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Precision Runway Monitor (PRM) Baseline System Performance Characteristics Test Report

Charles Dudas

September 1998

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16. Abstract

This report documents the baseline performance characteristics of the Precision Runway Monitor (PRM) system as recorded during the various phases of the PRM test program. This report is a composite of information from the various phases of the PRM test program.

Based on participation in the PRM test program and a review of applicable test reports, ACT-310 has determined that the PRM system meets the PRM specification requirements for each of the identified 19 system performance characteristics. ACT-310 recommends no additional system performance testing of the PRM system is needed unless future design changes occur that may affect the baseline system performance characteristics.

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EXECUTIVE SUMMARY

This report documents the baseline performance characteristics of the Precision Runway Monitor (PRM) system as recorded during the various phases of the PRM test program. The phases of the PRM test program include the final In-Factory and On-Site testing performed throughout the Developmental Test and Evaluation (DT&E), Production Acceptance Test and Evaluation (PAT&E) and contract modification phases of the PRM test program. This report is a composite of information from the various phases of the PRM test program which is documented in a series of Allied-Signal Test Report documents listed in section 1.2, Reference Documents. The Allied-Signal test reports document each phase of DT&E and PAT&E testing, but do not present the performance characteristics of the PRM system in a concise manner.

The PRM is a high-update rate, high accuracy, stand-alone secondary radar system designed to allow independent parallel approaches in Instrument Meteorological Conditions (IMC) at airports that have parallel runways less than 4300 feet separation and more than 3000 feet separation. Also, airports that have triple parallel configurations fall into this category.

Based on participation in the PRM test program and a review of applicable test reports, ACT-310 has determined that the PRM system meets the PRM Specification requirements for each of the identified 19 system performance characteristics. ACT-310 recommends no additional system performance testing of the PRM system is needed unless future design changes occur that may affect the baseline system performance characteristics.

1. INTRODUCTION.

The Precision Runway Monitor (PRM) is a high-update rate, high accuracy, stand-alone secondary radar system designed for use at some airports where runway separations do not currently allow independent parallel approaches in Instrument Meteorological Conditions (IMC). Airports that fall into this category are those with parallel runway less than 4300 feet separation and more than 3000 feet separation. Also, airports that have triple parallel configurations fall into this category.

The first article PRM system was installed and tested at the Minneapolis-St. Paul International Airport (MSP). Future installations are scheduled to occur at John F. Kennedy International Airport (JFK), St. Louis International Airport (STL), Philadelphia International Airport (PHL), and Atlanta /Hartfield International Airport (ATL).

The PRM uses an Electronically Scanned (E-Scan) phased array antenna to achieve an azimuth accuracy of 1 milliradian at a 1-second update rate while simultaneously tracking up to 35 targets. The PRM design provides audible and visual alerts to the PRM Monitor Controllers at the PRM Display. The PRM Displays are 20-inch (horizontal and vertical) high resolution, color digital displays capable of presenting accurate target information to the monitor controllers.

1.1 OBJECTIVES.

The objective of this report is to document the baseline performance characteristics of the PRM system as recorded in the final In-Factory and On-Site testing performed throughout the Developmental Test and Evaluation (DT&E), Production Acceptance Test and Evaluation (PAT&E) and contract modification phases of the PRM test program. This report is a composite of information from the various phases of the PRM test program which is documented in a series of Allied-Signal Test Report documents listed in section 1.2, Reference Documents. The Allied-Signal test reports document each phase of DT&E and PAT&E testing, but do not present the performance characteristics of the PRM system in a concise manner.

1.2 REFERENCE DOCUMENTS.

The following documents were used in developing this test report and are applicable to the extent specified herein:

a. Electronic Scan Precision Runway Monitor (E-SCAN PRM), FAA-E-2887 Rev. B, 15 October 1994.
b. Limited Production Precision Runway Monitor (PRM) Master Test Plan, November 1992, DOT/FAA/CT-TN92/93.
c. Allied Signal, Master Test Plan, A002-001-001.
d. Allied Signal, PRM Phase 1 Test Plan, A002-001-001.
e. Allied Signal, PRM Phase 1 Test Report, A003-001-001.
f. Allied Signal, PRM Phase 2 Test Plan, A002-001-001.
g. Allied Signal, PRM Phase 2 Test Report, A003-001-001.
h. Allied Signal, PRM Phase 3 Test Plan, A002-001-001.
i. Allied Signal, PRM Phase 3 Test Report System Serial #0002, C022-001-001.
j. Allied Signal, PRM Phase 3 Test Report System Serial #0005, C022-002-001.
k. Allied Signal, PRM Phase 3 Test Report System Serial #0003, C022-003-001.
l. Allied Signal, PRM Phase 3 Test Report System Serial #0004, C022-004-001.

m. Allied Signal, PRM Track Capacity/Alert Suppression, MOD 28 Test Report, P002-01-001.
n. Allied Signal, PRM Operational Test and Evaluation, MOD 29 Test Report, P002-01-001.
o. Allied Signal, PRM Airways Facilities Operational Test and Evaluation, MOD 30 Test Report, P002-01-001.
p. Limited Production (LP) Precision Runway Monitor (PRM) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Procedures.

1.3 PRM SYSTEM MISSION.

The primary mission of the PRM is to increase airport capacity by providing the capability to conduct simultaneous independent instrument approaches to parallel runways (including triple runways) spaced less than 4300 feet and greater than 3000 feet apart during IMC.

1.4 PRM SYSTEM DESCRIPTION.

The PRM is a secondary surveillance radar and display system capable of providing the aircraft surveillance necessary to reduce runway separation criteria applied to the independent operation of parallel runways during IMC. The PRM utilizes an electronically steered phased array antenna to provide variable update intervals to detect and display target aircraft. The PRM detects aircraft throughout its 360° coverage area and provides automatic tracking of the aircraft in operator-selected regions, nominally the parallel runway landing sector, and missed approach sector. PRM controllers monitor high-resolution graphics displays for visual and aural alerts of aircraft incursions into the area between parallel runways called the No Transgression Zone (NTZ).

The PRM system is comprised of six major subsystems and auxiliary system equipment:

a. Antenna Subsystem (ANT)
b. Beacon Radar Subsystem (BRS)
c. Radar Display Subsystem (RDS)
d. Communications Subsystem (CS)
e. Confidence and Performance Monitoring Subsystem (CPMS)
f. Recording and Playback Subsystem (RPS)

A block diagram showing the functional relationships between the PRM subsystems is shown in figure 1.4-1.

The ANT radiates interrogations to and receives replies from aircraft in the PRM coverage area as directed by the BRS. The ANT is composed of a 17-foot electronically-scanned (E-scan) antenna array, a Radio Frequency (RF) Distribution (RFD) assembly, and an antenna tower.

The BRS provides aircraft 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 RDS receives target track data from the BRS, correlates the track data with Automated Radar Tracking System (ARTS) data such as aircraft identification, runway assignment and aircraft type. The RDS also displays track data on the color graphics displays and generates visual and aural blunder alerts based on actual and projected aircraft position data.

The CS provides for intra-site communications between the equipment located within the Transmitter/Receiver Site (T/R Site) and within the Operations Site (Op Site). The CS also provides the communications between these two sites.

The CPMS provides for the monitoring of critical system performance parameters in the ANT, the BRS, the RDS, and the CS. The CPMS also provides for maintenance monitoring, including BRS maintenance control, subsystem and environmental status monitoring, and diagnostic provisions.

The RPS provides for the recording and playback of the operational data presented on the RDS.

Auxiliary system equipment for the PRM system includes a shelter and tower for the operational equipment at the T/R Site and a power system to provide and distribute power to the system equipment.

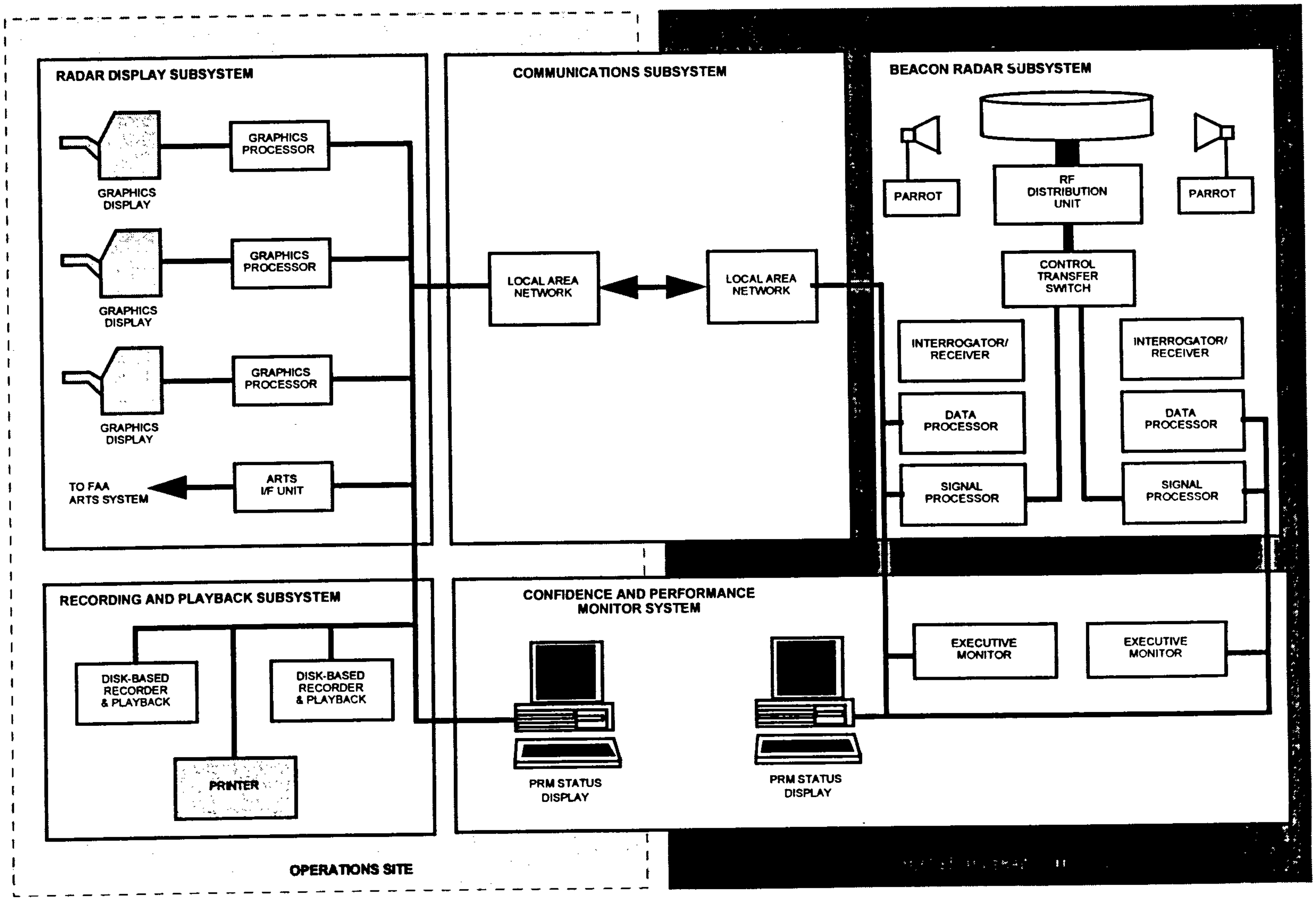

FIGURE 1.4-1. PRM FUNCTIONAL SUBSYSTEM BLOCK DIAGRAM

2. TEST PROGRAM DESCRIPTION.

The PRM system was tested as dictated by the PRM Master Test Plan. The PRM Master Test Plan was derived from the Quality Verification Matrix (QVM) included in the PRM Specification, FAA-E-2887. The Master Test Plan calls for a two-phase DT&E Test Program, a two-phase PAT&E Test Program, and a three-phase OT&E test program. The two phases of DT&E are the In-Factory Acceptance tests and On-Site Acceptance tests. The two phases of PAT&E are the In-Factory Acceptance Tests and the On-Site Acceptance Tests. The three phases of OT&E are the Air Traffic (AT) OT&E, Airways Facilities (AF) OT&E, and the Integration OT&E test phases. Table 2-1 is a summary of test phases and testing dates. Note that design changes incorporated into the system design in latter test phases caused regression testing in earlier run test phases to ensure testing integrity.

In addition to the test phases defined in the PRM Master Test Plan, two other test phases were performed due to contract modifications. The PRM Track Capacity/Alert Suppression contract modification (Mod 28 T&E) dictated a test program and associated contract deliverables. Likewise, the AT OT&E test phase led to a contract modification (Mod 29) which dictated a test program for this effort (Mod 29 T&E).

The AF OT&E test phase generated the need for a contract modification (Mod 30). Mod 30 dictated a test program and associated contract deliverables (Mod 30 T&E). These design changes dictated by Mod 30 did not affect the PRM System Performance Characteristics. Table 2-1 details the test dates of the various test phases of the PRM test program.

TABLE 2-1. PRM TEST PROGRAM TEST PHASES

Test Phase	Test Phase Description	Test Dates
(Phase 1) DT&E	In-Plant Acceptance Testing of First Article System	August 1994 through December 1994
(Phase 2) DT&E	On-Site Acceptance Testing of First Article System	May 1995 through April 1996
(Phase 3) PAT&E	In-Plant Acceptance Testing of Four Production PRMs	System 5- February 1995 through March 1995 System 3- December 1995 through March 1996 System 2- January 1996 through February 1996 System 4- March 1996
(Phase 4) PAT&E	On-Site Acceptance Testing of Four Production PRMs	To be Performed after each system is delivered, installed and integrated
AT OT&E	Air Traffic Operational Test and Evaluation of First Article System	October 1995
AF OT&E	Airways Facilities Operational Test and Evaluation of First Article System	October 1996
Integration OT&E	Integration Operational Test and Evaluation of First Article System	October 1996
Mod 28 T&E	Track Capacity/Alert Suppression Contract Modification Test and Evaluation	February 1996 through September 1996
Mod 29 T&E	Air Traffic Operational Test and Evaluation Changes Contract Modification Test and Evaluation	September 1996 through April 1997
Mod 30 T&E	Airways Facilities Operational Test and Evaluation Changes Contract Modification Test and Evaluation	June 1997 through July 1997 (the limited design changes had no effect on PRM System Performance Characteristics)

Phase 4 PAT&E has yet to be completed on the four remaining production PRMs. This testing will occur once sites have been identified and site installation/integration has been completed. The schedule for this effort continues beyond the year 2000.

Refer to the reference section for a complete list of documents which define the various phases of PRM testing.

2.1 TEST MANAGEMENT.

For Phase 1 through 3 of the test program and the Mod 28, 29, and 30 T&E efforts, FAA personnel witnessed all tests as they were run. While the contractor (Allied-Signal) was responsible for the production of all test plans, test procedures and test reports, FAA personnel aided in the development and review of these deliverables. FAA personnel have also assisted in the development and review of the Phase 4 test procedures.

The AF, AT, and Integration phases of OT&E were the responsibility of ACT-310. Test plans, procedures, test execution and Quick-Look test reports were developed, reviewed and executed by ACT-310 personnel with input from the various user groups throughout the FAA.

2.2 PHASE 1 THROUGH PHASE 4 TEST CONDUCT.

Various means were used to document test progress during the phases of testing. Test plans were used to guide the development of test procedures. Approved test procedures were used to guide the test execution. Test results were recorded in the data log section of the individual test procedures and later were included and summarized in test reports presented to the FAA by the contractor for approval. Test result discrepancies were documented when they occurred in a computerized database system implemented and managed by the contractor. This database system, which was the Discrepancy Control System (DCS) in the earlier phases of testing and Positive Verification and Control System (PVCS) in the later phases of testing, acted as the traffic signal to control the execution of test procedures within a test phase. Various test management milestones were installed to meter the beginning and end of the test phases. The DCS/PVCS system was invaluable for tracking the number and severity of open issues at the test management milestones. Typically, the number of DCS/PVCS trouble reports that were open when moving from test phase to test phase was very low and of minor significance.

In order to facilitate test progress during a test phase, testing continued where possible, and at the risk of the contractor, even though various DCS/PVCS trouble reports may have been open. Weekly DCS/PVCS meetings were held to reprioritize the testing schedule so as to run tests that were not affected by trouble reports and delay tests that would be affected by open trouble reports. At the DCS/PVCS meetings, the contractor would provide government personnel with detailed implementations of solutions for trouble reports that were ready for closure. This process typically included a line by line, unit by unit review of software changes and detailed descriptions of hardware changes. These meetings identified those tests or portions of tests that would need to be regression tested due to the nature of the proposed trouble report closure.

A complete listing of DCS/PVCS trouble reports for each test phase is included in the separate test reports submitted by the contractor (references e, g, i, j, k, l, m, n, and o of section 1.2).

Configuration control of the PRM system was maintained by the contractor and monitored by the FAA Quality & Reliability Officer (QRO) and test team members. Every test procedure data sheet recorded the current system configuration on it for later traceability.

To minimize risk to later phases of the test program and to facilitate accurate repeatable test results, the PRM Antenna and Test Target Simulator (PATTS) was extensively used during In-Factory Testing (Phase 1, Phase 3, and the appropriate portions of Mod 28, 29, and 30 T&E). The PATTS is a combined digital and radio frequency (RF) test set capable of responding to PRM interrogations with accurate and timely replies for as many as 90 different targets. The PATTS was verified as accurate through its own test program and is calibrated on a scheduled basis.

PATTS uses preprogrammed and stored scenarios to provide the PRM system with targets with realistic and variable flight paths. The scenarios contain many variable parameters including flight path, flight duration, reply power, and reply probability.

3. PRM SYSTEM PERFORMANCE CHARACTERISTICS.

Nineteen PRM System Performance Characteristics have been identified for the PRM. These performance characteristics are derived from the PRM Specification, FAA-E-2887. A summary of these characteristics, the PRM Specification Requirement number along with the final On-Site and In-Factory test results are listed in table 3-1.

TABLE 3-1. SUMMARY TABLE OF PRM SYSTEM PERFORMANCE CHARACTERISTICS

FAA-E-2887 Paragraph Number	Title	Requirement	Final In-Factory Test Result	Final On-Site Test Result
3.2.1.2.1.1	False Report Censoring.	95% of the time, known stationary reflectors will NOT be used to start or maintain displayed tracks.	100%	100%
3.2.1.2.1.2	False Track Removal.	95% of the time, a false displayed track, exclusive of those caused by known stationary reflectors, will be removed within 5 update periods.	100%	100%
3.2.1.2.2	Displayed Track Throughput.	0.50 seconds from receipt of reply at antenna to track update on Display. (Waiver PRM-W0019-044 raised the requirement to 0.5601 seconds.)	0.5 seconds	Not Applicable
3.2.1.2.3	Automatic Channel Switchover.	Channel Switch <1 second	0.626 seconds	Not Applicable
3.2.1.2.4	System Restoration.	System Restoration <= 1.125 seconds	0.91 seconds	Not Applicable
3.2.2.1.2.1	Azimuth Coverage.	360° - Interrogation Blanking Sector (IBS))	Not Applicable	360° - IBS
3.2.2.1.2.2	Range Coverage.	500 feet to 32 nmi. from antenna	Not Applicable	500 feet to 32 nmi
3.2.2.1.2.3	Elevation Coverage.	Elevation Coverage >= -0.2 and <= 31° from 500 feet to 3 nmi. in range; Elevation Coverage >= 1.5° and <=31° from 3 nmi. to 32 nmi. in range.	Not Applicable	Meets Requirement
3.2.2.1.3.1	Range Accuracy.	Range Accuracy <= 30 feet bias and 25 feet standard deviation (St. Dev.)	Not Applicable	28.2 feet bias < 25 feet St. Dev.
3.2.2.1.3.2	Range Resolution.	Range Resolution <= 600 feet 98% of the time.	Not Applicable	99.6%
3.2.2.1.3.3	Azimuth Accuracy.	When Elevation Angle <= 10°, Azimuth Error <= 0.06° rms; When Elevation Angle > 10° and <=31°, Azimuth Error <=0.28° rms.	Not Applicable	Meets Requirement
3.2.2.1.3.4	Azimuth Resolution.	Azimuth Resolution <= 0.57° 95% of the time.	Not Applicable	100%
3.2.2.1.4	Code Accuracy.	Code data must be accurate >= 99% of the time.	99.94%	100%

3.2.2.1.6.1	Search/Acquisition Target Report Probability.	Search PoD >= 0.90 within 7 sec. Search PoD >= 0.99 within 11 sec. Search PoD >= 0.999 within 15 sec.	.91 within 7 sec. 0.99 w/i 11 sec. 0.999 w/i 15 sec.	100% w/i 7 sec..
3.2.2.1.6.3	Track Update Probability.	PoD >= 99%	99.52%	99.14%
3.2.2.1.7.1	Search Coverage Interval.	Search Coverage Interval = 4 +/- 0.125 seconds	4.06 sec. maximum	Not Applicable
3.2.2.1.7.2	Displayed Track Update Interval.	Displayed track Update Interval = 1 +/- 0.125 seconds	100% < 1.125 seconds	Not Applicable
3.2.2.1.8	Track Capacity.	Track Capacity = 25 targets for dual runways configuration Track Capacity = 35 targets for triple runways configuration	35 targets (Note that all PRM systems have 35 target capacity)	35 targets
3.2.2.5.4.3.2	Displayed Track Overload/Overflow Processing	>99% PoD and actual update rate = scheduled update rate +/- 0.125 for each state change combination of normal, overload, overflow and target missing state.	> 99% PoD for normal, overload, overflow and missing state	> 99% PoD for normal, overload, overflow and missing state

Note 1: These requirements were tested during the Phase 3 testing of System Serial Number 3 in order to expedite the test program.

Each of the 19 system performance characteristics were tested as dictated by the PRM Specification QVM. As discussed above, the Mod 28 and Mod 29 T&E programs required the retesting of a portion of these system performance characteristics. Table 3-2 details each of the test phases and test procedures in which each of the system performance characteristics were tested. Complete details of the testing performed for each of the 19 system performance requirements can be found by reviewing the test report published for the appropriate test phase listed below.

TABLE 3-2. TEST PHASE/PROCEDURE LISTING FOR THE SYSTEM PERFORMANCE CHARACTERISTICS

FAA-E-2887 Paragraph Number and Title	Test Phase	Test Procedure(s)
3.2.1.2.1.1 False Report Censoring	Phase 1-------------------- Phase 2-------------------- Phase 3-------------------- Mod 28 T&E (In-Factory)- Mod 29 T&E (On-Site)----	SYS-1 SYS-202 SYS-301 Uses Phase 3, Sys. Ser. #2 test result SYS-202M
3.2.1.2.1.2 False Track Removal	Phase 1-------------------- Phase 2-------------------- Phase 3-------------------- Mod 28 T&E (In-Factory)- Mod 29 T&E (On-Site)----	SYS-1 SYS-202 SYS-301 Uses Phase 3, Sys Ser #2 test result SYS-202M
3.2.1.2.2 Displayed Track Throughput	Phase 1-------------------- Phase 3-------------------- Mod 28 T&E (In-Factory)-	SYS-3 SYS-303 Uses Phase 3, Sys. Ser. #2 test result
3.2.1.2.3 Automatic Channel Switchover.	Phase 1-------------------- Phase 3-------------------- Mod 28 T&E (In-Factory)-	CPMS-46 CPMS-346 CPMS-346
3.2.1.2.4 System Restoration	Phase 1-------------------- Phase 2-------------------- Mod 28 T&E (In-Factory)-	CPMS-46 CPMS-346 CPMS-346

3.2.2.1.2.1 Azimuth Coverage	Phase 1--------------------- Phase 2---------------------	AR-3 BRS-208, FT-201
3.2.2.1.2.2 Range Coverage	Phase 1--------------------- Phase 2---------------------	AR-4 BRS-208, FT-202, FT-203
3.2.2.1.2.3 Elevation Coverage	Phase 1--------------------- Phase 2---------------------	AR-5 BRS-208, FT-202, FT-203
3.2.2.1.3.1 Range Accuracy	Phase 1--------------------- Phase 2---------------------	AR-6 BRS-240, FT-201, FT-202, FT-203
3.2.2.1.3.2 Range Resolution	Phase 1--------------------- Phase 2---------------------	AR-7 FT-205
3.2.2.1.3.3 Azimuth Accuracy	Phase 1--------------------- Phase 2---------------------	AR-8 BRS-240, FT-201, FT-202, FT-203
3.2.2.1.3.4 Azimuth Resolution	Phase 1--------------------- Phase 2--------------------- Mod 29 T&E (On-Site)----	AR-9 FT-205 FT-205M
3.2.2.1.4 Code Accuracy	Phase 1--------------------- Phase 2--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)-	BRS-2 FT-202, FT-204 BRS-302 Uses Phase 3, Sys. Ser. #2 test result
3.2.2.1.6.1 Search/Acquisition Target Report Probability.	Phase 1--------------------- Phase 2--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)- Mod 29 T&E (On-Site)----	BRS-3 FT-204 BRS-303 Uses Phase 3, Sys. Ser. #2 test result FT-204M
3.2.2.1.6.3 Track Update Probability	Phase 1--------------------- Phase 2--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)- Mod 29 T&E (In-Factory)- Mod 29 T&E (On-Site)----	BRS-5 BRS-240 SYS-303, BRS-305 Uses Phase 3, Sys. Ser #2 test result BRS-5M BRS-240M
3.2.2.1.7.1 Search Coverage Interval.	Phase 1--------------------- Mod 28 T&E (In-Factory)-	BRS-9 BRS-309
3.2.2.1.7.2 Displayed Track Update Interval	Phase 1--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)-	BRS-5 BRS-305 Uses Phase 3, Sys. Ser. #2 test result
3.2.2.1.8 Track Capacity	Phase 1--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)-	BRS-5 BRS-305 Uses Phase 3, Sys. Ser #2 test result
3.2.2.5.4.3.2 Displayed Track Overload/Overflow Processing	Phase 1--------------------- Phase 2--------------------- Phase 3--------------------- Mod 28 T&E (In-Factory)- Mod 29 T&E (On-Site)----	BRS-8 BRS-208 BRS-308 Uses Phase 3, Sys. Ser. #2 test result BRS-208M

3.1 DISCUSSION OF PRM SYSTEM PERFORMANCE CHARACTERISTICS.

The following sections provide a description of the testing that was performed for each of the 19 PRM System Performance Characteristics. In order to illustrate the cumulative nature of the PRM test program, the final In-Factory and On-Site Acceptance testing results are detailed below. Each major design change was required to be retested in both the In-Factory and On-Site portions of the test program prior to system acceptance.

3.1.1 False Report Censoring.

False Report Censoring, requirement 3.2.1.2.1.1 of the PRM Specification, specifies that false reports due to known stationary reflectors shall not be used to start or maintain tracks 95 percent of the time. Also, any false track that is generated due to a known stationary reflector shall be removed from the display(s) after a coast display period.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1, 2, and 3 test programs. While the Mod 29 T&E test program was scheduled to revalidate this requirement in factory, the Phase 3 testing of System Serial Number 3 occurred during the Mod 29 T&E test program timeframe. In order to expedite the test program, the Phase 3 test procedure, SYS-301, was modified to account for the increase in target capacity. Phase 3, System Serial Number 3 test results were used in lieu of a redundant Mod 29 T&E test procedure.

3.1.1.1 False Report Censoring Final In-Factory Testing.

This requirement was last verified in the Phase 3 test program through the use of the SYS-301 test procedure. The philosophy of SYS-301 test procedure was to use the PATTS and specially developed scenarios to geometrically position targets in specific locations such that the reflection processing algorithms were fully exercised. Additional targets were added to the scenarios to raise the number of targets to the capacity level of 35 targets. This was done to ensure that the PRM could process the maximum number of false targets combined with the maximum number of real targets .

The system prevented 100 percent of false reports due to known stationary reflectors from starting tracks.

3.1.1.2 False Report Censoring Final On-Site Testing.

As the final step in the Mod 29 T&E test program, site regression testing included the rerunning of SYS-202M, the False Report Censoring Test. The original SYS-202 test procedure (run during Phase 2 testing) required the collection of 32 hours of target of opportunity data in which no new stationary reflectors were discovered. In the case that one of the hours of target of opportunity data did discover a new stationary reflector, the new reflector was added to the reflection list, and that specific hour of data was rerun until no new stationary targets were discovered.

For this test procedure, target of opportunity data was collected during eight carefully selected 1-hour traffic “pushes” while the geographic and altitude filters were opened to the maximum size. A “push” is a scheduled time of high number of arrivals and/or departures resulting in a large number of air traffic in the MSP PRM coverage area. Traffic flows vary from push to push depending on wind conditions and the scheduled flights' starting points and destinations. Also, a push during Visual Meteorological Conditions (VMC) results in a different mix of general aviation (GA) and commercial air traffic in and out of the PRM controlled airspace.

Targets of opportunity recorded during the various pushes provided testing of the reflection processing algorithms. Data analysis identified reflection targets by the source of the reflections. Reflections due to known reflectors were analyzed to ensure the replies were not used to start a displayed track at least 95 percent of the time.

In the case that a new stationary target was discovered, that "push" was rerun after the new reflector was added to the reflection list to ensure no more stationary reflectors would be found.

Two new reflectors were found during this test. With these two reflectors not in place, the system prevented 95.2 percent of false reports due to known stationary targets from starting tracks. With these reflectors in place in the reflection list, 100 percent of false reports due to known stationary targets were prevented from starting tracks.

3.1.2 False Track Removal.

False track removal, requirement 3.2.1.2.1.2 of the PRM Specification, specifies that a false displayed track generated due to any condition exclusive of a known stationary reflector be removed from the display within five displayed track update periods at least 95 percent of the time.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1, 2, and 3 test programs. While the Mod 29 T&E test program was scheduled to revalidate this requirement in factory, the Phase 3 testing of System Serial Number 3 occurred during the Mod 29 T&E test program time frame. In order to expedite the test program, the Phase 3 test procedure, SYS-301, was modified to account for the increase in target capacity. Phase 3, System Serial Number 3 test results were used in lieu of a redundant Mod 29 T&E test procedure.

3.1.2.1 False Track Removal Final In-Factory Testing.

In this test, PATTS scenarios were used to purposely force "image" tracks to be tracked by the PRM system. This was done by creating a series of mirror or image targets within the general correlation limits of the system with the same discrete Mode 3/A code. This caused the PRM system to use its general correlation processing routines to determine that the target with the longer range was an image of the track with the shorter range. This processing by the PRM system is performed once every 4 seconds in order to meet the requirement of removing false displayed tracks due to any condition exclusive of a known stationary reflector within 5 displayed track update periods (5 seconds for normal operations).

Results from Channel 1 and Channel 2 testing show that no false track was displayed for more than 4 seconds.

3.1.2.2 False Track Removal Final On-Site Testing.

This requirement was last tested On-Site as part of the Mod 29 T&E effort. It was run as part of the SYS-202M test procedure.

For this test procedure, target of opportunity data was collected during eight carefully selected 1-hour traffic "pushes" while the geographic and altitude filters were opened to the maximum size by using the geographic filter 11B and 29B. Geographic Filters 11B and 29B set the range to 32 nautical mile (nmi) and the altitude limit to 15,000 feet.

The False Track Removal portion of this test procedure was run in the preliminary portion of the test when the two new reflectors were discovered and before they were added to the PRM reflector file.

In each case of the two newly discovered reflectors, the false track was removed from the PRM display within 3 seconds.

3.1.3 Displayed Track Throughput.

Displayed Track Throughput, requirement 3.2.1.2.2 of the PRM Specification, specifies that the time between reception of a valid target reply at the antenna to the time the associated track update is displayed on the display shall not exceed 0.50 seconds. This requirement must be met under capacity conditions.

This requirement was tested as dictated by the PRM Specification QVM in the SYS-3 test procedure as part of the Phase 1 test program and in the SYS-303 test procedure as part of the Phase 3 test program. This requirement was also regression tested as part of the Mod 29 T&E effort in the SYS-303 test procedure.

3.1.3.1 Displayed Track Throughput Final In-Factory Testing.

While the Mod 29 T&E test program was scheduled to revalidate this requirement in factory, the Phase 3 testing of System Serial Number 3 occurred during the Mod 29 T&E test program time-frame. In order to expedite the test program, the Phase 3 test procedure, SYS-303 (Displayed Track Throughput), was modified to account for the increase in target capacity. Phase 3, System Serial Number 3 test results were used in lieu of a redundant Mod 29 T&E test procedure.

SYS-303 used the full PRM system configuration with the PATTS replacing the Antenna subsystem to provide the PRM system with simulated targets, arranged in a particular scenario suited to the Displayed Track Throughput test objectives.

The PRM processing delay was determined by measuring the time span from when a reply with the SPI pulse was sent by the PATTS to the PRM system to when the SPI pulse was first displayed on the PRM Graphics Displays. A PATTS scenario was created with a capacity number of 35 tracks and 25 secondary tracks in a 20-degree azimuth wedge with the target of interest positioned to avoid garbling and spurious interrogation responses. When the SPI pulse was transmitted by the PATTS reply generator, a probe connected to the PATTS caused an external Light Emitting Diode (LED) indicator positioned on the front of the PRM Graphics Display. A video camera was then used to record both the lighting of the LED and the changing of the target of interest data block to a red "ID", indicating the SPI bit was enabled. This process was repeated 50 times for both channel 1 and channel 2 of the PRM. At test completion, the video tape was analyzed frame by frame to determine the number of frames between when the LED was lit and when the red ID was lit. The number of frames multiplied by 1/30th of a second determined the Displayed Track Throughput for that sample.

The maximum Displayed Track Throughput measured during this test was 15/30 of a second or 0.5 seconds. Phase 1 analysis and testing had previously shown that the maximum displayed track throughput could exceed the 0.5 second requirement if a number of software events occurred at the same time. For this reason PRM Waiver Number W0019-044 was processed allowing the maximum Displayed Track Throughput to be 0.5601 seconds.

3.1.3.2 Displayed Track Throughput Final On-Site Testing.

The PRM QVM did not require that Displayed Track Throughput be tested on-site due to the need to use a controlled, repeatable scenario with special test hardware to accurately test this requirement.

3.1.4 Automatic Channel Switchover.

Automatic Channel Switchover, requirement 3.2.1.2.3 of the PRM specification, specifies that the time between the occurrence of a failure in the on-line channel to the time the standby channel is brought on-line shall not exceed 1 second. The 1-second time allotment is divided into 800 milliseconds (ms) for fault detection and isolation and 200 ms for channel switchover.

This requirement was tested as dictated by the PRM Specification QVM as part of the test procedure CPMS-46 during the Phase 1 test program. It was regression tested during both the Mod 28 and Mod 29 test program as part of test procedure CPMS-346, the CPMS Channel Switchover and Restoration test.

3.1.4.1 Automatic Channel Switchover Final In-Factory Testing.

CPMS-346, the CPMS Channel Switchover test procedure used a logic analyzer, Local Area Network (LAN) Sniffer and test probes to measure Channel Switchover Time, Fault Detection Time, Resumption of Normal Operation Time and Maximum Time Lost Due to Channel Failure. For this test, the full PRM system minus the antenna subsystem was connected to the PATTS to provide controlled, repeatable target scenarios. The PATTS scenario contained the capacity number of displayed targets (35) and secondary targets (25) spread around the coverage volume in order to eliminate garbling. Through analysis and dry-runs during Phase 1 testing, it was determined that the two worst case faults were a Data Processor Subsystem (DP) reset and a DP fault. Both fault methods were used in this test for a total of 10 failures for each of the two PRM channels. Analysis programs were developed, tested, and used to determine the actual results for each of the four metrics named above.

Results of this testing showed that the maximum Channel Switchover Time for the 20 measured and analyzed sample was 0.038 seconds, whereas the specification limit is 0.200 seconds.. The maximum Fault Detection Time was 0.588 seconds, whereas the specification limit is 0.800 seconds.

3.1.4.2 Automatic Channel Switchover Final On-Site Testing.

The PRM QVM did not require that Automatic Channel Switchover be tested On-Site due to the need to use a controlled, repeatable scenario with special test hardware to accurately test this requirement.

3.1.5 System Restoration.

System Restoration, requirement 3.2.1.2.4 of the PRM specification, specifies that the time from the standby channel being brought on-line to the time normal track, display, and alert functions are restored shall not exceed the displayed track update interval.

This requirement was tested as dictated by the PRM Specification QVM as part of the test procedure CPMS-46 during the Phase 1 test program. It was regression tested during both the Mod 28 and Mod 29 test program as part of test procedure CPMS-346, the CPMS Channel Switchover and Restoration test.

3.1.5.1 System Restoration Final In-Factory Testing.

System Restoration was tested in CPMS-346, the CPMS Channel Switchover test procedure as described in section 3.1.4, above.

Results of this testing showed that the maximum Resumption of Normal Operation Time was found to be 0.91 seconds, with a specification limit of 1.125 seconds. Also, the largest recorded value for Maximum Time Lost Due to Channel Failure was found to be 1.97 seconds, with a specification limit of 2.125 seconds.

3.1.5.2 System Restoration Final On-Site Testing.

The PRM QVM did not require that System Restoration be tested On-Site due to the need to use a controlled, repeatable scenario with special test hardware to accurately test this requirement.

3.1.6 Azimuth Coverage.

Azimuth Coverage, requirement 3.2.2.1.2.1 of the PRM specification, specifies BRS shall interrogate and process aircraft targets through 360° of azimuth. This requirement is mitigated by PRM specification requirement 3.2.2.3.6, Sector Blanking, which permits up to five sectors to be blanked from processing interrogations and replies with government approval. The intention of this requirement is to avoid radiating and processing replies in the direction of large fixed obstructions (multipath sources) such as Air Traffic Control Towers (ATCT).

This requirement was tested as dictated by the PRM Specification QVM as part of the FT-201 and BRS-208 test procedures during the Phase 2 test program.

3.1.6.1 Azimuth Coverage Final In-Factory Testing.

The PRM QVM did not require that Azimuth Coverage be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, an analysis report, AR-3, Azimuth Coverage was submitted and approved as part of the Phase 1 test program.

3.1.6.2 Azimuth Coverage Final On-Site Testing.

Azimuth Coverage was tested as part of the Phase 2 test procedures FT-201(Flight Profile 1, Orbits) and BRS-208 (Target Overload).

The FT-201 test procedure used test aircraft to fly a series of five orbits about the PRM antenna at various ranges and elevation angles while the PRM's Record and Playback Subsystem (RPS) recorded the data. The five orbits are described in table 3.1.6.2-1.

TABLE 3.1.6.2-1. FT-201- FLIGHT PROFILE 1 (ORBITS) DESCRIPTION

Orbit #	Distance from PRM antenna	Altitude (MSL)	Elevation Angle	Orbit Direction
1	6 nmi	8500 feet	11.7°.	Clockwise
2	6 nmi	8500 feet	11.7°	Counter-Clockwise
3	8.5 nmi	8500 feet	8.4°	Clockwise
4	12 nmi	8500 feet	6.0°	Counter-Clockwise
5	30 nmi	6500 feet	1.8°	Clockwise

As part of the FT-201 test procedure, the recorded data was then analyzed using specially developed analysis programs to determine the Azimuth Coverage of the PRM system.

The BRS-208 test procedure used targets of opportunity over four 1-hour periods with the following characteristics; (1) Visual Flight Rules (VFR) approaches with aircraft landing on runway 11, (2) VFR approaches with aircraft landing on runway 29, (3) Instrument Flight Rules (IFR) approaches with aircraft landing on runway 11, and IFR approaches with aircraft landing on runway 29. During BRS-208, data was recorded using the PRM's RPS. As part of the BRS-208 test procedure, the recorded data was then analyzed using specially developed analysis programs to determine the azimuth coverage for the PRM system.

Results of the above testing show that the PRM system has 360° of Azimuth Coverage with the exception of the government approved Tower Blanking Sector. The Tower Blanking Sector prevents unwanted interrogations and replies from being processed in the direction of the MSP Air Traffic Control (ATC) Tower. Specifically, interrogations and replies are not processed from beam positions 3054 to 3176. The use of the Tower Blanking Sector is designed to eliminate the control tower as a source of multipath contamination that the PRM would have to handle.

3.1.7 Range Coverage.

Range Coverage, requirement 3.2.2.1.2.2 of the PRM specification, specifies that the slant range coverage for target detection and processing shall be from 500 feet or less to no less than 32 nmi. For targets within 500 to 1000 feet of the antenna, target reports must be generated but the reports shall not be required to meet the range and azimuth accuracy and resolution requirements.

This requirement was tested as dictated by the PRM Specification QVM as part of the FT-202, FT-203, and BRS-208 test procedures during the Phase 2 test program.

3.1.7.1 Range Coverage Final In-Factory Testing.

The PRM QVM did not require that Range Coverage be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-4, Range Coverage was submitted and approved as part of the Phase 1 test program.

3.1.7.2 Range Coverage Final On-Site Testing.

Range Coverage was tested as part of FT-202 (Flight Profile 2, Overflights), FT-203 (Flight Profile 3, Low Glideslope), and BRS-208 (Track Overload) test procedures of the Phase 2 test program.

The FT-202 test procedure used test aircraft to fly a high-altitude overflight along the 190° radial off of the MSP airport from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 14,500 feet, which is 500 feet below the altitude limit of the PRM system. A lower altitude overflight along the 010° radial off of the MSP airport was also flown from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 7500 feet. During FT-202, data was recorded using the PRM's RPS. The recorded data was then analyzed using specially developed analysis programs to determine the range coverage for the PRM system.

The FT-203 test procedure used test aircraft to fly three low-glideslope approaches of 1.7° from 32 nmi away from the airport to 32 nmi past the airport. During FT-203, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to determine the range coverage for the PRM system.

The BRS-208 test procedure used targets of opportunity throughout the 32 nmi coverage volume of the PRM system over four 1-hour periods with the following characteristics; (1) Visual Flight Rule (VFR) approaches with aircraft landing on runway 11, (2) VFR approaches with aircraft landing on runway 29, (3) Instrument Flight Rule (IFR) approaches with aircraft landing on runway 11, and (4) IFR approaches with aircraft landing on runway 29. During BRS-208, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to determine the range coverage for the PRM system.

Results of the testing in FT-202, FT-203, and BRS-208 show that the PRM system has slant range coverage for target detection and processing of 500 feet to 32 nmi.

3.1.8 Elevation Coverage.

Elevation Coverage, requirement 3.2.2.1.2.3 of the PRM specification, specifies that the elevation coverage shall be from -2° to 31° for ranges from 500 feet to 3 nmi. The elevation coverage shall be from 1.5° to 31°, extending to a minimum altitude of 15,000 feet for ranges from 3 nmi to 32 nmi.

This requirement was tested as dictated by the PRM Specification QVM as part of the FT-202, FT-203, and BRS-208 test procedures during the Phase 2 test program.

3.1.8.1 Elevation Coverage Final In-Factory Testing.

The PRM QVM did not require that Elevation Coverage be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-5, Elevation Coverage was submitted and approved as part of the Phase 1 test program.

3.1.8.2 Elevation Coverage Final On-Site Testing.

Elevation Coverage was tested as part of FT-202 (Flight Profile 2, Overflights), FT-203 (Flight Profile 3, Low Glideslope), and BRS-208 (Track Overload) test procedures.

The FT-202 test procedure used test aircraft to fly a high-altitude overflight along the 190° radial off of the MSP airport from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 14,500 feet, which is just 500 feet below the altitude limit of the PRM system. A lower altitude overflight along the 010° radial off of the MSP airport was also flown from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 7500 feet. During FT-202, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to determine the elevation coverage for the PRM system.

The FT-203 test procedure used test aircraft to fly three low-glideslope approaches of 1.7° from 32 nmi away from the airport to 32 nmi past the airport. During FT-203, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to determine the elevation coverage for the PRM system.

The BRS-208 test procedure used targets of opportunity throughout the 32 nmi coverage volume of the PRM system over four 1-hour periods with the following characteristics; (1) VFR approaches with aircraft landing on runway 11, (2) VFR approaches with aircraft landing on runway 29, (3) IFR approaches with aircraft landing on runway 11, and (4) IFR approaches with aircraft landing on runway 29. During BRS-208, data was recorded using the PRM's RPS. The recorded data was then analyzed using specially developed analysis programs to determine the elevation coverage for the PRM system.

Results of the testing in FT-202, FT-203, and BRS-208 show that the PRM system has an elevation coverage in the distances from 500 feet to 3 nmi of -2° to 31°. The elevation coverage from 3 nmi to 32 nmi is 1.5° to 31°, extending to an altitude of 15,000 feet.

3.1.9 Range Accuracy.

Range Accuracy, requirement 3.2.2.1.3.1 of the PRM specification, specifies that the Beacon Radar Subsystem error shall not exceed +/- 30 feet bias (including long-term drift) and 25 feet standard deviation.

This requirement was tested as dictated by the PRM Specification QVM as part of the BRS-240 (BRS System Performance Test), FT-201 (Flight Profile 1, Orbits), FT-202 (Flight Profile 2, Overflights), FT-203 (Flight Profile 3, Low Approach), and RDS-222 (Range Bias and Map Features Test) Phase 2 test procedures.

3.1.9.1 Range Accuracy Final In-Factory Testing.

The PRM QVM did not require that Range Accuracy be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-6, Range Accuracy was submitted and approved as part of the Phase 1 test program.

3.1.9.2 Range Accuracy Final On-Site Testing.

Range Accuracy was tested as part of the BRS-240 (BRS System Performance Test), FT-201 (Flight Profile 1, Orbits), FT-202 (Flight Profile 2, Overflights), FT-203 (Flight Profile 3, Low Approach), and RDS-222 (Range Bias and Map Features Test) Phase 2 test procedures.

The BRS-240 test procedure verifies various system performance parameters under the conditions that the PRM system will be used operationally. The test uses targets of opportunity recorded using the PRM's RPS while using the operational geographic filters, 11A and 29A, in both VFR and IFR conditions. Multiple iterations of the four combinations of 1-hour pushes were recorded and analyzed during this test procedure. As part of the BRS-240 test procedure, the recorded data was analyzed to aid in the determination of the Range Accuracy of the PRM system.

The FT-201 test procedure used test aircraft to fly a series of five orbits about the PRM antenna at various ranges and elevation angles while the PRM's RPS recorded the data. The five orbits are described in table 3.1.6.2-1, above. As part of the FT-201 test procedure, the recorded data was analyzed using specially developed analysis programs to aid in the determination of the Range Accuracy of the PRM system.

The FT-202 test procedure used test aircraft to fly a high-altitude overflight along the 190° radial off of the MSP airport from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 14,500 feet, which is just 500 feet below the altitude limit of the PRM system. A lower altitude overflight along the 010° radial off of the MSP airport was also flown from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 7500 feet. During FT-202, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to aid in the determination of the Range Accuracy of the PRM system.

The FT-203 test procedure used test aircraft to fly three low-glideslope approaches of 1.7° from 32 nmi away from the airport to 32 nmi past the airport. During FT-203, data was recorded using the PRM's RPS . The recorded data was then analyzed using specially developed analysis programs to aid in the determination of the Range Accuracy of the PRM system.

The RDS-222 test procedure uses a mobile transponder to measure the range bias of the PRM system. Various surveyed locations were tested to determine this measurement. This test required the PRM system be in the Manual Built-In Test (MBIT) mode which permits the PRM system to be controlled by data entry commands by a test engineer. System parameters such as interrogation type, beam position, and Sensitivity Time Control (STC) were manually adjusted to interrogate and receive replies from the mobile transponder to determine the range bias component of the Range Accuracy requirement of the PRM system.

3.1.9.2.1 Range Accuracy Data Analysis and Results.

Data collected during the BRS-240, FT-201, FT-202, and FT-203 test procedures was analyzed using the POLY_FIT.M Data Reduction and Analysis (DR&A) program. The polynomial fit estimation of the target of interest flight path removes the flight technical error from the test flight data, while it leaves the PRM noise in the true flight path. The key in this technique is to remove just the flight technical error while leaving the PRM noise in the target's of interest flight path. For the purposes of this analysis, the number of data points used in the polynomial fit was 31 points; 15 points ahead of the aircraft and 15 points behind the aircraft. This translates to an average flight technical error of 31 seconds, which through analysis has been shown to be an effective value in removing just the flight technical error.

POLY_FIT.M uses PRM recorded positional information of selected targets of interest and performs a polynomial fit estimation of that target's true flight path. The true flight path is then compared with the PRM recorded flight path for accuracy tests in both range and azimuth. The output of the analysis program are plots of range error standard deviation and azimuth error standard deviation over the length of flight data desired. Data sectoring was used to minimize the impact of multipath sources on the analysis results. The size of the data sector was dependent on the type of flight. Radial flights (i.e., overflights, low glideslope approaches and straight inbound approaches of targets of opportunity) were examined over data sectors of 3.3 nmi. The first data sector started at 1000 feet (0.16 nmi). Additional data sectors began at 1 nmi increments from the first data sector. Orbital flights were examined over 13° azimuth sectors. The orbital sectors were examined around the 360° coverage requirement in 1° increments to the starting azimuth. The computed accuracy for each sector (both radial and orbital flights) was then graphed at the midpoint of each data sector.

As part of the RDS-222 test procedure, the Range Bias component of the Range Accuracy requirement was determined to be a maximum of 28.2 feet compared to a specification requirement of 30 feet or less. This result was determined by mathematically comparing the surveyed positional data of various points on the MSP airport property to the PRM reported positional data of a mobile transponder at the surveyed positions as collected during the data collection phase of the RDS-222 test procedure.

Results of the data analysis performed on the data for range accuracy show that +/- 30-foot bias and 25-foot standard deviation requirements are met by the PRM system. Of the 42 range sectors analyzed, two of the sectors exceed the 25-foot standard deviation requirement by less than 5 feet. Sample size of these 2 sectors is less than 100, which is much less than the thousands of samples collected for range sectors closer to the airport. The reason for the smaller number of samples at these ranges is simply due to traffic flow into the MSP airport during this testing.

3.1.10 Range Resolution.

Range Resolution, requirement 3.2.2.1.3.2 of the PRM Specification, specifies that when two or more beacon targets are at the same altitude and azimuth but separated by any range in excess of 600 feet, each target shall be individually detected and reported a minimum of 98 percent of the time.

This requirement was tested as dictated by the PRM Specification QVM as part of the FT-205 (Flight Profile 5, Resolution) Phase 2 test procedure.

3.1.10.1 Range Resolution Final In-Factory Testing.

The PRM QVM did not require that Range Resolution be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-7, Range Resolution was submitted and approved as part of the Phase 1 test program.

3.1.10.2 Range Resolution Final On-Site Testing.

Range Resolution was tested as part of the FT-205 (Flight Profile 5, Resolution) Phase 2 test procedure.

The Range Resolution portion of the Resolution Flight Test, FT-205 required that two test aircraft fly along radials towards and away from the PRM antenna. For this test, it was necessary for the two test aircraft to be within the azimuth resolution limits (0.57°) of each other in order to ensure that the PRM system was using range to resolve the targets' replies. The lead aircraft maintained a constant airspeed and the trailing aircraft varied his airspeed based on the test controllers' commands in order to vary the slant range between the test aircraft. Since the test was run in VFR conditions, the altitude separation of the test aircraft was left to the discretion, and comfort level of the test pilots. Both test aircraft had their Mode C transponders turned off in order to prevent the PRM system from using altitude data to maintain track separation of the aircraft. Test data was recorded using the PRM record and Playback Subsystem over the 128 miles of the flight profile.

Test data was analyzed using specially developed analysis software to determine the range resolution of the PRM system. The data was analyzed to determine if the sets of replies from each update period was within the same interrogation beam. This was done to insure that the PRM system used range information to resolve the targets as opposed to azimuth information. The data was then analyzed to determine if each set of replies was within the overlapped reply window of approximately 2.5 nmi in slant range. Analysis showed that there were 1244 sets of replies from the test aircraft that met both the azimuth and slant range criteria. The slant range distance between the test aircraft varied from a minimum of 178 feet to a maximum of 5467 feet and was randomly distributed due to the nature of the flight profile. In summary, 1239 of the 1244 sets of data points that met the analysis criteria were correctly resolved by the PRM system.

Results of this Range Resolution flight test show that the PRM system resolved the two targets 99.6 percent of the time when separated by greater than 178 feet. Data points less than the specification requirement of 600 feet were included in the final analysis since these data points did not adversely affect the test results.

3.1.11 Azimuth Accuracy.

Azimuth Accuracy, requirement 3.2.2.1.3.3 of the PRM Specification, specifies that azimuth error shall not exceed 0.06° root mean square (rms) for all target reports in the system range and azimuth coverage area and at elevation angles of 10° or less. At elevation angles in excess of 10° and up to 31°, the azimuth error shall not exceed 0.28° rms.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 2 test program. Specifically, the requirement was tested in the BRS-240 (BRS System

Performance Test), FT-201 (Flight Profile 1, Orbits), FT-202 (Flight Profile 2, Overflights). and FT-203 (Flight Profile 3, Low Approach) test procedures.

3.1.11.1 Azimuth Accuracy Final In-Factory Testing.

The PRM QVM did not require that Azimuth Accuracy be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-7, Azimuth Accuracy was submitted and approved as part of the Phase 1 test program.

3.1.11.2 Azimuth Accuracy Final On-Site Testing.

Azimuth Accuracy was tested as part of the BRS-240 (BRS System Performance Test), FT-201 (Flight Profile 1, Orbits), FT-202 (Flight Profile 2, Overflights), and FT-203 (Flight Profile 3, Low Approach), Phase 2 test procedures.

A discussion of both the range and accuracy testing performed on the PRM system is included in section 3.1.9.2, above.

3.1.11.2.1 Azimuth Accuracy DR&A and Results.

A discussion of both the range and accuracy DR&A performed on the PRM system is included in section 3.1.9.2.1, above.

The four test procedures that were used to test Azimuth Accuracy included a total of 13 composite flight profiles which tested both test aircraft and target of opportunity scenarios. A breakdown of the flight profiles run during this test are listed in table 3.1.11.2.1-1.

TABLE 3.1.11.2.1-1. AZIMUTH ACCURACY FLIGHT PROFILES

Test Procedure	Type of Test Aircraft	Type of Flight Profile	Range, Radial or Approach	Direction Clockwise (CW) or Counter CW (CCW)	Altitude or Glideslope Angle
FT-201	Controlled	Orbit	6 nmi	CW	8500 feet
FT-201	Controlled	Orbit	6 nmi	CCW	8500 feet
FT-201	Controlled	Orbit	8.5 nmi	CW	8500 feet
FT-201	Controlled	Orbit	12 nmi	CW	8500 feet
FT-201	Controlled	Orbit	30 nmi	CW	6500 feet
FT-202	Controlled	Overflight	190 deg	N/A	7600 feet
FT-202	Controlled	Overflight	10 deg	N/A	14600 feet
FT-203	Controlled	Low Glideslope	29 Left	N/A	1.7 deg
FT-203	Controlled	Low Glideslope	29 Right	N/A	1.7 deg
FT-203	Controlled	Low Glideslope	11 Left	N/A	1.7 deg
FT-203	Controlled	Low Glideslope	11 Right	N/A	1.7 deg
BRS-240	Target of Opportunity	VFR & IFR Approaches	11 L&R	N/A	variable
BRS-240	Target of Opportunity	VFR & IFR Approaches	29 L&R	N/A	variable

The output of each composite flight profile was a plot of PRM Azimuth rms Error versus either PRM Range (in nmi) or PRM Azimuth (in degrees). For those plots which analyzed the data in respect to range, data was processed in overlapping range bins of 3.287 nmi in order to minimize the effects of multipath sources on the test outcome. For those plots which analyzed the data in respect to azimuth, data was processed in overlapping azimuth bins of 13° in order to minimize the effects of multipath sources on test outcome.

Each of the individual plots was further analyzed to ensure that the number of data points in each of the range or azimuth bins was of statistical significance and that the results met the Azimuth Accuracy requirement of 0.06° for all range bins or azimuth bins. Because of the test and data analysis methodology, a single discrete Azimuth Accuracy result was not derived. However, in each of the 13 test cases, the test results show that the PRM system met the Azimuth Accuracy requirement of 0.06°.

Results of the data analysis performed on the data for azimuth accuracy show that the azimuth error does not exceed 0.06° rms for target reports in the system range and azimuth coverage area at elevation angles of 10° or less. Also, at elevation angles in excess of 10° and up to 31°, the azimuth error does not exceed 0.28° rms.

3.1.12 Azimuth Resolution.

Azimuth Resolution, requirement 3.2.2.1.3.4 of the PRM Specification, specifies that when two beacon targets are at the same range and altitude but separated by any angle in excess of 0.57°, each target shall be individually detected and reported a minimum of 95 percent of the time.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 2 test program. Specifically, Azimuth Resolution was tested as part of the FT-205 (Flight Profile 5, Resolution) Phase 2 test procedure. It was finally tested On-Site as part of the Mod 29 T&E test program in the FT-205M (Flight Profile 5, Resolution) test procedure.

3.1.12.1 Azimuth Resolution Final In-Factory Testing.

The PRM QVM did not require that Azimuth Resolution be tested In-Factory due to lack of system integration with the Antenna Subsystem. However, analysis report AR-8, Azimuth Resolution was submitted and approved as part of the Phase 1 test program.

3.1.12.2 Azimuth Resolution Final On-Site Testing.

Azimuth Resolution was finally test On-Site as part of the FT-205M (Flight Profile 5, Resolution) Mod 29 T&E test procedure.

FT-205M required that two test aircraft fly a series of radials towards and away from the PRM antenna. For this test, it was necessary for the two test aircraft to be within the range gate limits (120 feet) of each other while the azimuth separation was varied based on test controller instructions to the test pilots. Both test aircraft turned off the Mode C (Altitude) transponders in order to ensure that altitude information was not used to resolve the test aircraft. The lead aircraft in this flight test maintained a constant heading, airspeed, and altitude, while the maneuvering aircraft attempted to maintain the same altitude and relative range from the PRM antenna as the lead aircraft, while attempting to vary only the relative azimuth separation. The test controller instructed the maneuvering aircraft to merge towards the lead aircraft until azimuth separation of the test aircraft was lost. At this point the test controller instructed the maneuvering aircraft to separate from the lead aircraft. The maneuvering aircraft continued separating in azimuth until the PRM system regained two tracks on the PRM display. At this point the test controller repeated his order for the maneuvering aircraft to merge with the lead aircraft. This process continued across the PRM coverage area, excluding the zenith cone area above the PRM antenna. Test data was recorded using the PRM RPS throughout the flight profile. Test data was analyzed using specially developed analysis software to determine the azimuth resolution of the PRM system. As part of this analysis, test aircraft encounters which did not maintain a range separation of 120 feet or less were not used in order to ensure that the PRM system did not use range gate information to resolve the test targets.

Of the 60 test aircraft encounters that were performed, 48 encounters were not used in the final analysis because the relative range separation of the test aircraft was greater than the 120-foot test criteria. Of the 12 encounters that had a relative range separation of less than 120 feet, all 12 met the Azimuth Resolution requirement of 0.57° with the actual results ranging from a minimum of 0.00° to 0.47° of azimuth separation prior to the loss of azimuth resolution.

Results of the Azimuth Resolution Flight Test show that the PRM system achieved an azimuth resolution of 0.57° or greater 100 percent of the time during this test.

3.1.13 Code Accuracy.

Code Accuracy, requirement 3.2.2.1.4 of the PRM Specification, specifies that the reporting of incorrect beacon code data, including Mode 3/A, Mode C, and the SPI, due to fruit or other causes, shall not occur more than 1.0 percent of the time.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 and 2 test programs. This requirement was tested in the Phase 1 Code Accuracy test procedure (BRS-2). The requirement was retested in the Phase 3 and Mod 28 T&E test programs using the BRS-305 test procedure of the Phase 3, System Serial Number 3 test program. The Code Accuracy requirement was also tested in Phase 2 using the FT-202 (Flight Profile 2, Overflights) and the FT-204 (Flight Profile 4, Target Processing) test procedures.

3.1.13.1 Code Accuracy Final In-Factory Testing.

The final In-Factory testing for Code Accuracy occurred in the BRS-302 (Code Accuracy) test procedure of the Phase 3, System Serial Number 3, and Mod 28 T&E test programs. In BRS-302, the PRM system was configured with the PATTS replacing the PRM Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test was run at track capacity with the targets arranged in a 20°-azimuth wedge along with a maximum FRUIT environment of 10,000 FRUIT per second per 360°.

The PATTS scenario, CAP60.TST was run and data was collected using the PRM System RPS. This data was analyzed using specially developed analysis programs.

Results of the analysis show that the PRM system reports incorrect Mode 3/A, Mode C, and SPI data 0.04 percent of the time under a capacity load and FRUIT environment. Analysis showed that the 0.04 percent result was due to garbling situations between several targets in the PATTS scenario. This result is significantly below the 1 percent value specified in the Code Accuracy requirement.

3.1.13.2 Code Accuracy Final On-Site Testing.

Code Accuracy was finally verified On-Site through the use of two Phase 2 test procedures, FT-202 and FT-204.

The FT-202 test procedure used test aircraft to fly a high-altitude overflight along the 190°-radial off of the MSP airport from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 14,500 feet, which is 500 feet below the altitude limit of the PRM system. A lower altitude overflight along the 10° radial off of the MSP airport was also flown from 32 nmi away from the airport to 32 nmi past the airport. The altitude of this flight was 7500 feet. During FT-202, data was recorded using the PRM's RPS. The recorded data was then analyzed using specially developed analysis programs to determine the code accuracy for the PRM system.

The FT-204 test procedure used test aircraft to fly several maneuvers and aircraft responses to test the PRM's ability to process replies and handle them appropriately. This included testing of the Special Position Indicator (SPI) reply and emergency codes. During FT-204, data was recorded using the PRM's RPS. This data was then analyzed using specially developed analysis programs to determine the code accuracy for the PRM system.

Analysis results for data collected during FT-202 and FT-204 showed that the PRM incorrectly reported incorrect Mode 3/A, Mode C and SPI information 0 percent of the time during this test.

3.1.14 Search/Acquisition Target Report Probability.

Search/Acquisition Target Report Probability, requirement 3.2.2.1.6.1 of the PRM Specification, specifies that given a reply probability of 0.76, the search/acquisition probability of detection shall be; greater than or equal to 0.90 within 7 seconds of a target entering the coverage volume, greater than or equal to 0.99 within 11 seconds of a target entering the coverage volume, and greater than or equal to 0.999 within 15 seconds of a target entering the coverage volume.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 and Phase 2 test programs. The requirement was retested during the Mod 29 T&E test programs. This requirement was tested in the Phase 1 Search Target Report Probability test procedure (BRS-3, BRS New Target Processing). It was also tested in the FT-204 (Flight Profile 4, Target Processing) test procedure. As part of the Mod 29 T&E test program, the requirement was retested in the FT-204M test procedure.

3.1.14.1 Search/Acquisition Target Report Probability Final In-Factory Testing.

The BRS-3 test procedure used the PRM system connected to the PATTS instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test determined the Search Target Report Probability by measuring the new target processing time. This time is defined as the time from a new target entering the coverage region to the time the target is displayed on RDS displays. This time includes the time the target was in the coverage area, but not yet detected by a search interrogation (search time), the time for the acquisition interrogations (acquisition time), and the time for the RDS to process and display the target information (Graphics Processor (GP) processing time). Using the PATTS scenario, POPSRCH.TST, to provide target inputs to the PRM antenna ports, a logic analyzer was used to measure the time from PATTS loading the targets into memory to the time of the first PRM acquisition interrogation. A specially developed analysis program was then used to determine the time from the first acquisition interrogation to the time when the PRM's Data Processor sent the first set of target data to the GP. The GP Processing time was taken to be 0.5 seconds as determined by the Displayed Track Throughput Test, SYS-3.

Results of this test show that 91 percent of new targets were displayed in less than 7 seconds, as compared to the requirement of 90 percent. Analysis shows that 99 percent of the targets would be displayed in less than 11 seconds and 99.9 percent of the targets would be displayed in less than 15 seconds.

3.1.14.2 Search/Acquisition Target Report Probability Final On-Site Testing.

This requirement was verified as part of FT-204M (Flight Profile 4, Target Processing) during the Mod 29 T&E test phase. The FT-204M test procedure used test aircraft to fly several maneuvers and aircraft responses to test the PRM's ability to process replies and handle them appropriately. One portion of this flight profile required the test aircraft pilot to place his transponder in standby mode, wait for the target to be dropped from the PRM system, and on the command of the test controller, turn the transponder on. The time from the controller's command to the time the target reappeared on the PRM display was taken as the Search/Acquisition time. This process was repeated 20 times, 10 times on each PRM channel.

Results of this test confirmed that the PRM acquires new targets in less than 7 seconds greater than 90 percent of the time. (For this limited test, the actual result was 100 percent of the time.) Extrapolation shows that the PRM would therefore acquire new targets in less than 11 and 15 seconds greater than 99 percent and 99.9 percent of the time, respectively.

3.1.15 Track Update Probability.

Track update probability, requirement 3.2.2.1.6.3 of the PRM Specification, specifies that the Beacon Radar Subsystem shall update each established track 99 percent of the time, assuming a round reliability of 0.76. Also, pairs of replies that are drifting through each other, shall be decoded correctly 50 percent of the time. This requirement shall be met while the system is operating at system capacity.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1, Phase 2, and Phase 3 test programs. This requirement was also retested in the Mod 28 T&E and Mod 29 T&E test programs.

Track Update Probability was tested in the BRS-5 (BRS Track Update and Capacity) test procedure in the Phase 1 test program. It was tested in the BRS-240 (BRS System Performance Test) during the Phase 2 test program. It was finally tested In-Factory in the BRS-305 (BRS Track Update Test) in the Phase 3 test program. The BRS-305 Phase 3 test results were used as the Mod 28 T&E test results since those test programs were run concurrently. It was finally tested On-Site in the BRS-240M (BRS System Performance Test) of the Mod 29 T&E test program.

3.1.15.1 Track Update Probability Final In-Factory Testing.

The BRS-305 Phase 3 test procedure provided the final In-Factory testing of the Track Update Probability requirement. This test procedure also served as the test for the Mod 28 T&E test program.

BRS-305 had the PRM configured with the PATTS instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test actually used data collected by the PRM's RPS from the Phase 3, System 2 BRS-302 (Code Accuracy) test procedure for the Probability of Detection (PoD) portion of the requirement. The PoD portion of the requirement used the PATTS scenario CAP60.TST to simulate a capacity target load on the PRM system. The recorded data was analyzed using a specially developed analysis program to provide the results.

The "drifting replies" portion of the Track Update Probability requirement was tested using the ADRIFTER.TST PATTS scenario. This scenario had pairs of replies slowly drifting through each other while the RPS recorded this data. After the test, an analysis program was used to determine the PoD for these drifting targets.

Results of the Track Update Probability test show that the PRM system had an overall PoD for the capacity scenario of 99.52 percent, as compared to the required value of 99 percent. Results of the "drifting reply" portion of this test show that drifting targets had a PoD of slightly greater than 84 percent, whereas the PRM specification required a result of 50 percent.

3.1.15.2 Track Update Probability Final On-Site Testing.

Final On-Site testing of the Track Update Probability requirement was provided by the BRS-240M test procedure during the Mod 29 T&E test program. The BRS-240M test procedure verified various system performance parameters under the conditions that the PRM system will be used operationally. The test uses targets of opportunity recorded using the PRM's RPS while using the operational geographic filters, 11A and 29A, in both VFR and IFR conditions. Multiple iterations of the four combinations of 1-hour pushes were recorded and analyzed during this test procedure. As part of the BRS-240M test procedure, the recorded data was analyzed to aid in the determination of the PoD of the PRM system. The drifting reply portion of the Track Update Probability requirement was not retested in this test procedure due to the nature of Target of Opportunity testing and the completeness of the final In-Factory testing.

The results of the BRS-240M test procedure show that the PRM has an overall operational PoD of 99.14 percent.

3.1.16 Search Coverage Interval.

Search coverage interval, requirement 3.2.2.1.7.1 of the PRM Specification, specifies that the Beacon Radar Subsystem provide surveillance coverage of the entire system coverage area every 4 seconds.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 test program in the BRS-9 (BRS Search Processing) test procedure. The requirement was retested in the Mod 28 T&E test program through the use of the BRS-309 (BRS-Search Processing) test procedure.

3.1.16.1 Search Coverage Interval Final In-Factory Testing.

BRS-309 configured the PRM system with the PATTS connected to the PRM antenna ports instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test uses a PATTS scenario with three sets of 36 stationary targets. Each set of targets is equally spaced 10° apart around the 360° coverage area, with each of the three sets rotated 3.3° from the previous set. While the test was being run, data was being recorded using the RPS. This data was then analyzed using a specially developed analysis program to determine the Search Coverage Interval for each of the 104 targets. The test was run on both PRM channels.

Results of the analysis performed on the data collected during the Search Coverage Interval test show that the 4-second search scan rate requirement is met. The maximum Search Coverage Interval was found to be 4.06 seconds, well within the requirement of 4 seconds +/- 0.125 seconds testing tolerance.

3.1.16.2 Search Coverage Interval Final On-Site Testing.

The PRM QVM did not require that Search Coverage Interval be tested On-Site due to the need to use a controlled, repeatable scenario to accurately test this requirement.

3.1.17 Displayed Track Update Interval.

Displayed track update interval, requirement 3.2.2.1.7.2 of the PRM Specification, specifies that the BRS shall interrogate and update displayed tracks at an update interval of 1 +/- 0.125 seconds 99 percent of the time, exclusive of overflow and overload conditions.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 test program in the BRS-5 (BRS Track Update and Capacity) test procedure. The requirement was also tested in the Phase 3 test program BRS-305 (BRS Track Update Test) test procedure. The requirement was scheduled to be retested in the Mod 28 T&E test program; however, the results of the Phase 3 BRS-305 test procedure was used to fulfill this testing requirement in order to expedite the test program. This substitution was permitted because PRM System Serial 3 was updated to the MOD 28 T&E configuration prior to its Phase 3 testing.

3.1.17.1 Displayed Track Update Interval Final In-Factory Testing.

The BRS-305 Phase 3 test procedure provided the final In-Factory testing of the Displayed Track Update Interval requirement. This test procedure also served as the test for the Mod 28 T&E test program.

BRS-305 had the PRM configured with the PATTS instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test actually used data collected by the PRM's RPS from the Phase 3, System 2 BRS-302 (Code Accuracy) test procedure for the Displayed Track Update Interval requirement. BRS-302 uses the CAP60.TST PATTS scenario to provide a capacity load situation to the PRM. The recorded data was then analyzed using a specially developed analysis program.

Results of the Displayed Track Update Interval test procedure's data analysis show that all of the 48,000 target updates were provided within the 1 +/- 0.125 second requirement.

3.1.17.2 Displayed Track Update Interval Final On-Site Testing.

The PRM QVM did not require that the Displayed Track Update Interval requirement be tested On-Site due to the need to use a controlled, repeatable scenario to accurately test this requirement.

3.1.18 Track Capacity.

Track capacity, requirement 3.2.2.1.8 of the PRM Specification, specifies that the Beacon Radar Subsystem shall simultaneously track the number of displayed and secondary tracks specified below:

TABLE 3.1.18-1. TRACKING REQUIREMENTS

Number of Parallel Runways	Displayed track Update Interval	Displayed Track Capacity	Secondary Track Capacity
2	1.0 Second	25	15
3	1.0 Second	35	25

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 test program in the BRS-5 (BRS Track Update and Capacity) test procedure. The requirement was also tested in the Phase 3 test program BRS-305 (BRS Track Update Test) test procedure. The requirement was scheduled to be retested in the Mod 28 T&E test program; however, the results of the Phase 3 BRS-305 test procedure was used to fulfill this testing requirement in order to expedite the test program. This substitution was permitted because PRM System Serial 3 was updated to the MOD 28 T&E configuration prior to its Phase 3 testing.

3.1.18.1 Track Capacity Final In-Factory Testing.

The BRS-305 Phase 3 test procedure provided the final In-Factory testing of the Track Capacity requirement. This test procedure also served as the test for the Mod 28 T&E test program.

BRS-305 had the PRM configured with the PATTS instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. This test actually used data collected by the PRM's RPS from the Phase 3, System 2 BRS-302 (Code Accuracy) test procedure for the Displayed Track Update Interval requirement. BRS-302 uses the CAP60.TST PATTS scenario to provide a capacity load situation to the PRM. The recorded data was then analyzed using a specially developed analysis program.

Results of data analysis performed on the BRS-305 data show that the PRM system can track 35 targets at a 1-second update rate while meeting all other performance requirements.

3.1.18.2 Track Capacity Final On-Site Testing.

The PRM QVM did not require that the Displayed Track Update Interval requirement be tested On-Site due to the need to use a controlled, repeatable scenario to accurately test this requirement.

3.1.19 Displayed Track Overload/Overflow Processing.

Displayed Track Overload/Overflow Processing, requirement 3.2.2.5.4.3.2 of the PRM Specification, specifies, in part, that when 100 percent of the displayed track capacity is utilized, the Beacon Radar Subsystem shall increment the displayed track update interval as needed to maintain all displayed tracks in the coverage area, up to the maximum displayed track update interval of 2.4 +/- 0.25 seconds. Also, when in the track overflow condition, and the track load reduces below 90 percent utilization, the BRS shall resume interrogating and updating the displayed tracks at the 1 +/- 0.25 second displayed track update interval.

This requirement was tested as dictated by the PRM Specification QVM as part of the Phase 1 test program in the BRS-8 (BRS Track Overload) test procedure. The requirement was then tested during the Phase 2 test program through the use of the BRS-208 (BRS Track Overload) test procedure. The final In-Factory testing of this requirement occurred during the Phase 3 test program BRS-308 (BRS Track Overload) test procedure. The requirement was scheduled to be retested in the Mod 28 T&E test program; however, the results of the Phase 3 BRS-308 test procedure was used to fulfill this testing requirement in order to expedite the test program. This substitution was permitted because PRM System Serial 3 was updated to the Mod 28 T&E configuration prior to its Phase 3 testing. The final On-Site testing of this requirement occurred during the Mod 29 T&E test program through the use of BRS-208M (BRS Track Overload) test procedure.

3.1.19.1 Displayed Track Overload/Overflow Processing Final In-Factory Testing.

BRS-308 had the PRM configured with the PATTS instead of the Antenna Subsystem. The PATTS allows simulated targets, arranged in a particular scenario suited to the test objectives, to be input to the PRM antenna ports. The track processing load is the number of targets that the Beacon radar Subsystem reports are in track. The BRS tracks targets as displayed tracks, secondary tracks, and image tracks. Only displayed tracks are sent to the RDS for display. The track processing load reflects all three types of tracks. Since the update rate of the tracks is not the same, the track processing load is determined by weighting the targets by track type.

The PATTS scenarios ACAPOVL.TST and ACAPOVL2.TST used in this test consist of various levels of target load to test the PRM tracking capacity. The target load in each scenario gradually increases to overload, overflow, and maximum capacity prior to reducing the target load in the same fashion. The two scenarios use different mixes of track type to more fully test the system. While the test was running, the PRM RPS recorded the data. This data was then analyzed using specially developed analysis routines to determine the results of this test.

The detailed analysis provided in the BRS-308 test show that the PRM system transitions properly from normal, overload, and overflow states. While in each of these states, the PRM maintains the required 99 percent PoD for the targets within the coverage area and maintains track updates at the proper update rates.

3.1.19.2 Displayed Track Overload/Overflow Processing Final On-Site Testing.

BRS-208M verifies the PRM system performance under operational conditions. For this test, the PRM operates under full coverage conditions (range of 32 nmi and altitude limit of 15,000 feet) while Targets of Opportunities land and takeoff during various "push" conditions. Data was recorded during these pushes using the PRM's RPS. This data was then analyzed using specially developed analysis programs to determine the Displayed Track Overload/Overflow Processing.

The analysis provided in the BRS-208M test show that the PRM system transitions properly from normal, overload, and overflow states. While in each of these states, the PRM maintains the required 99 percent PoD for the targets within the coverage area and maintains track updates at the proper update rates.

4. CONCLUSIONS.

ACT-310 has identified 19 system performance characteristics of the Precision Runway Monitor (PRM) system. Each of these 19 characteristics have been fully tested throughout the PRM Development Test and Evaluation (DT&E) test program. Based on participation in the DT&E test program and a review of the contractor provided DT&E test reports, it has been found that the PRM system meets the PRM Specification requirements for each of the 19 system performance characteristics.

Two deviations/waivers have been submitted and approved that relate to the PRM System Performance Characteristics. Deviation/Waiver Number PRM-W0019-43 relates to Requirement 3.2.1.2.1.2 (False Track Removal) of the PRM Specification. The waiver notes that during Phase 2 testing, 1 split target stayed on the Radar Display Subsystem (RDS) for a total of 11 seconds. This is significantly greater than the 5-second value stated in the requirement. However, since the PRM system did not have enough information regarding that target to ensure that it would be discarding the image target as opposed to the real target, it was decided to allow this exception. Contract Modification 29 design changes addressed this issue in part. A reoccurrence of this single event did not occur in the final On-Site testing during Mod 29 T&E, nor was it able to be reproduced using the PRM Antenna Simulator (PATTS) in additional In-Factory experimentation.

The second deviation/waiver relating to the PRM System Performance Characteristics is Deviation/Waiver Number Waiver PRM-W0019-044 relates to requirement 3.2.1.2.2 (Displayed Track Throughput) of the PRM Specification. The waiver notes that during the testing and analysis performed during the Phase 3 test for the SYS-303 test procedure, it was found that the theoretical Displayed Track Throughput maximum value could be 0.5601 seconds. While test results greater than the PRM Specification limit of 0.5 seconds have not occurred, it was felt that this waiver be processed.

5. RECOMMENDATIONS.

ACT-310 recommends no additional system performance testing of the PRM system unless future design changes occur that may affect the baseline system performance characteristics.

6. LIST OF ACRONYMS AND ABBREVIATIONS.

AF	Airways Facilities
ANT	Antenna Subsystem
AR	Analysis Report
ARTS	Automated Radar Tracking System
ARTS I/F	Automated Radar Tracking System Interface
AT	Air Traffic
ATCT	Air Traffic Control Tower
ATL	Atlanta International Airport
BRS	Beacon Radar Subsystem
CPMS	Confidence and Performance Monitoring Subsystem
CS	Communications Subsystem
DCS	Discrepancy Control System
DP	Data Processor
DR&A	Data Reduction and Analysis
DT&E	Developmental Test and Evaluation
EM	Executive Monitor
E-Scan	Electronically Scanned
FAA	Federal Aviation Administration
FAATC	FAA Technical Center
FRUIT	False Replies Unsynchronous In Time
FT	Flight Test
GA	General Aviation
GP	Graphics Processor
IFR	Instrument Flight Rules
IMC	Instrumented Meteorological Conditions
JFK	John F. Kennedy International Airport
LAN	Local Area Network
LED	Light Emitting Diode
MBIT	Manual Built-in Test
Mod	Modification
MSP	Minneapolis-St. Paul International Airport
NAS	National Airspace System
nmi	nautical mile
NTZ	No Transgression Zone
Op-Site	Operational Site
OT&E	Operational Test and Evaluation
PAT&E	Production Acceptance test and Evaluation
PATTS	PRM Antenna Simulator
PHL	Philadelphia International Airport
PoD	Probability of Detection
PRM	Precision Runway Monitor
PSD	PRM Status Display
PVCS	Positive Verification Control System
QRO	Quality Reliability Officer
QVM	Quality Verification Matrix
RDS	Radar Display Subsystem

RF	Radio Frequency
RFD	Radio Frequency Distribution Subsystem
rms	root mean square
RPS	Record and Playback Subsystem
SP	Signal Processor
SPI	Special Position Indicator
STL	St. Louis International Airport
SYS	System
T&E	Test and Evaluation
T/R	Transmit/Receive
TTG	Test Target Generator
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions