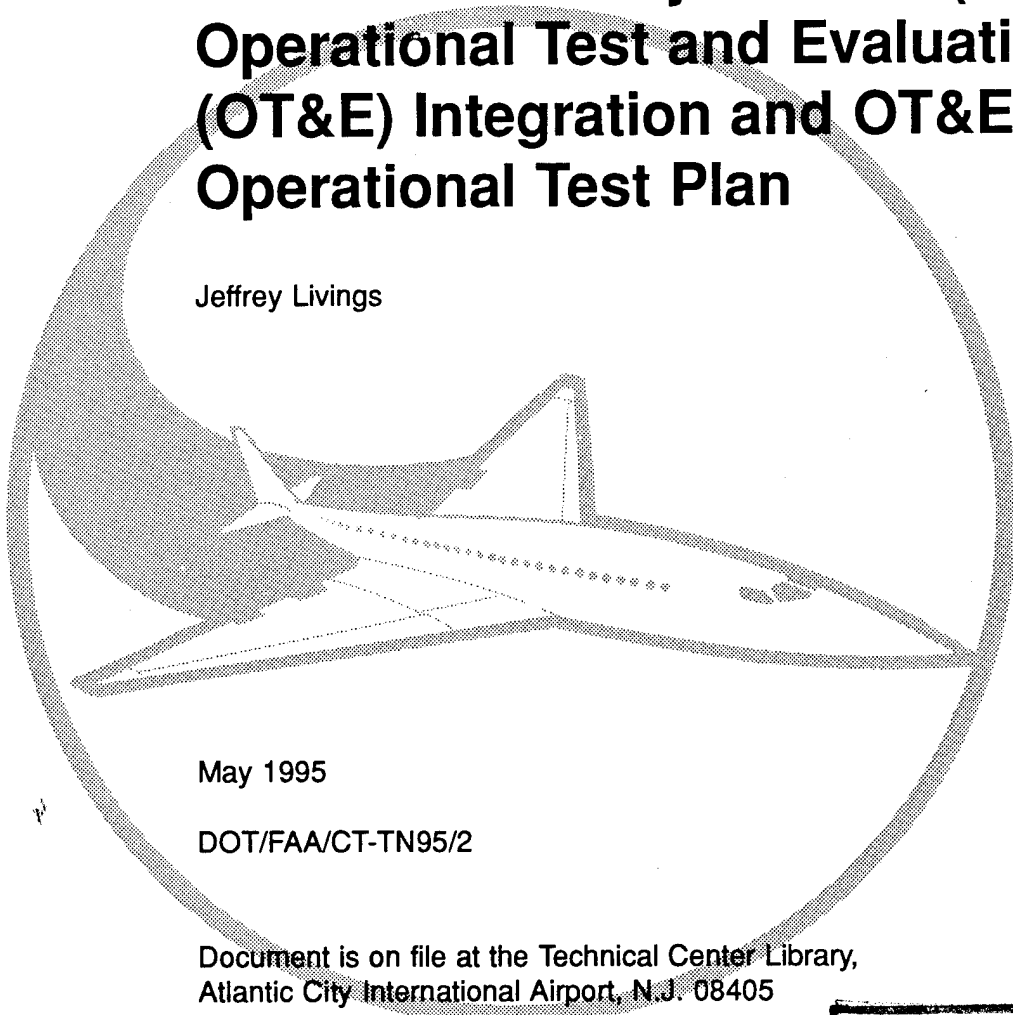


Technical note

Limited Production (LP) Precision Runway Monitor (PRM) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Plan

Jeffrey Livings



May 1995

DOT/FAA/CT-TN95/2

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16. Abstract <p>This document defines the Test Plan and corresponding Test Verification Requirements Traceability Matrix (TVRTM) that will be used to conduct the Limited Production (LP) Precision Runway Monitor (PRM) Operational Test and Evaluation (OT&E) Integration and OT&E Operational tests. These tests will be conducted at the Minneapolis-St. Paul International Airport following the Contractor Site Acceptance Test. The LP PRM OT&E test effort will concentrate on Operational Effectiveness and Operational Suitability.</p> <p>The Operational Effectiveness Test consists of a review of the contractor performed Development Test and Evaluation (DT&E) and Site Acceptance Tests. This review will evaluate whether each of the Measures of Effectiveness had been satisfactorily tested and whether the results meet the Minimum Acceptable Operational Requirements (MAORs). This review will be conducted solely by test engineers and does not require the PRM system.</p> <p>The Operational Suitability Tests will expose the test participants (Air Traffic (AT) Controllers and Airway Facilities (AF) Technicians) to the PRM system in an operational environment while they perform specified operational procedures. These tests will be conducted in two separate phases: AT Suitability and AF Suitability. Each of these phases is focused on the specific test participants.</p>					
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EXECUTIVE SUMMARY

The Limited Production (LP) Precision Runway Monitor (PRM) is designed to provide faster and more accurate surveillance of aircraft on instrument landing approaches. The system includes high resolution displays with specific blunder alarms to enable an air traffic controller to precisely monitor landing aircraft. The LP PRM is a procurement of five systems. The design of the LP PRM is based on the Upgrade PRM currently in operation at Raleigh-Durham International Airport in North Carolina.

This test plan establishes the framework to guide and direct the LP PRM Operational Test and Evaluation (OT&E) test program. Sufficient detail is provided in this document to define and direct the next lower level of test documentation and to allocate resources to the test program. Specific information is provided on the Critical Operational Issues (COI) to be addressed, the test concept, the evaluation approach, test descriptions, completion criteria, and support requirements.

1. INTRODUCTION.

1.1 BACKGROUND.

The Precision Runway Monitor (PRM) Program is part of the Federal Aviation Administration (FAA) approach to improve airport capacity. The implementation of the PRM system will achieve significant capacity gains at airports with closely spaced parallel runways. The use of the PRM will allow simultaneous, independent Instrument Flight Rules (IFR) approaches at these airports.

The Limited Production (LP) Precision Runway Monitor (PRM) is designed to provide faster and more accurate surveillance of aircraft on instrument landing approaches. The system uses a phased array, electronically scanned monopulse beacon radar to achieve target update rates of up to 1.0 second and a mean azimuth accuracy of 1.0 milliradian. The system includes high resolution displays with specific blunder alarms to enable a monitor controller to precisely monitor landing aircraft.

The LP PRM is a procurement of five systems from the Allied Signal Corporation. The design of the LP PRM is based on the Upgrade PRM currently in operation at Raleigh-Durham International Airport in North Carolina. The contract provides for full system requirement verification. That test effort will be fully monitored by the FAA Technical Center.

1.2 PURPOSE OF THE TEST PLAN.

The purpose of the LP PRM Operational Test and Evaluation (OT&E) Test Plan is to define the test approach and concept, required planning, and coordination necessary to fully test the LP PRM during the OT&E phase of testing.

This test plan establishes the framework to direct the LP PRM OT&E test program. Detail is provided in appendix A to define and direct the development of the LP PRM OT&E test procedures and to permit an allocation of resources to the test program. This test plan allocates responsibilities to the various organizations involved in the test effort.

This test program will ensure that the LP PRM meets the requirements as defined in the LP PRM Master Test Plan. Those requirements were developed from the Operational Requirements supplied by ATR-100. Additional requirements have been added to the test effort to ensure that the PRM/NAS system meets the suitability, effectiveness, maintainability, supportability, and security objectives as defined in FAA Order 1810.4B. The TVRTM in appendix B contains both the Master Test Plan Requirements and the additional OT&E requirements.

1.3 SCOPE OF THE TEST PLAN.

The scope of this test effort is strictly limited to the OT&E tests to be performed by ACW on the first article LP PRM system. Any subsequent PRM procurements will require their own OT&E Integration and OT&E Operational test efforts.

This test effort does not include demonstrations for commercial airlines or the pilot union community. This test effort is not intended to revalidate the concept of PRM monitored simultaneous approaches. This test program is concerned with determining whether the LP PRM system (including contractor provided training and documentation) is effective and suitable for inclusion into the National Airspace System (NAS).

2. REFERENCE DOCUMENTATION.

- a. Limited Production Precision Runway Monitor (PRM) Master Test Plan, November 1992, DOT/FAA/CT-TN92/23.

- b. Air Traffic Operational Requirements for a PRM System, 1991.
- c. Allied Sigal, Master Test Plan, A001-01-002.
- d. Allied Signal, Phase 1 Test Plan, A002-001-001.
- e. Allied Signal, Phase 2 Test Plan, B005-001-001.
- f. Electronic Scan Precision Runway Monitor (E-SCAN PRM), FAA-E-2887 Rev. A 5 November 1993.
- g. FAA NAS Test and Evaluation Policy, 10/22/92, FAA-ORDER-1810.4B.
- h. Content and Format Requirements for the Preparation of Test and Evaluation Documentation, FAA-STD-024B August 22, 1994.

3. SYSTEM DESCRIPTION.

3.1 SYSTEM OVERVIEW.

The LP PRM system is a monopulse secondary surveillance radar system that detects, acquires, tracks, and displays beacon-equipped air traffic within a predefined coverage area. Aircraft data is presented to air traffic controllers to assist in monitoring and maintaining the required separation of aircraft on approaches to closely spaced parallel runways. The LP PRM system is comprised of five main subsystems as listed below:

- a. Beacon Radar Subsystem (BRS)
- b. Radar Display Subsystem (RDS)
- c. Communication Subsystem (CS)
- d. Confidence and Performance Monitoring Subsystem (CPMS)
- e. Recording and Playback Subsystem (RPS)

The LP PRM equipment is located in two separate facilities; the Transmit/Receive (T/R) and Operations sites. The T/R site contains the BRS, CPMS, and portions of the CS. The Operations site contains RDS, CPMS, RPS, and portions of the CS. Figure 3.1-1 PRM System Block diagram shows a functional depiction of the PR system. The BRS provides beacon surveillance, acquisition, and tracking. The BRS interrogates aircraft transponders, processes the replies, establishes and updates system tracks, and transmits track data to the RDS. The BRS consists of an electronically scanned phased array antenna, connected through a control transfer switch to redundant channels. Each channel consists of an interrogator/receiver, a signal processor, a test target generator, a data processor, an executive monitor, and associated power supplies.

The RDS provides the display of the selected coverage area and map data, surveillance data, system status data, and system alert data. The RDS receives target track data from the BRS (via the CS); correlates the track data with ARTS data; presents past, current and predicted track data on high resolution color displays, and sends data to the RPS for recording. The RDS also generates and presents visual and aural blunder alerts. The RDS consists of up to four display consoles and associated processors as well as two ARTS interface units. In the normal operational configuration, one display console is located in the equipment room at the operations site and the remaining display consoles (one for each approach) are located in the Air Traffic Terminal Radar Approach Control (TRACON).

The CS provides both inter- and intrasite communications connecting all major subsystem together. The CS is a fully redundant ethernet local area network (LAN) with full error detection and automatic switching.

The CPMS provides for the monitoring of critical system performance parameters in the BRS, RDS, RPS, and CS as well as automatic BRS channel switching. A PRM Status Display (PSD) provides a keyboard interface to initiate CPMS maintenance monitoring including: BRS system testing, subsystem and environmental status monitoring, and fault detection and isolation. The CPMS consist of the Executive Monitors, two PSDs, and a speaker for alarm generation.

The RPS provides for the recording and playback of operational data. The RPS playback and listing functions allow operational data to be played back on the display consoles or printed onto paper. The RPS incorporates two redundant 9-track tape recorder/playback units and a printer.

The critical power is provided through Uninterruptable Power Supplies (UPS). The UPS conditions the power (removes line spikes, smoothes power fluctuations) and provides battery backup power when commercial and other backup power is not available.

The operational positions affected by the PRM are Air Traffic (AT) monitor controllers and Airways Facilities (AF) field technicians. The monitor controllers interface to the PRM system through the PRM display console. The field technicians interface with the PRM through the PSD and the PRM display consoles.

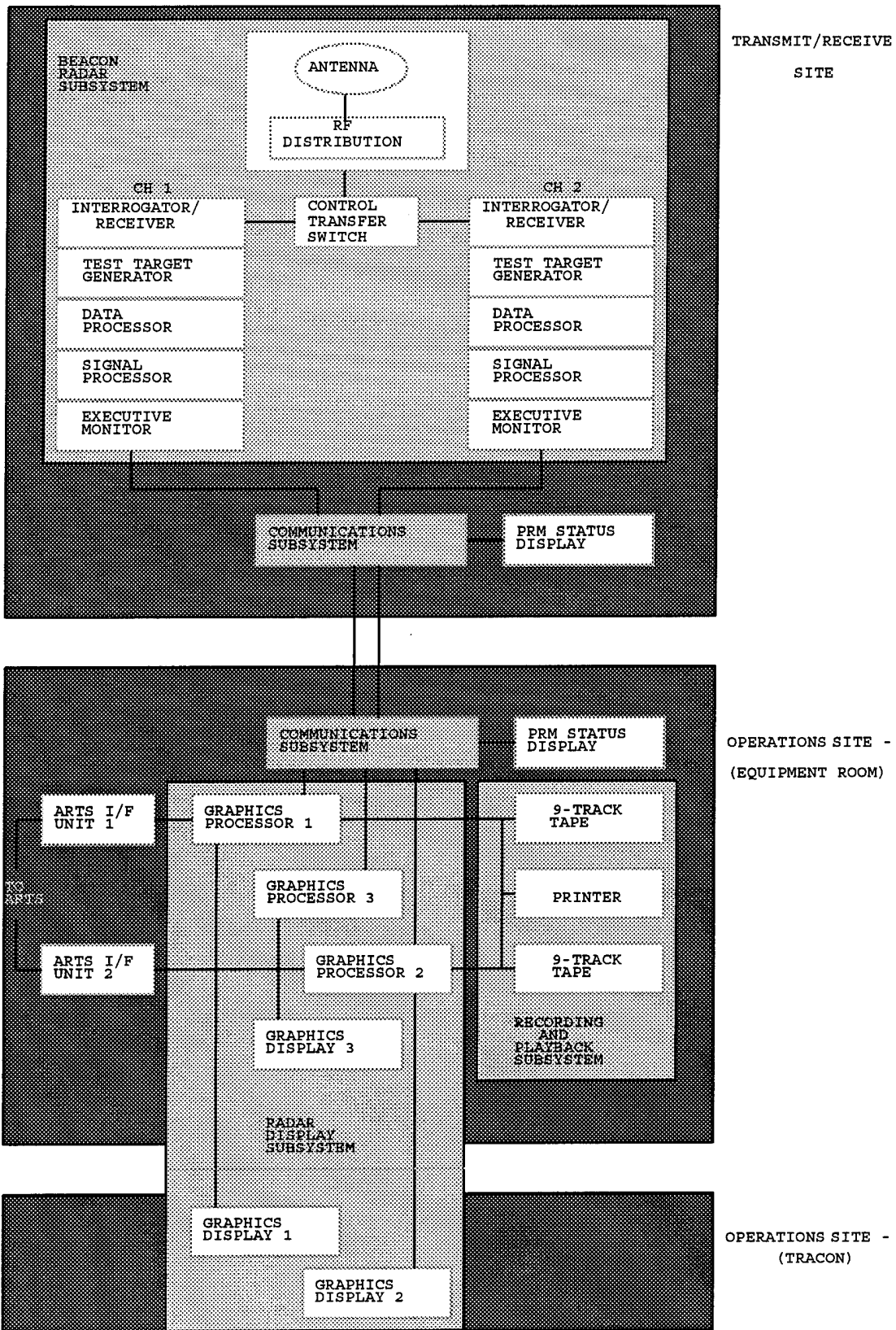


FIGURE 3.1-1. PRM SYSTEM BLOCK DIAGRAM

3.2 INTERFACES OVERVIEW.

The PRM system's only equipment interface consist of a passive, read-only interface with the ARTS system. Redundancy is achieved by connecting each of two PRM/ARTS interface units to separate Multiplexed Display Buffer Memory (MDBM) ports of the ARTS. The interface captures ARTS B and C words to correlate aircraft identification and type data to PRM tracks for display on the PRM display consoles.

4. TEST PROGRAM DESCRIPTION.

4.1 APPROACH AND CONCEPT.

The concept of the LP PRM OT&E test effort is to ensure that the PRM system complies with the Critical Operational Issues (COI) imposed by the LP PRM Master Test Plan.

The overall approach of the test effort is to separately evaluate the operational suitability and operational effectiveness of the PRM system for these COIs and for additional OT&E test components derived from FAA Order 1810.4B. Operational Effectiveness centers around the technical performance of the PRM System, while Operational Suitability centers on the usability of the PRM System.

Separate Measures of Suitability (MOS) and Measures of Effectiveness (MOE) have been developed for each COI. Likewise, each MOE has been further factored into Measures of Performance (MOP) and finally to Minimum Acceptable Operational Requirements (MAORs). These resultant MOS and MAORs are the critical success criteria that the PRM system must meet to successfully pass the OT&E evaluation. The COIs, along with their corresponding Measures and MAORs, are listed in table 4.1-1.

4.1.1 Evaluation Approach.

The approach for evaluating the Operational Effectiveness of the PRM is to conduct a review of the contractor performed Development Test and Evaluation (DT&E) and Site Acceptance Tests. This review will evaluate whether each of the MOEs had been satisfactorily tested and whether the results meet the MAORs.

The approach for evaluating the Operational Suitability of the PRM is to expose the test participants (AT controllers and AF technicians) to the PRM system in its operational environment while they perform specified operational procedures. The test participants will then fill out questionnaires using their experience and judgment. The questionnaires will be evaluated by the Test Director along with the test participants to obtain a consensus of opinion for each MOS.

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

The COIs of the PRM and the method to be used to measure the suitability and effectiveness of the PRM system in verifying each COI is listed in table 4.1-1. These COIs were developed from the TVRTM of the LP PRM Master Test Plan.

TABLE 4.1-1. CRITICAL OPERATIONAL ISSUE TEST MATRIX.

Critical Operational Issue	Measures of Suitability	Measures of Effectiveness	Measures of Performance	Minimum Acceptable Operational Requirement
1. Coverage Area: The area that the system acquires, tracks and displays aircraft.	The coverage area presented on the PRM display consoles is sufficient for PRM monitoring operations for all applicable approaches.	Elevation Coverage.	Minimum Elevation Coverage. Maximum Elevation Coverage.	-2deg for range 500ft-3nmi 1.5deg for range >3nmi Top of Approved Keyhole
		Range Coverage.	Minimum Range Coverage. Maximum Range Coverage.	1000ft with accuracy 500 feet w/o accuracy Extent of Approved Keyhole
		Azimuth Coverage.	Minimum Azimuths Covered.	Extent of Approved Keyhole
2. Display Mapping: The map data presented on the PRM display consoles.	The map data presented on the PRM display consoles is comprehensive enough for PRM monitoring operations.	Map Accuracy.	Map Runway Accuracy.	+/- system rng & az accuracy
			Map Obstructions Accuracy.	+/- system rng & az accuracy
			Map NTZ Accuracy.	+/- system rng & az accuracy
			Map Final Approach Accuracy.	+/- system rng & az accuracy
3. Sensor Accuracy: The accuracy with which the system presents targets on the PRM display consoles as correlated to tracked aircraft position.	None.	Range Accuracy.	Mean Range Bias.	+/- 30ft.
			Mean Range Jitter.	30ft std dev
		Azimuth Accuracy.	RMS Azimuth Accuracy.	+/- 2.0 mrad for elevations <10 deg
4. Display Resolution: The capability to resolve two closely spaced aircraft.	Closely spaced targets can be resolved on the PRM display consoles sufficiently enough for PRM monitoring operations.	Tracked Target Resolution.	Azimuth Resolution.	.57 deg @98%
			Range Resolution.	600ft @ 98%
5. System Capacity: The number of aircraft the PRM system can acquire, track and display.	The capacity of the system is sufficient to monitor all foreseeable aircraft in the coverage areas.	Maximum track capacity, for each applicable update rate.	Maximum displayed tracks.	25 @ 1 sec (dual) 35 @ 2.4 sec (triple)
			Maximum ground tracks.	15 (dual) 15 (triple)
6. ARTS Interface: The PRM/ARTS Interface must be a passive (read-only, one-way) interface.	None.	PRM/ARTS Interface effects on the ARTS system.	Effects on ARTS system due to PRM/ARTS Interface operations.	No effect

Critical Operational Issue	Measures of Suitability	Measures of Effectiveness	Measures of Performance	Minimum Acceptable Operational Requirement
7. System Reliability: An estimate of how frequently the PRM system will fail.	None.	Reliability.	Mean Time Between Critical Failures.	2190 hours
		Availability.	Availability.	.999
			Mean Time To Repair.	30 min with approved exceptions
8. System Failures: The capability to detect system failures and provide visual and aural alarms.	The visual and aural alarms provided on the PRM Display Console for system failures are suitable for notifying appropriate personnel.	Detection of System Faults.	Minimum Percent Fault Detection.	95%
	The visual and aural alarms provided on the PRM Status Display for system failures are suitable for notifying appropriate personnel.	False Alarm Rate.	Maximum False Alarm Rate.	No false alarms
9. Tracked Target: Display of tracked targets, ARTS data correlation, and timeliness of data.	The tracking and display of aircraft is sufficient for PRM monitoring operations for all applicable approaches.	Probability of Detection.	Minimum Probability of Detection for discreet beacon targets.	99%
		Track History	All Displayed Tracks have a Track History.	100% moving targets
		Track Projection Vector	All Displayed Tracks have a Projection Vector.	100% moving targets
	The timeliness of the displayed targets is sufficient for PRM monitoring operations.	System Throughput.	Maximum time from aircraft reply to target display.	0.5 sec
	The correlation and display of ARTS data is comprehensive enough for PRM monitoring operations.	Correlation of Data.	Probability of ARTS correlation.	100% for discreet targets with available ARTS data
		ARTS Data Integrity.	Maximum False Data Rate.	0%
10. Display Console: The PRM display console's quality and controls.	The PRM display is of sufficient quality for PRM monitoring operations.	None.	None.	N/A
	The PRM display console contains all controls (character size, intensity, data block offset, etc) sufficient for PRM monitoring operations.	PRM Display Console Keyboard Commands.	All PRM Display Console Keyboard Commands function accurately.	meets PRM spec and design
	The contrast and brightness of the PRM display console can be adjusted suitably for TRACON lighting conditions.	Brightness and Contrast Controls.	Availability of Brightness and Contrast Controls.	Front of PRM Display Console

Critical Operational Issue	Measures of Suitability	Measures of Effectiveness	Measures of Performance	Minimum Acceptable Operational Requirement
11. Recording, Playback and Listing: The capability to record, replay, and list target information.	The playback of recorded data suitably simulates actual PRM data and operations.	Data Recording Integrity.	Maximum False/Missing Data Rate.	0%
		Data Playback Integrity.	Maximum False/Missing Data Rate.	0%
	The listing of PRM data supplies appropriate operational data.	Data Listing Integrity.	Maximum False/Missing Data Rate.	0%
12. False Targets: The capability to inhibit the number of false targets presented on the PRM display consoles.	The number of false targets displayed on the PRM Display Console is few enough for PRM monitoring operations.	False Targets due to fixed reflectors.	Maximum Number of False Tracks.	<5% of false reports due to known stationary reflectors
		Split Tracks.	Maximum Time Until Removal.	5 updates
13. NTZ Alerts: The capability to provide alerts when targets are projected to enter the NTZ.	The Aural NTZ projection is suitable for PRM monitoring operations.	NTZ Projection Alerts Integrity.	Probability of Alert.	100%
			Maximum False Alert Rate.	0%

4.1.3 Minimum Acceptable Operational Requirements (MAOR).

The MAORs are listed in table 4.1-1: Critical Operational Issue Test Matrix.

4.1.4 Activities Leading to Test.

Prior to the commencement of these tests and evaluations the following activities must be accomplished:

- a. The LP PRM has successfully completed the contractor performed DT&E and Site Acceptance Tests.
- b. This test plan and subsequent test procedures are approved.
- c. Necessary coordination between ACW, the local user organizations (AT and AF), and the Program Office has been completed.
- d. The test participants (AT controllers and AF technicians) must have completed the contractor provided training.
- e. The PRM system has been placed under formal FAA configuration control.

4.2 TEST ENVIRONMENT.

The LP PRM OT&E test effort will be conducted at an operational using the full operational PRM/NAS configuration.

4.2.1 Test Location.

The OT&E on the first article LP PRM system will be performed at Minneapolis-St. Paul International Airport.

4.3 TEST AND ANALYSIS TOOLS.

There are no special test and analysis tools required.

4.4 TEST AND EVALUATION DESCRIPTIONS.

The LP PRM OT&E test effort consists of two main test phases and multiple sub-phases as discussed below. Further descriptions for each test sub-phase are provided in appendix A. Table 4.4-1: LP PRM OT&E Test Planning Matrix lists the various test phases and sub-phases along with the schedule estimates and the number and type of required test participants.

The Operational Effectiveness Test Phase consists of a review of the contractor performed DT&E and Site Acceptance Tests. This review will evaluate whether each of the MOE had been satisfactorily tested and whether the results meet the MAORs. This review will be conducted solely by test engineers and does not require the PRM system. The expected duration of this review is 2 weeks.

The Operational Suitability Test Phases will expose the test participants (AT controllers and AF technicians) to the PRM system in an operational environment while they perform specified operational procedures. These tests will be conducted in two separate phases: AT Suitability and AF Suitability. Each of these phases is focused on the specific test participants.

The AT Suitability Test Phase will be subdivided into four tests: a PRM Display Console Test, a Flight Test, a System Failure Test, and a Data Playback and Listing Test. All four tests will require four AT controllers. The Data Playback and Listing Test will also require one AT supervisor. The estimated duration of the AT

Suitability Test Phase is 1 week. Estimated duration for each test is listed in table 4.4-1: LP PRM OT&E Test Planning Matrix.

The AF Suitability Test Phase will be subdivided into three tests: Fault Detection and Isolation Test, LRU Removal and Replacement Test, and Maintenance Procedures Test. Each test will require two AF technicians. The estimated duration of the AF Suitability Test Phase is 3 weeks. Estimated duration for each test is listed in table 4.4-1.

TABLE 4.4-1. LP PRM OT&E TEST PLANNING MATRIX.

OT&E Test Phase	Test Title Test #s	Test Participants	System Requirements	Test Duration
Operational Effectiveness	DT&E Data Review E.1	Test Eng-2	DT&E Test Procs Test Reports	2 Weeks
AT Suitability	PRM Display Console Test ATS.1	Test Eng-2 AT Ctlrs-4	Full PRM System	1 Day
AT Suitability	Flight Test ATS.2	Test Eng-2 AT Ctlrs-4	Full PRM System Test Aircraft-2	2 Days
AT Suitability	System Failure Test ATS.3	Test Eng-2 AT Ctlrs-4	Full PRM System	1 Day
AT Suitability	Data Playback & Listing Test ATS.4	Test Eng-2 AT Ctlrs-4 AT Sup-1	Full PRM System	1 Day
AF Suitability	Fault Detection & Isolation Test AFS.1	Test Eng-2 AF Techs-2	Full PRM System	2 Days
AF Suitability	LRU Removal & Replacement Test AFS.2	Test Eng-2 AF Techs-2	Full PRM System	10 Days
AF Suitability	Maintenance Procedures Test AFS.3	Test Eng-2 AF Techs-2	Full PRM System	3 Days

5. TEST MANAGEMENT.

5.1 TEST MANAGEMENT ORGANIZATION.

ACW-100A has the primary responsibility for the direction of test planning, test conduct, and test reporting activities associated with the LP PRM OT&E program. The roles and responsibilities of other organizations involved in the LP PRM OT&E test effort are outlined below.

a. Roles and Responsibilities.

Organizational roles and responsibilities will be as described in FAA Order 1810.4B.

b. Other Participating Organizations.

Other organizations, not covered by FAA Order 1810.4B, that will take part in the LP PRM OT&E effort. Their roles and responsibilities are listed below:

AGL-400 Great Lakes Region, Airway Facilities Division and the Minneapolis-St. Paul International Airport Airways Facilities Sector Office (AFSO): Assist with the Site Acceptance equipment inspections, i.e., power/safety, provide AF technicians for AF Suitability tests, and review AF Suitability test procedures.

AGL-500 Great Lakes Region, Air Traffic Division and Minneapolis-St. Paul International Airport Air Traffic Control Tower (ATCT): Assist in flight test planning, provide AT controllers for the AT Suitability tests, and review AT Suitability test procedures.

c. Test Conduct Teams.

The test conduct teams shall consist of two Test Engineers and the Test Participants, i.e., AT controllers or AF technicians. One of the Test Engineers will be designated as Test Lead, the other as Test Conductor.

The Test Lead will be responsible for briefing the Test Participants about the test, verifying that the Pretest conditions have been met, filling out the test mission log, and deciding when the test has been completed.

The Test Conductor shall work with the Test Participants to assist and guide them through the test conduct and questionnaire process.

5.2 TRAINING.

a. Test Developer Training.

The FAA test developers will be required to be familiar with the complete PRM system including: the PRM specification, the various system configurations, and the PRM/NAS interfaces. This knowledge will have been gained through participation in the contractor DT&E test efforts of the Demonstration PRM, the Upgrade PRM, and the LP PRM programs. The test developers will also be required to know the operational use of the PRM including: AT Operations, AF Operations, and the operational requirements of the PRM. This knowledge will have been acquired through participation in the PRM Demonstration Flight Tests, the Upgrade PRM OT&E test effort, as well as the preparation for this OT&E test effort.

b. Test Participant Training.

The test participants who take part in the OT&E test effort will be either qualified AT controllers or AF technicians. Both the AT controllers and the AF technicians will be given formal training on the PRM system prior to their involvement in the PRM OT&E test effort.

c. Special Training Requirements.

There are no special training requirements.

5.3 SYSTEM CONFIGURATION MANAGEMENT.

Prior to the start of the OT&E effort, the PRM system will be placed under FAA configuration control. The only changes made to the system will require PRM Program Office approval. Additionally, an inspection of the PRM's maintenance log will be made before each OT&E test to ascertain whether any maintenance actions were made to the system.

5.4 TEST READINESS CRITERIA.

Before this OT&E effort is started, the PRM system should be accepted in its final form; e.g., hardware, software, operational documentation, and training courses. The test participants should have received the contractor provided training. Nonfinal items in these areas could result in changes to the MOE and MOS collected in this test effort.

5.5 TEST EXECUTION.

The actual process for conducting a test session is divided into three distinct phases. A pretest review, the actual test conduct and a post-test review. The test mission log will be used to document the activities of all three of these phases. The pretest section of the mission log shall be used to document any open items (to be determined or discrepancies from the test procedure), a list of the test conduct members, and any discrepancies from the planned test configuration. The test conduct section will be used to record specific test events as noted in the test procedure. The post-test section shall be used to document any deviations from the test procedure that were not noted in the pretest section, a summary of the test conduct, and a preliminary assessment of the test results. These phases are discussed in the following subsections.

5.5.1 Pretest Review.

This review will be held prior to the start of each test session. The purpose of this review will be to accomplish the following:

a. Review the actual hardware and software configurations of the test environment against that planned in the test procedure. If the actual configuration is different from that planned the Test Lead will decide whether the test's objectives can still be met or whether to postpone the test. Identify any needed changes to the test procedure and redline accordingly.

b. The Test Lead will brief the Test Participants on the objectives of the test and describe the test execution of the test.

c. Fill out the pretest section of the Test Mission Log.

5.5.2 Test Conduct.

During the test conduct the Test Conductor will guide and assist the Test Participants. The Test Lead will fill out the test conduct section of the test mission log.

5.5.3 Post-Test Review.

This review will be held upon the completion of each test. The purpose of this review will be to accomplish the following:

a. Identify any procedure changes or test discrepancies and their significance to the test results.

b. Identify the "as-run" hardware and software configurations.

c. Summarize the actual test conduct and determine a preliminary assessment of the test results and system deficiencies.

d. Fill out the post-test section of the Test Mission Log.

5.6 TEST COMPLETION CRITERIA.

The initial LP PRM OT&E effort will be complete when a determination has been made for each MOE and MOS listed in this plan. The complete OT&E effort will be complete when any critical system deficiencies have been resolved and the corresponding MOE and MOS have been reevaluated.

The DT&E Data Review shall be complete when a determination has been made for each requirement. This determination shall include whether the DT&E test conducted was sufficient and whether the results meet the MAORs.

The AT and AF Suitability test phases will be complete when a final consensus has been determined for each MOS.

5.7 TEST REPORTS.

A Quick Look Report will be provided to the PRM Program Manager within 2 weeks following the completion of the OT&E tests. The Quick Look Report will highlight any system deficiencies found during the OT&E effort. For each deficiency, the Quick Look Report will provide a description, a risk assessment, and a proposed resolution. The classifications for risk assessment are defined as:

High Risk - The deficiency constitutes a risk to the deployment of further LP PRM systems.

Moderate Risk - The deficiency constitutes a risk to the commissioning of the LP PRM system.

Low Risk - The deficiency constitutes a risk to the operational use of the LP PRM system that can be resolved through post-commissioning modifications.

A Final Test Report will be provided to the PRM Program Manager within 2 months following the completion of the OT&E tests. The Final Report will document the results of the OT&E effort and highlight the technical performance of the PRM system.

5.8 SYSTEM DEFICIENCY REPORTS.

System Deficiency Reports will be collected throughout the OT&E test effort. These reports will be filled out for all system deficiencies. They will contain a description of the deficiency, the test that initiated the deficiency, a risk assessment, and a proposed resolution.

5.9 TEST SCHEDULE.

The schedule of the LP PRM OT&E activities is depicted in table 5.9-1, LP PRM OT&E SCHEDULE. The start date of the OT&E effort is contingent on the acceptance of the LP PRM system and the availability of the required test participants.

TABLE 5.9-1. LP PRM OT&E SCHEDULE.

Test	Schedule			
Operational Effectiveness				
DT&E Review	Week1	Week2		
Operational Suitability				
AT Suitability	Week1			
PRM Display Console Test	M			
Flight Test	TW			
System Failure Test	T			
Data Playback & Listing Test	F			
AF Suitability		Week2	Week3	Week4
Fault Detection & Isolation Test		MT		
LRU Removal & Replacement Test		WTF	MTWTF	MT
Maintenance Procedures				WTF

5.9.1 Planning Considerations and Limitations.

The major planning consideration and limitation of this OT&E effort deals with the limitation of test aircraft. This effort calls for two test aircraft primarily to demonstrate nontransgression zone (NTZ) blunders. These types of flights can only be performed during VFR weather conditions. While the schedule shows specific days for the flight tests, the aircraft will be scheduled for the full week of AT Suitability Tests. The schedule also contains 2 days for the flight test although only 1 day of flight tests is required. Having only two flight aircraft will also preclude the demonstration of overload conditions on the PRM system. These events will be covered in the contractor provided training and thus AT controller opinions relating to capacity related MOS will still be collected.

The effectiveness of the PRM/Automated Radar Terminal System (ARTS) interface is being conducted as part of the DT&E Data Review. This can be done since the interface will be extensively tested on site as part of the contractor's Site Acceptance Tests.

Note that as part the Upgrade PRM's OT&E test a test was conducted to ensure that the addition of the PRM into the Raleigh-Durham air traffic environment did not degrade the performance of the current beacon interrogator. This test is not being conducted as part of this OT&E effort since the LP PRM has the same output power and employs the same interrogation scheme and pattern as the Upgrade PRM.

5.10 PERSONNEL RESOURCE REQUIREMENTS.

The personnel required for the LP PRM OT&E effort include Test Engineers, AT controllers, AT supervisors and AF technicians.

The Test Engineers will be supplied by the FAA Technical Center, ACW-100. They will be required to be familiar with the complete PRM system including: the PRM specification, the various system configurations, and the PRM/NAS interfaces. The test developers will also be required to be familiar with the operational use of the PRM including: AT and AF Operations, and the operational issues addressed by this OT&E effort.

The AT controllers and the AT supervisor will be supplied by the Minneapolis-St Paul International Airport ATCT. They will need to have completed the contractor provided training on the PRM system. The AT controller's role in the OT&E effort will be to determine if the PRM system meets the MOS for the AT-related COIs. The AT supervisor's role will be to determine if the PRM system meets the MOS for the AT Management related COIs, e.g., data recording, playback and listing.

The AF technicians will be supplied by the Minneapolis-St. Paul International Airport AFSO. They will need to have completed the contractor provided training on the PRM system. The AF technician's role in the OT&E effort will be to determine if the PRM system meets the MOS for the AF-related Operational Issues.

The number and type of test participants, which tests they are required for, and when those tests are expected to be conducted is listed in table 4.4-1, LP PRM OT&E Test Planning Matrix and table 5.9-1, LP PRM OT&E Schedule.

6. ACRONYMS AND GLOSSARY.

AF	Airways Facilities
AFSO	Airways Facilities Sector Office
ARTS	Automated Radar Terminal System
AT	Air Traffic
ATCT	Air Traffic Control Tower
BRS	Beacon Radar Subsystem
COI	Critical Operational Issue
CPMS	Confidence and Performance Monitoring Subsystem
CS	Communication Subsystem
DT&E	Developmental Test and Evaluation
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
LP PRM	Limited Production Precision Runway Monitor
LRU	Line Replaceable Unit
MAOR	Minimum Acceptable Operational Requirement
MDBM	Multiplexed Display Buffer Memory
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Suitability
NAS	National Airspace System
NTZ	Non-Transgression Zone
OT&E	Operational Test and Evaluation
PRM	Precision Runway Monitor
PSD	PRM Status Display
RDS	Radar Display Subsystem
RPS	Recording and Playback Subsystem
TVRTM	Test Verification Requirements Traceability Matrix
UPS	Uninterruptable Power Supply
VFR	Visual Flight Rules

APPENDIX A

TEST AND EVALUATION DESCRIPTIONS

This appendix contains a brief outline for each test planned for the LP PRM OT&E effort. Note: the Critical Operational Issues (COI) and the associated Measures of Suitability (MOS), Measures of Effectiveness (MOE), Measures of Performance (MOP), and Minimum Acceptable Operational Requirements (MAOR) that these tests address are listed in table 4.4-1 of section 4.1. Additional objectives have been added to each test derived from the OT&E test components of FAA Order-1810.4B. The system and test participant requirements are listed in table 4.4-1 of section 4.4. The proposed schedule is listed in table 5.9-1 of section 5.9.

Test Number E-1

Test Phase Operational Effectiveness

Test Title DT&E Data Review

Test Objectives The objective of this test is to collect the Measures of Effectiveness and Measures of Performance for each of the Critical Operational Issues listed in table 4.1-1 of section 4.1 and to collect the Measures of Effectiveness for each of the OT&E test components listed below.

Technical Performance: The capability of the PRM System to meet specified requirements.

Maintainability: The capability of the PRM system to be maintained at the Line Replaceable Unit (LRU) level.

System Training: The contractor provided training for PRM operation and maintenance.

Documentation: The contractor provided documentation for PRM operation and maintenance.

Supportability: The sparing program that supports the PRM system.

Safety: The capability of the PRM system to be maintained and operated safely.

Test Criteria For the Critical Operational Issues covered by this test the success criteria is to verify that each requirement was satisfactorily tested and the results meet the MAORs from table 4.4-1 of section 4.1. For the additional OT&E test components the success criteria is listed below.

OT&E Test Components	Measures of Effectiveness	Success Criteria
Technical Performance	PRM Specification	Meets Each Specified Requirement
Maintainability	Fault Isolation	Passed Fault Isolation DT&E Tests
Training	Maintenance Course Content	Received Contractual Approvals
	Operations Course Content	Received Contractual Approvals
Operational Documentation	Instruction Book Content	Received Contractual Approvals
	Operator's Manual Content	Received Contractual Approvals
Safety	Safety Related Specifications	Passed DT&E Safety Inspections
	PRM System Design	Received Contractual Approvals
Supportability	Quantity of Spares	Received Contractual Approvals
	Quality of Spares	Each Spare has been Tested Sufficiently to Ensure Proper Operation in the PRM System.

Test Approach The DT&E Data Review consists of a review of the contractor performed DT&E and Site Acceptance Tests, the contractor Spares Test Program, as well as of other contract related activities, i.e., training course and document reviews and approvals. This review will evaluate whether each of the Measures of Effectiveness

had been satisfactorily tested and whether the results meet the corresponding success criteria. This review will be conducted by two test engineers and does not require the PRM system.

Test Conduct

Before the DT&E Data Review can be conducted the contractor performed DT&E and Site Acceptance test must be completed. This review will require copies of the "as run" test procedures and the associated test reports (drafts may be used). The DT&E Data Review shall be complete when a determination has been made for each requirement. This determination shall include whether the DT&E test conducted was sufficient and whether the results meet the MAORs.

Execution Time

The expected duration of this review is 2 weeks.

Test Number ATS-1

Test Phase AT Suitability

Test Title PRM Display Console Test

Test Objectives The objective of this test is to collect the Measures of Suitability for Critical Operational Issues: 2 and 10 listed in table 4.1-1 of section 4.1 and to collect Measures of Suitability for each of the OT&E test components listed below.

System Training: The contractor provided training for Air Traffic PRM operation.

Documentation: The contractor provided Operator's Manual.

Test Criteria The success criteria for each of the Operational Issues evaluated in this test is to meet the Measures of Suitability as presented in table 4.1-11 of section 4.1 and below.

OT&E Test Components	Measures of Suitability
Training	The Training provided to the AT controllers must suitably cover the commands, controls, and features of the PRM Display Console.
Operational Documentation	The Operators Manual provided to the AT controllers must suitably cover the commands, controls, and features of the PRM Display Console.

Test Approach This test does not require the actual control of aircraft, but uses what ever traffic is available (targets of opportunity) simply as a display feature. This test will collect opinions from four AT controllers (two at a time) by having them use the PRM display commands and controls while monitoring targets of opportunity on PRM Display Consoles. The AT controllers will be given a set of questionnaires that will lead them through the test by having them enter specific commands and controls and answer corresponding questions. These questions investigate the suitability of (1) the commands and controls used, (2) the contractor provided documentation and training, and (3) the PRM display presentation and map. An analysis of the questionnaires will be conducted by the test lead along with the AT controllers to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a set of PRM displays in their normal operational environment. Associated commands and controls will be grouped together for each specific questionnaire. The test can be stopped or paused between questionnaires. The test will be complete when a final consensus has been determined for each Measure of Suitability. If required, portions of the test may be rerun to obtain this consensus.

Execution Time The expected duration of this test is 2 days.

Test Number ATS-2

Test Phase AT Suitability

Test Title Flight Test

Test Objectives The objective of this test is to collect the Measures of Suitability for Critical Operational Issues: 1, 4, 5, 9, 12, and 13 listed in table 4.1-1 of section 4.1 and to collect Measures of Suitability for each of the OT&E test components listed below.

System Training: The contractor provided training for Air Traffic PRM operation.

Documentation: The contractor provided Operator's Manual.

Test Criteria The success criteria for each of the Operational Issues evaluated in this test is to meet the Measures of Suitability as presented in table 4.1-1 of section 4.1 and below.

OT&E Test Components	Measures of Suitability
Training	The Training provided to the AT controllers must suitably cover the required system knowledge for performing PRM monitoring operations.
Operational Documentation	The Operators Manual provided to the AT controllers must suitably cover the required system knowledge for performing PRM monitoring operations.

Test Approach This test uses two FAA test aircraft to supply targets for four AT controllers (two at a time) to monitor and control at the PRM Display Consoles. The test aircraft will fly side by side simultaneous approaches that will include as a minimum:

NTZ blunders
radio failure transponder alert
missed approach

Additional approaches will be selected by the Test Participants (AT controllers). Questionnaires will be collected from the AT controllers to obtain their opinions on the Measures of Suitability for each Operational Issue. An analysis of the questionnaires will be conducted by the test director along with the AT controllers to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a set of PRM displays in their normal operational environment including operational communications. The test will be complete when a final consensus has been determined for each Measure of Suitability. To obtain this consensus portions of the test may be rerun using targets of opportunity. All flights should be conducted under visual flight rules (VFR).

Execution Time The expected duration of this test is 1 day with a second day scheduled in case of weather or other problems.

Test Number ATS-3

Test Phase AT Suitability

Test Title System Failures Test

Test Objectives The objective of this test is to collect the Measures of Suitability for Critical Operational Issue 8 listed in table 4.1-1 of section 4.1 and to collect Measures of Suitability for each of the OT&E test components listed below.

System Training: The contractor provided training for Air Traffic PRM operation.

Documentation: The contractor provided Operator's Manual.

Test Criteria The success criteria for each of the Operational Issues evaluated in this test is to meet the Measures of Suitability as presented in table 4.1-1 of section 4.1 and below.

OT&E Test Components	Measures of Suitability
Training	The Training provided to the AT controllers must suitably cover the required system knowledge for performing PRM monitoring operations.
Operational Documentation	The Operators Manual provided to the AT controllers must suitably cover the required system knowledge for performing PRM monitoring operations.

Test Approach This test does not require the actual control of aircraft, but uses targets of opportunity simply as a display feature. This test will collect opinions from four AT controllers (two at a time) by having them monitor the PRM displays as PRM system failures are demonstrated. These system failures will include as a minimum:

- full data recording tape (single and dual)
- dectalker failure (single and dual)
- antenna failure
- channel failure with automatic switch
- ARTS Interface failure (single and dual)

Additional system failures will be selected by the Test Participants (AT controllers). Questionnaires will be collected from the AT controllers to obtain their opinions on the Measures of Suitability for each Operational Issue. An analysis of the Questionnaires will be conducted by the test director along with the AT Controllers to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a fully operational PRM system in its normal operational environment. The test may be stopped or paused between any system failure. Any system failure can be repeated as necessary. The test will be complete when a final consensus has been determined for each Measure of Suitability.

Execution Time The expected duration of this test is 1 day.

Test Number ATS-4

Test Phase AT Suitability

Test Title Data Playback and Listing Test

Test Objectives The objective of this test is to collect the Measures of Suitability for Critical Operational Issue 11 listed in table 4.1-1 of section 4.1 and to collect Measures of Suitability for each of the OT&E test components listed below.

System Training: The contractor provided training for Air Traffic PRM operation.

Documentation: The contractor provided Operator's Manual.

Test Criteria The success criteria for each of the Operational Issues evaluated in this test is to meet the Measures of Suitability as presented in table 4.1-1 of section 4.1 and below.

OT&E Test Components	Measures of Suitability
Training	The Training provided to the AT controllers must suitably cover the operation of the data recording, playback, and listing functions of the PRM system.
Operational Documentation	The Operators Manual provided to the AT controllers must suitably cover the operation of the data recording, playback, and listing functions of the PRM system.

Test Approach This test does not require the actual control of aircraft, but uses targets of opportunity and the data tapes collected during test: ATS.2 Flight Test. This test will use four AT controllers and one AT supervisor to record, playback, and list targets of opportunity and flight test data. Questionnaires will be collected from the AT controllers and the AT supervisor to obtain their opinions on the Measures of Suitability for each Operational Issue. An analysis of the questionnaires will be conducted by the test director along with the AT controllers to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a fully operational PRM system in its normal operational environment and the data tapes collected during test: ATS.2 Flight Test. The test may be stopped or paused any time after the targets of opportunity data have been collected. The test will be complete when a final consensus has been determined for each Measure of Suitability.

Execution Time The expected duration of this test is one day.

Test Number AFS-1

Test Phase AF Suitability

Test Title Fault Detection and Isolation Test

Test Objectives The objective of this test is to collect the Measures of Suitability for each of the OT&E test components listed below.

Maintainability: The capability of the PRM system to be maintained at the LRU level.

System Training: The contractor provided training for PRM operation and maintenance.

Documentation: The contractor provided documentation for PRM operation and maintenance.

Safety: The capability of the PRM system to be maintained safely.

Test Criteria The success criteria is listed below.

OT&E Test Components	Measures of Suitability
Maintainability	The PSD must be suitably usable by appropriate trained personnel to detect and isolate system faults to the Line Replaceable Unit (LRU) level.
Training	The Training provided to the AF Technicians must suitably cover the operation of the PSD to detect and isolate faults.
Operational Documentation	The Instruction Book provided to the AF Technicians must suitably cover the operation of the PSD to detect and isolate faults.

Test Approach This test will collect opinions from two AF technicians by having them use the PSD to detect and isolate faults at the LRU level placed into the PRM system by the test engineers. As a minimum, the LRUs to be faulted will consist of those listed below:

Transmitter Power Supply	Data Processor CPU
Interrogator Power Amplifier	Receiver Reply Decoder
ARTS Interface Unit	Tape Drive
Display Console Keyboard	Display Graphics Driver
RFD Power Supply	RFD Steering Memory
Antenna Dipole Column	Ethernet Switch

Questionnaires will be collected from the AF technicians to obtain their opinions on the Measures of Suitability for each Operational Issue. An analysis of the questionnaires will be conducted by the test director along with the AF technicians to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a fully operational PRM system in its normal operational environment. The test may be stopped or paused after each fault detection and isolation. The test will be complete when a final consensus has been determined for each Measure of Suitability. Specific faults may be tested again if required.

Execution Time The expected duration of this test is 2 days.

Test Number AFS-2

Test Phase AF Suitability

Test Title LRU Removal and Replacement Test

Test Objectives The objective of this test is to collect the Measures of Suitability for each of the OT&E test components listed below.

Maintainability: The capability of the PRM system to be maintained at the LRU level.

System Training: The contractor provided training for PRM operation and maintenance.

Documentation: The contractor provided documentation for PRM operation and maintenance.

Safety: The capability of the PRM system to be maintained safely.

Supportability: The sparing program that supports PRM maintenance operations.

Test Criteria The success criteria is listed below.

OT&E Test Components	Measures of Suitability
Maintainability	The design of the PRM system must allow for the removal and replacement of all LRUs of the PRM system.
Training	The Training provided to the AF Technicians must suitably cover the removal and replacement of all the LRUs of the PRM system.
Operational Documentation	The Instruction Book provided to the AF Technicians must suitably cover the removal and replacement of all LRUs of the PRM system.
Safety	The design of the PRM system must allow for the safe removal and replacement of all LRUs of the PRM system.
Supportability	The spares provided are of suitable quantity and quality to maintain the PRM system.

Test Approach This test will collect opinions from two AF technicians by having them remove and replace or walk through the removal and replacement sections of the PRM Instruction Book for each LRU of the PRM system. The LRUs that will be removed and replaced will consist of:

Frequency Generator	Receiver
Cabinet Blower	Tape Drive
Fiber Optic Transceiver	Sony CRT Assembly
Graphics Driver	Phase Shifter
RFD Power Supply	Antenna Dipole Column

Additional LRUs may be tested depending on the schedule. These LRUs will be selected by the Test Participants (AF technicians). Questionnaires will be collected from the AF technicians to obtain

their opinions on the Measures of Suitability for each Operational Issue. An analysis of the questionnaires will be conducted by the test director along with the AF technicians to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct

This test requires a fully operational PRM system in its normal operational environment. The test may be stopped or paused after each LRU removal and replacement. The test will be complete when a final consensus has been determined for each Measure of Suitability. Specific LRUs may be tested again if required.

Execution Time

The expected duration of this test is 10 days.

Test Number AFS-3

Test Phase AF Suitability

Test Title Maintenance Procedures Test

Test Objectives The objective of this test is to collect the Measures of Suitability for each of the OT&E test components listed below.

Maintainability: The capability of the PRM system to be maintained at the LRU level.

System Training: The contractor provided training for PRM operation and maintenance.

Documentation: The contractor provided documentation for PRM operation and maintenance.

Safety: The capability of the PRM system to be maintained safely.

Test Criteria The success criteria is listed below.

OT&E Test Components	Measures of Suitability
Maintainability	Maintenance Procedures must be executable by appropriate trained personnel
Training	The Training provided to the AF technicians must suitably cover the maintenance procedures of the PRM system.
Operational Documentation	The Instruction Book provided to the AF technicians must suitably cover the maintenance procedures of the PRM system.
Safety	The design of the PRM system must allow for the safe conduct of all maintenance procedures of the PRM system.

Test Approach This test will collect opinions from two AF technicians by having them perform each of the maintenance procedures of the PRM system. Questionnaires will be collected from the AF technicians to obtain their opinions on the Measures of Suitability for each Operational Issue. An analysis of the questionnaires will be conducted by the test director along with the AF Technicians to obtain a consensus of opinion for each Measure of Suitability.

Test Conduct This test requires a fully operational PRM system in its normal operational environment. The test may be stopped or paused after each maintenance procedure. The test will be complete when a final consensus has been determined for each Measure of Suitability. Specific maintenance procedures may be retested if required.

Execution Time The expected duration of this test is 3 days.

APPENDIX B

TEST VERIFICATION REQUIREMENTS TRACEABILITY MATRIX

The TVRTM below shows which tests collect Measures of Effectiveness and Measures of Suitability for each of the Operational Issues evaluated in this OT&E effort.

Operational Issue	Critical	Tests for Effectiveness	Tests for Suitability
1. Coverage Area	Yes	E-1	ATS-2
2. Display Mapping	Yes	E-1	ATS-1
3. Sensor Accuracy	Yes	E-1	None
4. Display Resolution	Yes	E-1	ATS-2
5. System Capacity	Yes	E-1	ATS-2
6. ARTS Interface	Yes	E-1	None
7. System Reliability	Yes	E-1	None
8. System Failures	Yes	E-1	ATS-3
9. Tracked Targets	Yes	E-1	ATS-2
10. Display Console	Yes	E-1	ATS-1
11. Recording, Listing and Playback	Yes	E-1	ATS-4
12. False Targets	Yes	E-1	ATS-2
13. NTZ Alerts	Yes	E-1	ATS-2
14. Technical Performance	No	E-1	None
15. Maintainability	No	E-1	AFS-1,2,3
16. Training	No	E-1	ATS-1,2,3,4 AFS-1,2,3
17. Operational Documentation	No	E-1	ATS-1,2,3,4 AFS-1,2,3
18. Safety	No	E-1	AFS-2,3
19. Supportability	No	E-1	AFS-2