity

	Track	-Probability	Detect-		Id	Id	Alt	Alt	Beacon	Radar	Search
	Life	Beacon	Search	Total	Rel	Conf	Rel	Conf	Hits	Reinf	Collim
DISCRETE	10779	99.35	79.22	99.60	98.63	97.89	98.80	97.85	20.0	0.00	0.00
NON DISCRETE	8588	97.43	69.47	98.75	97.77	95.45	97.60	95.71	18.5	0.00	0.00
ATCRBS	19367	98.50	74.90	99.23	98.25	96.82	98.28	96.91	19.3	0.00	0.00
TOTAL	19367	98.50	74.90	99.23	98.25	96.82	98.28	96.91	19.3	0.00	0.00

Number of tracks included in the statistics = 193
Number of antenna updates = 192
Uncorrelated records: reports = 375 tracks = 291
Uncorrelated percentage: reports = 1.93 tracks = 1.50

TABLE 4.1.11.3-2. SURVEILLANCE ANALYSIS - RUN137

RUN137 - Test Targets with 10,000 FRUIT

	Track	-Probability	Detect-		Id	Id	Alt	Alt	Beacon	Radar	Search
	Life	Beacon	Search	Total	Rel	Conf	Rel	Conf	Hits	Reinf	Collim
DISCRETE	7687	98.95	90.57	99.40	98.92	96.31	51.92	1.92	9.8	89.05	97.78
NON DISCRETE	1617	94.68	86.52	97.84	97.13	93.01	63.64	13.64	9.1	84.32	95.77
ATCRBS	9304	98.21	89.86	99.13	98.62	95.75	58.47	8.47	9.7	88.26	97.45
TOTAL	9304	98.21	89.86	99.13	98.62	95.75	58.47	8.47	9.7	88.26	97.45

Number of tracks included in the statistics = 138
Number of antenna updates = 105
Uncorrelated records: reports = 1082 tracks = 167
Uncorrelated percentage: reports = 10.59 tracks = 1.79

TABLE 4.1.11.3-3. SURVEILLANCE ANALYSIS - RUN139

RUN139 - Test Targets with 10,000 FRUIT and 0.75 Round Reliability											
	Track	-Probability Detect-			Id	Id	Alt	Alt	Beacon	Radar	Search
	Life	Beacon	Search	Total	Rel	Conf	Rel	Conf	Hits	Reinf	Collim
ATCRBS	41288	99.66	0.47	99.72	98.72	87.18	98.61	87.61	9.1	0.00	0.00
Number of tracks included in the statistics = 360											
Number of antenna updates = 115											
Uncorrelated records: reports = 887 tracks = 141											
Uncorrelated percentage: reports = 2.11 tracks = 0.34											

TABLE 4.1.11.3-4. SURVEILLANCE ANALYSIS - RUN519

RUN519 - Targets of Opportunity (Dobbins AFB)											
	Track	-Probability Detect-			Id	Id	Alt	Alt	Beacon	Radar	Search
	Life	Beacon	Search	Total	Rel	Conf	Rel	Conf	Hits	Reinf	Collim
DISCRETE	8075	99.33	78.29	99.81	98.55	98.27	98.88	96.66	18.9	0.00	0.00
NON DISCRETE	770	97.27	77.79	99.35	99.87	99.60	99.60	98.40	18.0	0.00	0.00
ATCRBS	8845	99.15	78.25	99.77	98.67	98.38	98.94	96.81	18.8	0.00	0.00
TOTAL	8845	99.15	78.25	99.77	98.67	98.38	98.94	96.81	18.8	0.00	0.00
Number of tracks included in the statistics = 82											
Number of antenna updates = 211											
Uncorrelated records: reports = 192 tracks = 75											
Uncorrelated percentage: reports = 2.14 tracks = 0.85											

4.1.12 Beacon False Report Rate.

4.1.12.1 Criteria.

This test evaluates the effectiveness of the TDX-2000d beacon reply processor (REPRO) and PLot EXtractor (PLEX) in tecting and processing replies. The TDX-2000d beacon data was analyzed for splits, multipath, and ring-around. The TDX-2000d should produce less than 50 false beacon target reports per scan in a steady state condition of 10,000 Air Traffic Control Radar Beacon System (ATCRBS) fruit replies per second. (Reference: Performances Measures; Paragraph 3.a.(4)(b). False Target Processing, Paragraph 8. Critical Operational Issues (COI) COI 2. False Alarm Rate.)

4.1.12.2 Configuration.

Site parameters were optimized with the cooperation of the TDX-2000d system contractor at the Technical Center and at Dobbins AFB.

Performance was evaluated through analysis of targets of opportunity collected at the Technical Center ASR-8 radar site and Dobbins AFB AN/GPN-20 radar site. Data was collected at the TDX-2000d, SDU output port using an MX-6A record board, and RTADS or RRAP record software. The data used in the analysis were collected from the Technical Center as RUN007 and from the Dobbins AFB as RUN514.

An additional scenario, RUN137, was collected on August 10, 1998, from the Technical Center, was used to verify false beacon target reports per scan in a steady state condition of 10,000 FRUIT replies per second. The FRUIT scenario was injected at the input to the AN/UPX-27 beacon system at the Technical Center using the VideoBITS test tool. This scenario was run in conjunction with targets of opportunity.

RBAT was used to analyze the above data collected during the test period. Beacon False Target Summary (BFTS) listings were used to group false targets into split, ringaround, PRF, downlink and uplink reflection categories. The complete listings were not included in this report, due to the length of output, but is explained briefly in the results section. BFTS was also used to summarize the percentage of false target categories.

4.1.12.3 Results.

RBAT Filter was used to filter RUN007 and RUN514 to obtain 400 scans of data for each run and to remove fixed transponder codes. The fixed transponder codes from a parrot are not considered false targets. The listings were analyzed scan by scan and resulted in a range of one to three false targets per scan, with an overall average false target rate of two false targets per scan. Tables 4.1.12.3-1 and 4.1.12.3-2 contain BFTS summaries of RUN007 and RUN514, with a categorized false target percentage of less than 1.0 percent. The possibly false target categories were examined through Surveillance Print and Plot program to be targets with duplicate Mode 3A codes.

Table 4.1.12.3-3 contains BFTS summary of 105 scans of data from RUN137. The listings was analyzed scan by scan and resulted in a range of one to four false targets per scan. The overall false target percentage was less than 1.0 percent.

In summary, the TDX-2000d REPRO and PLEX was effective in detecting and processing replies and eliminating false targets. The BFTS analysis of RUN007 and RUN514 showed that the TDX-2000d meets the criteria. The BFTS analysis of RUN137 showed that the TDX-2000d produced an average of 2.5 false beacon target reports per scan in a steady state condition of 10,000 FRUIT replies per second. This is less than the 50 false reports per scan allowed by the performance measures document.

TABLE 4.1.12.3-1. BEACON FALSE TARGET SUMMARY - RUN007

RUN007 - Targets of Opportunity (Technical Center)
Total number of discrete code target reports = 11057
Total number of false target reports = 13
False target report percentage = 0.12
Total number of possibly false target reports = 3
Possibly false target report percentage = 0.03
Category Number Percent
Split 10 0.09
Ringaround 0 0.00
Down reflection 1 0.01
PRF 0 0.00
Up reflection 2 0.02
ATCRBS/Mode S 0 0.00
Other 3 0.03
Total number of target reports = 12405
Total number of target reports with ATCRBS id 0000 = 65
ATCRBS id 0000 target report percentage = 0.52

TABLE 4.1.12.3-2. BEACON FALSE TARGET SUMMARY - RUN514

RUN514 - Targets of Opportunity (Dobbins AFB)
Total number of discrete code target reports = 10545
Total number of false target reports = 40
False target report percentage = 0.38
Total number of possibly false target reports = 1
Possibly false target report percentage = 0.01
Category Number Percent
Split 8 0.08
Ringaround 1 0.01
Down reflection 3 0.03
PRF 5 0.05
Up reflection 23 0.22
ATCRBS/Mode S 0 0.00
Other 1 0.01
Total number of target reports = 10639
Total number of target reports with ATCRBS id 0000 = 25
ATCRBS id 0000 target report percentage = 0.23

TABLE 4.1.12.3-3. BEACON FALSE TARGET SUMMARY - RUN137

RUN137 - Targets of Opportunity with 10,000 FRUIT		
Total number of discrete code target reports = 7771		
Total number of false target reports = 63		
False target report percentage = 0.81		
Total number of possibly false target reports = 0		
Possibly false target report percentage = 0.00		
Category	Number	Percent
Split	48	0.62
Ringaround	0	0.00
Down reflection	1	0.01
PRF	0	0.00
Up reflection	14	0.18
ATCRBS/Mode S	0	0.00
Other	0	0.00
Total number of target reports = 10223		
Total number of target reports with ATCRBS id 0000 = 976		
ATCRBS id 0000 target report percentage = 9.55		

4.1.13 Beacon Range and Azimuth Resolution.

4.1.13.1 Criteria.

Verify that the TDX-2000d resolves noninterfering (nonoverlapping) beacon targets 95 percent of the time when at the same center azimuth and separated by 0.05 to 0.5 nmi in range inclusive. (Reference: Performances Measures; Paragraph 3.a.(2).4. Range Resolution.) Verify that the TDX-2000d resolves noninterfering beacon targets 99 percent of the time when separated by more than 0.5 nmi in range. (Reference: Performances Measures; Paragraph 3.a.(2).4. Range Resolution.)

Verify that the TDX-2000d resolves two detected, stationary, identical targets at least 95 percent of the time which are within 0.5 nmi in range and separated by an absence of beacon replies for 18 Pulse Repetition Time (PRT). (Reference: Performances Measures; Paragraph 3.a.(2).5. Azimuth Resolution.) Verify that the TDX-2000d resolves two detected noninterfering, stationary or moving targets which are within 0.05 nmi in range and have one or more distinguishing characteristics at least 99.5 percent of the time. Distinguishing characteristics include different Mode 2, 3/A, or C codes. (Reference: Performances Measures; Paragraph 3.a.(2).5. Azimuth Resolution.)

4.1.13.2 System Configuration.

Dedicated flight tests, conducted at the Technical Center, were used for resolution analysis. The data was collected at the SDU output ports using an MX-6A record board and RTADS record software.

Range resolution flight test data, RUN063, RUN064, and RUN065 was collected on March 23, 25, and 26, 1998, at the Technical Center. RUNXXX represent data files recorded at the output of the digitizer. The ASR-9 CD format data was recorded at the RS-232 output of the SDU. This output supplies surveillance and weather messages to the local modem.

Azimuth resolution flight test data, RUN009, RUN059, RUN060, RUN065, and RUN073 was collected on January 14, March 16, 17, 26, and April 20, 1998, at the Technical Center. The ASR-9 CD format data was recorded at the RS-232

output of the SDU. Simultaneously, data was also recorded at the output of the SRAP and CD-2D digitizers for selected resolution tests. Site parameters were optimized with the cooperation of the contractor. The ASR-8 mode of operation was LP for the conduct of this test. The TDX-2000d adjustable parameters were set to provide no association of radar and beacon to monitor and collect individual radar and beacon reports.

Range resolution tests were performed by simultaneously flying two aircraft of dissimilar RCS in closely spaced flight patterns. The holding pattern was performed in a clear environment, at an altitude of 12,500 feet, from 25 nmi to 55 nmi at a 50° and a 218° radial from the radar site. The aircraft flew in a tail chase configuration maintaining a nominal range separation of one-half nmi. Azimuth resolution tests used a similar holding pattern with a lateral separation of 2° to 4.5° and 0 nmi range separation. Flights were performed in a clear environment, at altitudes of 12,000 feet and 12,500 feet, from 20 nmi to 55 nmi, at a 50° and a 218° radial from the radar site.

Range and azimuth resolution analysis were performed using IRES. The data was first converted in PCS format using COPYCD. The data was then sorted into range and azimuth order for each scan using the PREPPCS program. SELECT, an alpha-beta tracker in IRES, was used to isolate the test aircraft and FILTER was used to eliminate turns. The COPYLLA program reformats the GPS ASCII latitude, longitude, and altitude position data into PCS reference reports. This reformat includes a coordinate transform to the position of the radar antenna.

Next, the tracked target reports were merged with the GPS data by the MERGEPCS program. The percent resolution was computed based on the GPS reported separation and the existence of one (no resolution) or two (targets resolved) radar reports. The PLOTRES program presents resolution results in the form of radar detection histograms. The histogram show how often both aircraft were seen and at what separation.

Range resolution analysis was performed for RUN063, RUN064, and RUN065. Azimuth resolution analysis was performed for RUN009, RUN059, RUN060, RUN065, and RUN073.

Individual test data associated with range or azimuth tests were combined to provide additional samples at or near the specified performance measure (requirement). GPS was used as a source of truth to determine the actual separation of the two aircraft.

Beacon test targets were injected into the AN/UPX-27 interrogator at the RF port using VideoBITS. Three azimuth resolution scenarios were used; AZRES001, AZRES002, and AZRES003. Each scenario contained six pairs of identical targets positioned at the same range. Target pairs were separated in azimuth by 17 to 19 PRTs. Round reliability was set to 100 percent for each run. Data was recorded at the output of the SDU on June 23, 1998, as RUN124, RUN125, and RUN126.

Analysis for RUN124, RUN125, and RUN126 was performed using IRES. The data was first converted in PCS format using COPYCD. Next, the beacon and radar reinforced targets were selected using FILTER. COUNTPCS was used to count the beacon and reinforced reports.

4.1.13.3 Results.

Figure 4.1.13.3-1 presents the results of the beacon range resolution analysis performed on the range resolution flight data. Range samples were bounded

from 0 to 10 ACPs. The data indicates a hole in range resolution when targets are separated by more than 6/64 nmi. The resolution percentage again crosses the required 95 percent level at 11/64 nmi. The figure also shows that targets separated in range greater than 32/64 nmi resolve at a rate of 97 percent to 100 percent.

Figure 4.1.13.3-2 shows the azimuth resolution analysis performed on the azimuth resolution flight data. Azimuth samples were bounded from 0 to 14/64 nmi. The data shows that two targets resolve at least 95 percent from 3 ACPs to 36 and beyond 53 ACPs.

A hole in azimuth resolution exists from 37 ACPs to 53 ACPs. Targets in this region resolve at a minimum rate of 75 percent. The reason for the reduced resolution on either side of the required 18 PRT separation (46 ACPs) is not determined.

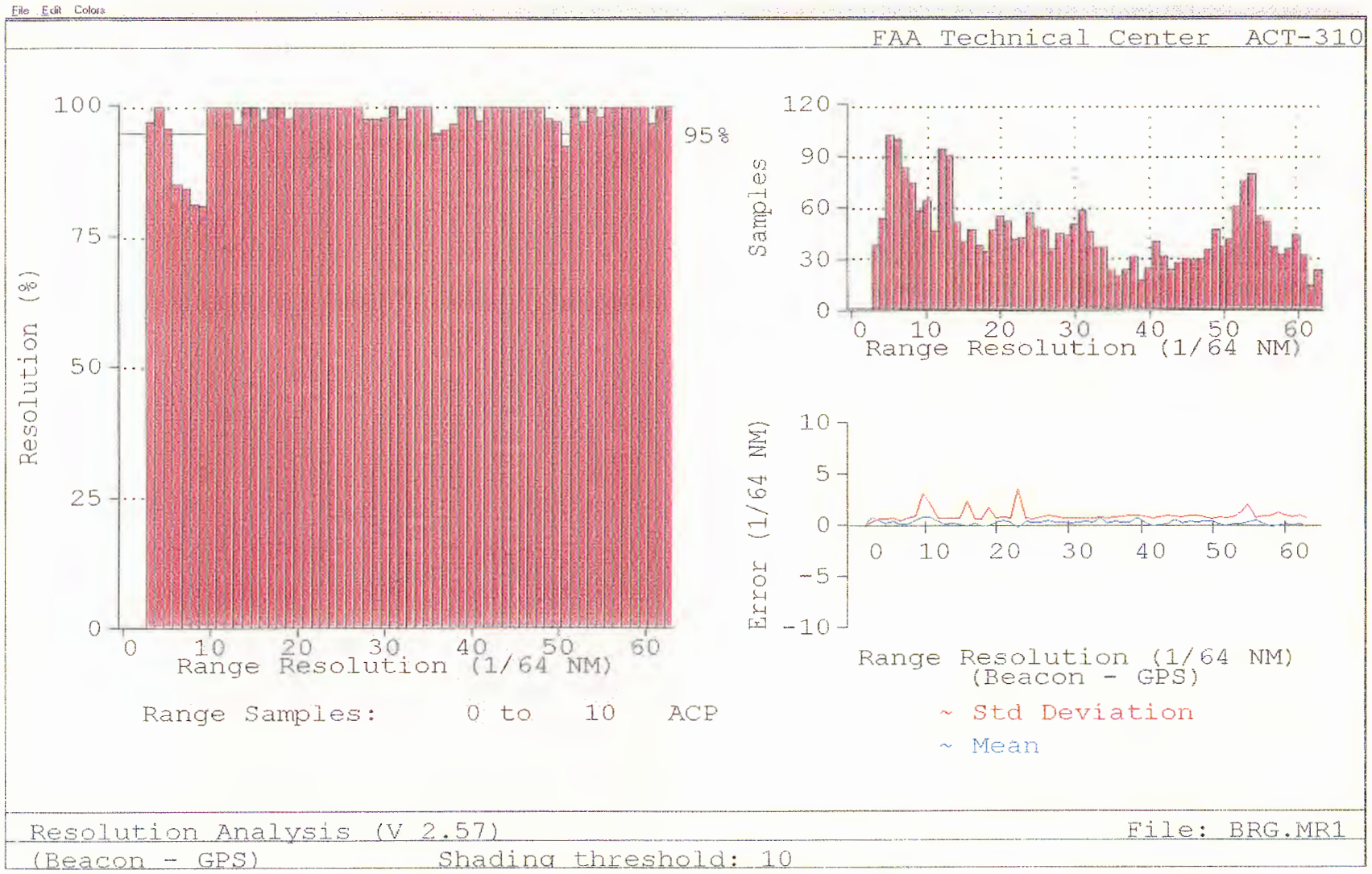

FIGURE 4.1.13.3-1. BEACON RANGE RESOLUTION

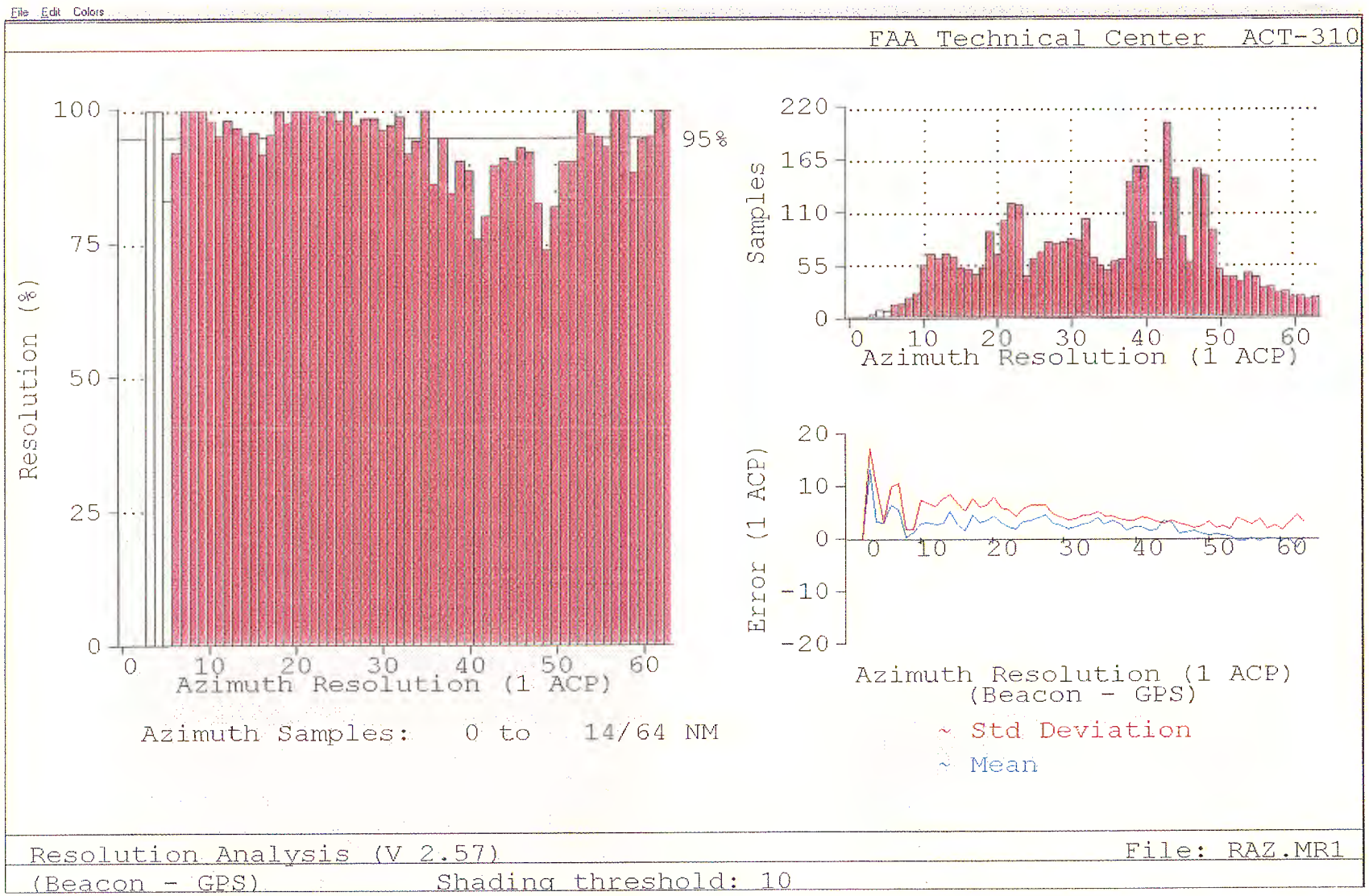

FIGURE 4.1.13.3-2. BEACON AZIMUTH RESOLUTION

Additional azimuth resolution tests were performed to further document the hole centered around 46 ACPs. Test targets were injected at 43 ACPs, 46 ACPs, and 49 ACPs separation. Table 4.1.13.3-1 suggests that resolution is greater than 99 percent in the area of interest. The 3/A codes were correct and validated 100 percent for all three scenarios.

TABLE 4.1.13.3-1. RUNS 124, 125, 126 AVERAGE BEACON REPORTS

RUN	Azimuth Separation (PRT)	Average Reports Per Scan	Percent Resolution
124	18 (46 ACPs)	12.00	100.0
125	17 (43 ACPs)	12.00	100.0
126	19 (49 ACPs)	11.96	99.7

In summary, the TDX-2000d provides (a) good range separation of beacon reports at 1 nmi and greater; (b) adequate range separation of beacon reports at ranges less than 1 nmi; and (c) acceptable azimuth resolution of beacon reports at separations greater than three ACPs.

4.1.14 Beacon Positional Accuracy.

4.1.14.1 Criteria.

This test evaluates that the performance of the TDX-2000d beacon REPRO and PLEX accurately reports range and azimuth position. The TDX-2000d standard deviation range errors should not exceed 0.03125 nmi (190 feet) and the azimuth error should not exceed 1/10 of the antenna's 3 dB azimuth beamwidth. (Reference: Performances Measures; Paragraph 3.a.(2)(b)(2) Range Accuracy, (3) Azimuth Accuracy.)

4.1.14.2 Configuration.

Beacon positional accuracy was evaluated through analysis of dedicated flight test conducted at the Technical Center. Data was collected at the TDX-2000d SDU output port using an MX-6A record board and RRAP record software. Positional accuracy flight test data, RUN172, was collected on December 14, 1998, at the Technical Center. ASHTEC GPS receiver data, aboard the aircraft and at the ASR-8 radar site, was simultaneously collected during the flight test.

Site parameters were optimized with the cooperation of the TDX-2000d system contractor. The TDX-2000d adjustable parameters was set to provide no association of radar and beacon to monitor and collect individual radar and beacon reports.

Positional accuracy tests was conducted by flying an aircraft in a single radial pattern. The holding pattern was performed in a clear environment, at an altitude of 11,000 feet, from 25 nmi to 55 nmi at a 218° radial from the radar site.

Positional accuracy analysis was performed using IRES. The data was first converted in PCS format using COPYCD. The target reports were then sorted into range and azimuth order for each scan using the PREPPCS program. SELECT, an alpha-beta tracker in IRES, was used to isolate the test aircraft and FILTER was used to eliminate turns. The COPYLLA program reformats the GPS ASCII latitude, longitude, and altitude position data into PCS reference

reports. This reformat includes a coordinate transform to the position of the radar antenna.

Next, the tracked target reports were merged with the GPS data by the MERGEPCS program. The beacon range and azimuth collimation was computed based on the GPS reported position and the beacon reported position. The IRES COLRB program presents accuracy results in the form of number of hits per beacon range or azimuth position histograms. The histogram show how the beacon reported position compares to GPS reported position.

The beamwidth of the ASR-8 site beacon antenna was computed from the average system runlength. The system runlength was obtained from the CMC, TDX Stats, PLEX menus.

4.1.14.3 Results.

The average system runlength statistics reported by the CMC was 48 ACPs at 3dB. The beacon antenna beamwidth was computed as:

$$360°/4096 \text{ ACPs} * 48 \text{ ACPs} = 4.2°.$$

The 10 percent beamwidth error allowance at 3dB was computed as:

$$4.2°/10 = 0.42°.$$

Figure 4.1.14.3-1 contains a histogram showing the beacon azimuth accuracy. The azimuth mean error was -2.60 ACPs and is computed in degrees as:

$$360°/4096 \text{ ACPs} * -2.60 \text{ ACPs} = -0.229°.$$

The azimuth standard deviation was 1.890 ACPs and is computed in degrees as:

$$360°/4096 \text{ ACPs} * 1.890 \text{ ACPs} = 0.17°.$$

Figure 4.1.14.3-2 contains a histogram showing the beacon range accuracy. The range mean error was 3.74 64ths nmi and is computed in nmi as:

$$3.74 \text{ 64ths}/64 = 0.058 \text{ nmi}.$$

The range standard deviation was 2.495 64ths nmi and is computed in nmi as:

$$2.495 \text{ 64ths}/64 = 0.039 \text{ nmi}.$$

The difference between the reported and allowed range standard deviation is:

$$(0.039 \text{ nmi} - 0.03125 \text{ nmi}) * 6080 \text{ feet} = 47 \text{ feet}.$$

In summary, the beacon range and azimuth errors of the TDX-2000d are within the required performance measure.

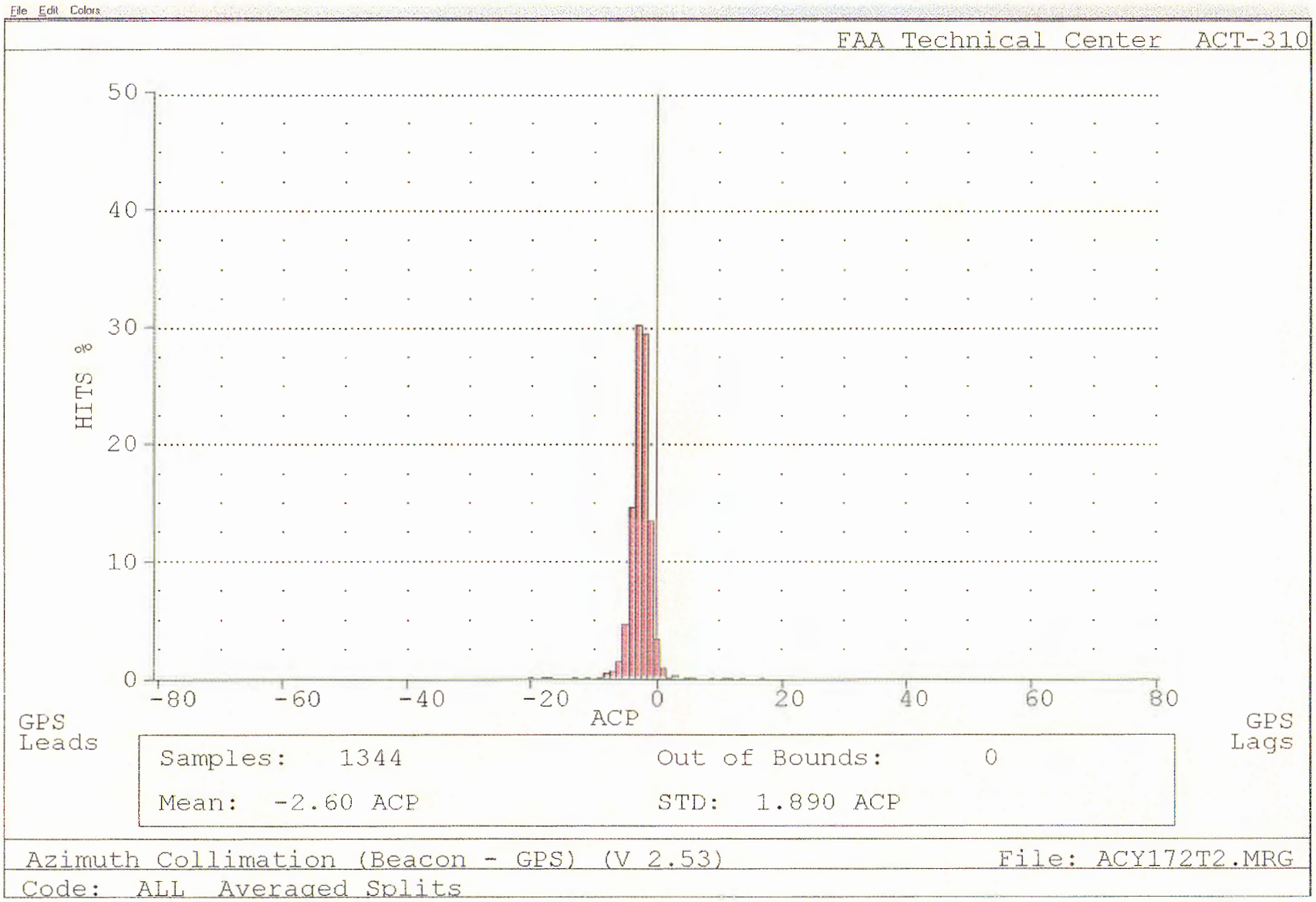

FIGURE 4.1.14.3-1. TDX BEACON AZIMUTH ACCURACY

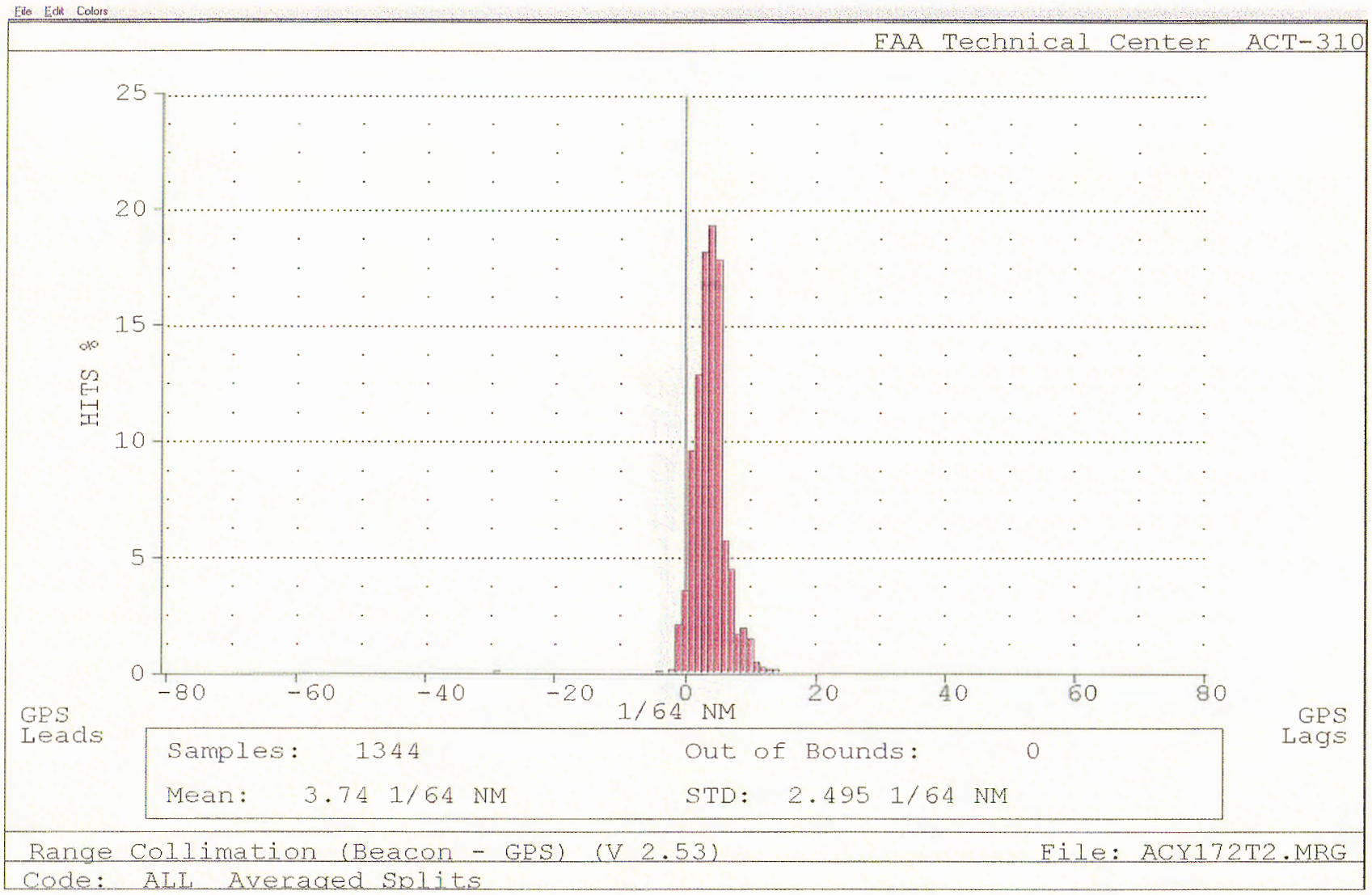

FIGURE 4.1.14.3-2. TDX BEACON RANGE ACCURACY

4.1.15 Beacon Code Validation and Code Accuracy.

4.1.15.1 Criteria.

This test ensures that the TDX-2000d beacon processor reports accurate beacon codes with a high validation rate. The TDX-2000d should validate the beacon code information as contained in the aircraft's reply for Modes 2, 3/A, and C including SPI and X-bit pulses at least 95 percent of the time when five or more hits are received per mode. The TDX-2000d should validate the beacon code information as contained in the aircraft's reply for Modes 2, 3/A, and C including SPI and X-bit pulses at least 98 percent of the time when the number of hits received per mode is 11 or greater. The TDX-2000d should effectively detect and resolve phantom replies and garble cases. Validated codes should be accurate at least 99 times out of 100. The validation of incorrect codes due to FRUIT or other causes should occur less than 1.0 percent of the time.

4.1.15.2 Configuration.

The TDX-2000d site parameters were optimized with the cooperation of the contractor. The AN/UPX-27 beacon interrogator could not reliability process more than two reply mode interlaces. Therefore, separate test had to be conducted to verify reply Modes 2, 3/A and C.

Performance was evaluated through analysis of targets of opportunity and test target data collected at the Technical Center's ASR-8 radar site. Data was collected at the TDX-2000d SDU output port using a MX-6A record board and RTADS record software. Four different beacon test target scenarios were used to measure the code validation and code accuracy performance of the TDX-2000d beacon processor. Table 4.1.15.2-1 describes each scenario.

Data was recorded over several days during the test period. RUN032 and RUN037 was collected on February 12, 1998; 20 scans of data were recorded with the UPX-27 operating normally and the ASR-8 high voltage off. RUN150, RUN151, and RUN152 was collected on October 6, 1998; 20 scans of data were recorded with the UPX-27 and ASR-8 operating normally. RUN194 and RUN195 was collected on February 26, 1999; 30 scans of data were recorded with the UPX-27 and ASR-8 operating normally.

TABLE 4.1.15.2-1. CODE VALIDATION AND CODE ACCURACY TEST SCENARIOS

RUN	Scenario	Description
37	PULSE03	Eight individual targets injected. Each target reply has the same pulse width for all bracket and code pulses. Target / Pulse Width (nsec) / Azimuth (deg) 1 / 250 / 30 2 / 300 / 60 3 / 350 / 90 4 / 400 / 120 5 / 450 / 150 6 / 500 / 180 7 / 550 / 210 8 / 550 / 240
150 194	VAL95SX	Sixteen spokes of ten targets each. The X and SPI bits were set for modes 2 and 3/A. Target Runlength = 15 ACPs. Round Reliability = 100%.
32 151 195	VAL98SX	same as VAL95SX except target runlength = 25 ACPs.
152	PHANTOM1	6 pairs of individual targets with C2-SPI pulse interference.

The TDX-2000d code validation and code accuracy was analyzed using IRES. The data was first converted in PCS format using COPYCD. The COUNTPCS and SHOWPCS programs were used to inspect the beacon report codes and count the number of reports with the correct and validated codes. COUNTPCS and SHOWPCS present the data in tabular form.

4.1.15.3 Results.

RUN032 contains test target data with a FRUIT rate of 10,000 replies per second added to the scenario. Incorrect codes were evaluated using the beacon report listings of SHOWPCS. The analysis revealed that the TDX-2000d validated incorrect codes due to FRUIT less than 1 percent of the time.

RUN037 contains test target data with reply pulse widths varying from 250 to 550 nanoseconds. Table 4.1.15.3-1 shows the results of RUN037. The TDX-2000d correctly reported all eight targets for all 20 scans of the scenario.

TABLE 4.1.15.3-1 PULSE WIDTH DISCRIMINATION RESULTS

Correct and Validated Codes - 20 SCANS			
RUN#	Number of Targets	Mode 3A	Mode C
37	160	100%	100%

Table 4.1.15.3-2 shows the results of RUN150 and RUN151 using a Mode 3/A and C interlace. The TDX-2000d reported the correct and validated codes (including

the X and SPI bits) over 95 percent of the time when the test targets had hit counts of 5 or more, and 100 percent of the time when the scenario had hit counts of 11. Validated code accuracy was 99 percent.

TABLE 4.1.15.3-2. MODE 3A AND C CODE VALIDATION RESULTS

Correct and Validated Codes (including X and SPI bits)			
RUN#	Target Hit Count	Mode 3A	Mode C
150	5	95.1%	95.3%
151	11	100%	100%

RUN152 contains test target data with phantom replies. The replies were evaluated using the beacon report listings of SHOWPCS. The listing showed that the TDX-2000d detected and reported the correct codes for each of the six sets of overlapped replies. This phantom case is ambiguous since it is difficult to determine whether an overlapped C2 and SPI bit belongs to the first or second reply. When the C2 bit of the second reply is set, and the C1 and A1 bits of the second reply are not set, the TDX-2000d recognizes the first reply as having a Mode 3/A code with an SPI bit set and validates it. When the C2, C1, and A1 bits of the second reply are set, the TDX-2000d does not recognize the first reply as having an SPI bit set and does not validate it.

Table 4.1.15.3-3 shows the results of RUN194 and RUN195 using a Mode 2 and 3/A interlace. A hit count of 5 was not feasible to obtain for this interlace combination, so a minimum hit count of 7 was used for these tests. RUN194 shows that the TDX-2000d reported correct and valid codes (including the X and SPI bits) over 96 percent of the time when the scenario had hit counts of at least 7 or more. The TDX-2000d reported correct and valid codes 100 percent of the time when the scenario had hit counts of 11 or more. Validated code accuracy was 99 percent.

TABLE 4.1.15.3-3. MODE 3A AND 2 CODE VALIDATION RESULTS

Correct and Validated Codes (including X and SPI bits)			
RUN#	Target Hit Count	Mode 3A	Mode 2
194	7	96.2%	100%
195	11	100%	100%

In summary, the TDX-2000d adequately validates the Modes 2, 3/A, and C, including the X and SPI pulses, when the number of actual hits received per mode is 5 or greater. The TDX-2000d provides good code accuracy and acceptable suppression of incorrect codes in a FRUIT environment.

4.1.16 Capacity and Processing Delay.

4.1.16.1 Criteria.

This test ensures that the TDX-2000d and AIU can adequately process and output a capacity target load within a specified delay time. The TDX-2000d should process and provide message outputs for a steady state maximum load of 700 aircraft returns within the primary coverage area. The TDX-2000d should process and provide message outputs for a load of 250 aircraft returns uniformly distributed in a 90° sector. The TDX-2000d should process and provide message outputs for a load of 100 aircraft returns uniformly distributed across two contiguous 11.25° sectors. The TDX-2000d should process and provide message outputs for a small sector peak consisting of 16 aircraft returns in each of two contiguous 1.3° wedges. The total delay, or throughput time, from detection of a target at the antenna boresight to output at the controller display of the target report shall not exceed 2.2 seconds.

4.1.16.2 Configuration.

The TDX-2000d site parameters were optimized with the cooperation of the system contractor. The TDX-2000d target capacity and processing delay was conducted at the Technical Center.

The target capacity delay time was evaluated through time measurements of displayed test target data on ARTS-IIA displays, conducted on February 18, 1999. Figure 4.1.16.2-1 shows the setup of time measurements for test targets displayed on an ARTS-IIA display. The test involved a photoelectric probe used for sensing the video light intensity on the ARTS-IIA display. An HP-54520A oscilloscope was used to measure the time the test target was displayed on the controller display. The oscilloscope was triggered by the ARP directly from the ASR-8 radar. The test target was injected into the AN/UPX-27 interrogator at the RF port using VideoBITS. The test target was injected at 0° coincident with the ARP. The photoelectric probe was placed directly on the display where the TDX-2000d test target video would be illuminated. The actual time measurement was taken from the time the ASR-8's ARP was triggered until the photoelectric probe sensed the illumination of the test target video. All reply video data was provided by the TDX-2000d and the reconstituted reply video of the AIU.

The capability of the TDX-2000d to process and provide capacity data within the primary coverage area was analyzed by verifying its output data. Data were collected at the TDX-2000d SDU output port using a MX-6A record board and RTADS record software at the ASR-8 radar site. A total target load of 700 test targets was injected into the AN/UPX-27 interrogator and the ASR-8 at the RF ports using VideoBits. The data was recorded as RUN082 on May 1, 1998.

The TDX-2000d target capacity processing was analyzed using IRES. The data was first converted in PCS format using COPYCD. The COUNTPCS, SHOWPCS and PLOTPCS programs were used to inspect the beacon report codes and count the number of reports.

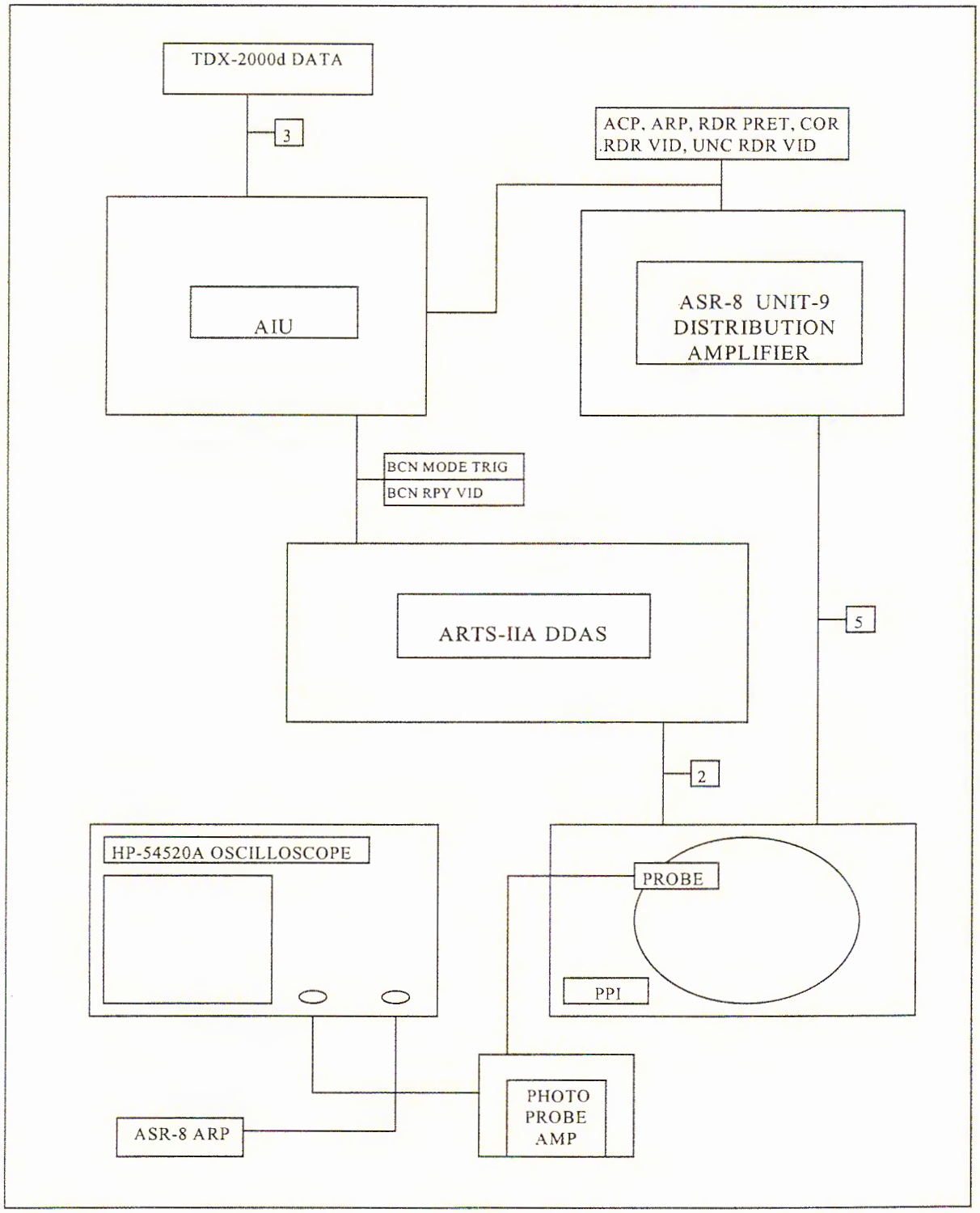

FIGURE 4.1.16.2-1. TDX-2000d/AIU TARGET DELAY TIME TEST CONFIGURATION

4.1.16.3 Results.

Table 4.1.16.3-1 contains the results of the TDX-2000d/AIU capacity target delay time. A capacity of 365 targets was used for this test. The ARTS IIA was operating at maximum capacity during the TDX-2000d test period. There were 30 samples measured for both scenario cases. The average time delay measurements for capacity and targets of opportunity were 2.5 seconds.

TABLE 4.1.16.3-1. TARGET DELAY TIME MEASUREMENTS

Scenario	Samples	Ave Time Delay
ARTS-IIA Capacity - 365	30	2.5 sec
Targets of Opportunity	30	2.5 sec

Figures 4.1.16.3-1 and 4.1.16.3-2 show photographs of the time delay from the capacity and targets of opportunity scenario cases, respectively, captured by the HP-54520A oscilloscope. A typical sample measurement was printed for each case. The printout show the time position of the ASR-8's ARP trigger (X1) and the time position of the photoelectric probe's sensing of the TDX-2000d/AIU beacon reply video (X2) on the ARTS-IIA display. The average delta time measurements was 2.5 seconds.

A plot of the recording used to validate TDX-2000d capacity is shown in figure 4.1.16.3-3. The plot of RUN103 shows over 700 surveillance targets. The plot contains a mix of RO, Radar/Beacon Merge (R/B), RC, and Beacon Only (BO) targets as shown with different colors in the diagram.

In summary, the TDX-2000d adequately processed and provided a steady state maximum load of 700 surveillance targets within the coverage area. Large sector and small sector peak capacity was not tested. The throughput time of 2.5 seconds exceeded the required delay of 2.2 seconds. However, the 2.5 second measurement is the total delay through the ASR-8 radar, TDX-2000d, AIU, and ARTS-IIA systems. Measured delay includes video reconstitution and re-digitization to accommodate the Palm Springs configuration.

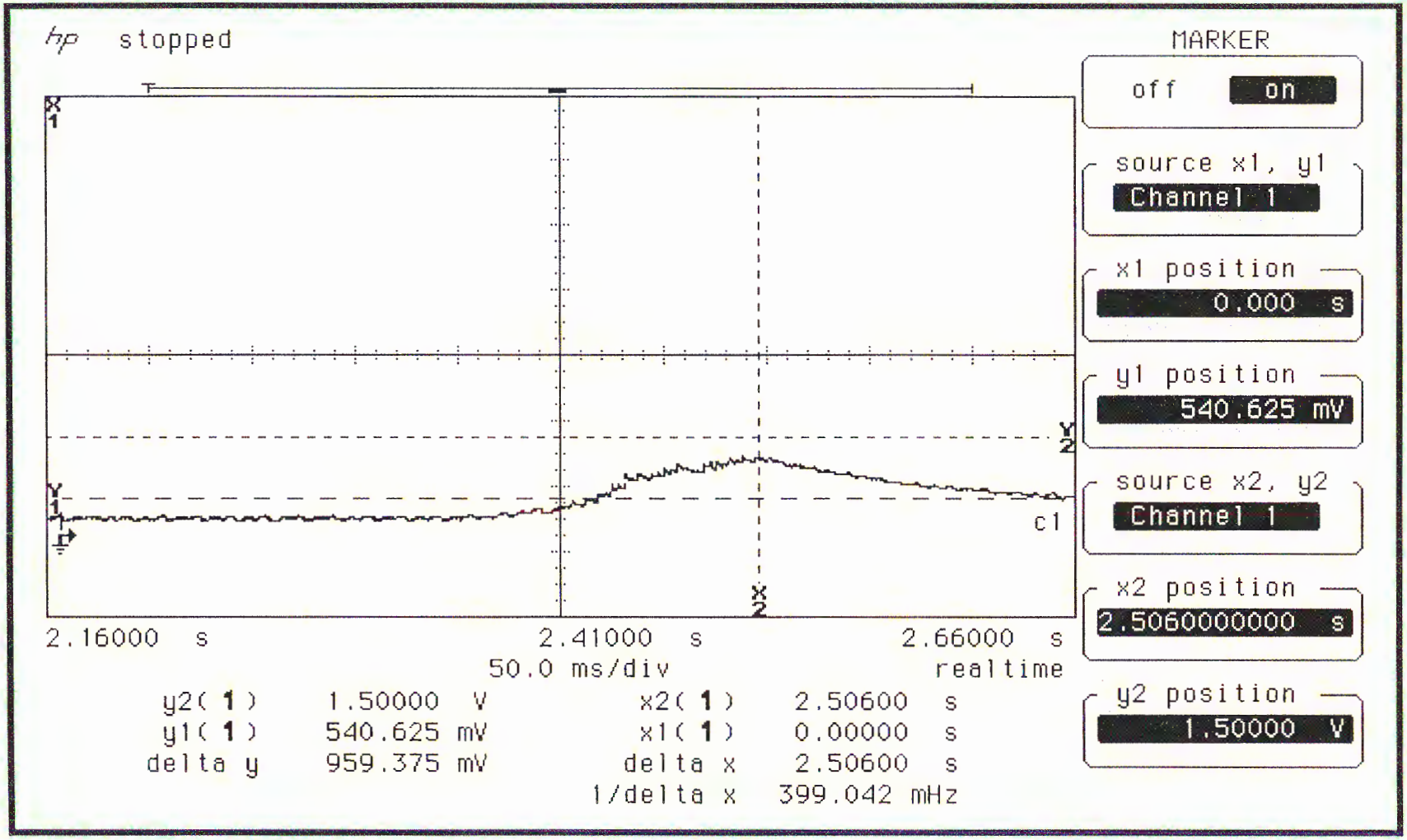

FIGURE 4.1.16.3-1. TDX/AIU TARGET CAPACITY THROUGHPUT TIME

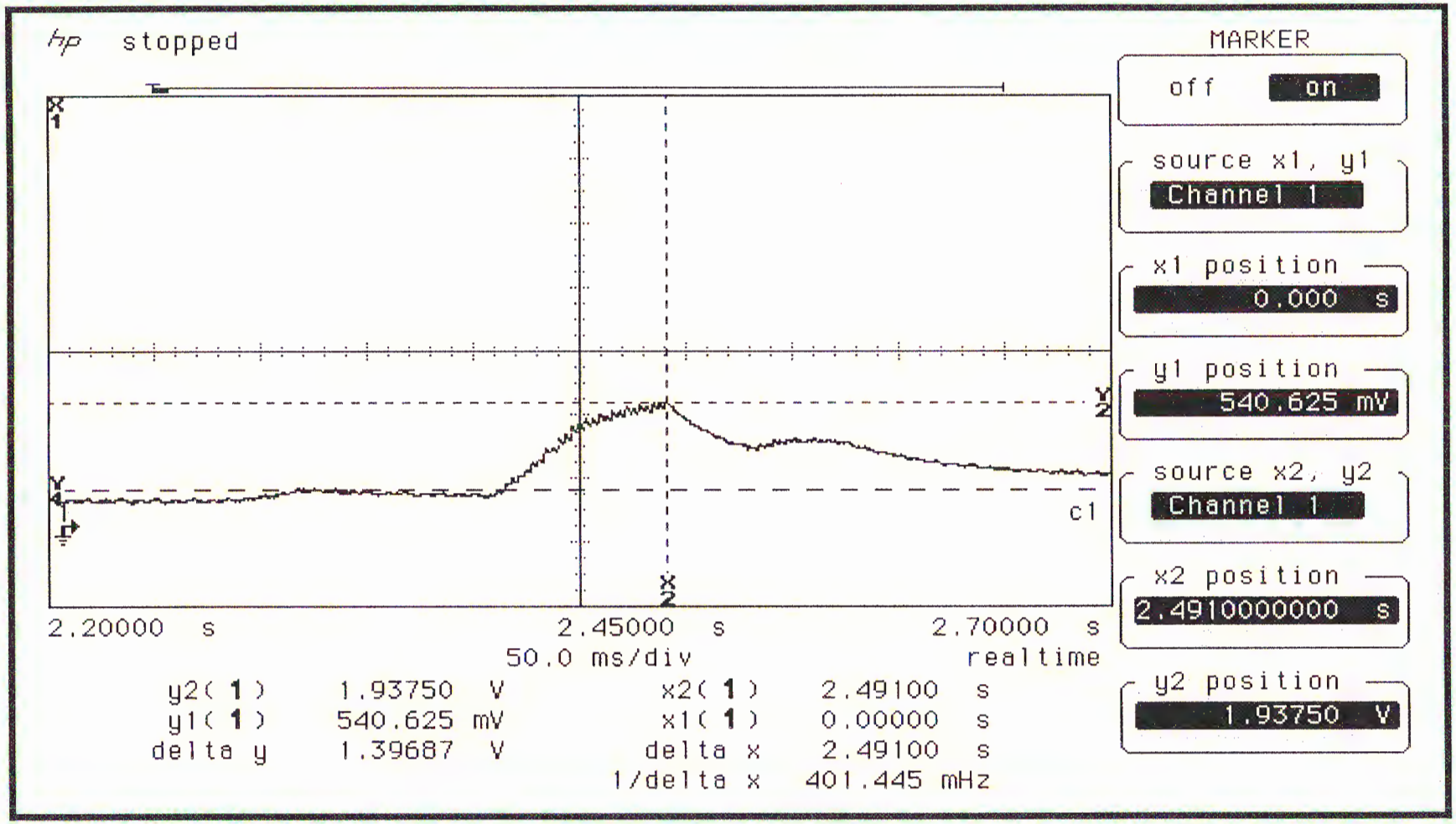

FIGURE 4.1.16.3-2. TDX/AIU TARGETS OF OPPORTUNITY THROUGHPUT TIME

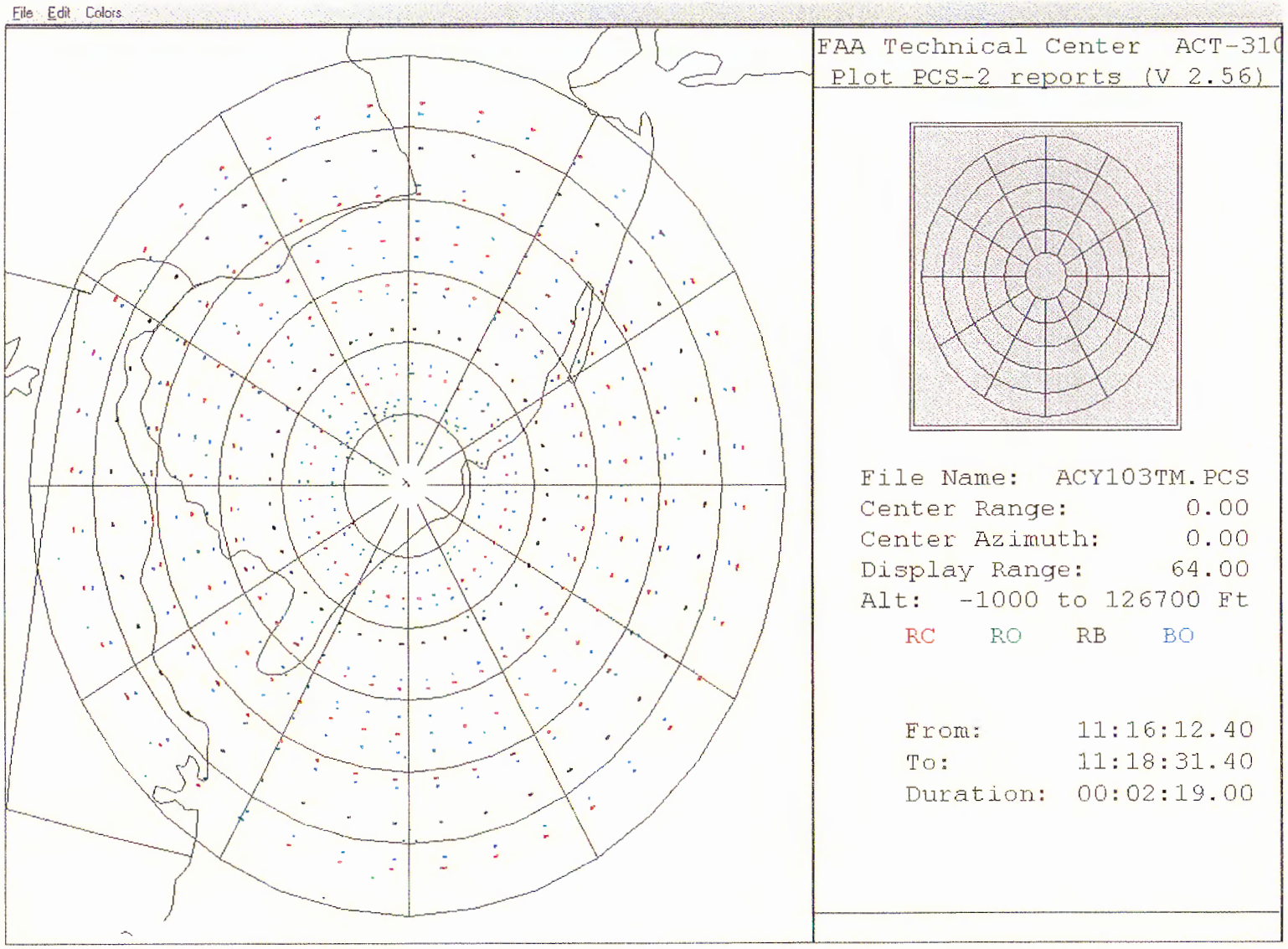

FIGURE 4.1.16.3-3. TDX TARGET CAPACITY OUTPUT

4.1.17 System Control Operation.

The system control operation tests ensure that the local and remote CMC provide the means to control and maintain the TDX-2000d and AIU, and provide sufficient performance information to the user. Due to the large number of control and maintenance menu options, this section has been divided into four subsections as follows:

a. 4.1.17.1 Local and Remote CMC Terminal Operations
b. 4.1.17.2 Equipment Performance
c. 4.1.17.3 Alarm Reporting and Fault Isolation
d. 4.1.17.4 Data Logging

All CMC figures contained in this section are printed by the CMC Screen Dump to file option.

4.1.17.1 Local and Remote CMC Terminal Operations.

4.1.17.1.1 Criteria.

This test ensures that the CMC and AIU can reliably provide control and status to facilities personnel. The operator should have the ability to fully control TDX-2000d operation at the local and remote locations. The operator should have sufficient control of TDX-2000d adjustable parameters, performance statistics, and display of surveillance data.

4.1.17.1.2 Configuration.

CMC menus were exercised to their full capability at the local (radar site) and remote (ARTS-IIA lab) locations. The AIU menus were also exercised to their full capability at the remote location. All menus were examined for control, feedback, and display features. Menus were also checked for ease of operation and functional use. The CMC and AIU were monitored to verify that the action taken produced the expected results. Menus that displayed incorrect information and parameters that did not adjust over their full range of values were noted in the test log book.

4.1.17.1.3 Results.

The results of the affected area of the CMC display which did not perform as expected were recorded in the test log book. The Air Situation Display (ASD) menu, as shown in figure 4.1.17.1.3-1, allows the operator to interact with the PPI and the RHI display data. All ASD options worked as documented in the CMC User's Manual.

The Display Data menu, located at the bottom of the ASD, as shown in figure 4.1.17.1.3-1, allows the operator to select various operating features. The surveillance plot options, weather levels, raw replies, range rings, azimuth spokes, and target history toggled as required. The Screen Dump feature located in the ASD menu did not send the CMC display to a printer. This problem is described in TDR ACT023 an listed in appendix A.

The radar filtering option filtered the display data as expected. The zooming features worked as predicted. The Tracks, Geomaps, Overlays, and Right Button pop-up menu buttons all worked as expected. All Display Data menu options worked as documented in the CMC User's Manual.

The CMC Config menu, as shown in figure 4.1.17.1.3-2, allows the operator to select the data communications media type, command connect to TDX #1 or TDX

#2, control status log, enter and/or change passwords, manage system files, and save/load CMC configurations. All CMC Config options worked as predicted in the CMC User's Manual. The TDX Tools menu was not tested in this section due to the high volume of options available, but has been used extensively to optimize the TDX-2000d.

The Multi Scan Correlator (MSC) Control menu, as shown in figure 4.1.17.1.3-3, allows the operator to change the current Correlator operating parameters. Those operating parameter options are the Correlator Control parameter, Aircraft parameters, Radar parameters, and Beacon False Target Logic (BFTL) parameters. All operating parameter changes, including the BFTL logic and its parameters, functioned normally.

All other MSC options such as Active/Bypass Regions, Clutter Map Options/Edit, UNIO Config, Search Beacon Association, Second Time Around Detect, MSC Clock/Reset, and Dump EEPROM, performed as predicted in the CMC User's Manual.

The TDX Control menu is presented in figure 4.1.17.1.3-4. It allows the operator to select on-line TDX output, configure the RS-232 port, select the data type output, and save/load TDX configuration. All TDX control options operated as required.

The AIU Main menu, as shown in table 4.1.17.1.3-1, allows the operator to reset and acknowledge board status, reset radar report status, generate test targets and range/azimuth gates, setup azimuth extents and communications processor controls, and to display errors and UNIO status. All AIU menu options worked as expected in the AIU User's Manual.

TABLE 4.1.17.1.3-1. AIU MAIN MENU

AIU Main Menu
F1 - Reset Boards
F2 - Data Collection
F3 - Test Targets
F4 - Rng/Az Gates
F5 - Azimuth Extent
F6 - CP Controls
F7 - Error Controls
F8 - Weather Control
F9 - Ack Brd Status
F10 - Reset Stats
Alt F1 - UNIO Stats
Alt F2 - Error Display
Alt F10 - Exit

The TDX Stats menu test results are explained in section 4.1.17.2. and the Data Analysis and Display System (DADS) menu test results are explained in section 4.1.17.4.

The Search, Beacon, and Weather menus were not fully tested due to the large number of parameters and the complex menu structure. However, these menus have been used extensively to optimize the TDX-2000d and are reported in section 4.2.

In summary, the CMC and AIU menus provide adequate control and status to facilities personnel. The operator has the ability to fully control TDX-2000d operation at the local and remote locations through the use of the CMC menus.

The operator has sufficient control of TDX-2000d adjustable parameters, performance statistics, and display of surveillance data on the ASD.

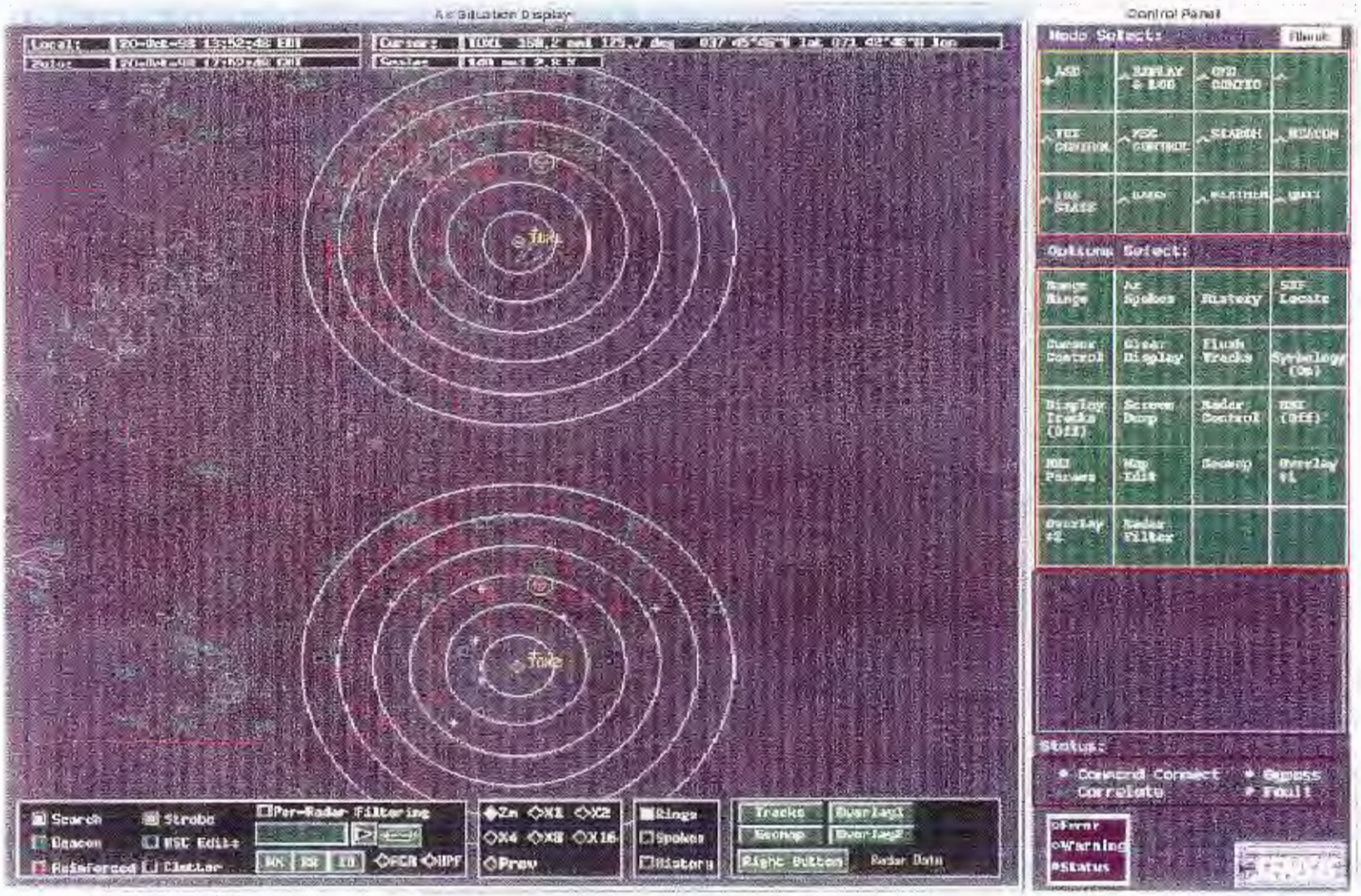

FIGURE 4.1.17.1.3-1. ASD MENU

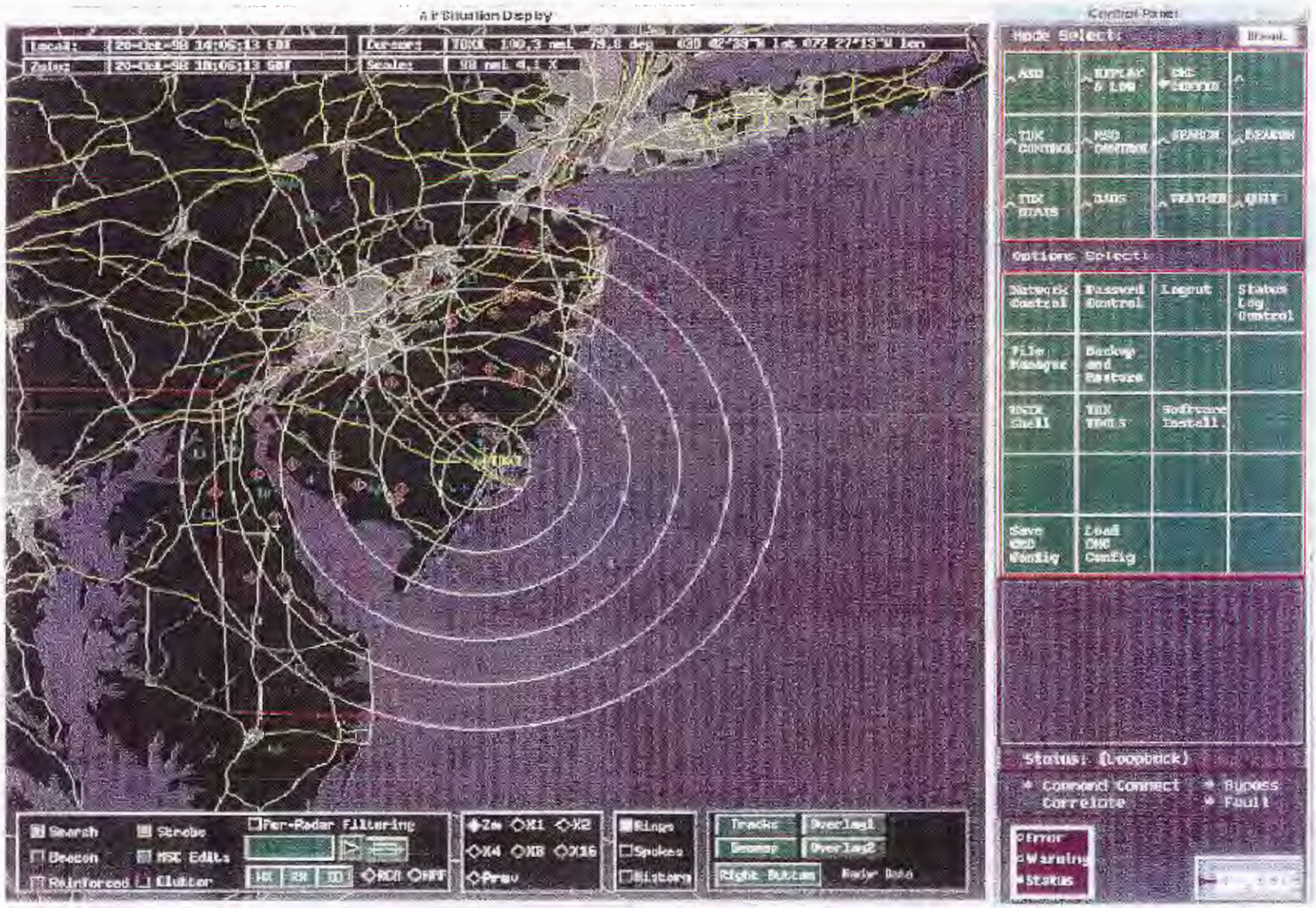

FIGURE 4.1.17.1.3-2. CMC CONFIG OPTIONS

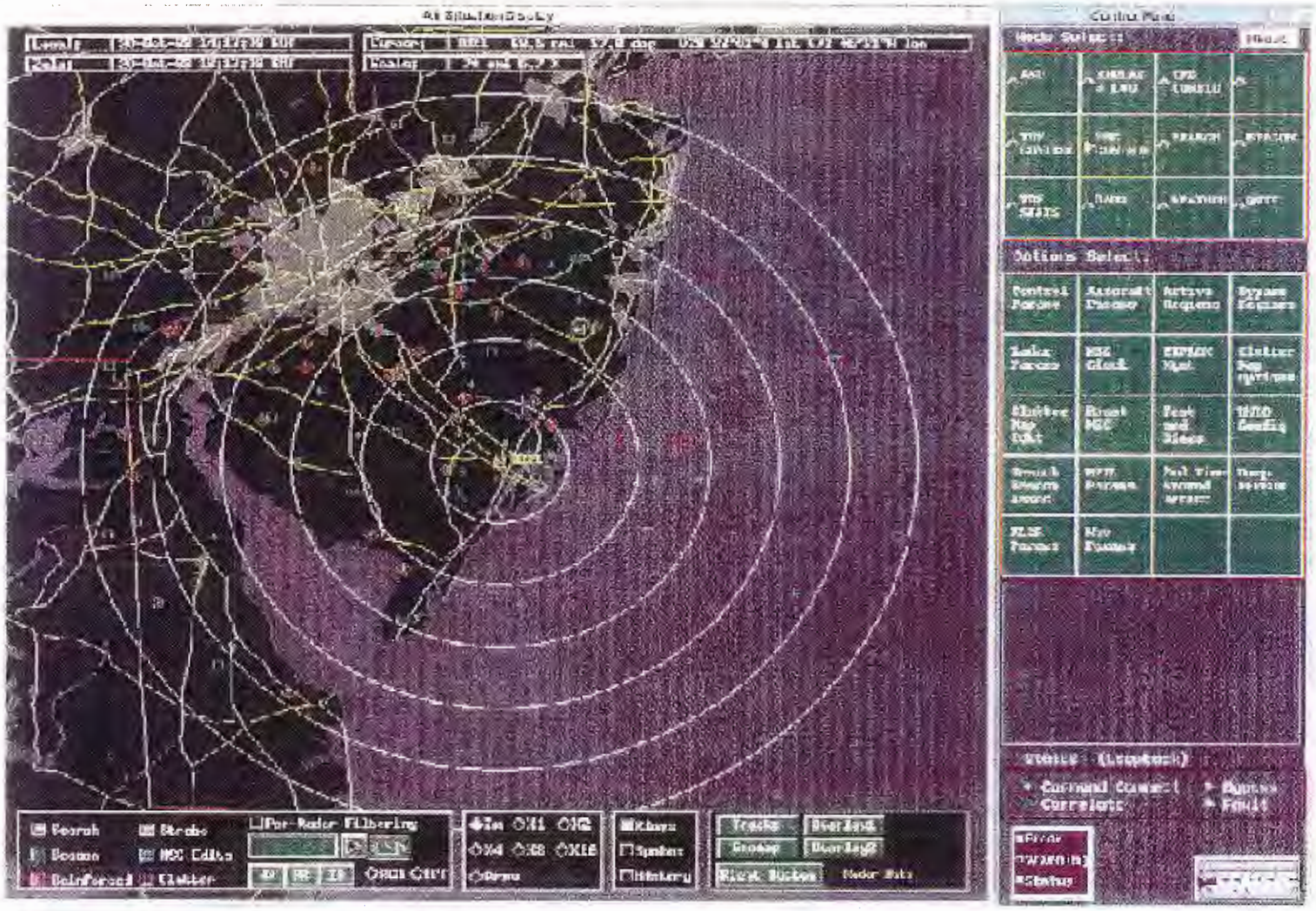

FIGURE 4.1.17.1.3-3. MSC CONTROL OPTIONS

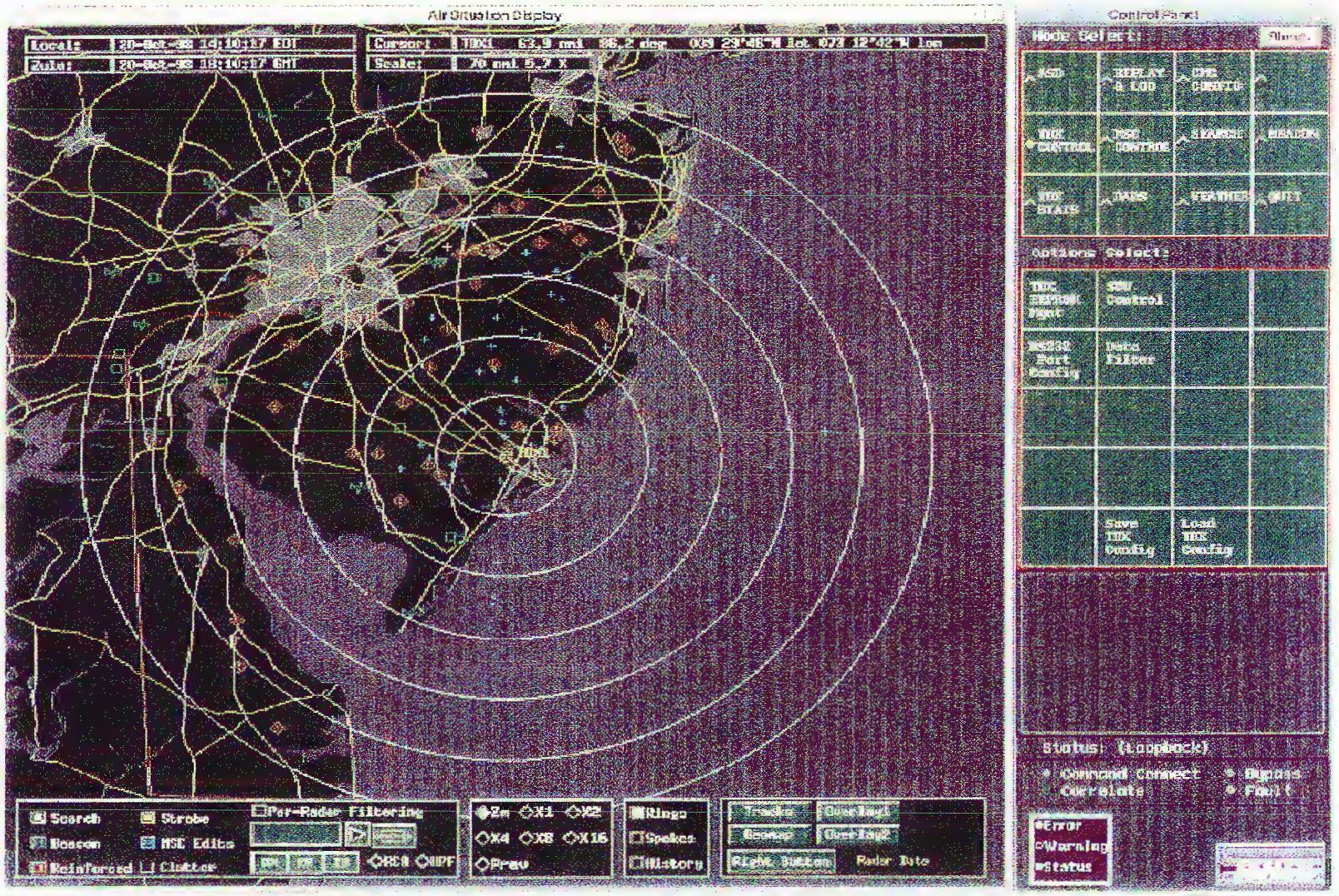

FIGURE 4.1.17.1.3-4. TDX CONTROL OPTIONS

4.1.17.2 Equipment Performance.

4.1.17.2.1 Criteria.

This test ensures that the TDX-2000d and AIU can provide accurate status, configuration, and performance information to the operator. The proper operation of the TDX-2000d hardware and software should allow for switching and control of on-line channels or redundant elements. The TDX-2000d should provide the necessary hardware and software parameters to display, edit, and control the operational equipment and properly configure the system to the needs of a unique site. The TDX-2000d should automatically detect and display equipment status. The AIU should provide the necessary hardware and software parameters to control and display the output data to the ARTS-IIA.

4.1.17.2.2 Configuration.

The TDX-2000d operational configuration and parameters were changed at the local and remote CMC menus. The CMC menus and ASD were used to display equipment performance. The ASD was viewed and compared to ARTS-IIA displays to verify that it provides accurate graphical representations of target data. The AIU operational configuration and parameters were changed through its main menu. Table 4.1.17.2.2-1 contains a brief description of each of the CMC, TDX-2000d, and AIU system configuration changes.

TABLE 4.1.17.2.2-1 SYSTEM CONFIGURATION CHANGES

Test No.	Configuration Changes
A1	Command connect to standby TDX.
A2	Radar channel association change.
A3	UNIO channel data enable/disable.
A4	CMC configuration change
A5	ASD data comparison with ARTS-IIA.
A6	TDX STATS menu observation.
A7	On-line TDX change.
A8	Remote TDX reset.
A9	CMC display data update consistency and CMC sluggishness observation.
B1	Local and Remote switching of AIUs.
B2	AIU configuration change.

If the TDX and AIU configuration changes did not change correctly, or if the ASD graphical representations did not perform correctly, or if the CMC did not provide proper TDX-2000d performance statistics, then those discrepancies were noted in the test log book.

4.1.17.2.3 Results.

The TDX-2000d had good performance through all system configurations. When command connected to TDX #1 or TDX #2, the Status Log window showed the connect status, and the corresponding TDX-2000d front panel Remote light illuminated. When the radar channel association was changed, the data switched to the appropriate channel. The data was able to be enabled/disabled on each of the UNIO channels. The CMC was uniquely configured to the needs of the radar site. Targets of opportunity were accurately displayed on the ASD ARTS-IIA displays. The ASD showed good performance when all display features were selected.

The TDX STATS options, as shown in figure 4.1.17.2.3-1, allow the operator to view operational statistics of each of the individual processor boards, including the MSC and UNIO boards. The TDX STATS options menus displayed accurate statistics of the corresponding hardware as documented in the CMC User's Manual. The Radar Stats options, as shown in figure 4.1.17.2.3-2, provides the operator with TDX data messages that are received by the CMC. The radar statistics compiled entirely on the CMC contained data which corresponded to the MSC statistics menus. The SDU Control menu, as shown in figure 4.1.17.2.3-3, allows the operator to switch and display the TDX on-line data channels. The SDU Control menu properly switched the TDX-2000d output data from the on-line channel to the standby channel. Each of the TDX-2000d channels were correctly reset via the local and remote CMCs by using the MSC Control menu as shown in a previous diagram, figure 4.1.17.1.3-3. The CMC consistently updated surveillance data from scan-to-scan. The CMC menus, including the ASD screen, operates and performs without any sluggishness.

The AIU's were switched from the on-line channel to the standby channel using the local and remote switches. The AIU was uniquely configured to the needs of the ARTS-IIA system by using the AIU Main menu as shown in figure 4.1.17.1.3-5.

In summary, the TDX-2000d and AIU provides accurate status, configuration, and performance information to the operator. The TDX-2000d properly switches to and has control of on-line channels. The TDX-2000d provides the necessary hardware and software parameters to display, edit, and control the operational equipment and properly configure the system to the needs of a unique site. The AIU provides the necessary hardware and software parameters to control and display the output data to the ARTS-IIA displays.

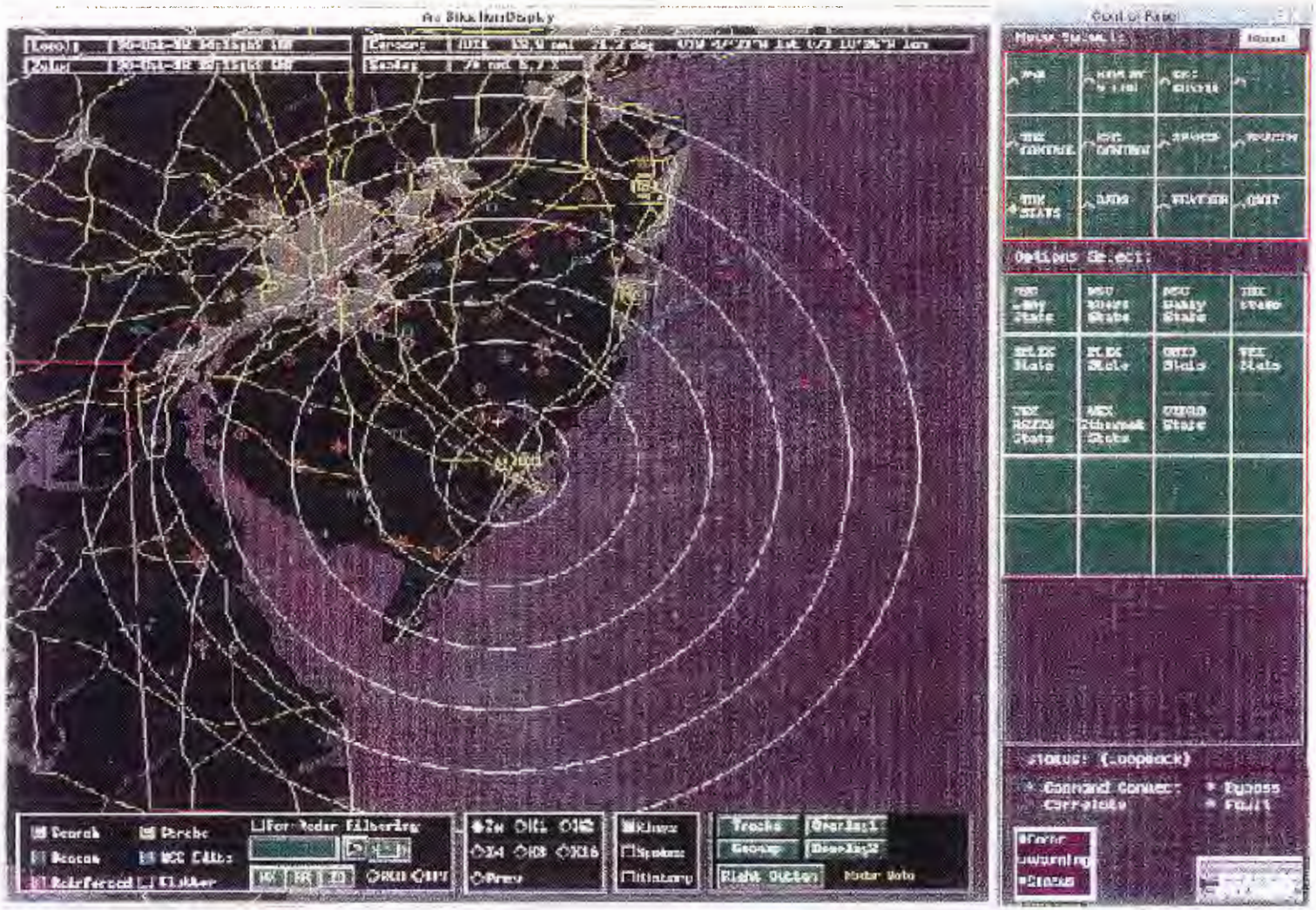

FIGURE 4.1.17.2.3-1. TDX STATUS OPTIONS

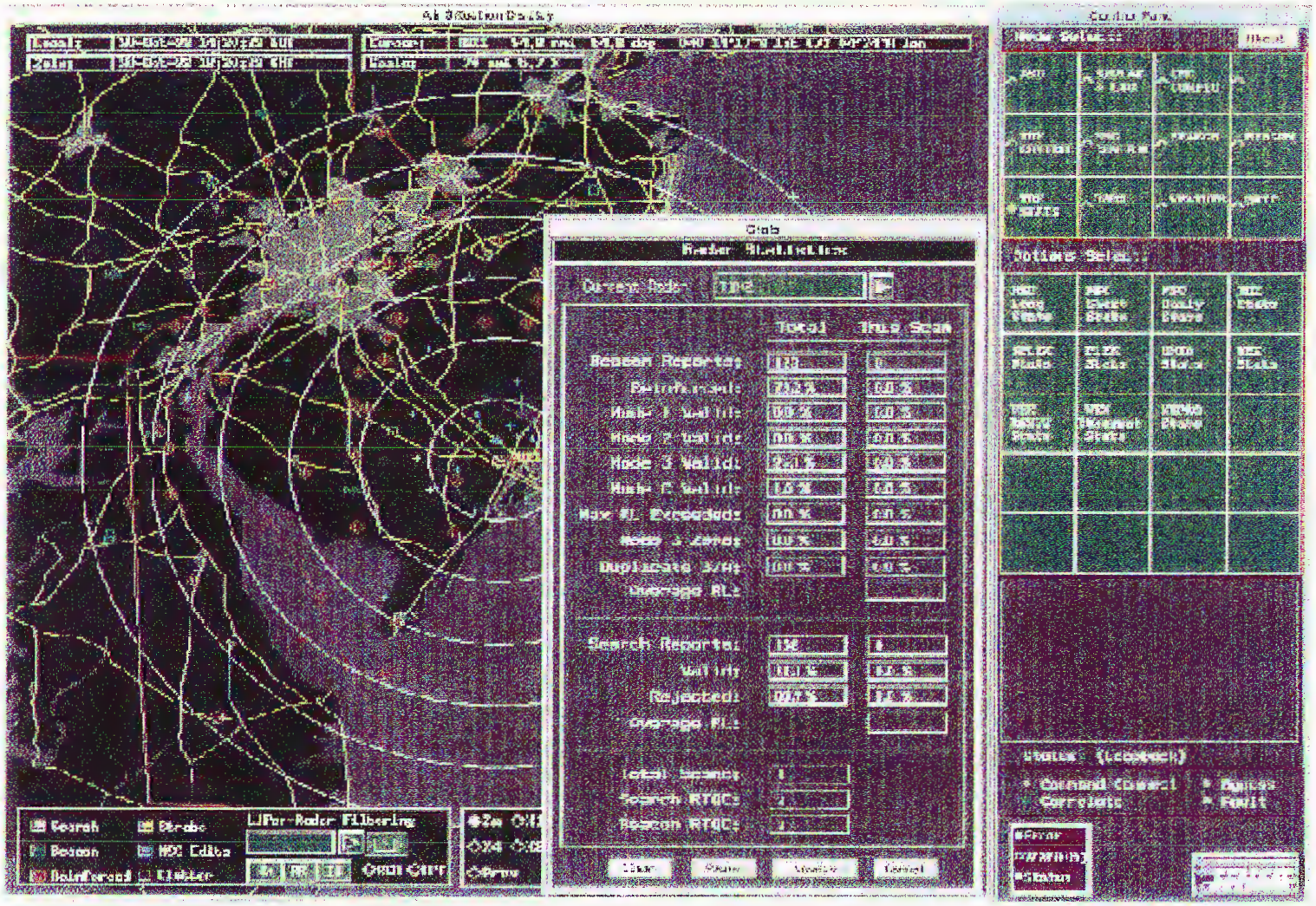

FIGURE 4.1.17.2.3-2. RADAR STATUS MENU

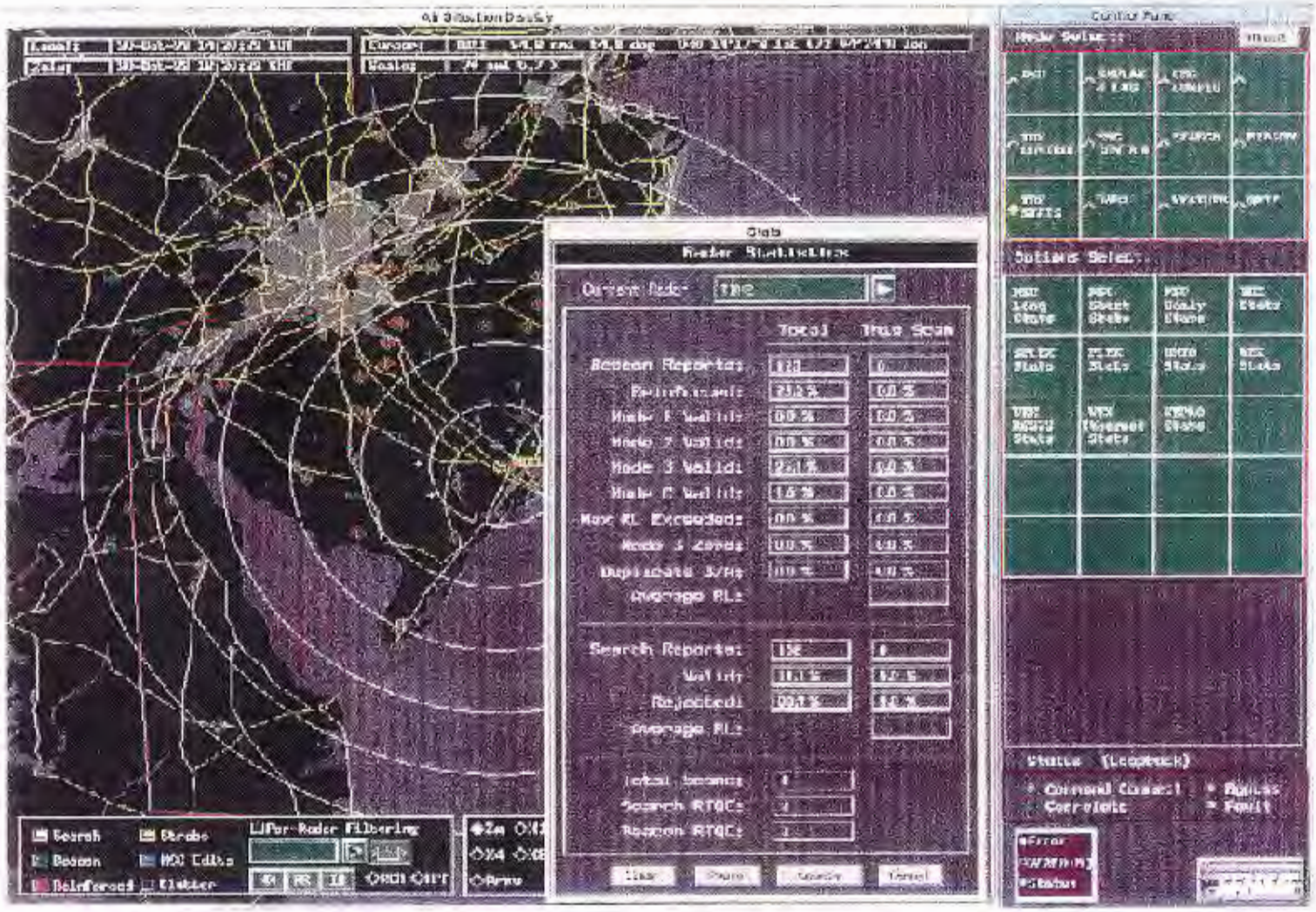

FIGURE 4.1.17.2.3-3. SDU CONTROL MENU

4.1.17.3 Alarm Reporting and Fault Isolation.

4.1.17.3.1 Criteria.

This test ensures that the TDX-2000d and AIU can detect and display equipment faults and provide a means to isolate hardware and software failures. The TDX-2000d and AIU systems should detect faults, and accurately report alarm status in a timely manner. The maintenance personnel should be able to detect/isolate faults and restore system operation within maintenance guidelines.

4.1.17.3.2 Configuration.

The Technical Center did not have contractor provided TDX-2000d or AIU hardware schematics to create prospective, nondestructive, hardware faults. Therefore, the TDX-2000d normal operating parameters were changed in order to generate most fault conditions. The AIU fault conditions were generated by disconnecting cables from the back of the AIU chassis. Prospective fault conditions were injected to test the following TDX-2000d and AIU circuit boards:

a. Target Extractor (TEX) and Target Extractor A/D (TEX A/D)
b. Search Plot Extractor (SPLEX)
c. Reply Processor (REPRO)
d. Plot Extractor (PLEX)
e. Weather Reply Processor (WEPRO)
f. Weather Extractor (WEX)
g. Correlation and Track Processor (CTP)
h. Communications Processor (CP)
i. AIU Beacon Video Reconstitutor (BVR)
j. AIU Search Video Reconstitutor (SVR)

Table 4.1.17.3.2-1 contains a list of parameter and hardware changes used in injecting fault conditions to the TDX and AIU. Fault conditions were checked by observing fault lights on each TDX, the SDU, and the CMC control panel. Error messages were checked by observing the CMC Status Log window. Once a fault was created, the switchover from the faulted channel to the standby channel was verified. Maintenance Manual were checked to verify that there were suitable guidelines to isolate and clear the faulted conditions. Fault messages or fault lights that did not report the proper faulted conditions were noted in the test log book. If the faulted channel did not properly switch to the standby channel, by viewing the SDU front panel or the SDU Control menu, it was also noted in the test log book.

TABLE 4.1.17.3.2-1 TDX AND AIU FAULT CONDITIONS

Test No.	Faulted Hardware	Parameter/Hardware Changes
A	TDX - TEX	DC level parameter increment
B	TDX - PLEX/SPLEX	Operate to idle mode
C	TDX - WEPRO	Reset Wex
D	TDX - UNIO	Swap MSC EEPROMs U3 and U4
E	AIU - BVR	Remove ARP's at J13
F	AIU - BVR	Remove Beacon Video at W22-J1-A4A8J1
G	AIU - SVR	Remove Normal Video at W21-J1-A4A10J1
H	AIU - SVR	Remove MTI Video at W20-J1-A4A12J1
I	TDX - REPRO	Excessive FRUIT levels
J	TDX - TCP/CP	Exceed system 5VDC tolerance
K	TDX - WEX	Pull WEPRO board out

4.1.17.3.3 Results.

Each of the TDXs had the proper hardware fault light activated during the injected fault conditions, with the SDU having the corresponding TDX fault light activated. The CMC Control Panel illuminated a red light to indicate a TDX fault condition. The CMC Status Message Log, as shown in figure 4.1.17.3.3-1, provides the operator with messages pertaining to the failed component of the TDX-2000d. The Fault status indicator is located to the right of the Status Message Log. The CMC Status Log contained suitable error messages pertaining to the corresponding fault condition. When the TDX faults were created, the faulted channel switched to the standby channel to continuously output surveillance data. The on-line to standby channel switchover was observed by viewing the SDU Control menu as shown in a previous diagram, figure 4.1.17.2.3-3.

The Maintenance Manuals for the TDX-2000d has system Fault Location Diagrams (FLDs) used for isolating faulty components to one or more lowest replaceable units (LRUs). The FLDs had reasonable guidelines to localize and clear the faulted devices without interruption of mission operations.

The Maintenance Manuals for the AIU had error codes used for isolating faulty conditions which was accessible by using the AIU Main Menu as shown in figure 4.1.17.1.3-5. The Maintenance Manuals contained reasonable guidelines for identifying error codes. These error codes can be used to isolate and clear the faulted conditions.

In summary, the TDX-2000d and AIU suitably detect and display equipment faults and provide a means to isolate hardware and software failures. The TDX-2000d and AIU systems accurately detect faults and report alarm status in a timely manner. The maintenance personnel was able to detect and isolate fault conditions and restore system operations within maintenance guidelines.

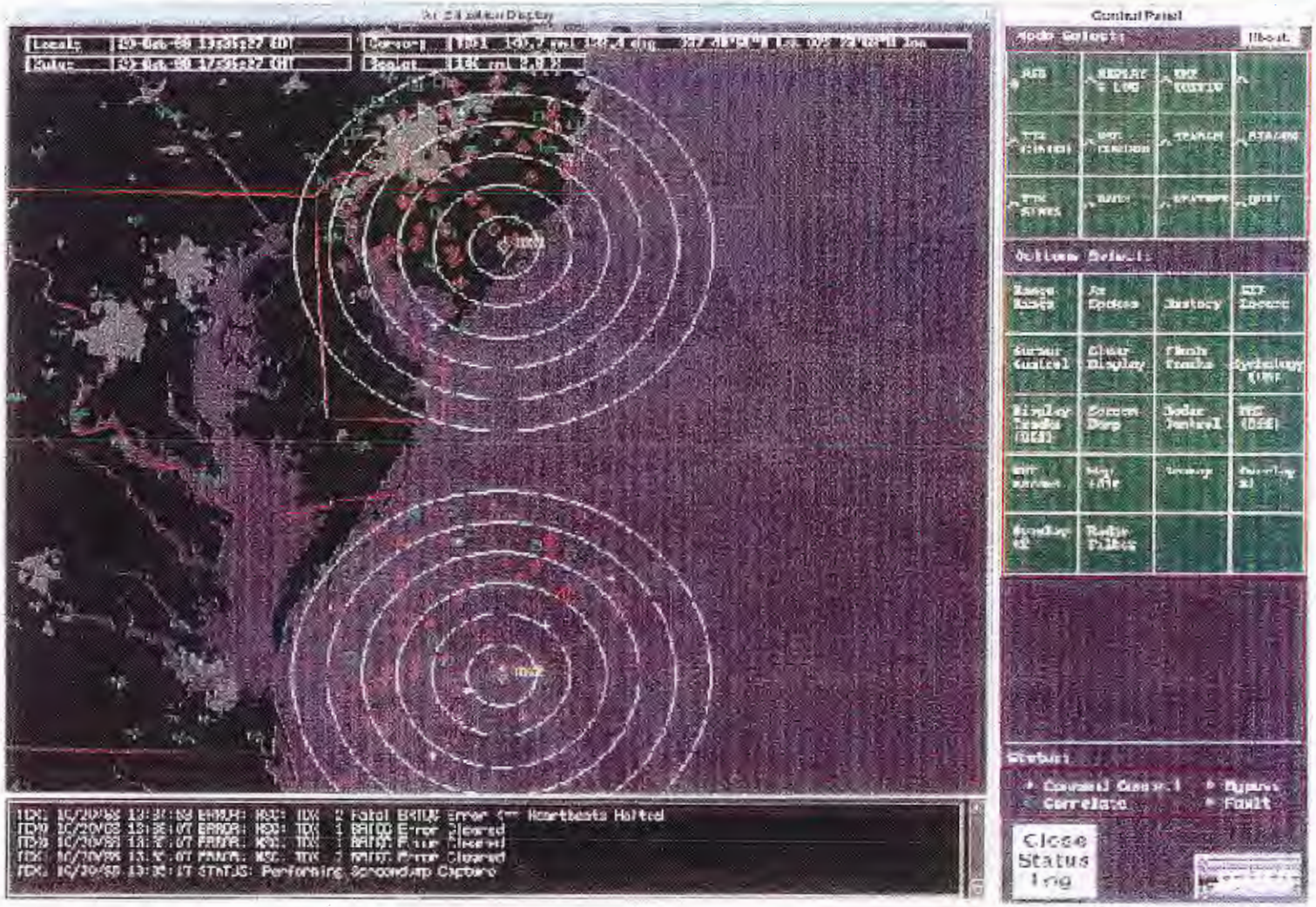

FIGURE 4.1.17.3.3-1. STATUS MESSAGE LOG

4.1.17.4 Data Logging.

4.1.17.4.1 Criteria.

This test ensures that the CMCs and AIU provide a method to reliably store, retrieve, and analyze surveillance and status information. The user should be able to initiate and terminate data logging by following published instructions. The CMC logging filter and the report filtering functions should be suitable for collecting radar data. The previously recorded CMC data file should be able to be played back using the data playback function. The AIU should have logging features for contractor system troubleshooting.

4.1.17.4.2 Configuration.

The data logging test consisted of the CMC logging and playback functions, AIU logging capabilities, and CMC DADS. The CMC logging and playback test used a VideoBITS scenario which contains test targets at known range and azimuth locations. The Data Logging and Data Playback menu was used to log and playback the scenario. The CMC DADS menu was used to analyze the CMC data log file with the given menu options. The AIU Data Collection File Control menu was used to save configurations to a file and to log data. Each of the original and new configuration files were restored to verify the restore options feature. The data log and error files would be used by the contractor to perform analysis and corrective maintenance. If problems were identified in (a) CMC data logging and playback options, (b) AIU data logging options, or (c) DADS data file analysis, those issues were recorded in the test log book.

4.1.17.4.3 Results.

When the AIU faults were created, the General Status screen would indicate a bad or idle state. The error log also recorded the fault condition. The error log was successfully copied to a floppy by using the AIU Maintenance menu, shown in table 4.1.17.4.3-1. The file can be used for fault analysis.

The CMC Replay and Log menu options, as shown in figure 4.1.17.4.3-1, allows the operator to log and playback data. The CMC data logging and playback features reliably recorded data to a file and played back data to the ASD, respectively. The CMC logging filter and the report filtering functions were suitable for collecting radar data.

The AIU Maintenance menu allows the operator to save and restore software configurations, save the logged data and error file to floppy which will assist in corrective maintenance. The AIU maintenance features reliably saved and restored the minor and the entire AIU configurations to floppy. The logged data and error files were successfully saved to floppy.

TABLE 4.1.17.4.3-1 AIU MAINTENANCE MENU

AIU Maintenance Menu	
A	return to main menu
B	save configuration to floppy
C	restore configuration from floppy
D	save entire aiu to floppy
E	restore entire aiu from floppy
F	save logged data to floppy
G	save error file to floppy

The CMC DADS menu options, as shown in figure 4.1.17.4.3-2, provided the operator with a method to analyze a previously recorded data file stored in memory. When the logged data file was used by the DADS, the CMC system resources were allocated such that the DADS did not interfere with normal CMC operations. DADS contains suitable filter combinations for logged data analysis. The Display and Analyze Data options enabled the graphical data to be presented with any combination of filtered data. Single or multiple charts are available for data comparisons.

In summary, the CMCs and AIU provides a method to reliably store, retrieve, and analyze surveillance and status information. The CMC logging filter and the report filtering functions were suitable for collecting radar data by following user's manual instructions. The CMC data logged files were correctly played back on the CMC. The AIU provided acceptable data logged files for contractor maintenance and analysis.

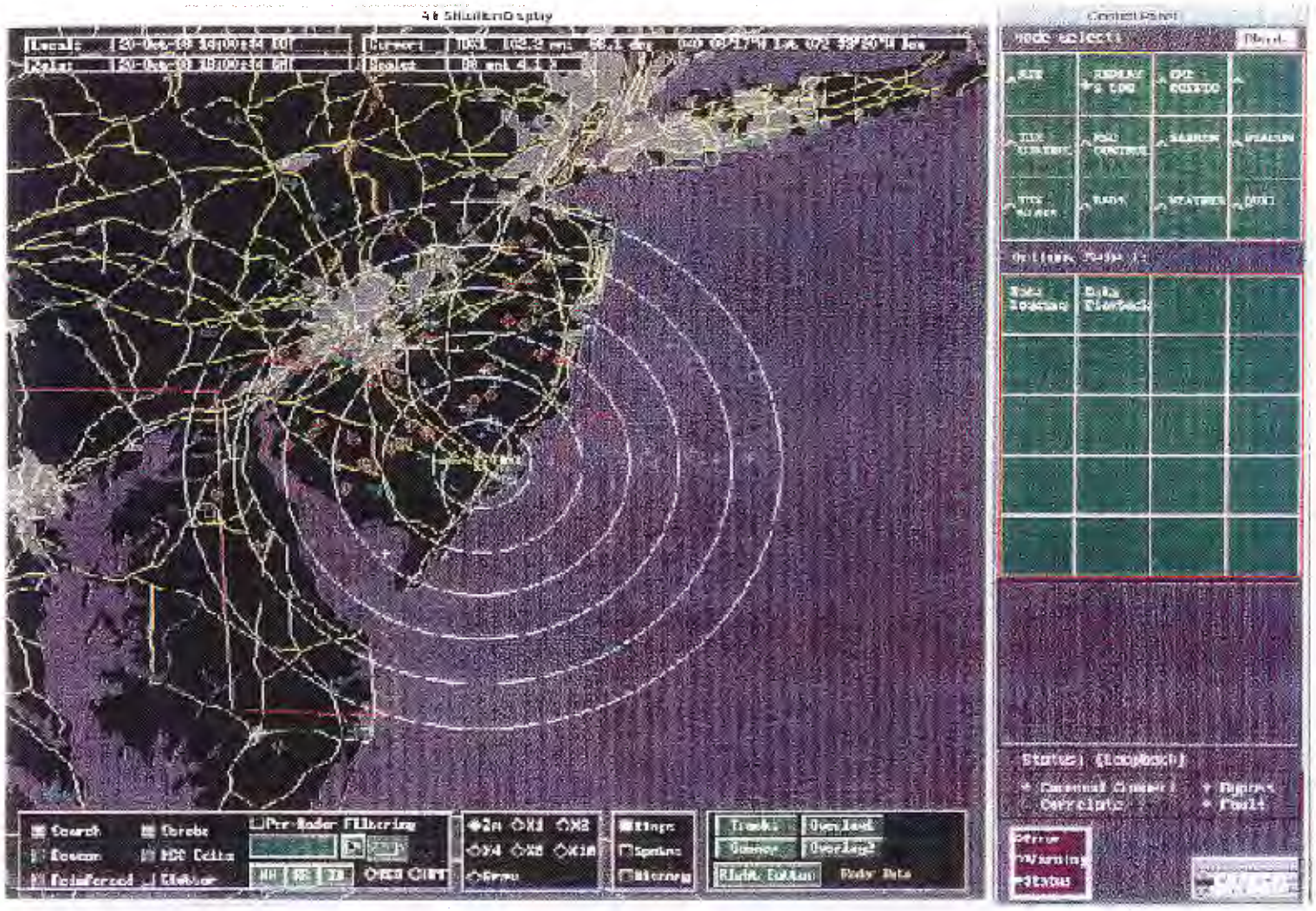

FIGURE 4.1.17.4.3-1. DATA LOG/PLAYBACK OPTIONS

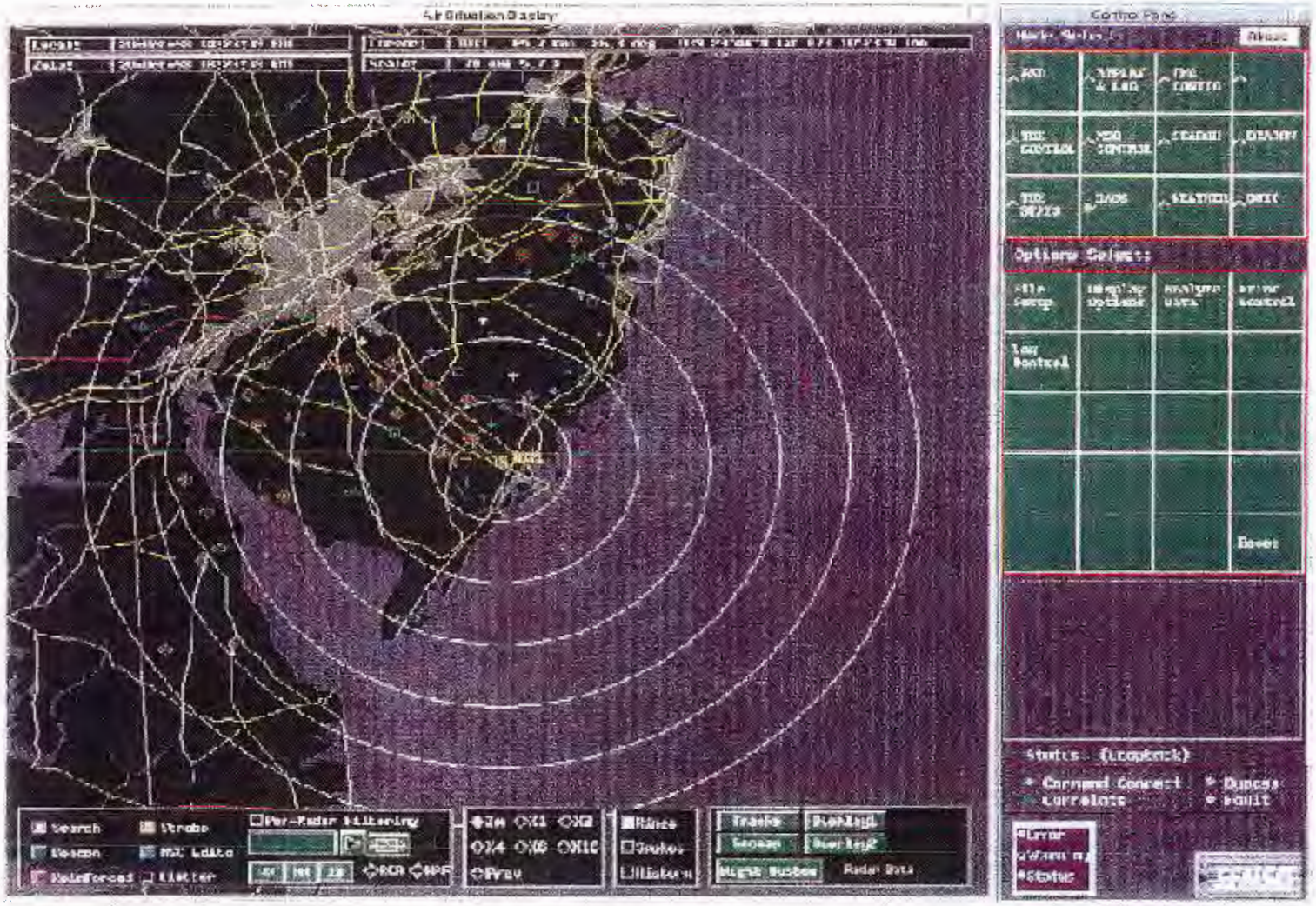

FIGURE 4.1.17.4.3-2. DADS OPTIONS

4.2 OPERATIONAL TESTS.

This section describes the final results of TDX-2000d system operational T&E. The TDX-2000d and AIU operational tests evaluate the system Reliability, Maintainability, and Availability (RMA), site adaptation and optimization, and human factors. The TDX-2000d operational testing was limited to a minimum since it is not part of a full OT&E process and is an interim program. The TDX-2000d operational tests have been conducted at the Technical Center from June 20, 1997, to March 30, 1999, and Dobbins AFB, from July through September 1998. The TDX-2000d was optimized and adapted to each site specific radar. The AIU operational tests has been conducted only at the Technical Center.

4.2.1 Reliability, Maintainability, Availability.

4.2.1.1 Criteria.

This test ensures that the RMA of the TDX-2000d system and AIU are suitable for incorporation into the NAS. The RMA is assessed for the TDX-2000d and AIU in an operational environment with the available resources, logistics plan, and maintenance procedures and personnel. The TDX-2000d and AIU hardware and software should perform reliably during the test period. Single points of failures in the TDX-2000d and AIU design should be identified. The Mean-Time-To-Repair (MTTR) should be not more than 0.5 hours and Mean-Time-To-Restore (MTR) should not be more than 1 hour.

4.2.1.2 System Configuration.

The reliability was assessed by documenting hardware and software failures in the logbook. Alarm and status information, daily statistics, and equipment failures were monitored throughout the test period.

The TDX-2000d and AIU maintainability were tested through verification of fault detection and isolation techniques and the ability of the operator to perform typical maintenance tasks. Site personnel participated in maintenance and repair actions. Problems associated with spares configuration and availability were documented in the test logbook.

The MTR and MTTR were calculated by timing a trained maintenance technician to perform fault detection and isolation procedures and remove and replace operations. These tests were logged in the test logbook and compiled at the completion of the test period.

Hardware and software fault data collected during testing were examined for any instances that resulted in the loss or corruption of data. Failures that affected the ability to control TDX-2000d and/or AIU operation were also investigated.

4.2.1.3 Results.

Trained technicians were required to maintain the TDX-2000d system in an operational state by clearing most faults through restarting or resetting the individual TDX processor boards, the TDX units, or the CMC. The technicians were timed while performing one board remove and replace operation, three separate power supply adjustments and a system reboot operation. The outcome of the timed results were used to compute the MTTR. The MTTR is equal to the following:

MTTR = total maintenance downtime/total maintenance actions.

The technicians performed the above five procedural operations in a total of 96 minutes. The MTTR was equal to:

MTTR = 96 minutes/5 = 19.2 minutes.

The TDX-2000d has a dual redundant TDX system that requires the SDU to switch from the faulted unit to the standby unit. In a dual redundant system, the MTR is equal to the following:

MTR = the time the SDU switches the operation to the standby unit.
MTR = total system outage time/total system outages.

The MTR was without delay in a normal (fault free) SDU configuration.

If the SDU is in a faulted condition, a faulted TDX unit must be manually switched to the standby unit. The MTR would then be the time it takes for the technician to manually switch the TDX units. The TDX-2000d was not tested with the SDU in a faulted state.

There were no maintenance procedures conducted for the AIU. Therefore, the MTTR and MTR cannot be calculated. Note that the dual AIU has a manual switch that places AIU #1 or AIU #2 on-line. The operator must manually switch the standby unit to on-line.

There were no problems associated with spares configuration and availability throughout the test period.

The following TDX-2000d/AIU hardware/software reliability issues caused loss of redundancy or caused loss of data to the end user:

a. Missing BRTQC messages to the end user. This problem is noted in TDR ACT038. The contractor is investigating a solution to the problem.

b. Fault lights on Target Correlation Processor (TCP), Communication Processor (CP), and two UNIO boards on TDX #2. This failure was noted in TDR ACT011 and was caused by an out-of-tolerance +5 volt power supply. The failure was corrected by adjusting the power supply within tolerance.

c. The AIU does not send Status messages to the MALA board. This problem has been noted in TDR ACT050 and closed by consensus of the test team.

d. The CMC fault indicator illuminates for unknown reasons. This problem has been noted in TDR ACT002 and resolved by the contractor.

In summary, the TDX-2000d and AIU maintainability was adequate considering the limited available maintenance data. Controls and indicators provided the operator with satisfactory control of system operations. The availability of spares was suitable for maintenance procedures.

The reliability issues described above need to be resolved by the contractor.

The overall availability of the TDX-2000d and AIU systems cannot be calculated with the limited RMA information collected during an interim test program.

4.2.2 Site Adaptation and Optimization.

4.2.2.1 Criteria.

This test evaluates the ability to optimize and adapt the TDX-2000d and AIU to radar type and site specific conditions. It determines the ability of the TDX-2000d design and procedures to adapt to environmental changes without frequent reoptimization.

4.2.2.2 System Configuration.

ACT and AOS test team verified the radar system baseline and validated system contractor checkout and optimization procedures. Specific adjustments to the radar system that were necessary for optimization were documented in the logbook and included in the maintenance handbook where appropriate. The test team exercised radar modes of operation, such as CP and LP, to determine the need for additional changes to TDX-2000d and AIU setup.

TDX-2000d and AIU performance were monitored throughout system test. Any problems related to incorrect site optimization or adaptation were documented.

Daily timing and video signal input measurements to the TDX-2000d were taken by the technicians. MSC daily statistics were logged. Any radar system changes in noise, offsets, or video levels were documented and compared to any corresponding changes that occurred in daily statistics.

The MSC, REPRO, PLEX, SPLEX, TEX, and WEX variable parameters were validated through required changes that affect radar site adaptable parameter limitations, offsets, and tolerances.

4.2.2.3 Results.

The CMC has the required parameters to perform optimization to the TDX-2000d through the use of the MSC, Search, Beacon, and WEX menus. The TDX-2000d did not have to be reoptimized during the test period, except to improve radar azimuth resolution performance.

The TDX Tools application contains insufficient documentation to create or update required variable maps. The TDX Tools application also lacks documentation in analyzing surveillance data debugging files.

The TDX-2000d optimization procedures contained the information to optimize the MSC, Search Extractor and Beacon Extractor, but did not contain adequate information to optimize the Weather Extractor. This lack of weather optimization information has been noted in TDR ACT004.

AOS personnel are currently standardizing the TDX-2000d optimization procedures with the cooperation of the contractor. AOS will also be developing a TDX-2000d Maintenance Handbook. Field personnel also noted that unauthorized access to critical system parameters in the TDX-2000d menus may cause performance and operational problems. This issue is described in TDR ACT051 in appendix A.

The AIU has the required parameters to adapt to the ARTS-IIA requirements. The AIU did not have to be reoptimized throughout the test period.

In summary, the TDX-2000d and AIU have adequate parameters to adapt the system to site specific requirements. Final TDX-2000d optimization procedures will be developed by AOS with contractor support. The TDX Tools application does not contain adequate documentation to assist in system optimization.

4.2.3 Human Factors.

4.2.3.1 Criteria.

This test evaluates the user interfaces to ensure maintenance functions were effectively performed. The system equipment design should conform to human engineering design criteria and principles to achieve safe, reliable, and effective performance by operator and maintenance personnel.

4.2.3.2 System Configuration.

Routine maintenance and system control functions were observed during the test period and the ease with which these functions can be performed were evaluated. Any anomalies were documented in the logbook at each test site. System contractor provided training has been completed by Government personnel. Those personnel that completed the system training documented the effectiveness of training and documentation. Personnel from various organizations observed ARTS-IIA displays and made evaluations through questionnaires during dedicated flight tests. All evaluations and observations were compiled and used to identify deficiencies and areas of improvement.

4.2.3.3 Results.

The CMC has a reliable interface to the TDX-2000d which enabled the user to effectively perform maintenance tasks and monitor system operations. The CMC error and status message display and log provide error messages in the event of a TDX-2000d failure. TDX Stats menu provided the user with reliable status information and facts concerning the MSC and CMC. The CMC fault indicator provides acceptable system fault status with the aid of fault tree documentation provided by the contractor. The CMC fault light problem is described in TDR ACT002 in appendix A. The CMC has a dependable user interface to control and monitor the selected TDX.

The TDX-2000d front panel has reliable indicators to alert the technician of a fault condition. However, technicians reported that the monitoring and adjustment of the critical +5 volt power supply was difficult. Also, the test team indicated that the SDU did not have data available at the front panel jack J44 and had missing data on jack J45, as described in TDR ACT025 in appendix A.

The AIU Main Menu Display has a reliable interface to the AIU which enabled the user to effectively perform maintenance tasks and monitor system operations. The AIU display provided a message log which provides error messages in the event of an AIU failure.

A general consensus of personnel who attended the contractor provided training revealed that the overall training and its documentation was inadequate. The training course had insufficient time to familiarize, optimize, and have hands-on the TDX-2000d system. The course contents provided was too complex for technician level training. The training personnel indicated that a prerequisite in an ASR-9 Common Digitizer system or CD-2 system would clarify the understanding of the TDX-2000d operations.

The ARTS-IIA display observers viewed the TDX-2000d/AIU performance in a NAS end-to-end system configuration. The questionnaires, completed by observers, did not reveal any degradation of radar or beacon data presentations. There were instances where the observers noted incorrectly displayed target data during dedicated flight tests. Incorrect target data was attributed to the types of flight patterns conducted when observers were monitoring the displays.

In summary, the CMC and AIU display has a reliable interface to the TDX-2000d and AIU, respectively. The CMC and AIU display can be used effectively to perform maintenance tasks and monitor system operations. The TDX-2000d front panel indicators are adequate to alert the technician of a fault condition. The system contractor provided training and its documentation was inadequate. The TDX-2000d surveillance data, in conjunction with the reconstituted video provided by the AIU, presented acceptable information to the ARTS-IIA displays.

5. TEST SUMMARY.

The final test results were based on system testing in light and heavy radar clutter and weather conditions at the Technical Center and at Dobbins AFB, Atlanta, GA. The final test results were also based on the outcome of regression tests of Test Discrepancy Report (TDR) software/hardware changes made to the Target Data Extractor Model 2000d (TDX-2000d). The TDX-2000d test results are summarized as follows:

a. Successful preliminary tests were performed on Standard Terminal Automation Replacement System (STARS).

b. Results from the Test and Evaluation (T&E) program indicate that the TDX-2000d successfully validated the following performance measures (requirements):

1. Interface to Automated Radar Terminal System Model IIA (ARTS-IIA) including electrical characteristics and communication protocols.

2. Detects and reports aircraft throughout the coverage volume.

3. Primary detection with false alarm control provided the site is carefully optimized. Primary detection in clutter is equal to or better than other digitizers in the National Airspace System (NAS) such as Common Digitizer Model 2D (CD-2D) or Surveillance Receiver and Processor (SRAP); Primary detection in light to moderate precipitation, in operating modes of Linear Polarization (LP) or Circular Polarization (CP), is a limitation of the radar (ASR-8, AN\GPN-20) not the TDX-2000d.

4. Control of beacon false target reports.

5. Acceptable, limited weather data to the end user.

6. Beacon azimuth resolution and range resolution.

7. Primary range resolution.

8. Primary and secondary positional accuracy.

9. Beacon detection using different beacon systems and in conditions of low and high target densities.

10. Performance and statistical information to the operator; provides maintenance data to the properly trained technician.

c. Results from the T&E program indicate that the TDX-2000d did not successfully validate the following performance measures (requirements):

1. Throughput time of 2.5 seconds that exceeds the required delay of 2.2 seconds, however, the performance measure of 2.2 seconds does not accurately reflect the allocated throughput delay for the system as configured. Measured delay includes video reconstitution and redigitization to

accommodate the Palm Springs configuration. Subsequent ARTS-IIE/IIIE tests will evaluate the 2.2-second requirement.

2. Primary azimuth resolution that exceeds the performance measure by two Azimuth Change Pulses (ACPs) or 6 percent of the requirement.

6. ACRONYMS AND ABBREVIATIONS.

ACP	Azimuth Change Pulse
AFB	Air Force Base
AN/GPN-20	Army Navy/General Pulsed Navigation Model 20
AN/UPX-27	Army Navy/general Use Pulsed Identification Model 27
ARP	Azimuth Reference Pulse
AGL	Above Ground Level
AIU	ARTS Interface Unit
AMP	AMPlifier
APC	American Power Conversion
ARTS	Automated Radar Terminal System
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon Systems
ASD	Air Situtation Display
ASR	Airport Surveillance Radar
BFTL	Beacon False Target Logic
BFTS	Beacon False Target Summary
BO	Beacon Only
BRTQC	Beacon Real-Time Quality Control
BVR	Beacon Video Reconstitutor
CD	Common Digitizer
CDR	Continous Data Recorder
CMC	Control and Maintenance Monitor
COI	Critical Operational Issues
CP	Circular Polarization, Communications Processor
CTP	Correlation and Track Processor
DADS	Data Analysis and Display System
dB	Decibel
DR&A	Data Reduction & Anlaysis
FLD	Fault Location Diagram
FRUIT	False Replies Unsynchronous in Time
GPS	Global Positioning System
HP	Hewlett Packard
I/O	Input/Output
IRES	Integrated Radar Evaluation System
Kft	Thousands of Feet
LP	Linear Polarization
MALA	Mode S/ASR-9 Line Adapter
MDS	Minimum Discernible Signal
MTI	Moving Target Indicator
MTR	Mean Time to Restore
MTTR	Mean Time to Repair
MSC	MultiScan Correlator
NAS	National Airspace System
NEXRAD	NEXt generation RADar
nmi	nautical mile
OT&E	Operational Test and Evaluation
PC	Personal Computer
PCS	Personal Computer Surveillance
Pd	Probability of detection
PE	Permanent Echo
PLEX	PLot EXtractor
PPI	Plan Position Indicator
PRT	Pulse Repetition Time
R/B	Radar/Beacon merge
RC	Radar Correlated
RCS	Radar Cross Section
RBAT	Radar Beacon Analysis Tool
REPRO	REply PROcessor
RF	Radio Frequency

T&E Test Discrepancy Reports

Test Discrepancy Reports (TDRs) were developed to track and identify each test failure or system problem discovered during T&E. These reports identify the test in progress, TDX-2000d software build in use, criticality of the problem, a description of the problem/failure, and recommended course of action.

Table 1 provides a summary of the 56 TDRs written by the test team during the T&E test period. Included in this table is the TDR number, the date the TDR was developed, a brief description, the criticality of the problem, and the closure status.

Problem criticality is listed as Critical, Moderate, or Minor. Critical problems include those items which must be corrected for the TDX-2000d to properly operate as part of the NAS. Those TDRs with Critical priority which remain open after completion of retest are shaded in the Priority column of the table.

Moderate problems are those which primarily effect user ability to maintain the radar. Problems identified as Minor are those discrepancies which are an annoyance and result in increased work for the end user.

The TDR status definitions are "Open" or "Closed." The "Open" status identifies problems which have no agreement with TDX-2000d contractor to correct. The "Open" status also classifies those items which are believed by the system contractor to be corrected through software or hardware changes to the TDX-2000d, or items that the system contractor could not duplicate which may have been fixed by software changes during T&E. Finally, discrepancies marked as "Closed" were corrected through system modifications and/or contractor documentation, and verified through retest.

Table 1: T&E Test Discrepancy Reports (Oct 30, 1997 through June 16, 1999)				
TDR #	Date	Description of TDR	Priority	Status
ACT001	10/30/97	Cannot establish Ethernet connection between the Correlation & Track Processor (CTP) and the Control & Maintenance Console (CMC) when both TDX's are operating normally.	Critical	Closed
ACT002	10/31/97	Red FAULT light located in the MSC Status Lights area of the CMC illuminates for unknown reasons.	Moderate	Open
ACT003	10/31/97	TEX Configuration Menu; CFAR Parameters Frame, 'Rank Percentile Value' changes from 76% to 100% when SPLEX overload is invoked.	Critical	Closed
ACT004	10/31/97	Setup and optimization procedures for the weather channel are confusing and incomplete.	Minor	Closed
ACT005	10/31/97	The setup and optimization procedures for the weather channel require entering specific site related parameters into the WEPRO Configuration Menu.	Minor	Closed
ACT006	11/15/97	In Auto Mode, the SDU will switch TDX-2 on-line when a fault occurs in TDX-1 (i.e. when heartbeats are halted). When TDX-1 is reset and the fault is cleared, the SDU will switch back to TDX-1, although no fault is present in TDX-2. This switch occurs prematurely which causes a temporary loss of target data and sector marks to automation equipment and the end user.	Critical	Closed
ACT007	11/15/97	The APG selection switch on the front panel of the SDU is operational when the SDU is in auto mode. APGs can be switched manually when in auto mode.	Minor	Closed
ACT008	11/15/97	The SDU FAULT message in the CMC Status Log window does not correspond to the SDU Fault light on the front panel of the SDU. The light is not illuminated when the message appears. The status message appears in the Status Log when the SDU STATUS menu or SDU CONTROL menu is opened and any TDX or APG fault is present.	Moderate	Closed
ACT009	11/15/97	In Auto-Switching Mode, the SDU will switch TDX-2 on-line when a fault occurs in TDX-1. The TDX-1 fault light will also illuminate on the front panel of the SDU. When the fault condition is cleared and TDX-1 is operating with no errors, the TDX-1 fault light will stay illuminated on the front panel of the SDU until it is manually reset.	Moderate	Closed
ACT010	1/15/98	Parity errors occur on UNIO channel 3, weather channel, when weather is present inside of 2 miles. The error messages are shown on the UNIO stats menu and AIU error message screen.	Moderate	Closed
ACT011	2/4/98	Board faults have occurred in TDX2 - UNIO board #1 and occasionally UNIO board #3 and front panel red fault lights on TCP and Communications Processor and amber light on CP. This is a recurring problem with the above symptoms with no fault indications logged in the status log or surveillance status messages. No fault were observed on the SDU control or stats menus, or on the SDU front panel	Critical	Closed
ACT012	2/4/98	See TDR ACT011. SDU successfully switched TDX2 on-line. Observed that no surveillance or weather data was output to the modems. No fault indications were observed in the status log. System must prevent switching a faulty TDX to on-line.	Critical	Closed
ACT013	2/4/98	See TDR's ACT011 and ACT012. Placed TDX2 UNIO and Correlator to STANDBY and IDLE. One minute later, returned UNIO and Correlator to Operational. Data was output to all modem channels normally. Fault light on UNIO board did not clear. TCP and CP front panel lights remained illuminated.	Critical	Closed
ACT014	2/5/98	Beacon Parrot altitude is fixed at -1000 ft. The display readback is shown as 408.6 Kft when selected using the cursor and right mouse button, 'Radar Data Information' menu. Messages sent to the user by modem have the correct value.	Minor	Closed
ACT015	12/19/97	An error occurred during Factory Acceptance Testing (FAT) of the current S/W build. When TDX's are first turned on, an errant SDU fault message usually appears on the CMC.	Moderate	Closed
ACT016	2/10/98	The local and remote CMC, routinely, is sluggish to respond to menu selections. The CMC automatically resets and the CMC must be restarted and/or the configuration file must be loaded.	Moderate	Closed

Table 1: T&E Test Discrepancy Reports (Oct 30, 1997 through June 16, 1999)				
ACT017	2/26/98	Military emergency replies are not being transformed into 7700 emergency codes for output to the user.	Critical	Closed
ACT018	2/26/98	Military emergency replies are not being properly detected when either the second or third (but not both) reply is missing in the set of four complete reply pulse trains.	Critical	Closed
ACT019	2/27/98	Military emergency replies are not being output in the proper format. The output shall include the range, azimuth, and transformed 7700 code from the first reply train only. The TDX incorrectly outputs a report for each of the four reply pulse trains. This is true for the case with all zero-code in the remaining three code trains, or, the case with a Mode 3A code in all four code trains.	Critical	Closed
ACT020	2/27/98	Weather channel status in the status message (Word 2, bit 11; bit 24 of message) does not report correct weather channel configuration. Weather status is always reported as 'Off-Line' (bit 24 is always '0') with weather channel in the Idle or Operational state.	Moderate	Closed
ACT021	3/6/98	History trails maintains target symbol when selecting Inf (infinity) at History Control Menu. When Inf (infinity) is selected, infinite histories continue normally, but, one target symbol remains for all tracked targets.	Minor	Closed
ACT022	3/6/98	When a 3/A code is entered for SIF Locate option, other targets with different 3/A codes are highlighted yellow and blink at the same time.	Minor	Closed
ACT023	3/6/98	When Screen Dump option is executed, it does not output screen data to a dump file as described in the CMC Operator's Manual. A pop-up window indicates that the Screen Dump will output screen data to a printer. There is no instruction in the CMC Operator's Manual on how to configure a printer to operate with the CMC.	Minor	Open
ACT024	3/6/98	Radar Control options, (Radar Display Control Menu), Current Radar Configuration, when selecting Radar 2 (TDX2), and changes are made to longitudinal values, the display range rings change size -- the radar display center does not change position. Longitudinal changes should move the radar display center left or right. Latitude change operate normally.	Minor	Closed
ACT025	3/14/98	No data is provided at SDU inside panel jack J44. Documentation indicates that channel 3 RS-232 data is available at this jack. No data is provided at SDU inside panel jack J45, pins: 12, 11, (channel 3), and pins: 18, 17, (channel 6). Documentation indicates that RS-422 data is available at this jack.	Moderate	Open
ACT026	3/23/98	TDX1 On-line, observed a large number of correlated targets in our magnified ASD viewing area. Turned on Raw Replies and saw more MTI and Normal replies than usual. Checked SPLEX Stats Menu and saw 'Ave CPU Loading (%)' = 100. TDX2 operated normally, no overloading. Local ASR-9 interference not an issue. SPLEX overload protection not enabled. No indication of fault or problem in Status Log. Cause of overload was undetermined.	Critical	Closed
ACT027	3/23/98	CMC screen went blank (no cursor, mouse, or window) under the following conditions: TDX1 on-line, Search/beacon association off, window zoomed at 5 nmi window box, RHI is on (0-60nmi, 45-60 degrees), right mouse button set to Range & Bearing, tracked 2 targets with Range & Bearing feature. Recycle power to restore operation.	Moderate	Closed
ACT028	3/24/98	Reference: TDX-2000d and TDX-2000d Operation and Maintenance Manual, Paragraph, 4.4.1.6, DC Power Supply Voltage Adjustment. This procedure did not contain or reference tolerances for +5 VDC, ±12 VDC, or +28 VDC.	Critical	Closed
ACT029	3/24/98	Reference: TDX-2000d and TDX-2000d Operation and Maintenance Manual, Paragraph, 4.4.1.6, DC Power Supply Voltage Adjustment. Terminal strip TB1 located inside the TDX, on right side of cabinet, has exposed AC and DC voltages. Also, no warning or caution message is contained in the procedure.	Critical	Closed

Table 1: T&E Test Discrepancy Reports (Oct 30, 1997 through June 16, 1999)				
ACT030	4/1/98	During flight testing (TDX1 On-line) data recorded at the output of the UNIOs indicated that sector marks were missing on one occasion.	Critical	Closed
ACT031	4/14/98	The weather channel fault status in the status message (Word 2, bit 12; bit 25 of message) does not report correct weather channel fault conditions. Weather fault status is not declared when faults are present on the WEPRO board or on the weather processor front panel fault light. See TDR ACT032 for a description of the fault injection technique.	Moderate	Closed
ACT032	4/14/98	The Reset Weather command under Weather Configuration - Weather Commands menu creates a fault condition rather than reset the weather processor. WEPRO board fault light and a weather processor front panel fault light are illuminated. This condition occurs even when the weather processor is in idle mode or when using the Reset button on the WEX processor card. The MSC must be reset to clear fault condition resulting in loss of redundancy.	Moderate	Closed
ACT033	4/13/98	The CMC manual does not instruct the user to set the CMC time to MSC time and reset the MSC prior to start of data logging functions. These times must be synchronized in order to playback logged data files.	Minor	Closed
ACT034	4/28/98	The SDU Controls and Indicators (TDX-2000d) illustration Figure 2-3, on pg 20, shows the stencil on the SDU card as "TDX SEL". Actual hardware shows "BDX SEL". Para 2.2.1., Step 3, states; "Ensure the system is on-line within 20 seconds ..." and para 2.2.2. Step 5, states; "Ensure the system is on-line within 20 seconds ...". Actual time required to power up on-line with no alarms has been timed at 40 to 45 seconds. No reference to the individual configuration for UNIOs #1, #2, and #3 for board jumper JP2.	Minor	Closed
ACT035	5/12/98	The Pandora password can not be changed by the user, under File Manager Menu.	Minor	Closed
ACT036	5/12/98	There are several TDX Stats options that do not accurately present status data. Those TDX Stats options are: 1. CD Status, this status retains old history data, even when both TDX's are reset. The CMC has to be reset in order to receive current CD Status; 2. Radar Statistics, The column labeled "This Scan", under TDX Stats does not accurately update the values each scan. It flashes a value briefly, but clears out to 0% or 0, depending on whether "Percentage" or "Counts" is selected, respectively; 3. Unit Control, The Network Connect Status menu does not display colored-coded status for the four (4) items listed in the menu.	Minor	Closed
ACT037	5/12/98	The Range Delay value, under REPRO Configuration Menu, Processing Ranges, can be changed by the user. The TDX-2000d Installation and Setup manual indicates that this value should not be altered.	Minor	Closed
ACT038	5/12/98	Output to the modems is missing the B-RTQC and STATUS messages when TDX1 is on-line. Statistics menus show B-RTQC is present. No fault indications are seen at front panel fault lights or in the status log. TDX2 on-line, operation is normal. A hard (power) reset was necessary to clear this problem.	Critical	Open
ACT039	**5/15/98**	When sector marks are lost at the output of the second of three modem channels, it does not switchover to the other remaining, operating modem channels. This creates loss of data to the end user. Data was disabled by removing pin #2 from serial port channel 2, at the TDX I/O back panel, using a DB-25 jumper box. The data output was monitored and collected using RTADS software. Missing sector marks are a critical operational concern and should be corrected.	**Critical**	Closed

Table 1: T&E Test Discrepancy Reports (Oct 30, 1997 through June 16, 1999)				
ACT040	5/15/98	When data is lost at the output of any of three modem channels, even when the data gets redirected to another channel, the TDX does not show any fault light or status message on the CMC to indicate a modem failure has occurred. Data loss was setup and monitored as described in TDR #39, except clock and data (pin 17 & 2) were also removed on all 3 serial I/O channels, which showed no TDX/CMC faulted indications. A lost modem channel only allows data to be transmitted over the two remaining modem channels. A fault light or status message will allow the technician to make corrective actions should another modem fail. This failed modem condition indicates a lack of fault reporting.	**Critical**	Closed
ACT041	5/15/98	With VideoBITS generating 80 - 90 beacon targets squawking 7700 codes, CMC became very sluggish. User could not access menus. Data output to modems was unaffected. Status log operation did not appear to be a factor in slowing CMC response. (Sluggishness was repeatable with Status Log enabled or disabled) Upon turning off the target scenario, CMC response was fast and immediate. Note: With a target scenario of 12 beacon targets squawking 7700 codes, CMC response was normal. This user must have the ability monitor and change configuration with various target loading.	**Moderate**	Closed
ACT042	5/27/98	On two occasions we found AIU #1 with power automatically removed. Troubleshooting revealed that with only the PC UNIO board plugged into the motherboard, the power supply folded back resulting in no power to the PC. We re-seated the UNIO board and applied power. Operation was restored to normal. The PC ±5VDC supplies were +5.05 VDC and -5.05 VDC measured at the motherboard. AIU #2 operation was normal, no power problems. This type of problem could cause an unscheduled outage and is an operational concern.	**Critical**	Closed
ACT043	6/2/98	Search targets have reduced sensitivity at ranges less than 1.4 nmi. A test target was injected, using VideoBITS, into the front end of the ASR-8 at about 10 dB above MDS. Target was walked in from 5 nmi and disappeared at 1.4 nmi. ASR-8 set up: STC off, low beam, HV off. TDX set up: zero cmap, normal site tmap or a 3.1 tmap, aircraft parameters - minimum velocity = zero. (Using a 3.1 tmap or our regular site tmap returned a similar result of poor sensitivity at ranges less than 1.78 nmi.) Evidently, this is not a problem at Palm Springs but is a problem at the Tech. Ctr. and Phoenix. Reduced search performance at close-in ranges is an operational concern.	**Critical**	Closed
ACT044	6/3/98	Beacon False Target Logic (BFTL) is not properly handling 'reinforced' or 'different altitude' test cases in the False Range Azimuth Gate (FRAG) regions. Eliminating real beacon targets is an operational concern.	**Critical**	Closed
ACT045	6/8/98	When channel 2, sector marks, is removed from the input of the AIU, other input data is temporarily lost for a few scans on channel 1. The input data included status messages, BRTQC's & SRTQC's, and surveillance messages, including priority (emergency) messages. Data loss on one channel should not interrupt data on another channel. The data was disabled by disconnecting the RS-232 connector at J13 input AIU back panel for 10 scans or 50 seconds. The input data was monitored and collected at the input locations HY1-J3, HY2-J3, and HY2-J3, using RTADS software, and the ARTSIIA data extraction was used to verify that this data was missing. Missing priority and status messages are a critical operational concern and should be corrected.	**Critical**	Closed
ACT046	8/24/98	The Radar Microwave Link (RML) was causing automatic and erratic AN/GPN-20 control panel changes. These faulty control panel changes resulted in TDX faults. Status log messages included: BRTQC error, SPLEX Data Block Overflow, Fatal BRTQC error, and Global Memory FIFO Overflow in both TDX's. No beacon targets were observed on CMC or UNIO output ports. No beacon fault lights were seen on either TDX. Switching beacon processor to Idle and back to Operational had no effect.	**Critical**	**Closed**
ACT047	9/1/98	Software release tapes do not install correctly. The user has to seek support from the vendor to install the updated software. After installation of software, there were configuration, application, and map files missing on the CMC. The software installation method deletes files without any warning to the user.	**Critical**	**Closed**

Table 1: T&E Test Discrepancy Reports (Oct 30, 1997 through June 16, 1999)				
ACT048	9/1/98	CMC randomly does not display broadcasted TDX1 and TDX2 surveillance data. However, weather data is displayed on the CMC and the on-line TDX modem is transmitting all data during this condition. The TDX's have to be reset to clear this problem.	Moderate	Closed
ACT049	9/4/98	With VideoBITS generating 12 beacon targets squawking 7700 codes, CMC properly highlighted and flashed all twelve 7700 codes. An 18 beacon target scenario with 7700 codes caused the CMC to display two (2) of the 7700 codes as ordinary green beacon symbols. Disabling WARNING message at status log had no effect. Removing search and weather symbols had no effect	Moderate	Closed
ACT050	9/14/98	The AIU does not send Status Messages to the MALA board.	Critical	Closed
ACT051	9/29/98	Unrestricted access to critical system parameters in the TDX and AIU menu structure could cause problems with TDX/AIU performance and operation. Current password protection may not be adequate to preserve important parameters.	Minor	Open
ACT052	10/1/98	Resolution flight tests were performed at the Technical Center. Analysis of azimuth resolution flight data indicates that two dissimilar aircraft resolved 80% when separated by 51 ACPs or 4.5 degrees. Performance Measures document requires 80% resolution at 2.8 degrees.	Critical	Open
ACT053	10/21/98	Attempts to switch TDX #1 or TDX #2 correlator (MSC Control Menu, in Control Parameters Menu) from 'correlate' to 'idle' and back to 'correlate' did not function properly. Typically, it took two (2) ACCEPT or OK actions to change to 'idle'. Also, returning to the 'correlate' selection in the Control Parameters Menu showed a correct readback on the radio button and the CMC symbols and modem data indicated that system was in 'correlate', but, the front panel amber light remained lit. A TDX reset was necessary to force the Correlator status light from amber to green.	Minor	Closed
ACT054	11/03/98	Mode 2 beacon code is not properly sent to the UNIO output. The CMC display shows that the radar data has valid mode 2 reply messages. The UNIO output has a mode 2 code that is different than the mode 2 code on the CMC display.	Moderate	Closed
AOS001	11/19/97	While saving files to floppy disk, using File Manager, the CMC reboots if the floppy drive runs out of storage space.	Minor	Closed
AOS002	11/19/97	File Manager cannot change directories backward or laterally from the default directory. Can only change subdirectories.	Minor	Closed

APPENDIX B

IRES PROGRAM DESCRIPTIONS

IRES PROGRAM DESCRIPTIONS

This appendix contains a brief description of the IRES programs used during T&E. The descriptions were extracted from IRES user's manual. A more detailed description of the programs can be found in the user's manual.

BlipScan	Blipscan/Scan Ratio	Analysis

BlipScan requires a tracked reports file (either from Select or Track) and calculates a Blip/Scan ratio for each track in the file, and the overall Blip/Scan ratio. The Blip / Scan ratio show the percent of radar and beacon detections over the life of the track (# Detections / Track Age).

Copycd	Copy CD format into PCS	Reformat

Copycd reformats CD messages into PCS-2 surveillance reports. CD messages from ASR-9, ARSR-4, CD-2, and CD-1 are supported.

ColRB	Collimate Radar/Beacon	Analysis

ColRB produces range, azimuth or height collimation histograms. The collimation histogram shows the frequency of position differences between:

- both surveillance types (radar and beacon),
- one surveillance and one reference, or
- both reference types (to establish confidence in the reference used).

Each histogram shows the mean and standard deviation of position difference.

CopyLLA	Copy Lat/Long/Altitude data into PCS	Reformat

CopyLLA reformats ASCII Latitude, Longitude, and Altitude position data into PCS-2 Reference reports, performing a coordinate transform to the position of the radar antenna. This is required before merging reference data with the tracked reports of the flight test aircraft. The coordinate transform conforms to the WGS-84 (NAD-83) earth Model.

CountPCS	Count PCS surveillance reports	Summary

CountPCS counts the number of each type of surveillance report in the PCS file. For radar reports (RC and RO), the number of each Quality and Confidence pair is counted. For beacon reports (RB and BO), the number of each beacon mode (3/A, 2, and C) validation is counted.

CountTrk	Count TQA qualified reports	Summary

CountTrk counts the number of each surveillance report type in the qualified tracked reports file by track quality. Also counts tracks by track criteria. The track qualities are assigned by Qualify. This is summary step in the Track Quality Assessment (TQA) process, following Track, Qualify and PlotTQA.

Filter	Filter PCS surveillance reports	Utility