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MILITARY GROUND SEGMENT (MGS) SPECIFICATION

For

Joint Precision Approach and Landing System (JPALS) Local Area Differential Global Positioning System (LDGPS)

Revision B
February 2, 2004

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REVISIONS

Revision Number	Date	Description	Sections Affected
A	August 12, 2003	Initial Release of Draft / Bruce Peterson	All
B	February 2, 2004	Update of Draft – extensive updates for second contract milestone / Bruce Peterson	All

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1. SCOPE

1.1 Identification

This Specification establishes the requirements for the Military Ground Segment (MGS) of the Joint Precision Approach and Landing System (JPALS), Local Differential Global Positioning System (LDGPS). These requirements were derived from the System Requirements Document (SRD) [29] for the JPALS Common Program. Shipboard requirements contained in the JPALS Operational Requirements Document (ORD) [19] are contained in a separate shipboard specification, hence the use of the term JPALS herein refers to the system level implementation of LDGPS only.

1.2 System Overview

JPALS provides the Department of Defense (DoD) with a precision approach and landing capability for Fixed Base, Tactical, and Special Mission Operations[1]. JPALS can also provide terminal area operations including missed approach guidance and potentially other applications.

The Global Positioning System (GPS) positioning service currently provided is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. JPALS applies LDGPS techniques to augment the GPS positioning service in order to meet these demands.

JPALS is modeled on the Federal Aviation Administration (FAA) Local Area Augmentation System (LAAS). This is done for two main reasons. First, because LAAS, like JPALS, is an LDGPS based precision approach landing system. Second, because compatibility with the LAAS Ground Facility (LGF) an FAA implementation of the International Civil Aviation Organization (ICAO) Ground Based Augmentation System (GBAS), is required to ensure JPALS civil interoperability.

JPALS differs from LAAS in three major aspects. First, JPALS must support military operations world-wide and, consequently, is required to support three different operating environments. Second, JPALS must support both the military L1 and L2 precise code P(Y) signals as well as the civilian L1 Coarse/Acquisition Code (C/A) signal. Third, JPALS may be subjected to both unintentional and intentional interference across the L1 and L2 frequencies at higher levels than those likely to be encountered by LAAS.

[1] For ease of development, requirements to support all three operations will be kept in this single document during development. At final revision, this document will be separated into three, one for each operation type: 1) a Fixed Base MGS, optimized to meet the requirements of fixed base operating environments, 2) a tactical MGS, optimized to be mobile and meet the requirements of tactical operating environments, and 3) a man-portable MGS, optimized to be man-portable and meet the requirements of special missions operating environments.

JPALS is comprised of two segments, the MGS and the Military Air Segment (MAS), which provide the accuracy, integrity, and continuity performance similar to other modern landing systems.

The MAS and MGS support JPALS Service Level 7 (SL 7) and Service Level 8 (SL 8) precision approach operations with autoland capability. Autoland (including rollout) guidance is applicable to fixed base and mobile equipment, but not man-transportable. Autoland guidance is provided to aircraft touch down. An objective of growth to JPALS Service Level 9 (SL 9) is defined in the SRD [29]. JPALS Service Levels 7, 8, and 9 are equivalent to services for FAA Category I (CAT I), Category II/IIIa, and Category IIIb (CAT IIIb) precision approach operations respectively. A Space Segment provides the MGS and MAS with GPS and optional Satellite-Based Augmentation System (SBAS) ranging signals and orbital parameters as illustrated in

Figure 1-1.

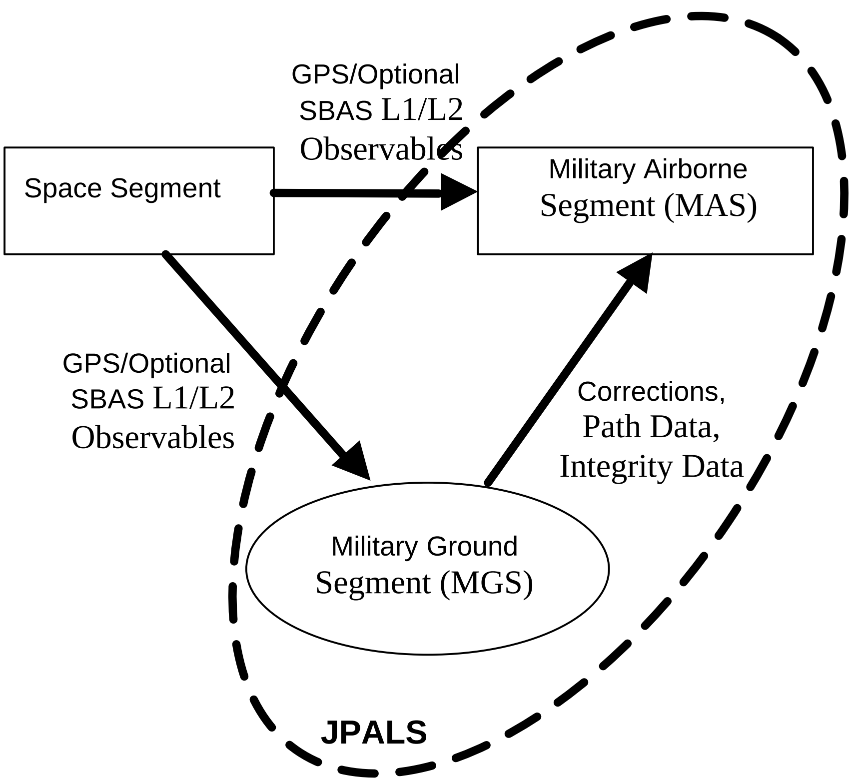


Figure 1-1: Overview of JPALS

The MGS is a safety-critical system consisting of the hardware and software to augment the GPS Standard Positioning Service (SPS) & Precise Positioning Service (PPS) to perform a precision approach and landing capability. The MGS provides differential corrections, integrity parameters, and precision approach path data that are transmitted via data broadcasts to the MAS for processing.

The MAS applies LDGPS corrections from a GBAS or MGS, to the GPS and optional SBAS ranging signals to obtain position with the required accuracy, integrity, continuity, and availability. The differentially corrected position is used, along with precision approach path data, to supply deviation signals to drive appropriate aircraft systems supporting terminal area and precision approach operations. Furthermore, using the position, velocity and time (PVT) from the airborne receiver, LDGPS could augment the availability of terminal area operations for aircraft equipped with Area Navigation (RNAV) capability.

1.3 Operating Environment

US forces conduct operations throughout the spectrum of threat environments. These operations may occur before, at, or beyond the forward edge of the battle area. The system must operate in an environment that includes a large number of Radio Frequency (RF) emitters (both friendly and unfriendly) and hostile electronic attack assets that operate across the electromagnetic spectrum. JPALS supports three different operating environments; Fixed Base, Tactical, and Special Mission.

The fixed base aircraft precision approach and landing, operating environment (military and civil) is generally a prepared field with a well-established airfield infrastructure. The probability of hostile action at fixed bases can vary from low to high. Aircraft activity ranges from low to high air traffic and for a relatively long period of time. The duration of the fixed base deployment is intended to be a permanent installation. The fixed base, operating environment involves military aircraft, allied aircraft, and Civil Reserve Air Fleet (CRAF) aircraft.

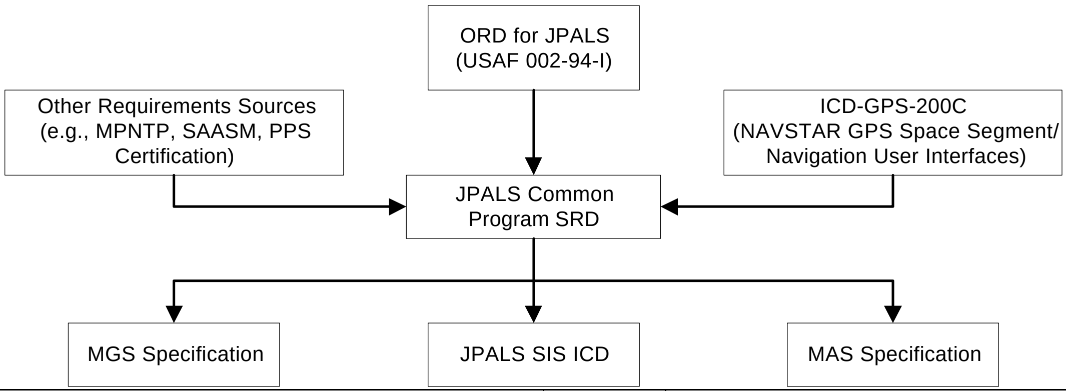
The tactical aircraft precision approach and landing operating environment (military and civil) is unprepared assault strips, bare bases, or expeditionary fields with limited airfield infrastructure. There is a high potential for enemy hostile action influencing tactical operations. Sustained air traffic may not be as high as fixed bases; however, surge launch and recovery rates may exceed fixed base rates. The duration of a tactical deployment can range from several days to several months or longer. The tactical operating environment involves military aircraft and may involve allied and CRAF aircraft.

The special mission precision approach and landing operating environment may be unprepared assault strips, bare bases, expeditionary fields, and in areas with limited or no infrastructure. This operating environment may be in politically denied territory or within enemy lines, with a corresponding high potential for enemy encounter. Special mission operations may be clandestine in nature and can involve many aircraft types and numbers but for a shorter period of time in comparison to fixed base or tactical operations. Operations security usually requires communication-out operations for all aircraft.

1.4 JPALS Requirements Hierarchy

The SRD [29] is part of a family of documents that establish the system, performance, and interface requirements for JPALS that have been or are being developed to completely specify

JPALS characteristics. Figure 1-2 illustrates the hierarchy of the various JPALS requirements documents.



ICD	Interface Control Document	ORD	Operational Requirements Document [14]
GPS	Global Positioning System	PPS	Precise Positioning Service [15]
MAS	Military Airborne Segment	SAASM	Selective Availability and Anti-Spoofing Module
MGS	Military Ground Segment	SIS	Signal In Space
MPNTP	Master Positioning Navigation and Timing Plan		

Figure 1-2: JPALS Requirements Hierarchy

The ORD [19] contains the JPALS operational requirements, which are the primary source for the JPALS performance requirements contained in the SRD [29]. Other documents also contain requirements or capabilities that establish performance requirements that must be met by JPALS. From the SRD [29], JPALS performance requirements are then allocated to the MAS Specification, the JPALS Signal-In-Space (SIS), Interface Control Document (ICD), or this MGS Specification, as applicable.

1.5 Evolutionary Acquisition

JPALS is being acquired and developed using an Evolutionary Acquisition strategy. JPALS capabilities are being acquired and fielded to meet user demands consistent with the necessary technology development and maturation. The initial JPALS capability or system is a JPALS tactical CAT I system followed by a fixed base CAT I system. CAT II capabilities will follow later. This document covers capabilities for both CAT I and CAT II.

Subsequent JPALS capabilities are to be fielded as user needs and technology are identified and developed. A new GPS signal code (M-Code) and frequency (L5) as well as GPS III modifications are to be considered and incorporated as they become available.

1.6 Document Overview

This document contains the following sections:

1. Scope: Contains the project identification, system and document overviews, and a list of the terms, definitions and acronyms used in this document.

2. Referenced Documents: Provides a list of the documents referenced in this specification. References contain the document number, exact title, revision level and issue date.

3. System Requirements: Specifies the requirements for the system to which this specification applies.

4. Quality Assurance: Ensures that the requirements of sections 3 and 5 are satisfied.

5. Preparation for Delivery: Specifies the requirements for preparation and delivery, including packaging and handling of the system and its components.

Appendices: Includes a compliance matrix, vulnerability requirements, environmental testing, and issues to be resolved.

1.7 Assumptions

1.7.1 Interference Environment

Although the JPALS is not a likely target for hostile signal disruption, JPALS could employ signals of frequencies that are vulnerable to collateral jamming. The specific levels of interference or jamming under which JPALS shall meet its applicable navigation system performance are contained in Appendix B of the JPALS SRD [29].

1.7.2 GPS SIS

For purposes of this specification, the signal-in-space will be a VHF Data Broadcast (VDB) and will not include military requirements such as Low Probability of Intercept and Low Probability of Detection (LPI/LPD).

2. REFERENCED DOCUMENTS

The following documents, in the exact revision and date shown, form a part of this specification to the extent specified herein. If the document's revision or date is not indicated, the most current version of the document as of the date of this specification applies.

The references below are listed in alpha-numerical order of the identifying numbers or titles cited in the text of this document.

[1] ANSI/ISO/IEC 9899-1999, International Standard, *Programming Languages C*, American National Standards Institute, 1 Dec 1999.

[2] ARINC 743A-4, ARINC Specification, *GNSS Sensor*, December 2001, Aeronautical Radio Inc., 2551 Riva Road, Annapolis, MD 21401.

[3] *Code of Federal Regulations*, Title 14, Aeronautics and Space, Chapter I, Department of Transportation, Federal Aviation Administration, subchapter C, Aircraft, Part 25, Airworthiness Standards: Transport Category Airplanes.

[4] DoD GPS Standard Positioning Service (SPS) Performance Standard, (no number), October 2001.

[5] CI-GRAM-500, Performance Specification For The Global Positioning System (GPS) Receiver Application Module – Modified Standard Electronic Module-E (Mod SEM-E), 23 April 2003, SMC/CZU, Los Angeles AFB, CA

[6] FAA-G-2100G, Specification, *Electronic Equipment, General Requirements*, 22 October, 2001, United States Department of Transportation, Federal Aviation Administration.

[7] FAA-E-2937A, Specification, *LAAS Ground Facility Specification for Category 1*, 17 April 2002, United States Department of Transportation Federal Aviation Administration.

[8] HF-STD-001, Human Factors Design Standard (HFDS) For Acquisition of Commercial Off-The-Shelf Subsystems, Non-Developmental Items, and Developmental Systems, U.S. Department of Transportation, Federal Aviation Administration Headquarters, May 2003.

[9] ICD-GPS-200D, *NAVSTAR GPS Space Segment/Navigation User Interfaces,* ARINC Research Corporation, 2250 E. Imperial Highway, Suite 450, El Segundo, CA 90245-3509.

[10] IEEE 1394-1995, IEEE Standard for a High Performance Serial Bus.

[11] Joint Precision Approach and Landing System (JPALS) Security Classification Guide, **TBD.**

[12] Joint Precision Approach and Landing System (JPALS) Signal-in-Space (SIS) Interface Control Document (ICD), **Date and exact title TBD when published**, DoD.

[13] MIL-PRF-GB-GRAM-300A, Performance Specification for the NAVSTAR Ground-Based GPS Receiver Applications Module (GB-GRAM), NAVSTAR GPS Hoint Program Office (SMC/CZ), El Segundo, CA.

[14] MIL-P-90024, *(Need details)*

[15] MIL-STD-129 Rev P, Marking for Shipment and Storage

[16] MIL-STD-461, Electromagnetic Emissions and Susceptibility, Requirements for the Control of Electromagnetic Interference

[17] MIL-STD-2073-1D, Standard Practice for Military Packaging

[18] *NAVSTAR Global Positioning System, System Protection Guide*, 13 June 1997, Headquarters Space And Missile Systems Center (AFMC), United States Air Force, Los Angeles Air Force Base (LAAFB), Los Angeles, CA 90245-4659.

[19] Operational Requirements Document (ORD) for Joint Precision Approach and Landing System (JPALS), USAF-002-94-I, 8 July 2002, Air Force Flight Standards Agency.

[20] Precise Positioning Service (PPS) Certification, (**Number TBD when published**), (Date TBD).

[21] RTCA/DO-228, Minimum Operational Performance Standards (MOPS) for Global Navigation Satellite System (GNSS) Airborne Antenna Equipment, 20 October 1995, RTCA Inc.

[22] RTCA/DO-245, Minimum Aviation System Performance Standards (MASPS) for Local Area Augmentation System (LAAS), 28 September 1998, RTCA Inc.

[23] RTCA/DO-246B, Global Navigation Satellite System (GNSS) Based Precision Approach Local Area Augmentation System Signal-in-Space - Interface Control Document, 28 September 1998, RTCA Inc.

[24] RTCA/DO-253A, Minimum Operational Performance Standards (MOPS) for GPS Local Area Augmentation System Airborne Equipment, 28 November 2001, RTCA Inc.

[25] RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware, 19 April 2000, RTCA Inc.

[26] RTCA/DO-278, Guidelines for Communications, Navigation, Surveillance, and Air Traffic Management (CNS/ATM) Systems Software integrity Assurance, March 5, 2002, RTCA Inc.

[27] SS-GPS-001A, Selective Availability and Anti-Spoofing Module (SAASM), 12 March 1998.

[28] *Standards and Recommended Practices (SARPs)*, Aeronautical Telecommunications Vol. I, Radio Navigation Aids, International Civil Aviation Organization (ICAO), Annex 10, Vol. I, Amendment. 77.

[29] System Requirements Document (SRD) for the Joint Precision Approach and Landing System (JPALS) Common Program, April 2003, Revision 2.2, Draft V13, Electronic Systems Center, Global Air Traffic Operations/Mobility Command and Control System Program Office (ESC/GA), JPALS Integrated Product Team, Hanscom AFB, MA 01731-2103.

[30] *TSO-C161*, *Ground Based Augmentation System Positioning and Navigation Equipment,* 30 May 2003, Department of Transportation, Federal Aviation Administration, Aircraft Certification Service, Washington, DC.

[31] *TSO-C162*, *Ground Based Augmentation System Very High Frequency Data Broadcast Equipment,* 30 May 2003, Department of Transportation, Federal Aviation Administration, Aircraft Certification Service, Washington, DC.

[32] *UL-268, Standard for Smoke Detectors for Fire Alarm Signaling Systems*, Underwriters Laboratories, Dec 30, 1996.

2.1 Order of Precedence

In case of a conflict between this document and the referenced documents, the order of precedence in descending order is as listed below unless otherwise noted herein:

1. Applicable Federal, State, or Local Laws and Regulations
2. JPALS ORD [19]
3. JPALS SRD [29]
4. MGS (this document)
5. Other referenced specifications and documents referenced in Section 2.

In case of conflict between referenced documents at a lower order of precedence than this document, the more restrictive requirement applies, unless otherwise approved by the Government in the form of a change to this document or by other contractually effective means.

Lack of a requirement at a higher level of precedence or a more general requirement at a higher level of precedence is not considered a conflict. The more detailed requirement applies.

3. SYSTEM REQUIREMENTS

The MGS system requirements are delineated in the following subparagraphs.

3.1 System Definition

The JPALS ground segment is equipment installed on the ground within the local area where JPALS operations are to be performed, usually near a runway. Three ground segment equipment configurations specified herein are: fixed base, tactical and special mission. All requirements of this document shall apply to each of the configurations, unless specifically delineated otherwise. The JPALS ground segment will be referred to herein as the MGS.

The MGS will be capable of supporting the functional requirements in Section 3.2.1.

The fixed base equipment configuration will support fixed base operational environments.

The tactical equipment configuration will nominally support tactical operational environments.

The special mission configuration will nominally support special missions operational environments.

All MGS performance characteristics shall be met under the signal strength defined in ICD-GPS-200 (for GPS satellites) [9], and the interference environment defined by the JPALS SRD Appendix B [29].

GPS shall be used to meet all requirements in this specification. The use of signals from other constellations (e.g. SBAS, Galileo) are optional.

3.1.1 Major Functional Capabilities

The functions of the MGS are illustrated in Figure 3-1. The illustration is neither intended to specify an architecture, nor to allocate requirements among components, but rather to assist the following narrative. The contractor has leeway in specifying architecture and in making allocations among components.

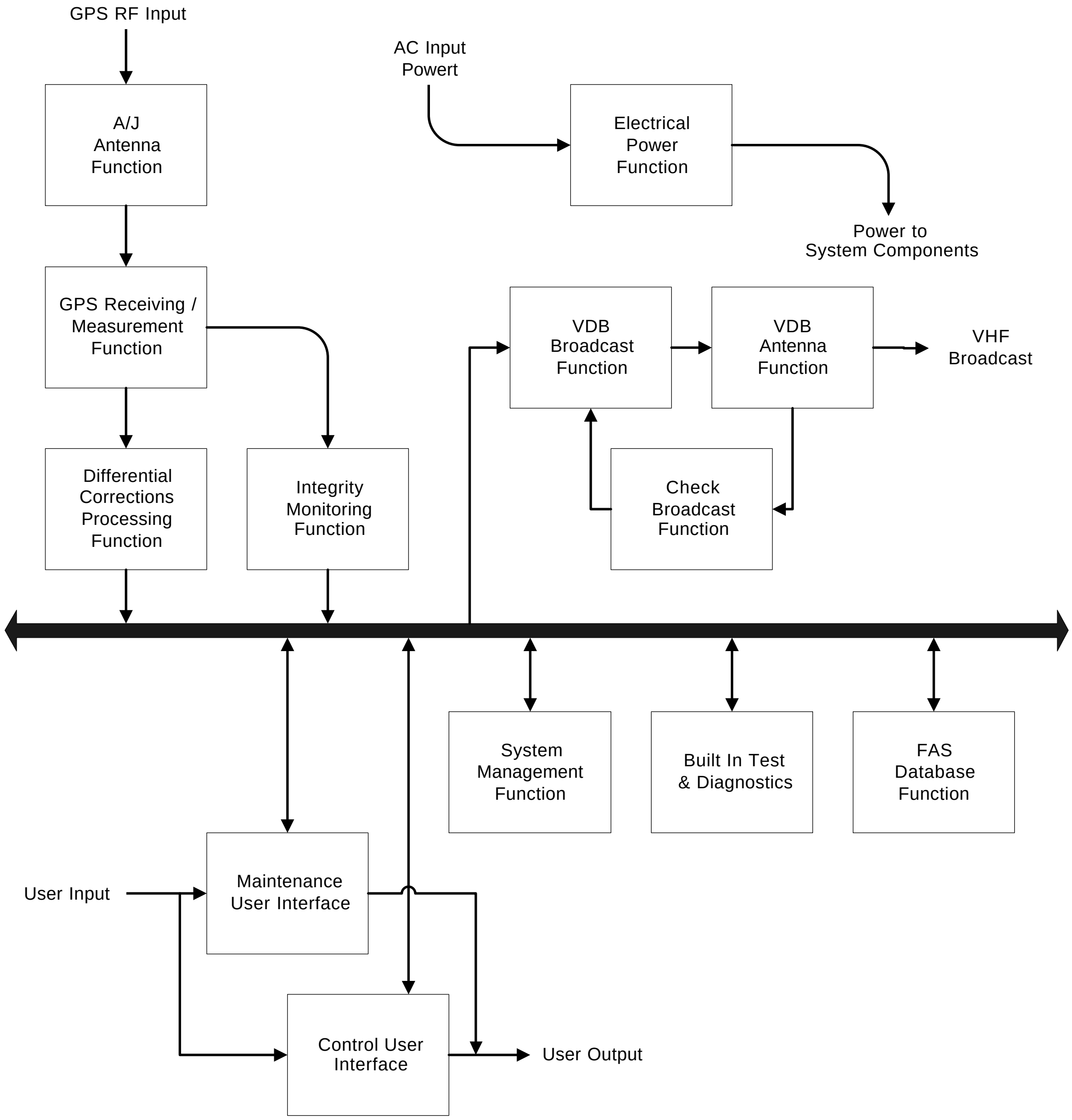


Figure 3-1: MGS Functional Block Diagram

3.1.1.1 Anti-jam (AJ) Antenna Function

The AJ antenna function will filter the GPS RF signal, perform low-noise amplification, mitigate jamming sources, and mitigate multipath effects.

3.1.1.2 GPS Receiving and Measurement Function

The GPS receiving and measurement function will include:

a. Down conversion from RF to Intermediate Frequency (IF)

b. Digitization of the IF signal

c. Acquisition and tracking of ranging sources

d. Generation of raw observables

e. Synchronization of messages from multiple receivers to the same epoch

f. Validation of messages from receivers

g. Generation of a 1 pulse per second timing signals for use in timing the Very High Frequency (VHF) Data Broadcast (VDB)

3.1.1.3 Differential Corrections Processing

The differential corrections processing function will use the raw measurements from the GPS receiving and measurement function to calculate the corrections for broadcast.

3.1.1.4 Integrity Monitoring Function

JPALS shall provide an indication to the aircraft if a loss of integrity is detected.

The integrity monitoring function will perform all the calculations necessary to assure the integrity of the VDB SIS. These functions include:

a. Fusion of sensor data to aid integrity monitoring

b. Reference receiver monitoring and exclusion when needed

c. Ephemeris monitoring

d. Ranging source monitoring and exclusion when needed

e. Signal quality monitoring (for signal deformation)

f. B-value monitoring

g. Sigma monitoring

h. Message generation

3.1.1.5 System Management Function

The system management function will control all flow of data and will synchronize all system functions.

The Central Processing Unit (CPU) on which it operates shall have at least 50% margin on processing speed, data storage, and communications channels throughput.

If the design includes multiple CPUs, each shall have at least 50% margin on processing speed, data storage, and communications channels throughput, regardless of the functions performed.

3.1.1.6 VDB Broadcast Function

The VDB broadcast function will modulate the message data and provide the modulated signal to the VDB antenna. The messages will be synchronized using the GPS 1 PPS signal as the means of meeting the Time Domain Multiple Access (TDMA) time slot requirements.

3.1.1.7 VDB Antenna Function

The VDB antenna function will use the transmitter signal to provide a SIS which meets the coverage volume requirements.

3.1.1.8 Check Broadcast Function

The check broadcast function will monitor the VDB broadcast to assure that the actual broadcast matches the intended messages. It will shut down the broadcast in the case of a mismatch.

3.1.1.9 FAS Database Function

The MGS will maintain a database containing Final Approach Segment (FAS) data as well as any other site specific operations data. The database will be updated via the Maintenance Data Terminal (MDT).

3.1.1.10 Maintenance User Interface Function

The MGS will provide detailed status information to support maintenance requirements. Status, maintenance control, data loading, and software loading capabilities will be executed through a MDT. The MDT display will be provided as part of the MGS. For maintenance purposes, MGS status information will also be available on a Local Status Panel (LSP).

3.1.1.11 Control Unit Interface Function

The MGS will provide status information to Air Traffic Control (ATC) via an Air Traffic Control Unit (ATCU). The ATCU will provide air traffic controllers with MGS status information and runway control capabilities. Control through the ATCU will include the ability to switch Sub Modes, to switch runway ends, and to acknowledge alarms and alerts. For maintenance purposes, MGS status information will also be available on a Local Status Panel (LSP).

3.1.1.12 Built In Test and Diagnostic Function

The MGS will include built in testing capability with both manually initiated testing and scheduled automatic testing. Manual testing will be initiated through the MDT.

3.1.1.13 Electrical Power Function

For fixed base and tactical configurations, the electrical power function will convert Alternating Current (AC) power from either the power grid or from portable generators into Direct Current (DC) power needed by the design.

For special mission, the electrical power function will either convert AC power from portable generators or from batteries into DC power needed by the design.

3.1.1.14 General Considerations

The Tactical and Special Mission configurations shall each include a deployment package as a major component. The required contents of the deployment packages are defined in Section 3.4.

All other major components of the three configurations shall be as defined by the development contractor or manufacturer.

3.1.2 States and Modes

Service levels SL 7 and SL 8 shall have identical States and Modes.

3.1.2.1 States

The MGS shall have the following two states:

MGS On: Main or supplemental power is applied to the MGS equipment, and

MGS Off: No power is applied to the MGS equipment.

Only one state shall exist at a time.

3.1.2.2 Modes

The MGS shall provide the following modes of operation:

a. Normal Mode
    1. Initialization Phase of Normal Mode
    2. Normal Phase of Normal Mode
        a) Civil Sub Mode
            1) Service Level SL 7
            2) Service Level SL 8
        b) Military Sub Mode
            1) Service Level SL 7
            2) Service Level SL 8

b. Not Available, and

c. Test.
    1. Civil Sub Mode
        a) Service Level SL 7
        b) Service Level SL 8
    2. Military Sub Mode
        a) Service Level SL 7
        b) Service Level SL 8

Only one mode shall exist at a time.

Only one phase shall exist at a time.

Only one Sub Mode shall exist at a time.

The MGS shall automatically transition from Normal to Not Available when there is an alarm condition.

When transitioning from Normal Mode to Test Mode, or from Test Mode to Normal Mode, the Sub Mode and Service Level shall not change.

3.1.2.3 Normal Mode

The MGS shall be in Normal Mode when Test Mode has not been commanded and an alarm does not exist.

The capability for the following conditions and actions to coexist within the Normal Mode shall include, but is not limited to:

a. Conditions:

   1. Alert (Section 3.2.2.9.1.7)

   2. Service Alert (Section 3.2.2.9.1.8)

   3. Constellation Alert (Section 3.2.2.9.1.9)

b. Actions:

   1. Approach Control

   2. Periodic Maintenance

   3. Non-intrusive diagnostics

   4. Line Replaceable Unit (LRU) Replacement

   5. Data Recording

   6. Status monitoring

   7. User Identification (ID) and password change

   8. Adjustment storage

   9. Fault recovery

   10. Audit log file archiving

c. Transition Criteria:

   1. Entering Normal Mode:

      a) Enter Normal Mode from Off State (power applied)

      b) Enter Normal Mode from Test Mode (Normal Mode Commanded)

      c) Enter Normal Mode from Not Available Mode (Auto Restart or Fault Recovery Commanded)

2. Exiting Normal Mode:

   a) Exit Normal Mode to Not Available Mode (alarm)

   b) Exit Normal Mode to Test Mode (Test Mode Commanded)

   c) Exit Normal Mode to Off State (powering off)

In all three configurations, the MGS Normal Mode shall include two independently selectable Sub Modes. The Sub Modes are Civil Sub Mode and Military Sub Mode.

3.1.2.3.1 Civil Sub Mode

When the Civil Sub Mode is selected the MGS shall only provide L1 C/A corrections.

3.1.2.3.2 Military Sub Mode

When the Military Sub Mode is selected the MGS shall only provide L1 P(Y) and L2 P(Y) differential corrections with ability for both L1 and L2 at the same time.

3.1.2.4 Not Available Mode

The MGS shall transition from the Normal Mode to the Not Available Mode when an alarm exists and when it is not in Test Mode.

The MGS shall remain in the Not Available Mode until the alarm is cleared or the MGS is placed in the Test Mode.

The Not Available Mode shall include the following conditions, actions and transition criteria:

a. Condition:

   1. Alarm (Section 3.2.2.9.1.10)

b. Actions:

   1. Automatic Restart

   2. States and modes display

   3. System power display

   4. System events recording

c. Transition Criteria:

1. Entering Not Available Mode:
    a) Enter Not Available Mode from Normal Mode (Alarm)
    b) Enter Not Available Mode from Test Mode (Alarm)
2. Exiting Not Available Mode:
    a) Exit Not Available Mode to Normal Mode (following Auto Restart or Fault Recovery Commanded)
    b) Exit Not Available Mode to Test Mode (Test Mode Commanded)

3.1.2.5 Test Mode

Test Mode is defined as when the MGS is undergoing either maintenance or test. The MGS shall enter Test Mode when commanded by the MDT.

While in Test Mode, the VDB shall be capable of broadcasting all message types as if in the Normal or Not Available Mode.

The Test Mode shall include the following conditions, actions and transition criteria:

a. Conditions:
    1. Alert
    2. Service Alert
    3. Constellation Alert
    4. Alarm
b. Maintenance and test actions:
    1. Restart the MGS
    2. Intrusive and non-intrusive diagnostic control
    3. Trouble shooting
    4. Site specific parameter change
    5. Alert, service alert, constellation alert, and alarm threshold change
    6. Redundant equipment status change
    7. Monitor by-pass

8. VDB by-pass

9. Approach control

10. Periodic maintenance

11. LRU replacement

12. Data recording

13. Status monitoring

14. User ID and password change

15. Adjustment storage

16. Fault recovery

17. Audit log file archiving

c. Transition Criteria:

1. Entering Test Mode:

   a) Enter Test Mode from Normal Mode (Test Mode Commanded)

   b) Enter Test Mode from Not Available Mode (Test Mode Commanded)

2. Exiting Test Mode:

   a) Exit Test Mode to Normal Mode (Normal Mode Commanded)

   b) Exit Test Mode to Not Available Mode (Alarm)

   c) Exit Test Mode to Off State

Upon exiting the Test Mode, the MGS shall revert to either the Normal (if an alarm does not exist) or to Not Available Mode (if an alarm exists).

Figure 3-2 illustrates the allowable conditions and actions within the MGS Modes.

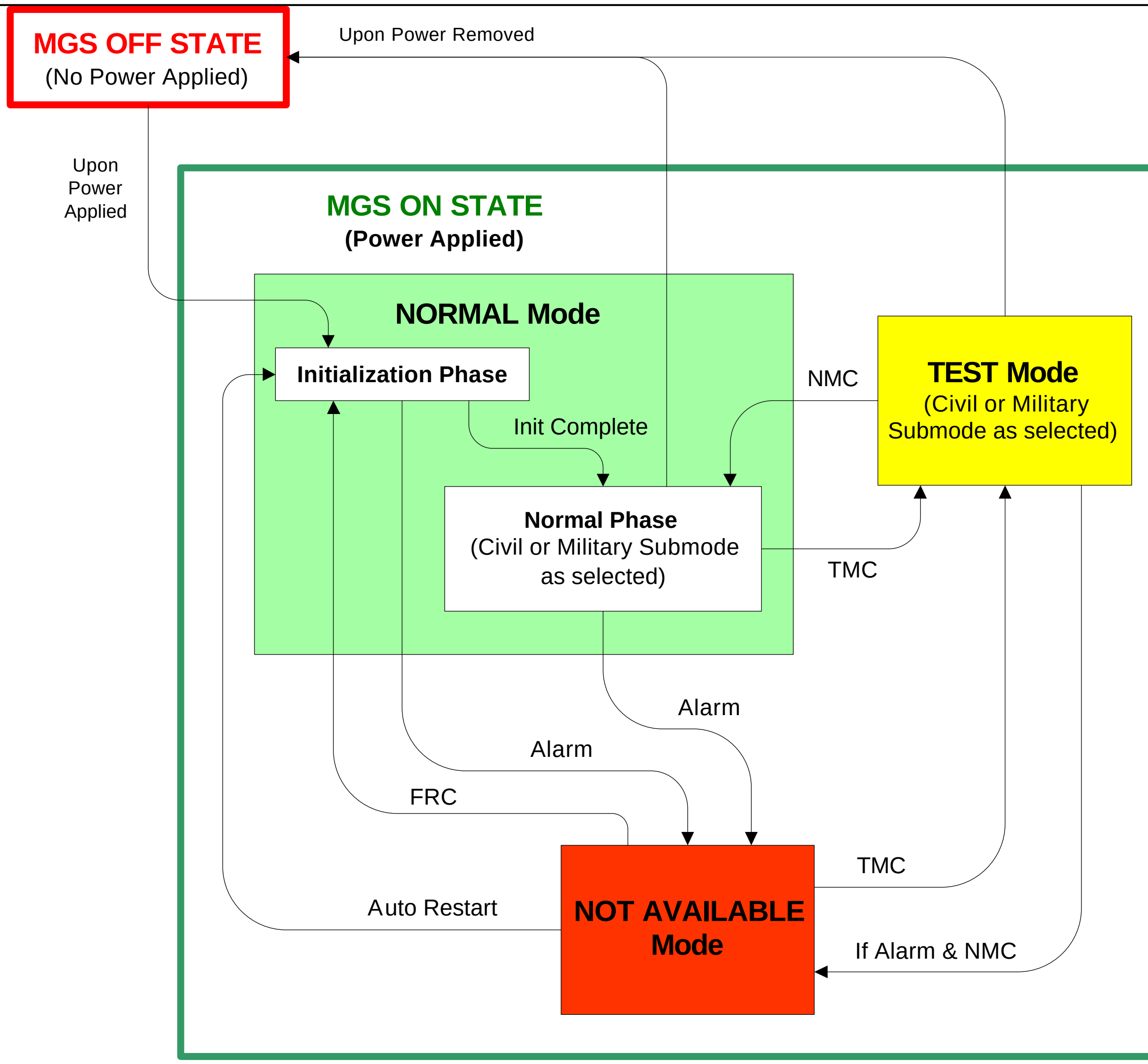


Figure 3-2: MGS States and Modes

3.1.3 Interface Definitions

3.1.3.1 MGS External Interface Definitions

The MGS will provide the external interfaces identified in the following sub-sections.

3.1.3.1.1 MGS/GPS Interface

The MGS shall provide an interface with the GPS satellite constellation in accordance with ICD-GPS-200D [9] and all current interface revision notices.

The MGS may optionally provide an interface with the SBAS satellites.

3.1.3.1.2 MGS/MAS Civil VHF Data Broadcast Interface

The Fixed Base and Tactical configurations of the MGS shall provide a Civil VDB Interface in accordance with the JPALS SIS ICD [12].

3.1.3.1.3 MGS/MAS Military VHF Data Broadcast Interface

The MGS shall provide a VDB Interface in accordance with the JPALS SIS ICD [12].

3.1.3.1.4 MGS Operator Interface

The MGS will provide an operator interface in accordance with Section 3.2.2.11.1 below.

3.1.3.1.5 MGS Maintenance Interface

The MGS will provide a maintenance interface in accordance with Section 3.2.2.11.2 below.

3.1.3.1.6 MGS/Tower Interface

The MGS will provide an interface with the Tower or other remotely located personnel in accordance with Section 3.2.2.11.3 below.

3.1.3.1.7 MGS Electrical Power Interface

The MGS will provide an interface to accept external electrical power in accordance with Section3.2.3.2 below.

3.1.3.1.8 Geospatial Information and Services (GI&S) Support

GI&S requirements are contained in the SIS ICD [12]. MGS subsystems or components requiring GI&S support shall be capable of accepting National Imagery and Mapping Agency (NIMA) standard products.

The MGS shall use World Geodetic System 1984 (WGS-84), or its replacement.

3.1.3.2 MGS Internal Interface Definition

The MGS internal interfaces that are not specified here, will be defined and documented by the development contractor.

3.1.3.2.1 MDT/CPU Interfaces

The hardware interfaces between the MDT and the CPU shall be of a contractor proposed and government approved industry standard.

The hardware interfaces between the MDT and the CPU shall include both a hard wired configuration and a wireless configuration.

3.1.3.2.2 ATCU/CPU Interface

The hardware interfaces between the ATCU and the CPU shall be of a contractor proposed and government approved industry standard.

The hardware interfaces between the ATCU and the CPU shall include both a hard wired configuration and a wireless configuration.

3.1.3.2.3 Reference Receiver (RR)/CPU Interface

The hardware interfaces between the RR and the CPU shall be of a contractor proposed and government approved industry standard hard wired connection.

3.1.3.2.4 VDB/CPU Interface

The hardware interfaces between the VDB and the CPU shall be of a contractor proposed and government approved industry standard hard wired connection.

3.2 Characteristics

3.2.1 Functional Requirements

These sections summarize the top level functional requirements of the MGS.

3.2.1.1 Approach and Landing Guidance

The MGS shall support both precision approaches based on “straight-in” procedures (i.e., those supported by ILS and MLS) as well as complex procedures. Complex procedures are defined as approach paths that contain one or more descending straight or curved segments leading to a stabilized straight segment to the runway threshold.

The MGS shall broadcast guidance data (FAS and correction data) as defined in the JPALS SIS ICD [12], that the aircraft uses to align laterally and vertically along a missed approach path to the designated missed approach waypoint.

The relationship of the FAS data shall be consistent with the following definitions as depicted in Appendix C of the JPALS SRD [29].

The MGS shall support both precision approaches based on "straight-in" procedures (i.e., those supported by Instrumented Landing Systems (ILS) and Microwave Landing Systems (MLS)) as well as complex procedures. Complex procedures are defined as approach paths that contain one or more descending straight or curved segments leading to a stabilized straight segment to the runway threshold.

The MGS will use data from multiple GPS receivers for its processing.

The MGS will compute differential GPS corrections for all satellites it can track in phase and code.

The MGS will monitor the integrity of all GPS signals it uses to compute corrections and the integrity of MGS equipment and functions.

The MGS will compute integrity parameters for usage by the MAS.

The MGS shall transmit correction, integrity, and FAS data for usage by the MAS according to the LDGPS SIS ICD [12].

3.2.1.2 Interoperability

3.2.1.2.1 Information Exchange Requirements

The MGS information exchange requirements (IER's) are presented in Table 3-1. All top level critical IER's are Key Performance Parameters (KPP's) and shall be satisfied.

Table 3-1: Information Exchange Requirements (IER) Matrix

Rationale/ UJTL Number	Event	Information Characterization	Sending Node	Receiving Node	Critical	Format	Timeliness	Classification	Remarks
ST 1.3.3 ST 1.4 ST 4.4 OP 1.2.4.3 OP 1.2.4.4 OP 1.3.2 OP 4.5.1 OP 4.6	Periodic scan for data	Situational Awareness-Status Information	MGS	Airfield Tower	Yes	Data – JPALS System Requirement Document (SRD)	2 Sec	U	System operational status provided via visual indications to ATC facilities
		Guidance Information	MGS (will be interoperable with civil and allied aircraft)	MAS or Pilot	Yes	Data Per JPALS Signal-in-space Interface Control Document (ICD)	0.5 Sec	U	GPS Error data (one way data link) (azimuth and elevation) provided to aircraft receiver during last 10 miles prior to landing
			GPS Satellite	MAS and MGS	Yes	Data ICD-GPS-200D – NAVSTAR GPS Space Segment Navigation User Interfaces	30 Sec (ICD-GPS-200D)	U-FR	GPS position data sent to aircraft and ground stations for GPS position calculation

Table Notes:
Universal Joint Task List (UJTL) Reference List (CJCSM 3500.04B):
Strategic Theater (ST) – Establish Airspace Control Measures
Operational (OP) – Conduct Operational Movement
ST 1.4 Enhance Strategic Mobility
ST 1.3.3 Synchronize Forcible Entry in Theater
ST 4.4 Develop and Maintain Sustainment Bases
OP 1.2.4.3 Conduct Forcible Entry
OP 1.2.4.4 Reinforce and Expand Lodgment
OP 1.3.2 Enhance Movement of Operational Forces
OP 4.5.1 Provide for Movement Services in the Joint Operations Area
OP 4.6 Build and Maintain Sustainment Bases in the Joint Operations Area

3.2.1.2.2 C4I/Standardization, Interoperability, and Commonality

The MGS shall provide precision approach guidance to all suitably equipped Service aircraft, as well as suitably equipped civil aircraft supporting military operations.

The MGS shall be compatible with other current and planned domestic and international air traffic control, navigation, and landing systems to the extent specified in this document.

The MGS shall provide for interoperability with military forces of allied nations to the extent specified in this document.

In order to achieve interoperability with fielded and proposed system(s), the MGS shall comply with applicable information technology standards contained in the Joint Technical Architecture (Reference TBD).

3.2.1.3 Mission Planning Assistance Functions

Note: In order to meet the mission need for rapid deployment in tactical and special mission environments there is likely to be significant mission planning done prior to arriving on-site. This could include database and instrument procedure development using information gathered through intelligence sources. There needs to be some external interface or component of the system that makes that data available when the system is deployed. For example, something like the MDT could be used in a mission planning function to pre-enter data for the FAS blocks to be used in type 4 messages. There needs to be requirements that identify what mission planning functions the MGS needs to support and/or what interface(s) the MGS has to get data from other systems used to perform mission planning.

3.2.1.4 JPALS Siting Assistance Functions

The MGS shall provide siting assistance functions to facilitate rapid deployment of the system as deemed necessary by the contractor to meet the specification.

The MGS shall provide siting assistance functions to aid in determining and validating siting requirements needed to meet accuracy and integrity requirements of this specification.

The MGS shall provide the ability to generate site specific landing data that cannot be determined during mission planning, including but not limited to Type 2 messages.

3.2.2 Performance Requirements

Service levels are related to performance as given in Table 3-2.

Table 3-2 Service Level Definitions

Service Level	NSE Accuracy lateral 95% (at threshold)	NSE Accuracy vertical 95% (at threshold)	Integrity Risk	Time to alert (to the aircrew)	Alert Limits (FASVAL = vertical FASLAL = lateral) (at threshold)	Continuity Risk	Typical Operation
SL 7	16.0 m (52 ft)	4.0 m (13 ft)	$2x10^{-7}$ per approach	6 s	FASLAL = 40.0 m (130 ft) FASVAL = 10.0 m (33 ft)	8×10^{-6} in any 15 s	CAT I Precision Approach, CAT I Autoland
SL 8	6.9 m	2 m	10^{-9} per	2 s	FASLAL	4×10^{-6} in	CAT II

			approach		=17.3 m FASVAL = 5.3 m	any 15 s	Precision Approach
SL 9	TBD	TBD	TBD	TBD	TBD	TBD	CAT IIa Precision Approach

3.2.2.1 Guidance Quality

3.2.2.1.1 Accuracy

Accuracy requirements are given in Section 3.2.2.8.2.8.7.1.

3.2.2.1.2 Integrity

The MGS is required to meet the integrity to support SL 7 and SL 8 precision approach, area navigation, and other operations that use differentially corrected positioning service. Some of the integrity allocations have different requirements for the operations and are specified separately in the subsections below.

3.2.2.1.2.1 MGS Integrity Risk (3.1.2.1)

3.2.2.1.2.1.1 Service Level 7 Precision Approach

The probability that the MGS transmits Misleading Information (MI) for 3 seconds or longer due to a ranging source or MGS failure, when operating within the Radio Frequency Interference (RFI) environment defined in appendix D of the LAAS MOPS (RTCA/DO-253A) [24] shall not exceed $2x10^{-7}$ during any 150-second approach interval. Misleading information is defined as broadcast data that results in a position error exceeding the protection level and ephemeris error bound for any user that complies with RTCA/DO-253A [24] and is located anywhere within 60 nautical miles of the centroid of the reference receivers.

Ranging source failures shall include:

a. Signal deformation as defined in Appendix E of FAA-E-2937A [7], with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition;

b. Signal levels below those specified in Sections 3.3.1.6 and 6.3.1 of ICD-GPS-200D [9] for L1 C/A code, L1 P(Y) code, and L2 P(Y) code, with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition;

c. Code/carrier divergence, with a failure rate of 1.0 x 10^{-4} per hour per satellite during initial acquisition, and a prior probability 4.2 x 10^{-6} per approach per satellite after acquisition;

d. Excessive pseudorange acceleration, such as step or other rapid change, with a failure rate of 1.0 x 10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2 x 10^{-6} per approach per satellite after acquisition; or

e. Erroneous broadcast of GPS ephemeris data, with a failure rate of 1.0 x 10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2 x 10^{-6} per approach per satellite after acquisition.

The MGS failures shall include the broadcast of erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (PR_{sca}) from more than one RR. Erroneous data is defined to be any broadcast parameter that is not computed and broadcast in accordance with Section 3.2.2.8. Precision Approach Misleading Information (PAMI) is defined as information that, when processed by a fault-free receiver compliant with RTCA/DO-253A [24] and RTCA/DO-246B [23], results in an out-of-tolerance lateral or vertical relative position error. An out-of-tolerance lateral or vertical relative position error is defined as an error that exceeds both the SL 7 precision approach protection level and the ephemeris error position bound.

The JPALS SIS accuracy requirements are defined in terms of the output from a fault-free MAS. The probability that the vertical NSE and the lateral NSE are within their applicable limits as defined below shall be at least 0.95.

For SL 7, the 95% NSE lateral accuracy at the landing threshold shall not exceed 16.0m.

For SL 7, the 95% NSE vertical accuracy at the landing threshold shall not exceed 4.0 m.

For SL 7 the probability that the NSE exceeds the lateral or the vertical alert limits without annunciation for longer than the time-to-alert (6 seconds is allocated between air and ground as TBD) shall not exceed the integrity risk probability shown below for the desired SL. The time-to-alert requirement is defined to begin at the point in time at which a failure condition affects the guidance provided to the aircrew, and to end when the alert condition is detectable at the fault-free MAS.

For SL 7, the FASLAL shall be = 40.0 m.

For SL 7, the FASVAL shall be = 10.0 m.

Note: Failure rate assumptions need to be verified.

3.2.2.1.2.1.2 Service Level 8

The probability that the MGS transmits MI for 1 second or longer due to a ranging source or MGS failure, when operating within the RFI environment defined in appendix D of the LAAS MOPS (RTCA/DO-253A) [24] shall not exceed 10^{-9} during any 15-second approach interval. MI is defined as broadcast data that results in a position error exceeding the protection level and ephemeris error bound for any user that complies with RTCA/DO-253A [24] and is located anywhere within 60 nautical miles of the centroid of the reference receivers.

Ranging source failures shall include:

a. Signal deformation as defined in Appendix E of FAA-E-2937A [7], with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition;

b. Signal levels below those specified in Sections 3.3.1.6 and 6.3.1 of ICD-GPS-200D [9] for L1 C/A code, L1 P(Y) code, and L2 P(Y) code, with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition;

c. Code/carrier divergence, with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability 4.2×10^{-6} per approach per satellite after acquisition;

d. Excessive pseudorange acceleration, such as step or other rapid change, with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition; or

e. Erroneous broadcast of GPS ephemeris data, with a failure rate of 1.0×10^{-4} per hour per satellite during initial acquisition, and a prior probability of 4.2×10^{-6} per approach per satellite after acquisition.

The MGS failures shall include the broadcast of erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (PR_{sca}) from more than one RR. Erroneous data is defined to be any broadcast parameter that is not computed and broadcast in accordance with Section 3.2.2.8. PAMI is defined as information that, when processed by a fault-free receiver compliant with RTCA/DO-253A [24] and RTCA/DO-246B [23], results in an out-of-tolerance lateral or vertical relative position error. An out-of-tolerance lateral or vertical relative position error is defined as an error that exceeds both the SL 8 precision approach protection level and the ephemeris error position bound.

For SL 8, the 95% NSE lateral accuracy at the landing threshold shall not exceed 6.9 m.

For SL 8, the 95% NSE vertical accuracy at the landing threshold shall not exceed 2.0 m.

For SL 8 the probability that the NSE exceeds the lateral or the vertical alert limits without annunciation for longer than the time-to-alert (2 s is allocated between air and ground as TBD) shall not exceed the integrity risk probability shown below for the desired SL. The time-to-alert requirement is defined to begin at the point in time at which a failure condition affects the guidance provided to the aircrew, and to end when the alert condition is detectable at the fault-free MAS.

For SL 8, the FASLAL shall be = 17.3 m.

For SL 8, the FASVAL shall be = 5.3 m.

3.2.2.1.2.2 Protection Level Integrity Risk

In conforming to the integrity risk assigned to the MGS, the broadcast integrity parameters (B-values, s_{pr_mgs} , $s_{vert\_iono\_gradient}$, P-value, K-values, Refractivity Index Section, Scale Height, and Refractivity Uncertainty) shall be defined to ensure proper operation under fault-free conditions (both system and local environment.)

3.2.2.1.2.2.1 Service Level 7

When the MGS is not broadcasting erroneous data and no failures exist that would affect the smoothed pseudorange corrections (PR_{sca}) from more than one RR, the probability that the MGS transmits PAMI for 3 seconds or longer when operating within the Radio Frequency Interference (RFI) environment defined in appendix D of the LAAS MOPS, RTCA/DO-253A [24], shall not exceed $5x10^{-8}$ during any 150-second approach interval.

3.2.2.1.2.2.2 Service Level 8

When the MGS is not broadcasting erroneous data and no failures exist that would affect the smoothed PR_{sca} from more than one RR, the probability that the MGS transmits PAMI for 1 seconds or longer when operating within the RFI environment defined in appendix D of the LAAS MOPS, RTCA/DO-253A [24], shall not exceed $5.2x10^{-10}$ in any 150-second approach interval.

3.2.2.1.2.3 Integrity of a Single Reference Receiver

The integrity risk of a single RR is the probability that an undetected failure exists that affects any smoothed pseudorange, any predicted range or any smoothed pseudorange correction from a single RR.

3.2.2.1.2.3.1 Service Level 7

The integrity risk that an undetected failure exists that affects any smoothed pseudorange, any predicted range or any smoothed pseudorange correction from a single RR shall not exceed 1×10^{-5} in any 150-second interval.

3.2.2.1.2.3.2 Service Level 8

The integrity risk that an undetected failure exists that affects any smoothed pseudorange, any predicted range or any smoothed pseudorange correction from a single RR shall not exceed 1×10^{-5} in any 150-second interval.

3.2.2.1.2.4 Integrity in the Presence of Excessive RFI

3.2.2.1.2.4.1 Service Level 7

The probability that the MGS broadcasts data that result in a position error exceeding the H_0 protection level for 3 seconds or longer (assuming use of all satellites for which the MGS provides corrections), for any user that complies with RTCA/DO-253A [24] in the presence of RFI that exceeds the levels in appendix D of the LAAS MOPS (RTCA/DO-253A) [24] shall not exceed **TBD** *(to be provided when jamming test data becomes available).*

3.2.2.1.2.4.2 Service Level 8

The probability that the MGS broadcasts data that result in a position error exceeding the H_0 protection level for 1 second or longer (assuming use of all satellites for which the MGS provides corrections), for any user that complies with RTCA/DO-253A [24] in the presence of RFI that exceeds the levels in appendix D of the LAAS MOPS (RTCA/DO-253A) [24] shall not exceed **TBD** *(to be provided when jamming test data becomes available).*

3.2.2.1.3 Continuity

Continuity is defined as the probability of an unscheduled interruption of MGS service.

3.2.2.1.3.1 Data Broadcast Transmission Continuity

3.2.2.1.3.1.1 Service Level 7

The probability of an unscheduled interruption of the Data Broadcast transmission, where messages are not transmitted in accordance with Section 3.2.2.8.1 for a period equal to or greater than 3 seconds, shall not exceed $8x10^{-6}$ in any 15-second interval.

On average, the MGS shall transmit at least 999 messages out of 1000 consecutive messages.

3.2.2.1.3.1.2 Service Level 8

The probability of an unscheduled interruption of the Data Broadcast transmission, where messages are not transmitted in accordance with Section 3.2.2.8.1 for a period equal to or greater than 3 seconds, shall not exceed $4x10^{-6}$ in any 15-second interval.

On average, the MGS shall transmit at least 999 messages out of 1000 consecutive messages.

3.2.2.1.3.2 Reference Receiver and Ground Integrity Monitoring Continuity

The RR and ground integrity monitoring continuity risk is the probability that the number of valid B-values is reduced for any valid ranging source within the reception mask.

3.2.2.1.3.2.1 Service Level 7

The reference receiver and ground integrity monitoring continuity risk that the number of valid B-values is reduced for any valid ranging source within the reception mask shall not exceed 2.3×10^{-6} in any 15-second interval.

3.2.2.1.3.2.2 Service Level 8

The reference receiver and ground integrity monitoring continuity risk that the number of valid B-values is reduced for any valid ranging source within the reception mask shall not exceed ***TBD*** in any 15-second interval.

3.2.2.1.3.3 Latent Failures Affecting Continuity

The JPALS SIS continuity requirement is defined in terms of the output from a fault-free MAS. Given that a SL is available at a point in time, the probability of an unscheduled interruption of navigation performance meeting applicable SL accuracy and integrity, shall not exceed the continuity risk probability specified below for the desired SL.

3.2.2.2 Availability

Note: Per ARINC Engineering Services(AES) internal review, the availability section needs to be reworked: "The operational availability requirement has been incorrectly allocated solely to the MGS. This requirement is properly specified at the system level (and is currently included in the Systems Requirement Document). The requirement is then allocated to the Ground Segment and Airborne Segment in terms of GPS accuracy and tracking requirements and Ground Segment MTBF and MTTR."

3.2.2.2.1 Fixed Base Availability

The standard equipment configuration defined in Section 3.3.1.1.1 shall have a mean time between critical failures (MTBCF) of at least 7,200 hours and an inherent availability, of 0.99993.

Inherent availability is defined as the probability that the MGS is operating at any instant in time.

The fixed base inherent availability shall be greater than or equal to (=) 99.5% (threshold) or Ao is = 99.6% (objective).

A critical failure shall be defined as any failure resulting in an alarm condition as defined in Section 3.2.2.9.1.10.

This assumes an ideal support environment, with the mean time to repair (MTTR) as specified in Section 3.2.5.5, the mean time between failures (MTBF) as specified in Section 3.2.4, and instantaneous response time.

3.2.2.2.2 Tactical Availability

The standard equipment configuration defined in Section 3.3.1.1.1 shall have an MTBCF of at least 7,200 hours and an inherent availability, of ***TBD***.

Inherent availability is defined as the probability that the MGS is operating at any instant in time.

The tactical inherent availability shall be greater than or equal to (=) 99.0% (threshold) or Ao is = 99.5% (objective).

A critical failure shall be defined as any failure resulting in an alarm condition as defined in Section 3.2.2.9.1.10.

This assumes an ideal support environment, with the MTTR as specified in Section 3.2.5.5, the MTBF as specified in Section 3.2.4, and zero response time.

3.2.2.2.3 Special Missions Availability

The standard equipment configuration defined in Section 3.3.1.1.1 shall have a MTBCF of at least 7,200 hours and an inherent availability, of ***TBD***.

Inherent availability is defined as the probability that the MGS is operating at any instant in time.

The special missions inherent availability shall be greater than or equal to (=) 98.0% (threshold and objective).

A critical failure shall be defined as any failure resulting in an alarm condition as defined in Section 3.2.2.9.1.10.

This assumes an ideal support environment, with the MTTR as specified in Section 3.2.5.5, the MTBF as specified in Section 3.2.4, and zero response time.

3.2.2.3 AJ Requirements

Environments for which AJ requirements must be met are 1) the interference environment, and 2) the threat environment.

3.2.2.3.1 Interference Environment

The fixed base MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the JPALS SRD [29] for fixed base operating environments.

The tactical MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the JPALS SRD [29] for tactical operating environments.

The special missions MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the JPALS SRD [29] for the special mission operating environments.

3.2.2.3.2 Threat Environment

The requirements of this specification shall be met under the conditions of intentional jamming and/or spoofing of the GPS signal as defined in the JPALS SRD Appendix B [29].

The requirements of this specification shall be met under the conditions of interference, and intentional jamming and/or spoofing of the data link signals, as defined in the JPALS SRD Appendix B[29].

3.2.2.4 Multipath Requirements

TBD

3.2.2.5 Coverage and Service Volumes

MGS requirements are defined in terms of two types of volumes, the data broadcast coverage volume and the service volume(s). The MGS data broadcast coverage volume is defined as the volume of airspace within which the system meets the VDB field strength requirements. The MGS service volumes are the volumes of airspace (azimuth, glide path, and range from the intended point of landing) in which JPALS meets all the guidance quality requirements for a particular level of service; i.e., SL 7, SL 8, etc.

3.2.2.5.1 Data Broadcast Coverage Volume

The data broadcast coverage volume shall support one runway end as a threshold requirement and multiple runway ends as an objective requirement.

3.2.2.5.1.1 Minimum Field Strength

The MGS shall meet the minimum field-strength requirements of Section 3.2.2.8.8.4 using a single VDB antenna.

The MGS shall meet these minimum field-strength requirements (1) when there is no blockage of line-of-sight due to local terrain or obstacles, (2) when the on-channel power is set to the lower alarm limit, and (3) within the following minimum coverage volume (illustrated in Figure 3-3):

Laterally:

- Encompassing 360° around the VDB antenna,
- Beginning at 200 m, and
- Extending to 15 nm required, 20 nm objective,

Vertically, within the lateral region:

- Within 1.5 nm of the VDB antenna, between the horizontal plane 8 ft above the ground at the antenna and a conical surface inclined at not less than 85° above the horizontal plane, up to a height of 5,000 ft (10,000 ft objective), and
- From 1.5 nm to 23 nm, between 10,000 ft above ground level (AGL) and a conical surface that is inclined at 0.9° above the horizontal plane with an origin 137 ft below the ground at the antenna.

Note: Insert a new figure for Minimum Field Strength here. The figure in the SRD is not correct.

3.2.2.5.1.2 Maximum Field Strength

The MGS shall not exceed the maximum field strength requirements of Section 3.2.2.8.8.4, in the same volume as described for Minimum Field Strength.

The MGS shall meet these maximum field strength requirements when (1) there is no blockage of line-of-sight due to local terrain or obstacles, and (2) the on-channel power is set to the upper alarm limit.

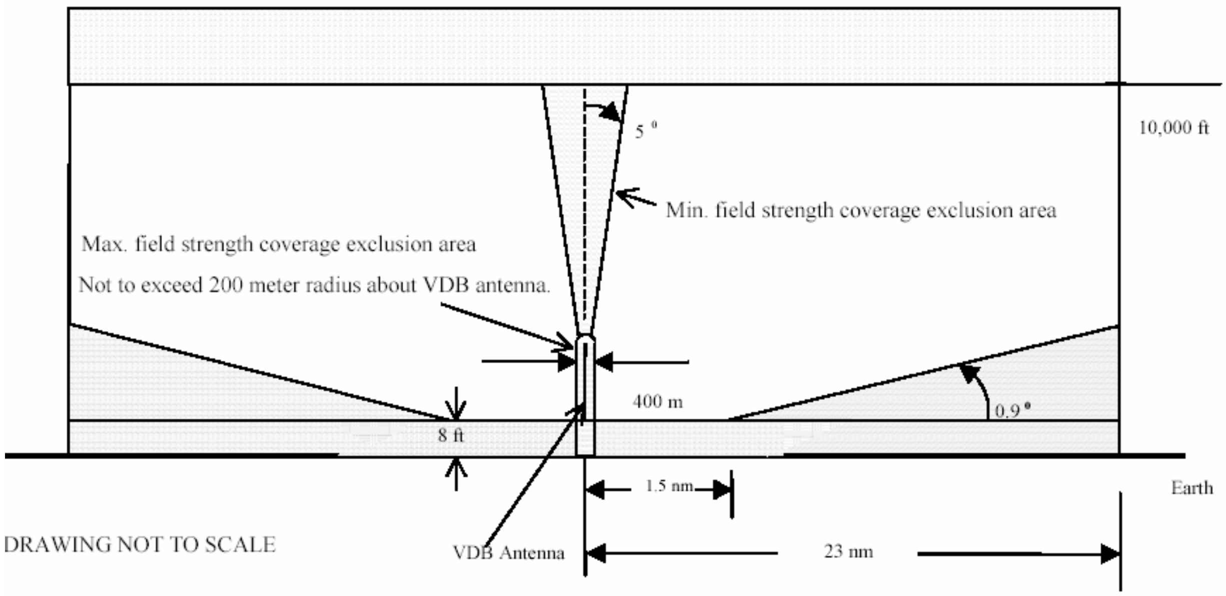


Figure 3-3: MGS Data Broadcast Coverage Volume

3.2.2.5.2 Service Volumes

The service volume is the volume of airspace (azimuth, glide path, and range from the intended point of landing) in which JPALS meets all the guidance quality requirements.

The JPALS system shall have the capability to service converging, intersecting, and parallel runways and opposite end approaches.

JPALS shall have a service volume that supports one runway end as a threshold and multiple runway ends as an objective.

3.2.2.5.2.1 SL 7 Precision Approach Service Volume

For each SL 7 precision approach procedure to be supported, the service volume shall be as follows, except where topographical features dictate and operational requirements do not permit:

Laterally: beginning at 450 ft each side of the landing threshold point/fictitious threshold point (LTP/FTP) and projecting out ±35 degrees either side of the final approach path to a distance of 20 NM (objective) and 16 NM (threshold) from the LTP/FTP; and

Vertically: within the lateral region, up to the greater of 7 degrees or 1.75 times the promulgated glide path angle (GPA) above the horizontal with an origin at the glide path interception point (GPIP) up to a maximum height of 10,000 ft above the LTP/FTP; and down to 0.9 degrees above the horizontal with an origin at the GPIP, down to a minimum height of 100 ft above the LTP/FTP.

3.2.2.5.2.2 SL 8 Precision Approach Service Volume

For each SL 8 precision approach procedure to be accommodated, the service volume shall be as follows:

Laterally: beginning at 450 ft each side of the LTP/FTP and projecting out ±35 degrees either side of the final approach path out to an intersection with the SL 7 service volume; and

Vertically: within the lateral region, up to the greater of 7 degrees or 1.75 times the promulgated GPA above the horizontal with an origin at the GPIP up to a maximum height of 200 ft; and down to 0.9 degrees above the horizontal with an origin at the GPIP, down to a minimum height of 100 ft above the LTP/FTP.

3.2.2.5.2.3 Autoland Service Volume (including rollout)

For each precision approach procedure for which an autoland capability is desired, the service volume shall be the sum of the two volumes defined as follows:

Laterally: beginning at 450 ft each side of the LTP/FTP and projecting out ±35 degrees either side of the final approach path out to an intersection with the SL 7 service volume; and

Vertically: within the lateral region, up to the greater of 7 degrees or 1.75 times the promulgated GPA above the horizontal with an origin at the GPIP up to a maximum height of 200 ft; and down to 0.9 degrees above the horizontal with an origin at the GPIP, down to a minimum height of 12 ft above the LTP/FTP.

And:

Laterally, within ±450 feet either side of the runway centerline extending from the departure end of the runway to the approach end; and

Vertically, within the lateral region, between 12 ft and 200 ft above the LTP/FTP.

3.2.2.5.2.4 Missed Approach Service Volume

For each guided missed approach procedure to be supported, the service volume shall be the sum of the three volumes defined as follows, except where topographical features dictate and operational requirements permit:

Laterally: ±1.0 NM either side of the runway centerline, from the approach end of the runway, to the departure end of the runway; and,

Vertically: within the lateral region, from 10,000 ft to 100 ft above the LTP/FTP.

And:

Laterally: ±1.0 NM either side of the runway centerline, from the departure end of the runway out to 4.0 NM; and,

Vertically: within the lateral region, from 10,000 ft above the LTP/FTP down to 0.9 degrees above the horizontal with an origin at the GPIP, down to a minimum height of 100 ft above the LTP/FTP;

And:

Laterally: beginning at 450 ft each side of the LTP/FTP and projecting out ±35 degrees either side of the final approach path out to an intersection with the upper surface of the SL 7 service volume; and

Vertically: within the lateral region, a maximum height of 10,000 ft above the LTP/FTP and down to the upper surface of the SL 7 service volume.

3.2.2.6 Guidance Quality for Functions Other Than Precision Approach

3.2.2.6.1 Autoland

Autoland (including rollout) guidance is applicable to fixed base and mobile equipment, but not man-transportable. Autoland guidance is provided to aircraft touch down. Autoland guidance quality will be provided at SL 7.

3.2.2.6.2 Guided Missed Approach

Guided missed approach accuracy shall be less than or equal to TBD m.

Guided missed approach accuracy shall have a vertical NSE of less than or equal to TBD meters (m).

The guided missed approach alert limit for integrity shall be TBD meters vertical.

Guided missed approach alert limit for integrity shall be TBD meters lateral.

Guided missed approach integrity shall have a probability of NSE exceeding the alert limit (AL) of TBD.

The guided missed approach time to alert shall not exceed TBD seconds.

Once the missed approach has commenced, the probability of unscheduled interruption of navigation performance meeting the missed approach accuracy and integrity requirements above, shall not exceed TBD.

3.2.2.6.3 Take-Off and Landing

Take-off and departure accuracy shall have a horizontal NSE of less than or equal to TBD m.

Take-off and departure accuracy shall have a vertical NSE of less than or equal to TBD m.

Take-off and departure alert limit for integrity shall be TBD m.

Take-off and departure integrity shall have a probability of NSE exceeding the AL of less than or equal to TBD per hour.

The take-off and landing time to alert shall not exceed TBD seconds.

Once the take-off and departure has commenced, the probability of unscheduled interruption of navigation performance meeting the take-off and departure accuracy and integrity requirements above, shall not exceed TBD/hour.

3.2.2.6.4 Taxi

Taxi accuracy shall support a horizontal NSE of = TBD m.

Taxi integrity shall have a probability of NSE exceeding the AL of = TBD per hour.

The taxi time to alert shall not exceed TBD seconds.

Once the taxi/roll-out has commenced, the probability of unscheduled interruption of navigation performance meeting the taxi accuracy and integrity requirements above, shall not exceed TBD/hour.

The JPALS system shall have the capability to service converging, intersecting, and parallel runways and opposite end approaches.

3.2.2.7 Vulnerability to Disruption/Spoofing

Vulnerability to Disruption/Spoofing is the ability of the MGS to operate in an electromagnetic environment that includes both offensive and defensive electronic warfare (EW) as well as extensive collocated electromagnetic interference (EMI). The MGS has two electromagnetic signals of concern: the GPS satellite signal and the data link signal. The MGS will rely on the GPS encrypted signal to mitigate the spoofing of the GPS signal itself.

In military mode, the MGS shall use an information assurance technique on the data link to mitigate data spoofing. **Further definition of the military data link is beyond the scope of this specification.**

Mitigation of hostile electromagnetic disruption for both the data link and GPS signal is **outside the scope of this specification**.

Note: The military data link is intended to operate while precluding a hostile force's ability to identify the presence of a signal, classify the emitting platform, locate its source of origin, and decode operationally significant data in order to impose a threat.

3.2.2.8 Broadcast Data Requirements

The MGS shall accept and use keying data for P(Y) signal acquisition and tracking.

The MGS in Civil mode shall transmit a non-encrypted VDB in accordance with GBAS Standards and Recommended Practices (SARPs) in ICAO Annex 10 [28].

The MGS data link shall broadcast differential corrections and integrity monitoring data for usage by the MAS.

All message types and fields shall be in accordance with the field definitions, formats, and protocols of the JPALS SIS ICD [12].

All static parameters to be broadcast and default values shall be stored in the MGS Non-Volatile Memory (NVM).

NVM storage shall be a minimum of 90 days without power applied.

The MGS shall support L1 C/A, L1 P(Y) and L2 P(Y) ranging signals and corrections from GPS ranging sources. However the MGS will be capable of transmitting both at the same time.

3.2.2.8.1 MGS Message Block

The MGS shall transmit the MGS message block. The MGS message block consists of the Message Block Header, the Message, and the Cyclic Redundancy Check (CRC).

3.2.2.8.1.1 Message Block Header

3.2.2.8.1.1.1 Message Block Identifier

The MGS shall set the Message Block Identifier (MBI) field to 1010 1010 when in the Normal Mode and the Civil Sub Mode as defined in Section 3.1.2.3.1.

The MGS shall set the MBI field to 0101 0101 when in the Normal Mode and the Military Sub Mode as defined in Section 3.1.2.3.1.

The MGS shall set the MBI field to 1111 1111 when in the Test Mode.

3.2.2.8.1.1.2 Ground Station Identification

The Ground Station Identification Field shall denote the MGS station Identification (ID) stored in MGS NVM.

3.2.2.8.1.1.3 Message Type Identifier

The Message Type Identifier field shall denote the Message Type.

3.2.2.8.1.1.4 Message Length

The Message Length Field shall denote the number of 8-bit words in the message block. The message length includes the header, the message, and the CRC field.

3.2.2.8.1.2 Cyclic Redundancy Check

The CRC Field shall denote the CRC calculated on the message header and the message.

3.2.2.8.2 Type 1 Message—Differential Corrections

The MGS shall broadcast the Type 1 Message a minimum of once per frame from each VDB antenna.

The MGS shall broadcast the Type 1 Message a maximum of once per slot including transmissions from all VDB antennas.

If the Type 1 Message is broadcast in different slots within a frame, the modified Z-count shall not change, and the measurement block shall contain the same data.

The MGS shall generate a ranging source measurement block for all ranging sources when available within the reception mask.

The MGS shall accommodate up to 24 ranging sources, 12 each for L1 and L2.

3.2.2.8.2.1 Modified Z-Count

The Modified Z-count shall indicate the time of the pseudorange measurements (PR_r in Section 3.2.2.8.2.8.5.1) and phase measurement (f in Section 3.2.2.8.2.8.5.1) to within 0.05 seconds.

The broadcast corrections shall be broadcast within 0.5 seconds after the time indicated by the Modified Z-count corresponding to the broadcast corrections.

3.2.2.8.2.2 Additional Message Flag

The Additional Message Flag Field shall denote that additional messages are provided. This is necessary in order to have enough space in the messages for both L1 and L2 corrections simultaneously.

3.2.2.8.2.3 Number of Measurements

The Number of Measurements Field shall denote the number of ranging source measurement blocks broadcast in the Type 1 Message.

3.2.2.8.2.4 Measurement Type

The Measurement Type Field shall denote the measurement type from which the differential corrections have been computed. The possible options are L1 C/A, L1 P(Y), or L2 P(Y).

3.2.2.8.2.5 Ephemeris CRC

The Ephemeris CRC Field shall denote the CRC for the ranging source associated with the first ranging source measurement block in the Type 1 Message.

3.2.2.8.2.6 Source Availability Duration

The Source Availability Duration Field shall denote the period that the ranging source is predicted to remain within the reception mask associated with the first ranging source measurement block relative to the Modified Z-count.

The accuracy of the calculated Source Availability Duration shall be better than ± 10 seconds for all source availability duration less than the maximum range of the Source Availability Duration Field.

3.2.2.8.2.6.1 Reception Mask

The reception mask for each RR shall define the region in which the RR can provide sufficient data to the MGS such that measurement blocks can be calculated.

The reception mask shall include all elevations from 5º to 90º and all azimuths from 0º to 360º, excluding blockage of line-of-site due to any permanent obstacle.

3.2.2.8.2.6.2 Azimuth/Elevation Sector Masking

The MGS shall have the capability to exclude measurements from the pseudorange correction calculation within azimuth/elevation sector(s) on a per RR basis.

The resolution of the azimuth and elevation limits shall be 0.1 degrees.

The azimuth/elevation sector mask(s) shall be stored in the MGS NVM.

3.2.2.8.2.7 Ephemeris Decorrelation Parameter (P)

The Ephemeris Decorrelation Parameter field shall characterize the impact of residual ephemeris errors due to spatial decorrelation for the ranging source, associated with the first ranging source measurement block, in the Type 1 message.

For every valid GPS ranging source, the MGS shall broadcast a *P*-value to represent the impact of undetected ephemeris errors on user range error.

The maximum value for *P* shall be 1.5×10^{-4} m/m.

Note: May want to relax this requirement for different configurations. This value may require a long baseline for monitoring.

The MGS shall exclude any ranging source for which the *P*-value cannot be validated.

The broadcast ephemeris *P*-value for a given satellite shall account for the condition where the broadcast reference point (Section 3.2.2.8.3.9) does not match the reference receiver centroid location.

3.2.2.8.2.8 Ranging Source Measurement Block

The first ranging source in the message shall sequence so that the ephemeris decorrelation parameter, the ephemeris CRC, and source availability duration for each ranging source is transmitted at least once every 10 seconds from each VDB antenna, except when new ephemeris data are received from a ranging source.

When new ephemeris data are received from a ranging source, the MGS shall broadcast the new ephemeris data for that ranging source in three consecutive Type 1 Messages from each VDB antenna.

When new ephemeris data are received from more than one ranging source, the first ranging source in the Type 1 Message shall sequence so that the ephemeris decorrelation parameter, the ephemeris CRC, and source availability duration for each ranging source are transmitted at least once every 27 seconds from each VDB antenna.

3.2.2.8.2.8.1 Ranging Source Identification

The Ranging Source ID Field shall denote the satellite pseudorandom number assigned to the ranging source associated with the ranging source measurement block.

3.2.2.8.2.8.2 Ranging Signal Sources

The MGS shall be capable of processing:

a. GPS SPS signals, as defined in the SPS Performance Standard,

b. GPS PPS signals, as defined in the Navstar GPS Space Segment / Navigation User Interfaces, ICD-GPS-200D [9]

3.2.2.8.2.8.3 Conditions for Transmitting the Ranging Source Measurement Block

The MGS shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the associated ranging source failures.

3.2.2.8.2.8.3.1 Valid GPS Navigation Data

The MGS shall cease broadcast of the ranging source measurement block associated with a given ranging source if:

a. Three or more parity errors have been detected from multiple receivers in the previous 6 seconds, in accordance with the parity algorithm equations defined in Section 20.3.5, 20.3.5.1, and 20.3.5.2 of ICD-GPS-200D [9].

b. Broadcast Issue of Data (IOD) Ephemeris (IODE) does not match eight least-significant bits of broadcast IOD Clock (IODC),

c. Bit 18 of the Hand-over-Word (HOW) is set to 1 (Section 20.3.3.2 of ICD-GPS-200D [9],

d. All data bits are zeros in sub-frames 1, 2, or 3,

e. Default navigation data are being transmitted in sub-frames 1, 2, or 3 (Section 20.3.2 of ICD-GPS-200D [9] for C/A code on L1 only); P(Y) code on L1 and on L2 are ***TBD***,

f. The preamble does not equal 8B (hexadecimal),

g. At any time in the next 12 hours, any point on the orbit defined by the broadcast ephemeris is more than 7,000 m from the orbit defined by the broadcast almanac,

h. Reserved,

i. The ephemeris CRC changes and the IODE does not,

j. The Pseudo Random Number code (PRN) is 33, 34, 35, 36, or 37, or

k. The health bits in sub-frame 1, word 3 indicate that the satellite is unhealthy.

If a long-baseline integrity monitor is not implemented for erroneous ephemeris protection, a new ephemeris shall be compared to the previously broadcast ephemeris, if available, and is validated if the difference in satellite position is less than 250 m and none of the conditions in (a) through (k) exists.

Ephemerides shall be validated and applied within 3 minutes of receiving a new set, but not before they have been continuously present for 2 minutes.

3.2.2.8.2.8.3.2 Reserved

3.2.2.8.2.8.3.3 Invalid GPS Codes

3.2.2.8.2.8.3.3.1 Invalid GPS C/A Code

The MGS shall cease broadcast of the ranging source measurement block if non-standard C/A code (NSC) is transmitted for that satellite, as described in Section 3.2.1 of ICD-GPS-200D [9].

3.2.2.8.2.8.3.3.2 Invalid GPS P(Y) Codes

The MGS shall cease broadcast of the ranging source measurement block if non-standard P(Y) code is transmitted for that satellite.

3.2.2.8.2.8.4 Issue of Data

The IOD Field shall denote the IODE for GPS associated with the ephemeris data used to determine the broadcast correction.

3.2.2.8.2.8.5 Pseudorange Corrections

The Pseudorange Correction Field shall denote the broadcast pseudorange correction.

3.2.2.8.2.8.5.1 Smoothed Pseudorange

In steady state, each pseudorange measurement from each RR shall be smoothed using the filter:

$$PR_s(K) = \left(\frac{1}{N}\right) PR_r(k) + \left(\frac{N-1}{N}\right)\left[PR_s(k-1) + f(k) - f(k-1)\right]$$ **Equation 3-1**

$$N = S/T$$

Where:

PR_r	is the raw pseudorange (m),
PRs	is the smoothed pseudorange (m),
N	is the number of samples,
S	is the time filter constant[2], equal to 200 seconds for C/A code and 200 seconds for P(Y) code,
T	is the filter sample interval, nominally equal to 0.5 seconds and not to exceed 1 second,
ϕ	is the accumulated phase measurement (m),
k	is the current measurement, and
k-1	is the previous measurement.

Note: The requirement for T allows compensation for a momentary loss of signal to ensure continuity for valid ranging sources.

3.2.2.8.2.8.5.1.1 C/A Ranging Signals

For C/A ranging signals, raw pseudorange shall be determined under the following conditions:

a. The code loop is carrier driven and of first order, or higher, and has a one-sided noise bandwidth = 0.125 Hz.

b. The strongest correlation peak is acquired.

3.2.2.8.2.8.5.1.2 P(Y) Ranging Signals

For P(Y) ranging signals, raw pseudorange shall be determined under the following conditions:

a. The code loop is carrier driven and of first order, or higher, and has a one-sided noise bandwidth = 0.125 Hz.

b. The strongest correlation peak is acquired.

[2] Filter time constant values are to be validated as part of the ongoing availability studies.

3.2.2.8.2.8.5.2 GPS Predicted Range

The predicted range to each GPS ranging source shall be computed from the corresponding RR antenna phase center location and the validated ephemeris.

The satellite position shall be determined in accordance with Section 20.3.3.4.3 of ICD-GPS-200D [9].

3.2.2.8.2.8.5.3 Reserved

3.2.2.8.2.8.5.4 Global Positioning System Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for a GPS ranging source shall be calculated using the equation:

$$PR_{sc}(n,m) = R(n,m) - PR_s(n,m) - t_{sv\_gps}(n)$$ **Equation 3-2**

Where:

R	is the predicted range
n	is the satellite index
m	is the RR index
t_{sv_gps}(n)	is the correction due to the satellite clock from the decoded GPS Navigation Data in accordance with the algorithms given in Section 20.3.3.3.3.1 of ICD-GPS-200D [9].

Ionospheric and tropospheric corrections shall not be applied to the smoothed pseudorange correction.

3.2.2.8.2.8.5.5 Reserved

3.2.2.8.2.8.5.6 Broadcast Correction

The broadcast correction shall be calculated using the equations:

$$PR_{corr}(n) \equiv \frac{1}{M(n)} \sum_{m \in S_n} PR_{sca}(n,m)$$ **and** **Equation 3-3**

$$PR_{sca}(n,m) \equiv PR_{sc}(n,m) - \frac{1}{N_c}\sum_{n \in s_c} PR_{sc}(n,m). \qquad \textbf{Equation 3-4}$$

Where:

PR_{corr} is the broadcast correction;

$M(n)$ is the number of elements in set S_n;

PR_{sca} is the carrier smoothed and receiver clock adjusted pseudorange correction;

n is the satellite index;

S_n is the set of RRs with valid measurements for satellite n;

m is the RR index;

S_c is the set of valid ranging sources tracked by all RRs; and

N_c is the number of elements in set S_c;

Given the following conditions:

a. If N_c is less than four, a constellation alert shall be generated in accordance with 3.1.5.1.4.

b. If N_c is predicted to be greater than four and more than two or more ranging sources are determined to be faulted by the MGS, resulting in N_c less than four, an alarm shall be generated in accordance with 3.1.5.1.5.

c. Each RR measurement (*n*,*m*) used to determine the broadcast corrections shall be updated at no less than a 2 Hz rate.

3.2.2.8.2.8.5.6.1 Conditions for Broadcast Corrections

The MGS shall cease broadcast of the ranging source measurement block if the magnitude of the pseudorange correction exceeds a threshold.

The default value of this threshold shall be field selectable via the MDT.

The MGS shall cease broadcast of the ranging source measurement block unless the pseudorange correction is computed using identical valid navigation data decoded from the reference receivers.

3.2.2.8.2.8.6 Range Rate Correction (RRC)

The Range Rate Correction Field shall indicate the rate of change of the pseudorange correction, defined to be RRC_{corr}, based on the difference between the current and immediately prior broadcast corrections, but replacing S_c (and related terms) using the set of valid ranging sources tracked by all RRs for both epochs.

3.2.2.8.2.8.6.1 Condition for Valid RRC

3.2.2.8.2.8.6.1.1 Performance Type 1 Valid Pseudorange Correction Rate

The MGS shall cease broadcast of the ranging source measurement block if the RRC exceeds +/- 3.4 meters per second.

3.2.2.8.2.8.6.1.2 Performance Type 2 Valid Pseudorange Correction Rate

The MGS shall cease broadcast of the ranging source measurement block if the RRC exceeds +/- ***TBD*** meters per second.

3.2.2.8.2.8.7 Sigma Pseudorange Ground

The broadcast s_{pr_mgs} for each ranging source shall account for all equipment and environmental effects, including the received signal power, the local interference environment, and any transient error in smoothing filter output, relative to steady-state, caused by ionospheric divergence. The code-carrier divergence rate can be assumed to be represented by a Normal distribution with zero mean and a standard deviation of 0.018 m/s.

3.2.2.8.2.8.7.1 GPS Sigma Pseudorange Accuracy

3.2.2.8.2.8.7.1.1 GPS Sigma Pseudorange Accuracy for C/A Code in a Standard Interference Environment

In the standard interference environment (no jamming) defined in appendix D of the LAAS MOPS (RTCA/DO-253A) [24] the accuracy of the MGS shall be such that the broadcast σ_{pr_mgs} satisfies the following inequality:

$$s_{pr\_mgs}(q_n) \leq \left(\sqrt{\frac{\left(a_0 + a_1 e^{-q_n/q_0}\right)^2 + (a_2)^2}{M}} \right) \qquad \textbf{Equation 3-5}$$

Where θn is the nth ranging source elevation angle, a_0, a_1, a_2, and θ_0 are the coefficients for the applicable Accuracy Designator defined in Table 3-3.

Table 3-3: GPS Accuracy Designator C in Standard Interference Environment

Accuracy Designator C	a_0 meters	a_1 meters	a_2 meters	q_0 degrees
$?_n = 35^o$	0.15	0.84	0.04	15.5
$?_n < 35^o$	0.24	0	0.04	-

The accuracy requirement shall be met for a satellite at any azimuth or elevation in the reception mask.

The accuracy requirement shall be met for RR Antenna phase center heights that are determined by site specific designs.

The accuracy requirement shall be met at the reference receiver centroid.

In cases of antenna designs with multiple phase centers, the highest phase-center shall be used.

Note for this draft: This requirement is subject to validation. Preliminary indications are that AJ antennae will be able to meet the Ground Accuracy Designator (GAD) C curve specified here, at least for P(Y) code and possibly for C/A code. As AJ antenna accuracy data becomes available, a new GAD curve may be added to take advantage of the characteristics of that technology.

3.2.2.8.2.8.7.1.2 GPS Sigma Pseudorange Accuracy for C/A Under Jamming

TBD - not yet able to specify the GPS C/A pseudorange accuracy under jamming. The accuracy will be specified in terms of both elevation angle and jamming to signal ratio (J/S) received at the antenna.

3.2.2.8.2.8.7.1.3 GPS Sigma Pseudorange Accuracy for L1 P(Y) in a Standard Interference Environment

TBD - not yet able to specify the GPS L1 P(Y) pseudorange accuracy.

3.2.2.8.2.8.7.1.4 GPS Sigma Pseudorange Accuracy for L1 P(Y) Under Jamming

TBD - not yet able to specify the GPS L1 P(Y) pseudorange accuracy under jamming. The accuracy will be specified in terms of both elevation angle and J/S received at the antenna.

3.2.2.8.2.8.7.1.5 GPS Sigma Pseudorange Accuracy for L2 P(Y) in a Standard Interference

TBD - not yet able to specify the GPS L2 P(Y) pseudorange accuracy.

3.2.2.8.2.8.7.1.6 GPS Sigma Pseudorange Accuracy for L2 P(Y) Under Jamming

TBD - not yet able to specify the GPS L2 P(Y) pseudorange accuracy under jamming. The accuracy will be specified in terms of both elevation angle and the J/S received at the antenna

3.2.2.8.2.8.7.2 Reserved

3.2.2.8.2.8.7.3 Condition for Valid Sigma Pseudorange Ground

The MGS shall detect conditions relating to the broadcast Sigma Pseudorange Ground that result in noncompliance with the results in Sections 3.2.2.1.2.1 and 3.2.2.1.2.2.

When the increase in system risk associated with degraded performance is minimal (is no greater than one order of magnitude), but exceeds design tolerances, the MGS shall initiate a service alert.

The threshold shall be adjustable, with a default value set to achieve a nominal false alert rate of $1x\ 10^{-7}$ per 15-second interval.

When the increase in system risk is not minimal, the MGS shall exclude the offending RR or generate an alarm, as appropriate.

The alarm threshold shall be adjustable.

A service alert shall be issued when a RR is excluded except when a single RR remains.

If a single RR remains when an RR is excluded, an alarm shall be issued.

Self-recovery shall not be applied in either case.

Automatic restart shall not be attempted when an alarm condition exists when system risk is not minimal.

3.2.2.8.2.8.8 B-Values

The B-Value Field shall denote the B-value calculated using the equation:

$$B_{PR}(n,m) \equiv PR_{coor}(n) - \frac{1}{M(n)-1} \sum_{\substack{i \in S_n \\ i \neq m}} PR_{sca}(n,i)$$ **Equation 3-6**

Where $B_{PR}(n,m)$ is the estimate of the error contribution to the average correction from RR m.

3.2.2.8.2.8.8.1 Conditions for Broadcast

The MGS shall indicate the reference receiver measurement is invalid in the B_{PR} field for any measurement who's B_{PR}(n,m) exceeds:

$$\frac{K_{B\_PR}\, s_{pr\_mgs}(q_n)}{\sqrt{M(n)-1}}$$ **Equation 3-7**

for GPS ranging sources.

Where K_{B_PR} is the PR B-value threshold, K_{B_PR} shall:

a. Be configurable, and

b. Have a minimum configurable value of 5 and a maximum configurable value of 6.

3.2.2.8.3 Type 2 Message—Differential Reference Point

The MGS shall broadcast the Type 2 Message at least once every 20 consecutive frames from each VDB antenna.

The MGS shall broadcast the Type 2 Message a maximum of once per frame including transmissions from all VDB antennas.

3.2.2.8.3.1 Ground Station Installed Receivers

The Ground Station Installed Receivers Field shall denote the number of installed reference receivers stored in MGS NVM.

3.2.2.8.3.2 Ground Station Accuracy Designator

The Ground Station Accuracy Designator Field shall denote the accuracy designator stored in MGS NVM.

3.2.2.8.3.3 Continuity and Integrity Designator

The MGS Ground Continuity and Integrity Designator (GCID) Field shall denote the MGS GCID.

The MGS GCID value shall be 1 when no alarm and the MGS meets the integrity and continuity requirements for SL 7.

The MGS GCID value shall be 2 when no alarm and the MGS meets the integrity and continuity requirements for SL 8.

The MGS GCID value shall be seven (7) when an alarm exists.

3.2.2.8.3.4 Local Magnetic Variation

The Local Magnetic Variation Field shall denote the local magnetic variation stored in MGS NVM.

3.2.2.8.3.5 Sigma Ionosphere

The Sigma Vertical Ionosphere Gradient Field shall denote the value stored in MGS NVM.

3.2.2.8.3.5.1 Condition for Valid Sigma Ionosphere

The MGS shall detect Ionospheric conditions that result in noncompliance with the requirements in Sections 3.2.2.1.2.1 and 3.2.2.1.2.2.

When the increase in system risk associated with increased ionosphere gradients exceeds design tolerances, the MGS shall exclude the offending ranging source(s) and generate alerts as appropriate.

When ionospheric disturbances cannot be isolated to specific ranging sources, and system risk is not minimal (increases by more than one order of magnitude) as a result, the MGS shall generate an alarm.

Self-recovery shall be accomplished after ranging source exclusions or alarms are generated once the integrity requirements in Sections 3.2.2.1.2.1 and 3.2.2.1.2.2 are again met.

Note: The sigma ionosphere vertical gradient term must be valid for all users within D_{max} *from the MGS reference point.*

3.2.2.8.3.6 Refractivity Index

The Refractivity Index Field shall denote the refractivity index stored in MGS NVM.

3.2.2.8.3.7 Scale Height

The Scale Height Field shall denote the scale height stored in MGS NVM.

3.2.2.8.3.8 Refractivity Uncertainty

The Refractivity Uncertainty Field shall denote the refractivity uncertainty stored in MGS NVM.

3.2.2.8.3.9 Reference Point

3.2.2.8.3.9.1 Latitude

The Latitude Field shall denote the MGS reference point latitude stored in MGS NVM.

3.2.2.8.3.9.2 Longitude

The Longitude Field shall denote the MGS reference point longitude stored in MGS NVM.

3.2.2.8.3.9.3 Reference Point Height

The Reference Point Height Field shall denote the MGS reference point height above the WGS-84 ellipsoid stored in MGS NVM.

3.2.2.8.3.10 Reference Station Data Selector (RSDS)

The Reference Station Data Selector field shall denote the MGS RSDS stored in MGS NVM.

3.2.2.8.3.11 Maximum Use Distance (D_{max})

The Maximum Use Distance field shall denote the MGS Maximum Use Distance stored in MGS NVM for any user that complies with RTCA/DO-253A [24].

3.2.2.8.3.12 Ephemeris Fault-Free Missed Detection Parameters

3.2.2.8.3.12.1 $K_{md\_e\_POS, GPS}$

The $K_{md\_e\_POS, GPS}$ field shall denote the ephemeris fault-free missed detection parameter for the GPS Differential Positioning Service stored in MGS NVM.

3.2.2.8.3.12.2 $K_{md\_e\_CAT\ I,GPS}$

The $K_{md\_e\_CAT\ I, GPS}$ field shall denote the ephemeris fault-free missed detection parameter for the GPS Category I Precision Approach stored in MGS NVM.

3.2.2.8.3.12.3 $K_{md\_e\_POS, GLONASS}$

The $K_{md\_e\_POS, GLONASS}$ field shall denote that this parameter is not used.

3.2.2.8.3.12.4 $K_{md\_e\_CAT\ I, GLONASS}$

The $K_{md\_e\_CAT\ I, GLONASS}$ field shall denote that this parameter is not used.

3.2.2.8.4 Type 4 Message - Final Approach Segment Data

The MGS shall broadcast each FAS data block at least once every 20 consecutive frames from each VDB antenna.

The MGS shall broadcast each FAS data block a maximum of once per frame including transmissions from all VDB antennas.

3.2.2.8.4.1 Data Set Length

The Data Set Length Field shall denote the Type 4 Message data set length, which indicates the number of bytes in the data set.

3.2.2.8.4.2 Final Approach Segment Data Block

The Type 4 Message shall contain the FAS data block for each runway approach served by the MGS. The following subsections define the required content of the data block. This block and its corresponding approach performance designator are broadcast depending on the runway end(s) selected.

3.2.2.8.4.2.1 Operation Type

The Operation Type Field shall denote the operation type stored in MGS NVM.

3.2.2.8.4.2.2 Reserved

3.2.2.8.4.2.3 Airport Identification

The Airport Identification Field shall denote the airport identification stored in MGS NVM.

3.2.2.8.4.2.4 Runway Number

The Runway Number Field shall denote the runway number stored in MGS NVM.

3.2.2.8.4.2.5 Runway Letter

The Runway Letter Field shall denote the runway letter stored in MGS NVM.

3.2.2.8.4.2.6 Approach Performance Designator

The Approach Performance Designator Field shall denote the approach Performance Type stored in MGS NVM.

3.2.2.8.4.2.7 Route Indicator

The Route Indicator Field shall denote the route indicator stored in the MGS.

3.2.2.8.4.2.8 Reference Path Data Selector

The Reference Path Data Selector Field shall denote the reference path data selector stored in MGS NVM.

3.2.2.8.4.2.9 Reference Path Identifier

The Reference Path Identifier Field shall denote the reference path identifier stored in MGS NVM.

3.2.2.8.4.2.10 LTP / FTP Latitude

The Landing Threshold Point / Fictitious Threshold Point (LTP/FTP) Latitude Field shall denote the LTP/FTP latitude stored in MGS NVM.

3.2.2.8.4.2.11 LTP / FTP Longitude

The LTP/FTP Longitude Field shall denote the LTP/FTP longitude stored in MGS NVM.

3.2.2.8.4.2.12 LTP / FTP Height

The LTP/FTP Height Field shall denote the LTP/FTP height stored in MGS NVM.

3.2.2.8.4.2.13 Delta FPAP Latitude

The Delta Flight Path Alignment Point (Δ FPAP) Latitude Field shall denote the Δ FPAP latitude stored in MGS NVM.

3.2.2.8.4.2.14 Delta FPAP Longitude

The Δ FPAP Longitude Field shall denote the Δ FPAP longitude stored in MGS NVM.

3.2.2.8.4.2.15 Approach Threshold Crossing Height

The Approach Threshold Crossing Height (TCH) Field shall denote the TCH stored in MGS NVM.

3.2.2.8.4.2.16 Approach TCH Units Selector

The TCH Units Selector Field shall denote the TCH Unit Selector stored in MGS NVM.

3.2.2.8.4.2.17 Glidepath Angle

The Glidepath Angle (GPA) Field shall denote the GPA stored in MGS NVM.

3.2.2.8.4.2.18 Course Width

The Course Width Field shall denote the course width stored in MGS NVM.

3.2.2.8.4.2.19 Delta Length Offset

The Δ Length Offset Field shall denote the Δ length offset stored in MGS NVM.

3.2.2.8.4.2.20 FAS Cyclic Redundancy Check

The FAS CRC Field shall denote the FAS CRC stored in MGS NVM.

3.2.2.8.4.3 FAS VAL / Approach Status

The FAS Vertical Alarm Limit (VAL)/Approach Status Field shall denote the FAS VAL stored in the MGS NVM, or “Do Not Use Vertical” when selected in accordance with Sections 3.2.2.11.3 or 3.2.2.11.2.15.

3.2.2.8.4.4 FAS LAL / Approach Status

The FAS Lateral Alarm Limit (LAL)/Approach Status Field shall denote the FAS LAL stored in the MGS NVM, or “Do Not Use Approach” when selected in accordance with Sections 3.2.2.11.2.15.

3.2.2.8.5 Type 5 Message—Ranging Source Availability

Message Type 5 shall be broadcast in accordance with the JPALS SIS ICD [12].

3.2.2.8.6 Type 6 Message—Differential Carrier Phase Corrections

In the Military Modes, the MGS shall broadcast differential carrier correction data as specified in the JPALS SIS ICD [12].

Note: This data may be used to support a kinematic (carrier phase tracking and ambiguity resolution) calculation in Navy-unique and North Atlantic Treaty Organization (NATO) airborne equipment. Does this message need to be included? There is no performance specification at present.

3.2.2.8.7 Type 7 Message—Landing System Alignment Data

The MGS shall support the alignment of the JPALS approach with other certified military approach systems installed at the same runway (e.g., ILS, MLS, and carrier landing systems).

The alignment data shall include Cartesian offsets of the azimuth and elevation transmitters, the course width used, and origin.

Message Type 7 shall be broadcast in accordance with the JPALS SIS ICD [12].

3.2.2.8.8 Radio Frequency Transmission Characteristics

The MGS shall meet the requirements of the JPALS SIS ICD [12] with respect to radio frequency transmission characteristics.

The data link function contained within the MGS shall be flexible and allow for future growth for use of alternative physical data links beyond the VDB RF transmission characteristics defined in the JPALS SIS ICD [12].

3.2.2.8.8.1 Symbol Rate

The symbol rate of the MGS data broadcast shall be 10,500 ±0.005% symbols per second. Each symbol defines one of eight states (3 bits) resulting in a nominal bit rate of 31,500 bits per second.

3.2.2.8.8.2 Emission Designator

The emission designator of this modulation technique is 14K0G7DET.

3.2.2.8.8.3 Signal Polarization

The MGS shall broadcast an elliptically polarized (EPOL) signal.

3.2.2.8.8.4 Field Strength

3.2.2.8.8.4.1 Horizontal Field Strength

The minimum field strength shall not be less than 215 µV/m (-99 dBW/m2) for the horizontally polarized signal.

The maximum field strength shall not be greater than 350 mV/m (-35 dBW/ m2) for a horizontally polarized signal.

3.2.2.8.8.4.2 Vertical Field Strength

The minimum field strength shall not be less than 136 µV/m (-103 dBW/ m2) for the vertically polarized signal.

The maximum field strength shall not be greater than 221 mV/m (-39 dBW/ m2) for the vertically polarized signal.

3.2.2.8.8.5 Spectral Characteristics

3.2.2.8.8.5.1 Carrier Frequencies

The VDB shall use radio frequencies in the band 108 – 117.975 MHz.

The lowest selectable channel shall be 108.025 MHz.

The highest selectable channel shall be 117.950 MHz.

The separation between selectable frequencies shall be 25 kHz.

3.2.2.8.8.5.2 Unwanted Emissions

Unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3-4.

The total power in any VDB harmonic or discrete signal shall be no greater than -53 dBm.

Table 3-4: Unwanted Emissions Levels

Frequency	Relative Unwanted Emission Level [2]	Maximum Unwanted Emission Level [1]
9 kHz to 150 kHz	-93 dBc [3]	-55 dBm/1kHz [3]
150 kHz to 30 MHz	-103 dBc [3]	-55 dBm/10 kHz
30 MHz to 106.125 MHz	-115 dBc	-57 dBm/100 kHz
106.425 MHz	-113 dBc	-55 dBm/100 kHz
107.225 MHz	-105 dBc	-47 dBm/100 kHz
107.625 MHz	-101.5 dBc	-53.5 dBm/10 kHz
107.825 MHz	-88.5 dBc	-40.5 dBm/10 kHz
107.925 MHz	-74 dBc	-36 dBm/1 kHz
107.9625 MHz	-71 dBc	-33 dBm/1 kHz
107.975 MHz	-65 dBc	-27 dBm/1 kHz
118.000 MHz	-65 dBc	-27 dBm/1 kHz
118.0125 MHz	-71 dBc	-33 dBm/1kHz
118.050 MHz	-74 dBc	-36 dBm/1 kHz
118.150 MHz	-88.5 dBc	-40.5 dBm/10 kHz
118.350 MHz	-101.5 dBc	-53.5 dBm/10 kHz
118.750 MHz	-105 dBc	-47 dBm/100 kHz
119.550 MHz	-113 dBc	-55 dBm/100 kHz
119.850 MHz to 1 GHz	-115 dBc	-57 dBm/100 kHz
1 GHz to 1.7 GHz	-115 dBc	-47 dBm/1MHz

Note 1: The maximum unwanted emission level (absolute power) applies if the authorized transmitter power exceeds 150 W.

Note 2: The relative unwanted emission level is to be computed using the same bandwidth or desired and unwanted signals. This may require conversion of the measurement for unwanted signals done using the bandwidth indicated in the maximum unwanted emission level column of Table 3-4.

Note 3: These values include measurement limitations. Actual performance is expected to be better.

Note 4: The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-5.

3.2.2.8.8.6 Adjacent Channel Emissions

The amount of power during transmission, under all operating conditions, when measured over a 25 kHz bandwidth centered on any adjacent channel, shall not exceed the values given in Table 3-5.

Table 3-5: Adjacent Channel Emissions

Channel	Relative Power	Maximum Power
1st Adjacent	-40 dBc	12 dBm
2nd Adjacent	-65 dBc	-13 dBm
4thAdjacent	-74 dBc	-22 dBm
8th Adjacent	-88.5 dBc	-36.5 dBm
16th Adjacent	-101.5 dBc	-49.5 dBm
32nd Adjacent	-105 dBc	-53 dBm
64th Adjacent	-113 dBc	-61 dBm
76th Adjacent and beyond	-115 dBc	-63 dBm

Note 1: The maximum power applies if the authorized transmitter power exceeds 150 W.

Note 2: The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-5.

3.2.2.8.8.6.1 Adjacent Temporal Interference

Under all operating conditions, the maximum power over a 25 kHz bandwidth, centered on the assigned frequency, when measured over any unassigned time slot, shall not exceed -105 dBc referenced to the authorized transmitter power.

3.2.2.8.8.6.2 Frequency Stability

The long-term stability of the transmitter carrier frequency shall be ±0.0002%.

3.2.2.8.8.7 Modulation

Binary data shall be assembled into symbols, each consisting of three consecutive bits.

The end of the data shall be padded by up to two fill bits if necessary to form the last 3-bit symbol of the burst.

Symbols shall be converted to differentially encoded 8-phase shift keyed (D8PSK) carrier phase shifts (? f_k) as shown in Table 3-6.

The carrier phase for details regarding modulation the k^{th} symbol (f_k) is given by:

$$f_k = f_{k-1} + \Delta f_k$$ **Equation 3-8**

The transmitted signal shall be:

$$H(e^{j(2pft+f(t))})$$ **Equation 3-9**

Where H(•) is a raised cosine filter with a = 0.6 as defined in Section 3.2.2.8.8.7.1.

Table 3-6: Data Encoding

Message Bits (note)			**Symbol Phase Shift**
I3k-2	**I3k-1**	**I3k**	**?f k**
0	0	0	0
0	0	1	1p/4
0	1	1	2 p /4
0	1	0	3 p /4
1	1	0	4 p /4
1	1	1	5 p /4
1	0	1	6 p /4
1	0	0	7 p /4

Note: I_j is the j^{th} bit of the burst to be transmitted, where I_1 is the first bit of the training sequence. The values of ?f $_k$ represent counter clockwise rotations in the complex I-Q plane of Figure 2-1 of RTCA/DO-246B [23].

3.2.2.8.8.7.1 Pulse Shaping Filters

The output of differential phase encoder shall be filtered by a pulse shaping filter whose output, s(t), is:

$$s(t) = \sum_{k=-\infty}^{k=\infty} e^{jf_k}\, h(t - kT) \qquad \textbf{Equation 3-10}$$

Where:

h = the impulse response of the raised cosine filter,

t = time,

T = duration of each symbol (T=1/10500 second, approximately 95.2 µsec), and

F_k = as defined in Section 3.2.2.8.8.7

This pulse shaping filter shall have a nominal complex frequency response of a raised-cosine filter with a = 0.6.

The frequency response, *H(f)*, and the time response, *h(t)*, of the base band filters shall be in accordance with:

$$H(F)=\begin{cases} 1 & 0 < f < \dfrac{1-a}{2T} \\ \dfrac{1-\sin\left(\dfrac{p}{2a}(2fT-1)\right)}{2}, & \dfrac{1-a}{2T} \le f \le \dfrac{1+a}{2T} \\ 0 & f > \dfrac{1+a}{2T} \end{cases}$$ **Equation 3-11**

$$h(t)=\frac{\sin\left(\dfrac{pt}{T}\right)\cos\left(\dfrac{pat}{T}\right)}{\dfrac{pt}{T}\left[1-\left(\dfrac{2at}{T}\right)^2\right]}$$ **Equation 3-12**

Where:

f	is the absolute value of the frequency offset from the channel center,
T	is the symbol period of 1/10500 seconds (approximately 95.2 µsec),
t	is time, and
a	is 0.6.

3.2.2.8.8.7.2 Error Vector Magnitude

The error vector magnitude of the transmitted signal shall be less than 6.5% root-mean-squared (RMS).

3.2.2.8.8.8 Data Burst Content

Burst Data Content shall comply with Section 2.3 of RTCA/DO-246B [23].

3.2.2.8.8.9 Broadcast Timing Structure Division Multiple Access

The broadcast timing structure shall comply with Section 2.2 of RTCA/DO-246B [23].

The MGS shall be capable of transmitting in any two of eight time slots within each frame from each VDB antenna.

In every frame, the MGS shall broadcast a message in every slot designated in MGS NVM.

3.2.2.8.9 Broadcast Monitoring

The data broadcast transmissions from each VDB antenna shall be monitored.

The transmission of the data from a single VDB antenna shall cease within 0.5 seconds when any of the following conditions exist:

a. Continuous disagreement for any 3 second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission,

b. A transmitted power reduction of more than 3 dB from the on-channel assigned power for 3 seconds,

c. A transmitted power increase of more than 3 dB from the on-channel assigned power for 1 second. The probability that the transmitted power is increased more than 3 dB for 1 second shall be less than 2.0 x 10-7 in any 30-second period,

d. More than 0.2% of messages in the last hour are not transmitted,

e. No transmission for 3 seconds, or

f. Any transmitted data outside of the assigned TDMA time slots for 1 second in excess of the limit defined in 3.2.2.6.1. The risk that the MGS transmits a signal in an unassigned slot and fails to detect an out-of-slot transmission, within 1 second, shall be less than 1.0 x 10^{-7} in any 30-second period.

Conditions (a) through (f) include the time to switch to redundant equipment, if available.

3.2.2.8.10 MGS Reference Receiver Characteristics

The MGS RR's shall be capable of receiving L1 C/A, L1 P(Y) and L2 P(Y) GPS signals.

The MGS RR's may optionally be capable of receiving SBAS signals.

The MGS RR's shall meet all the requirements of MIL-PRF-GB-GRAM-300A [13].

The RR's shall meet all the requirements of SS-GPS-001A [27].

3.2.2.8.11 GPS Antenna Subsystem

The RR antenna shall have at least 0 dBi gain at 5º elevation and no more than –10 dBi gain at 0.5º elevation.

The antenna gain shall monotonically decrease from 5º elevation to 0º elevation at a rate of not less than 2dB per degree.

3.2.2.8.11.1 Beamforming and Nulling

The antenna shall be a Controllable Reception Pattern Antenna (CRPA).

The antenna shall be capable of being used for both beam forming and nulling.

3.2.2.8.11.1.1 Antijam Performance

TBD *as part of the antijam testing tasks.*

3.2.2.8.11.1.2 Multipath Mitigation Performance

TBD *as part of multipath mitigation tasks. May be sufficient to specify GAD-C?*

3.2.2.9 Executive Monitoring

3.2.2.9.1 Fault Monitoring

3.2.2.9.1.1 Ranging Source Faults

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of signal deformation per 3.2.2.1.2.1.1 (a) or 3.2.2.1.2.1.2 (a).

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of low signal power per 3.2.2.1.2.1.1 (b) or 3.2.2.1.2.1.2 (b).

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of code/carrier divergence per Section 3.2.2.1.2.1.1 (c) or 3.2.2.1.2.1.2 (c).

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of excessive acceleration per Section 3.2.2.1.2.1.1 (d) or 3.2.2.1.2.1.2 (d).

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of erroneous ephemeris per Section 3.2.2.1.2.1.1 (e) or 3.2.2.1.2.1.2 (e).

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of invalid GPS C/A code per Section 3.2.2.8.2.8.3.3.1.

The MGS shall exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc) upon detection of invalid GPS P(Y) code per Section 3.2.2.8.2.8.3.3.2.

3.2.2.9.1.2 Correction Faults

The MGS shall exclude PR_{mn}[1] from pseudorange corrections (PRC) and B-value calculation upon detection of filters not being converged per Section 3.2.2.8.2.8.7.

The MGS shall exclude ranging source from Type 1 Message broadcast upon detection of filters not being converged per Section 3.2.2.8.2.8.7.

The MGS shall exclude PR_{mn} from PRC and B-value calculation upon detecting that a B-value exceeds limit per Section 3.2.2.8.2.8.8.1.

The MGS shall exclude ranging source from Type 1 Message broadcast upon detection of pseudorange correction exceeding its limit per Section 3.2.2.8.2.8.5.6.1.

The MGS shall exclude ranging source from Type 1 Message broadcast upon detecting that navigation data is inconsistent between RRs per Section 3.2.2.8.2.8.5.6.1.

The MGS shall exclude ranging source from Type 1 Message broadcast upon detecting that the range rate correction (RRC) exceeds limit per Section 3.2.2.8.2.8.6.1.

The MGS shall exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation upon detecting faulted σ_{pr_mgs} per Section 3.2.2.8.2.8.7.3.

The MGS shall exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation upon detecting Faulted $\sigma_{vert\_iono\_gradient}$ per Section 3.2.2.8.3.5.1.

3.2.2.9.1.3 RFI Faults

The MGS shall exclude the affected measurements from calculations and/or Type 1 Message Broadcast as appropriate upon detecting excessive RFI per Section 3.2.2.1.2.4.

3.2.2.9.1.4 Data Broadcast Faults

The MGS shall terminate VDB output upon detecting disagreement between transmitted data per Section 3.2.2.8.9 (a).

The MGS shall terminate VDB output upon detecting power in excess of on-channel assigned limits per Section 3.2.2.8.9 (b) and (c).

The MGS shall terminate VDB output upon detecting 0.2% of messages not transmitted in last hour per Section 3.2.2.8.9 (d).

The MGS shall terminate VDB output upon no transmission for 3 consecutive seconds per Section 3.2.2.8.9 (e).

The MGS shall terminate VDB output upon detecting transmitted data outside of assigned Time Division Multiple Access (TDMA) time slots per Section 3.2.2.8.9 (f).

3.2.2.9.1.5 Fault Monitoring Summary

Requirements for fault monitoring are stated in the above subsections, and are summarized in Table 3-7 and Table 3-8 for ease of use. Additional performance checks and system monitors may be required to meet the integrity requirements.

Table 3-7: Fault Conditions and Actions Summary

Ranging Source		
Section	**Fault**	**Action**
3.2.2.1.2.1.1 (a) / 3.2.2.1.2.1.2 (a)	Signal Deformation	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.1.2.1.1 (b) / 3.2.2.1.2.1.2 (b)	Low Signal Power	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.1.2.1.1 (c) / 3.2.2.1.2.1.2 (c)	Code/Carrier Divergence	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.1.2.1.1 (d) / 3.2.2.1.2.1.2 (d)	Excessive Acceleration	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.1.2.1.1 (e) / 3.2.2.1.2.1.2 (e)	Erroneous Ephemeris	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.8.2.8.3.3.1	Invalid GPS C/A Code	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
3.2.2.8.2.8.3.3.2	Invalid GPS P(Y) Code	Exclude Ranging Source Measurement Block from Type 1 Message Broadcast and the clock correction (Sc).
Correction Faults		
Section	**Fault**	**Action**
3.2.2.8.2.8.7	Filters not converged	Exclude PR_{mn}[1] from PRC and B-value calculation. exclude ranging source from Type 1 Message broadcast.
3.2.2.8.2.8.8.1	B-value exceeds limit	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.2.8.2.8.5.6.1	Pseudorange correction exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.2.8.2.8.5.6.1	Navigation data inconsistent between RRs	Exclude ranging source from Type 1 Message broadcast.
3.2.2.8.2.8.6.1	Range Rate Correction (RRC) exceeds limit	Exclude ranging source from Type 1 Message broadcast
3.2.2.8.2.8.7.3	Faulted σ_{pr_mgs}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.2.8.3.5.1	Faulted $\sigma_{vert\_iono\_gradient}$	Exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
RFI Faults		
Section	**Fault**	**Action**
3.2.2.1.2.4	Excessive RFI	Exclude affected measurements from calculations and/or Type 1 Message Broadcast as appropriate
Data Broadcast Faults		
Section	**Fault**	**Action**
3.2.2.8.9 (a)	Disagreement between transmitted data	Terminate VDB output.

3.2.2.8.9 (b) (c)	On-channel assigned power exceeds limits	Terminate VDB output.
3.2.2.8.9 (d)	0.2% of messages not transmitted in last hour	Terminate VDB output.
3.2.2.8.9 (e)	No transmission for 3 seconds	Terminate VDB output.
3.2.2.8.9 (f)	Transmitted data outside of assigned Time Division Multiple Access (TDMA) time slots	Terminate VDB output.

[1] Pseudorange (PR), where *m* indicates an individual RR and *n* indicates an individual ranging source.

Table 3-8: Valid GPS Navigation Data

Section	Fault	Action
3.2.2.8.2.8.3.1 (a)	Failed parity	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (b)	Bad IODC	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (c)	HOW bit 18 set to “1”	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (d)	Data bits in subframes 1, 2, or 3 set to “0”	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (e)	Subframes 1, 2, or 3 set to default	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (f)	Preamble incorrect	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (g)	Almanac differs from ephemeris by more than 7000 m at any point	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (h)	Reserved	Reserved
3.2.2.8.2.8.3.1 (i)	Ephemeris CRC changes and IODE does not	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (j)	GPS PRN = 33 - 37	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1 (k)	Satellite declared unhealthy	Exclude GPS ranging source from Type 1 Message broadcast
3.2.2.8.2.8.3.1	Ephemeris not consistent to within 250 m	Exclude GPS ranging source from Type 1 Message broadcast

3.2.2.9.1.6 Fault Recovery

Upon exclusion of a single measurement, ranging source, or RR the MGS will continue to monitor the excluded single measurement, ranging source, or RR.

For ranging source faults and correction faults in Table 3-7, the MGS shall re-introduce the excluded single measurement, ranging source, or RR when the fault no longer exists.

The MGS shall use a probability of missed detection consistent with an apriori failure probability of one for excluded single measurement on a ranging source to meet MGS integrity risks in Section 3.2.2.1.2.

3.2.2.9.1.7 Generation of Alerts

The MGS shall generate an alert upon detecting a fault that does not affect the ability of the system to meet the integrity requirements of Section 3.2.2.1.2.

Faults shall include the ranging source and correction faults identified in Table 3-7, navigation data in Table 3-8, and environmental conditions specified in Sections 3.2.2.10.1 and 3.2.2.10.3.

Alert thresholds shall be defined during the design process.

3.2.2.9.1.8 Generation of Service Alerts

A service alert is defined as a fault that could affect MGS service and requires corrective maintenance. Service alert thresholds shall be defined during the design process.

3.2.2.9.1.8.1 Continuity Faults

A service alert shall be generated when the MGS is unable to ensure that the continuity requirements of 3.2.2.1.3 can be met due to a fault in any of the following items:

a. Main and standby Line Replaceable Units (LRUs), and/or

b. Uninterruptible power supply.

3.2.2.9.1.8.2 Environmental Faults

A service alert shall be generated when the thresholds for the following environmental sensors are exceeded:

a. Intrusion detector (Section 3.2.2.10.1), (Only required for systems that will be contained inside a shelter.)

b. Smoke detector (Section 3.2.2.10.2), (Only required for systems that will be contained inside a shelter.)

c. Alternating Current (AC) power (Section 3.2.2.10.4), and

d. Inside temperature (Section 3.2.2.10.5). (Only required for systems that will be contained inside a shelter.)

3.2.2.9.1.9 Generation of Constellation Alerts

Note: This adds considerable complication to the MGS, for example, the requirement to consider NOTAMS implies a requirement to interface with the NOTAM system. How is that interface going to work in a special missions environment? Recommend this be discussed with LD CONOPS people. This whole capability may be better implemented in an external mission planning software package.

A constellation alert shall be generated when the constellation no longer supports SL 7 service, or is predicted not to support CAT I service.

The predictive constellation alert shall be generated prior to the loss of service availability in accordance with the following:

a. Constellation alerts shall be based on aircraft equipage with Aircraft Accuracy Designator stored in NVM (Section 3.2.2.11.2.24), the s_{pr_mgs} achieved by the installed and operating MGS (including the number of operating RRs), and assuming standard interference environment defined in Appendix D of RTCA/DO-253A [24].

b. The constellation alert shall be generated by comparing the Precision approach Protection Level equations for Hypothesis H_0 (Vertical Protection Limit (VPL) H_0 and Lateral Protection Limit (LPL) H_0) for all in view GPS satellites, to their tightest alert limits as indicated by FASVAL and FASLAL in Section 3.2.2.11.2.6.

   Numerical values of VPL H_0 and LPL H_0 shall be generated in accordance with RTCA DO-253A [24].

   In numerical evaluation of VPL H_0 and LPL H_0, the MGS shall not use information or measurements from satellites that are:

   1. Flagged unhealthy by Operational Control Segment (OCS).

   2. Flagged unhealthy in its transmitted message.

   3. Currently excluded by the MGS.

   4. Scheduled to be unavailable (via Notice to Airman (NOTAM)).

c. The constellation alert shall be generated with respect to the centroid of the reference receiver locations.

d. Constellation alert generation shall include effect of reception masking, as defined in Section 3.2.2.8.2.6.1.

e. Constellation alert generation shall use current ephemeris for all visible satellites within the reception mask.

   For all satellites entering the reception mask, most recent almanac shall be used.

The period over which this prediction is made shall be from the current time to a time that is configurable up to 30 minutes.

3.2.2.9.1.10 Generation of Alarms

The MGS shall generate an alarm when integrity requirements of Section 3.2.2.1.2 can not be guaranteed.

The MGS shall generate an alarm when the VDB monitor has detected any fault identified in Section 3.2.2.8.9.

When an alarm is generated, one of the following actions is taken:

a. The MGS shall broadcast the Type 1 Message with no measurement blocks when the integrity requirements of Section 3.2.2.1.2 cannot be met.

b. When there is a fault detected in accordance with the requirements of Section 3.2.2.8.9 the MGS shall terminate the VDB output.

Alarm thresholds shall be stored in NVM.

The default thresholds shall be defined during the design process.

3.2.2.9.1.10.1 Automatic Restart

The MGS shall attempt an automatic restart within 3 minutes following an alarm.

If an alarm condition still exists following the restart attempt, restart shall be available only through manual command via the MDT (Section 3.2.2.11.2.1).

3.2.2.10 Environmental Sensors

The MGS designs shall include an

a. Intrusion detector sensor (Only required for systems that will be contained inside a shelter.),

b. Smoke detector sensor (Only required for systems that will be contained inside a shelter.),

c. Obstruction lights sensor,

d. AC power sensor,

e. Inside temperature sensor (Only required for systems that will be contained inside a shelter.), and

f. Outside temperature sensor.

The environmental sensor output shall be processed by the MGS and retrievable by the MDT.

The MGS shall be capable of being configured to bypass any sensor that is not used in a particular installation.

To be added – matrix showing environmental sensors vs. configuration.

3.2.2.10.1 Intrusion Detector

The intrusion detector shall detect when the MGS shelter door has been opened for any period greater than 0.50 seconds.

The MGS shall generate an alert message if valid log-on ID and password entries are not received within 5 minutes of detecting an open shelter door.

Upon command, the MGS shall arm and bypass the intrusion detector through the MDT.

3.2.2.10.2 Smoke Detector

The smoke detector shall be an ionization-type smoke detector.

The smoke detector shall meet the requirements of Underwriters Laboratories (UL), Inc. Standard 268, [32].

The smoke detector shall bear the UL, Inc. label.

The MGS shall generate a service alert upon detection of combustion products.

3.2.2.10.3 Obstruction Lights

The MGS shall identify when a lamp has failed in the obstruction light assembly of the antennas.

The MGS shall generate an alert message when a lamp fails.

3.2.2.10.4 AC Power

The AC power sensor shall detect the presence of primary AC power.

The MGS shall generate a service alert when a loss of AC power is detected.

The MGS shall generate a service alert when the AC power sensor detects the absence of acceptable primary AC power.

3.2.2.10.5 Inside Temperature

The inside temperature sensor shall provide the temperature inside the MGS equipment shelter to the MGS, with a minimum resolution of one-degree centigrade.

The accuracy over the range of -10º to +50º centigrade shall be ± 5º centigrade without calibration.

The MGS shall generate an alert when the temperature has exceeded the alert thresholds.

The MGS shall generate a service alert message when the upper and lower temperature design thresholds are exceeded.

3.2.2.11 Operational Command, Control, and Display Requirements

All control and display units shall be in accordance with Human Factors guidelines, defined in Section 3.3.6 of FAA-G-2100G [6] and Sections 7 and 8 of the HF-STD-001 [8]. In the event of a conflict within these documents, the Human Factors Design Guide shall take precedence.

To be added – matrix showing displays vs configuration.

3.2.2.11.1 Local Status Panel

3.2.2.11.1.1 Local Status Panel – Modes and Service Alerts

The LSP shall annunciate MGS operating status as follows:

a. Green for Normal,

b. Red for Not Available,

c. Yellow for Test, and

d. Orange for Service Alert.

The LSP shall display a change in mode and service alerts within 2 seconds of detection by the MGS.

The LSP shall indicate current mode and Sub Mode.

3.2.2.11.1.1.1 Local Status Panel – Initialization

The LSP shall simultaneously annunciate green, red, yellow, and orange during a power-up, manual reset, or automatic restart, as a test to ensure all indicators are displaying properly.

The LSP shall have a legible label to denote panel indicator functions.

3.2.2.11.1.2 Local Status Panel – Aural Signal

The LSP shall have the capability to initiate a steady tone aural signal when the MGS is Not Available.

The LSP shall have the capability to disable all aural tones.

The LSP shall initiate an intermittent beep aural signal when there is a service alert.

Annunciating "Not Available" shall take precedence over a service alert.

Aural signals shall be implemented in accordance with FAA HF-STD-001 [8].

3.2.2.11.1.3 Local Status Panel – Silence Switch

Upon command, the LSP shall manually silence an aural signal.

The LSP shall automatically reset the signal, once it has been silenced, until another alarm, or service alert.

3.2.2.11.2 Maintenance Data Terminal

The MDT shall be provided as the operator interface feedback to support maintenance functions.

The MDT shall support the Universal Serial Bus (USB) interface revision 1.1 or higher.

The MDT shall provide an Ethernet interface.

The MDT shall be capable of supporting internal or external data storage device(s).

The MDT shall have the capability of receiving site specific information in a manner that maintains integrity of the data. An example is the reception of FAS data.

The external data storage device shall be connected to the MDT through a standard USB port.

All manually entered data shall be stored in MGS NVM.

The MDT shall be capable of storing information on a commercially available read/write device.

The MDT shall be capable of supporting an internal or external data storage device(s) through a standard USB interface in accordance with IEEE 1394-1995 [10].

The data storage device shall use a removable magnetic or optical media capable of storing no less than 250 megabytes (MB) of data.

The MDT shall include a computer virus check for malicious code.

A method shall be provided to assure that data transfer to and from the MDT is not corrupted.

This virus check shall be performed on any data to be transferred to the MGS via the MDT before transferring the data to the MGS. Malicious code is defined as an unauthorized attempt to include software or firmware that is capable of corrupting the operation of the MGS.

The MDT shall command and monitor all test and maintenance actions available through the interface.

The MDT shall have the capability to select and copy data files to removable media.

3.2.2.11.2.1 Restart

Upon command, the MDT shall restart the MGS.

Commanding restart shall cause all program variables and all software and firmware-controlled hardware to be initialized to a pre-defined condition upon entering the Normal Mode.

3.2.2.11.2.2 States and Modes Display

The MDT shall provide the capability to display the current MGS state, mode, and Sub Mode, defined in Section 3.1.2.

The MDT shall provide the capability to change modes and Sub Modes.

3.2.2.11.2.3 Alerts and Alarm Display

The MDT shall display, within 2 seconds, all alert and alarm messages generated by the MGS.

3.2.2.11.2.4 VDB Display

The MDT shall display the VDB status as either transmitting or not transmitting.

The MDT shall provide the capability to display the VDB message type and data fields.

The MDT shall display the Voltage Standing Wave Ratio (VSWR) of each of the VDB transmitter(s).

3.2.2.11.2.5 VDB Control

Upon command, the MDT shall activate and deactivate the VDB transmission to any antenna.

VDB deactivate shall by-pass the VDB antenna and terminate into a dummy load.

3.2.2.11.2.6 VDB Message Data

Upon command, the MDT shall allow adjustment of the following VDB message data for each message type and parameter:

a. Message Header
    1. Reference Station ID
b. Type 1 Message
    1. Measurement Type
    2. Sigma Pseudorange Ground
    3. Ephemeris Decorrelation Parameter
c. Type 2 Message
    1. MGS Installed RRs
    2. MGS Accuracy Designator
    3. Local Magnetic Variation
    4. Refractivity Index
    5. Scale Height
    6. Refractivity Uncertainty
    7. Latitude
    8. Longitude
    9. Reference Point Height
    10. Sigma Ionosphere
    11. Reference Station Data Selector
    12. Maximum Use Distance

13. Ephemeris Fault-Free Missed Detection Parameters

d. Type 4 Message

1. Data Set Length

2. FAS Data Block – entered as a block in its entirety:

   a) Operation Type

   b) SBAS Provider ID if SBAS option is used

   c) Airport ID

   d) Runway Number

   e) Runway Letter

   f) Approach Performance Designator

   g) Route Indicator

   h) Reference Path Data Selector

   i) Reference Path Identifier

   j) LTP/FTP Latitude

   k) LTP/FTP Longitude

   l) LTP/FTP Height

   m) Δ FPAP Latitude

   n) Δ FPAP Longitude

   o) Approach TCH Height

   p) Approach TCH Unit Selector

   q) GPA

   r) Course Width

   s) Δ Length Offset

   t) FAS CRC

3. FAS VAL

4. FAS LAL

To be added – Type 5; Military unique message types

3.2.2.11.2.7 System Power Display (3.3.2.2.7)

The MDT shall display the MGS power source.

3.2.2.11.2.8 Alerts and Alarm Status Display (3.3.2.2.8)

The MDT shall display the status of all existing alerts and alarms.

3.2.2.11.2.9 Alerts and Alarm Threshold Display

Upon command, the MDT shall display the thresholds and tolerances for alert, service alert, constellation alert, and alarm parameters used in the generation of alerts and alarms.

3.2.2.11.2.10 Alerts and Alarm Threshold Control

Upon command, the MDT shall enable the modification of the thresholds for alert, service alert, constellation alert, and alarm parameters.

Upon command, the MDT shall enable the modification of the defined thresholds, in minimum steps, within design tolerances.

The MDT shall enable the manual input of all pre-defined thresholds within the design tolerances.

3.2.2.11.2.11 Monitor By-Pass

3.2.2.11.2.11.1 Annunciation By-Pass

Upon command, the MDT shall by-pass the aural annunciation of all alerts and alarms to the LSP or ATCU, or all simultaneously while the MGS is in the Test Mode.

The MDT by-pass annunciation function shall have a configurable default setting.

3.2.2.11.2.11.2 By-Pass Actions

Upon command, the MDT shall by-pass the VDB shutdown action associated with Section 3.2.2.8.9 item (b).

Note: This capability is provided for maintenance purposes.

3.2.2.11.2.12 Static Site Data Display

Upon command, the MDT shall display the following site-specific parameters:

a. Transmitter Frequency,

b. Measured power of each VDB,

c. TDMA Time Slot(s) of each VDB,

d. RR Geodetic Coordinates, and

e. Reception Mask.

3.2.2.11.2.13 Static Site Data Control

Upon command, the MDT shall enable the input of the following site-specific parameters:

a. VDB Frequency, 108.000 MHz to 117.975 MHz in 25 kHz channels,

b. VDB Power Adjustment,

c. TDMA Time Slot(s),

d. RR Geodetic Coordinates (WGS-84), and

e. Reception Mask.

3.2.2.11.2.14 Approach Status Display

The MDT shall simultaneously display the approach status for up to 16 runway ends.

The MDT shall display the enable, disable, and Lateral Navigation (LNAV) status of each runway end supported by the MGS.

3.2.2.11.2.15 Approach Control

Upon command, the MDT shall enable any approach associated with each runway end served by the MGS.

Upon command, the MDT shall disable any approach associated with each runway end served by the MGS.

3.2.2.11.2.15.1 LNAV Only Approach

Upon command, the MDT shall enable LNAV only for any approach associated with each runway end served by the MGS.

Upon command, the MDT shall disable LNAV only for any approach associated with each runway end served by the MGS.

3.2.2.11.2.16 Redundant Equipment Status Display

If redundant equipment is provided by design, the MDT shall provide the capability to display the status for both classifications of MGS equipment, Main and Standby.

Main and Standby equipment and the possible status shall be:

a. Main – Primary MGS Equipment

b. On-line – Primary MGS equipment is on-line and operational

c. Failed – Equipment has failed and is not available for operational use

d. Disabled – Equipment has been disabled

e. Standby – Backup/redundant MGS Equipment

f. Available – Equipment is functional and is available for switchover following a main equipment failure

g. Failed – Equipment has failed and is not available for operational use

3.2.2.11.2.17 Redundant Equipment Control

Upon command, the MDT shall change the classification of the MGS.

3.2.2.11.2.18 Diagnostics Display

The MDT shall display diagnostic results following a failure or a manually initiated diagnostic.

The MDT shall have on-screen-help in order to perform diagnostics and other maintenance related actions.

3.2.2.11.2.19 Diagnostics Control

The MDT shall enable manually initiate diagnostics.

This shall include both Non-intrusive and Intrusive maintenance actions, as follows:

a. Non-intrusive - Non-intrusive diagnostics do not affect the current MGS operation

b. Intrusive - Intrusive diagnostics may affect the MGS operation or require a re-certification Flight Check

3.2.2.11.2.20 Temperature Display

The MDT shall display the temperature inside and outside of the MGS equipment facility.

3.2.2.11.2.21 Adjustment Storage

Before log-off, MDT-entered settings and adjustment shall be confirmed and the values stored in MGS NVM.

3.2.2.11.2.22 Processing and Memory Load Display

The MDT shall display the processor and memory loading factors, and error sensing and reporting.

3.2.2.11.2.23 Logons Display List

Upon logon, the MDT shall display all active MGS maintenance users.

3.2.2.11.2.24 Aircraft Accuracy Designator

Upon command, the MDT shall enable input of the Aircraft Accuracy Designator.

Upon command, the MDT shall display the Aircraft Accuracy Designator stored in the NVM.

3.2.2.11.2.25 Azimuth/Elevation Sector

Upon command, the MDT shall enable inputs of the Azimuth/Elevation sector masks.

Upon command, the MDT shall display the Azimuth/Elevation sector masks stored in the NVM.

3.2.2.11.3 Air Traffic Control Unit (ATCU)

To be added – matrix of ATCU features vs. configuration.

The MGS configuration shall include a primary ATCU and optionally one secondary ATCU.

3.2.2.11.3.1 ATCU - Approach Control

Upon command, the ATCU shall simultaneously enable all approaches associated with any individual runway end served by the MGS.

Upon command, the ATCU shall simultaneously enable all approaches associated with any individual runway end at a single airport.

Upon command, the ATCU shall enable or disable all approaches to a runway end with a single action.

The ATCU shall be site adaptable to each airport landing runway configuration.

Upon command, the ATCU shall display up to six (6) landing runway configurations in accordance with the airport's runway use plan.

Upon command, the ATCU shall enable/disable approaches for each landing runway configuration.

A landing runway configuration is a unique pattern of active and inactive runway ends.

3.2.2.11.3.2 ATCU – Operational Status Display

The ATCU shall simultaneously display the operational status for up to 16 runway ends.

This shall include notice that the runway end is either enabled, disabled, or LNAV Only.

"LNAV Only" shall be displayed when the vertical guidance for a runway end is disabled.

3.2.2.11.3.3 Control Display

The ATCU control display shall:

- Enable the selection and de-selection of active runway ends, and
- Enable release and request for the "Primary ATCU" control.

3.2.2.11.3.4 ATCU – Modes

The ATCU shall display "Not Available-Alarm", corresponding to the Not Available Mode.

The ATCU shall display "Not Available-Power Off at MGS" when the MGS is in the Off State.

The ATCU shall display changes in modes within 2 seconds of detection by the MGS.

The ATCU shall display Sub Mode, either civil or military.

3.2.2.11.3.5 ATCU - Maintenance Display

At all times, the ATCU shall display MGS health information to the local control towers or to any other location that includes an ATCU.

When the MGS is in the Test Mode, the ATCU shall simultaneously display “Test” and “Not Available.”

No other display lights shall be illuminated.

3.2.2.11.3.6 ATCU Alert Display

The ATCU shall display a constellation alert within 2 seconds from the time of prediction.

The ATCU shall display the start time and the end time of the predicted outage.

The ATCU shall indicate when SL 7 service is available.

The ATCU shall indicate when SL 8 service is available.

3.2.2.11.3.7 Aural Signal

The ATCU shall initiate a brief (like a “chirp”), intermittent (approximately every 1.5 seconds) aural signal for all MGS mode changes.

The ATCU shall initiate a short duration, intermittent aural signal for all three stages of a constellation alert: the initial warning of constellation loss, the actual constellation loss, and when the service becomes available.

The ATCU shall initiate a brief, intermittent aural signal for loss of VDB coverage to any runway(s) because of VDB subsystem failure.

The aural signals sounded by the ATCU shall not change in pitch, as measured in cycles per second.

Aural signals shall be implemented in accordance with FAA Human Factors Design Standard [8].

3.2.2.11.3.7.1 Audio Control

The ATCU shall manually control an aural signal with a range from low, but not silenced, to audible over ambient noise levels. Ambient noise levels in current controller environments range between 63 and 79 dB, with a mean of 67.7 dB.

The ATCU shall have a switch, to be labeled "Acknowledge," that acknowledges, silences, and resets the aural signal until a change in mode, or a constellation alert occurs.

3.2.2.11.3.8 Design Requirements

The ATCU design shall have transfer and lockout control between the primary ATCU and the secondary ATCUs.

All ATCUs shall be configurable to lock out control functions and provide status display only.

All ATCUs shall have visual and aural annunciation for changes and updates of MGS status information.

3.2.2.11.3.8.1 Monitor Design Requirements

Note: need to run these requirements by AFFSA. May not have the room for this in a Tactical or Special Mission system. These requirements from the FAA spec came about because certain FAA controllers were sold on a particular vendor's monitor, and they wanted to mandate it's use. So the requirements came from that vendor's spec sheet. Does the AF need to do the same? Recommend only a few high-level requirements, and let the vendor derive these more detailed requirements after considering the human factors requirements and talking with military controllers.

The ATCU monitor shall comply with the following requirements:

- Configurable for the following physical environments, including:
    - Rack-mounted in standard 19" equipment racks,
    - Flush-mounted into the control tower console, terminal radar approach control (TRACON), and air route traffic control center (ARTCC), and
    - Set-up as an independent workstation.
- Display screen attributes:

- Diagonal color flat screen LCD, between 14” and 15.1”,
- A resolution of at least 800 x 600 pixels and 72 Dots Per Inch (dpi),
- Refresh rate of more than 70 Hz,
- Viewing angle at least 160º in vertical and horizontal planes,
- Equipped with a touch screen input, in accordance with the guidelines of the Human Factors Design Standard [8].
- Visible under all control tower lighting conditions, including direct sunlight and night operations,
- Luminescence rating ranging from = 40 nits to = 900 nits, and
- Anti-glare treatment that does not reduce available light to less than 800 nits at the highest brightness setting.

- External components and controls, including:
  - Speaker,
  - Volume control, and
  - Brightness control.
- The luminescence rating for the ATCU monitor shall be verified under actual operating conditions.
- The ATCU monitor shall default to a standard resolution of not less than 800 x 600 pixels in the event of a power failure.
- The ATCU monitor shall store the last used resolution internally.
- The ATCU monitor shall store configuration and calibration settings for resolution when the MGS performs a cold boot.

3.2.2.12 Security

3.2.2.12.1 Access Control

3.2.2.12.1.1 Identification and Authentication

3.2.2.12.1.1.1 User Identification and Authentication Management

The System Administrator will provide security management for system access.

The Administrator shall have sole rights and access to add, delete, and change user identifiers and initial passwords via an MDT.

Upon completion of editing changes or adding or deleting a user identifier data, the Administrator shall be prompted for confirmation of the Administrator's password.

All identifier or password changes shall be updated automatically and immediately in the user identifier and password file.

3.2.2.12.1.1.2 User Identification and Authentication

Each user shall be identified by a unique identifier and password.

3.2.2.12.1.1.3 Number of Users

The MGS shall accommodate a minimum of 10 users.

3.2.2.12.1.2 Access Management

3.2.2.12.1.2.1 Access Authorization

Only users authorized by the System Administrator shall have access to the MGS components.

All users shall logon at their authorized access level.

3.2.2.12.1.2.1.1 Invalid Access Attempt

An invalid logon entry shall cause:

a. An "Invalid User ID or Password" error message to be displayed,

b. 'Denial of access' for a default period of 15 minutes after three (3) invalid entries, and

c. Generation of an alert for each invalid access attempt.

3.2.2.12.1.2.1.2 Denial of Access

The system shall generate an alert (Section 3.2.2.9.1.7) upon detection of ‘denial of access’ events at each user interface.

3.2.2.12.1.2.2 Identifier Access Characteristics

3.2.2.12.1.2.2.1 Session Duration

The System Administrator shall assign a session idle time for each user based on access level and operational function.

Maintenance Specialists shall be able to adjust their own session duration per session.

3.2.2.12.1.2.2.1.1 Inactive User Sessions

The system shall automatically logout any user session inactive for more than its assigned session idle time.

Forced logouts of inactive user sessions shall generate an alert for a nominal time of 5 minutes prior to logout.

3.2.2.12.1.2.2.2 Access Levels

Logical user access levels shall consist of the following:

a. Access Level 1: General Use/System Monitoring– Read Only,

b. Access Level 2: ATCU Specialist – Modify runway operational parameters,

c. Access Level 3: Remote Certified Maintenance Specialist – Modify configuration parameters (Test Mode only),

d. Access Level 4: Local Certified Maintenance Specialist – Modify operational states and modes, modify runway operational parameters, and

e. Access Level 5: System Administrator – Add, Change, Delete User ID, Password, and Access Level; Audit Log File Processes.

3.2.2.12.1.2.2.3 User Access Constraints

The System Administrator shall assign user identifier access constraints as appropriate for time-of-day and port-of-entry.

3.2.2.12.1.2.2.4 User Access Rights

The System Administrator shall assign user access rights (read, write, execute) to data objects as appropriate.

3.2.2.12.1.2.2.4.1 Read Access

Upon command, an MDT shall read MGS internally stored data and diagnostic information.

3.2.2.12.1.2.2.4.2 Write Access

Upon command, an MDT shall load FAS data, input site-specific parameters, and all other maintenance actions.

3.2.2.12.1.2.2.4.3 Write Access – MDT

The MDT shall have write access while in Test Mode, Normal Mode, and Not Available Mode.

3.2.2.12.1.2.2.5 User Identifier Duration

User identifiers shall be suspended after a period of time set by the System Administrator ranging from a minimum of one day to infinity.

3.2.2.12.1.2.2.5.1 User Identifier Suspension

User identifier shall be suspended after a default of three (3) failed logon attempts, or a number set by the System Administrator up to a maximum of 10.

3.2.2.12.1.2.2.6 User Password Duration

The MGS shall prompt users to change passwords as specified by the System Administrator.

Password life shall be configurable up to a maximum of 365 days by the System Administrator.

The MGS shall not allow the reuse of passwords during 12 consecutive password changes.

The System Administrator shall be able to force the changing of all user passwords on an ad hoc basis, either individually or for all users.

3.2.2.12.1.2.2.7 Password Management

3.2.2.12.1.2.3 Password Characteristics

The MGS shall allow passwords to contain upper and lower case letters, numbers and special characters.

Password length shall be adaptable up to 16 characters and will be based on local operational procedures.

3.2.2.12.1.2.4 Password Distribution

The System Administrator distributes the user identifier and initial password to an authenticated user.

User identifiers and passwords shall be stored in a protected file and in an encrypted format if maintained on the MGS.

The password file shall be accessible only to the System Administrator.

3.2.2.12.1.2.5 User Password Changes

A user shall be able to change their password.

The user shall be prompted to change their password after the first logon and at every subsequent expiration of their identifier's password life.

All password changes shall be confirmed by a password confirmation prompt before acceptance by the system.

The MGS shall display user identifiers on the logon terminal.

When the MGS displays user identifiers on the logon terminal, the password display shall be obscured.

3.2.3 Physical Characteristics

3.2.3.1 Set-up Time

The set-up time is the time to assemble and perform ground checks on the ground unit. Set-up times include unpacking from the transport mode, assembling, aligning, and performing ground checks. Other actions that may be required prior to allowing precision approach activity, such as, site survey, database development, Terminal Instrument Procedures (TERPS) development, and flight inspection are not included in the set-up time. The Tactical MGS system three-person set-up team will consist of JPALS maintenance and on-site air traffic control and landing system (ATCALS) personnel. In addition it is assumed that the power source for the Tactical system will be in place during or before set up.

No more than three people and one hour shall be required to set-up the Tactical MGS, with an objective of no more than 30 minutes.

No more than two people and 30 minutes shall be required to set-up the Special Mission MGS.

No more than three hours shall be required for site survey and data base development for the Tactical MGS, with an objective of no more than 1 hour.

The Special Mission site survey and data base development time constraints are ***TBD*** but should be no longer than that required for current Tactical systems.

JPALS shall not require airborne equipment for alignment of a ground guidance signal.

An objective is to eliminate the need of the official flight inspection for the Tactical MGS.

Table 3-9 summarizes the time requirements of this section.

Table 3-9: Set-up Time

Parameter/System	Threshold	Objective
a) Set-up time: Tactical	≤ 1 hour	≤ 30 minutes
b) Set-up time: Special Mission	≤ 30 minutes	≤ 30 minutes
c) Site survey and data base development time: Tactical	≤ 3 hours	≤ 1 hour
d) Site survey and data base development time: Special Mission	***TBD***	***TBD***

3.2.3.2 Power

The MGS shall operate from common worldwide commercial utility power and mobile electric power systems with the following nominal characteristics: 47-53/57-63 hertz (Hz) and voltages of 96-130 volts AC (VAC), 210-250 VAC, and 208 VAC.

The MGS shall include all the necessary power cords to interface with these power sources.

Fixed Base MGS shall have an uninterruptible power system (UPS) to provide backup power to the complete system.

At a minimum, the UPS shall provide power, from a fully-charged condition, for the worst-case of ***TBD*** hours operation (objective: 8 hours stand-by, meaning the system is tracking but not transmitting, and 2 hours full operation).

If external power is interrupted, the UPS shall automatically assume the power load with no loss in function.

The battery recharge time shall not exceed two hours while the system is operating.

The Tactical MGS shall provide an external power input that is compatible with at least one type of standard Military power generator, with an existing National Stock Number, that can be included in the Tactical MGS deployment package.

The Special Mission MGS shall provide an external power input that is compatible with at least one type of standard Military power generator, with an existing National Stock Number, that is commonly deployed in a special mission environment.

The Special Mission MGS shall include a self-contained power supply that meets the sustainability requirements of Section 3.4.1.

3.2.3.3 Dimensions

The dimensions of the Tactical and Special Mission MGS shall be as needed to meet the set-up and tear-down requirements of 3.2.3.1 and the transportability and portability requirements of 3.2.7.

3.2.3.4 Weight

The weight of the Tactical and Special Mission MGS shall be as needed to meet the set-up and tear-down requirements of 3.2.3.1 and the transportability and portability requirements of 3.2.7.

3.2.4 Reliability

MGS Reliability requirements shall meet or exceed the threshold values in Table 3-10. For purposes of this SSS, MTBF refers to failures that render the system non-operational.

Table 3-10: Reliability

Parameter/System	Threshold	Objective
MTBF: Fixed	≥ 4,000 hours	≥ 5,000 hours
MTBF: Tactical and Special Mission	≥ 3,600 hours	≥ 4,400 hours

3.2.5 Maintainability

3.2.5.1 Conformance to the Maintenance Concept

The design of the MGS shall allow the MGS to be maintained using a two level (organizational and depot) maintenance concept.

Organizational level maintenance procedures shall utilize Built-In Test-Equipment (BITE) to the maximum extent possible.

The digital technical order shall be incorporated into the BITE to facilitate fault isolation and decrease repair time.

Depot support equipment shall be that type of automatic test equipment approved by the service selected to be the source of repair, or the commercial equivalent tester available from the JPALS manufacturer.

A capability to correct failures of hardware, firmware, and software shall be required by the initial operational test and evaluation (IOT&E) phase.

An integrated capability for system hardware and software maintenance shall be required.

The MGS shall include a remote monitoring capability.

3.2.5.2 Scheduled Maintenance

MGS scheduled maintenance and inspection procedures shall be designed to ensure that system components remain operational and/or prepared for deployment.

The capability to isolate latent faults affecting integrity and continuity shall be provided through the MDT.

Isolation of latent failures shall be provided through either embedded equipment, software, or with special test equipment.

The maximum amount of scheduled maintenance tasking (labor hours and system down time) required by the MGS to ensure system performance while in an operational environment shall be as specified in Table 3-11. This specification includes the time required to complete the routine checks, inspections, replenishment, and other tasks necessary to assure normal and sustained operation.

Table 3-11: Scheduled Maintenance Tasking

MGS Configuration	Threshold	Objective
All	= 2 hours per 30 days	= 1 hour per 90 days

Routine procedures shall be accomplished in less than 15 minutes.

No single group of procedures shall require more than two hours to complete.

No single group of procedures shall be required more frequently than every 2,190 hours.

3.2.5.3 Reserved

3.2.5.4 Built-In Test

The avionics and ground station design shall include the use of BIT, in conjunction with the digital technical order, permitting the isolation, removal, and replacement of faulty units.

The MGS shall include a means of recording system faults.

The MGS shall include the capability to perform automatic and manually-initiated fault diagnosis to the LRU level.

The resulting data shall be stored in memory until manually cleared via the MDT.

Stored data shall be accessible via the MDT.

Manually initiated diagnostics shall be available from the MDT.

A combination of fault diagnostics, BIT, Built-In Test Equipment (BITE), and manual isolation shall enable the following:

a. Automatically initiating the diagnostic routine when an alarm occurs,

b. Automatic diagnostic fault isolation rates at 90% or greater to an ambiguity group of three LRUs or less, and

c. Manual isolation to a single LRU 100% of the time.

The fraction of failures detected (FFD) using MGS self-test shall be greater than 95% (threshold requirement) and greater than 98% (objective requirement).

The MGS shall detect 100% of critical failures.

The MGS shall isolate greater than 95% (threshold and objective) of the failures detected to a single line replaceable unit using BIT and self test.

The MGS shall isolate 100% (threshold and objective) of failures detected to a single LRU using BIT, self test, support equipment and technical orders.

The mean time between BIT false alarms shall exceed 50,000 hours.

BIT performance requirements for the MGS are summarized in Table 3-12.

Table 3-12: MGS Built-In Test

Parameter	Threshold	Objective
i) Fault Detection	The fraction of failures detected (FFD) using self-test will be greater than 95%. 100% of critical failures will be detected.	Same as threshold except FFD using BIT and self-test will be greater than 98%
ii) Fault Isolation	95% of the failures detected will be isolated to a single line replaceable unit using BIT and self test. 100% of failures detected will be isolated to a single LRU using BIT, self test, support equipment and technical orders.	Same as threshold
iii)Mean Time Between False Alarms	The mean time between BIT false alarms will exceed 50,000 hours.	Same as threshold

3.2.5.5 Corrective Maintenance

Corrective MTTR is defined as the average man-hours required to correct an alarm or service and alert condition.

The MTTR of the JPALS MGS equipment shall not exceed 30 min [20 min objective]. This is not applicable to special missions since no maintenance personnel are deployed.

MTTR includes the time required for fault detection, diagnostic isolation, removal of the failed LRU, installation of the new LRU, initialization of the new LRU, functional test and checkout, and all adjustments required to return the system to a normal operating condition. Administrative and logistics delay time is not included in MTTR.

3.2.6 Environmental Conditions

3.2.6.1 Electrical and EMI

The MGS equipment shall be electromagnetically compatible with all collocated equipment.

The MGS equipment shall operate within specified limits in all expected external electromagnetic environments.

The fixed base MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the SRD [29] for fixed base operating environments.

The Tactical MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the SRD [29] for tactical operating environments.

The special missions MGS shall meet all requirements of this specification in the presence of interference as specified in Appendix B of the SRD [29] for the special mission operating environments.

3.2.6.1.1 Interference

The MGS shall be designed such that the requirements of Section 3.2.6.1 are met.

Necessary provisions for electrical grounding, bonding, and shielding shall be part of the basic equipment design and/or installation instructions. Subsystem requirements such as those contained in MIL-STD-461 [16] should be applied as necessary, based on the expected electromagnetic host environment.

3.2.6.1.2 Electromagnetic Radiation

The MGS shall not degrade the effectiveness of the ground's defensive systems, nor restrict aircraft handling and aircraft parking.

The MGS will be electromagnetically compatible with command, control, communication, computers and intelligence (C4I) infrastructure for all aircraft, and ground-based components in the operating environment in which it will be deployed.

To ensure electromagnetically compatibility, the civil MGS unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3-13.

To ensure this compatibility, the military MGS unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3-14.

The total power in any transmitter harmonic or discrete signal shall not be greater than -53dBm.

Table 3-13 Unwanted Civil Emissions

Frequency	Relative unwanted emissions level (note 2)	Maximum unwanted emissions level (note 1)
9 kHz to 150 kHz	-93 dBc (note 3)	-55 dBm / 1 kHz (note 3)
150 kHz to 30 MHz	-103 dBc (note 3)	-55 dBm / 10 kHz
30 MHz to 106.125 MHz	-115 dBc	-57 dBm / 100 kHz
106.425 MHz	-113 dBc	-55 dBm / 100 kHz
107.225 MHz	-105 dBc	-47 dBm / 100 kHz
107.625 MHz	-101.5 dBc	-53.5 dBm / 10 kHz
107.825 MHz	-88.5 dBc	-40.5 dBm / 10 kHz
107.925 MHz	-74 dBc	-36 dBm / 1 kHz
107.975 MHz	-65 dBc	-27 dBm / 1 kHz
118.000 MHz	-65 dBc	-27 dBm / 1 kHz
118.050 MHz	-74 dBc	-36 dBm / 1 kHz
118.150 MHz	-88.5 dBc	-40.5 dBm / 10 kHz
118.350 MHz	-101.5 dBc	-53.5 dBm / 10 kHz
118.750 MHz	-105 dBc	-47 dBm / 100 kHz
119.550 MHz	-113 dBc	-55 dBm / 100 kHz
119.850 MHz to 1 GHz	-115 dBc	-57 dBm / 100 kHz
1 GHz to 1.7 GHz	-115 dBc	-47 dBm / 1 MHz

Notes:

1) If the authorized transmitter power exceeds 150 watts, then the relative unwanted emissions requirements and the maximum unwanted emission requirements both apply. This column indicates the bandwidth over which the maximum unwanted emission levels is to be met.

2) The relative unwanted emission level is to be computed using the same bandwidth for desired and unwanted signals. This may require conversion of the measurement for unwanted signals done using the bandwidth indicated in the maximum unwanted emission level column.

3) This value is driven by measurement limitations. Actual performance is expected to be better.

The relationship is linear between single adjacent points designated by the adjacent channels identified above.

Table 3-14 Unwanted Military Emissions

Frequency	Relative unwanted emissions level (note 2)	Maximum unwanted emissions level (note 1)
TBD		

3.2.6.1.3 TEMPEST

The installation of JPALS MGS equipment shall not adversely affect the TEMPEST characteristics of the installation. The need for TEMPEST compliance, or specific TEMPEST installation techniques, should be evaluated on a case-by-case basis.

3.2.6.1.4 Lightning

The JPALS MGS system shall comply with facility lightning requirements.

Externally-mounted JPALS MGS equipment shall be evaluated for direct lightning effects.

Internally-mounted equipment shall be designed to withstand indirect lightning effects. The specific lightning requirements are platform-specific, and should be tailored for each intended installation.

3.2.6.2 Threat Environment

The requirements of this specification shall be met under the conditions of interference of the GPS signal as defined in Appendix B of the SRD [29].

3.2.6.3 Environment, Safety and Health

The MGS equipment shall incorporate environmental, safety, and health planning throughout the program life cycle.

The MGS shall be designed and manufactured so that it can be tested, operated, maintained, repaired, and disposed of in compliance with applicable federal, state, interstate, and local environmental laws and regulations, executive orders, treaties, and agreements.

The MGS shall include a certification from the manufacturer, prior to installation and operation, stating that the MGS design and equipment is safe for their intended operating environment.

All safety deficiencies identified during the development of the MGS will be evaluated and resolved prior to the start of the Factory Qualification Test (FQT) or system test.

3.2.6.4 Operational Environment Conditions

JPALS provides safe landing guidance in all terrain environments and conditions of adverse weather in which an aircraft may be expected to conduct an approach to a landing. Both airborne and ground equipment will be considered. Parameters contained in Table 3-15 are not inclusive. Additional parameters may be developed in the future based on the specific technology employed by JPALS. Table 3-15 may be selectively implemented depending on the airborne design (i.e., Gun Fire Vibration would not be required for the C-17).

JPALS shall be qualified in accordance with MIL-STD-810 or other equivalent standard (RTCA DO-160D).

JPALS shall also physically survive the range of environmental conditions that airfields and aircraft platforms are expected to encounter without experiencing significant physical damage.

Table 3-15: MGS Operating Environment

Parameter	Threshold	Objective
Precipitation (effects on signal and sensor)	16 mm/hr in 5 NM wide rain cell without signal degradation below precision landing system parameters/minima	25 mm/hr in 5 NM wide rain cell without signal degradation below precision landing system parameters/minima
Fog (effects on signal and sensor)	Operate in advection and radiation fogs without signal degradation below precision landing system parameters / minima	Same as threshold
Salt Fog	TBD	TBD
Chemical and Biological	TBD	TBD
Fungus	TBD	TBD
Shock and Vibration	TBD	TBD
Storage Temperature	TBD	TBD
Lightning Protection	TBD	TBD
Humidity	TBD	TBD
Temperature (effects on ground equipment and signal)	-51 degrees Celsius to +49 degrees Celsius	-70 degrees Celsius to +60 degrees Celsius
Wind (effects on ground equipment)	Signal will remain within limits up to 75 knots. No damage to equipment and remain in position up to 101 knots	Same as threshold
Snow (effects on signal)	Withstand up to two feet of accumulation without signal degradation	Same as threshold
Elevation (effects on ground equipment)	-200 feet to 14,000 feet (MSL)	-200 feet to 14,000 feet (MSL)
Ice and hail (effects on signal and ground equipment)	Withstand up to ½ inch accumulation of ice or ½ inch diameter size hail without damage or signal degradation	Same as threshold
Blowing Sand and Dust (effects on signal and ground equipment)	Withstand sand concentration of 2.2g/M3 in 40 kt wind without damage or signal degradation below precision landing system parameters / minima	Same as threshold
Temperature and Altitude	TBD	TBD
Sunshine	TBD	TBD
Surrounding Air Pressure	TBD	TBD

Parameter	Threshold	Objective
Explosive Atmosphere	TBD	TBD
Vibration (Airborne)	TBD	TBD
Gunfire Vibration	TBD	TBD
Crash Safety	TBD	TBD
Design Shock	TBD	TBD
Acceleration	TBD	TBD
Fluids	TBD	TBD
Performance Dynamics	TBD	
Fog (effects on signal and sensor)	Operate in advection and radiation fogs without signal degradation below precision landing system parameters / minima	Same as threshold

3.2.7 Transportability

The MGS is intended to be worldwide transportable by ground, air, and sea. The design should permit rapid on/off loading by personnel. The MGS shall be transportable by worldwide rail systems and 1.25-ton and larger trucks over paved or smooth dirt surfaces. The mobile and man-transportable have additional transportability requirements.

3.2.7.1 Tactical MGS Transportability

The Tactical MGS shall be 3-man transportable (65 lbs each).

The Tactical MGS shall be independently air transportable by:

- single C-130 or
- sling-loaded by a single CH-47,CH-53, UH-60.

The sling load limit is 8,000 lbs.

Note: this section needs clarification and addition requirements, e.g. load and volume restrictions on aircraft.

3.2.7.2 Special Mission MGS Transportability

The Special Missions MGS shall be 2-man transportable (31 lbs each).

The Special Missions MGS shall be independently air transportable by:

- single C-130 or
- sling-loaded by a single CH-47,CH-53, UH-60.

The sling load limit is 8,000 lbs.

Note: this section needs clarification and addition requirements, e.g. load and volume restrictions on aircraft.

3.2.8 Flexibility

TBD

3.3 Design and Construction

3.3.1 Materials, Processes, and Parts

3.3.1.1 Design, Construction, and Workmanship

Design, construction, and workmanship of the JPALS MGS shall conform to best commercial practices. In addition:

a. Fastener hardware shall use standard parts and be simple to manipulate.

b. Fastener hardware that is removed for normal operations, maintenance, and set-up shall be captive.

c. Cable routing shall not interfere with operating and maintaining the equipment.

d. Cable routing shall protect the cables from damage.

e. Connectors on all cables that are installed or removed during set-up or tear-down shall be labeled to prevent incorrect assembly with a simple, unique identification number that signifies the two devices they interconnect.

f. The cable labels shall be permanently affixed to the cable near each connector.

g. The system shall have a durability to withstand at least 100 setups and teardowns.

h. The design tolerances of like assemblies, subassemblies, modules, and parts shall permit interchangeability.

i. Exterior surfaces shall be finished to be corrosion resistant.

j. External surfaces and materials shall withstand exposure to CB agents and CB decontamination cleaning methods.

k. Exterior surfaces shall be ***TBD*** color, subject to Government approval.

l. Exterior surfaces and materials shall withstand prolonged exposure to sunshine.

m. Exterior surfaces and materials shall not fade, crack, or deteriorate.

The use of Class I Ozone Depleting Chemicals (ODC) is prohibited. The use of Class II ODCs, Environmental Protection Agency (EPA)-17 materials and other toxic production and formulations shall be minimized and eliminated where feasible.

3.3.1.2 Design Assurance

3.3.1.2.1 Software Design Assurance

The JPALS MGS software shall also be developed in accordance with RTCA/DO-278 [26] or an equivalent standard.

All software developed for this system shall be in accordance with the C programming language specified in ANSI/ISO/IEC 9899-1999. The C Programming language may need to be limited to a subset of the full language in order to meet the requirements of RTCA/DO-278 [26].

3.3.1.2.2 Complex Electronic Hardware Design Assurance

Electronic hardware is complex when its normal operation has a multiplicity of states, and its design must be constrained to ensure that failures or errors in a normal operational state have a one-to-one mapping to failure conditions or failure modes. The design of complex electronic hardware devices, including Application Specific Integrated Circuits (ASIC) and Programmable Logic Devices (PLD), shall be constrained to ensure deterministic behavior with one-to-one mapping of failures to failure modes.

The level of design assurance required shall be based on the complexity of the device and its contribution to potential failure conditions that adversely affect the safety of the system.

The level of production process rigor associated with complex electronic hardware shall be based on the contribution of the hardware to potential failure conditions as determined by the System Safety Assessment (SSA) process.

3.3.1.3 Product Marking

Nameplates and labels shall be permanent and legible for the life of the equipment.

Lettering shall be in a contrasting color from the background of the nameplate or label.

Letters shall be sans-serif.

Numbers shall be Arabic.

All equipment shall be labeled to identify the assembly name, weight, and, if applicable, the number of people required for lifting.

All equipment shall have external nameplates containing system nomenclature, Government procuring activity, contract number, part number, system number, design activity, manufacturer's contractor and government entity (CAGE) code, name, and address.

The nameplates shall be visible when the equipment is operating and in the storage/transport modes.

3.3.1.4 Equipment Exterior Color

The nominal exterior color of the Fixed Base MGS equipment, except for markings, controls, and displays, shall be [**TBD, USAF gray?**], federal standard **TBD**.

The exterior color of the Tactical and Special missions MGS equipment (including dedicated reusable shipping containers, if applicable), except for markings, controls, and displays, shall be as specified in the applicable procurement contract.

3.3.2 Interchangeability/Modularity

TBD

3.3.3 Safety

The MGS equipment shall be designed to minimize the potential for injury to personnel or damage to equipment during setup, tear down, operation, transportation, and maintenance.

Safety features shall not impair efficiency or operational capabilities.

Hazards, such as sharp corners, projections, moving parts, or electrical potential that could cause injury, shall be eliminated or covered with protective shields or guards.

3.3.4 Human Factors

The MGS shall be designed so that it can be operated, maintained, set-up, and torn-down by personnel wearing restrictive clothing, including cold weather gear and a full chemical warfare ensemble.

The JPALS operational user interface shall be designed to allow operators and maintainers to perform their duties without increasing levels of workload and fatigue as compared to current systems.

Accepted human factors and engineering principles shall be used to optimize performance and reduce workload where practical.

The user interface shall provide efficient workload management through the effective use of graphical displays, text displays, and presentation of system and task status information.

Design of controls, displays, symbology, and operating procedures shall promote smooth, expeditious and error free system operation.

System messages and displays presented to operators shall be appropriate and relevant to operators' activities and knowledge levels.

Except for use of pre-existing displays, any aircraft or tactical/special mission visual display, readout, or operator message shall be visible at night with or without night vision devices and selectable by the user.

User interface commands shall be designed to minimize operator performance errors and preclude operator errors on critical tasks through the use of error checking and user validation.

3.3.5 Software

3.3.5.1 Computer Resource Reserve Requirements

The MGS shall provide a minimum of 50% percent spare capacity for each type of computer memory (e.g., Random Access Memory (RAM), Read Only Memory (ROM), Electrically Programmable ROM (EPROM), etc.) for each computer processor.

The MGS shall provide a minimum of 50% percent spare processing capacity for each computer processor including Input/Output (I/O) processing capacity.

3.3.6 Hardware

The JPALS MGS hardware shall also be developed in accordance with the design assurance requirements of RTCA DO-254 [25] or an equivalent standard.

3.3.7 Existing/Pre-Defined Property Usage

TBD

3.4 Logistics

JPALS will be a fully deployable, self-contained (batteries, fuel, and power generators included) system for tactical operations and minimize the required number of maintenance and support personnel for all operations.

3.4.1 Sustainability

Mission sustainability is defined as the length of time after initial deployment that the MGS can operate in the operating environment using deployment package logistics assets and on-site support personnel.

The JPALS mobile equipment shall be capable of sustaining at least a 60 day deployment at a 24 hour per day utilization rate, using deployment package logistics assets and on-site support personnel for mission limiting failures or required scheduled maintenance as summarized in Table 3-16.

Table 3-16: Sustainability

Environment	Threshold	Objective
a) Tactical	Sustain a 60 day deployment at a 24 hour per day utilization rate, using deployment package logistics assets and on-site support personnel for mission limiting failures or required scheduled maintenance.	Same as threshold
b) Special Mission	Sustain a 72 hour deployment (4 hours full operation and 68 hours in standby) using only power sources provided in the deployment package without a critical failure or need for any scheduled maintenance and shall be able to operate off generator power, if required.	Same as Threshold except 8 hours of full operations and 64 hours in standby

3.4.2 Mean Logistics Delay Time

For the purposes of showing compliance with requirements in this specification, the following mean logistics delay time may be assumed: 2 hrs requisition response time for spares on-site, 48 hrs for spares off site.

3.4.3 Spares

Sparing shall be based on the performance based logistics supply support philosophy. A common supply support management approach for jointly shared items and individual service performance based logistics philosophies for unique items will be employed. Spares shall be provisioned with sufficient lead-time to allow delivery prior to or concurrent with testing, equipment installation, and the IOC. Estimated quantities of components by type shall be compiled by the services as the program matures.

The mobile MGS deployment package for tactical operations shall include on-site spares for up to a 60-day deployment.

The mobile MGS deployment package for tactical operations shall be stocked such that the most critical 80% of spares are included.

3.4.4 Support Equipment

Minimal reliance on external support equipment is a goal for maintaining the MGS, and if needed, common support equipment should be used. Any MGS ground system must not require a unique ground support generator. If ground equipment is required, the MGS should be compatible with standard worldwide commercial electrical power. The MGS should be operable using existing aerospace ground equipment.

3.4.4.1 Peculiar Support Equipment

The requirement for peculiar support equipment (PSE) in the design of the MGS shall be kept to absolute minimum. The goal is to have no PSE required.

3.5 Personnel and Training

The MGS will be designed so that operation and maintenance of the MGS shall not increase current service manpower authorizations or skill level requirements.

The total number of dedicated maintenance and/or logistics personnel needed to support the MGS per shift for a deployed MGS is defined in Table 3-17.

Table 3-17: Personnel Requirements for Deployed MGS

System	Threshold	Objective
a) Tactical*	1 person	No personnel required
b) Special Mission	No personnel required	Same as threshold

The support personnel requirement for non-deployed ground stations including fixed base, Tactical and Special Mission systems when in garrison is defined in Table 3-18.

Table 3-18: Personnel Requirements for Non-Deployed MGS

Environment	Threshold	Objective
All	Not to exceed current authorized levels	Reduce current authorized levels

3.5.1 Installation Personnel

The total number of personnel needed to field-assemble and perform ground checks on the Tactical MGS equipment shall not exceed three persons.

3.5.2 Maintenance Personnel

The total number of dedicated maintenance and/or logistics personnel needed to support deployed Tactical MGS equipment shall not exceed one (1) person per shift (no personnel per shift objective.

No personnel shall be required for the Special Mission MGS.

3.5.3 Training

No unique skills shall be required for the operation or maintenance of JPALS.

3.5.4 Geospatial Information and Services (GI&S) Support

Systems requiring GI&S support shall be capable of accepting National Imagery and Mapping Agency (NIMA) standard products. JPALS shall use WGS-84 geodetic survey data.

4. QUALITY ASSURANCE AND VERIFICATION REQUIREMENTS

This section specifies proposed qualification and acceptance requirements for JPALS (Civil and Military Modes). Functional performance verification requirements are depicted in Table 4-1: Requirements Verification Matrix, JPALS Requirements Verification Matrix. Standard verification methodologies described in paragraph 4.1 shall be implemented during all phases of JPALS system development, production and delivery. A quality management system shall be established for the maintenance of, and means of identifying, collecting, indexing, filling, storing, maintaining, retrieving, and disposing of pertinent quality documentation and records, as appropriate, in accordance with the best commercial practice.

4.1 Verification Strategy

The contractor must consider that Prime/Sub contractor cooperative agreements may be required in order to develop both the JPALS MGS and MAS segment. The MGS/MAS may be developed on dual tracks requiring exchange of design/test data, hardware and software to support development/test. After each segment has undergone contractor design, development and test (laboratory/field) both segments will come together for a system demonstration leading to a Formal Qualification Test (FQT)/System Test of the JPALS software and system performance. System Test will require field deployment installation and operation of the MGS while the MAS will require installation and check out of JPALS avionics/Antenna electronics on a JPALS modified aircraft. Flight demonstration/testing will be conducted in both benign and electronic jamming environments in open air ranges (TBD) to demonstrate (statistically relevant) functional performance and to gather data to validate JPALS models. Completion of this phase will lead to development of a production/pre-production MAS system for installation on an operational aircraft leading to deployment and follow on production of a fielded JPALS. Additionally, a MGS production system will be fielded at the same time. The contractor could be required to provide maintenance/technical support during Development/Operational Test (DT/OT) conducted by the Government. The Government test program will be conducted by a Responsible Test Organization (RTO) and will consist of both Developmental and Operational test events. Headquarters Air Force Operational Test and Evaluation Command will lead operational and suitability tests conducted in realistic field environments.

4.1.1 Responsibilities

This section will identify the assignment of the responsibility to perform inspections on delivered products, materials, or services to determine compliance with all specified requirements.

4.1.2 Special Tests and Examinations

This section will identify the special tests and examinations required for sampling, qualification evaluation, or other tests or examinations, as necessary.

4.2 Verification Methods

4.2.1 Inspection

Inspection (I) - Inspection is used to determine system characteristics by examination of the item and comparing the item with descriptive documentation, engineering drawings, and computer program listings to determine conformance with specified requirements. Inspection is generally nondestructive and consists of visual examinations (including system documentation) or simple measurements without the use of precision measurement equipment.

4.2.2 Analysis

Analysis (A) - Verification shall be performed by evaluation or simulation using mathematical representations, charts, graphs, circuit diagrams, and data reduction. Analysis or review of simulation data is a study method resulting in data used to verify conformance of characteristics with specified requirements. Worst-case data may be derived from design solutions where quantitative performance cannot be demonstrated cost-effectively. In addition to performing parametric analysis to define system requirement parameters, simulations are also used. Modeling and simulations shall be used to perform early testing of units, subsystems and systems. Modeling and simulations shall be used to finding and resolving system design issues as early as possible in the design and development process.

4.2.3 Demonstration

Demonstration (D) - Demonstration is a variation of the test method used to verify requirements by go/no-go criteria without the use of elaborate measurement equipment. In general, software functional requirements are validated by demonstration since the functionality must be observed through secondary media.

4.2.4 Test

Test (T) - Test is used to verify performance requirements. The test process will generate data, and these data are normally recorded by precision measurement equipment or procedures. Analysis or review is subsequently performed on the data derived from the testing. Analysis as described here is an integral part of this method and should not be confused with the “analysis” described in the "Analysis" paragraph. Quantitative values are measured, compared against previous predicated success criteria and then evaluated to determine the degree of compliance.

4.2.5 Qualification by Similarity

A qualification by similarity is a prediction based on existing data with detailed examination of the differences and similarities between the previously qualified item and the item under consideration. The contractor may propose this method for use to the Government on a case by case basis.

4.3 Requirements Verification Matrix

The contractor shall perform verification per the methods of

Table 4-1.

Table 4-1: Requirements Verification Matrix

Standard Requirements		Verification Method				Notes
Requirement	**Paragraph Title**	**I**	**A**	**D**	**T**	
	Note: This RVM will be completed on a requirement by requirement basis per DOORS tracing.					

5. PACKAGING AND PREPARATION FOR DELIVERY

The Mobile MGS shall be packaged so as to be air droppable.

Preservation, packaging, and packing of the JPALS MGS and MAS shall insure that no damage shall be incurred during handling, storage and shipment from the source of supply to the Government-designated destination.

Level A preservation and packaging and Level A packing shall be provided per MIL-STD-2073 [17]. MIL-P-90024 [14] shall also be applicable. Markings shall be per MIL-STD-129 [15].

Note: Need to verify need for and applicability of Mil-Std/Specs or could substitute commercial practices.

APPENDIX A: TERMS AND ACRONYMS

This section defines the terms, acronyms, and abbreviations as used in this document.

A.1 Terms

The following terms are used throughout this document:

Term	Definition
abnormal maneuvers	Abnormal maneuvers are defined to be maneuvers having accelerations/jerks that exceed those specified in 3.2.2.3.2.
H_0 hypothesis	The H_0 hypothesis assumes the situation where no faults are present in the range measurements (includes both the signal and the receiver measurements) used in the ground station to compute the differential corrections.
H_1 hypothesis	The H_1 hypothesis assumes the situation when a fault is present in one or more range measurements and is caused by one of the reference receivers used in the ground station.
Line Replaceable Unit (LRU)	An item that is normally removed and replaced as a single unit to correct a deficiency or malfunction on a weapon or support system. Such items have a distinctive stock number for which spares are locally authorized to support the removal and replacement action. These items are repair cycle assets subject to “due in from maintenance” controls (Technical Order 00-20-3) and may be disassembled into separate components during shop processing.
LAAS	A generic reference to GBAS as defined by ICAO, as the requirements in this standard are intended to comply with the ICAO Standards and Recommended Practices (SARPs) [28] for the GBAS aircraft element.
Mean Time Between Failure	(MTBF) The duration of probability of failure-free performance when in an operational environment. Mean time between failures is based on any downing event or failure which degrades system performance while in an operational environment.
Must	The degree of obligation of a requirement/attribute is mandatory.

normal maneuvers	Normal maneuvers are defined to be maneuvers having accelerations/jerks that are within those specified in 3.2.2.3.2.
open architecture	An architecture whose specifications are public. This includes officially approved standards as well as privately designed architectures whose specifications are made public by the designers.
Scheduled Maintenance	A series of planned inspection, detection, service and/or hardware replacement actions performed at a prescribed point in the item's life in an attempt to retain it in a specified condition and prevent an unacceptable condition from occurring.
Shall	The degree of obligation of a requirement/attribute is mandatory.
Should	The degree of obligation of a requirement/attribute is recommended
Will	Indicates futurity and does not indicate any degree of obligation or requirement.

A.2 Acronyms

The following abbreviations, acronyms, and mnemonics are used throughout this document:

Acronym	**Description**
AC	Alternating current
AES	ARINC Engineering Services
AFB	Air Force Base
AGL	above ground level
AJ	anti-jam
AL	Alert Limit
ARTCC	Air Route Traffic Control Center
ASIC	Application-Specific Integrated Circuit
ATC	Air Traffic Control
ATCALS	Air Traffic Control and Landing System
ATCU	Air Traffic Control Unit

BIT	built-in-test
BITE	BIT Equipment
C/A	GPS Coarse/Acquisition Code available to all users
CAGE	Government coding system
CAT I	Category I (one)
CAT II	Category II (two)
CAT IIIa	Category IIIa (three a)
CAT IIIb	Category IIIb (three b)
CB	chemical biological
CDRL	Contract Data Requirements List
CPU	central processing unit
CRAF	Civil Reserve Air Fleet
CRC	cyclic redundancy check
CRPA	controllable reception pattern antenna
dB	decibel
dBc	decibel referred to the carrier
dBi	decibel referred to isotropic radiator
dBm	decibel referenced to 1 milliwatt
DC	Direct Current
Δ	delta
DT	Development Test
DoD	Department of Defense
EMI	Electromagnetic Interference
EPA	Environmental Protection Agency
EPOL	Elliptically Polarized
EPROM	erasable programmable read only memory
FAA	Federal Aviation Administration
FAS	Final Approach Segment

FASLAL	Final Approach Segment Lateral Alert Limit
FASVAL	Final Approach Segment Vertical Alert Limit
FFD	fraction of failures detected
FPAP	flight path alignment point
FQT	Formal Qualification Testing
ft	foot
FTP	fictitious threshold point
GAD	Ground Accuracy Designator
GBAS	Ground Based Augmentation System
GCID	Ground Continuity Integrity Designator
GI&S	Geospatial Information and Services
GPS	Global Positioning System
GLS	GNSS Landing System
GPIP	glide path intercept point
GNSS	Global Navigation Satellite System
GRAM	GPS Receiver Application Module
HOW	Hand-Over-Word
Hz	Hertz
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ID	identification
IER	Information Exchange Requirements
IF	Intermediate Frequency
ILS	Instrument Landing System
I/O	input/output
IOC	Initial Operational Capability
IOD	issue of data
IODC	issue of data clock

IODE	issue of data ephemeris
IOT&E	Initial Operational Test and Evaluation
JPALS	Joint Precision Approach and Landing System
J/S	jammer power to signal power ratio
kHz	kilo-Hertz
KPP	Key Performance Parameter
kts	knots (nautical miles per hour)
L1	GPS L-band signal and/or frequency at 1575.42 MHz
L2	GPS L-band signal and/or frequency at 1227.60 MHz
L5	GPS L-band signal and/or frequency at 1176.45 MHz
LAAS	Local Area Augmentation System
LAL	Lateral Alert Limit
LDGPS	Local Area Differential Global Positioning System
LGF	LAAS Ground Facility
LNAV	Lateral Navigation
LPI	low probability of intercept
LPD	low probability of detection
LPL	Lateral Protection Limit
LRU	Line Replacement Unit
LSP	Local Status Panel
LTP	Landing Threshold Point
m	meter
MASPS	Minimum Aviation System Performance Standards
MAS	Military Airborne Segment
MB	Megabytes
M-Code	GPS Military Code available only to authorized users
MBI	Message Block Identifier
MDT	Maintenance Data Terminal

MI	misleading information
MGS	Military Ground Segment
MHz	Mega-Hertz
MLS	Microwave Landing System
m/s	meters per second
MOPS	Minimum Operational Performance Standards
MPNTP	Master Positioning Navigation and Timing Plan
MTTR	Mean Time To Repair
MTBF	mean time between failure
MTBCF	Mean Time Between Critical Failures
NATO	North Atlantic Treaty Organization
NIMA	National Imagery and Mapping Agency
NOTAM	Notice to Airmen
NSC	Non-Standard C/A Code
NSE	Navigation System Error
NVM	Non-Volatile Memory
OCS	Operational Control Segment
ODC	ozone depleting chemical
ORD	Operational Requirements Document
OT	Operational Test
PAMI	Precision Approach Misleading Information
PLD	Programmable Logic Device
PPS	Precise Positioning Service
PRN	Pseudo Random Number (a code of a specific GPS satellite)
PRsca	Smoothed Pseudorange Corrections
PSE	Peculiar Support Equipment
PVT	Position, Velocity and Time
P(Y)	GPS Precise Code available only to authorized users

RAM	random access memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	root-mean-squared
RNAV	Area Navigation
ROM	read only memory
RTO	Responsible Test Organization
RR	Reference Receiver
RRC	Range Rate Correction
RSDS	Reference Station Data Selector
s	seconds
SAASM	Selective Availability and Anti-Spoofing Module
SARPs	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System
SIS	Signal In Space
SL 7	JPALS guidance quality Service Level 7
SL 8	JPALS guidance quality Service Level 8
SL 9	JPALS guidance quality Service Level 8
SPS	Standard Positioning Service
SRD	System Requirements Document
SSA	System Safety Aswssment
TBD	to be determined
TCH	Threshold Crossing Height
TDMA	Time Domain Multiple Access
TEMPEST	Unclassified US government code word for compromising emanations; now called Emissions Security or EMSEC
TERPS	Terminal Instrument Procedures
TRACON	Terminal Radar Approach Control

TSO	FAA Technical Standard Order
UJTL	Universal Joint task List
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
US	United States (of America)
USB	Universal Serial Bus
VAL	Vertical Alert Limit
VDB	VHF Data Broadcast
VHF	Very High Frequency
VPL	Vertical Protection Level
VSWR	Voltage Standing Wave Ratio
WGS-84	World Geodetic System 1984

APPENDIX B: VULNERABILITY REQUIREMENTS

TBD

APPENDIX C: ENVIRONMENTAL QUALIFICATION TESTS

TBD

APPENDIX D: INTEGRITY RISK ALLOCATION TREE

TBD

APPENDIX E: CROSS REFERENCES AND RATIONALE

3.1 System Definition and General Requirements

Source: SRD 3.1.1.1.

Rationale: Slight rephrasing of SRD wording. It is possible that one design may fulfill the requirements of more than one configuration, hence, “up to three” rather than “three”.

Source: SRD 3.2.6.1, 3.2.6.2, and the previous version MGS 3.2.1.

Rationale: Placeholder. These may be moved to a later paragraph.

3.1.1 MGS Major Component List

Source: Adapted from SRD 3.1.3.1, tower interface.

Rationale: Military operations and maintenance of the MGS will be similar to FAA operations and maintenance of the LGF.

Comment: ESC confirmed the need for an ATCU for the M-T configuration.

Comment: ESC confirmed the need for an ATCU, but not an RSP.

3.1.2 States and Modes of Operation

Source: Adapted from LGF

Rationale: Interoperability with FAA LGF.

3.1.2.3 Normal Mode

Source: SRD 3.1.2 for Military and Civil Modes.

Source: SRD 3.1.2.1 for MIL mode.

Rationale: Civil Mode is inconsistent with special missions uses for the Special Mission unit.

Source: SRD 3.1.2 for MIL and Civil Modes.

Rationale: Combination of MIL and Civil Sub Modes.

Rationale: Interoperability with FAA LGF.

Comment: ESC indicated in TIM that Mixed Mode is not necessary, but hedged their decision by stating they were still awaiting clarification of encryption issues, hence, this mode could be deleted or retained pending confirmation.

Comment: ESC confirmed no Civil mode for the MT configuration, but indicated they would run it by AFFSA for confirmation.

Comment: ESC indicated that data recording is not required.

3.1.2.3.1 Civil Sub Mode

Source: SRD 3.1.2.2.

Rationale: Civil is a Sub Mode of normal mode.

3.1.2.3.2 Military Sub Mode

Source: SRD 3.1.2.2.

Rationale: MIL is a Sub Mode of normal mode.

3.1.2.4 Not Available Mode

Rationale: Interoperability with FAA LGF.

Comment: ESC indicated that data recording is not required.

3.1.2.5 Test Mode

Rationale: Interoperability with FAA LGF.

Comment: ESC indicated that data recording is not required.

3.1.3.1.1 MGS/GPS Satellite Interface

Source: SRD 3.1.3.1.

Rationale: This is the fundamental interface for positioning measurements.

3.1.3.1.2 MGS/MAS Civil VHF Data Broadcast Interface

Source: SRD 3.1.3.1.

Rationale: Interoperability with FAA LGF. Assumption: This does this apply to Special Mission configuration as it is incompatible with a special mission role.

3.1.3.1.4 MGS Operator Interface

Source: SRD 3.1.3.1.

Rationale: Various operator actions are required to support initialization and operation of the MGS.

3.1.3.1.5 MGS Maintenance Interface

Source: SRD 3.1.3.1.

Rationale: Various maintenance actions will be required to support operation of the MGS.

3.1.3.1.6 MGS/Tower Interface

Source: SRD 3.1.3.1.

Rationale: Tower and other remotely located personnel will have a need to know the status of the MGS and perform some control functions, such as select active runway ends.

3.1.3.1.8 Geospatial Information and Services (GI&S) Support

Source: SRD 3.5.4.

Rationale: Compatibility with existing data standards.

3.1.3.2 MGS Internal Interface Definition

Rationale: The development contractor should have the freedom to define the internal interfaces of the MGS.

3.2.1.2.1 Information Exchange Requirements

Source: ORD 4.2.

Comment: ESC acknowledged that control commands for the MGS could come from the "tower". Table 3-0 will be updated to show the tower as the sending node and MGS as the receiving node for MGS control commands.

3.2.1.2.2 C4I/Standardization, Interoperability, and Commonality

Source: ORD 5.3.

Comment: ESC stated that the SRD would capture these requirements and agreed that this paragraph was not required in the MGS spec. This will be clarified again.

3.2.1.3.2 Maintenance Data Terminal

Comment: In TIM with ESC, need for an ATCU was confirmed but not for an RSP which would have display but no control capability.

3.2.2.1.1 Accuracy

Source: SRD 3.2.2.1.1

Rationale: TBD.

3.2.2.1.2.1 MGS Integrity Risk

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.2.1.2 Service Level 8

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF and proposed performance for SL 8.

3.2.2.1.2.2 Protection Level Integrity Risk

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.2.2.1 Service Level 7

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.2.2.2 Service Level 8

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF and proposed performance for SL 8.

3.2.2.1.2.2.3 Integrity of a Single Reference Receiver

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.2.3.1 Service Level 7

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.2.3.2 Service Level 8

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF and proposed performance for SL 8.

3.2.2.1.2.3.1 Latent Failure

Source: SRD 3.2.2.1.2

Rationale: Interoperability with FAA LGF.

3.2.2.1.3.1 Data Broadcast Continuity

Source: SRD 3.2.2.1.3

Rationale: Interoperability with FAA LGF.

3.2.2.1.3.2 Reference Receiver and Ground Integrity Monitoring Continuity

Source: SRD 3.2.2.1.3

Rationale: Interoperability with FAA LGF.

3.2.2.1.3.2.1 Service Level 7

Source: SRD 3.2.2.1.3

Rationale: Interoperability with FAA LGF.

3.2.2.1.3.2.2 Service Level 8

Source: SRD 3.2.2.1.3

Rationale: Interoperability with FAA LGF and proposed performance for SL 8.

3.2.2.1.3.3 Latent Failures Affecting Continuity

Source: SRD 3.2.2.1.3

Rationale: Interoperability with FAA LGF.

3.2.2.5 Coverage Volume

Source: SRD 3.2.2.5

Rationale: Interoperability with FAA LGF.

Comment: The omni signal may not be appropriate for an Low Probability of Intercept (LPI) link for the M-T configuration. This is still an open issue.

3.2.2.5.1 Data Broadcast Coverage Volume

Source: SRD 3.2.2.5

Rationale: Interoperability with FAA LGF.

3.2.2.6 Operational Availability

Source: SRD 3.2.2.6.

Rationale: TBD

Comment: This information is subject to change and might be different for SPS and PPS services.

3.2.2.6.1 Fixed Base Ao.

Source: SRD 3.2.2.6.1.

Rationale: TBD

3.2.2.6.2 Tactical Ao.

Source: SRD 3.2.2.6.2.

Rationale: TBD

3.2.2.6.3 Special Mission Ao.

Source: SRD 3.2.2.6.3.

Rationale: TBD

3.2.2.7 Vulnerability to Disruption/Spoofing

Source: SRD 3.2.2.7.

Rationale: See first paragraph. Also, CJCSI 6130.01B requires the P(Y) code differential corrections must be encrypted during military combat operations.

3.2.2.8.6 Type 6 Message—Differential Carrier Phase Corrections

Comment: ESC indicated there would be no mixed mode, pending resolution of crypto issues.

3.2.3.2 Power

Source: Adapted from SRD 3.2.3.2.

Comment: AES will define the input power characteristics.

3.2.3.3 Dimensions

3.2.3.4 Weight

3.2.4 Reliability

Source: ORD 4.3.6 and SRD 3.2.4.

Rationale: From ORD "The MTBF and MRT parameters were established to minimize logistics life cycle costs and on-site maintenance. The stated thresholds are consistent with current technology and provide a significant improvement over existing systems." It is assumed that these requirements apply only to the MGS and not in combination with the MAS.

3.2.5.1 Conformance to the Maintenance Concept

Source: Adapted from SRD 3.2.5.1 and SRD 3.2.5.3.

3.2.5.2 Scheduled Maintenance

Source: Adapted from SRD 3.2.5.1.

Source: SRD 3.2.5.2.

Source: Prior MGS spec 3.2.3.2.2.

3.2.5.4 Built-In Test

Source: SRD 3.2.5.4.

3.2.5.5 Corrective Maintenance

Source: ORD 4.3.6 and SRD 3.2.5.5.

Rationale: From ORD "The MTBF and MRT" [MTTR] "parameters were established to minimize logistics life cycle costs and on-site maintenance. The stated thresholds are consistent with current technology and provide a significant improvement over existing systems. Remote monitoring, aggressive BIT and a capability to remove and replace a degraded or defective Line Replacement Unit without degrading beyond acceptable minima or downing the system is required to meet maintainability requirements."

3.2.6.1 Electrical and EMI (Electromagnetic Interference)

Source: Prior MGS spec paragraph 3.2.2.

Source: SRD paragraph 3.2.6.1

3.2.6.1.1 Interference

Source: Prior MGS spec paragraph 3.3.2.1

3.2.6.1.2 Electromagnetic Radiation

Source: SRD paragraph 3.3.2.1

3.2.6.1.3 TEMPEST

Source: Prior MGS spec paragraph 3.3.2.2

3.2.6.1.4 Lightning

Source: Prior MGS spec paragraph 3.3.2.3

3.2.6.2 Threat Environment

Source: SRD paragraph 3.2.6.2.

3.2.6.4 Environment, Safety and Health

Source: SRD paragraph 3.2.6.4 (rewritten as system requirements rather than tasks).

3.2.6.5.1 Operating Environment

The LGF has earthquake requirement that will be considered, as well.

3.2.7 Transportability

Source: ORD 4.3.3.

Rationale: SRD applies these requirements to the Fixed Base MGS, the ORD does not.

3.2.7.1 Tactical MGS Transportability

3.2.7.2 Special Mission MGS Transportability

Source: ORD 4.3.3.

Rationale: ORD makes the distinction between threshold and objective requirements, the SRD does not.

3.3.1.3 Product Marking

Source: Prior MGS 3.3.3

3.3.4 Safety Engineering

Source: Prior MGS 3.3.4.

3.3.5 Human Engineering

Source: Adapted from prior MGS 3.3.6.

3.4 Logistics Requirements

Source: Part of prior MGS 3.5.

Rationale: Derived from ORD 4.3, Logistics and Readiness, requirement for self-contained operation in tactical and special mission environments and ORD 4.3.5, Sustainability, referencing use of deployment package.

3.4.4 Support Equipment

Source: ORD 5.2 and SRD 3.4.4. ORD paragraph was used in preference to SRD paragraph SRD .

3.4.4.2 Depot Support Equipment

Source: ORD 5.1 and SRD 3.2.5.3.

3.5 Personnel and Training

Source: SRD 3.5.

Rationale: SRD assumes power is handled by host base personnel.

5. Packaging and Preparation for Delivery

Source: SRD section 5.