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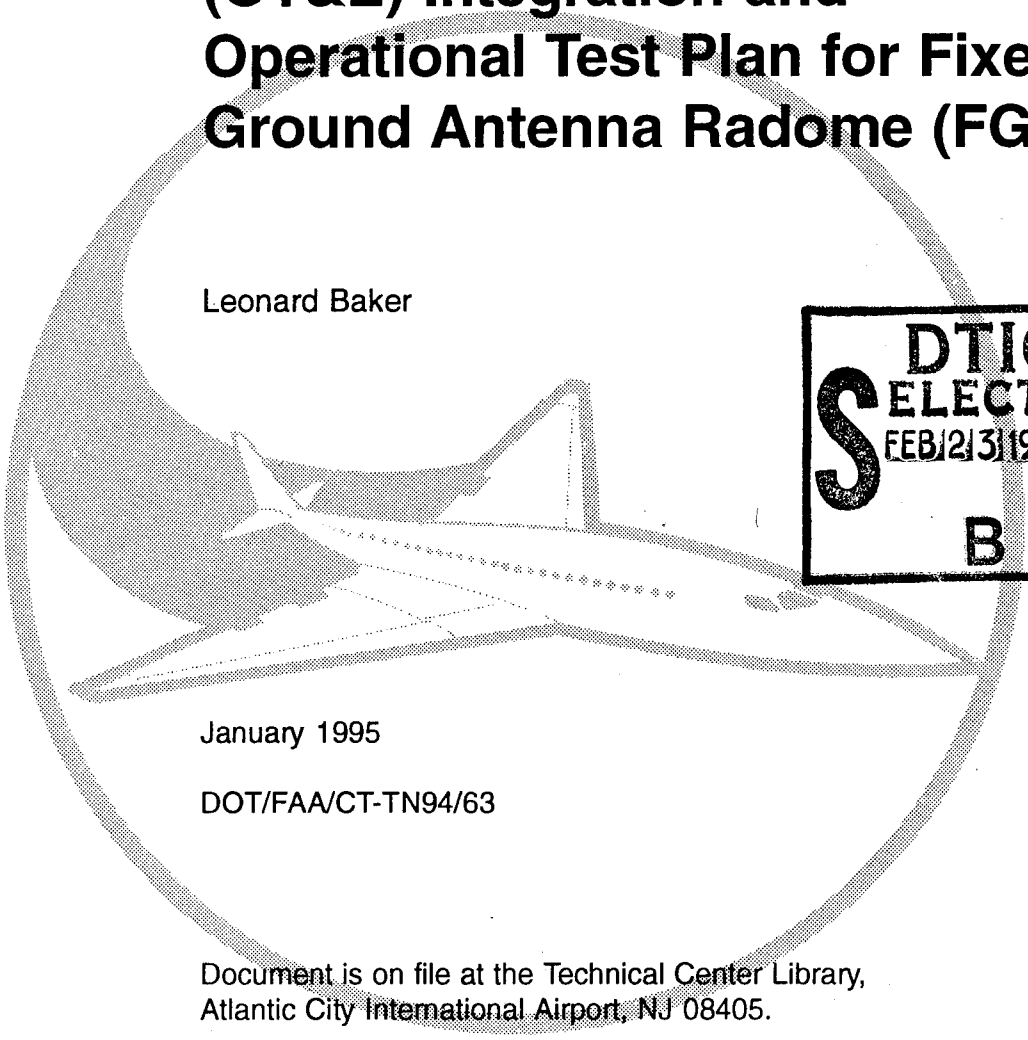
Operational Test and Evaluation (OT&E) Integration and Operational Test Plan for Fixed Ground Antenna Radome (FGAR)

Leonard Baker



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16. Abstract

The Federal Aviation Administration (FAA) Fixed Ground Antenna Radome (FGAR) Operational Test and Evaluation (OT&E) Integration and Operational Test Plan is prepared by the Associate Program Manager for Test (APMT). It defines the overall planning, test activities, and coordination associated with OT&E Integration and Operational testing required to ensure the project meets the requirements of the project specification and the system and subsystem requirements allocated to the project.

The purpose of the FGAR project is to provide new, larger radomes for en route surveillance radars that require collocated Mode Select Beacon System (Mode S) installations. As a result of the FAA's program to implement Mode S, many existing en route surveillance radar radomes cannot accommodate the additional space required by the new Mode S antennas. The FGARs will provide an environmental enclosure for a variety of single or dual-face monopulse beacon phased array and en route surveillance radar installations. Installations will be comprised of an installation mix ranging from beacon-only-sites (BOS) to collocated beacon and en route surveillance radar sites.

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EXECUTIVE SUMMARY

The Fixed Ground Antenna Radome (FGAR) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Plans have been combined due to the limited amount of integration testing required.

This test plan describes the FGAR Integration and Operational testing required by Order 1810.4B, FAA National Airspace System (NAS) Policy. This plan provides the details not identified in the Federal Aviation Administration (FAA) Test and Evaluation Master Plan (TEMP) for Fixed Ground Antenna Radome (FGAR), report DOT/FAA/CT-TN93/17. There are no NAS requirements for the FGAR defined in either the NAS-SS-1000 or the NAS-DD-1000E. The plan is designed to determine the effect, if any, on the Air Route Surveillance Radar's (ARSR), Air Traffic Control Radar Beacon System's (ATCRBS), or Mode Select Beacon System's (Mode S) antenna patterns and its operational effectiveness and suitability, when maintained by Airway Facilities (AF) field personnel.

There are three distinct types of FGARs being procured: they are Types I, II, and V. Each vary principally in size. OT&E Integration and OT&E Operational testing will be performed at the first two Type I FGAR sites. Follow-on testing may be performed on Types's II and V after installation.

The first Type I FGAR will be delivered to the FAA Technical Center's Elwood, New Jersey (NJ) En Route Beacon Test Facility (ERBTF); the second radome will be installed at the Northwest Mountain Region's Trinidad, Colorado (CO) En Route Radar Facility (TAD). The first Type II radome will be installed at the Rockville, Nebraska (NE) Beacon Only Site (BOS); and the first Type V radome will be installed at the Burns, Oregon (OR) En Route Radar Facility.

OT&E will include electromagnetic performance testing. Data will be collected at the Elwood facility using the En Route Mode S Sensor and its associated monopulse open-array back-to-back antenna. In addition, electromagnetic performance data will be collected at the Trinidad En Route Radar Facility (TAD) using the Northwest Mountain Region's Spectrum Analysis and Interference Locator (SAIL) van (same as a Radio Frequency [RF] Interference Monitoring [RFIM] van) and the Albuquerque (ZAB) and Denver (ZDV) Air Route Traffic Control Center's (ARTCC) HOST computers. In addition, Air Traffic Control Specialists (ATCS) at the ARTCCs will evaluate the Trinidad En Route Radar Facility (TAD) video presentation, on their displays.

Baseline data will be collected prior to the installation of the FGAR. Similar data will be collected after the removal of the existing radome and again after the FGAR is installed. These data will be analyzed to determine if the primary and/or secondary radar systems antenna patterns have changed.

1. INTRODUCTION.

1.1 BACKGROUND.

The Federal Aviation Administration's (FAA) program to implement the En Route Mode Select Beacon System (Mode S) project resulted in a requirement to replace the existing radomes. The existing radomes are not physically large enough to accommodate the new Mode S Monopulse Open-Array Back-To-Back antennas. Facilities that will receive the Fixed Ground Antenna Radomes (FGAR) include: FAA Air Route Surveillance Radar [ARSR] sites, military type [AN/FPS] long range surveillance radars sites, and Beacon Only Sites (BOS). FGAR's will also be procured for Mode S en route facilities presently without radomes. There are three distinct types of FGARs being procured: they are Types I, II, and V.

The FAA awarded the FGAR contract to the Electronic Space Systems Corporation (ESSCO) September 30, 1993. FAA-E-2773b, Specification for Fixed Ground Antenna Radome (Mode S Compatible), establishes the requirements for performance, design, production and acceptance of a state-of-the-art radome which provides environmental protection for sophisticated L-band antenna systems. The contract provides for a turnkey installation. There are no FGAR National Airspace System (NAS) requirements defined in NAS-SS-1000, NAS System Specification, or NAS-DD-1000E, National Air Space Level I Design Document.

The contractor shall conduct a Test and Evaluation (T&E) program in accordance with FAA-E-2773b and the Statement Of Work (SOW). First Article testing will be conducted by the contractor and witnessed by the FAA. The contractor shall conduct factory acceptance testing. The contractor will deliver and install the first three Type I production radomes as First Articles. The contractor shall complete First Article testing at the site to verify those contract requirements not verifiable at the factory. The contractor shall conduct Site Acceptance Tests (SAT). The Contract Acceptance Inspection (CAI) shall occur after the contractor successfully completes the SAT. The CAI is the final acceptance of the turnkey installation by the Government from the contractor.

The FAA Technical Center's Secondary Surveillance Systems Division, ACW-100, will conduct Operational Test and Evaluation (OT&E) Integration and Operational testing. OT&E Integration and Operational testing is designed to ensure the FGAR meets the design requirements. The OT&E program will ensure the operational effectiveness and suitability of the FGAR will meet user's requirements. OT&E Integration and Operational testing will be performed at the Technical Center's Elwood, New Jersey (NJ) En Route Beacon Test Facility (ERBTF). Testing will include electromagnetic performance testing using the Mode S Sensors and ARSR-2 radar. Additional testing will be performed at the Northwest Mountain Regions Trinidad, Colorado (CO) En Route Radar Facility (TAD). The Northwest Mountain Regions Spectrum Engineering Group, ANM-464, the Albuquerque Air Route Traffic Control Center (ARTCC) [ZAB], and the Denver ARTCC (ZDV) will support the electromagnetic performance testing. In addition, Air Traffic Control Specialists (ATCS) at the ARTCCs will evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.

Follow-on OT&E may be conducted on the first Type II and V radomes installed to evaluate those characteristics which are different from the Type I FGAR.

1.2 PURPOSE.

The purpose of this document is to define the overall planning, testing activities, and coordination associated with OT&E Integration and Operational testing. The testing will be performed in accordance with Order 1810.4B, FAA NAS Test and Evaluation Policy, and NAS-MD-110, Test and Evaluation (T&E) Terms and Definitions for the National Airspace System.

OT&E Integration and Operational testing will ensure the FGAR meets the requirements defined in Order 1810.4B. It will focus on determining to what degree the FGAR meets, exceeds, or degrades the operational characteristics of the enclosed en route surveillance radar system, Air Traffic Control Radar Beacon System (ATCRBS), and/or Mode S system. The operational effectiveness and suitability of the FGAR will be verified by user participation in the testing.

1.3 SCOPE.

This test plan defines:

a. The requirements to be verified at the first two Type I FGAR sites.

b. The test objectives.

c. The criteria for the successful completion of each test.

d. The configuration(s) to be used during testing.

e. The scope of the testing to be accomplished.

f. The resources and activities to be coordinated in preparation for, and in support of the testing.

g. The development of detailed test procedures to perform the testing.

2. REFERENCE DOCUMENTS.

A list of applicable documentation and reference materials that relate to the contents of this plan are provided in the following paragraphs. The hierarchical dependency of the documents used in developing this test plan are shown in figure 2-1.

2.1 FAA ORDERS.

Order 1810.4B	FAA NAS Test and Evaluation Policy
Order 6050.32	Spectrum Management Regulations and Procedures Manual
Order 6300.12	Project Implementation Plan (PIP) Fixed Ground Antenna Radome (FGAR) Including Tower Retrofit Modification

2.2 FAA STANDARDS.

FAA-STD-019b	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities
FAA-STD-020a	Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment

FAA-STD-024b	Content and Format Requirements for the Preparation of Test and Evaluation Documentation

2.3 FAA SPECIFICATIONS.

FAA-E-2773b	Specification for Fixed Ground Antenna Radome (Mode S Compatible)
FAA-G-2100e	Electronic Equipment, General Requirements

2.4 NAS DOCUMENTS.

NAS-MD-110	Test and Evaluation (T&E) Terms and Definitions for the National Airspace System

2.5 OTHER FAA DOCUMENTS.

DTFA01-93-C-00075	Fixed Ground Antenna Radome (FGAR) Contract
DOT/FAA/CT-TN93/17	Fixed Ground Antenna Radome (FGAR) Master Test and Evaluation Plan (TEMP)
FAA-4306N-6H	User's Manual - Quick Analysis of Radar Sites (QARS) Program

2.6 DEPARTMENT OF DEFENSE (DOD) DOCUMENTS.

MIL-STD-1472D	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities

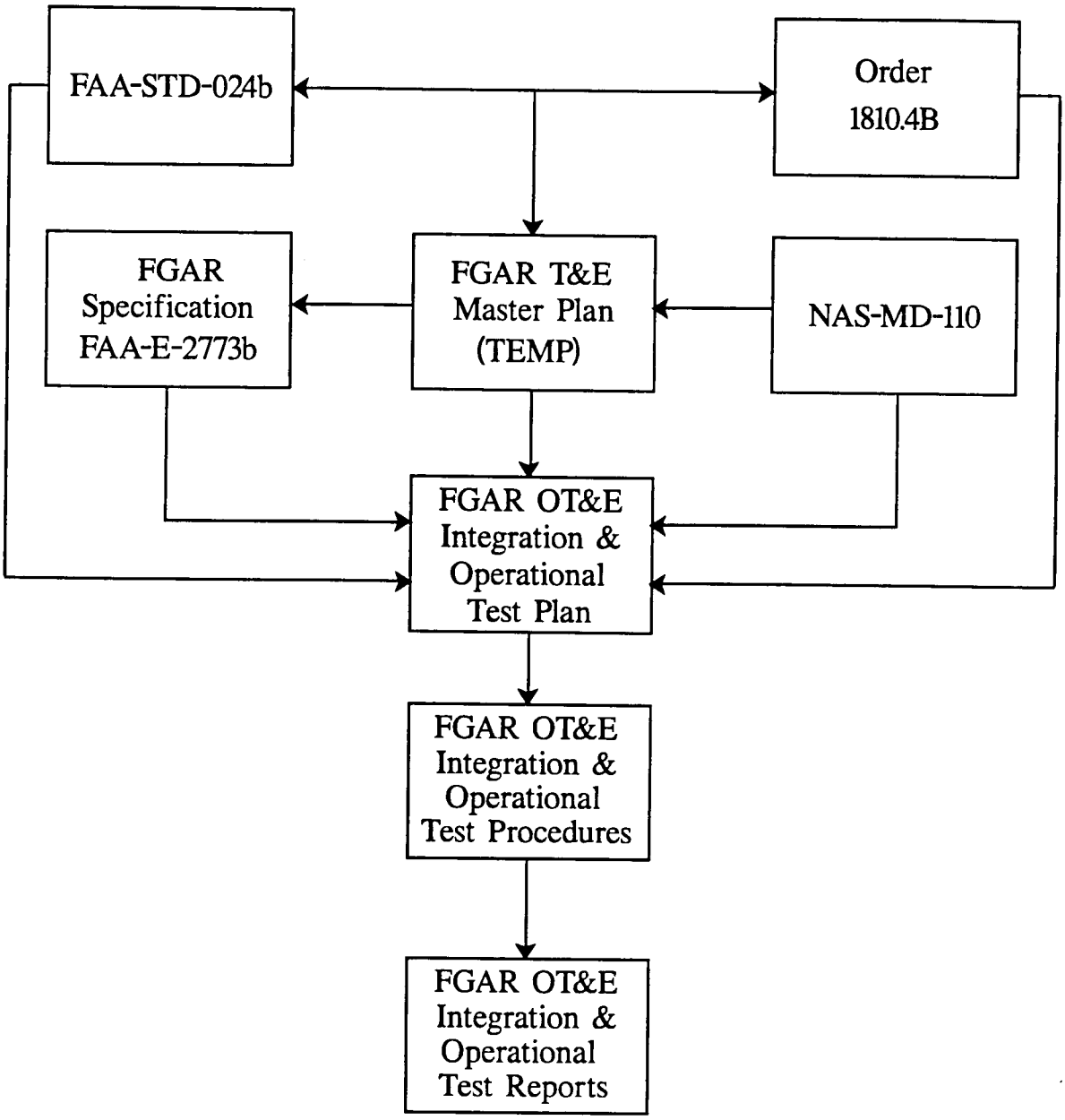


FIGURE 2-1 REFERENCE DOCUMENTS

3. SYSTEM DESCRIPTION.

3.1 SYSTEM OVERVIEW.

The FGAR supplies optimal protection of the antenna(s) from the outside environment while providing minimal degradation to the electromagnetic performance characteristics of the enclosed antenna(s). The hardware required for installation, i.e., cables, wiring, support equipment, radome mounted/supported equipment, radome base ring (Type II only), and spare parts are part of the FGAR procurement. There are five types of radomes (no Type IV radomes are being procured). They are the following:

a. Type I Radome

This type of radome will provide an environmental enclosure for a collocated L-band surveillance radar reflector and top-mounted dual-faced L-band beacon phased array antenna. The radome will be capable of withstanding wind velocities of 150 miles per hour (MPH). They will have an inside diameter of 59 feet at their widest point, and will fit a base ring diameter equal to the present CW-396A radome. The enclosed antennas will rotate at a speed of either 5 or 6 revolutions per minute (RPM).

b. Type II Radome

This type of radome will provide an environmental enclosure for a dual-faced L-band beacon phased array antenna consisting of two identical rectangular back-to-back antennas approximately 6 feet high by 27 feet wide, rotating at speeds up to 5 RPM. The radome will be capable of withstanding wind velocities of 150 MPH and have an inside diameter of 35 feet at its widest point. It will fit the standard beacon-only antenna platform.

c. Type III Radome

This type of radome will be identical to the Type I in all respects, except that it will be capable of withstanding wind velocities of 100 MPH maximum.

d. Type V Radome

This type of radome will provide an environmental enclosure for a collocated L-band surveillance radar reflector and top-mounted dual-faced L-band beacon phased array antenna. The radome will be capable of withstanding wind velocities of 150 MPH. They will have an inside diameter of 57.5 feet at their widest point, and will fit a base ring diameter equal to the present ARSR-3 radome.

e. Type VI Radome

This type of radome will be identical to the Type V in all respects, except that it will be capable of withstanding wind velocities of 100 MPH maximum.

3.2 INTERFACES OVERVIEW.

3.2.1 Mechanical Interface.

The Type I, III, V, and VI FGARs will interface mechanically with the existing antenna tower radome base ring. The Type II FGAR radome base ring is part of the procurement and will interface with the antenna tower.

3.2.2 Electrical Interface.

The FGAR will interface electrically with the following facility systems:

a. Electrical system

b. Lightning protection system

c. Remote Maintenance Monitoring System (RMMS)/Environmental Remote Monitoring Subsystem (ERMS)

d. Transient protection

These interfaces will be verified during the contractor's SAT and will not be repeated during the FAA's OT&E.

A block diagram of the electrical interfaces are shown in figure 3.2.2-1.

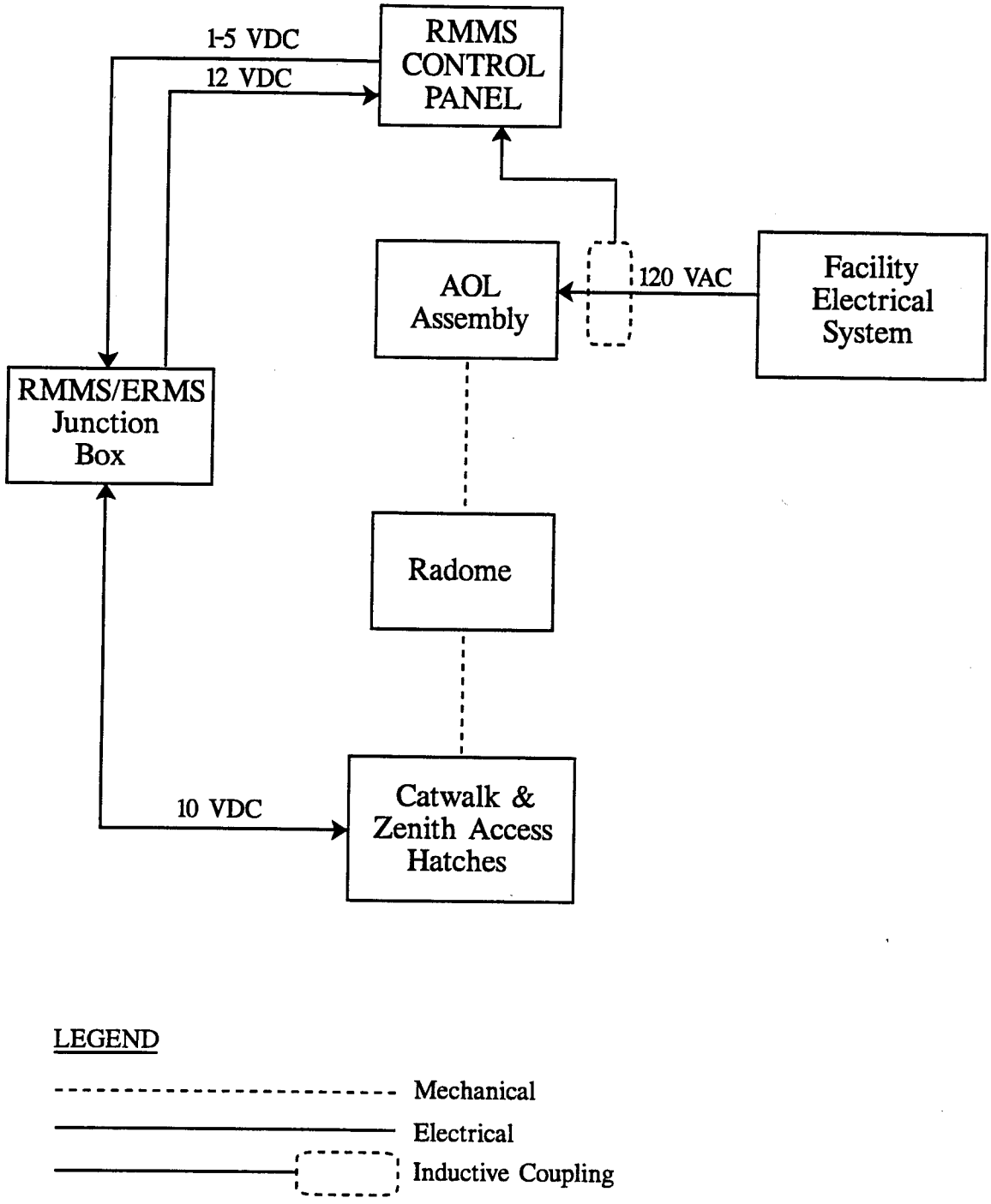


FIGURE 3.2.2-1 ELECTRICAL INTERFACES BLOCK DIAGRAM

4. TEST PROGRAM DESCRIPTION.

4.1 APPROACH AND CONCEPT.

The three types of FGARs to be tested are the Type I, designed for the ARSR-1/2 and AN/FPS antenna towers; the Type II, designed for the BOS antenna tower; and the Type V, designed for the ARSR-3 antenna tower. The Type III and VI FGARs will not be tested since the production contractor will build these radomes to the more stringent Type I and V FGAR wind loading requirement.

The OT&E program will be conducted in two phases. The first phase will use "live" aircraft (targets of opportunity) reply data collected at the Technical Center's ERBTF. The ERBTF has an inflatable radome, En Route Mode S system, and a ARSR-2. The inflatable radome is nearly transparent to both the primary and secondary antenna's radiated patterns, i.e., there is no measurable electromagnetic performance degradation. Radar data will be collected periodically for both wet and dry conditions until the FGAR is installed. The FGAR is scheduled for installation in September 1994. The contract provides a 2-day period between the removal of the existing radome and the installation of the FGAR, for Government testing. During this 2-day period, primary and secondary radar data will be collected. When the FGAR is installed, primary and secondary radar data will be collected again. Comparison of the three sets of data (inflatable radome, no radome, FGAR) will allow the performance of the FGAR to be characterized.

The second phase of the test program will be conducted at the Northwest Mountain Region's Trinidad En Route Radar Facility (TAD).

a. Radiated radar antenna pattern and solar-based antenna pattern measurements will be made using ANM-464's Spectrum Analysis and Interference Locator (SAIL) van (same as a Radio Frequency [RF] Interference Monitoring [RFIM] van). Data will be collected with the existing radome in place, the radome removed, and with the FGAR installed. Data comparisons will be used to characterize the FGAR's performance.

b. The Albuquerque (ZAB) and Denver (ZDV) ARTCCs will analyze the ARSR and ATCRBS/Mode S data received from the Trinidad En Route Radar Facility (TAD) using the QARS program.

c. The ARTCCs ATCSs will evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.

4.1.1 Evaluation Approach.

The OT&E testing approach is to verify the FGAR's electromagnetic performance, physical characteristics, human engineering, and transient protection Measures of Effectiveness (MOE) and Measures of Suitability (MOS) separately. "Live" aircraft (targets of opportunity) radar data will be collected to determine the electromagnetic MOEs and MOSs. Data will be collected using the Real-Time Analysis Display System (RTADS) and the Mode S Analysis Recording Display Equipment (MARDE). Existing data analysis programs will be used to characterize both the primary and secondary radar systems electromagnetic MOEs and MOSs. The radomes physical characteristic MOEs and MOSs will be verified through visual inspections. The human engineering MOEs and MOSs will be measured and evaluated using Airway Facilities (AF) site technicians. The transient protection MOEs and MOSs will me measured and evaluated by test. The FAA's TEMP Test Verification Requirements Traceability Matrix (TVRTM) defines the verification methods.

The specific areas to be evaluated during OT&E testing are:

a. Electromagnetic performance

b. Physical characteristics

c. Human engineering

d. Transient protection

4.1.2 Critical Operational Issues (COI)/Test Requirements Summary.

The COIs are:

a. Physical Interfaces

The radome interfaces to existing antenna tower, the lightning protection system, and the RMMS/ERMS. These interfaces will be verified during contractor's SAT.

b. Electromagnetic Performance

There is no degradation to the primary radar, ATCRBS, or Mode S aircraft positional accuracy.

4.1.3 Minimum Acceptable Operational Requirements (MAOR).

The MAORs are:

a. Physical Interfaces

No modifications to the antenna tower, the lightning protection system, or the RMMS/ERMS are required after the radome is delivered.

b. Electromagnetic Performance

The electromagnetic performance of the primary radar, ATCRBS, and Mode S Sensor antenna patterns will be measured from at least three points, located approximately 120° apart, with the radome both wet and dry. The electromagnetic MAORs for both the wet and dry conditions are:

1. Antenna main lobe beam width change of ±0.05° maximum.

2. Boresight error of 0.0085° root-mean-square (RMS) and 0.0255° maximum in either elevation or azimuth.

3. Sidelobe level error change of ±1 decibel (dB), using a sidelobe that is 25 dB below the main lobe for all frontal and back lobes.

4.1.4 Activities Leading to Test.

Prior to conducting the tests defined in this plan, the contractor shall have demonstrated compliance with the requirements in specification FAA-E-2773b. The contractor shall have completed the First Article Design Qualification Tests (DQT) and the SAT.

Coordination with the Northwest Mountain Region Spectrum Engineering Group, ANM-464, to use their SAIL van has been completed. Dry runs using the SAIL van at the Seattle, Washington (WA) En Route Radar Facility (SEA) have been

completed. The same type electromagnetic performance data scheduled to be collected at the Trinidad En Route Radar Facility (TAD) has been collected at the Seattle En Route Radar Facility (SEA).

OT&E inflatable radome baseline testing at the Technical Center's ERBTF using the Mode S Sensor and ARSR-2 systems will have been completed. These tests will not only serve as the performance baseline for later comparison, but will provide an opportunity to dry run the tests prior to installation of the FGAR.

4.2 TEST ENVIRONMENT.

OT&E testing will be accomplished at the first two Type I FGAR facilities. The Technical Center's Elwood ERBTF permits testing with the new monopulse Mode S Sensor and its associated back-to-back antenna; testing at Trinidad En Route Radar Facility (TAD) will use the Northwest Mountain Region's SAIL van. The SAIL van is currently the only tool available to measure the critical antenna electromagnetic performance parameters required by specification FAA-E-2773b.

A subset of the tests may be performed at the first Type II and V FGAR sites. Determination of which tests are to be performed at the Type II and V sites will be based on the results of Type I OT&E testing; Type II and V Development Test and Evaluation (DT&E) testing; and the unique electrical, mechanical, and/or structural differences between the three types of radomes.

4.2.1 Test Locations.

OT&E testing will be accomplished at the Technical Center's Elwood, NJ ERBTF, Northwest Mountain Region's Trinidad, CO En Route Radar Facility (TAD), Albuquerque ARTCC (ZAB), and the Denver ARTCC (ZDV).

The testing scheduled to be accomplished at these facilities:

a. Technical Center's Elwood ERBTF

Physical interface and electromagnetic performance testing using the installed ARSR-2, Common Digitizer (CD)-2, and Mode S system.

b. Northwest Mountain Regions Trinidad En Route Radar Facility (TAD)

Electromagnetic performance testing using ANM-464's SAIL van. Human engineering utilizing AF site personnel.

c. Albuquerque ARTCC (ZAB)

Journeyman ATCSs will evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.

d. Albuquerque ARTCC (ZAB) Airway Facilities Sector (AFS)

Electromagnetic performance testing using the Albuquerque ARTCC (ZAB) HOST computer and the QARS program to analyze the ARSR and ATCRBS/ Mode S data received from the Trinidad En Route Radar Facility (TAD).

e. Denver ARTCC (ZDV)

Journeyman ATCSs will evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.

f. Denver ARTCC (ZDV) AFS

Electromagnetic performance testing using the Denver ARTCC (ZDV) HOST computer and the QARS program to analyze the ARSR and ATCRBS/Mode S data received from the Trinidad En Route Radar Facility (TAD).

4.3 TEST AND ANALYSIS TOOLS.

4.3.1 Data Collection.

Data will be collected using four special purpose test tools developed at the Technical Center and by visual evaluation:

a. The Northwest Mountain Region's (ANM-464) SAIL van will record the radiated antenna patterns and perform solar-based antenna pattern measurements for the primary and secondary radar systems.

b. The Technical Center's RTADS will record Mode S and ARSR-2 data. The ARSR-2 data is recorded at the output of the CD-2.

c. The MARDE will record Mode S Sensor data. The recording will be made via the Mode S Data Extraction Port.

d. Albuquerque (ZAB)/Denver (ZDV) ARTCC's QARS program printouts.

e. Albuquerque (ZAB)/Denver (ZDV) ARTCC ATCS visual evaluation of display presentation.

4.3.2 Data Analysis.

The data collected by the SAIL van will be analyzed using its internal programs. These programs will be used to plot horizontal antenna radiation patterns while the facility operates normally, spectrum signatures, coverage, and field strengths. The SAIL van will also be used to plot vertical antenna radiation patterns using solar measurement techniques; this requires the facility to be taken out of service (off-line).

The RTADS and MARDE data gathered during the test conduct phase will be analyzed on the Mode S Program Support Facility (PSF) at the Technical Center. There are two main sets of data reduction and analysis (DR&A) programs. These programs are the UNIX based Data Reduction (DR) programs developed to support Mode S OT&E testing and the Disk Operating System (DOS) based Transportable Radar Analysis Computer System (TRACS) Data Reduction (TDR) programs used by field personnel to analyze radar and beacon performance. Appendix B, Data Analysis Programs, lists the DR and TDR analysis programs and provides a brief description of them.

The QARS program will provide statistical "live" aircraft tracking data that will be analyzed to determine if any degradation of NAS has occurred due to the installation of the FGAR.

The visual evaluation by the ATCSs will provide an "end user" evaluation by trained observers.

4.4 TEST AND/OR EVALUATION DESCRIPTIONS.

The tests to be conducted are contained in appendix A. Each test is uniquely identified by a test number and contains sufficient information to plan for the test activity. Each test includes a test title, objectives, criteria, approach, conduct, and execution time.

5. TEST MANAGEMENT.

5.1 TEST MANAGEMENT ORGANIZATION.

The FGAR test management team is responsible for ensuring all requirements are verified during OT&E Integration and Operational testing. The test management team is composed of representatives from ANR-400, ANR-800, and ACW-100.

The FGAR test management team has the responsibility to direct, control, and monitor all activities relative to FGAR OT&E Integration and Operational testing. Specifically these responsibilities include:

a. Implementing a test program that is consistence with the requirements of Order 1810.4B.

b. Reviewing and providing concurrence/nonconcurrence with all test plans, procedures, and related T&E documentation.

c. Distribution of T&E activity related documents to all participating organizations for review.

d. Assigning roles and responsibilities to the OT&E Integration and Operational test support group.

e. Directing and conducting OT&E Integration and Operational testing.

5.1.1 Roles and Responsibilities.

The FGAR test management team consists of personnel who are knowledgeable in the specific technical areas. The role of this team is to develop test requirements, plans, procedures, and other support tools. The composition and duties of the team are listed below.

Organization	Primary Roles/Functions
ANR-400	Program Manager (PM) Provides ultimate authority and direction for test operations.
ANR-800	Associate Program Manager for Engineering (APME) Provides engineering support to the PM.
ACW-100B	Associate Program Manager for Test (APMT) Appointed by the Technical Center. Manages test program for the PM, prepares the OT&E Integration and Operational Test Plan and Procedures, conducts OT&E Integration and Operational testing; prepares test reports, coordinates and schedules all test activities, determines test requirements, and provides coordination and direction for implementing the OT&E Integration and Operational Test Plan.

5.1.2 Other Participating Organizations.

The FGAR test support team will be supplemented by members of the following organizations:

Organization	Primary Roles/Functions
ACW-100	Provides trained personnel to collect and analyze the ARSR and Mode S data.
ANM-464	Provides the SAIL van and engineers to perform electromagnetic performance testing at the Trinidad En Route Radar Facility (TAD).
Albuquerque ARTCC (ZAB)	Provide the journeyman ATCSs to evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.
Albuquerque ARTCC (ZAB) AFS	Provides the computers, software, and trained personnel to run the QARS program, on data received from the Trinidad En Route Radar Facility (TAD), and to analyze the results.
Denver ARTCC (ZDV)	Provide the journeyman ATCSs to evaluate the Trinidad En Route Radar Facility (TAD) video presentation on their displays.
Denver ARTCC (ZDV) AFS	Provides the computers, software, and trained personnel to run the QARS program, on data received from the Trinidad En Route Radar Facility (TAD), and to analyze the results.

5.1.3 Test Conduct Team.

There will be a Test Director (TD) assigned to each test. The TD duties include:

a. Scheduling the required test facilities.

b. Assigning test team member duties.

c. Holding pretest and post-test reviews.

d. Supervising conduct of the test.

e. Collection of test data, e.g., test team log sheets, computer printouts, automated test equipment printouts, plotter data, etc.

f. Analysis of test data and documentation from the test.

5.2 TRAINING.

The test team members do not require any special training for test conduct. Personnel who are fully qualified in their present positions, e.g., electrical/electronic engineers and technicians, computer operators, ATCSs, etc., will be used for test conduct. The analyses of data will be performed by radar/beacon test engineers and ARTCC Systems Performance Specialist (SPS) who are familiar with the interpretation of the statistical outputs provided by the software analysis programs. The visual evaluation of the video presentations will be made by journeyman ATCSs familiar with the Trinidad En Route Radar Facility (TAD) presentation.

5.3 SYSTEM CONFIGURATION MANAGEMENT.

System Configuration Management (SCM) is divided between the Technical Center and the Northwest Mountain Region field facility.

a. FAA Technical Center

SCM of the ERBTF is the responsibility of the Mode S Configuration Manager (ACW-100) and the ERBTF Engineer. The ERBTF configuration is controlled by the Technical Center's Technical Facilities Division, ACN-300.

b. Northwest Mountain Regional Facility

SCM is the responsibility of the facility manager.

5.3.1 Testbed Configuration.

Two testbeds will be used during OT&E Integration and Operational testing.

a. The Technical Center's ERBTF located at Elwood is a noncommissioned test facility. Its configuration includes an ARSR-2, CD-2, AN/UPX-62 Beacon, and a En Route Mode S System.

b. The Northwest Mountain Region's Trinidad En Route Radar Facility (TAD) is a commissioned facility. Its configuration includes an ARSR-2, CD-2, and a Air Traffic Control Beacon Interrogator (ATCBI)-3.

5.4 TEST READINESS CRITERIA.

The electromagnetic performance testing is divided into three phases and will be preformed in conjunction with the FGAR installation. This testing will ensure the FGAR does not degrade the electromagnetic performance of the en route surveillance radar, ATCRBS, or Mode S systems. The phases are:

a. Phase 1

Before removal of the existing radome.

b. Phase 2

After the contractor has removed the existing radome, including any work scaffolding, crane boom, etc., required for its removal.

c. Phase 3

After the installation of the FGAR is completed and the contractor has removed any work scaffolding, crane boom, etc., required for its installation.

The remainder of the testing will commence upon completion of the CAI.

5.5 TEST EXECUTION.

The following sections describe the pretest and post-test reviews that will be held for each OT&E Integration and Operational test. These reviews will be conducted by the TD, in conjunction with the test team members assigned for the specific test, and other interested test observers, e.g., AOS-200 personnel, etc.

5.5.1 Pretest Review.

This review will be scheduled before the start of each test. The purpose of this review is to:

a. Identify any required changes to the test procedures and make the necessary documentation changes, i.e., "red-line" changes.

b. Review the test environment and hardware configuration(s).

c. Ensure all test equipment, tools, etc., are available and ready for use, i.e., calibrated, etc., and available in the test area.

d. Generate a record of the pretest briefing minutes.

5.5.2 Post-Test Review.

This review will be held upon completion of each test. The TD will prepare a post-test review package. This package will contain at least the following:

a. The "as-run" hardware configuration(s).

b. Any procedural, step, or configuration deviation(s).

c. Any discrepancies or anomalies noted during the test, and their effect on the test results.

d. A summary of the overall test outcome. This summary will be derived by reviewing the following:

1. Preliminary test assessment.

2. Test logs.

3. Preliminary test data analysis, if available.

4. Any discrepancy or anomaly reports generated during the test.

5.6 TEST COMPLETION CRITERIA.

The individual test completion criteria is contained in the test descriptions (see appendix A).

5.7 TEST REPORTS.

A description of the reports required for reporting the OT&E Integration and Operational test activities are presented in the following paragraphs. Figure 5.7-1 illustrates the sequence in which the test documents and reports are prepared. A description of the reports and when they are prepared is shown in table 5.7-1.

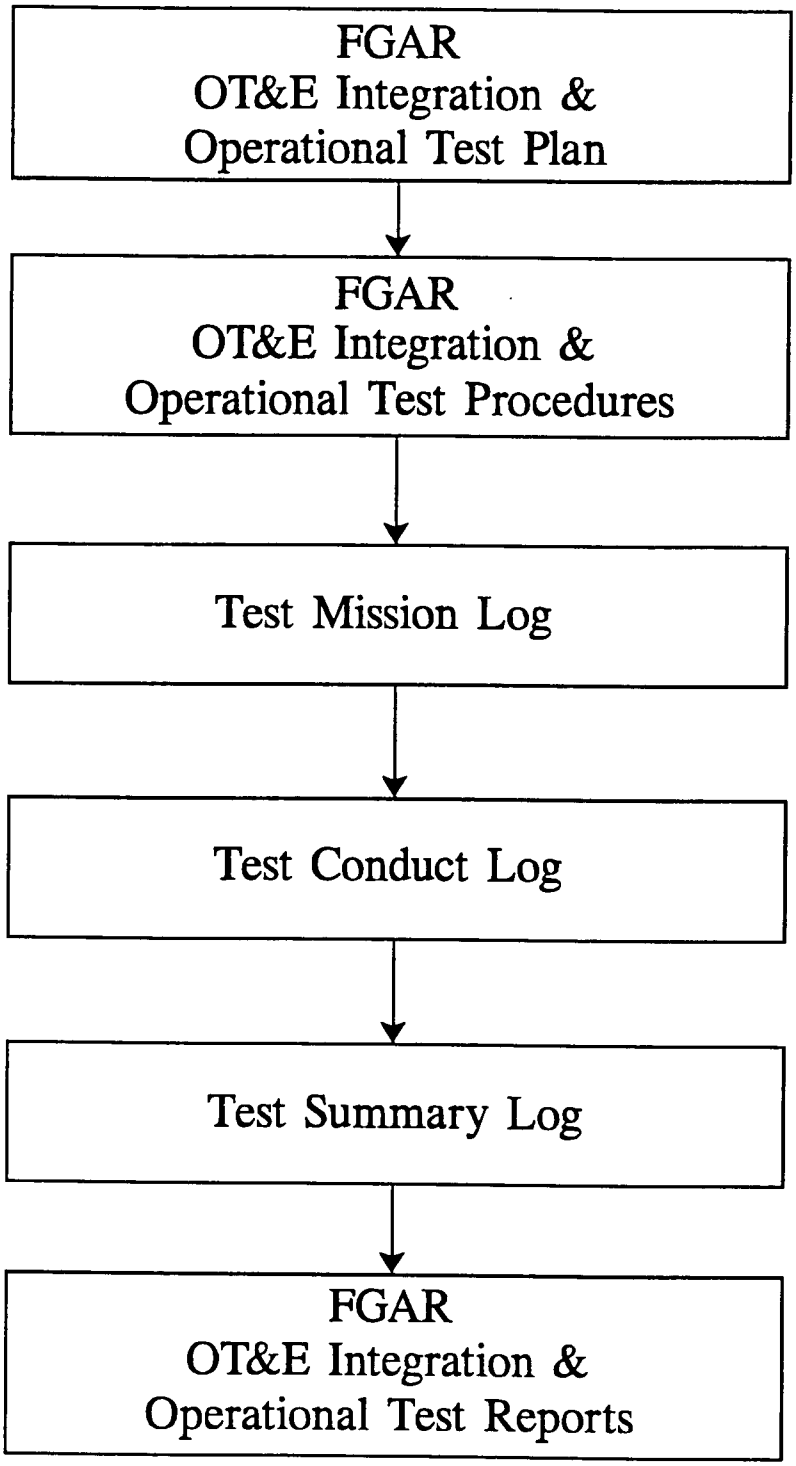


FIGURE 5.7-1 TEST DOCUMENT AND REPORT FLOW

TABLE 5.7-1 TEST REPORT MATRIX

Report	Required Completion
Test Mission Log	Pretest review
Test Conduct Log	During the test
Test Summary Log	Post-test review
Test Anomaly/Deficiency Report	During test and/or Post-test review
OT&E Integration and Operational Test Reports:	
1. Quick Look Report	Fifteen calendar days after completion of OT&E Integration & Operational testing, for each type of FGAR tested.
2. Preliminary OT&E Integration and Operational Test Report	Thirty calendar days after the Quick Look Report is submitted, for each type of FGAR tested.
3. Final OT&E Integration and Operational Test Report	Thirty calendar days after Preliminary OT&E Integration and Operational Test Report is submitted, for each type of FGAR tested.

5.7.1 Test Mission Log.

The Test Mission Log is completed by the TD during the pretest review meeting. The log will contain any open items, e.g., deviations from the test procedures, required regression testing, etc.; test objectives; hardware configuration(s); and a list of the test team members and their assignments.

5.7.2 Test Conduct Log.

The test team members complete the Test Conduct Log during the test. The log contains a record specific events, measurements, etc., problems encountered, anomalies, etc.

5.7.3 Test Summary Log.

The TD completes the Test Summary Log during the post-test review. The log is used to record any deviations from the test procedures noted in either the Test Mission Log or Test Conduct Log. In addition, it contains a summary of the test conduct and a preliminary assessment of the results.

5.7.4 Test Reports.

The test reports trace the test results to relevant issues, and the integration and operational test requirements. The reports describe anomalous test results, highlight any outstanding or unresolved problems, and identify options for their resolution. There are three test reports.

a. Quick Look Report

b. Preliminary OT&E Integration and Operational Test Report

c. Final OT&E Integration and Operational Test Report

5.8 TEST ANOMALY/DEFICIENCY REPORTS.

Test Anomaly/Deficiency Reports are prepared, if required, by the TD during the test and at the post-test reviews. These reports document any analogies or deficiencies encountered during the conduct of a test. They describe in detail problems, failures, etc., encountered during the test. The reports are the basis for further investigation and the preparation of an FGAR Trouble Report (TR), if required.

5.9 TEST SCHEDULE.

The FGAR OT&E test schedule flows from the FGAR contract and TEMP requirements. The integration and operational testing time frames are based on the project delivery and acceptance dates. The schedule is shown in figure 5.9-1.

5.9.1 Planning Considerations and Limitations.

In the event there is excessive slippage in the FGAR delivery schedule, installation and testing at the Trinidad En Route Radar Facility (TAD) may not be possible due to weather conditions. In this event an alternate site will be selected, based upon availability, weather conditions, etc.

5.9.2 Regression Testing.

In the event all or portions of a test fail, the TD with the aid of the test team members will determine which, if any, other tests must be repeated after correction of the problem(s) causing the test failure.

5.10 PERSONNEL RESOURCE REQUIREMENTS.

The personnel required for each phase of the test are described below.

a. Elwood ERBTF

This phase of the testing will be supported by electrical/electronic engineers and technicians assigned to ACW-100 and the Elwood ERBTF.

b. Trinidad En Route Radar Facility (TAD)

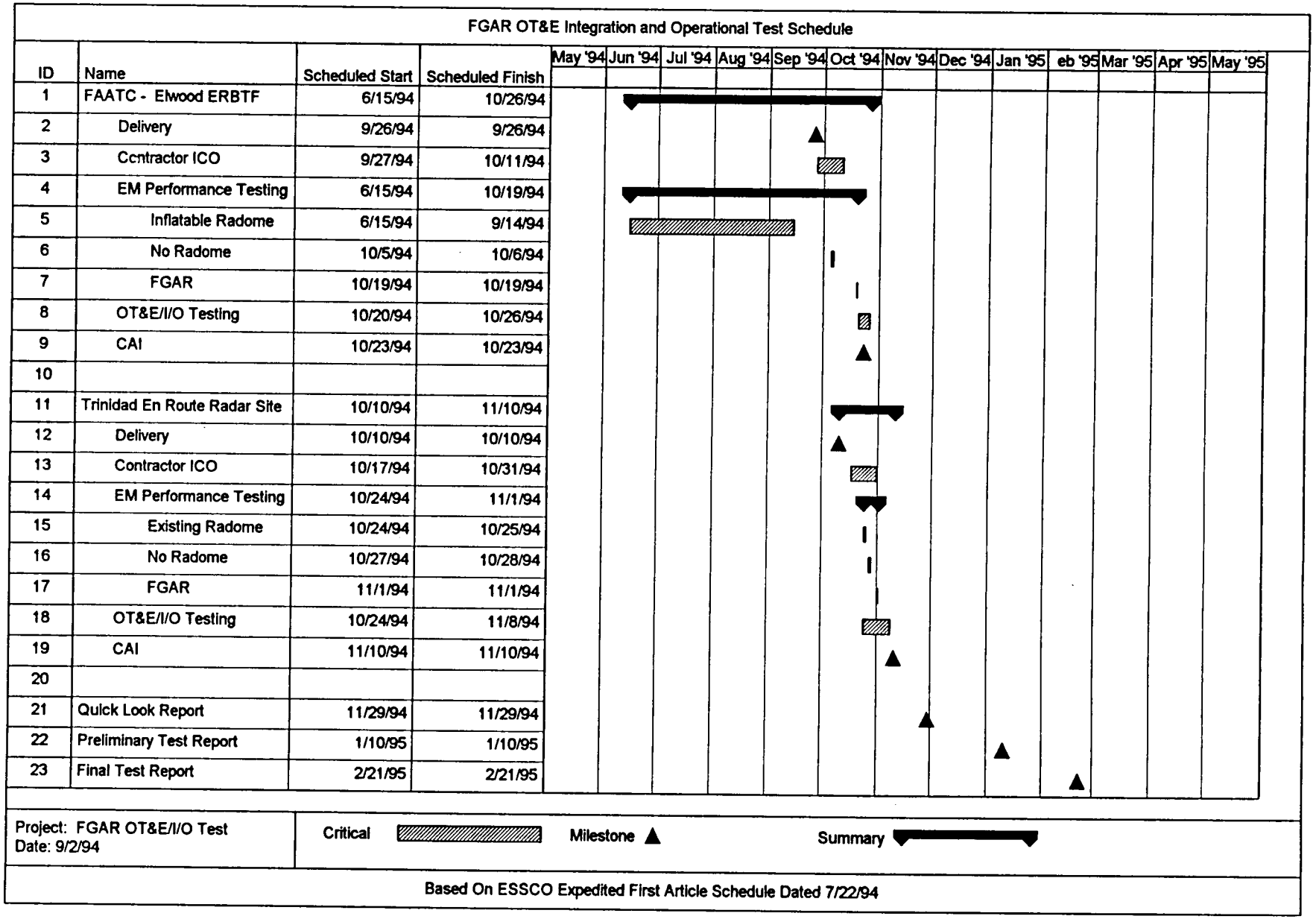
This phase will be supported by:

1. ACW-100 electronic engineers.

2. ANW-464 electronic engineers.

3. Albuquerque ARTCC (ZAB) ATCSs.

4. Albuquerque ARTCC (ZAB) AFS SPSs and computer operators.
5. Denver ARTCC (ZDV) ATCSs.
6. Denver ARTCC (ZDV) AFS SPSs and computer operators.



ID	Name	Scheduled Start	Scheduled Finish
1	FAATC - Elwood ERBTF	6/15/94	10/26/94
2	Delivery	9/26/94	9/26/94
3	Contractor ICO	9/27/94	10/11/94
4	EM Performance Testing	6/15/94	10/19/94
5	Inflatable Radome	6/15/94	9/14/94
6	No Radome	10/5/94	10/6/94
7	FGAR	10/19/94	10/19/94
8	OT&E/I/O Testing	10/20/94	10/26/94
9	CAI	10/23/94	10/23/94
10			
11	Trinidad En Route Radar Site	10/10/94	11/10/94
12	Delivery	10/10/94	10/10/94
13	Contractor ICO	10/17/94	10/31/94
14	EM Performance Testing	10/24/94	11/1/94
15	Existing Radome	10/24/94	10/25/94
16	No Radome	10/27/94	10/28/94
17	FGAR	11/1/94	11/1/94
18	OT&E/I/O Testing	10/24/94	11/8/94
19	CAI	11/10/94	11/10/94
20			
21	Quick Look Report	11/29/94	11/29/94
22	Preliminary Test Report	1/10/95	1/10/95
23	Final Test Report	2/21/95	2/21/95

FIGURE 5.9-1 FGAR OT&E INTEGRATION AND OPERATIONAL TEST SCHEDULE

6. ACRONYMS.

AC	Alternating Current
ACP	Azimuth Change Pulse (QARS program)
AF	Airway Facilities
AFS	Airway Facilities Sector
ALT	Altitude (QARS program)
AN/FPS	Army-Navy/Fixed Ground Radar Search (military designation)
AN/UPX	Army-Navy/General Utility Radar Identification and Recognition (military designation)
AOL	Aircraft Obstruction Lights
APME	Associate Program Manager for Engineering
APMT	Associate Program Manager for Test
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASPLT	Azimuth Split (QARS program)
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon System
ATCS	Air Traffic Control Specialist
AZ	Azimuth (QARS program)
BCN	Beacon (QARS program)
BOS	Beacon Only Site
C	Critical
CAI	Contract Acceptance Inspection
CB	Circuit Breaker
CD	Common Digitizer
COI	Critical Operational Issues
COLL	Collimation (QARS program)
CO	Colorado
CPME	Calibration Performance and Monitoring Equipment
CW	Radomes (military designation)
dB	Decibel

DC	Direct Current
DEV	Deviation (QARS program)
DOD	Department of Defense
DOS	Disk Operating System (abbreviated from MS-DOS - Microsoft Disk Operating System)
DQT	Design Qualification Test
DR	Data Reduction
DR&A	Data Reduction and Analysis
DT&E	Design Test and Evaluation
DVM	Digital Voltmeter
EM	Electromagnetic
ERBTF	En Route Beacon Test Facility
ERMS	Environmental Remote Monitoring Subsystem
ESSCO	Electronic Space Systems Corporation (company name)
FAA	Federal Aviation Administration
FGAR	Fixed Ground Antenna Radome
FS	Field Site
GPS	Global Positioning System
HOST	Air Traffic Control HOST Computer (not an acronym)
I	Integration
ICO	Installation and Checkout
LCN	Location
M3REL	Mode 3/A Reliability (QARS program)
M3VAL	Mode 3/A Validity (QARS program)
MAOR	Minimum Acceptable Operational Requirements
MARDE	Mode S Analysis Recording Display Equipment
MCREL	Mode C Reliability (QARS program)
MCVAL	Mode C Validity (QARS program)
Mode S	Mode Select Beacon System
MOE	Measures Of Effectiveness
MOS	Measurers Of Suitability
MPH	Miles Per Hour

MTI	Moving Target Indicator (QARS program)
NAS	National Airspace System
NC	Noncritical
NE	Nebraska
NJ	New Jersey
NM	New Mexico
NML	Normal (QARS program)
NO.	Number
O	Operational
OR	Oregon
ORG	Organization
OT&E/I/O	Operational Test and Evaluation Integration and Operational
OT&E	Operational Test and Evaluation
PE	Permanent Echo (QARS program)
PIP	Project Implementation Plan
PM	Program Manager
PSF	Program Support Facility
QARS	Quick Analysis of Radar Sites (computer program)
RAR	Ring-A-Round (QARS program)
REF	Reference
REF	Reflection (QARS program)
RF	Radio Frequency
RFIM	Radio Frequency Interference Monitoring
RMMS	Remote Maintenance Monitoring System
RMS	Root Mean Square
RPM	Revolutions Per Minute
R/R	Radar Reinforced (QARS program)
RSPLT	Range Split (QARS program)
RTADS	Real-Time Analysis Display System
SAIL	Spectrum Analysis and Interference Locator
SAT	Site Acceptance Test

SCH	Combined Moving Target Indicator and Normal Video (QARS program)
SCM	System Configuration Management
SEA	Seattle En Route Radar Facility (identifier)
SOW	Statement of Work
SPS	Systems Performance Specialist
T&E	Test and Evaluation
TAD	Trinidad En Route Radar Facility (identifier)
TB	Terminal Board
TD	Test Director
TDR	TRACS Data Reduction
TEMP	Test and Evaluation Master Plan
TR	Trouble Report
TRACS	Transportable Radar Analysis Computer System
TVRTM	Test Verification Requirements Traceability Matrix
UNIX	Computer Operating System (not an acronym)
V	Volts
VERIF	Verification
WA	Washington
ZER	Code Zero Percentage (QARS program)
ZAB	Albuquerque Air Route Traffic Control Center (identifier)
ZDV	Denver Air Route Traffic Control Center (identifier)

APPENDIX A

TEST DESCRIPTIONS

TEST DESCRIPTIONS

1. TEST TITLE.

EPEL-1 Elwood Primary Radar (ARSR) Electromagnetic Performance Tests (3.2.1.1 and 4.1.2.1.7)

1.1 TEST OBJECTIVES.

The objective is to collect primary radar (ARSR) electromagnetic performance data with the presently installed inflatable radome, without a radome, and with the FGAR installed. The data will be analyzed and compared to verify the FGAR does not degrade the performance of the primary radar (ARSR) system.

1.2 TEST CRITERIA.

The primary radar (ARSR) antenna electromagnetic patterns are not degraded by the installation of the FGAR. The performance characteristics are those described in the Radar Analysis program (see appendix B).

1.3 TEST APPROACH.

Primary radar (ARSR) electromagnetic performance data will be collected at the output of the CD-2, analyzed and compared using the Radar Analysis program to measure radar reinforced targets (see appendix B).

The data will be collected with the FGAR, both wet and dry. In the event there are no rain showers during the testing period, the radome will be wet down using an Atlantic City International Airport Fire Department pumper truck.

Tests EPEL-1A, -1B, -1C and will be accomplished by testing.

1.4 TEST CONDUCT.

The test will be divided into three phases, with the same measurements made during each phase.

a. EPEL-1A Before removal of the inflatable radome.

b. EPEL-1B After the inflatable radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

c. EPEL-1C After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

Upon completion of testing, ACW-100 engineers will analyze the data and prepare a report of the results.

1.5 EXECUTION TIME.

Phase 1, will take approximately 2 weeks. Phase 2, will take 2 days. Phase 3, will take approximately 2 weeks.

2. TEST TITLE.

EPEL-2 Elwood Mode S Electromagnetic Performance Tests (3.2.1.1 and 4.1.2.1.7)

2.1 TEST OBJECTIVES.

The objective is to collect Mode S data, using the system Calibration Performance Monitoring Equipments (CPME) and the output of the CD-2, with the inflatable radome installed, without a radome, and with the FGAR installed. The data will be analyzed and compared to verify the FGAR does not degrade the performance of the Mode S system.

2.2 TEST CRITERIA.

The Mode S antenna electromagnetic patterns are not degraded by the installation of the FGAR. The performance characteristics are those described in the analysis programs listed in appendix B.

2.3 TEST APPROACH.

Mode S electromagnetic performance data will be collected at the output of the Mode S Data Extraction Port, analyzed and compared using the Beacon False Target Summary, Mode S List, Mode S Extraction Plot, Monopulse Analysis, Nine Point, Surveillance Analysis, Surveillance File Analysis, Surveillance Plot, and Surveillance Print programs (see appendix B) to measure:

a. Beacon false targets.

b. Distribution of monopulse values.

c. Range and azimuth accuracy of fixed targets.

d. Beacon and search performance parameters.

The data will be collected with the FGAR, both wet and dry. In the event there are no rain showers during the testing period, the radome will be wet down using an Atlantic City International Airport Fire Department pumper truck.

Tests EPEL-2A, -2B, and -2C will be accomplished by testing.

2.4 TEST CONDUCT.

The test will be divided into three phases, with the same measurements made during each phase.

a. EPEL-2A Before removal of the inflatable radome.

b. EPEL-2B After the inflatable radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

c. EPEL-2C After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

Upon completion of testing, ACW-100 engineers will analyze the data and prepare a report of the results.

2.5 EXECUTION TIME.

Phase 1, will take approximately 2 weeks. Phase 2, will take 2 days. Phase 3, will take approximately 2 weeks.

3. TEST TITLE.

EPTD-1 Trinidad Primary Radar (ARSR) Electromagnetic Performance Tests (3.2.1.1, 3.2.1.1.1, 3.2.1.1.2, 3.2.1.1.5, and 4.1.2.1.7)

3.1 TEST OBJECTIVES.

The objective is to collect primary radar (ARSR) electromagnetic performance data for the following parameters:

a. Main beam width

b. Boresight error

c. Sidelobe level error

The Northwest Mountain Region's SAIL van will be used to make the measurements. The measurements will be made with the existing radome installed, without a radome, and with the FGAR installed. The data will be analyzed and compared to verify the FGAR does not degrade the performance of the primary radar (ARSR) system.

3.2 TEST CRITERIA.

The difference(s) measured between the primary radar (ARSR) electromagnetic performance parameters, without a radome installed and with the FGAR installed, if any, do not exceed the following.

a. Maximum main beam width change of ±0.05°.

b. Boresight error of 0.0085° RMS and 0.0255° maximum, in either the elevation or azimuth plane.

c. Sidelobe level error change of ±1 dB, using a sidelobe that is -25 dB from the main lobe of reference, for all frontal and back side lobes.

3.3 TEST APPROACH.

The primary radar (ARSR) electromagnetic performance parameters will be measured, using the SAIL van and ANM-464 engineers. The measurements will be made from at least three points, located approximately 120° apart, around the antenna tower.

The primary radar (ARSR) solar-based antenna pattern measurements will be made, using the SAIL van and ANM-464 engineers. Both horizontal and vertical antenna pattern measurements will be made.

The ANM-464 engineers will analyze the data collected. They will prepare a report, including any data sheets, strip charts, etc., produced during the test.

Tests EPTD-1A, -1B, -1C, -1D, and 1E will be accomplished by testing.

3.4 TEST CONDUCT.

The test will be divided into three phases.

a. Electromagnetic Performance Tests

1. EPTD-1A Before removal of the existing radome.

2. EPTD-1B After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

3. EPTD-1C After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

The locations from which the SAIL van will make the measurements will be clearly marked on the ground and/or located by use of a Global Positioning System (GPS) receiver, so that the van can be located in exactly the same location every time. The selection of the locations for making the measurements will be made by ANM-464 engineers.

The measurements will be made, during each test, from at least three points located approximately 120° apart, around the tower. Upon completion of each phase the ANM-464 engineers will analyze the resulting data and upon completion of all three phases will compare the data to determine if the FGAR is degrading the electromagnetic performance of the primary radar (ARSR) pattern.

b. Solar-Based Antenna Pattern Measurement Tests

The solar-based antenna pattern measurement tests will not be performed on the existing radome.

1. EPTD-1D After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

2. EPTD-1E After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

The SAIL van will be located at one of the three previously used measurement sites, for making the solar-based antenna pattern measurements. The location of the site will be determined by use of the previously installed marker and/or use of the GPS receiver. The selection of the location will be made by the ANM-464 engineers.

Upon completion of each phase the ANM-464 engineers will analyze the resulting data and upon completion of the testing will compare the data to determine if the FGAR is degrading the electromagnetic performance of the primary radar (ARSR) pattern and prepare a report.

3.5 EXECUTION TIME.

Phase 1, will take approximately 3 days. Phase 2, will take 2 days. Phase 3, will take 1 day.

4. TEST TITLE.

EPTD-2 Trinidad Air Traffic Control Radar Beacon System (ATCRBS)/Mode S Electromagnetic Performance Tests (3.2.1.1, 3.2.1.1.1, 3.2.1.1.2, 3.2.1.1.5, and 4.1.2.1.7)

4.1 TEST OBJECTIVES.

The objective is to collect secondary radar (ATCRBS/Mode S) electromagnetic performance data for the following parameters:

a. Main beam width

b. Boresight error

c. Sidelobe level error

The Northwest Mountain Regions SAIL van will be used to make the measurements. The measurements will be made with the existing radome installed, without a radome, and with the FGAR installed. The data will be analyzed and compared to verify the FGAR does not degrade the performance of the secondary radar (ATCRBS/Mode S).

4.2 TEST CRITERIA.

The difference(s) measured between the secondary radar (ATCRBS/Mode S) electromagnetic performance parameters, without a radome installed and with the FGAR installed, if any, do not exceed the following:

a. Maximum main beam width change of ±0.05°.

b. Boresight error of 0.0085° RMS and 0.0255° maximum, in either the elevation or azimuth plane.

c. Sidelobe level error change of ±1 dB, using a sidelobe that is -25 dB from the main lobe of reference, for all frontal and back side lobes.

4.3 TEST APPROACH.

The secondary radar (ATCRBS/Mode S) electromagnetic performance parameters will be measured, using the SAIL van and ANM-464 engineers. The measurements will be made from at least three points, located approximately 120° apart, around the antenna tower.

The secondary radar (ATCRBS/Mode S) solar-based antenna pattern measurements will be made, using the SAIL van and ANM-464 engineers. Both horizontal and vertical antenna pattern measurements will be made.

The ANM-464 engineers will analyze the data collected. They will prepare a report, including any data sheets, strip charts, etc., produced during the test.

Tests EPTD-2A, -2B, -2C, -2D, and -2E will be accomplished by testing.

4.4 TEST CONDUCT.

The test will be divided into three phases.

a. Electromagnetic Performance Tests

1. EPTD-2A Before removal of the existing radome.

2. EPTD-2B After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

3. EPTD-2C After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

The locations from which the SAIL van will make the measurements will be clearly marked on the ground and/or located by use of a GPS receiver, so that the van can be located in exactly the same location every time. The selection of the locations for making the measurements will be made by ANM-464 engineers.

The measurements will be made, during each test, from at least three points located approximately 120° apart, around the tower. Upon completion of each phase the ANM-464 engineers will analyze the resulting data and upon completion of all three phases will compare the data to determine if the FGAR is degrading the electromagnetic performance of the secondary radar (ATCRBS/Mode S) pattern.

b. Solar-Based Antenna Pattern Measurement Tests

1. EPTD-1D After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

2. EPTD-1E After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

The SAIL van will be located at one of the three previously used measurement sites, for making the solar-based antenna pattern measurements. The location of the site will be determined by use of the previously installed marker and/or use of the GPS receiver. The selection of the location will be made by the ANM-464 engineers.

Upon completion of each phase the ANM-464 engineers will analyze the resulting data and upon completion of the testing will compare the data to determine if the FGAR is degrading the electromagnetic performance of the secondary radar (ATCRBS/Mode S) pattern and prepare a report.

4.5 EXECUTION TIME.

Phase 1, will take approximately 3 days. Phase 2, will take 2 days. Phase 3, will take 1 day.

5. TEST TITLE.

EPAB-1/2/3 Albuquerque ARTCC (ZAB) Quick Analysis of Radar Sites (QARS) Program Test (3.2.1.1 and 4.1.2.1.7)

5.1 TEST OBJECTIVES.

The objective is to determine if there is any difference(s) in the performance characteristics of the primary (ARSR) and secondary (ATCRBS/Mode S) radar data, being received by the ARTCC after the FGAR is installed.

5.2 TEST CRITERIA.

The performance characteristics of the primary (ARSR) and secondary (ATCRBS/Mode S) radar data being received by the ARTCC is not degraded by the FGAR. The performance characteristics are those described for the QARS program (see appendix B).

5.3 TEST APPROACH.

The Albuquerque ARTCC (ZAB) will run the QARS program on the HOST computer system using primary (ARSR) and secondary (ATCRBS/Mode S) data from the Trinidad En Route Radar Facility (TAD). The ARTCCs AF SPS's will analyze the data and provide a report of the results.

Tests EPAB-1, -2, and -3 will be accomplished by testing.

5.4 TEST CONDUCT.

The test will be divided into three phases.

a. EPAB-1 - Before removal of the existing radome.

b. EPAB-2 - After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

c. EPAB-3 - After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

During all three phases the HOST computer operators will run the QARS program using the Trinidad En Route Radar Facility (TAD) primary (ARSR) and secondary (ATCRBS/Mode S) radar data and provide a printout of the results to the AF SPSs. The AF SPSs will analyze the data and prepare a report.

5.5 EXECUTION TIME.

The test will take approximately 2 hours each time the test is run.

6. TEST TITLE.

EPDV-1/2/3 Denver ARTCC (ZDV) Quick Analysis of Radar Sites (QARS) Program Test (3.2.1.1 and 4.1.2.1.7)

6.1 TEST OBJECTIVES.

The objective is to determine if there is any difference(s) in the performance characteristics of the primary (ARSR) and secondary (ATCRBS/Mode S) radar data, being received by the ARTCC after the FGAR is installed.

6.2 TEST CRITERIA.

The performance characteristics of the primary (ARSR) and secondary (ATCRBS/Mode S) radar data being received by the ARTCC is not degraded by the FGAR. The performance characteristics are those described for the QARS program (see appendix B).

6.3 TEST APPROACH.

The Denver ARTCC (ZDV) will run the QARS program on the HOST computer system using primary (ARSR) and secondary (ATCRBS/Mode S) data from the Trinidad En Route Radar Facility (TAD). The ARTCCs AF SPS's will analyze the data and provide a report of the results.

Tests EPDV-1, -2, and -3 will be accomplished by testing.

6.4 TEST CONDUCT.

The test will be divided into three phases.

a. EPDV-1 - Before removal of the existing radome.

b. EPDV-2 - After the existing radome is removed and the contractor has removed any scaffolding, cranes, etc., required for its removal.

c. EPDV-3 - After installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation.

During all three phases the HOST computer operators will run the QARS program using the Trinidad En Route Radar Facility primary (ARSR) and secondary (ATCRBS/Mode S) radar data and provide a printout of the results to the AF SPSs. The AF SPSs will analyze the data and prepare a report.

6.5 EXECUTION TIME.

The test will take approximately 2 hours each time the test is run.

7. TEST TITLE.

ATAB-1 Albuquerque ARTCC (ZAB) Air Traffic Control Specialists (ATCS) Evaluation Test

7.1 TEST OBJECTIVES.

The objective is to determine if there is any difference(s) in the primary (ARSR) and secondary (ATCRBS/Mode S) videos presented to the ATCSs, e.g., apparent strength of targets, loss of targets, or other anomalies, with the FGAR installed as compared to the existing radome.

7.2 TEST CRITERIA.

The primary (ARSR) and secondary (ATCRBS/Mode S) videos strength appears the same to the ATCSs. The number of lost/coasting targets do not increase. There are no other apparent anomalies.

7.3 TEST APPROACH.

The Albuquerque ARTCC (ZAB) ATCSs will observe Trinidad En Route Radar Facility (TAD) primary (ARSR) and secondary (ATCRBS/Mode S) videos on their displays. They will visually compare the presentation, using targets of opportunity.

Test ATAB-1 will be accomplished by demonstration.

7.4 TEST CONDUCT.

The evaluation will be conducted after the installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation. The ATCSs will evaluate the target presentations on their displays and complete a questionnaire. The questionnaires will be forwarded to the TD for analysis.

7.5 EXECUTION TIME.

The test will take approximately 1 hour.

8. TEST TITLE.

ATDV-1 Denver ARTCC (ZDV) Air Traffic Control Specialists (ATCS) Evaluation Test

8.1 TEST OBJECTIVES.

The objective is to determine if there is any difference(s) in the primary (ARSR) and secondary (ATCRBS/Mode S) videos presented to the ATCSs, e.g., apparent strength of targets, loss of targets, or other anomalies, with the FGAR installed as compared to the existing radome.

8.2 TEST CRITERIA.

The primary (ARSR) and secondary (ATCRBS/Mode S) videos strength appears the same to the ATCSs. The number of lost/coasting targets do not increase. There are no other apparent anomalies.

8.3 TEST APPROACH.

The Denver ARTCC (ZDV) ATCSs will observe Trinidad En Route Radar Facility (TAD) primary (ARSR) and secondary (ATCRBS/Mode S) videos on their displays. They will visually compare the presentation, using targets of opportunity.

Test ATDV-1 will be accomplished by demonstration.

8.4 TEST CONDUCT.

The evaluation will be conducted after installation of the FGAR is complete and the contractor has removed any scaffolding, cranes, etc., required for its installation. The ATCSs will evaluate the target presentations on their displays and complete a questionnaire. The questionnaires will be forwarded to the TD for analysis.

8.5 EXECUTION TIME.

The test will take approximately 1 hour.

9. TEST TITLE.

PCNP Physical Characteristics - Nameplate and Labeling Tests (3.3.3)

9.1 TEST OBJECTIVES.

The objective is to verify assemblies, e.g., aircraft obstruction light (AOL) assembly, cables, circuit breakers (CB), etc., are correctly, permanently, and legibly labeled.

9.2 TEST CRITERIA.

Successful completion of the tests will be measured by the following criteria:

a. PCNP-1 Assemblies, e.g., AOL assembly, etc., have a nameplate with the equipment title, designation, and serial number (if applicable) displayed. The nameplate:

1. Information is recorded in a permanent, legible manner, which will be unaffected by weather, etc.

2. Is permanently affixed to the assembly.

3. Is visible, without having to disassemble or remove any parts, covers, etc.

b. PCNP-2 All cables, cable connectors, CBs, wires, terminal boards (TB), etc., are correctly, permanently, and legibly labeled with their appropriate designation, value, and/or other descriptive information, e.g., ON/OFF for switch positions, etc., as appropriate.

9.3 TEST APPROACH.

Tests PCNP-1 and -2 will be accomplished by inspection.

9.4 TEST CONDUCT.

The ARSR and Mode S/ATCRBS radars must be shutdown and the antennas stopped during the testing.

The testing will be conducted as follows:

a. PCNP-1 Assemblies, e.g., AOL assembly, etc., will be inspected to verify they have a nameplate with the equipment title, designation, and serial number (if applicable) displayed. The nameplate information:

1. Is recorded in a permanent, legible manner, which is unaffected by the weather, etc.

2. Is permanently affixed to the assembly.

3. Is visible, without having to disassemble or remove any parts, covers, etc.

b. PCNP-2 Cables, cable connectors, CBs, wires, terminal boards, etc., will be inspected to verify they are permanently and legibly labeled with their appropriate designation, value, and/or other descriptive information, e.g., ON/OFF for switch positions, etc., as appropriate.

9.5 EXECUTION TIME.

The test will take approximately 2 hours.

10. TEST TITLE.

HECT/HEET Human Engineering - Clothing Constraints/Electrical Tests (3.3.7)

10.1 TEST OBJECTIVES.

The objectives are to verify:

a. The configuration of the radome access hatches do not present a constraint to personnel in heavy winter clothing, when passing through the hatches.

b. Electrical equipment is designed and provided with safety features to prevent personnel injury.

10.2 TEST CRITERIA.

Successful completion of the tests will be measured by the following criteria:

a. Clothing Constraints

1. HECT-1 Zenith hatch assembly mounted equipment can be serviced, repaired, removed, and/or replaced by individuals wearing heavy winter clothing, e.g., parka, insulated suit, heavy winter gloves, etc.

2. HECT-2 An individual can pass through the catwalk access hatch in either direction with ease, while wearing heavy winter clothing.

3. HECT-3 Latches, handles, or devices used to open the zenith service and catwalk access hatches are designed to allow an individual wearing heavy winter gloves to operate them. The latches can be latched/unlatched from either the inside outside of the radome.

b. Electrical

1. HEET-1 All switches, CBs, terminal boards, etc., with 30 volts (V) alternating current (AC) RMS or direct current (DC) or greater present during normal operation have covers, shrink tubing, etc., to protect personnel from accidentally contacting current carrying parts.

2. HEET-2 Caution labels are affixed to doors, or other means of access to equipment with 30V AC RMS or DC or greater present during normal operation.

3. HEET-3 CB(s) are provided with a means of locking them in the open (de-energized) position.

10.3 TEST APPROACH.

The testing will be accomplished in the following manner:

a. Tests HECT-1, -2, and -3 by inspection and demonstration.

b. Tests HEET-1, -2, and -3 by inspection.

10.4 TEST CONDUCT.

The ARSR and Mode S/ATCRBS radars must be shutdown and the antennas stopped during the testing.

The testing will be conducted as follows:

a. Clothing Constraints

1. HECT-1 The zenith hatch assembly will be inspected to verify there is sufficient clearance available for an individual servicing, repairing, and/or removing equipment mounted on the zenith crown plate. An individual wearing heavy winter clothing, e.g., parka, insulated suit, heavy winter gloves, etc., will pass through the zenith service hatch, in both directions, several times.

2. HECT-2 The catwalk access hatch will be inspected to verify there is sufficient clearance available for an individual to pass through. An individual wearing heavy winter clothing, e.g., parka, insulated suit, heavy winter clothing, etc., will pass through the catwalk access hatch, in both directions, several times.

3. HECT-3 The zenith service hatch and catwalk access hatch latching handles will be inspected to verify there is sufficient room for any individual wearing heavy winter gloves to latch/unlatch the hatches. An individual wearing heavy winter gloves will latch/unlatch the hatches from inside the radome and from the antenna tower catwalk.

b. Electrical

1. HEET-1 All switches, CBs, terminal boards, etc., with 30V AC RMS or DC or greater present during normal operation, will be inspected to verify they have covers, shrink tubing, etc., to protect personnel from accidentally contacting current carrying parts.

2. HEET-2 Electrical cabinets, boxes, etc., with 30V AC RMS or DC or greater present during normal operation, will be inspected to verify CAUTION labels are affixed to doors or other means of access.

3. HEET-3 The CB(s) will be inspected to verify they are provided with a means of locking them in the open (de-energized) position.

10.5 EXECUTION TIME.

The tests will take approximately 4 hours.

11. TEST TITLE.

PPTP Physical Performance - Transient Protection (3.2.1.2.11)

11.1 TEST OBJECTIVES.

The objectives are to verify:

a. The RMMS zenith and catwalk access hatch cable, AOL power cable, and RMMS AOL Monitor unit are protected against induced electrical transients entering the facility systems.

b. The RMMS AOL Monitor unit is not triggered by induced electrical transients.

11.2 TEST CRITERIA.

Successful completion of the tests will be measured by the following criteria:

a. PPTP-1 There are no induced electrical transients present on the zenith and catwalk access hatch cable when measured at the output of the RMMS AOL Monitor unit.

b. PPTP-2 There are no induced electrical transients on the AOL power cable when measured at the input to the RMMS AOL Monitor unit.

c. PPTP-3 There are no induced electrical transients in the output of the AOL Adjustable Linear Current Sensor when measured at the output of the RMMS AOL Monitor unit.

d. PPTP-4 The RMMS AOL Monitor unit is not triggered by induced electrical transients.

11.3 TEST APPROACH.

Tests PPTP-1, -2, -3, and -4 will be accomplished by testing.

11.4 TEST CONDUCT.

The ARSR and Mode S/ATCRBS must be operating normally and the antenna rotating during the testing.

The testing will be conducted as follows:

a. PPTP-1 The zenith and catwalk access cable will be monitored for induced electrical transients, at TB4, RMMS AOL Monitor unit. An oscilloscope and/or spectrum analyzer will be used to monitor the cable.

b. PPTP-2 The AOL power cable will be monitored for induced electrical transients, at TB1, RMMS AOL Monitor unit. An oscilloscope and/or spectrum analyzer will be used to monitor the cable.

c. PPTP-3 The output of the AOL Adjustable Linear Current Sensor will be monitored for induced electrical transients, at TB4, RMMS AOL Monitor unit. An oscilloscope and/or spectrum analyzer will be used to monitor the output lines.

d. PPTP-4 The output of the AOL Adjustable Linear Current Sensor will be monitored, at TB4, RMMS AOL Monitor unit, with a digital voltmeter (DVM) to verify it is not being triggered by induced electrical transients.

11.5 EXECUTION TIME.

The test will take approximately 2 hours.

12. LIST OF TEST TITLES.

ATAB-1	Albuquerque ARTCC (ZAB) Air Traffic Control Specialists (ATCS) Evaluation Test
ATDV-1	Denver ARTCC (ZDV) Air Traffic Control Specialists (ATCS) Evaluation Test
EPAB-1/2/3	Albuquerque ARTCC (ZAB) Quick Analysis of Radar Sites (QARS) Program Test
EPDV-1/2/3	Denver ARTCC (ZDV) Quick Analysis of Radar Sites (QARS) Program Test
EPEL-1	Elwood Primary Radar (ARSR) Electromagnetic Performance Tests
EPEL-2	Elwood Mode S Electromagnetic Performance Tests
EPTD-1	Trinidad Primary Radar (ARSR) Electromagnetic Performance Tests
EPTD-2	Trinidad Air Traffic Control Radar Beacon System (ATCRBS)/Mode S Electromagnetic Performance Tests
HECT-1/2/3	Human Engineering - Clothing Constraints Tests
HEET-1/2/3	Human Engineering - Electrical Tests
PCNP-1/2	Physical Characteristics - Nameplate and Labeling Tests
PPTP-1/2/3/4	Physical Performance - Transient Protection

APPENDIX B

DATA ANALYSIS PROGRAMS

DATA ANALYSIS PROGRAMS

The programs that will be used to analyze the electromagnetic performance of the primary and secondary radars are described below.

1. Beacon False Target Summary - Analyzes false beacon targets in azimuth, i.e., target splits, ring around, and uplink and downlink reflections. The uplink reflections are used to calculate the location and orientation of the reflectors. Range versus azimuth, range versus altitude, and azimuth versus altitude plots are provided for the false targets. The program also provides a plot of the reflections.

2. Mode S List - Prints the replies, reports, surveillance files, and disseminated reports. All of the information is contained on one line.

3. Mode S Extraction Plot - Plots replies and reports from a Mode S extraction file.

4. Monopulse Analysis - Analyzes the distribution of monopulse values for a stationary target. Plots of monopulse versus antenna azimuth, azimuth error versus antenna azimuth, absolute value of azimuth error versus antenna azimuth, mean and standard deviation, the Mode S Sensor monopulse table, and scatter plots of the raw data points are provided.

5. Nine Point - Analyzes the range and azimuth accuracy of the target reports for a given target. The reference range and azimuth positions are determined using a nine point curve fit centered on the target report of interest.

6. Radar Analysis - Analyzes search performance on all tracks. Statistics are provided individually for each track and combined for all the tracks. A range versus azimuth plot is provided that contains track initiations, coasts, and drops.

7. Surveillance Analysis - Analyzes beacon and search performance for all beacon tracks. Statistics are provided individually for each track and combined into ATCRBS, Mode S, and total categories. Range versus azimuth, range versus altitude, and azimuth versus altitude plots are provided which contain track initiations, coasts, and drops.

8. Surveillance File Analysis - Analyzes the surveillance file and hence the tracking function of the Mode S Sensor. Statistics are provided individually for each track and combined into ATCRBS, Mode S, and total categories.

9. Surveillance Print - Prints the replies, reports, surveillance files, and disseminated reports, using several lines for each. This printout contains similar, but more detailed information than the Mode S List program.

10. Quick Analysis of Radar Sites (QARS) Program - The QARS programs is divided into two sections, (1) verification of the radar system interface, and (2) Radar Data Analysis Summary routine which analyzes the beacon tracks.

    a. Radar System Interface Verification

       The following applicable parameters are supplied:

       1. Site identification.

2. Beacon percentages.

   (a) Radar reinforced percentage

   (b) Mode 3/A validation percentage

   (c) Mode C validation percentage

   (d) Mode 2 validation percentage

3. Status summary - provides the status of the primary and secondary radars, and the CD.

b. Radar Data Analysis Summary

The following parameters are supplied:

1. Adapted radar site name.

2. Video - The receiver videos used for the CD input.

   (a) Beacon (BCN)

   (b) Moving Target Indicator (MTI)

   (c) Normal (NML)

   (d) Combined MTI and Normal video (SCH)

3. Scans -

   (a) Beacon - total number of antenna revolutions for the period of time the beacon return was tracked.

   (b) Surveillance - will vary according to a targets range and elevation.

4. Blip/Scan - The percentage ratio of the number of times a target was detected (BLIP) to the number of times a target could have been detected (SCAN).

5. Radar Reinforced (R/R) - Ratio of number of beacon messages with the reinforced bit set to the total number of beacon messages received.

6. Collimation (COLL) - The collimation percentage for NML and MTI video.

7. Beacon split -

   (a) Azimuth Split (ASPLT)

   (b) Range Split (RSPLT)

8. False Beacon (FALSE-BCN) -

   (a) Ring-a-round (RAR)

   (b) Reflections (REF)

   (c) Code zero percentage (ZER)

9. Code reliability -

   (a) Mode 3/A reliability percentage (M3REL)

   (b) Mode 3/A validity (M3VAL)

   (c) Mode C reliability percentage (MCREL)

   (d) Mode C validity (MCVAL)

10. Range - Beacon track start and stop histories.

11. Azimuth (AZ) - Beacon track start and stop histories.

12. Altitude (ALT) - Beacon track start and stop histories.

13. Deviation (DEV) - Mean difference of the predicted versus the actual position of a track.

14. Collimation Distribution - Variations of the closest surveillance return relative to the beacon return that was being tracked.

15. Permanent Echo (PE) Verification - Range of the adapted PE in whole and eighths of a mile, together with the mean error in whole and tenths of Azimuth Change Pulses (ACP).

16. The mean predicted versus actual position of all the tracks for the site.

APPENDIX C

TEST VERIFICATION REQUIREMENTS TRACEABILITY MATRIX (TVRTM)

FAA-2773b, Specification for Fixed Ground Antenna Radome (Mode S Compatible)	Test Level		Test Verif	Lcn & Method	C/NC	Support Org	OT&E/I/O Test(s)	TEMP Ref
Paragraph No.	I	O	FAATC	FS				
1) 3.2.1.1 Electrical Performance Requirements		X	X	X	C	ACW-100 ANM-464 ZAB ZDV AFS	ATAB ATDV EPAB EPDV EPEL EPTD	7.5
2) 3.2.1.1.1 Antenna Main Lobe Beam Width Error		X	X	X	C	ACW-100 ANM-464 AFS	EPEL EPTD	7.5
3) 3.2.1.1.2 Boresight Error		X	X	X	C	ACW-100 ANM-464 AFS	EPEL EPTD	7.5
4) 3.2.1.1.5 Sidelobe Level Error		X	X	X	C	ACW-100 ANM-464 AFS	EPEL EPTD	7.5
5) 3.2.1.2.11 Transient Protection		X	X	X	C	ACW-100 AFS	PPTP	7.6
5) 3.3.3 Nameplates or Product Markings		X	X	X	NC	ACW-100 AFS	PCNP	7.4
6) 3.3.7 Human Engineering		X	X	X	C	ACW-100 AFS	HECT HEET	7.4
7) 4.1.2.1.7 Electromagnetic Performance Test		X	X	X	C	ACW-100 ANW-464 ZAB ZDV AFS	ATAB ATDV EPAB EPDV EPEL EPTD	7.5

LEGEND:
- AFS Airway Facilities Sector
- C Critical
- NC Noncritical
- ZAB Albuquerque ARTCC
- ZDV Denver ARTCC