Rhino™ II Transportable Transponder Landing System

Expanded Service Volume System Design Specification

ADVANCED NAVIGATION & POSITIONING CORPORATION

Milestone #29
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ENGINEERING CHANGE ORDER RECORD
SYSTEM SPECIFICATION

Document No. 010-00057 – REV -

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SECTION 1 SCOPE

1-1 Introduction

This document defines down to the assembly level system requirements that affect the Technical Demonstration Model, design, fabrication, testing, and certification of the Rhino™ II Transportable Transponder Landing System being developed by Advanced Navigation and Positioning Corporation (ANPC).

Specific terms used in this document are defined follows:

Terminology	Word/Phrase Meaning In This Document
Shall	Marks the statement following as a requirement to the Advanced Navigation and Positioning Corporation Engineering Department for development and construction of the System known as Rhino II.
Cooperating Aircraft	An aircraft equipped with an Air Traffic Control Radar Beacon Transponder (ATCRBS) that is functioning and capable of responding to interrogations, and whose operator will adjust the Mode 3/A output coding to correspond with Rhino II requirements.
Main Runway	Primary approach end of a designated runway where Rhino II will be deployed to ensure Category 1 flight operations are possible.
Reciprocal Runway	The opposite approach end of the Main Runway, Rhino II priority placement will ensure Category 1 service to the main therefore service volume and accuracy of approach to the reciprocal runway will be dependant on environmental circumstances.
Secondary Track	Track data obtained by use of transponder response signals from all cooperating aircraft Cooperating Aircraft within a 20 mile range 360 degrees area about the runway centered on threshold, being displayed to an air traffic controller for air space management.
Secondary Tracking	The use and provision of Secondary Track data

1-2 System Overview

The original Rhino™ Transportable Transponder Landing System was designed as a tactical military version of the civilian Transponder Landing System (TLS®). The landing system meets or exceeds the accuracy and integrity listed in the ICAO Annex 10 standards for Category I precision approach. The Rhino is deployed in one C-130 aircraft, and three men can site, install, survey, calibrate, and operate the system from expeditionary airfields.

The Rhino is, first and foremost, a precision tracking system. The system determines the location of the aircraft by interrogating the aircraft transponder and then resolving the transponder's location, in azimuth, elevation angle, and range, from measurements provided from two Angle-of-Arrival (AOA) sensors.

To complement the tracking capability, the system can provide guidance to a tracked aircraft. Guidance is available to the aircraft in two different platforms, Ground Controlled Approach (GCA) and VHF/UHF Instrument Landing System (ILS). In the GCA platform the system presents a Precision Approach Radar (PAR) display format to the system operator, enabling the controller to complete conventional ground controlled approach. Secondly, the system is able to emulate an ILS approach aid. When receiving Rhino II guidance, the pilot flies the aircraft as if it were on an ILS approach. To receive Rhino guidance, the aircraft must be equipped with a standard ILS receiver and an ILS display.

Under guidance from Headquarters of Marine Corps and Marine Corps Warfighting Laboratory, ANPC is augmenting the capabilities of the Rhino system resulting in the Rhino II. A Cooperative Agreement has been established to fund this development, which is being managed by Naval Air Warfare Center Aircraft Division (NAWCAD).

The government expressed interest in a Rhino-type system that is augmented to provide 360^{o} tracking, provide guidance to reciprocal runways, and track multiple aircraft on final approach. Rhino II shall display aircraft position and guidance information on up to 5 monitors serving one approach controller and four GCA controllers. Secondary Tracking shall provide position and transponder information on all Cooperating Aircraft up to a 20-mile radius of airspace centered on the Rhino II site.

1-3 Applicable Documents

1-3.1 Government Documents

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement

Code of Federal Regulations, Title 14, Aeronautics and Space, Parts 140 to 199; 1993 edition.

Code of Federal Regulations, Title 47 Telecommunications, Part 15 Radio Frequency Devices, United States Federal Communications Commission, October 1991.

Code of Federal Regulations, Title 47 Telecommunications, Part 87 Aviation Services, United States Federal Communications Commission, October 1990.

Code of Federal Regulations, Title 14 Federal Aviation Regulations, Part 171: Non-Federal Navigation Facilities, September 1992.

Federal Aviation Administration Specification, G-2100F, the Electronic Equipment, General Requirements Specification, December 06, 1993.

Mil-Std-461C, Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, August 4, 1986.

Mil- Std-810E, Environmental Test Methods and Engineering Guidelines, Revised February 9, 1990.

Mil-HDBK-454, General Guidelines for Electronic Equipment, Guideline 1, Safety Design Criteria, April 28, 1995.

Mil-Std-1366C, Transportability Criteria, February 27, 1992.

Mil-F-14072, Military Specification Finishes for Ground Based Electronic Equipment, October 4, 1990.

Mil-P-9503B, Paint, rubber and rigid and air supported radome, September 30, 1986.

Mil-Std-808, Finish, materials and processes for corrosive prevention and control in support equipment, July 18, 1996.

Federal Aviation Administration Advisory Circular, Change 4 to Airport Design 150/5300-13, November 10, 1994

1-3.2 Non-Government Documents

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

International Standards and Recommended Practices and Procedures for Air Navigation Services: Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation; Volume I, Part I - Equipment and Systems; International Civil Aviation Organization; Fourth Edition of Volume I - April 1985.

International Standards and Recommended Practices: Aerodromes, Annex 14 to the Convention on International Civil Aviation; Volume I-- Aerodrome Design and Operations; International Civil Aviation Organization; First Edition -- July 1990.

ANPC. Rhino II Software Development Plan, Document No. 010-00006-B.

ANPC. System Specification for the Transponder Landing System, Document No. 010-00007-D.

ANPC Letter to AND-520 entitled "*Preliminary Design for Rhino II Level B Design Assurance*", February 5, 1997.
International Standards and Recommended Practices and Procedures for Air Navigation Services: Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation; Volume I, Part I -- Equipment and Systems; International Civil Aviation Organization; Fourth Edition of Volume I, April,1985.

International Standards and Recommended Practices: Aerodromes, Annex 14 to the Convention on International Civil Aviation; Volume I -- Aerodromes Design and Operations; International Civil Aviation Organization; First Edition, July, 1990.

Software Considerations in Airborne Systems and Equipment Certification, Document No. RTCA/DO-178B, December 1, 1992.

Certification Considerations for Highly Integrated or Complex Aircraft Systems, ARP 4754, Systems Integration Requirements Task Group, Society of Automotive Engineers, 1996.

Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment, ARP 4761, S-18 Committee, Society of Automotive Engineering, 1996.

1-4 Order Of Precedence

In the event of a conflict between text of this specification and any references cited herein, the text of this specification takes precedence. Nothing in this specification however supercedes applicable laws and regulations, unless a specific exception has been obtained.

SECTION 2 Rhino II PERFORMANCE REQUIREMENTS

2-1 System Definition

The Rhino II shall consist of ground-based precision approach and Secondary Tracking equipment that shall provide guidance to a tracked aircraft. Guidance is available to the aircraft in two different platforms, GCA and VHF/UHF ILS. Rhino II shall also provide Secondary Tracking from all Cooperating Aircraft within a 20 mile 360º radius for ground level to 10,000-feet. Rhino II shall conform to the structure of the Block Diagram (Figure 1) and perform to the following specifications.

2-2 Modes and States

Rhino II shall have the following modes: OFF, STANDBY, TEST and ON. Rhino II shall exist in two states, deployed, and stored. When Rhino II is in the deployed state, all modes shall be possible.

2-2.1 OFF Mode

When OFF, primary power shall be removed and the system shall be inoperative.

2-2.2 STANDBY Mode

When STANDBY is active, primary power shall be applied and the system shall radiate only as required to perform Built In Test Equipment (BIT). All BITE functions shall be enabled. Monitor limits shall be activated and shall be capable of inhibiting radiation.

2-2.3 TEST Mode

When TEST mode is selected, Rhino II shall continue to radiate as specified herein but selected monitor functions shall be inhibited from shutting down the equipment. Monitor functions that are inhibited shall be selectable from the maintenance interface.

2-2.4 ON Mode

When ON is selected, Rhino II shall function as specified herein as long as the system remains within monitor limits.

2-3 System Functions

Rhino II shall provide ground control and display functions by interrogating aircraft Air Traffic Control Radar Beacon Transponders (ATCRBS) and perform a transponder based Secondary Tracking function of transponder-based aircraft to determine range, azimuth, and elevation. The Secondary Track function shall be provided simultaneously with the Main or Reciprocal Runway precision approach. Precision approach guidance shall be provided to the Main Runway or the Reciprocal Runway using high-rate approach guidance over selectable VHF/UHF ILS frequency. System approach minimums will not be the same for the main and reciprocal approach and will be specified in Sub-sections 2-3.3.2, and 2-3.4.2.

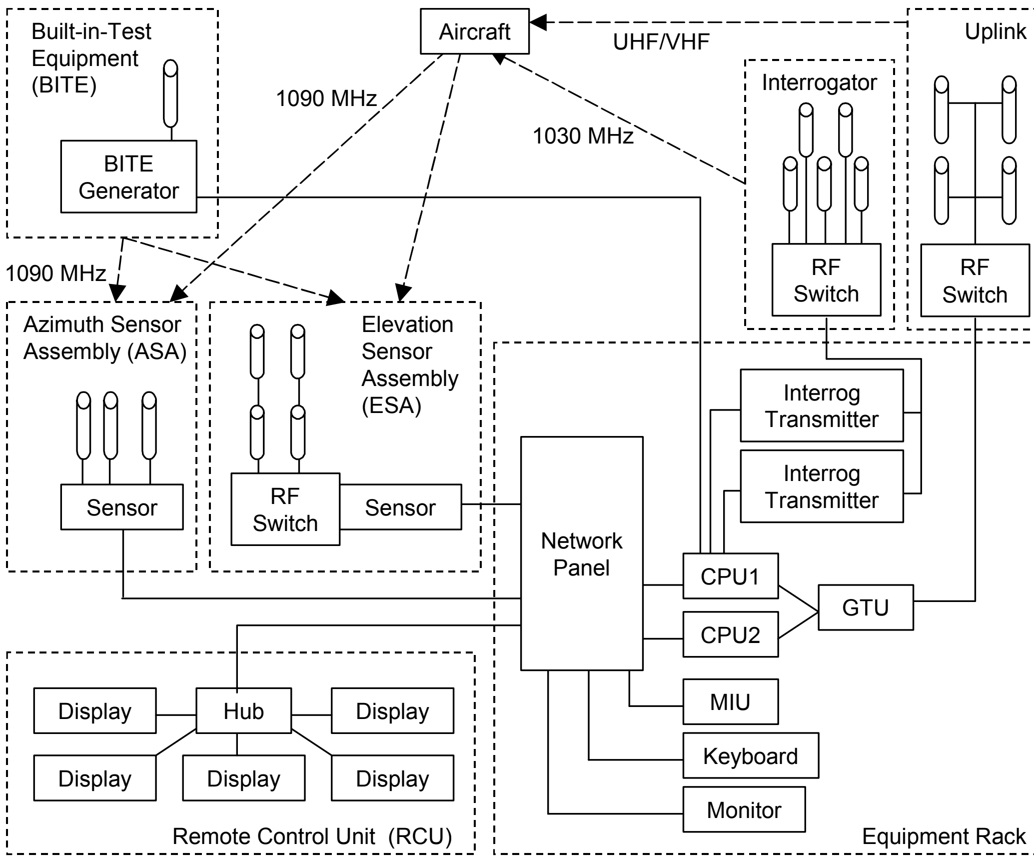

Figure 1 Rhino II Block Diagram

2-3.1 <u>Transponder Interrogation</u>

A transponder interrogation signal shall be transmitted to the landing aircraft at a periodic rate. The transponder interrogation signal shall be equivalent to that which would be produced by a secondary surveillance radar system with Mode A/C capabilities as specified in the International Civil Aviation Organization (ICAO) publication Convention on International Civil Aviation Annex 10.

2-3.1.1 <u>Interrogation Volume</u>

The interrogation volume differs between Secondary Track, Main Runway, and Reciprocal Runway functions and is described individually.

2-3.1.2 <u>Interrogation Radiated Power</u>

The radiated power of the interrogation transmission shall be ≥ -86 dBW/m^2 (peak power) throughout the interrogation volume. The radiated amplitude of P_3 shall be within 1 dB of the radiated amplitude of P_1 at any point throughout the interrogation volume. The radiated amplitude of P_2 shall allow transponder interrogation within the coverage volume.

2-3.2 Secondary Tracking

2-3.2.1 Service Volume

The system shall track all cooperative targets that are in line of sight of the antennas and within the coverage volume. The secondary tracking coverage volume shall at least encompass the regions illustrated in Figure 2 and 3 and as listed in Table 1.

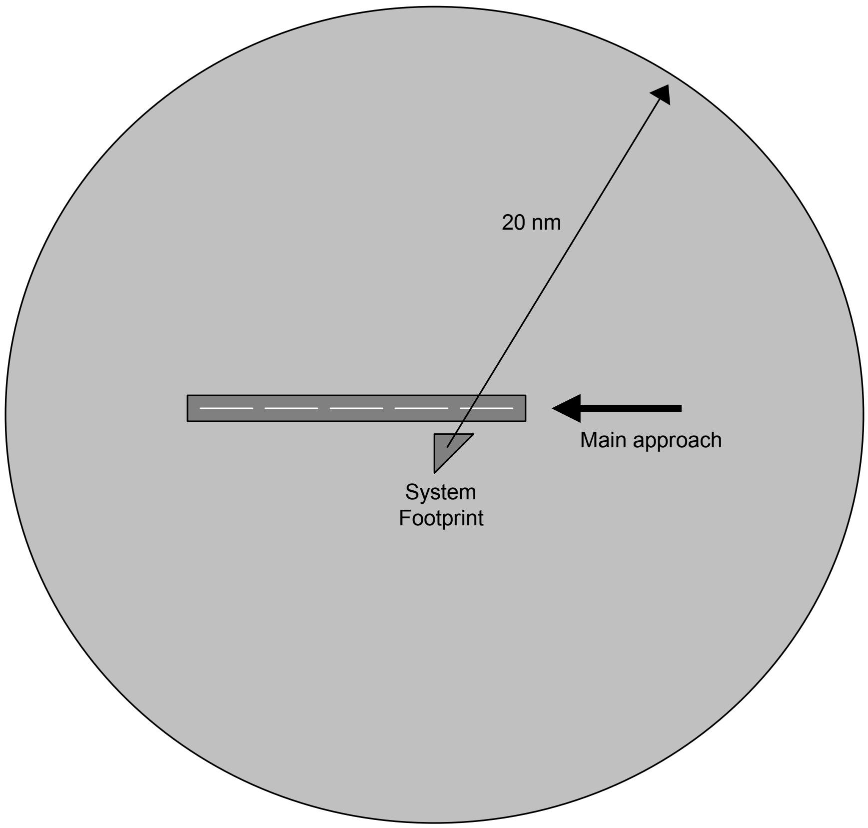

Figure 2 Secondary Tracking Service Volume in Azimuth

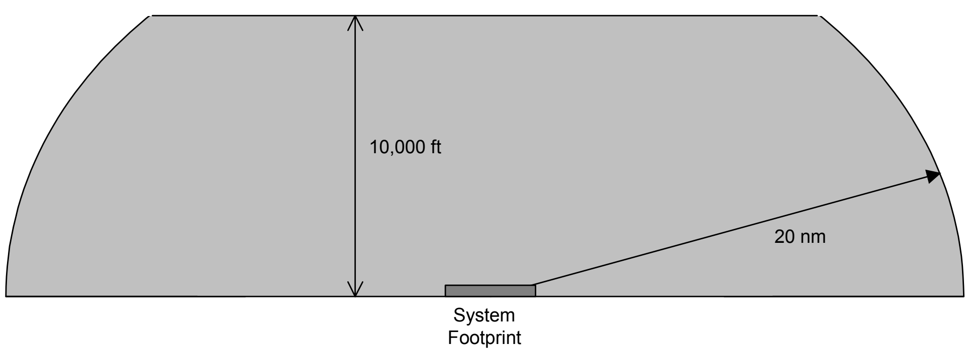

Figure 3 Secondary Tracking Service Volume in Elevation

Table 1 Secondary Tracking Coverage Volume Requirements

Parameter	Requirements
Azimuth	Omni-directional surrounding the system
Altitude	0° to 90° from horizontal
Range	Touchdown to 20 nm
Maximum Coverage Altitude	10,000 Feet

2-3.2.1.1 Service Volume Transition Zones

Tracks of aircraft position shall be upgraded from secondary to approach tracking or downgraded from approach to secondary tracking within the transition zone depicted in Figure 4.

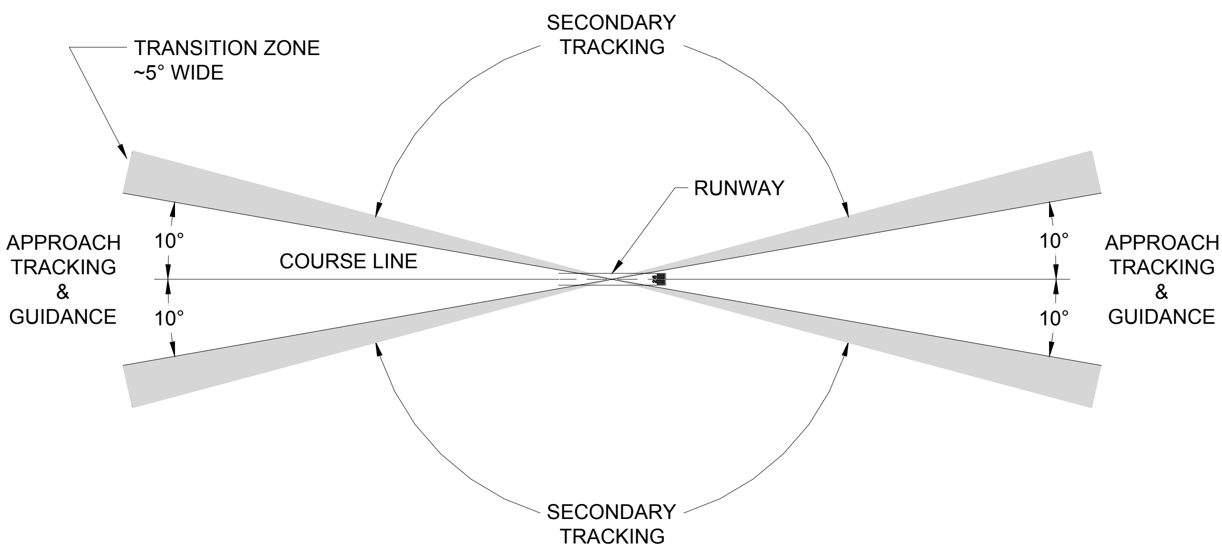

Figure 4 Coverage Volume Relationship And Transitional Zones

2-3.2.2 Accuracy

The distance and azimuth accuracy requirements are indicated for the system in Table 2 and shall meet or exceed ICAO Annex 10 Volume 1 section 3.2 (Surveillance Radar Element). The accuracy requirements for secondary tracking are indicated in Table 2.

Table 2 Secondary Tracking Accuracy Requirements

Parameter	Requirements
Azimuth	Within 2 degrees of true position, 2 sigma
Altitude	±100 ft of true aircraft altitude (within Mode C spec)
Range	Within 5% of aircraft range or 490', whichever is greater

2-3.2.2.1 Azimuth Accuracy

The indication of position in azimuth shall be within plus or minus 2 degrees of true position. It shall be possible to resolve the positions of two aircraft, which are at 4 degrees of azimuth of one another.

2-3.2.2.2 Range Accuracy

The error in range indications shall not exceed 5 per cent of the true range, or 150 meters, whichever is greater. It shall be possible to resolve the positions of two aircraft that are separated by a distance of 1 per cent of the true distance from the point of observation or 230 meter, whichever is the greater.

2-3.2.3 Tracking

The Rhino II shall utilize a Kalman filter algorithm to estimate the horizontal position of all aircraft replying to interrogations described herein.

2-3.2.4 Monitoring

BITE functions shall be able to detect failure conditions that would result in secondary track errors beyond permissible limits.

2-3.3 Main Runway Service

2-3.3.1 Service Volume

The ILS guidance coverage volume shall at least encompass the area illustrated in Figures 5 and 6 and indicated in Table 3.

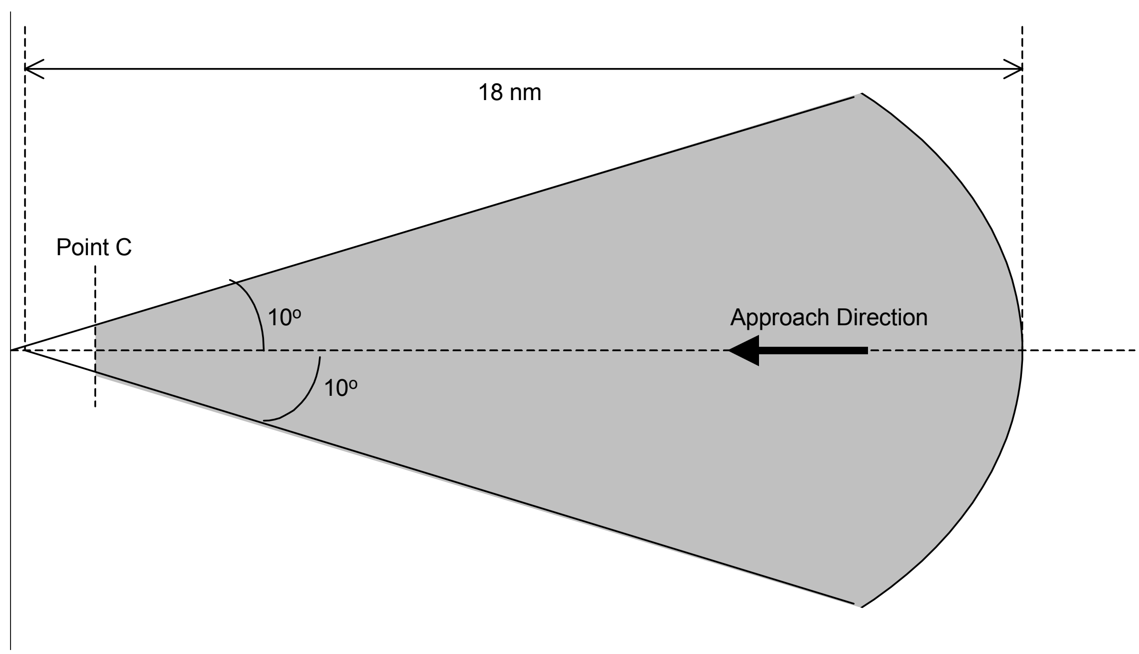

Figure 5 Main Runway Localizer Coverage in Azimuth

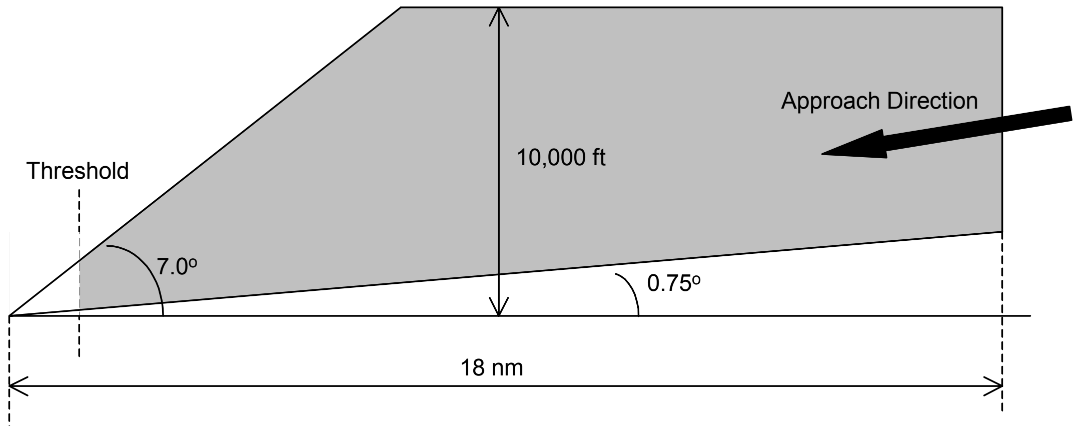

Figure 6 Main Runway Localizer Coverage in Elevation

Table 3 Guidance Coverage Volume Requirements

Parameter	Requirements
Azimuth	±10 degrees on either side of approach centerline
Altitude	1 degree to 7 degrees above horizontal
Range	Touchdown to 18 nm
Decision Height	200 feet

2-3.3.2 Accuracy

2-3.3.2.1 Localizer Course Alignment

The mean course line shall not deviate from the runway centerline by more than ± 35 ft. or the linear equivalent of 0.3 degree (0.015 DDM), whichever is less.

2-3.3.2.2 Localizer Displacement Sensitivity

The nominal displacement sensitivity shall correspond to a DDM of 0.155 at angular displacements of 3.0 degrees ± 0.5 degrees on both sides of the center course line. The increase of DDM shall be substantially linear with respect to angular displacement from the course line (where DDM is zero) to an angle on either side of the course line where the DDM is 0.180. From that angle to ± 35 degrees, the DDM shall not be less than 0.180 as illustrated in Figure 7.

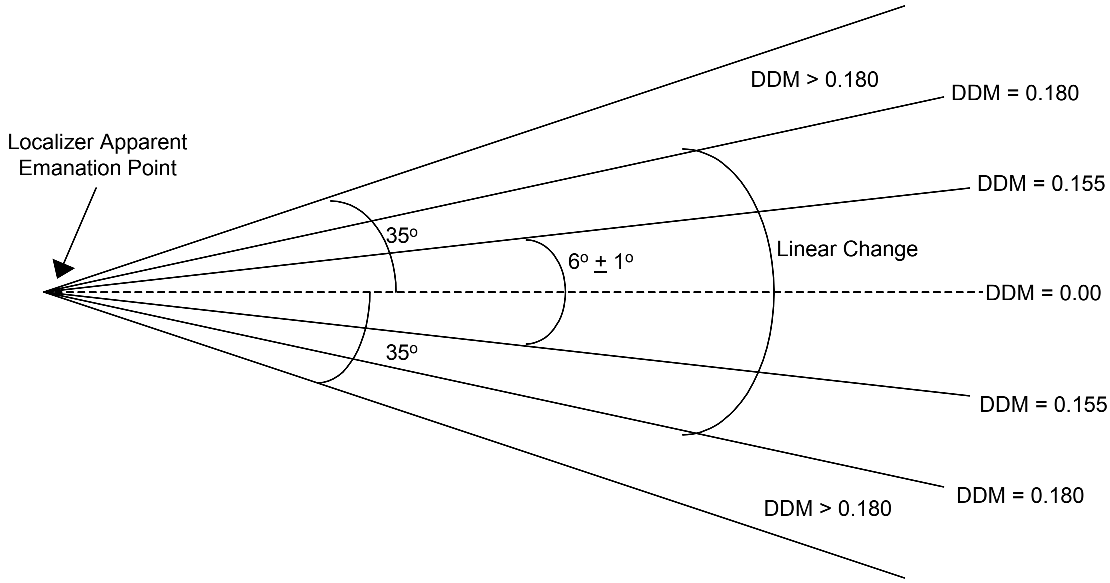

Figure 7 DDM and Displacement Sensitivity

2-3.3.2.3 Localizer Course Structure

Structure in the course line shall not have amplitudes that exceed the following:

- Outer limit of coverage to ILS point A - 0.031 DDM (0.6 deg)
- Decreasing at a linear rate from 0.031 DDM (0.6 deg) at point A to 0.015 DDM (0.3 deg) at ILS point B
- ILS point B to ILS point C - 0.015 DDM (0.3 deg)

2-3.3.3 Interrogation Requirements

The Rhino II shall provide an interrogation rate of 10Hz within the Main Runway Service volume described above in Figures 5 and 6.

2-3.3.4 Tracking

The Rhino II shall accomplish the aircraft tracking function by using transponder reply measurements of the time-of-arrival and angle-of-arrival.

2-3.3.5 Guidance

A localizer signal shall be transmitted to the landing aircraft corresponding to the most recent guidance correction computed by the system. The localizer shall be equivalent to that which would be produced by a standard VHF localizer as specified in ICAO Annex 10, paragraph 3.1.3 and specified below, with the exception that these signal properties shall apply at the position of the tracked aircraft only.

2-3.3.6 Monitoring

BITE functions shall be able to detect failure conditions that would result in Main Runway Service errors beyond permissible limits.

2-3.4 Reciprocal Runway Service

2-3.4.1 Service Volume

Reciprocal Runway Service volume is illustrated in Figures 8 and 9.

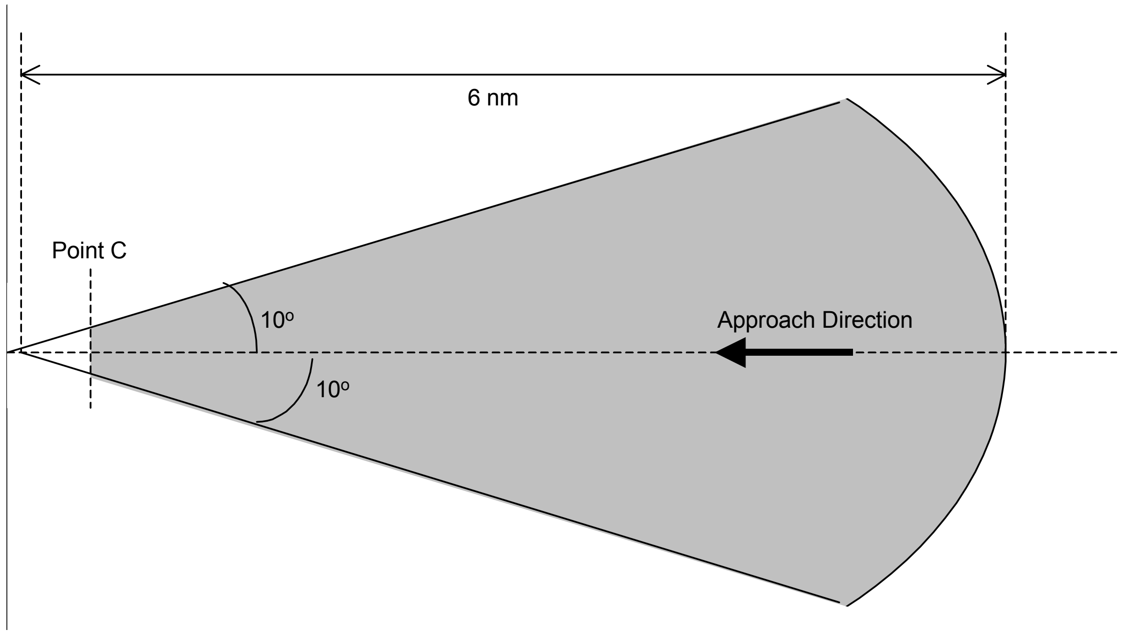

Figure 8 Reciprocal Runway Localizer Coverage in Azimuth

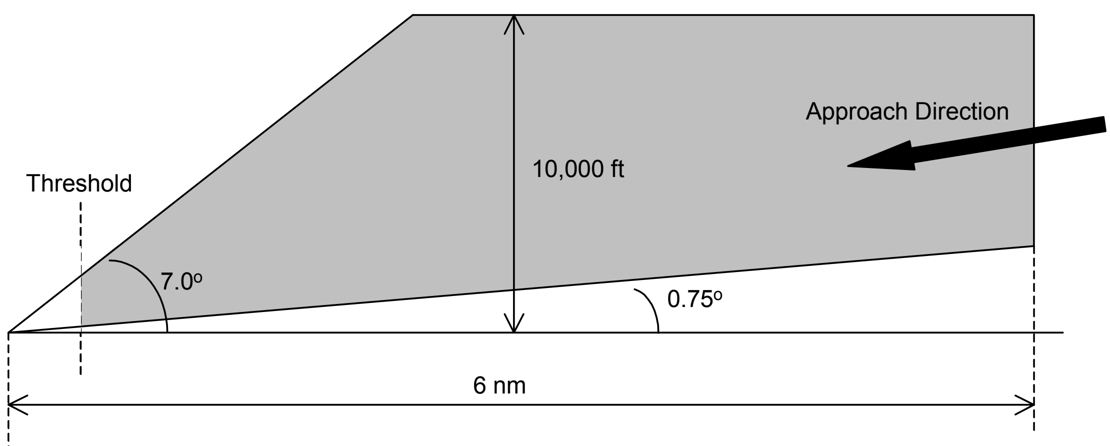

Figure 9 Reciprocal Runway Localizer Coverage in Elevation

2-3.4.2 Accuracy

The accuracy requirements for both the VHF/UHF and GCA guidance are listed in Table 4

Table 4 Reciprocal Runway Guidance Accuracy Requirements

Parameter	Requirements
Azimuth	±15 ft from centerline, or ±0.3°, whichever is greater
Altitude	0.3 degrees
Range	±250 ft
Decision Height	300 feet

2-3.4.3 Glide Slope Displacement Sensitivity

The nominal displacement sensitivity shall correspond to a DDM of 0.0875 at angular displacements of 0.35 degrees ± 0.07 degrees above and below the glide path. The angular displacement sensitivity shall be maintained as symmetrical as practicable and within ± 25% of the nominal.
The increase of DDM shall be linear with respect to angular displacement from the glide path (where DDM is zero) to an angle on either side of the glide path where the DDM is 0.220. From that angle to edges of the glide slope coverage volume, the DDM shall not be less than 0.220 as illustrated in Figure 10.

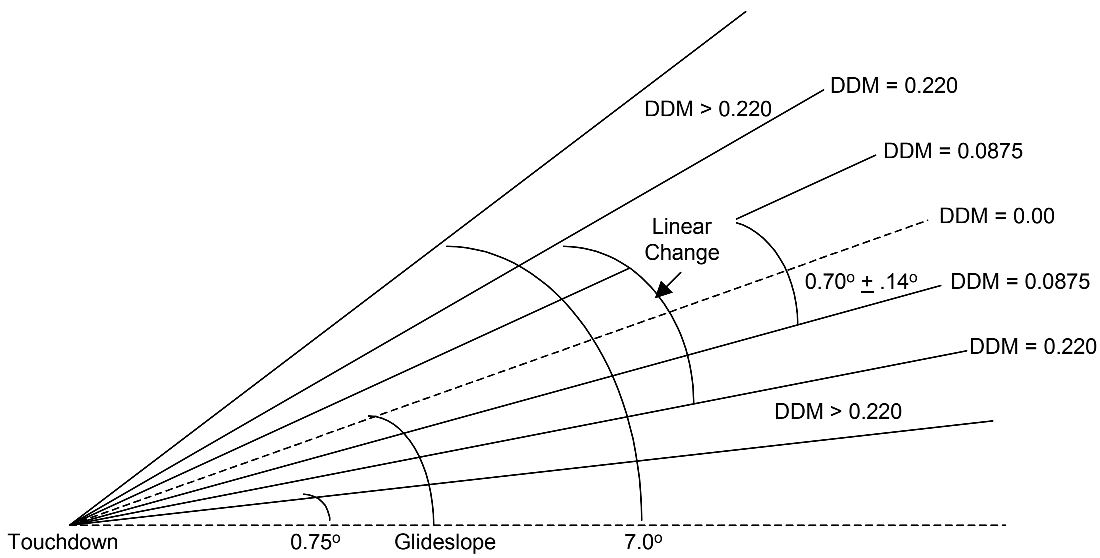

Figure 10 Glide Slope Displacement Sensitivity

2-3.4.4 Interrogation Requirements

The Rhino II shall provide an interrogation rate of 10 Hz within the Reciprocal Runway Service volume described above in Figures 8 and 9.

2-3.4.5 Tracking

The Rhino II shall utilize a Kalman filter algorithm to estimate the horizontal position of all aircraft replying to interrogations described herein.

2-3.4.6 Guidance

The glide slope signal shall be equivalent to that which would be produced by a standard UHF glide path system as specified in ICAO Annex 10, paragraph 3.1.5 and specified below, with the exception that these signal properties shall apply at the position of the tracked aircraft only.

2-3.4.7 Monitoring

BITE functions shall be able to detect failure conditions that would result in Reciprocal Runway service errors beyond permissible limits.

2-4 Capability Interface

The system shall switch from Main Runway end to Reciprocal Runway end, or vice versa, within 5 minutes. The mechanism for switching runway ends shall not include any rotating, moving, or re-installing any of the antenna arrays.

2-5 Logistics /Transportation

2-5.1 Rhino II Vehicle

An M1097 HMMWV shall be used as the Rhino II system prime mover. The operational characteristics of the M1097 HMMWV shall not be degraded by the integration/addition of system hardware. The Rhino II shall support transport of 2 persons in the HMMWV vehicle. No persons shall be permitted to occupy the Rhino II shelter or trailer during transport operations.

2-5.2 Rhino II Shelter

The M1097 HMMWV Shelter shall provide housing for critical elements of the Rhino II system. The shelter when installed shall conform to the size requirements in Sub-section 2-6.4.

2-5.3 Rhino II Trailer

An M1101 high mobility trailer (HMT) or equivalent (including commercial options) shall be used to transport Rhino II elements.

2-5.4 Rhino II Highway Transport

The Rhino II vehicle including the towed trailer shall meet all highway regulations for transportation on highways across the United States. The Rhino II shall also be capable of traversing terrain with a slope gradient of 40 percent. The Rhino II vehicle in its ground transport configuration shall not exceed the following outside dimensions:

- Height 13.1 feet
- Length 35.0 feet
- Width 8.0 feet

2-5.5 Rhino II Aircraft Transport

The Rhino II shall be transportable via military aircraft on a single C-130, a C-141, or a C-5A. The vehicle and trailer shall have the necessary tie downs for transport. Weight and center of gravity shall be clearly marked for the transport configuration. Rhino II components shall withstand air transportation up to 50,000 feet above sea level (unpressurized). The Rhino II vehicle in its air transport configuration shall not exceed the following outside dimensions:

- Height 8.5 feet
- Length 35.0 feet
- Width 8.0 feet

2-5.6 Rhino II Transport Configurations

The dimensions for a single vehicle provided in MIL-STD-1366 shall be used for guidance for ground and air shipment. Component disassembly may be utilized to accommodate overhead clearances during system transport.

Removal of components shall not require powered external lifting equipment. The removal and reinstallation of components shall be a simple task using bolts and cables with quick disconnects whenever possible. Reinstallation shall use self-aligning pins to preclude use of bore sighting or any other formal precision alignment. The removal and reinstallation sequences shall be kept to a minimum.

2-6 Installation/Certification

2-6.1 Component Siting

2-6.1.1 Distances From Runways

Siting of Rhino II equipment shall meet the requirements defined in FAA Advisory Circular (AC) 150/5300-13, Change 4, DTD 11/10/94. Criteria for aircraft size, approach speed, visibility minimums, and runway elevation shall comply with requirements for the Runway Safety Area (RSA) and Obstacle Free Zone (OFZ)**.**

2-6.1.2 Frangibility

Equipment positioned within the Runway Safety Area (RSA) shall meet the requirements for Frangible NAVAID as defined in AC 150/5300-13 CH 4.

2-6.1.3 Line of Site Requirements

Rhino II components shall have line of site with aircraft within the interrogation volume, as defined in Sub section 3-11.3.4.

2-6.1.4 Terrain Gradient Requirements

The system shall be capable of setup on terrain with up to a maximum 5 percent lateral slope and a 3 percent longitudinal slope.

2-6.2 Rhino II Soil Loading Requirements

The Rhino II shall be designed to allow setup and operation in soil conditions supporting a minimum of 20 PSI.

2-6.3 Rhino II Installation time

The Rhino II system shall be installed, tested, and made ready for flight inspection by 3 persons within a 24-hour work period.

SECTION 3 System Equipment Elements Functional and Performance Requirements

3-1 Operator Control Interface

The term Remote Control Unit (RCU) is used interchangeably with Operator Control Interface throughout this document. The RCU shall provide the following functions:

- Provide a graphical display of the approach area.
- Allow the operator to provide either ILS or GCA guidance to a single aircraft.
- Provide a graphical display of the current position and history of the guidance track.
- Provide a graphical display of the current position and history of tracks from secondary tracking.
- Display the current system mode and integrity monitor status.
- Digitally record all secondary and guidance tracks and allow replay of these tracks.
- Allow the operator to configure the RCU for using either the Main or Reciprocal runway.

3-1.1 Interface Layout

The RCU interface shall consist of a single window containing the following areas: a title bar, a menu bar, a graphical display, and controls.

3-1.2 Title Bar

The title bar shall display the RCU number (i.e., 1 through 5) to identify the RCU. The title bar shall also display the runway location and runway number.

3-1.3 Menu Bar

The menu bar shall contain menus to allow the user to perform the following functions:

- Exit the RCU application.
- Toggle the audible alarm function.
- Clear the approach track history.
- Clear the secondary track history.
- Toggle the display of secondary tracks.
- Toggle the display of the approach, compass rose, controls area, markers, range rings, service volume, approach direction, and background color.
- Allow the user to open a settings dialog.
- Allow the user to display the About box for the RCU application.

3-1.4 Graphical Display

The RCU interface shall allow the user to select between two graphical display modes: Secondary Track and GCA.

3-1.5 Secondary Track View

The Secondary Track view shall display a top-down view of the approach area; this view is similar to a Secondary Surveillance Radar (SSR) azimuth display. The center of the display area shall be runway threshold.

3-1.5.1 Range Rings

The RCU shall provide a means to toggle the display of range rings. Range rings shall be displayed with labels in nautical miles. The RCU shall provide a means for the operator to change the maximum range displayed.

3-1.5.2 Approach

The RCU shall provide a means to toggle the display of the approach. This function shall use dotted lines to display the approach centerline and course width boundaries.

3-1.5.3 Compass Rose

The RCU shall provide a means to toggle the display of a compass rose. The compass rose shall consist of tick marks drawn at radials on the outermost range ring. The length of tick marks at 5-degree increments shall be half the length of those at 10-degree increments. Headings shall be displayed every 30 degrees.

3-1.5.4 Service Volume

The RCU shall provide a means to toggle the display of the azimuth service volume. The azimuth service volume defines the azimuth area in which guidance can be provided.

3-1.6 GCA View

The GCA view shall display both profile (elevation) and top-down (azimuth) views of the approach area. The origin of both views shall be touchdown. The profile view shall be displayed on the top half of the display; the top-down view shall be displayed on the bottom half of the display. RCU that is providing VHF/UHF ILS guidance shall be capable of displaying the ILS needles.

3-1.6.1 Range Indicators

The RCU shall provide range indications in nautical miles along the horizontal axis of the profile view. The RCU shall provide a means for the operator to change the maximum range displayed.

3-1.6.2 Approach

The RCU shall provide a means to toggle the display of the approach. This function shall use dotted lines to display the approach centerline and path width boundaries on the profile view. This function shall use dotted lines to display the approach centerline and course width boundaries on the top-down view.

3-1.7 Controls

3-1.7.1 Function Control

The RCU interface shall provide controls to perform the following functions: select between operational and replay modes; select between GCA and Secondary Track views; set the maximum range; enter the transponder code for guidance; acquire for an ILS approach; acquire for a GCA approach; reset (i.e., terminate) an approach; toggle the altitude limit function of secondary tracks; and specify the altitude limit for secondary tracks. In addition, controls shall be provided to indicate the current approach, the current system mode, and the integrity monitor status.

3-1.7.2 Acquisition Control

An acquisition shall be performed using one of two buttons, one labeled “ILS ACQUIRE” and one labeled “GCA ACQUIRE”. The “ILS ACQUIRE” button shall command the system to acquire the entered transponder code and provide VHF/UHF ILS uplink signals to the aircraft. At the instant of pressing the “ILS ACQUIRE” button, the “ILS ACQUIRE” button on all other RCUs shall be disabled (i.e., grayed out). When VHF/UHF ILS guidance is being provided, all other RCUs shall be able to press the “GCA ACQUIRE” button, which will track the entered transponder code for track display only (no ILS uplink). Only the RCU that is providing VHF/UHF ILS guidance will display the ILS needles.

3-1.8 Track Display

The RCU interface shall display two types of tracks: secondary and guidance. Secondary Tracks consist of all aircraft being tracked by the system. The guidance track is the aircraft currently being provided guidance by the RCU.

3-1.8.1 Secondary Track Function Tracks

The RCU shall provide the means for the operator to toggle the display of Secondary Tracks. The aircraft position shall be indicated by a crosshair display. Beside the crosshair, the transponder code and aircraft Mean Sea Level (MSL) altitude shall be displayed. In addition, for guidance tracks controlled by other RCUs, an indication of which RCU is providing guidance shall be provided. The altitude shall be displayed with three digits in units of 100 feet, e.g., 030 for 3000 feet, 292 for 29,200 feet, etc and unknown altitude symbols. The track history of a Secondary

Track shall consist of small dots displayed at the positions of the aircraft over the last 20 seconds. The "trail of dots" gives the controller a visual indication of aircraft velocity. A heading vector indicating the predicted flight path of the aircraft shall be displayed at the current position.

3-1.8.2 Guidance Track

The aircraft position shall be indicated by a crosshair display. Beside the crosshair, the transponder code and aircraft MSL altitude shall be displayed. The altitude shall be displayed with three digits in units of 100 feet, i.e., 030 for 3000 feet, 292 for 29,200 feet, etc. The track history shall consist of small dots displayed at the positions of the aircraft over the last 20 seconds. The "trail of dots" gives the controller a visual indication of aircraft velocity. A heading vector indicating the predicted flight path of the aircraft shall be displayed at the current position.

3-1.9 Tooltips

On mouse-over of any particular aircraft, a "tool tip" shall appear that displays the aircraft's transponder code range in nautical miles to touchdown, ground speed, MSL altitude, and heading.

3-2 Lighting System Requirements

3-2.1 Shelter

Adequate adjustable illumination shall be provided to allow for operator monitor observations, the reading of maps and small print as well as adequate illumination for maintenance activities.

3-2.2 Blackout Lighting

Blackout lighting requirements are to be determined.

3-2.3 Obstruction

Obstruction lighting shall be provided according to Federal Aviation Administration Regulations.

3-3 Communication System

3-3.1 Air to Ground

Air to Ground Communication Systems are to be determined.

3-3.2 Intercom

Intercom Systems are to be determined.

3-4 Calibration/Installation

A calibration procedure shall provide sufficient truth and system track data to compensate for sensor measurement errors and terrain-induced multipath errors.

3-4.1 Truth Data

The truth data shall be provided by an optical tracking system. The truth data shall be compared with the system track data to result in site-dependent, error compensation information.

3-4.2 Interface

An RF data link shall be used to connect the optical tracking system to the MIU.

3-5 Maintenance Interface Assembly

3-5.1 Maintenance Interface Unit (MIU)

3-5.1.1 CPU

The MIU shall have an Intel or AMD x86 processor with a minimum speed of 2.0 GHz.

3-5.1.2 Memory

The MIU shall have a minimum of 512 MB of RAM and be compatible with the motherboard.

3-5.1.3 Motherboard

The MIU motherboard shall be compatible with the CPU and Hard Drive, and will contain a minimum of three PCI interface slots.

3-5.1.4 Operating System

The MIU shall run Windows XP Professional.

3-5.1.5 Peripheral Configuration

All peripherals shall be compatible with Windows XP Professional.

3-5.1.6 Hard Drive

The MIU shall have a minimum hard drive capacity of 120 GB.

3-5.1.7 Floppy Drive

The MIU shall have one (1) 3.5-inch floppy drive accessible from the front panel.

3-5.1.8 CD-ROM Drive

The MIU shall have one CD-ROM drive accessible from the front panel.

3-5.1.9 Network Adapter

The MIU network adapter shall be a 10/100 MBPS Ethernet Network Adapter with a RJ-45 port.

3-5.1.10 Input / Output

The MIU shall have the following I/O: connections:

- One (1) PS/2 keyboard port
- One (1) PS/2 mouse port
- One (1) VGA monitor port
- One (1) bi-directional parallel port
- One (1) RS-232 serial port
- Two (2) external USB 2.0 ports

All connections shall be computer standard with appropriate securing mechanisms.

3-5.1.11 Input Power Electrical Requirements

The MIU shall run with 120 VAC ± 10%, 47 to 63 Hz single-phase power input.

3-5.1.12 Mean Time Between Failure

The MIU shall have a MTBF of greater than 100,000 hours @ 25 degrees Centigrade.

3-5.1.13 Physical Design

Provisions shall be made for the MIU to have a maximum depth of 25 inches and for mounting into a standard 19-inch equipment rack.

3-5.2 Oscilloscope

Provisions shall be made for the mounting of an Oscilloscope into a standard 19-inch equipment rack.

3-5.3 Monitor

The monitor shall have the performance capability of VGA or greater performance and be compatible with the video adapter in the MIU CRT display. The monitor shall be mounted in a standard 19-inch equipment rack.

3-5.4 Keyboard

The keyboard shall be an ASCII standard keyboard mounted in a standard 19-inch equipment rack. Cabling shall meet or exceed the current Mil Specification.

3-5.5 Interface Control

3-5.5.1 MIU to Network Panel

The MIU shall connect to the Network Panel by:

- One (1) PS2 mouse cable
- One (1) PS2 keyboard cable
- One (1) VGA cable
- One (1) Ethernet Cable

3-5.5.2 Monitor to Network Panel

The monitor shall connect to the Network panel by one (1) VGA cable.

3-5.5.3 Keyboard to Network Panel

The Keyboard shall connect to the Network Panel by:

- One (1) PS2 mouse cable
- One (1) PS2 keyboard cable

3-6 Central Processing Units

3-6.1 CPU 1

This section specifies the hardware and operating system requirements for CPU1.

3-6.1.1 CPU

CPU1 shall have an Intel or AMD x86 processor with a minimum speed of 2.0 GHz.

3-6.1.2 Memory

CPU1 shall have a minimum 256 MB of RAM.

3-6.1.3 Motherboard

The CPU1 motherboard shall provide a minimum of one ISA and three PCI interface slots.

3-6.1.4 Operating System

CPU1 shall run QNX version 4.25.

3-6.1.5 Peripherals

All peripherals shall be compatible with QNX 4.25.

3-6.1.6 Hard Drive

CPU1 shall have a minimum hard drive capacity of 20 GB.

3-6.1.7 Floppy Drive

CPU1 shall have one (1) 3.5-inch floppy drive accessible from the front panel.

3-6.1.8 CD-ROM Drive

CPU1 shall have one CD-ROM drive accessible from the front panel.

3-6.1.9 Network Adapter

The CPU1 network adapter shall be a 10/100 MBPS Ethernet Network Adapter with a RJ-45 port.

3-6.1.10 Input / Output

CPU1 shall have at a minimum the following I/O connections:

- One (1) PS/2 keyboard port
- One (1) PS/2 mouse port
- One (1) VGA monitor port
- One (1) bi-directional parallel port
- One (1) RS-232 serial port

3-6.1.11 Mounting

Provisions shall be made for the mounting of CPU 1 into a standard 19-inch rack.

3-6.2 CPU2

This section specifies the hardware and operating system requirements for CPU2.

3-6.2.1 CPU

CPU2 shall have an Intel or AMD x86 processor with a minimum speed of 2.0 GHz.

3-6.3 Memory

CPU2 shall have a minimum of 512 MB of RAM.

3-6.4 Motherboard

The CPU2 motherboard shall provide a minimum of three PCI interface slots.

3-6.5 Operating System

CPU2 shall run Windows NT 4.0 with Service Pack 5 or later.

3-6.6 Peripherals

All peripherals shall be compatible with Windows NT 4.0 Service Pack 5.

3-6.7 Hard Drive

CPU2 shall have a minimum hard drive capacity of 120 GB.

3-6.8 Floppy Drive

CPU2 shall have one (1) 3.5” floppy drive accessible from the front panel.

3-6.9 CD-ROM Drive

CPU2 shall have one CD-ROM drive accessible from the front panel.

3-6.10 Network Adapter

The CPU2 network adapter shall be a 10/100 MBPS Ethernet Network Adapter with a RJ-45 port.

3-6.11 Input / Output

CPU2 shall have at a minimum the following I/O connections:

- One (1) PS/2 keyboard port
- One (1) PS/2 mouse port
- One (1) VGA monitor port
- One (1) bi-directional parallel port
- One (1) RS-232 serial port

3-6.12 Mounting

Provisions shall be made for the mounting of CPU2 into a standard 19-inch equipment rack.

3-7 Local Area Network

A single 100 Mbps Ethernet LAN shall be used for network communications between computers.

3-7.1 Network Topology

The Ethernet LAN shall consist of the following components: a main Ethernet switch; a remote RCU switch; computers connected to the switches; and cabling to connect the computers and switches. (Note that there is a distinction between an Ethernet hub and an Ethernet switch. A hub is a repeater that indiscriminately broadcasts messages to all connected nodes; a switch is a repeater that selectively re-distributes messages based on hardware MAC address.) The system shall use switches, not hubs.

3-7.2 Main Switch

The main Ethernet switch shall provide a minimum of eight (8) 10/100 RJ-45 ports and a minimum of two (2) 10/100 fiber ports. At least one of the eight RJ-45 ports, or an additional RJ-45 port, shall allow a link connection to the RCU Ethernet switch.

3-7.3 Remote Control Unit (RCU) Hub

The RCU Ethernet switch shall provide a minimum of eight (8) 10/100 RJ-45 ports. At least one of the eight RJ-45 ports, or an additional RJ-45 port, shall allow an uplink connection to the main Ethernet switch.

3-7.4 Interconnectivity

The MIU, CPU1 and CPU2 shall be connected to the main Ethernet switch using CAT-5 RJ-45 cabling. The sensors shall be connected to the main Ethernet switch using 100 Mbps fiber. A CAT-5 cable shall be used to connect the main Ethernet switch to the RCU Ethernet switch.

3-8 Remote Control Unit (RCU)

This section specifies the hardware and operating system requirements for the RCU. The RCU should be a laptop computer.

3-8.1 Central Processing Unit (CPU)

The RCU shall have an Intel or AMD x86 processor with a minimum speed of 800 MHz.

3-8.2 Memory

The RCU shall have a minimum 512 MB of RAM.

3-8.3 Motherboard

The RCU shall be a laptop computer.

3-8.4 Operating System

The RCU shall run Windows 2000 or Windows XP.

3-8.5 Peripherals

All peripherals shall be compatible with Windows 2000 or Windows XP, as appropriate.

3-8.6 Hard Drive

The RCU shall have a minimum hard drive capacity of 20 GB.

3-8.7 Floppy Drive

The RCU does not need a floppy drive.

3-8.8 CD-ROM Drive

The RCU shall have one CD-ROM drive.

3-8.9 Network Adapter

The RCU network adapter shall be a 10/100 Mbps Ethernet Network Adapter with an RJ-45 port.

3-8.10 Input / Output

The RCU shall have at a minimum the following I/O connections:

- One (1) PS/2 keyboard port
- One (1) PS/2 mouse port
- One (1) VGA monitor port

3-9 Power Requirements

3-9.1 Power Input

The input power to the system shall be 240 VAC ± 10%, 47 to 63 HZ single-phase power.

3-9.2 Uninterruptible Power Supply/Battery Pack

3-9.2.1 Primary Input Power

The input power of the UPS shall be 240 VAC ± 10%, 47 to 63 HZ single-phase power.

3-9.2.2 Output Power

The output of the UPS shall be a minimum of 3 KVA at 120 VAC ±5%, 60 ± 2Hz.

3-9.2.3 Mean Time Between Failure

The MTBF of the UPS shall be greater than 50,000 hours @ 25 degrees Centigrade.

3-9.2.4 Battery Hold-Up Time

The battery pack shall provide a minimum of 20 minutes of operation at full load @ 25 degrees Centigrade.

3-9.3 Interface Control

3-9.3.1 Signal Entry Panel to UPS/Battery

The signal entry panel shall provide an external power source for the UPS.

3-9.3.2 UPS to shelter power

The UPS shall provide sufficient output power for shelter lighting and auxiliary power outlets for ancillary equipment.

3-9.3.3 UPS to rack power

The UPS shall provide sufficient power for all rack-mounted components.

3-10 Uplink Assembly

The Uplink Assembly shall consist of a Guidance Transmitter Unit, two sets of Uplink Antennas, and a Main/Reciprocal Service RF Switch.

3-10.1 Guidance Transmitter Unit (GTU)

The GTU shall receive and measure samples of the transmitted GS and Loc signals and provide signal measurement data to the CPUs via the control interfaces. The Monitor functions within the GTU shall be able to be tuned for sample input levels between 20 and 50 dB below the transmitter output power levels. The measurement isolation shall be such that when calculating DDM from carrier, 90 and 150 Hz tones, the maximum error shall be less than .001 DDM.

3-10.1.1 RF Output – Localizer

3-10.1.2 Localizer Output Power

The carrier output power of the localizer signal shall be 24 dBm ± 2 dB into a 50 Ω load.

3-10.1.3 Localizer Carrier Frequency

The localizer shall operate in the band 108.10 MHz to 111.95 MHz. The localizer carrier frequency shall be controllable via the computer interface to any of the allowable frequencies. See Table 12 for specific frequencies authorized within this band. All specifications defined herein shall be met at any allowable output frequency. The frequency variation of the carrier shall not exceed ± 0.002 %.

3-10.1.4 Localizer Carrier Modulation

When enabled, the localizer carrier shall be AM modulated, double side band, un-suppressed carrier with modulation tones at 90 and 150 Hz. Guidance commands are conveyed by changing the relative % modulation (difference of depth of modulation DDM) of these tones, without changing the sum of depth of modulation (SDM).

3-10.1.5 Localizer Depth of Modulation

With a transmitted Difference of Depth of Modulation (DDM) of 0.000, the depth of carrier modulation for each of the 90 Hz and 150 Hz tones shall be within the limits of 18 and 22%. The Sum of Depth of Modulation (SDM) of localizer modulation tones shall 40 ± 1 %. This SDM limit shall be met with DDM in the range of –0.180 to +0.180.

3-10.1.6 Localizer Modulation Control Resolution and Accuracy

The DDM of localizer modulation tones shall be controllable in DDM steps not larger than 0.0004 DDM. The accuracy of localizer DDM shall be within 0.002 DDM for any DDM setting between –0.180 to +0.180 DDM.

3-10.2 RF Output – Glide Slope

3-10.2.1 Glide Slope Output Power

The carrier output power of the Glide Slope signal shall be 34 dBm ±2dB into a 50 Ω load.

3-10.2.2 Glide Slope Frequency

The glide slope transmission shall operate in the band 329.15 MHz to 335.00 MHz. The glide slope carrier frequency shall be set to the frequency paired with the commanded localizer frequency. See Paragraph 3.4 for specific frequency pairings. All specifications defined herein shall be met at any allowable output frequency. The frequency variation of the carrier shall not exceed ± 0.002%.

3-10.2.3 Glide Slope Carrier Modulation

When enabled, the glide slope carrier shall be AM modulated, double side-band, un-suppressed carrier with modulation tones at 90 and 150 Hz. Guidance commands are conveyed by changing the relative % modulation (difference of depth of modulation DDM) of these tones, without changing the sum of depth of modulation (SDM).

3-10.2.4 Glide Slope Depth of Modulation

With a transmitted Difference of Depth of Modulation (DDM) of 0.000, the depth of carrier modulation for each of the 90 Hz and 150 Hz tones shall be within the limits of 38 and 42%. The Sum of Depth of Modulation (SDM) of glide slope modulation tones shall 80 ± 1 %. This SDM limit shall be met with DDM in the range of -0.220 to +0.220.

3-10.2.5 Glide Slope Modulation Control Resolution and Accuracy

The DDM of glide slope modulation tones shall be controllable in DDM steps not larger than 0.0005 DDM. The accuracy of glide slope DDM shall be within 0.002 DDM for any DDM setting between –0.220 to +0220 DDM.

3-10.3 Monitor Functions

3-10.3.1 DDM Monitors

The GTU shall provide monitor data, via the CPU interfaces, so that the CPUs can monitor transmitted signal modulation characteristics.

3-10.3.1.1 DDM Monitor Resolution

The RF monitor elements shall provide measurements of the carrier, 90 Hz, 150 Hz, and tone freq. band (loc only) power levels. The measurement resolution shall be such that when calculating DDM from carrier, 90 and 150 Hz tones, the bit error shall be less than .0005 DDM.

3-10.3.1.2 DDM Monitor Accuracy

The measurement isolation shall be such that when calculating DDM from carrier, 90 and 150 Hz tones, the maximum error shall be less than .001 DDM.

3-10.4 Uplink Antennas

The localizer uplink antenna of the Uplink Antenna Assembly shall operate between 108-118 MHz and the glide slope uplink antenna will operate between 328.6-335.4 MHz. FCC licensing is required to operate at this frequency. There shall be two (2) identical sets of uplink antennas, one set established for Main Runway Service, the other set established for Reciprocal Runway Service.

3-10.4.1 Localizer Antenna

The localizer antenna specifications shall be as indicated in Table 5.

Table 5 Localizer Antenna Specifications

Antenna Parameter	Antenna Performance
Type	Uni-directional
Polarization	Horizontal
Gain, Main beam	7 dB/iso
Horizontal field pattern	The radiation pattern in the horizontal plan has lobe not more than 80 degrees wide at the half power points.

3-10.4.1.1 Localizer Antenna Power

The antenna EIRP output power level for the Localizer signal shall be 30 dBm (1.0 watts).

3-10.4.1.2 Localizer Transmission

The requirements for the localizer transmission shall be:

- Minimum field strength of –107 dBW/m^2 on glide path between 10 nm from threshold and the point 200' above threshold.
- Minimum field strength of –114 dBW/m^2 elsewhere in the coverage volume.
- Receivable 2000' above threshold at the ranges specified or 1000' above the highest point, whichever is higher (based on ICAO Annex 10 3.1.3.3.1). Using the maximum service volume range of 18 nm and 2000' yields an elevation angle of 1.0°.

The lowest antenna gain occurs at the point 18 nm from threshold, 35 degrees azimuth off bore-site (off the approach centerline), and at 0.75° elevation. The localizer transmit antenna characteristics are as summarized in Table 6.

Table 6 Localizer Transmit Antenna Characteristics

Quantity	Value
Transmitter Power (dBm)	24±2
Cable Loss (dB)	2
Peak Antenna Gain on Bore sight (dBi)	+7
Antenna Gain at 35° azimuth (dBi)	+3
Minimum EIRP at 35° azimuth (dBm)	23 (.2 watt)
Peak EIRP (dBm)	31

3-10.4.2 Glide Slope Antenna

The localizer antenna specifications shall be as indicated in Table 7.

Table 7 Glide Slope Antenna Specifications

Antenna Parameter	Antenna Performance
Type	Uni-directional
Polarization	Horizontal
Gain, Main beam	7 dB/iso
Horizontal field pattern	The radiation pattern in the horizontal plan has lobe not more than 80 degrees wide at the half power points.

3-10.4.2.1 Glide Slope Antenna Power

The antenna EIRP output power level for the Glide Slope signal shall be 40 dBm (10.0 watts).

3-10.5 Glide Slope Transmission

The requirement for the glide slope transmission shall be minimum field strength of –95 dBW/m^2 throughout the glide slope coverage volume. The lowest antenna gain occurs at the point 10 nm, 8° azimuth off bore site (off the approach centerline), and 0.75° elevations. The glide slope transmit antenna characteristics shall be as summarized in Table 8.

Table 8 Glide Slope Transmit Characteristics

Quantity	Value
Transmitter Power (dBm)	34±2 (32 – 36)
Cable Loss (dB)	2
Peak Antenna Gain on Bore sight (dBi)	+7
Antenna Gain at 35° azimuth (dBi)	+6
EIRP at 35° azimuth (dBm)	36 (4.0 watts)
Peak EIRP (dBm)	41

3-10.6 Interface Control

Two parallel interface ports on the Modulation Generator board provide control and status access to both the Rhino II base CPUs. The CPU interfaces are used to enable transmitter outputs, control the Difference of Depth of Modulation (DDM) between the 90 and 150 Hz side tones, set the carrier frequency, and enable ID tones (localizer only). Monitor and transmitter status data is available for the CPUs to read back.

As a key system safety component, the interface section includes compare logic which is used to verify that digital control signals from the two CPUs match each other and are updated at a regular rate (updates at > 5 Hz). If a mismatch or slow update rate are detected, this compare function disables the transmitter and provides diagnostic status information to the CPUs.

3-10.7 Placement/Polarization

The emissions from the localizer shall be horizontally polarized. The vertically polarized component of the radiation on the course line shall not exceed that which corresponds to a DDM error of .016 when an aircraft is positioned on the course line and is on a roll attitude of 20 degrees from the horizontal. The emission from the glide path equipment shall be horizontally polarized.

3-10.7.1 Antenna Clear Zone

No part of the assembly, or any structural elements that are part of the assembly may be placed within the signal transmit path area of the mounted antenna. Therefore the area ± 55 degrees azimuth of the antenna bore-site shall be kept clear of structural elements.

3-10.8 Monitoring

The GTU shall receive and measure samples of the transmitted GS and Loc signals and provide signal measurement data to the CPUs via the control interfaces. The Monitor functions within the GTU shall be able to be tuned for sample input levels between 20 and 50 dB below the transmitter output power levels. The measurement isolation shall be such that when calculating DDM from carrier, 90 and 150 Hz tones, the maximum error shall be less than .001 DDM.

3-11 Interrogation Assembly

There shall be five antennas, referred to as Front, Back, Left, Right and Center as indicated in Figure 10. The antenna pattern in azimuth shall be as shown in Figure 11.

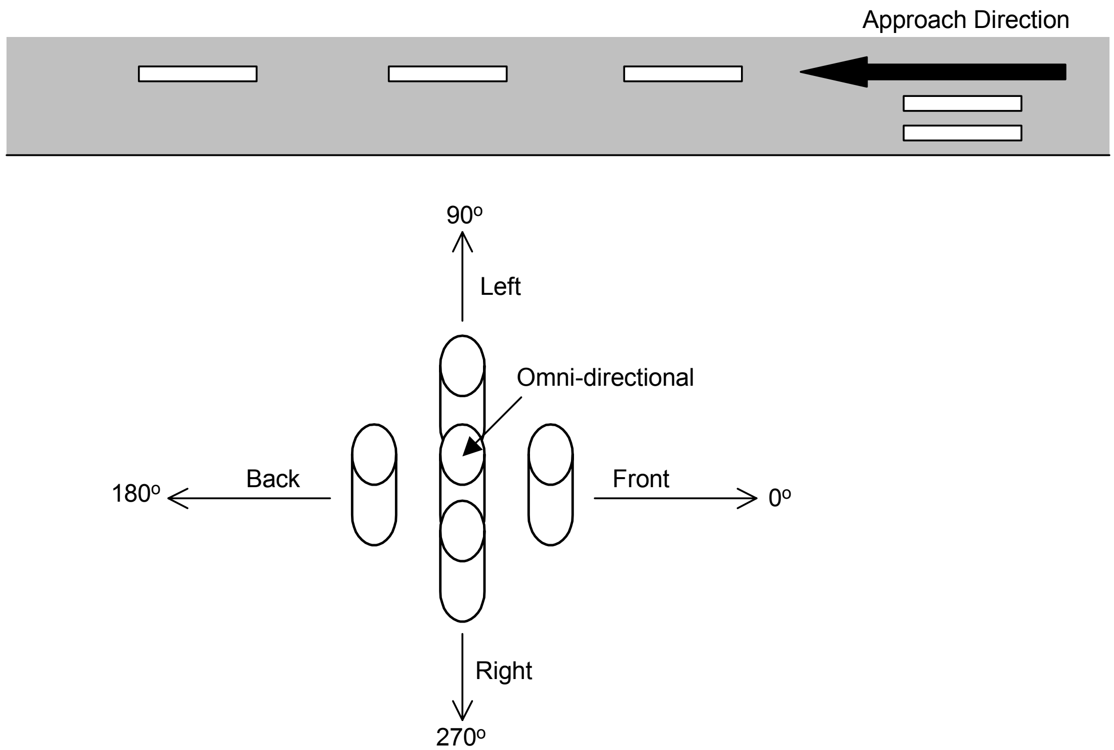

Figure 11 Front, Back, Left and Right Antenna Orientation

3-11.1 Antennas

There shall be five antennas, referred to as Front, Back, Left, Right, and Center Antenna.

3-11.1.1 Interrogator Uni directional Antenna Specifications

The Front, Back, Left, and Right Interrogation Antennas shall be all Uni-directional antennas, and shall function as per the specifications in Table 9.

Table 9 Interrogator Uni directional Antenna Specifications

Antenna Parameter	Antenna Performance
Azimuth coverage	Uni-directional
Polarization	Vertical
Gain, Main beam	9 dB/iso, main horizontal beam
Main beam elevation peak	10°±0.1° above the horizon
Vertical field pattern	The radiation pattern in the vertical plan has lobe not more than 12 degrees wide at the half power points.
Horizontal field pattern	The radiation pattern in the vertical plan has lobe not more than 90 degrees wide at the half power points.

3-11.1.2 Interrogator Omni-directional Antenna Specifications

The Center Antenna shall function as per the specifications in Table 10.

Table 10 Interrogator Omni-directional Antenna Specifications

Antenna Parameter	Antenna Performance
Azimuth coverage	Omni-directional
Polarization	RHCP
Gain, Main beam	6 dB/iso, main beam
Main beam elevation peak	90°±2° above the horizon
Vertical field pattern	The radiation pattern in the vertical plan has a lobe not more than 120 degrees wide at the half power points.

3-11.1.3 Antenna Mounting

The antennas shall be mounted with the main beams of the Front, Left, Back, and Right antennas at 0°, 90°, 180°, and 270°, respectively, with 0° parallel to runway centerline and positive angles are counter clockwise. The Front antenna shall be within ±5° of the desired orientation, and the other 3 antennas shall be within ±1° of their position with respect to the Front antenna.

The Center antenna shall be mounted at the intersection of the lines between the Front / Back and the Left / Right antennas.

The installation tolerance for antenna position with respect to vertical shall be ≤ 0.5 degrees. Assembly stability shall be such that vertical level is maintained to the installation level ± 1.0 degrees.

3-11.2 Interrogation Rate and Switching

A nominal 10 Hz interrogation rate shall be utilized with system guidance tracks updated at a 5 Hz rate to maintain the required accuracy. The surveillance tracks shall use a nominal 2 Hz interrogation rate. Since the Front antenna is used to interrogate guidance and surveillance tracks and the other 4 antennas are used to interrogate surveillance tracks, the interrogation rate shall be ≥ 18 Hz.

Therefore, the interrogation pattern per second shall be as indicated in Table 11:

Table 11 Interrogation Pattern per Second

Interrogation #	Antenna
1	Front
2	Left
3	Front
4	Back
5	Front
6	Right
7	Front
8	Center
9	Front
10	Front
11	Left
12	Front
13	Back
14	Front
15	Right
16	Front
17	Center
18	Front

Interrogations and suppression timing shall provide that when either FRONT, BACK, LEFT or RIGHT interrogation uni-directional antenna is selected, and omni-directional broadcast side lobe suppression signal will be transmitted from the CENTER antenna. The uni-directional antenna power output shall be tuned using attenuation, such that side lobe suppression is provided beyond /-45 degrees off the bore site of the uni-directional. When CENTER antenna is selected no suppression pulse shall be transmitted. Interrogations and suppression pairing is listed in Table 12.

Table 12 Interrogations and Suppression Pairing

Interrogation	Suppression
Front	Center
Left	Center
Back	Center
Right	Center
Center	None

3-11.3 Interrogation Transmitters

A transponder interrogation signal shall be transmitted to the landing aircraft at a periodic rate. The transponder interrogation signal is intended to be equivalent to that which would be produced by a secondary surveillance radar system with Mode A/C capabilities as specified in the International Civil Aviation Organization (ICAO) publication Convention on International Civil Aviation Annex 10. Coverage shall be equal or greater than the service area described in Sub-Section 2-3.2.1, 2-3.3.1 and 2-3.4.1.

3-11.3.1 Interrogation Frequency

The carrier frequency of the interrogation transmission shall be 1030 MHz ± 0.2 MHz. The carrier frequencies of each of the interrogation pulse transmissions shall not differ from each other by more than 0.2 MHz.

3-11.3.2 Interrogation Polarization

Interrogation transmissions shall be vertically polarized.

3-11.3.3 Interrogation Pulse Timing

The interrogation shall consist of transmitted pulses designated P_1 and P_3 identifying mode of interrogation and a control pulse P_2, which shall under certain conditions be transmitted. Transmission of P_2 is following P_1 transmission time and before P_3 transmission time to provide side lobe suppression to targets outside area of interest.

- The duration of pulses P_1, P_2, and P_3 shall be 0.8 ± 0.1 μs
- The rise time of pulses P_1, P_2, and P_3 shall be between 0.05 and 0.1 μs.
- The decay time of pulses P_1, P_2, and P_3 shall be between 0.05 and 0.2 μs.
- The interval between P_1 and P_3 shall be 8 ± 0.2 μs to provide mode A interrogation only
- The interval between P_1 and P_3 shall be 21 ± 0.2 μs to provide mode C interrogation only
- The interval between P_1 and P_2 shall be 2.0 ± 0.15 μs.

3-11.3.4 Interrogation Volume

The interrogation volume depends on the Secondary Track (Figures 2 and 3), Main Runway (Figures 5, and 6) Reciprocal Runway (Figures 8 and 9) functions.

3-11.3.5 Interrogation Radiated Power

The radiated power of the interrogation transmission shall be ≥ -86 dBW/m^2 (peak power) throughout the interrogation volume. The radiated amplitude of P_3 shall be within 1 dB of the radiated amplitude of P_1 at any point throughout the interrogation volume. The radiated amplitude of P_2 shall allow transponder interrogation within the coverage volume.

3-11.4 Interface Control

The connection between the base station and the Interrogation assembly shall be a Radio Frequency cable.

3-11.5 Placement

The Interrogation assembly must be able to interrogate the entire service volume. To minimize signal interference, the signal transmit path needs to be kept clear of structural elements. Therefore, the assembly, or any structural elements that are part of the assembly shall not be within the top and bottom of the antenna.

3-12 Azimuth Sensor Assembly (ASA)

3-12.1 Antennas

There shall be three antennas referred to as the reference, low, and high antennas. The antenna pattern shall be omni-directional in azimuth. The antenna pattern in elevation shall be as shown in Table 13, with the exception that the Relative Voltage above 20° shall be above 0.5.

Table 13 ASA Antenna Specifications

Antenna Parameter	Antenna Performance
Azimuth coverage	Omni-directional
Polarization	Vertical
Gain, Main beam	12 dB/iso, main horizontal beam
Main beam elevation peak	7°±0.1° above the horizon
Vertical field pattern	The radiation pattern in the vertical plan has a lobe not more than 6 degrees wide at the half power points.

3-12.2 Antenna Mounting

The antennas shall be mounted such that the low and the high antennas are between the reference antenna and the Elevation Sensor Assembly. The assembly shall provide mounting surfaces such that the three antennas can be mounted such that their base mounting plate heights are between 2.5 and 4 feet above ground level. The installation tolerance for antenna position with respect to vertical shall be ≤ 1.0 degree. The installation tolerance for horizontal level of the antennas is ≤1.0 degree. Assembly stability shall be such that horizontal level is maintained to the installation level ± 0.5 degrees.

3-12.3 Antenna Placement

To meet the accuracy and initialization requirements of the error budget, the lateral spacing of the antennas shall be as follows:

- The distance from the Reference antenna phase center to Low Resolution antenna phase center shall be 30.0 inches ± 0.1 inch
- The distance from the Reference antenna phase center to High Resolution antenna phase center shall be 120.0 inches ± 0.1 inch.
- The antennas shall be aligned to be within ±2.0° of being perpendicular with respect to centerline.

3-12.4 Angle of Arrival Sensor

3-12.4.1 Performance

The proposed sensor specifications below shall be the basis for the ANPC sensor design.

3-12.4.1.1 Radio Frequency Inputs

The AOA Sensor Assembly shall have four RF inputs. For each of these inputs, the following signal characteristics and specifications apply.

3-12.4.1.2 Dynamic Range

The AOA Sensor shall meet the performance specifications defined herein with an input RF Operating power range of -80 dBm to -20 dBm.

3-12.4.1.3 Input Power

The AOA Sensor instantaneous input power level without causing damage to the assembly shall be greater than or equal to +15 dBm.

3-12.4.1.4 VSWR

The VSWR of each AOA Sensor input shall be 1.5:1 MAX into 50 ohms.

3-12.4.2 RF Path Controls

3-12.4.2.1 RF Distribution Path Control

The AOA Sensor shall provide the capability to switch signals from the High, Medium, and Low RF inputs to either or both of the sensor A and C measurement output paths. The paths shall reflect the control signal settings and all performance requirements shall be met within 100 us of a change in the commanded path control values.

3-12.4.2.2 Low Input Phase Control

The AOA Sensor shall provide the capability to select the amount of phase shift in the Low input indicated in Table 14. The low path phase shall reflect the control signal settings and all performance requirements shall be met within 100 us of a change in the commanded phase control values. Phase change of the Low path signal, measured at either IF output A or C, relative to the phase with no phase shift commanded, shall be controllable to the following values (electrical degrees):

Table 14 Low Input Phase Control

Phase Change	+ Degree	- Degree
45	15	15
90	5	5
135	20	20
180	10	10
225	25	25
270	15	15
315	30	30

3-12.4.2.3 High Input Phase Control

The AOA Sensor shall provide the capability to select the amount of phase shift in the High input. The high path phase shall reflect the control signal settings and all performance requirements shall be met within 100 us of a change in the CPU commanded phase control values. Phase change of the High path signal, measured at either IF output A or C, relative to the phase with no phase shift commanded, shall be controllable to 45 + 5 / - 20 electrical degrees.

3-12.4.3 Acquisition Control

3-12.4.3.1 Sensor Acquisition Enable

The AOA Sensor shall include an acquisition enable signal via the CPU interface. When this control is enabled, the sensor shall start data acquisition upon receipt of a valid Start Signal. When this control is disabled, the sensor shall not start data acquisition.

3-12.4.3.2 Start Signal

The AOA Sensor Start Signal shall be provided to the sensor via a single fiber-optic pulse detecting input (J2-3). Transitions from low to high light level cause data acquisition to start if enabled. RX Input Sensitivity shall be a minimum of –25 dBm peak at 850 nm, via a 62.5 / 125 µm multimode fiber. A valid start pulse shall have a rise time of less than 50 ns and pulse duration of greater than 200 ns. Acquisition shall start within 10 ns of the receipt of the leading edge of a valid start signal.

3-12.4.3.3 Acquisition Window Duration

After receipt of a valid start signal, the sensor shall measure and record data for a period of 511.97 µs.

3-12.4.4 Sensor CPU

The AOA Sensor shall contain a CPU that provides the interface between the sensor control and data and the other processor elements of the Rhino II. The CPU shall include the following.

3-12.4.4.1 CPU

Shall be a Intel Pentium, 130 MHz minimum, or compatible.

3-12.4.4.2 RAM Memory

Shall be 16 MB minimum.

3-12.4.4.3 Non-volatile Memory

Shall be 16 MB minimum configurable as a drive partition.

3-12.4.4.4 Ethernet Interface

The CPU shall have an Ethernet interface to external processing elements. The Ethernet shall meet standards of 10 Base - T Ethernet. The Ethernet interface shall be physically implemented with two fiber-optic lines. The Transmit Data (J2-2) and Receive Data (J2-1). RX Input Sensitivity shall be a minimum of –25 dBm peak. TX Output Power shall be a minimum of –15 dBm into 62.5 / 125 multimode fiber at 850 nm.

3-12.4.4.5 Amplitude Measurement Performance

The amplitude measurements of the Log Video signals on paths A, B, and C shall be measured and recorded in Sensor memory for CPU access. These amplitude measurements shall meet the following specifications.

3-12.4.4.6 Digital Amplitude Measurement Output

An 8-bit digital data field shall represent amplitude data for each path. Amplitude data shall be over the range of 0 to 2 volts, where the Lest Significant Bit = 25 mV.

3-12.4.4.7 Amplitude Measurement Rate

The amplitude measurements of the Log Video signals on paths A, B, and C shall be measured and recorded every clock cycle, or every 31.25 nSec.

3-12.4.4.8 Log Slope

The log video output shall change 25 mV per dB of change to the IF input level.

3-12.4.4.9 Log Accuracy

For an input range of –80 dBm to –20 dBm, the log accuracy shall be ± 2.0 dB. This accuracy is defined as the errors as compared to a fixed slope of 25 mV/dB over this power range, the operational temperature range, and frequency range. The fixed slope line of 25 mV/dB is defined in Table 15 below. The fixed slope line may be offset over temperature within the range defined below, but must remain fixed over frequency at each specific temperature.

Table 15 Log Accuracy

Input Power (dBm ± 2 dB)	Output Voltage (Volts)
No Signal	< 0.100
-73	0.625 ± 0.1
-63	0.875 ± 0.1
-53	1.125 ± 0.1
-43	1.375 ± 0.1
-33	1.625 ± 0.1
-23	1.875 ± 0.1

3-12.4.4.10 Channel to Channel Matching

Given equal IF input power, the log video outputs for the Low, Medium, and High inputs shall be within ± 75 mV of the log video output for the Reference input.

3-12.4.4.11 Channel to Channel Isolation

When an input is applied to any one input, the log video output of the other two channels shall be a minimum of 625 mV (25 dB) below the output of the channel with the applied signal.

3-12.4.4.12 Signal to Noise Ratio

With input signals above –70 dBm, the signal to noise ratio shall be a minimum of 325 mV (13 dB).

3-12.4.5 Selectivity

Selectivity specifications shall be met for any RF input, output, distribution switch, and phase shifter setting.

3-12.4.5.1 Pass Band

Within the 1090 ± 8 MHz input band, there shall be a maximum power delta of ± 25 mV (± 1 dB). Between 8 and 12 MHz from center frequency, the output power shall be within 2 dB of the average power through the ± 8 MHz pass band.

3-12.4.5.2 Image Frequency Rejection

Rejection of inputs in the band of 1405 MHz ± 12 MHz shall be such that the measured output shall be a minimum of 30 dB below the input image power level.

3-12.4.5.3 Out of Band

Sensor out of band rejection shall be, at a minimum, as diagrammed in Figure 12.

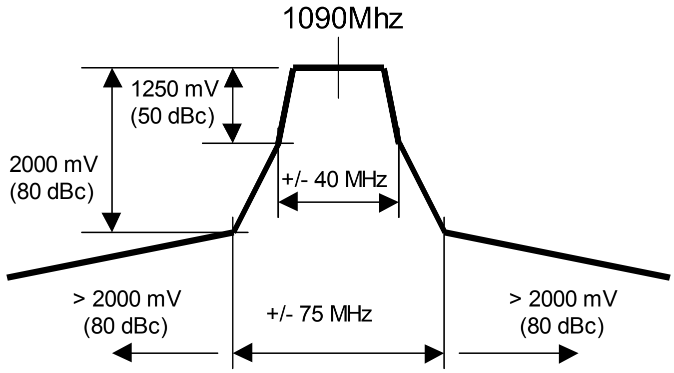

Figure 12 Sensor Out of Band Rejection

3-12.4.6 Delay Time

Delay time between the 50% power point of the input pulse to 90% voltage point of the log video output shall be less than 50 ns.

3-12.4.7 Delay Jitter

Given any constant input power and pulse edge timing, the log video output pulse rising edge shall have a peak to peak jitter of 2 ns, measured at a point 75 mV below the peak pulse video output.

3-12.4.8 Amplitude Jitter

For input power range of –73 dBm to -20 dBm amplitude measurement jitter shall be less than 25 mV (1 dB).

3-12.4.9 Phase Measurements

Measurements of the phase difference between the path B / path A signals and path B / path C shall be measured and recorded in Sensor memory for CPU access. These phase measurements shall meet the following specifications.

3-12.4.10 Digital Phase Measurement Output

Phase data shall be represented by an 8 bit digital data field. Phase data shall be over the range of 0 to 360 degrees, where LSB = 1.40625 degrees, word 00_{16} = 0 deg, and word FF_{16} = 358.59375 degrees.

3-12.4.11 Phase Measurement Rate

The phase measurements of B-A and B-C shall be measured and recorded every fourth clock cycle, or every 125 nSec.

3-12.4.12 Phase Stability – Amplitude Variation

Over time and environmental conditions of this specification, given RF inputs that have the following conditions:

- A fixed phase relationship between the B and A inputs and the B and C
- Identical input frequency of 1090 MHz
- Amplitude of inputs balanced ± 3 dB and greater than -40 dBm

The relative phase difference between B and A, and B and C shall not vary by more than ± 7 degrees.

3-12.4.13 Phase Stability – Frequency and dynamic balanced power

Given RF inputs that have the following conditions:

- Any fixed temperature within the Operating temperature range of this specification
- Any fixed input frequency within the range of 1082 MHz and 1098 MHz
- Amplitude of inputs balanced ± 3 dB and within the range of –70 to -20 dBm

The relative phase difference between B and A, and B and C shall not vary by more than ± 9 degrees.

3-12.4.14 Phase Stability – Frequency and Dynamic Balanced Low Power

Given RF inputs that have the following conditions:

- Any fixed temperature within the Operating temperature range of this specification
- Any fixed input frequency within the range of 1082 MHz and 1098 MHz
- Amplitude of inputs balanced ± 3 dB and within the range of –80 to -70 dBm

The relative phase difference between B and A, and B and C shall not vary by more than ± 13 degrees.

3-12.4.15 Phase Stability – Delta Power

Given RF inputs that have the following conditions:

- Any fixed temperature within the Operating temperature range of this specification
- Any fixed input frequency within the range of 1078 MHz and 1102 MHz
- Amplitude of inputs different by up to 15 dB, and both inputs in the range of –70 to -20 dBm

The relative phase difference between B and A, and B and C shall not vary by more than ± 6 degrees.

3-12.4.16 Phase Polarity

When the input phase of channel A and C are held constant, and the relative input phase of channel B is increased, (or lead), the two output phase words shall both increase in value.

3-12.4.17 Delta Phase

For Low, Medium, and High assembly inputs (J4, J6 and J5 respectively), the phase of that signal at the path A measurement relative to the same signal at the path C measurement shall be less than ±30 degrees. This delta phase specification shall be met for any RF distribution switch and phase shifter setting.

3-12.4.18 Delay to Stable Output

The AOA Sensor phase measurement output shall be stable within 75 ns of any change to the input frequency.

3-12.4.19 Phase Jitter

For input power range of –73 dBm to -20 dBm, and with the input phase held constant, phase measurement jitter shall be less than 5.5 degrees.

3-12.4.20 Frequency Measurement Performance

Measurement of the frequency of the path a signal shall be measured and recorded in Sensor memory for CPU access. These frequency measurements shall meet the following specifications.

3-12.4.21 Digital Frequency Measurement Output

An 8-bit digital data field shall represent frequency data. Frequency data shall be over the range of –1 volt to +1 volt, where LSB = 7.8125 mV = 0.086806 MHz.

3-12.4.22 Frequency Measurement Rate

The frequency measurement on the A path shall be measured and recorded every fourth clock cycle, or every 125 nSec.

3-12.4.23 Frequency to Voltage Conversion

The AOA Sensor output level shall change at a rate of 90 mV per MHz through the input frequency range..

3-12.4.24 Slope

The AOA Sensor frequency measurement shall increase as the input frequency decreases.

3-12.4.25 Center Frequency Accuracy

With a sensor input of 1090.0 MHz, the voltage output shall be -225 mV ± 180 mV.

3-12.4.26 Through the Band Accuracy

The maximum frequency error for any input frequency or power level shall be 180 mV from the ideal 90 mV / MHz ideal line, through the measured voltage point for an input at 1090 MHz.

3-12.4.27 Delay to Stable Output

The AOA Sensor frequency measurement shall be stable within 50 ns of any change to the input frequency.

3-12.5 Health Monitors

The Sensor shall provide health monitor data to the computer interface to allow system diagnostics of the Sensor. These health monitors shall include, but not be limited to the following.

3-12.5.1 Sensor Temperature

A 12-bit digital data field shall represent internal sensor temperature. Temperature data range shall be –50 to + 359 degrees C; LSB = 0.1 degree C; and 0 deg C at 500 counts.

3-12.5.2 DC Voltage Monitors

All Sensor DC voltages shall be measured and provided to the computer interface. A voltage measurement resolution of less than 10 mV shall be used in all cases.

3-12.5.3 AC Input Power

The performance specifications defined herein shall be met when the AC input power voltage is 120 VAC ±10% at an input frequency in the range of 47 to 63 Hz. Circuit breaker protection internal to the AOA Sensor is required.

3-12.5.4 Mean Time Between Failure

The AOA Sensor shall be designed to meet a MTBF of greater than 40,000 hrs.

3-12.5.5 Electromagnetic Compatibility (EMC)

3-12.5.6 Electromagnetic Radiation

3-12.5.7 Conducted Limits

Conducted emissions shall comply with the limit specified in 47 CFR Chapter 1 (1-0-1-94), Part 15 paragraph 15.107 or the equivalent European Directives to this requirement, EN50081-1.

3-12.5.8 Radiated Limits

Radiated emissions shall comply with the limit specified in 47CFR Chapter 1 (10-1-94), Part 15 paragraph 15.109(b) or the equivalent European Directives to this requirement, EN50081-1.

3-12.5.9 Electromagnetic Susceptibility

The AOA Sensor shall comply with European Directives EN61000-4-3, EN61000-4-4, and EN61000-4-5. Testing shall be performed with the sub-system(s) Operating, in a stand-alone mode, or in a system mode when housed in the enclosure used in normal operation.

3-12.6 Interface Control

The connection between the base station and the ASA sensor shall be an integrated fiber / optic power cable.

3-12.7 Placement

The ASA assembly must be able to measure phase for a primary approach and a reciprocal approach. To minimize signal interference, the signal receive path needs to be kept clear of structural elements. Therefore, no part of the assembly, or any structural elements that are part of the assembly shall be placed within ±55 degrees of the bore sight of the runway and above the base plate of the antenna towards either end of the runway.

3-13 Elevation Sensor Assembly (ESA)

3-13.1 Antennas

There shall be four antennas referred to as the reference, low, medium, and high antennas. The antenna pattern shall be omni-directional in azimuth for all antennas. The antenna pattern in elevation for the high and the low antennas shall be as indicated in Table 16, with the exception that the Relative Voltage above 10° shall be above 0.5.

Table 16 ESA Antenna Specifications

Antenna Parameter	Antenna Performance
Azimuth coverage	Omni-directional
Polarization	Vertical
Gain, Main beam	9 dB/iso, main horizontal beam
Main beam elevation peak	10°±0.1° above the horizon
Vertical field pattern	The radiation pattern in the vertical plan has a lobe not more than 12 degrees wide at the half power points.

3-13.2 Antenna Mounting

The antennas shall be mounted in stacked pairs with the high antenna above the medium in one pair and the low antenna above the reference in another pair. The low/reference antenna pair shall be the pair closest to runway threshold. The base plate of the lower antenna in each pair shall be 1 – 2 feet above ground. The installation tolerance for antenna position with respect to vertical shall be ≤ 0.5 degree. Assembly stability shall be such that vertical level is maintained to the installation level ± 0.2 degrees. The ESA Assembly shall be required to measure phase for a primary approach and a reciprocal approach. To minimize signal interference, the signal receive path needs to be kept clear of structural elements. Therefore, the assembly, or any structural elements that are part of the assembly within ±55 degrees of the bore sight and above the base plate of the antenna towards either end of the runway shall be minimized.

3-13.2.1 Antenna Stability - Short Duration

Structure stability shall be that vertical plumb is maintained to the installation level ± 2.0 degrees during short duration movements of the antennas due to wind gust conditions. The position shall not exceed the 0.2 degree stability requirement for more than 3 seconds.

3-13.3 Antenna Separation/Placement

To meet the accuracy and initialization requirements of the error budget, the separation between the lower and upper antenna base plates of the antenna pairs shall be 5.5 ± 0.083 feet (1 inch). The two pairs of antennas shall be aligned parallel to runway centerline within ± 1 degree. The separation of the antenna pairs shall be 300 to 350 feet.

3-13.4 Angle of Arrival Sensor

Refer to Sub-Section 3-12.4 as the ASA and the ESA shall utilize the same model sensor.

3-13.5 Interface Control

The connection between the base station and the ESA sensor shall be an integrated fiber / optic power cable.

3-13.6 Switching

The ESA shall have the capability to switch the RF antenna inputs as follows:

- Reference and Medium
- High and Low
- The time required to complete the switch shall be less than 5 seconds

3-14 Built in Test Equipment (BITE)

3-14.1 Antennas

3-14.1.1 Antenna Performance

Antenna shall perform according to uni-direction antenna specifications as found in Table 9.

3-14.1.2 Antenna Mounting Vertical Height / Plumb

The assembly shall provide mounting surfaces such that the mounted antenna phase center can be placed between the heights of 2.5 and 4 feet above ground level. The installation tolerance for antenna position with respect to vertical shall be ≤ 1.0 deg.

3-14.1.3 Antenna Stability

The assembly stability shall be such that the antenna base location remains within ± 0.1 inches of its installation location, and vertical plumb is maintained to the installation level ± 0.2 degrees.

3-14.1.4 Antenna Position Maintenance

Maintenance shall be required to maintain installation position settings for periods greater than 24 hours. Use of special tools to perform any position maintenance should be avoided. Design shall be done in a manner that minimizes the need for a regular position maintenance activity.

3-14.1.5 Provisions for Harness Tie Downs

The assembly shall include provisions for tying down harnesses that are routed from the BITE transmitter to each of the other mounted items. The design should allow for strain relief near the harness termination points, ability to weather proof harness ends, and assist in routing water paths away from the harness terminations.

3-14.2 Built In Test Equipment (BITE) Generator

3-14.2.1 Radio Frequency (RF) Output

The output frequency of BITE signal shall be 1090 MHz ± 50ppm during all of the operating conditions specified herein. The peak pulse output power of the 1090 MHz signal shall be 40 dBm -0dB + 2dB into a 50 ohm load.

3-14.2.1.1 Spectral Purity

The BITE Generator intentional radiation outputs shall pass and be licensed per FCC Part 87 for all outputs. All outputs shall meet these FCC requirements with a FCC Emission designation of 6MM1D.

3-14.2.1.2 Radio Frequency Output Voltage Standing Wave Ratio

The output VSWR for the RF Output port shall be < 1.5:1.

3-14.2.1.3 RF Output Rise / Fall Time

For all output signal pulses, the rise time of the output RF pulse, measured from the 10% point to the 90% point shall be 75 ns ± 15 ns. For all output signal pulses, the fall time of the output RF pulse, measured from the 10% point to the 90% point shall be between 75 ns and 200 ns.

3-14.2.1.4 RF Output Pulse Width

The pulse width of the output RF pulse, measured from the 90% point of the rising edge to the 90% point of the falling edge shall be within 5 % of the pulse width of the Transmit Gate input control signal, measured from the 90% point of the rising edge to the 90% point of the falling edge.

3-14.2.1.5 RF Output Delay - Multiple Pulses

For any single output signal, modulated with multiple pulses within a 25 us time frame, the output delay shall be the same as the transmit gate delay ± 10.0 ns. Delay is measured at the rising edge 50% points of the Tx gate and output pulse.

3-14.2.1.6 RF Output Jitter - Rising Edge

For any single output signal the output jitter with respect to the transmit gate input shall be < 2.0 ns (2 sigma). Jitter is measured at the rising edge 50% points of the output relative to the 50% point of the transmit gate input.

3-14.2.1.7 RF Output Protection

The BITE Generator shall not be damaged if the RF Output port is left in either a open circuit or short circuit condition while operation is attempted.

3-14.2.1.8 Duty Cycle Protection

The BITE Generator shall safely operate (no damage) regardless of the input control states. If duty cycle protection is required, the protection circuitry shall be as flexible as possible in allowing input pulse control options while maintaining operation safe to the transmitter.

3-14.3 Interface Control

3-14.3.1 BITE Generator to Antenna

The RF Output Connector shall be RF cabling.

3-14.3.2 CPU1 to BITE Generator

The connection between CPU1 and the BITE generator shall be an integrated fiber optic / power cable.

3-15 Environment

3-15.1 Temperature

3-15.1.1 Internal to Shelter

All components internal to the shelter shall operate within –10 degrees Centigrade to +50 degrees Centigrade. All components internal to the shelter shall withstand storage within –50 degrees Centigrade to +70 degrees Centigrade.

3-15.1.2 External to Shelter

All components internal to the shelter shall operate within –10 degrees Centigrade to +50 degrees Centigrade. All components internal to the shelter shall withstand storage within –50 degrees Centigrade to +70degrees Centigrade.

3-15.2 Humidity

All components external to the shelter shall operate within 5 to 100% relative humidity. All components internal to the shelter shall operate within 30 to 80% relative humidity. Above 40 degrees Centigrade, the relative humidity shall be based on a dew point of 40 degrees Centigrade.

3-15.3 Wind

All components external to the shelter shall be capable of withstanding wind to 100 mph without permanent deformation or change that would impact upon critical performance parameters.

3-15.4 Ice

All components external to the shelter shall be operable with ½" of heavy ice accumulation during storage and operation.

3-15.5 Altitude

All components shall operate within 0 to 12,000 feet above sea level. All components shall be able to withstand 0 to 50,000 feet above sea level.

3-15.6 Vibration

No component will be exposed to a significant amount of vibration during normal operation. Under non-operating circumstances, components shall not suffer damage or degraded performance when exposed to the following Power Spectral Density (PSD) vibration spectrum with 3 axis inputs as graphed in Figure 13.

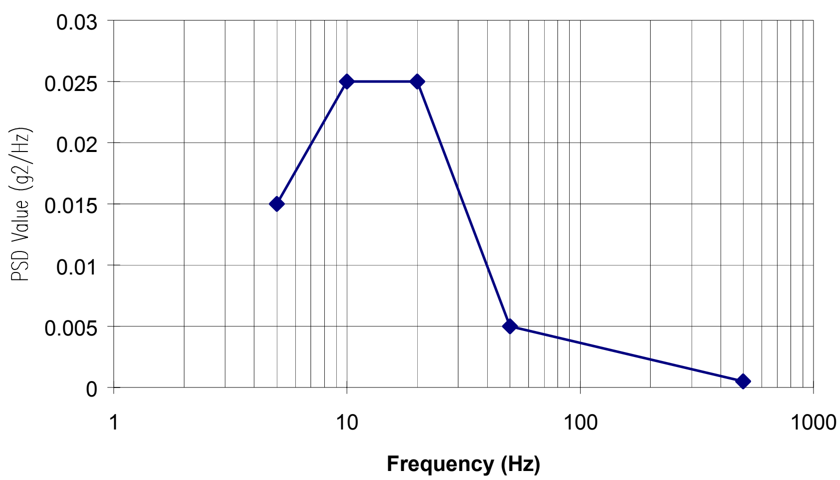

Figure 13 Vibration Spectrum

3-15.7 Shock

No component shall be exposed to shock during normal operation. All components shall meet or exceed non-operating shock in accordance with Per MIL-STD-810E method 516.4 procedure VI.

3-15.8 Environmental Control Unit

The ECU shall maintain the shelter contents within the temperature and humidity ranges prescribed in sections 3.14.1 and 3.14.2, respectively.

3-16 <u>System Siting</u>

3-16.1 <u>Siting Procedure</u>

3-16.1.1 <u>ESA Siting</u>

The center of the ESA array shall be less than 360 feet (110 m) from runway centerline and 330-360 feet behind touchdown. The ESA center is the point midway between the two elevation antenna assemblies that are separated on a runway parallel line as illustrated in Figure 14.

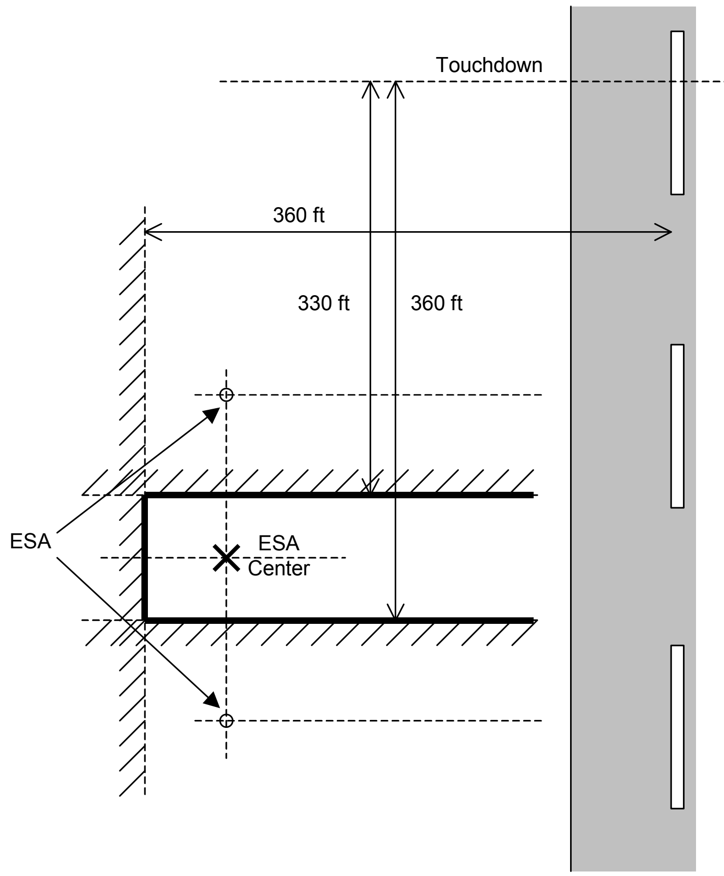

Figure 14 Elevation Sensor Assembly Siting

3-16.1.2 ASA Siting

The center of the ASA array shall be within ±5 degrees of one of the ESA antenna pairs with respect to a line perpendicular to runway centerline and intersecting the appropriate ESA antenna. The distance from the center of the ASA array to the line running through both ESA antenna pairs shall be greater than 165 feet (50 m). The center of the ASA array shall be less than 200 feet (60 m) from runway centerline. Refer to Figure 15.

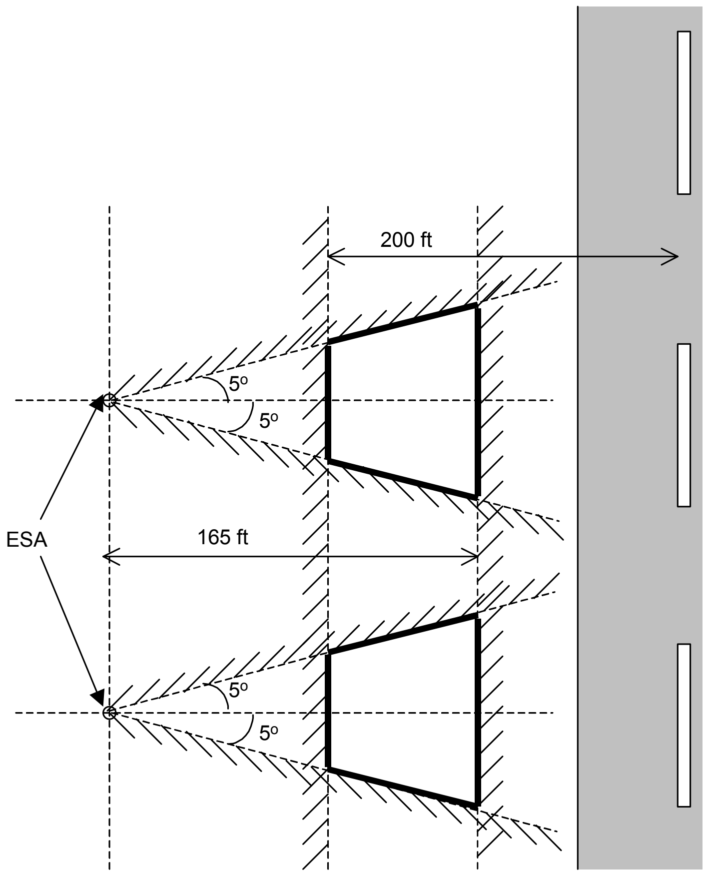

Figure 15 Azimuth Sensor Assembly Siting

3-16.1.3 Built In Test Equipment Antenna Siting

The BITE antenna shall be within 10 feet of the ESA Center as shown in Figure 16.

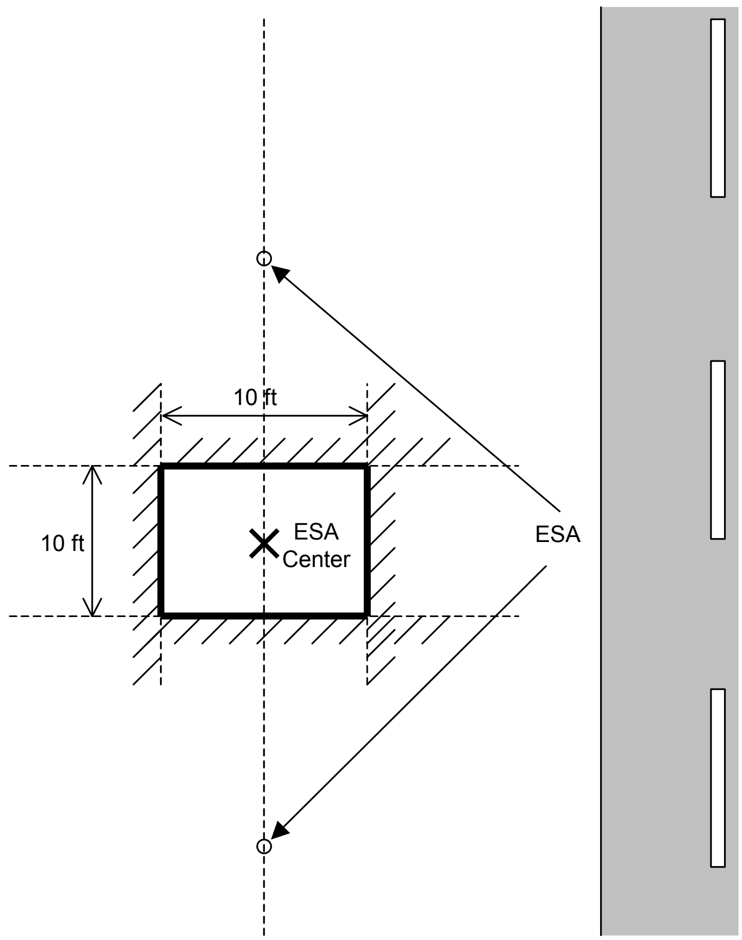

Figure 16 Built In Test Equipment Antenna Siting

3-16.1.4 <u>Interrogation Assembly Siting</u>

The Interrogation Assembly shall be between 80 to 100 feet from the line through the ESA antenna pairs, towards runway centerline. Refer to Figure 17.

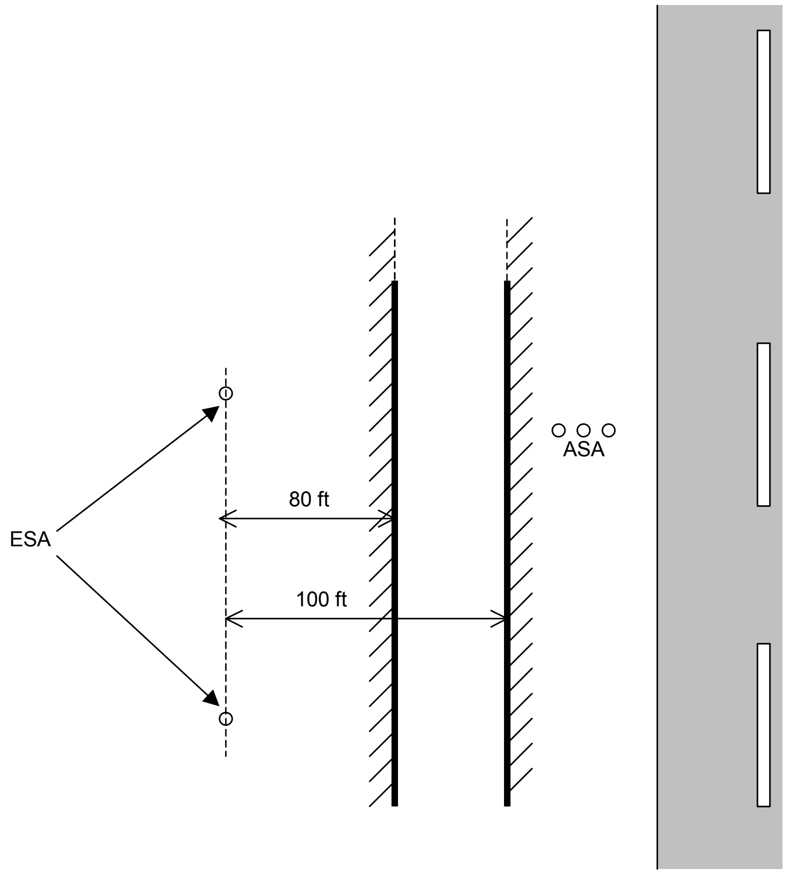

Figure 17 Interrogator Antenna Siting

3-16.1.5 Uplink Assembly Siting

The Uplink Assembly and Base Shelter shall be between 25 to 60 feet from the line through the ESA antenna pairs, away from runway centerline and within 10 feet of ESA center. Refer to Figure 18.

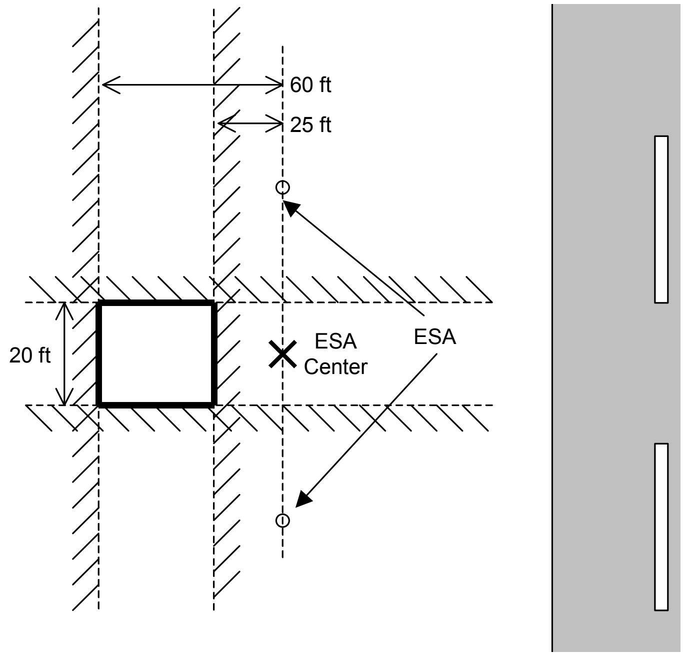

Figure 18 Uplink Antenna Siting

3-16.2 Terrain Gradient Requirements

The assembly shall be capable of setup on terrain with a slope of ≤ 5%. Ground-height step variations of up to 6 inches (as produced by local soil variations ex: rocks, pitting, etc.) over the installation area shall not prevent a successful assembly installation. Installation crew site preparation is an acceptable means to resolve local site abnormalities.

3-16.2.1 Soil Loading Requirements

The antenna assembly shall be designed to allow setup and operation in soil conditions supporting a minimum of 20 PSI. The assembly shall be designed to set up on sandy soil, rocky soil, and hard surface (asphalt or cement).

3-17 Error Budget

3-17.1 Main Runway Error Budget

The system shall have a Main Runway error budget as detailed in Tables 17 and 18.

Table 17 Main Runway ASA Error Budget

Quantity	Amount
Sensor Measurement	0.22
Critical Area	0.05°
Multipath	0.05°
Margin	0.03°
Total Measurement Error	**0.240°**
GDOP due to Siting	0.002°
Uplink	0.058°
Total Error	**0.3°**

Table 18 Main Runway ESA Error Budget

Quantity	Amount
Sensor Measurement	0.146
Critical Area	0.075°
Multipath	0.08°
Margin	0.023°
Total Measurement Error	**0.184°**
GDOP due to Siting	0.009°
Uplink	0.032
Total Error	**0.225**

3-17.2 Reciprocal Runway Error Budget

The system shall have a Reciprocal Runway error budget as detailed in Tables 19 and 20.

Table 19 Reciprocal Runway ASA Error Budget

Quantity	Amount
Sensor Measurement	0.22
Critical Area	0.05°
Multipath	0.05°
Margin	0.03°
Total Measurement Error	**0.240°**
GDOP due to Siting	0.002°
Uplink	0.058°
Total Error	**0.3°**

Table 20 Reciprocal Runway ESA Error Budget

Quantity	Amount
Sensor Measurement	0.194
Critical Area	0.100°
Multipath	0.106°
Margin	0.03°
Total Measurement Error	**0.245°**
GDOP due to Siting	0.012°
Uplink	0.043°
Total Error	**0.3°**

In order to meet the desired accuracy, it is necessary to account for all possible error sources. The meaningful sources of error are:

- Sensor Measurement - Errors due to the sensor, including power differences in channels, sensor non-linearity, received power, and sensor calibration. This is based on sensor performance. It is also a function of the sensor resolution.
- Critical Area – Errors due to obstructions outside the defined critical area. This is an allocated value, with an allocation large enough to achieve a reasonable critical area. It is also a function of the sensor resolution.
- Multipath – Errors due to multipath from snow and rain. This is an allocated value based on site data. It is also a function of the sensor resolution.
- Margin – Allowance for margin, 10% of desired accuracy.
- Uplink – Error in the uplink signal after guidance corrections have been calculated, so this error is added in at the end.

These error sources, with the exception of the Uplink, are Root Sum Squared together to determine the final measurement error. Since the measured value must be translated to a separate reference point (either touchdown or the apparent localizer), there is also an additional error due to the Geometric Dilution of Precision (GDOP). This is a function of the error in the range estimate and the location of antenna array.

3-17.2.1 Secondary Tracking Error Budget

Secondary Tracking Error Budget shall be as indicated in Table 21.

Table 21 Secondary Tracking Error Budget

Quantity	Amount
Sensor Measurement	1.5
Critical Area	0.9°
Multipath	0.9°
Margin	0.2°
Total Error (RSS)	**2.0°**

3-18 Critical and Sensitive Areas

Critical and sensitive areas are defined to prevent vehicles and aircraft from interfering with system operation. The critical area shall be defined as the area where no vehicles or activities are allowed during Rhino II operations. The sensitive area shall be defined as the area where there are restrictions on the type and activity of vehicles that are allowed during Rhino II operations. Cars and small trucks (≤ 24' in length and 12' in height) and small aircraft (fuselage length ≤ 45' and overall tail height ≤ 15') shall be allowed to traverse the sensitive area. Engineering analysis and field tests can be used to modify the critical and sensitive area boundaries, particularly the sensitive area boundaries for vehicles that exceed the sensitive area dimensions but are smaller than a Boeing 727. If there will be vehicles larger than a Boeing 727 outside the sensitive area there shall be a reassessment of the critical and sensitive areas with an anticipated expansion of either or both. The Rhino II critical and sensitive areas are a result of compiling all sub unit critical and sensitive areas, these sub-unit requirements are found below.

3-18.1 Main Runway Service Critical Area

3-18.1.1 ESA Critical and Sensitive Areas

The ESA critical and sensitive areas for the Main Runway service shall fit within the intersection of the dimensions shown in Figures 19 and 20.

Note: The size of the critical area and sensitive area are a function of the glide path angle (θ) but are shown in Figures19 – 20 at nominal 3 degree approach.

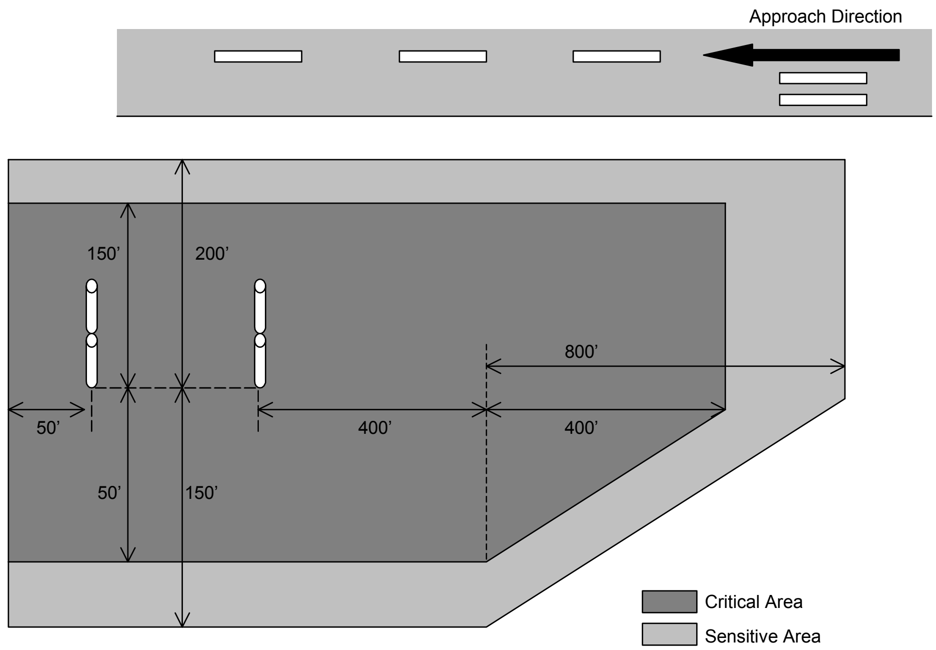

Figure 19 Plan View of ESA Critical and Sensitive Areas At 3degrees

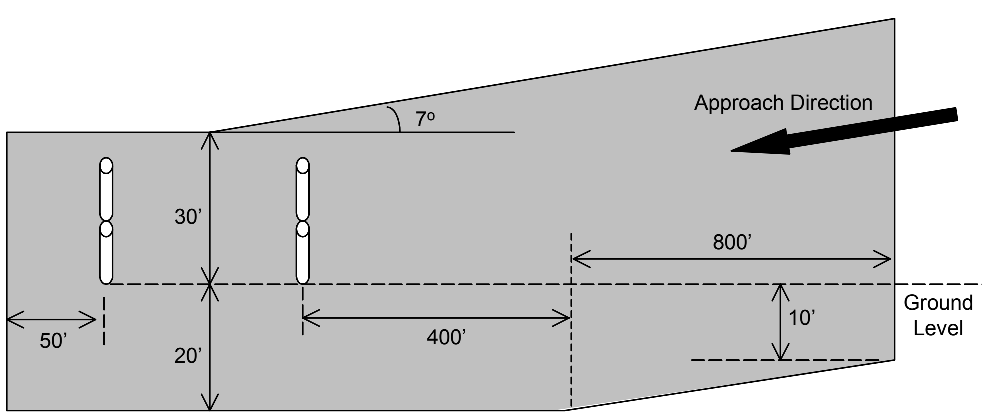

Figure 20 Profile View of ESA Critical and Sensitive Areas At 3 degrees

3-18.1.2 <u>ASA Critical and Sensitive Area</u>

The ASA critical and sensitive areas for the Main Runway service shall fit within the intersection of the dimensions shown in Figures 21 and 22.

Note: The size of the critical area and sensitive area are a function of the glide path angle (θ) but are shown in Figures 21 – 22 at nominal 3 degree approach.

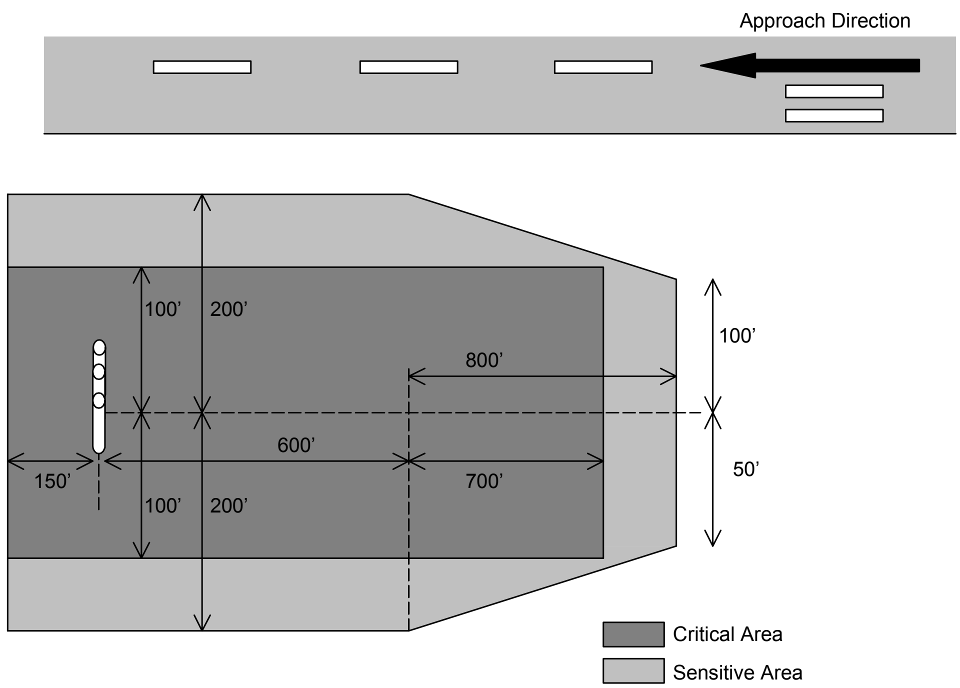

Figure 21 Plan View of ASA Critical and Sensitive Areas at 3 degrees

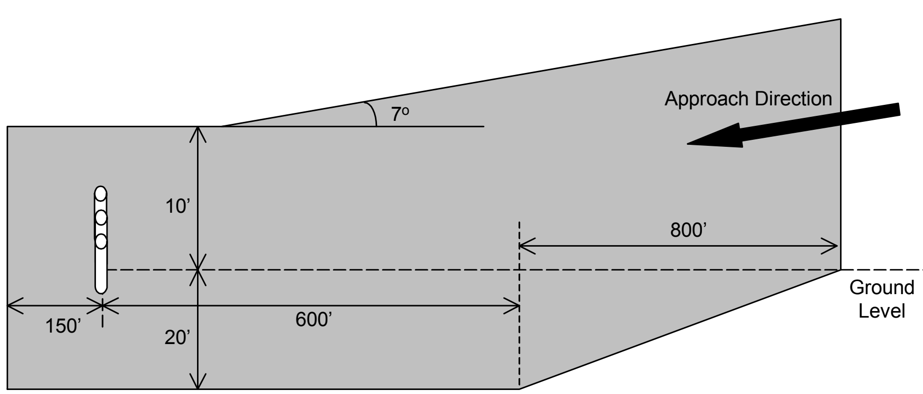

Figure 22 Profile View of ASA Critical and Sensitive Areas at 3 degrees

3-18.2 Reciprocal Runway Service Critical Area

3-18.2.1 ESA Critical and Sensitive Areas

The ESA critical and sensitive areas for the Reciprocal Runway service shall fit within the intersection of the dimensions shown in Figures 23 and 24.

Note: The size of the critical area and sensitive area are a function of the glide path angle (θ) but are shown in Figures23 – 24 at nominal 3 degree approach.

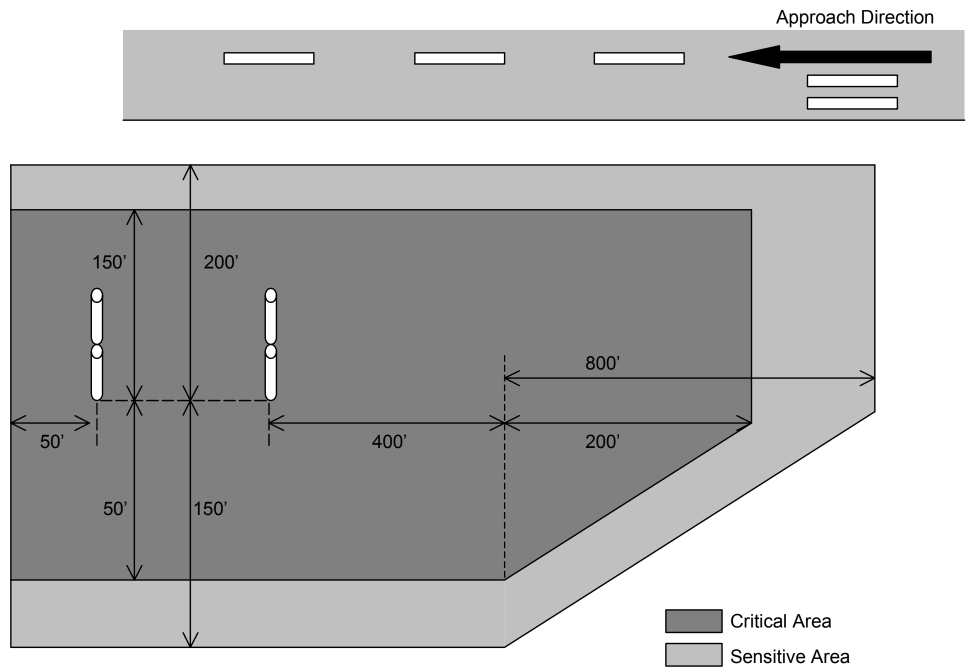

Figure 23 Plan View of ESA Critical and Sensitive Areas At 3 degrees

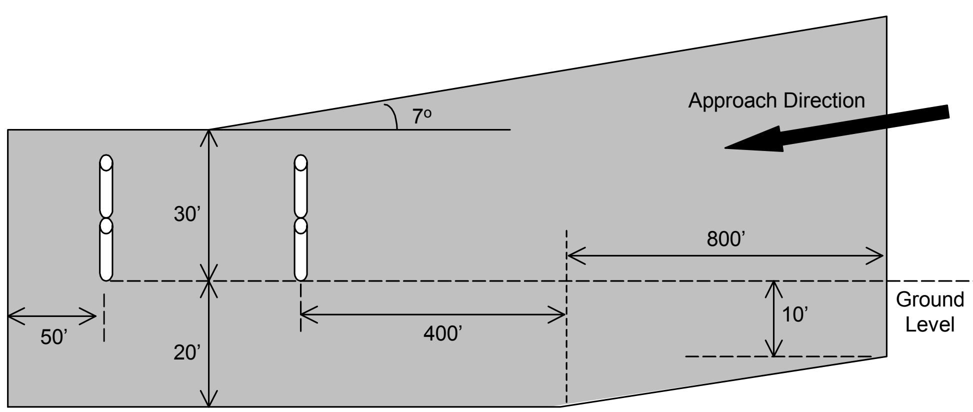

Figure 24 Profile View of ESA Critical and Sensitive Areas At 3 degrees

3-18.2.2 ASA Critical and Sensitive Area

The ASA critical and sensitive areas for the Reciprocal Runway service shall fit within the intersection of the dimensions shown in Figures 25 and 26.

Note: The size of the critical area and sensitive area are a function of the glide path angle (θ) but are shown in Figures 25 – 26 at nominal 3 degree approach.

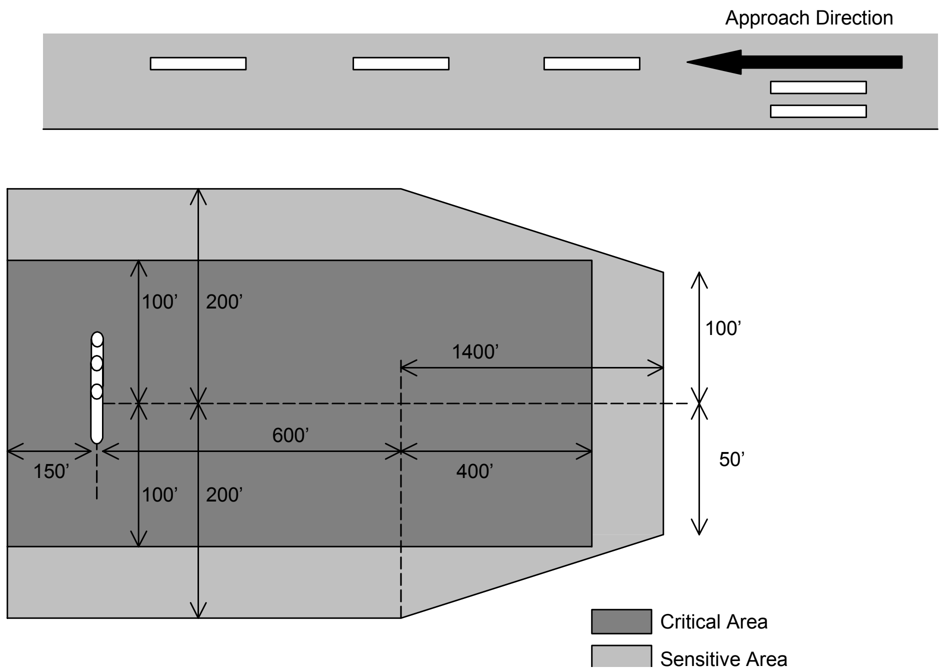

Figure 25 **Plan View of ASA Critical and Sensitive Areas At 3 degrees**

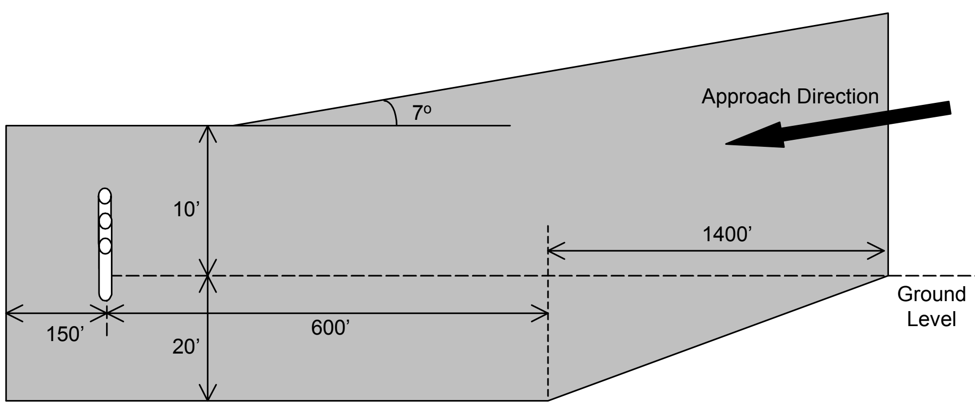

Figure 26 **Profile View of ASA Critical and Sensitive Areas At 3 degrees**

SECTION 4 Software Specifications Rhino II

4-1 Software Configuration Items

The Rhino II software shall be comprised of five Software Configuration Items (SCIs) that will be associated with the principal Rhino II components. These SCIs shall be hosted on different types of processors to include different operating systems. One SCI shall be classified as Software Level B (ref. RCTA/DO-178B), and the remainder shall be Level D. Table 22 below lists the SCIs, their software design assurance levels, operating systems, and the processors on which they run.

Table 22 The Five Software Configuration Items

SCI	DO-178B LEVEL	OPERATING SYSTEM	PROCESSOR
Base CPU1	B	QNX	Pentium (CPU1)
Base CPU2	D	Windows NT	Pentium (CPU2)
Sensor	D	QNX	586 (AOA)(2 each)
Remote Control Unit	D	Windows NT	Pentium (RCU)
Maintenance Interface	D	Windows NT	Pentium (MIU)

The two Base Station Processors (CPU1 and CPU2) provide for central control and guidance computation for the Rhino II system. The two solutions shall be input to a circuit in the guidance transmitter that compares them and shall stop the uplink to the aircraft if they do not match within a preset tolerance. This design shall address the random hardware or OS failure modes and ensure that guidance transmissions will be removed in the event of a failure. The two Base Station SCIs shall provide two parallel computational paths operating on the same sensor data, and producing guidance command outputs that, in the absence of a failure, should be identical.

The Sensor SCI shall be identical for the two AOA Sensors (ASA and ESA), which share all functions. The Sensor SCIs shall control and collect signal measurement data from transponder receivers and antenna arrays and pass it to the two Base Station SCIs via Ethernet over fiber optic cables. The interface to the receivers shall be via a Phase Acquisition Card (PAC). During interrogation setup, the Base1 SCI shall send the sensor acquisition setup data, which will vary for the ASA vs. the ESA.

The RCU SCI shall perform the software portion of the Rhino II operator functions for normal flight operations. It shall provide a means for the Rhino II Operator to designate the transponder identification code for the aircraft to be tracked and to initiate and terminate Rhino II guidance. It shall also display various information of interest to the operator, including Rhino II operational modes and health status.

The MI SCI shall provide the software portion of the Rhino II Technician interface to the system for configuring and calibrating the system when it is first installed at a site and subsequently diagnosing faults and maintaining the system. The Maintenance Interface shall provide functions for system calibration, real-time monitoring, troubleshooting, and remote Rhino II access for ANPC Engineering.

4-2 Base CPU1/CPU2 Software Configuration Items Description

Base CPU1 is the central controlling element of the Rhino II system. CPU1 shall be developed to DO-178B Level B standards all other SCI shall be developed, as Level D. Some of its functions are unique and Base CPU2 performs others redundantly. Major functions that this SCI alone performs shall be the following:

- Setup / Control of the Sensors
- Control of the interrogation / calibration-BIT transmitter
- System Mode control and transition

Major functions this SCI shall perform in common with Base CPU2 include:

- Aircraft tracking and guidance
- Command of the guidance transmitter
- Integrity Monitoring
- Data logging
- Network communications

The top-level architecture of the Base CPU1 SCI shall be as shown in Figure 27 and for Base CPU2 in Figure 28. Each Base process is described below in the context of the Computer Software Components (CSCs) comprising it. All processes are common to both SCIs; one description is given and any differences in operation between CPU1 and CPU2 are discussed.

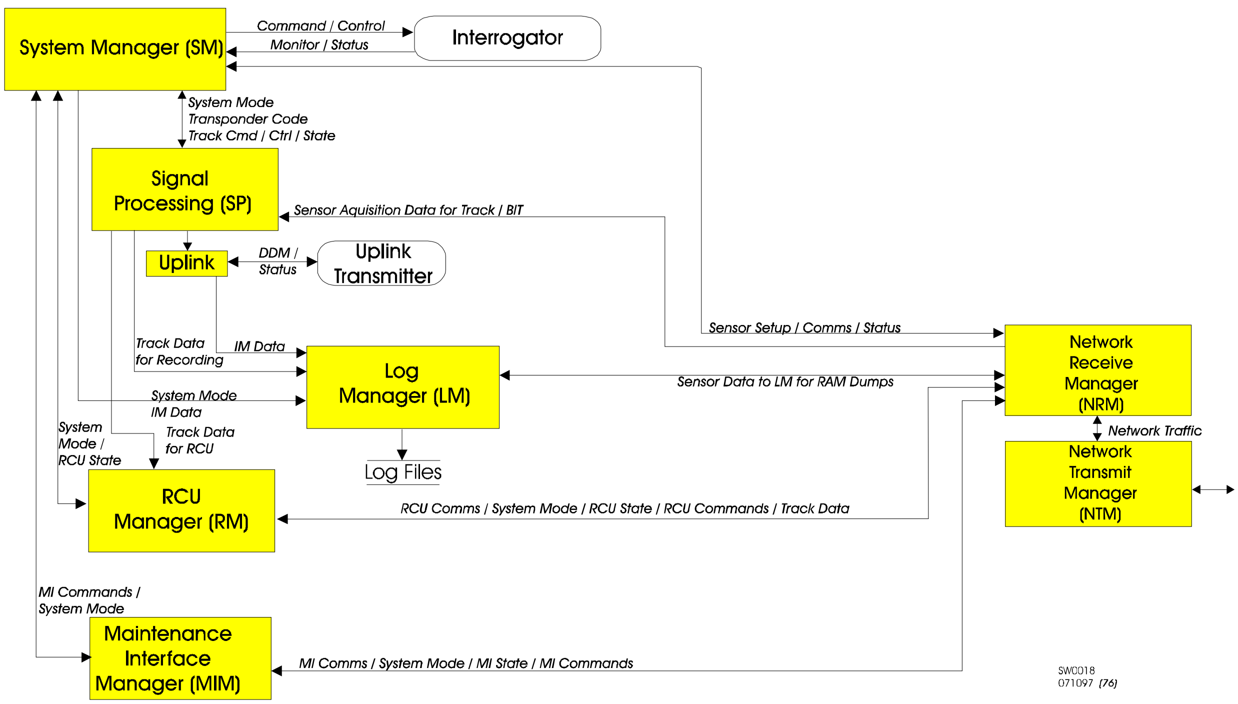

Figure 27 Base CPU1 Architecture

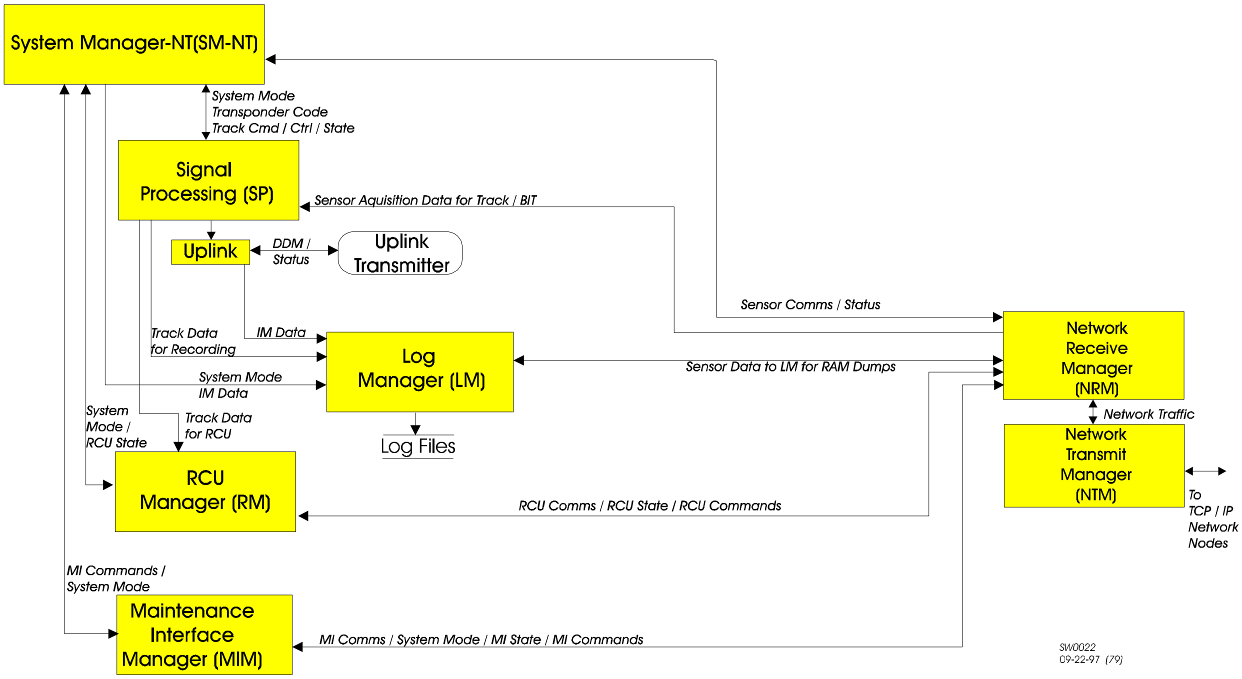

Figure 28 Base CPU2 Architecture

4-2.1 System Manager Process

The System Manager process is comprised of a single CSC and is the system mode and control center on each CPU. System Manager is responsible for receiving system mode change information and broadcasting this information to all local processes (e.g., transition the system to Maintenance Mode based on software detection of a system fault). The RCU commands to Start Acquisition for tracking or to Abort interrogations also flow through System Manager for mode change control. On Base CPU1, System Manager also interfaces with the interrogator hardware providing command and control and receiving feedback and integrity monitoring status information for both the interrogator and the Cal/BIT transmitter. CPU1's System Manager also shall provide sensor set-up and control for each interrogation and sensor health status for sensor integrity monitoring.

4-2.2 Network Communications Processes

Two processes, Network Receive Manager and Network Transmit Manager, each containing a single CSC, shall accomplish the network communications on the Base CPUs. These same two processes shall run on each sensor CPU and the RCU and MIU CPUs in identical format. They shall provide the Ethernet UDP/IP communications for all application processes to use across the network and include built-in auto-detect and correction of errors and reporting of failures to requesting application client processes.

4-2.3 Signal Processing Process

Signal Processing shall provide the processing required establishing; computing and sending the aircraft track information to the Uplink process to output to the Guidance Transmitter. It uses the pulse sample and signal measurement data from the sensors for inputs, calculates aircraft position, and computes corrections. Signal Processing also includes monitoring the quality of the input data and the tracking solution, and calibrating the signal path.

Signal Processing shall be comprised of seven CSCs as shown in Figure 29 and shall be the same on both Base CPUs. Each of these is briefly described below.

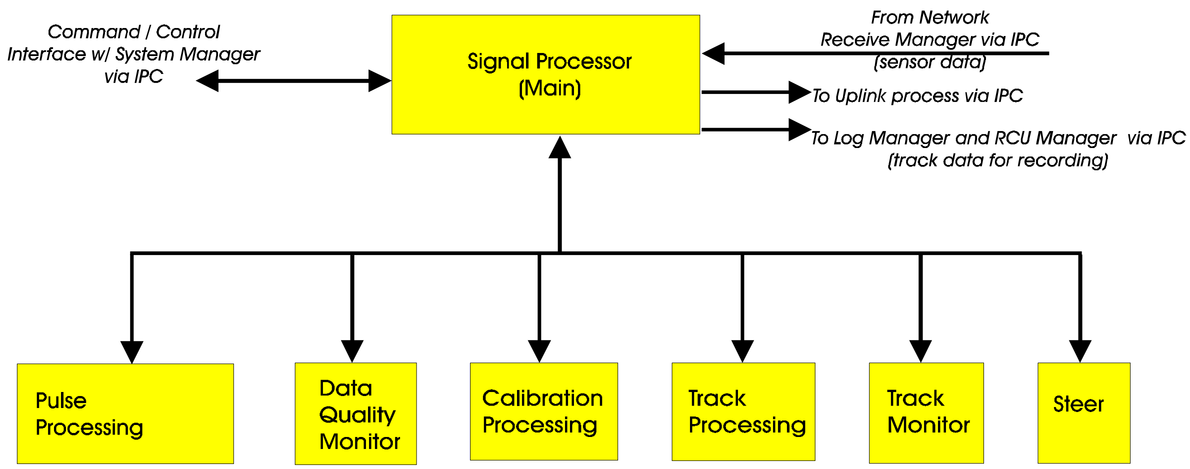

Figure 29 Signal Processing Components

4-2.3.1 Main

The Main CSC of Signal Processing shall send messages to or receive messages from other processes via Inter-Process Communication (IPC) or with the other applications on other CPUs via the network communications software. These messages include input of desired transponder code to track, output of sensor setup parameters, output of track data for recording, and output of aircraft correction information for Uplink processing. Main also controls Signal Processing's synchronization and data flow and internal process state (e.g., Acquiring or Tracking).

4-2.3.2 Pulse Processing

The Pulse Processing CSC shall receive the sensor data as input and determine the location of the transponder replies in the data using a combination of pulse phase and amplitude discrimination techniques.

4-2.3.3 Cal/BIT Processing

The Cal/BIT CSC shall provide integrity monitoring of the cal/BIT signal during BIT by validating the raw phase, amplitude, frequency, and sensor health data from each sensor.

4-2.3.4 Data Quality Monitor

The Data Quality Monitor CSC shall provide integrity monitoring of the sensor acquisition by validating the raw phase and power measurements across channels. It also checks frequencies of the Cal/BIT antenna and the aircraft transponder.

4-2.3.5 Calibration Processing

The Calibration Processing CSC shall update and validate the calibration tracks, which are used for integrity monitoring of the calibration and data quality.

4-2.3.6 Track Processing

The Track Processing CSC shall perform all of the processing required to maintain the aircraft tracks. This includes the following tasks: Conversion of raw measurements into physical measurements, initializing system and secondary tracks, filtering physical measurements into tracks, and track maintenance bookkeeping functions.

4-2.3.7 Track Monitor

The Track Monitor CSC shall monitor the system and secondary tracks and update the track status. It performs integrity-monitoring tests on track update rates and performs comparisons of estimates from different measurement sets.

4-2.3.8 Steer

The Steer CSC shall compute corrections to provide to the aircraft via the Uplink process. It shall use track information computed by Track Processing and approach information for the selected approach to calculate the corrections.

4-2.4 Uplink Process

The Uplink process shall provide command and control of the guidance transmitter. Uplink computes DDM values based on corrections provided by Steer in Signal Processing and sends these to the transmitter for modulation on desired ILS frequencies for glide slope and localizer. It also performs integrity monitoring of the uplink and shall provide this status back to System Manager for action. The Uplink process is identical on both CPU1 and CPU2.

4-2.5 RCU Manager Process

The RCU Manager process shall be comprised of a single CSC that establishes and maintains application-to-application communications with the RCU process running on the RCU CPU. The RCU Manager receives the RCU operator-entered approach selection and transponder code as part of the start approach message and also receives abort request messages from the RCU and forwards them to System Manager. It also shall provide the RCU process with system mode and alarm information as well as track information for RCU recording and approach replay. The RCU Manager is also responsible for detecting failure of the RCU communication link and generating an alert or alarm, depending on system mode. The RCU Manager process is identical on both CPU1 and CPU2 except that system mode and track data are sent to the RCU process from RCU Manager on CPU1 only.

4-2.6 Log Manager Process

The Log Manager process shall be comprised of a single CSC that receives disk-logging requests from local application processes and performs the disk file output. File recording includes BIT log file data and error/event messages. The Log Manager process shall be identical on both CPU1 and CPU2.

4-2.7 Maintenance Interface Manager Process

The Maintenance Interface Manager process shall be comprised of a single CSC that establishes and maintains application-to-application communications with the MI process running on the MIU CPU. The Maintenance Interface Manager receives the Rhino II Technician-entered system commands and controls to view system status, stop or start the system for maintenance activities, or enter calibration data during installation or repair. It also shall provide the Maintenance Interface process with system mode and alarm information. The Maintenance Interface Manager process shall be identical on both CPU1 and CPU2.

4-2.8 Sensor Software Configuration Items Description

The Sensor SCI shall be comprised of the Sensor process, which is a single CSC, and the Network Communication processes described in Section 3.3.1.2. The Sensor process' primary purpose is to interface with the sensor acquisition hardware. This includes receiving sensor setup data from the Base CPU1 and sending this setup information to the Phase Acquisition Card (PAC). It also performs the read of the PAC data once an acquisition is complete and sends the data in to both Base CPUs, and reads sensor hardware health data from the PAC.

4-2.9 Remote Control Unit Software Configuration Items Description

The RCU SCI shall be comprised of the RCU process (a single CSC) and the Network Communications processes (Section 3.3.1.2). The RCU process shall provide the Rhino II Operator interface to the system for the following operator functions:

- Transponder Code Entry (Code of aircraft desiring Rhino II approach)
- Enter/Abort commands for approach start/stop
- Alarm/Alert/System mode monitoring to determine Rhino II general health and availability

The RCU SCI communicates with the Base CPUs using UDP/IP and the network via PPP utility for Windows-NT across a physical serial link connected to Base CPU2 or by a physical Ethernet connection. The RCU CSC records track data received from the Base CPU1 for later approach replay by the optional Approach Replay tool. The RCU also maintains the communication link with the Base CPUs via a "ping" message.

4-2.10 Maintenance Interface Software Configuration Items Description

The Maintenance Interface SCI shall be comprised of the Maintenance Interface process (a single CSC) and the Network Communications processes (Section 3.3.1.2). It shall provide the Rhino II Technician, ANPC installer, and ANPC engineering an interface to the Rhino II. Rhino II Technician functions which are conducted through this interface include:

- Entry/maintenance of Integrity Monitoring Limits information
- Review equipment status/alarm status
- System control and control of data recording (with proper authorization)
- Manual control of Built-In-Test schedule, start, stop

In addition, the Maintenance Interface process allows for review and maintenance of ANPC entered calibration data and the ANPC installer access to tools used during installation and calibration. All Maintenance Interface functions will be password protected and provide for file security.

SECTION 5 Safety

5-1 HERO

The Frequencies and power levels utilized by this system are the identical to those currently existing on military air facilities.

5-2 HERP

The Frequencies and power levels utilized by this system are the identical to those currently existing on military air facilities.

SECTION 6 Maintainability

6-1 Mean Time To Repair (MTTR)
To be determined

6-1.1 Maximum Repair Time (MMAX)
To be determined

6-1.2 Scheduled Maintenance
To be determined

6-1.3 Periodicity
To be determined

6-1.3.1 Daily
Reserved for later use.

6-1.3.2 Weekly
Reserved for later use.

6-1.3.3 Monthly
Reserved for later use.

6-1.3.4 Quarterly
Reserved for later use.

6-1.3.5 Annually
Reserved for later use.

6-2 Level of Maintainability
To be determined

6-3 Special Tools and Test Equipment
To be determined

6-3.1 Equipment Handling
To be determined

6-3.2 Cable and Wire Marking
To be determined

6-3.3 Cable Connections and Cable Slack
To be determined

6-3.4 Panels, Handles and Fastener Standard
To be determined

6-3.5 Wire and Pin Designations
To be determined

6-3.6 CaNDI Markings

To be determined

6-3.7 Name Plate Data

To be determined

6-4 Safety Warning Labels

To be determined

6-5 Human Engineering

To be determined

6-6 Weather Proofing and Air Flow Filtering

To be determined

6-7 Built In Test Equipment (BITE)

To be determined

6-7.1.1 Power Monitoring

To be determined

6-7.1.2 Over Temperature, Humidity Sensors/Alarms

To be determined

6-8 Re-Certification Requirements

To be determined

SECTION 7 Materials And Processes

7-1 Hazardous Materials Utilized

To be determined

7-1.1 Paint Used/Required

To be determined

7-1.2 Flammability Of Materials

To be determined

7-2 Recycled Vice Virgin Materials

To be determined

SECTION 8 Logistics

8-1 Maintenance Concept

8-1.1 On Line

To be determined

8-1.2 Off Line

To be determined

8-2 Overhaul Periods/Hours

To be determined

8-3 Tools And Test Equipment

To be determined

8-4 Dimensions

8-4.1 Weights

To be determined

8-4.2 Appearances

To be determined

8-4.3 Workmanship

To be determined

SECTION 9 Methods Of Verification

9-1 Analysis

Analysis will be performed verifying data derived from developmental research as well as comparison from data developed during the Building and certification process of Transponder Landing System (TLS^{tm}).

9-2 Demonstration

Rhino II will be installed and aircraft approach demonstrations will be performed while using independent means of verifying Rhino II range coarse line and glide slope accuracy in the VHF/UHF ILS and GCA method of operation to the accuracies stated in Milestone 29. Range course, and altitude accuracy will be measured by independent means to verify accuracies as stated in Milestone 29 in the secondary track method of operation.

9-3 Examination

The visual inspection shall consist of visual verification of the measurements and standards established in Milestone 29.

9-3.1 Functional tests

Functional tests shall include the verification and validation of design documentation and shall include the verification of the modes and methods of operation, as well basic BITE function and fault isolation.

9-4 No formal testing will be associated with the Technical Demonstration.

9-4.1 Methods of Verification

The following methods shall be utilized to accomplish the verification of requirements:

- (1) Analysis
- (2) Demonstrations
- (3) Examinations
- (4) No Formal Testing will be associated with this Demonstration.

9-5 Classes of Verifications

The trainer shall be subject to the verification classes listed below. Under each verification class, the trainer will be subject to inspections and tests as specified below:

- (A) In-process inspections
- (B) Incremental development inspections
- (C) Technical Demonstration

9-6 Inspections and tests

Rhino II shall be subject to no inspections or test for this evolution.

9-6.1 Visual inspections

The visual inspection shall consist of verification of siting measurements and equipment placement.

9-6.2 Functional tests

Functional tests shall include the verification and validation of design documentation and shall include the following test sequence:

9-7 Requirement/Verification Cross-Reference Matrix

Requirement/Verification Cross-Reference Matrix is Table 23.

Table 23 Requirement/Verification Cross-Reference Matrix

Table 23 Requirement/Verification Cross-Reference Matrix

VERIFICATION METHOD

N/A - NOT APPLICABLE
1 – ANALYSIS
2 – DEMONSTRATION
3 – EXAMINATION
4 – NO TESTING WILL BE ASSOCIATED WITH THIS DEMONSTRATION

VERIFICATION CLASS

A – IN-PROCESS INSPECTIONS
B – INCREMENTAL DEVELOPMENT INSPECTIONS
C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
SECTION 1 SCOPE	X										
1-1 Introduction	X										
1-2 System Overview	X										
1-3 Applicable Documents	X										
1-3.1 Government Documents	X										
1-3.2 Non-Government Documents	X										
1-4 Order Of Precedence	X										
SECTION 2 Rhino II PERFORMANCE REQUIREMENTS	X										
2-1 System Definition			X	X				X			
2-2 Modes and States		X						X			
2-2.1 OFF Mode	X										
2-2.2 STANDBY Mode	X										
2-2.3 TEST Mode		X						X			
2-2.4 ON Mode			X					X			
2-3 System Functions	X										
2-3.1 Transponder Interrogation	X										
2-3.1.1 Interrogation Volume	X										
2-3.1.2 Interrogation Radiated Power			X					X			
2-3.2 Secondary Tracking	X										
2-3.2.1 Service Volume			X					X			
2-3.2.1.1 Service Volume Transition Zones	X										

Table 23 Requirement/Verification Cross-Reference Matrix

VERIFICATION METHOD

N/A - NOT APPLICABLE
1 – ANALYSIS
2 – DEMONSTRATION
3 – EXAMINATION
4 – NO TESTING WILL BE ASSOCIATED WITH THIS DEMONSTRATION

VERIFICATION CLASS

A – IN-PROCESS INSPECTIONS
B – INCREMENTAL DEVELOPMENT INSPECTIONS
C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
2-3.2.2 Accuracy		X						X			
2-3.2.2.1 Azimuth Accuracy		X	X					X			
2-3.2.2.2 Range Accuracy		X						X			
2-3.2.3 Tracking		X						X			
2-3.2.4 Monitoring		X						X			
2-3.3 Main Runway Service	X							X			
2-3.3.1 Service Volume		X	X					X			
2-3.3.2 Accuracy	X		X					X			
2-3.3.2.1 Localizer Course Alignment		X	X					X			
2-3.3.2.2 Localizer Displacement Sensitivity		X	X					X			
2-3.3.2.3 Localizer Course Structure		X	X					X			
2-3.3.3 Interrogation Requirements		X						X			
2-3.3.4 Tracking			X					X			
2-3.3.5 Guidance			X					X			
2-3.3.6 Monitoring		X						X			
2-3.4 Reciprocal Runway Service	X										
2-3.4.1 Service Volume	X		X								
2-3.4.2 Accuracy		X	X					X			
2-3.4.3 Glide Slope Displacement Sensitivity		X	X					X			
2-3.4.4 Interrogation Requirements		X						X			
2-3.4.5 Tracking		X						X			
2-3.4.6 Guidance		X	X					X			
2-3.4.7 Monitoring		X						X			
2-4 Capability Interface			X					X			

Table 23 Requirement/Verification Cross-Reference Matrix

VERIFICATION METHOD

N/A - NOT APPLICABLE
1 – ANALYSIS
2 – DEMONSTRATION
3 – EXAMINATION
4 – NO TESTING WILL BE ASSOCIATED WITH THIS DEMONSTRATION

VERIFICATION CLASS

A – IN-PROCESS INSPECTIONS
B – INCREMENTAL DEVELOPMENT INSPECTIONS
C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
2-5 Logistics / Transportation	X										
2-5.1 Rhino II Vehicle	X										
2-5.2 Rhino II Shelter	X										
2-5.3 Rhino II Trailer	X										
2-5.4 Rhino II Highway Transport	X										
2-5.5 Rhino II Aircraft Transport	X										
2-5.6 Rhino II Transport Configurations	X										
2-6 Installation / Certification	X										
2-6.1 Component Siting	X										
2-6.1.1 Distances From Runways	X										
2-6.1.2 Frangibility	X										
2-6.1.3 Line of Site Requirements	X										
2-6.1.4 Terrain Gradient Requirements	X										
2-6.2 Rhino II Soil Loading Requirements	X										
2-6.3 Rhino II Installation time	X										
SECTION 3 System Equipment Elements Functional and Performance Requirements			X								
3-1 Operator Control Interface			X	X				X			
3-1.1 Interface Layout			X	X				X			
3-1.2 Title Bar			X	X				X			
3-1.3 Menu Bar			X	X				X			
3-1.4 Graphical Display			X	X				X			

Table 23 Requirement/Verification Cross-Reference Matrix

VERIFICATION METHOD

N/A - NOT APPLICABLE
1 – ANALYSIS
2 – DEMONSTRATION
3 – EXAMINATION
4 – NO TESTING WILL BE ASSOCIATED WITH THIS DEMONSTRATION

VERIFICATION CLASS

A – IN-PROCESS INSPECTIONS
B – INCREMENTAL DEVELOPMENT INSPECTIONS
C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-1.5 Secondary Track View			X	X				X			
3-1.5.1 Range Rings			X	X				X			
3-1.5.2 Approach			X	X				X			
3-1.5.3 Compass Rose			X	X				X			
3-1.5.4 Service Volume			X	X				X			
3-1.6 GCA View			X	X				X			
3-1.6.1 Range Indicators			X	X				X			
3-1.6.2 Approach			X	X				X			
3-1.7 Controls			X	X				X			
3-1.7.1 Function Control			X	X				X			
3-1.7.2 Acquisition Control			X	X				X			
3-1.8 Track Display			X	X				X			
3-1.8.1 Secondary Track Function Tracks			X	X				X			
3-1.8.2 Guidance Track			X	X				X			
3-1.9 Tooltips			X	X				X			
3-2 Lighting System Requirements	X										
3-2.1 Shelter	X										
3-2.2 Blackout Lighting	X										
3-2.3 Obstruction	X										
3-3 Communication System	X										
3-3.1 Air to Ground	X										
3-3.2 Intercom	X										
3-4 Calibration / Installation			X					X			
3-4.1 Truth Data			X					X			
3-4.2 Interface			X					X			
3-5 Maintenance Interface Assembly	X										

Table 23 Requirement/Verification Cross-Reference Matrix

VERIFICATION METHOD

- N/A - NOT APPLICABLE
- 1 – ANALYSIS
- 2 – DEMONSTRATION
- 3 – EXAMINATION
- 4 – NO TESTING WILL BE ASSOCIATED WITH THIS DEMONSTRATION

VERIFICATION CLASS

- A – IN-PROCESS INSPECTIONS
- B – INCREMENTAL DEVELOPMENT INSPECTIONS
- C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-5.1 Maintenance Interface Unit (MIU)	X										
3-5.1.1 CPU	X										
3-5.1.2 Memory	X										
3-5.1.3 Motherboard	X										
3-5.1.4 Operating System	X										
3-5.1.5 Peripheral Configuration	X										
3-5.1.6 Hard Drive	X										
3-5.1.7 Floppy Drive	X										
3-5.1.8 CD-ROM Drive	X										
3-5.1.9 Network Adapter	X										
3-5.1.10 Input / Output	X										
3-5.1.11 Input Power Electrical Requirements	X										
3-5.1.12 Mean Time Between Failure	X										
3-5.1.13 Physical Design	X										
3-5.2 Oscilloscope	X										
3-5.3 Monitor	X										
3-5.4 Keyboard	X										
3-5.5 Interface Control	X										
3-5.5.1 MIU to Network Panel	X										
3-5.5.2 Monitor to Network Panel	X										
3-5.5.3 Keyboard to Network Panel	X										
3-6 Central Processing Units	X										
3-6.1 CPU 1	X										
3-6.1.1 CPU	X										
3-6.1.2 Memory	X										

Table 23 Requirement/Verification Cross-Reference Matrix

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C – TECHNICAL DEMONSTRATION

REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-6.1.3 Motherboard	X										
3-6.1.4 Operating System	X										
3-6.1.5 Peripherals	X										
3-6.1.6 Hard Drive	X										
3-6.1.7 Floppy Drive	X										
3-6.1.8 CD-ROM Drive	X										
3-6.1.9 Network Adapter	X										
3-6.1.10 Input / Output	X										
3-6.1.11 Mounting	X										
3-6.2 CPU2	X										
3-6.2.1 CPU	X										
3-6.3 Memory	X										
3-6.4 Motherboard	X										
3-6.5 Operating System	X										
3-6.6 Peripherals	X										
3-6.7 Hard Drive	X										
3-6.8 Floppy Drive	X										
3-6.9 CD-ROM Drive	X										
3-6.10 Network Adapter	X										
3-6.11 Input / Output	X										
3-6.12 Mounting	X										
3-7 Local Area Network	X										
3-7.1 Network Topology	X										
3-7.2 Main Switch	X										
3-7.3 Remote Control Unit (RCU) Hub	X										
3-7.4 Interconnectivity	X										
3-8 Remote Control Unit (RCU)	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-8.1 Central Processing Unit (CPU)	X										
3-8.2 Memory	X										
3-8.3 Motherboard	X										
3-8.4 Operating System	X										
3-8.5 Peripherals	X										
3-8.6 Hard Drive	X										
3-8.7 Floppy Drive	X										
3-8.8 CD-ROM Drive	X										
3-8.9 Network Adapter	X										
3-8.10 Input / Output	X										
3-9 Power Requirements	X										
3-9.1 Power Input	X										
3-9.2 Uninterruptible Power Supply/Battery Pack	X										
3-9.2.1 Primary Input Power	X										
3-9.2.2 Output Power	X										
3-9.2.3 Mean Time Between Failure	X										
3-9.2.4 Battery Hold-Up Time	X										
3-9.3 Interface Control	X										
3-9.3.1 Signal Entry Panel to UPS/Battery	X										
3-9.3.2 UPS to shelter power	X										
3-9.3.3 UPS to rack power	X										
3-10 Uplink Assembly	X										
3-10.1 Guidance Transmitter Unit (GTU)	X										
3-10.1.1 RF Output – Localizer	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-10.1.2 Localizer Output Power	X										
3-10.1.3 Localizer Carrier Frequency	X										
3-10.1.4 Localizer Carrier Modulation	X										
3-10.1.5 Localizer Depth of Modulation	X										
3-10.1.6 Localizer Modulation Control Resolution and Accuracy	X										
3-10.2 RF Output – Glide Slope	X										
3-10.2.1 Glide Slope Output Power	X										
3-10.2.2 Glide Slope Frequency	X										
3-10.2.3 Glide Slope Carrier Modulation	X										
3-10.2.4 Glide Slope Depth of Modulation	X										
3-10.2.5 Glide Slope Modulation Control Resolution and Accuracy	X										
3-10.3 Monitor Functions	X										
3-10.3.1 DDM Monitors	X										
3-10.3.1.1 DDM Monitor Resolution	X										
3-10.3.1.2 DDM Monitor Accuracy	X										
3-10.4 Uplink Antennas				X							
3-10.4.1 Localizer Antenna	X										
3-10.4.1.1 Localizer Antenna Power	X										
3-10.4.1.2 Localizer Transmission	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-10.4.2 Glide Slope Antenna	X										
3-10.4.2.1 Glide Slope Antenna Power	X										
3-10.5 Glide Slope Transmission	X										
3-10.6 Interface Control	X										
3-10.7 Placement/Polarization	X										
3-10.7.1 Antenna Clear Zone	X										
3-10.8 Monitoring	X										
3-11 Interrogation Assembly	X										
3-11.1 Antennas				X			X				
3-11.1.1 Interrogator Uni directional Antenna Specifications		X		X			X				
3-11.1.2 Interrogator Omni-directional Antenna Specifications		X		X			X				
3-11.1.3 Antenna Mounting				X			X				
3-11.2 Interrogation Rate and Switching				X			X				
3-11.3 Interrogation Transmitters			X					X			
3-11.3.1 Interrogation Frequency				X			X				
3-11.3.2 Interrogation Polarization				X			X				
3-11.3.3 Interrogation Pulse Timing				X							
3-11.3.4 Interrogation Volume	X										
3-11.3.5 Interrogation Radiated Power		X									

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-11.4 Interface Control				X			X				
3-11.5 Placement				X			X				
3-12 Azimuth Sensor Assembly (ASA)	X										
3-12.1 Antennas			X	X			X				
3-12.2 Antenna Mounting				X			X				
3-12.3 Antenna Placement				X			X				
3-12.4 Angle of Arrival Sensor	X										
3-12.4.1 Performance			X	X		X		X			
3-12.4.1.1 RF Inputs				X				X			
3-12.4.1.2 Dynamic Range			X	X		X		X			
3-12.4.1.3 Input Power			X	X		X		X			
3-12.4.1.4 VSWR			X	X		X		X			
3-12.4.2 RF Path Controls	X										
3-12.4.2.1 RF Distribution Path Control			X					X			
3-12.4.2.2 Low Input Phase Control				X			X				
3-12.4.2.3 High Input Phase Control				X			X				
3-12.4.3 Acquisition Control	X										
3-12.4.3.1 Sensor Acquisition Enable				X			X				
3-12.4.3.2 Start Signal				X			X				
3-12.4.3.3 Acquisition Window Duration			X					X			
3-12.4.4 Sensor CPU				X			X				
3-12.4.4.1 CPU				X			X				
3-12.4.4.2 RAM Memory				X			X				

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-12.4.4.3 Non-volatile Memory				X			X				
3-12.4.4.4 Ethernet Interface				X			X				
3-12.4.4.5 Amplitude Measurement Performance			X					X			
3-12.4.4.6 Digital Amplitude Measurement Output			X					X			
3-12.4.4.7 Amplitude Measurement Rate			X					X			
3-12.4.4.8 Log Slope			X					X			
3-12.4.4.9 Log Accuracy	X										
3-12.4.4.10 Channel to Channel Matching			X					X			
3-12.4.4.11 Channel to Channel Isolation			X					X			
3-12.4.4.12 Signal to Noise Ratio			X	X		X		X			
3-12.4.5 Selectivity			X	X		X		X			
3-12.4.5.1 Pass Band			X	X		X		X			
3-12.4.5.2 Image Frequency Rejection			X	X		X		X			
3-12.4.5.3 Out of Band			X	X		X		X			
3-12.4.6 Delay Time			X	X		X		X			
3-12.4.7 Delay Jitter			X	X		X		X			
3-12.4.8 Amplitude Jitter			X	X		X		X			
3-12.4.9 Phase Measurements			X	X		X		X			
3-12.4.10 Digital Phase Measurement Output			X	X		X		X			
3-12.4.11 Phase Measurement Rate			X	X		X		X			
3-12.4.12 Phase Stability – Amplitude Variation			X	X		X		X			

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-12.4.13 Phase Stability – Frequency and Dynamic Balanced Power	X										
3-12.4.14 Phase Stability – Frequency and Dynamic Balanced Low Power			X	X		X		X			
3-12.4.15 Phase Stability – Delta Power			X	X		X		X			
3-12.4.16 Phase Polarity			X	X		X		X			
3-12.4.17 Delta Phase			X	X		X		X			
3-12.4.18 Delay to Stable Output			X	X		X		X			
3-12.4.19 Phase Jitter			X	X		X		X			
3-12.4.20 Frequency Measurement Performance			X	X		X		X			
3-12.4.21 Digital Frequency Measurement Output			X	X		X		X			
3-12.4.22 Frequency Measurement Rate			X	X		X		X			
3-12.4.23 Frequency to Voltage Conversion			X	X		X		X			
3-12.4.24 Slope			X	X		X		X			
3-12.4.25 Center Frequency Accuracy			X	X		X		X			
3-12.4.26 Through the Band Accuracy			X	X		X		X			
3-12.4.27 Delay to Stable Output			X	X		X		X			
3-12.5 Health Monitors			X	X		X		X			
3-12.5.1 Sensor Temperature			X	X		X		X			
3-12.5.2 DC Voltage Monitors			X	X		X		X			

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-12.5.3 AC Input Power				X			X				
3-12.5.4 Mean Time Between Failure		X					X				
3-12.5.5 Electromagnetic Compatibility (EMC)	X										
3-12.5.6 Electromagnetic Radiation	X										
3-12.5.7 Conducted Limits		X					X				
3-12.5.8 Radiated Limits		X					X				
3-12.5.9 Electromagnetic Susceptibility		X					X				
3-12.6 Interface Control				X			X				
3-12.7 Placement				X			X				
3-13 Elevation Sensor Assembly (ESA)	X										
3-13.1 Antennas		X		X			X				
3-13.2 Antenna Mounting			X					X			
3-13.2.1 Antenna Stability - Short Duration				X			X				
3-13.3 Antenna Separation/Placement				X				X			
3-13.4 Angle of Arrival Sensor		X		X		X		X			
3-13.5 Interface Control			X				X				
3-13.6 Switching	X										
3-14 Build in Test Equipment (BITE)	X										
3-14.1 Antennas		X					X				
3-14.1.1 Antenna Performance				X			X				

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-14.1.2 Antenna Mounting Vertical Height / Plumb				X			X				
3-14.1.3 Antenna Stability				X			X				
3-14.1.4 Antenna Position Maintenance	X										
3-14.1.5 Provisions for Harness Tie Downs		X		X			X				
3-14.2 Build In Test Equipment (BITE) Generator	X										
3-14.2.1 Radio Frequency (RF) Output			X	X		X		X			
3-14.2.1.1 Spectral Purity		X				X					
3-14.2.1.2 Radio Frequency Output Voltage Standing Wave Ratio			X	X		X		X			
3-14.2.1.3 RF Output Rise / Fall Time			X	X		X		X			
3-14.2.1.4 RF Output Pulse Width			X	X		X		X			
3-14.2.1.5 RF Output Delay - Multiple Pulses			X	X		X		X			
3-14.2.1.6 RF Output Jitter - Rising Edge			X	X		X		X			
3-14.2.1.7 RF Output Protection			X	X		X		X			
3-14.2.1.8 Duty Cycle Protection			X	X		X		X			
3-14.3 Interface Control	X										
3-14.3.1 BITE Generator to Antenna				X			X				
3-14.3.2 CPU1 to BITE Generator				X			X				
3-15 Environment	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-15.1 Temperature	X										
3-15.1.1 Internal to Shelter		X					X				
3-15.1.2 External to Shelter		X					X				
3-15.2 Humidity		X					X				
3-15.3 Wind		X					X				
3-15.4 Ice		X					X				
3-15.5 Altitude		X					X				
3-15.6 Vibration		X					X				
3-15.7 Shock		X					X				
3-15.8 Environmental Control Unit		X					X				
3-16 System Siting	X										
3-16.1 Siting Procedure	X						X				
3-16.1.1 ESA Siting				X			X				
3-16.1.2 ASA Siting				X			X				
3-16.1.3 Build In Test Equipment Antenna Siting				X			X				
3-16.1.4 Interrogation Assembly Siting				X			X				
3-16.1.5 Uplink Assembly Siting				X			X				
3-16.2 Terrain Gradient Requirements				X			X				
3-16.2.1 Soil Loading Requirements		X									
3-17 Error Budget	X										
3-17.1 Main Runway Error Budget		X	X			X		X			
3-17.2 Reciprocal Runway Error Budget		X	X			X		X			
3-17.2.1 Secondary Tracking Error Budget		X	X			X		X			
3-18 Critical Area				X			X				

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
3-18.1 Main Runway Service Critical Area	X										
3-18.1.1 ESA Critical and Sensitive Areas		X					X				
3-18.1.2 ASA Critical and Sensitive Area		X					X				
3-18.2 Reciprocal Runway Service Critical Area	X										
3-18.2.1 ESA Critical and Sensitive Areas		X					X				
3-18.2.2 ASA Critical and Sensitive Area		X					X				
SECTION 4 Software Specifications Rhino II	X										
4-1 Software Configuration Items			X				X				
4-2 Base CPU1/CPU2 Software Configuration Items Description			X				X				
4-2.1 System Manager Process			X				X				
4-2.2 Network Communications Processes			X				X				
4-2.3 Signal Processing Process			X				X				
4-2.3.1 Main			X				X				
4-2.3.2 Pulse Processing			X				X				
4-2.3.3 Cal/BIT Processing			X				X				
4-2.3.4 Data Quality Monitor			X				X				
4-2.3.5 Calibration Processing			X				X				
4-2.3.6 Track Processing			X				X				

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
4-2.3.7 Track Monitor			X				X				
4-2.3.8 Steer			X				X				
4-2.4 Uplink Process			X				X				
4-2.5 RCU Manager Process			X				X				
4-2.6 Log Manager Process			X				X				
4-2.7 Maintenance Interface Manager Process			X				X				
4-2.8 Sensor Software Configuration Items Description			X				X				
4-2.9 Remote Control Unit Software Configuration Items Description			X				X				
4-2.10 Maintenance Interface Software Configuration Items Description			X				X				
SECTION 5 Safety	X										
5-1 HERO	X										
5-2 HERP	X										
SECTION 6 Maintainability	X										
6-1 Mean Time To Repair (MTTR)	X										
6-1.1 Maximum Repair Time (MMAX)	X										
6-1.2 Scheduled Maintenance	X										
6-1.3 Periodicity	X										
6-1.3.1 Daily	X										
6-1.3.2 Weekly	X										
6-1.3.3 Monthly	X										
6-1.3.4 Quarterly	X										
6-1.3.5 Annually	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
6-2 Level Of Maintainability	X										
6-3 Special Tools And Test Equipment	X										
6-3.1 Equipment Handling	X										
6-3.2 Cable And Wire Marking	X										
6-3.3 Cable Connections And Cable Slack	X										
6-3.4 Panels, Handles And Fastener Standard	X										
6-3.5 Wire And Pin Designations	X										
6-3.6 CaNDI Markings	X										
6-3.7 Name Plate Data	X										
6-4 Safety Warning Labels	X										
6-5 Human Engineering	X										
6-6 Weather Proofing And Air Flow Filtering	X										
6-7 Built In Test Equipment (BITE)	X										
6-7.1.1 Power Monitoring	X										
6-7.1.2 Over Temperature, Humidity Sensors/Alarms	X										
6-8 Re-Certification Requirements	X										
SECTION 7 Materials And Processes	X										
7-1 Hazardous Materials Utilized	X										
7-1.1 Paint Used/Required	X										

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REQUIREMENT	VERIFICATION METHOD					VERIFICATION CLASS					SECTION 4 VERIFICATION
	N/A	1	2	3	4	A	B	C	D	E	
7-1.2 Flammability Of Materials	X										
7-2 Recycled Vice Virgin Materials	X										
SECTION 8 Logistics	X										
8-1 Maintenance Concept	X										
8-1.1 On Line	X										
8-1.2 Off Line	X										
8-2 Overhaul Periods/Hours	X										
8-3 Tools And Test Equipment	X										
8-4 Dimensions	X										
8-4.1 Weights	X										
8-4.2 Appearances	X										
8-4.3 Workmanship	X										
SECTION 9 Methods Of Verification	X										
9-1 Analysis	X										
9-2 Demonstration	X										
9-3 Examination	X										
9-3.1 Functional Tests	X										
9-3.2 Methods of Verification	X										
9-4 Classes of Verifications	X										
9-5 Inspections and Tests	X										
9-5.1 Visual Inspections	X										
9-5.2 Functional Tests	X										
9-5.2.1 Computer System Tests	X										
9-5.2.2 Electrical Tests	X										

SECTION 10 GLOSSARY

Cooperating Aircraft	An Aircraft equipped with a Air Traffic Control Radar Beacon Transponders (ATCRBS) that is functioning and capable of responding to Interrogations, and who's operator will adjusted the Mode 3/A output coding to correspond with Rhino II requirements.
Course Line	The locus of points representing the aircraft-landing path onto the horizontal plane where the DDM is zero.
Course Sector	A section in the horizontal plane containing the course line and bounded by the lines where the DDM is 0.155.
Course Sector Angle	The angle between the lines that are centered on the course line and pass through the apparent localizer antenna location.
DDM	Differential depth of modulation. The percentage modulation depth of the larger signal minus the percentage modulation depth of the smaller signal divided by 100.
Front Course Line	The portion of the course line situated on the same side of the localizer as the runway.
Glide Path	The locus of points in the vertical plane containing the runway centerline representing the aircraft-landing path.
Glide Path Angle	The angle formed between the glide path and a horizontal plane.
Guidance Volume	The region of space within which the Rhino II is required to be capable of providing guidance to a landing aircraft within specified accuracies (See paragraph 3.2.4).
ILS Point A	A point on the approach projection of the runway centerline at a distance of 7.4 km (4 nm.) from the threshold (see Figure 3).
ILS Point B	A point on the approach projection of the runway centerline at a distance of 1050 m (3500 ft) from the threshold (see Figure 3).
ILS Point C	A point on the approach path 30 m. (100 ft.) above the horizontal plane containing the runway centerline.
ILS Reference Datum	A point at a specified height located vertically above the intersection of the runway centerline and the threshold and through which the downward extended straight portion of the glide path passes.
Intermediate Approach Area	The area between the intermediate approach fix and the final approach fix.
Main Runway	Primary approach end of a designated runway where Rhino II will be deployed to ensure Category 1 flight operations are possible.
Mode A	Transponder interrogation mode wherein response is an identification code. Contrasts with Mode C wherein response includes pressure-altitude. Civilian Aviation equivalent to Mode 3/A in Military Aviation).
Mode 3/A	Transponder interrogation mode wherein response is an identification code. Contrasts with Mode C wherein response includes pressure-altitude. in Military Aviation equivalent Civilian Aviation Mode A).
Missed Approach Point	Same as ILS point B (see above).
Mutipath	Undesirable Radio Frequency Energy reflections
Operational Alarm	A temporary condition of degraded Rhino II performance from which the Rhino II may be expected to recover automatically.
Reciprocal Runway	The opposite approach end of the Main Runway, Rhino II priority placement will ensure Category 1 service to the main, therefore service volume and accuracy of approach to the reciprocal runway will be dependant of environmental circumstances as indicated in Subsection???
Threshold	The approach end of the runway.

SECTION 11 ACRONYMS AND ABBREVIATIONS

ANPC	Advanced Navigation & Positioning Corporation
ASA	Azimuth Sensor Assembly
ASCII	American Standard Code for Information Interchange
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
BITE	Built In Test Equipment
CDI	Course Deviation Indicator
CSC	Computer Software Component
CW	Continuous Wave
DDM	Differential Depth of Modulation
EMC	Electromagnetic Compatibility
ESA	Elevation Sensor Assembly
ESD	Electrostatic Discharge
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCC	Federal Communication Commission
FMEA	Failure Modes and Effects Analysis
GAOA	Glide Slope Angle-of-Arrival
GTU	Guidance Transmitter Unit
HSI	Horizontal Situation Indicator
HMMWV-HV	High Mobility Multipurpose Wheeled Vehicle-Heavy Variant
ICAO	International Civil Aviation Organization
IFF	Identification Friend or Foe
ILS	Instrument Landing System
IP	Internet Protocol
LAOA	Localizer Angle-of-Arrival
LO	Local Oscillator
LRU	Line-Replaceable Unit
MAP	Missed Approach Point
MI	Maintenance Interface
MIU	Maintenance Interface Unit
MMAX	Maximum Time to Repair
MTBF	Mean Time Between Failures
MTBO	Mean Time Between Outages
MTTR	Mean Time To Repair
OFZ	Obstacle Free Zone
PSD	Power Spectral Density
RCU	Remote Control Unit
RSA	Runway Safety Area
SCI	Software Configuration Items
TOA	Time Of Arrival
UDP	User Datagram Protocol
UHF	Ultra High Frequency
VFR	Visual Flight Rules
VHF	Very High Frequency