Sea Based Joint Precision Approach and Landing System (JPALS) Ship System Performance Specification

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REVISIONS

Revision Number	Date	Description	Pages Affected
-	30 Oct 03	Initial Release	All
A	25 Jun 04	Complete update based on harmonizing outline with Land Based JPALS documents and ongoing engineering efforts.	All

Contents

1 Scope

1.1 Identification

This specification establishes the functional and performance requirements for the ship segment of the Sea Based Joint Precision Approach and Landing System (JPALS) (formerly known as the Shipboard Relative Global Positioning System (SRGPS)). It is not the intent of this specification to allocate requirements to hardware or software configuration items.

Requirements contained within this specification were derived from the Sea Based JPALS System Requirements Document (SRD) [15] to support the Operational Requirements Document (ORD) for the Joint Precision Approach and Landing System (JPALS) (USAF 002-94-I), Block I Shipboard Operating Environment (SOE) [4].

Note: This specification was developed to support the ORD referenced above. The ORD will be replaced by a Capability Development Document (CDD) and future versions of the Sea Based JPALS specifications will be developed to support the CDD.

1.2 System Overview

JPALS provides the Department of Defense (DoD) with a navigation, air traffic control (ATC), and landing capability for Shipboard operations and a terminal navigation, precision approach, and landing capability for Fixed Base, Tactical, and Special Mission operations ashore. JPALS consists of modular avionics and ground components to provide a range of navigation, air traffic control, and landing capabilities that can be tailored to satisfy mission needs. JPALS information will be broadcast from ground or ship systems to aircraft avionics. Aircraft will receive ranging and navigation data from the satellite constellation and differential ranging data or corrections from a ground/shipboard station via a data link (DL). The JPALS Operational View-1 (OV-1) is shown in Figure 1-1.

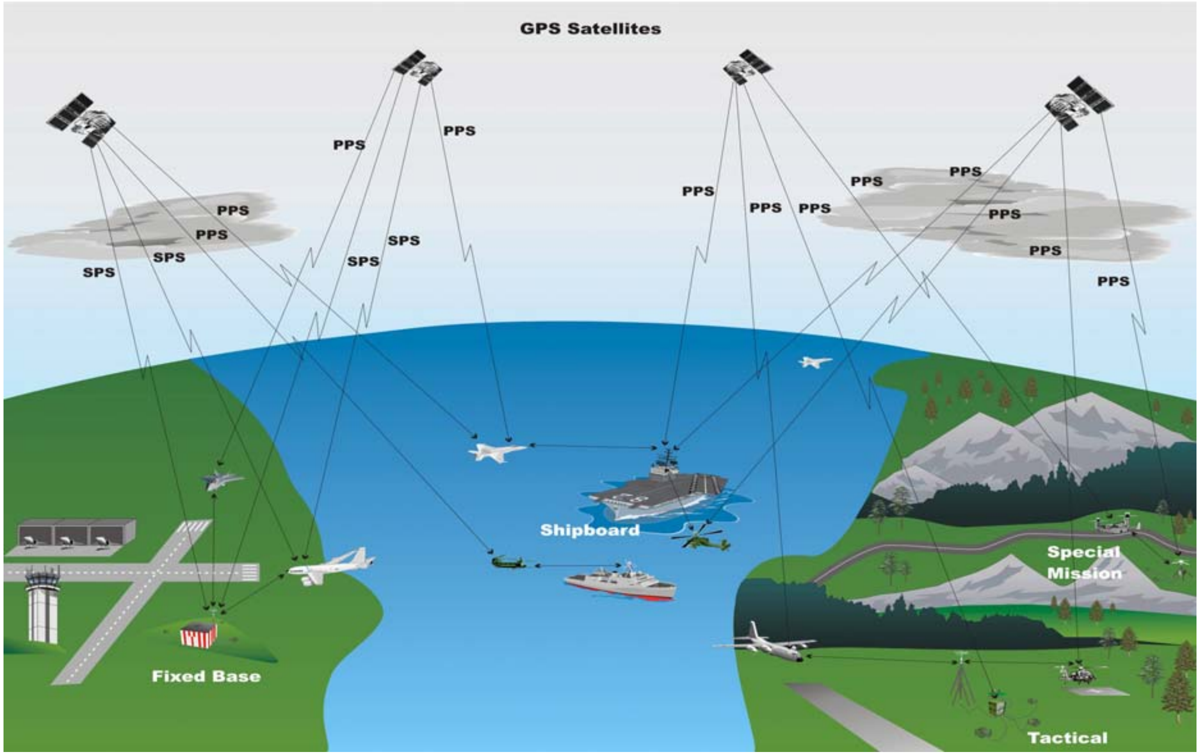

Figure 1-1: JPALS Operation View-1 (OV-1)

Sea Based JPALS supports three-dimensional positioning and guidance, secure two-way communications with the ship, separation of aircraft on approach, and monitoring of approach data by ship operators on military air-capable ships. Sea Based JPALS is a safety-critical system consisting of hardware and software that uses the Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) Precise Positioning Service (PPS) and a data link (DL) network to perform relative navigation to JPALS-equipped US Navy and North Atlantic Treaty Organization (NATO) ships. Relative measurement processing using GPS data is used to meet the accuracy, integrity, continuity, and availability requirements of Sea Based JPALS supported operations. The ship relative augmentations to GPS PPS are based on relative GPS positioning concepts. GPS measurement functions within Sea Based JPALS are protected by GPS anti-jam equipment. The DL network supports the relative navigation functions and is intended to aid in monitoring functions and to supplement ship-to-air and air-to-ship communications.

1.3 Operating Environment

The Sea Based JPALS must be capable of conducting its primary functions, such as navigation, approach and landing operations, while at sea under potentially severe marine weather and ship motion conditions and in a challenging electromagnetic environment. Hostile enemy action will normally be targeted on the aviation ship and will typically include long-range missiles and subsurface threats. Information generated by Sea Based JPALS must be protected against enemy efforts to detect, classify, geo-locate, and/or target friendly forces (e.g., the aircraft carrier). Flight operations are conducted on multiple classes and types of ships that may be deployed individually or within a battle group or task force. The role and use of Sea Based JPALS in support of operations in this environment are described in detail in the *Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System (JPALS)* (CONOPS) [7].

1.4 JPALS Requirements Hierarchy

This Sea Based JPALS Ship System Performance Specification is part of a family of documents that establish the system, performance, and interface requirements for Sea Based JPALS. Figure 1-2 illustrates the hierarchy of the various Sea Based JPALS requirements documents.

The JPALS ORD [4] contains the JPALS operational requirements, which are the primary source for the Sea Based JPALS performance requirements. Additional Sea Based JPALS performance requirements were derived to support the capabilities and operations described in the CONOPS [7]. The system level requirements derived from the JPALS ORD [4] and CONOPS [7] are documented in the Sea Based JPALS SRD [15]. From the SRD [15], Sea Based JPALS performance requirements are then allocated to the Sea Based JPALS-Ship specification and the Sea Based JPALS -Air specification, as applicable. The interface between ship and air is defined in the Sea Based JPALS SIS Interface specification.

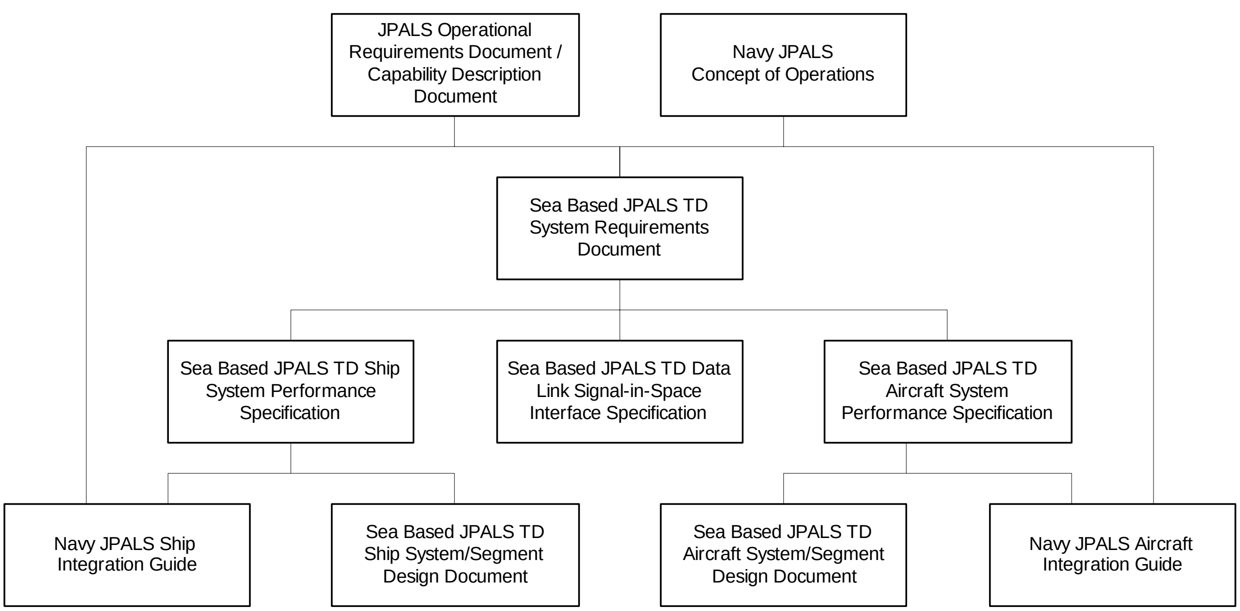

Figure 1-2 : Sea Based JPALS Specification Tree

Both the Sea Based JPALS-Ship and Sea Based JPALS-Air specifications have companion integration guidance documents. The integration guidance documents provide detailed information pertaining to the installation and integration of Sea Based JPALS on ships and aircraft.

Design documents will be created during the Technology Development (TD) phase to reflect the Sea Based JPALS-Ship and Sea Based JPALS-Air design used to validate these requirements and allocation decisions made during that phase.

This specification is to be used with the following specifications:

- Sea Based JPALS DL SIS Interface Specification [16]
- Sea Based JPALS-Air System Performance Specification [17].
- JPALS Ship Integration Guide [6].

1.5 Document Overview

This document contains the following sections:

1. **Scope:** Contains the project identification, system and document overviews, and a list of assumptions used in this document.
2. **Applicable Documents:** Provides a list of the documents referenced in this standard. References contain the document number, exact title, revision level and issue date.
3. **Requirements:** Specifies the requirements for the system to which this specification applies.
4. **Quality Assurance:** Ensures that the requirements of section 3 are satisfied.
5. **Terms and Acronyms**: Defines terms and acronyms defined in this document.
6. **Interface Definition**: Provides definition of data elements passed across the interfaces defined in this document.

The word "equipment", as used in this document, includes all components or units necessary (as determined by the equipment manufacturer or installer) to properly perform its intended function.

In this document, the term “shall” is used to indicate requirements. An approved design would comply with every requirement, which can be assured by inspection, test, analysis, or demonstration.

The terms “must” and "will" are used to identify items which are important but are either duplicated somewhere else in the document as a “shall”, or are specified in other documents.

The term “should” is used to denote a recommendation that would improve the Sea Based JPALS equipment, but does not constitute a minimum requirement.

While the specification development proceeds, a single term ("to be reviewed (TBR)") is used to identify any requirements that might ordinarily be labeled as to be determined/defined (TBD), to be specified (TBS), to be provided (TBP), or TBR.

1.6 Assumptions

1.6.1 Interference Environment

It is assumed that the environment specified in section 3.2.5 for which Sea Based JPALS-Ship must operate bounds the actual operational environment. If the environment is more severe than that specified in Section 3.2.5, the availability of Sea Based JPALS may be reduced; however, the requirements related to safety of flight will still be met.

1.6.2 GPS Signal-In-Space

It is assumed that GPS satellites transmit signals that comply with ICD-GPS-200C [1] and the *GPS Standard Positioning Service (SPS) Performance Standard* [5].

Note: The GPS Precise Positioning Service (PPS) Performance Standard will be applicable and referenced when published.

JPALS performance assumes all GPS satellites in view support dual frequency code and carrier phase measurements all the time.

1.6.3 Sea Based JPALS Signal-In-Space

It is assumed that the Sea Based JPALS-Air is providing SIS in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

1.6.4 Sea Based JPALS-Air System

It is assumed that the Sea Based JPALS-Air is operating in conformance with the requirements stated in the Sea Based JPALS-Air System Performance Specification [17].

1.6.5 Sea Based JPALS Application

Sea Based JPALS technology is fundamentally different from current navigation and ATC systems such as SPN-41, SPN-46, air surveillance radar, and TACAN. Therefore, Sea Based JPALS will incorporate some new and different procedures for operations around Navy ships. However, even though some procedures are different, it is possible to overlay them with current operations in a way that JPALS and legacy aircraft can operate in a compatible manner. In general, these differences will be in specific operator actions versus the generic functions supporting navigation, communications, and separation. In other words, despite the differences in some procedures, Sea Based JPALS can be used to support the same ATC functions as legacy systems. As the air wing approaches full JPALS equipage, it is anticipated that Sea Based JPALS procedures will be revised or extended to take greater advantage of the system's performance capabilities.

2 Reference 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.

[1] Department of Defense. (2000). NAVSTAR GPS Space Segment/Navigation User Interfaces (ICD-GPS-200C with IRN-200C-005R1, 14 January 2003). Washington, DC: U.S. Government Printing Office.

[2] Department of Defense. (1995). General Guidelines for Electronic Equipment (MIL-HDBK-454). Washington, DC: U.S. Government Printing Office.

[3] Department of Defense. (1989). Human Engineering Design Criteria for Military Systems Equipment and Facilities. (MIL-HDBK-1472). Washington, DC: U.S. Government Printing Office.

[4] Operational Requirements Document (ORD) for Joint Precision Approach and Landing System (JPALS), USAF-002-94-I, 19 March 2003, Air Force Flight Standards Agency.

[5] Department of Defense. GPS Standard Positioning Service (SPS) Performance Standard. October 2001.

[6] Shipboard Integration Trade Study Report (Shipboard Integration Guide) for the Sea Based Joint Precision Approach and Landing System (JPALS), 7 May 2004, Sierra Nevada Corporation.

[7] Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System (JPALS) IOC (2012), Draft, 15 May 2004, Naval Air Warfare Center.

[8] Department of Defense. Interface Standard for Shipboard Systems (MIL-STD-1399 Interface Standard for Shipboard Systems). Washington, DC: U.S. Government Printing Office.

[9] Department of Defense. Electronic Equipment Specifications, Preparation of (MIL-HDBK-2036). Washington, DC: U.S. Government Printing Office.

[10] Department of Defense. Program Managers Guide for the Standard Electronic Modules Program, General Specification for (MIL-HDBK-246A). Washington, DC: U.S. Government Printing Office.

[11] Department of Defense. Reliability Prediction of Electronic Equipment (MIL-HDBK-217F). Washington, DC: U.S. Government Printing Office.

[12] Department of Defense. Requirement for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (MIL-STD-461E). Washington, DC: U.S. Government Printing Office.

[13] Department of Defense. Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety (MIL-STD-1310G). Washington, DC: U.S. Government Printing Office.

[14] Department of Labor. Code of Federal Regulations. Title 29 Labor, Part 1910 Occupational Safety and Health Standards, Subpart Z Toxic and Hazardous Substances. 1 July 2003.

[15] Sea Based JPALS System Requirements Document (025323-001], 25 June 2004.

[16] ARINC. Sea Based JPALS-Data Link Signal In Space Interface Specification (025323-004), 25 June 2004.

[17] ARINC. Sea Based JPALS-Air System Performance Specification (025323-002), 25 June 2004.

[18] American National Standards Institute. Safety Color Code. (ANSI/NEMA Z535.1).

[19] American National Standards Institute. Environmental and Facility Safety Signs (ANSI/NEMA Z535.2).

[20] American National Standards Institute. Criteria for Safety Symbols (ANSI/NEMA Z535.3).

[21] American National Standards Institute. Product Safety Signs and Labels (ANSI/NEMA Z535.4).

[22] American National Standards Institute. Radio Frequency Radiation Hazard Warning Symbol (ANSI C95.2).

[23] Joint Technical Architecture (JTA) Version 6.0, 3 October 2003, Department of Defense.

[24] CJCSI 6130.01C, *2003 Chairman of the Joint Chiefs of Staff (CJCS) Master Positioning, Navigation, and Timing Plan*, 31 March 2003, Joint Staff, Washington, DC.

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
3. JPALS Sea Based JPALS SRD
4. Sea Based JPALS-Ship System Performance Specification (this document)
5. Other Referenced Specifications and Documents

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 contractually effective means.

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

3 Requirements

This section prescribes functional and performance requirements for the Sea Based JPALS-Ship. Functional requirements and their groupings do not imply allocation of functionality to hardware and software design. Only when required to establish interoperability, specific design and/or algorithms are specified. Certain other design-specific requirements are given to ensure the accuracy, continuity, availability, and integrity needed to support minimum performance levels required to operate safely in the ship environment.

3.1 System Definition

3.1.1 Major Functional Capabilities

The Sea Based JPALS-Ship provides two major functional capabilities:

1. Ship-relative navigation and
2. Communications with Sea Based JPALS-Air equipped and participating aircraft.

The Sea Based JPALS-Ship navigation function determines ship state information and GPS corrections and integrity parameters for use by Sea Based JPALS-Air. The Sea Based JPALS-Ship navigation function supports aircraft performing area navigation, launch, and recovery operations including taxi, take-off, departure, marshal, approach and landing, and missed approach operations using Sea Based JPALS-Air. The navigation function is specified in section 3.2.1.2.

The communication function allows exchange of data between Sea Based JPALS-Ship and Sea Based JPALS-Air. It provides the capability to supply ship state data, path definition data, environmental conditions, and other information to participating aircraft. The communication function will receive monitoring broadcasts from participating aircraft. It will also allow aircraft to initialize inertial sensors using ship sensor information while onboard the ship. The communication function includes a data link transmit and receive function and a communications processing function as specified in section 3.2.1.4.

3.1.2 States and Modes of Operation

3.1.2.1 States

The Sea Based JPALS-Ship shall have the following two states:

1. Sea Based JPALS-Ship On: Main or supplemental power is applied to the Sea Based JPALS-Ship equipment, and
2. Sea Based JPALS-Ship Off: No power is applied to the Sea Based JPALS-Ship equipment.

Only one state shall exist at a time.

3.1.2.2 Modes

The Sea Based JPALS-Ship shall provide the following modes of operation:

1. Normal,
2. Not Available, and
3. Test

Only one mode shall exist at a time.

3.1.2.2.1 Normal Mode

The Sea Based JPALS-Ship shall be in Normal mode when Test mode has not been commanded and an alarm condition does not exist.

3.1.2.2.2 Not Available Mode

The Sea Based JPALS-Ship shall automatically transition from Normal to Not Available when there is an alarm condition.

The Sea Based JPALS-Ship shall remain in the Not Available mode until the alarm condition is cleared or the Sea Based JPALS-Ship is placed in the Test mode.

Note: The functions and capabilities available in "Not Available" mode are still to be determined (TBR). The Alarm conditions are still being defined and their definition will drive what can and can't be done with the system during a given condition. It may force a change in the name of this mode.

3.1.2.2.3 Test Mode

The Sea Based JPALS-Ship shall automatically transition from either Normal or Not Available mode to Test mode when commanded by a maintenance specialist.

The Test mode shall support all capabilities needed in the performance of maintenance and test operations, including broadcasting of both Sea Based JPALS and pass-through messages.

Upon exiting the Test mode, the Sea Based JPALS-Ship shall revert to either the Normal or Not Available mode, depending on the existence of an alarm condition.

3.1.3 Interface Definition

3.1.3.1 External Interfaces

3.1.3.1.1 Global Positioning System

The Sea Based JPALS-Ship shall interface with the GPS satellite constellation in order to receive and use ranging signals and satellite orbital parameters. Both the L1 and L2 frequencies shall be used. This interface shall be in accordance with ICD-GPS-200C [1] and all current interface revision notices.

3.1.3.1.2 Network Related Interfaces

Sea Based JPALS requires a number of parameters to establish the DL network, including channel identification (ID), target ship ID, and ship ID. These may be internally generated by Sea Based JPALS functions or may be provided by external systems. External ship systems may identify a channel ID for the DL to use for tuning and establishing a network

3.1.3.1.3 Status and Alerts

Sea Based JPALS-Air outputs status information for distribution to and for use by other aircraft systems.

3.1.3.1.4 Sea Based JPALS-Ship Interfaces to External Ship Systems

The Sea Based JPALS-Ship external interfaces are described in Table 3-1. The data elements included in each data group listed in the table are defined in Section 6.

Table 3-1: Sea Based JPALS Shipboard External Interfaces

JPALS Function	Publishes	Subscribes To
Navigation		Ship Status Data
Guidance		Aircraft Geometry, Path Definition Data, Ship Geometry, Ship Wind Over Deck
Monitoring	Aircraft Approach Profile Changes, Aircraft Configuration, Aircraft ID, Aircraft Status, Guidance Data (deviation), Relative State Data	
Communications	Aircraft Maintenance Data, Air Traffic Management (ATM) Downlink Messages, J-UCAS Downlink Messages	ATM Broadcast Data, ATM Uplink Messages, Environmental Data, INS Alignment Data, J-UCAS Uplink Messages, Ship Wind Over Deck

3.1.3.1.5 Sea Based JPALS-Ship Interface to Sea Based JPALS-Air

The Sea Based JPALS-Ship segment shall interface with the Sea Based JPALS-Air segment via the Sea Based JPALS DL SIS in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.1.3.2 Internal Interfaces

The Sea Based JPALS-Ship internal interfaces are to be determined (TBR).

3.2 Characteristics

3.2.1 Performance

3.2.1.1 General System Requirements

The requirements of this section apply to all Sea Based JPALS functions.

3.2.1.1.1 Probability of Detection, Classification, Location, and Exploitation

Sea Based JPALS shall operate while precluding a hostile force's ability to identify the presence of a signal and use that signal or the data in it to threaten the ship when the hostile force is located beyond the distance specified in the classified (TBR) document.

Note: It is anticipated that this will be specified as a probability of detection (e.g., 5%) by an intercept receiver at a specified distance.

Per CJCSI 6130.01C [24], Sea Based JPALS shall encrypt any P(Y) code differential corrections.

3.2.1.1.2 Data Link Network

3.2.1.1.2.1 Network Selection

Sea Based JPALS shall provide a means for the ship to select the Sea Based JPALS Channel.

3.2.1.1.2.2 Network Connectivity

Sea Based JPALS shall establish network connectivity (within the capacity limitations defined in the SRD [15]) between Sea Based JPALS equipped platforms within the coverage volumes.

Reception of a transmitted signal from the selected ship shall be sufficient to establish a network connection.

Note: The acquisition of the DL network is determined by the reception of the DL signal from the ship. At this point the aircraft is part of the ship's DL network and begins to receive ship's location information. At the 200 nm threshold, this information will only be in a single direction and no transmissions take place from the aircraft to the ship.

3.2.1.1.2.3 Acquisition Time

Within 50 nm region of the ship, an aircraft must make a request on the DL network to acquire a slot within the network and begin transmitting data back to the ship. This login request process shall be completed within TBR seconds.

Note: This assumes a network connection and is quantified as the amount of time from the initiation of a login request until an acknowledgment back to the aircraft that DL transmission may occur.

If the aircraft is on the deck of the ship prior to flight operations, it will initially receive the 200 nm DL content. The aircraft will initiate the login request in the same manner as done at the 50 nm threshold.

3.2.1.1.2.4 Network Logoff

Sea Based JPALS shall include a mechanism to terminate individual network connections.

The Sea Based JPALS DL channel shall have a bandwidth of 1.2 MHz.

3.2.1.1.2.5 Network Operational Constraints

The Sea Based JPALS DL network must be capable of operating in the presence of another Sea Based JPALS network (at a different frequency) without performance degradation.

3.2.1.1.3 Message Prioritization

Sea Based JPALS-Ship shall prioritize the processing of messages sent from the ship and received from aircraft.

3.2.1.1.4 Interoperability

To achieve interoperability, Sea Based JPALS will comply with applicable information technology standards contained in the DoD Joint Technical Architecture (JTA) [23].

3.2.1.1.4.1 Geospatial Information and Services Support

Systems requiring geospatial information and services support shall be capable of accepting National Geospatial-Intelligence Agency (NGA) standard products.

Absolute position data shall be expressed in World Geodetic System 1984 (WGS-84) coordinates.

3.2.1.1.5 Test Support

Sea Based JPALS-Ship shall support test and qualification requirements for new ship installations.

Note: The Navy will be developing detailed requirements for this as the program and system development mature.

3.2.1.2 Navigation Functions

3.2.1.2.1 GPS Reference Receiver Characteristics

The GPS sensor function is made up of all hardware and software required to produce shipboard GPS observables data. This includes antennas, cables, GPS receivers, and any associated processors and software.

3.2.1.2.1.1 Output

The GPS Sensor Function shall output the following data at the rates defined:

- GPS Navigation Data-Complete set every 30 seconds per satellite vehicle (SV)
- 1 pulse per second derived from L1 or L2, accurate to 1.0 μS relative to top of epoch
- L1 and L2 Pseudorange Data at 2 Hz minimum
- L1 and L2 Carrier Phase Data at 10 Hz minimum
- Time of measurement - in GPS time, top of epoch and appropriate fraction of update rate

3.2.1.2.1.2 Ranging Sources

Sea Based JPALS-Ship shall automatically select ranging sources for use in the navigation computation. The ship system shall be capable of using signals from the GPS satellites. The GPS sensor function shall be capable of simultaneously tracking and continuously decoding the associated navigation data for at least 12 ranging sources on each frequency (L1 and L2).

3.2.1.2.1.3 Sensitivity and Dynamic Range

3.2.1.2.1.3.1 Input GPS Signal and Noise Levels

The GPS sensor function shall meet all requirements when receiving the minimum and maximum input signal and noise levels specified in *ICD-GPS-200C* [1].

3.2.1.2.1.4 Anti-Jamming Capability

The GPS sensor function shall have an Anti-Jam (A/J) Capability sufficient for the GPS sensor function to meet the SV availability requirements in both intentional and unintentional jamming situations.

Note: Jamming environment is TBR and will be separately documented.

3.2.1.2.1.5 GPS Sensor System Antenna-Specific Requirements

3.2.1.2.1.5.1 Antenna Gain Characteristics

The antenna gain characteristics, internal low noise amplifier (LNA) noise figure, gain, and compression characteristics, and cable performance, shall be adequate to meet the overall GPS sensor function requirements.

3.2.1.2.1.5.2 Differential Group Delay

On L1 and L2, the differential group delay of the GPS sensor antenna, including integrated LNA, shall not exceed 50 ns.

The differential group delay is defined as:

$$\left| \frac{d\phi}{d\omega}(f_c) - \frac{d\phi}{d\omega}(f_{3db}) \right| \qquad \textbf{(1)}$$

where

f_c is the pre-correlation band pass filter center frequency

f_{3db} are the 3db cut off points of the filter

ϕ is the phase response of pre-correlation ban pass filter

ω is the frequency

3.2.1.2.1.5.3 Out-of-band Rejection

The antenna out-of-band rejection characteristics shall be adequate to meet the overall GPS sensor function requirements.

3.2.1.2.1.5.4 Polarization

The GPS sensor function antenna shall receive right hand circularly polarized signals.

3.2.1.2.1.5.5 L1-L2 Propagation Delay

The difference in propagation delay in the antenna between L1 and L2 signals shall not exceed 1.5 ns.

3.2.1.2.1.5.6 Phase Center Variation

The corrected electrical phase center variation of the antenna at either L1 or at L2 shall not exceed 1.0 cm (TBR) over all environmental conditions.

3.2.1.2.1.6 GPS Signal Processing

3.2.1.2.1.6.1 Frequency

The GPS sensor function shall receive signals broadcast in accordance with SIS definitions specified in ICD-GPS-200C [1] at L1 and L2.

The GPS sensor function shall be capable of simultaneous tracking of at least 12 SVs at L1 and at least 12 SVs at L2. (24 channels)

Note: No reference is made here of L1 coarse acquisition (C/A). These requirements will be imposed separately on the airborne system at the platform level. This document deals expressly with operation with Sea Based JPALS.

3.2.1.2.1.6.2 GPS Sensor Dynamic Filtering and Corrections

Any internal filtering of the pseudorange, deltarange and carrier phase output data shall be disabled. This includes carrier phase smoothing, dynamic filtering, and compensation for ionospheric and tropospheric effects.

1. The output observables shall not have Selective Availability (SA) removed.
2. No atmospheric corrections shall be applied to pseudorange measurements.
3. The SV clock correction and relativistic correction of ICD-GPS-200C [1] paragraph 20.3.3.3.3.1 shall be applied to pseudorange measurements.
4. The group delay correction of ICD-GPS-200C [1] paragraph 20.3.3.3.3.2 shall be applied to SPS mode pseudorange measurements.
5. The ionospheric correction of ICD-GPS-200C [1] paragraph 20.3.3.3.3.3 shall not be applied to any pseudorange measurements.
6. Earth rotation effects during signal transmission shall not be applied to any pseudorange measurements.

The GPS sensor function shall initialize with any filters disabled.

3.2.1.2.1.6.3 Navigation Data

The GPS sensor function shall continue to decode ephemeris and clock parameters for all ranging sources being used in the navigation solution.

Note: Equipment should be able to track satellites under conditions of ionospheric scintillation that could occur during solar maximum at auroral and equatorial latitudes. There is insufficient information to characterize scintillation and define appropriate requirements and tests for inclusion in this document. However, equipment should be able to track satellites through phase jitter and amplitude fading that can result from scintillation. New requirements may be defined when ionospheric effects can be adequately characterized.

3.2.1.2.1.6.4 Tracking Characteristics (TBR)

Time to subsequent fix (TTSF) shall not exceed 10 seconds. TTSF is defined as the time to re-acquire a SV after the removal of interference or blockage that caused loss-of-lock of the SV.

The GPS sensor function can use any correlator spacing as long as all other sensor requirements are met.

The strongest correlation peak shall be acquired taking into account the effect of any secondary peak found at any code offset within the entire code sequence.

The GPS sensor function shall maintain carrier phase tracking under the specified input signal and noise environment.

3.2.1.2.1.7 Accuracy

The accuracy requirements specified in the following sections represent the performance in steady state conditions, including errors such as processing errors, thermal noise and interference. Steady state operation is defined to be following at least 3.6 time constants of the filter design of continuous operation.

3.2.1.2.1.7.1 Ranging Accuracy (TBR)

When the GPS sensor function is operating at the minimum input level, the pseudorange error attributed to the GPS sensor function, when filtered by a hypothetical 100-second carrier phase smoothing filter, after removal of clock bias, and excluding any multipath effects, shall not exceed 0.089 meters (TBR) root-mean-square (RMS).

The pseudorange inter-channel bias of the GPS sensor function, when compared with the average of all channels, shall not exceed 1.0 cm.

The GPS sensor function pseudorange shall be referenced to a point at the antenna phase center.

The GPS sensor function pseudorange accuracy, including inter-channel bias, group delay variations, and multipath, when filtered by a hypothetical 100-second carrier phase smoothing filter shall be within 1.0 meter (1-sigma) for any satellite tracked within the coverage volume at an elevation of 5 to 10 degrees. (TBR when more data on airborne accuracy curves is known.)

The GPS sensor function pseudorange accuracy, including inter-channel bias, group delay variations, and multipath, when filtered by a hypothetical 100-second carrier phase smoothing filter shall be within 0.75 meters (1-sigma) for any satellite tracked within the coverage volume at an elevation of 10 to 20 degrees. (TBR when more data on airborne accuracy curves is known.)

The GPS sensor function pseudorange accuracy, including inter-channel bias, group delay variations, and multipath, when filtered by a hypothetical 100-second carrier phase smoothing filter shall be within 0.5 meters (1-sigma) for any satellite tracked within the coverage volume at an elevation of 20 to 30 degrees. (TBR when more data on airborne accuracy curves is known.)

The GPS sensor function pseudorange accuracy, including inter-channel bias, group delay variations, and multipath, when filtered by a hypothetical 100-second carrier phase smoothing filter shall be within 0.5 meters (1-sigma) for any satellite tracked within the coverage volume at an elevation of 30 to 40 degrees. (TBR when more data on airborne accuracy curves is known.)

The GPS sensor function pseudorange accuracy, including inter-channel bias, group delay variations, and multipath, when filtered by a hypothetical 100-second carrier phase smoothing filter shall be within 0.4 meters (1-sigma) for any satellite tracked within the coverage volume at an elevation >40 degrees. (TBR when more data on airborne accuracy curves is known.)

3.2.1.2.1.7.2 Carrier Phase Accuracy (TBR)

The GPS sensor function integrated Doppler error, including receiver noise, antenna phase variations, and multipath, shall be less than .05 wavelength RMS (TBR) for all SV's in view from 5.0 degrees elevation to 90 degrees elevation, at all azimuth angles.

Note 1: 0.05 wavelength is defined since L1 and L2 will have slightly different requirements if specified in cm.

Note 2: The GPS sensor function will likely be required to use beam steering techniques in order to independently maintain a high direct path to multipath ratio for all received satellites, as well as to control antenna phase variations in the direction of the SV's. The GPS sensor function antenna system will have to contain sufficient azimuth aperture to maintain a direct path to multipath ratio of 10.2 dB (TBR) or higher due to airframe obstructions and reflectors, and to defeat broadband jammers.

3.2.1.2.2 Inertial Sensor Characteristics

3.2.1.2.2.1 Outputs

The inertial sensor shall be an all-attitude navigation system providing outputs of linear and angular acceleration, velocity, position, attitude (roll, pitch and platform azimuth), magnetic and true heading, altitude, body angular rates, time tags, and time.

3.2.1.2.2.2 Inputs

The inertial sensor shall require electrical power, and shall accept turn-on and mode commands, initialization data, and altitude data.

3.2.1.2.2.3 Modes

The inertial sensor shall be capable of operating in the various modes as defined below. The sensor shall operate at all latitudes and longitudes. Present position shall be calculated (as a default) in WGS-84 geographical coordinates.

3.2.1.2.2.3.1 Align (Ship Stationary)

This is the primary inertial alignment mode. In this mode, present position shall be entered, then a gyrocompass alignment shall be performed in azimuth to determine the vehicle true heading. This alignment shall be accomplished in 4 minutes or less assuming no vehicle motion.

3.2.1.2.2.3.2 Stored Heading Alignment (Stationary)

This is an accelerated alignment mode, which may be accomplished if a full gyrocompass alignment had been previously completed and the system was shut down in an orderly manner directly from the Align mode. A further requirement is that the platform had not been moved after system shutdown. This alignment shall be accomplished in 60 seconds (TBR).

3.2.1.2.2.3.3 Moving Base Alignment

The moving base alignment requires the input, from an external data source, of position and velocity and time. The time to complete the alignment and the quality of the alignment shall be dependent upon the quality of the external data being provided. For GPS data with a Figure of Merit (FOM) less than 5, the moving base alignment shall be accomplished in no more than 10 minutes.

3.2.1.2.2.3.4 Navigate

This is the normal operating mode after the completion of alignment. The sensor shall use the internal accelerometers and gyroscopes to sense linear and angular motion, which shall be integrated into velocity and position in an appropriate navigation reference frame.

3.2.1.2.2.3.5 Test

This is a mode utilized for maintenance purposes only. Test results shall be output and shall include failed tests and identify failed components. This mode is in addition to any continuous or periodic Built-in-Test (BIT) that is running after the system is powered on.

3.2.1.2.3 Guidance Quality

Note: The guidance quality parameters are subject to analyses that are still ongoing and will be documented after those analyses are completed.

3.2.1.2.3.1 Accuracy

3.2.1.2.3.1.1 GPS Accuracy

GPS accuracy requirements are TBR.

Note: The Accuracy Study will define and allocate these requirements for the next version of this document.

3.2.1.2.3.1.2 Inertial Sensor Accuracy

Inertial Sensor accuracy requirements are TBR.

3.2.1.2.3.2 Integrity

The SIS integrity value of 2.4×10^{-6} per hour shall be supported.

3.2.1.2.3.2.1 Integrity of Ranging Sources

Integrity requirements of ranging sources are TBR.

3.2.1.2.3.2.2 Integrity of a Single Reference Receiver

Integrity requirements of a single reference receiver are TBR.

3.2.1.2.3.2.3 Latent Failures

Latent failure requirements are TBR.

3.2.1.2.3.3 Continuity

The SIS continuity value of 9.6 x 10^{-4} per hour shall be supported.

3.2.1.2.3.3.1 GPS SIS Continuity

GPS SIS continuity requirements are TBR.

3.2.1.2.3.3.2 Reference Receiver Continuity

Reference receiver continuity requirements are TBR.

3.2.1.2.3.3.3 Inertial Sensor Continuity

Inertial Sensor continuity requirements are TBR.

3.2.1.2.3.3.4 Latent Failure Affecting Continuity

Latent failure affecting continuity requirements are TBR.

3.2.1.3 Monitoring Functions

Sea Based JPALS-Ship does not require any monitoring functions. The receipt, processing, and use of monitoring messages generated and broadcast by the Sea Based JPALS-Air are addressed in the Communications Functions section of this specification below. The monitoring messages are output by Sea Based JPALS-Ship and the content is used by external systems.

3.2.1.4 Communication Functions

Refer to *Sea Based JPALS DL SIS Interface Specification* [16] for all classified requirements.

Note: Waveform design using the 1.2 MHz bandwidth is in its design stage. Associated requirement parameters are being developed and are listed here as placeholders.

3.2.1.4.1 Coverage

Sea Based JPALS-Ship supports a variety of operations, ranging from situational awareness to precision approach.

For each operation, there is a defined set of messages to be transmitted or received by the Sea Based JPALS-Ship and a corresponding volume throughout which these messages are required to meet the signal strength, accuracy, integrity, continuity, and availability requirements for the corresponding operation.

3.2.1.4.1.1 Coverage Volume

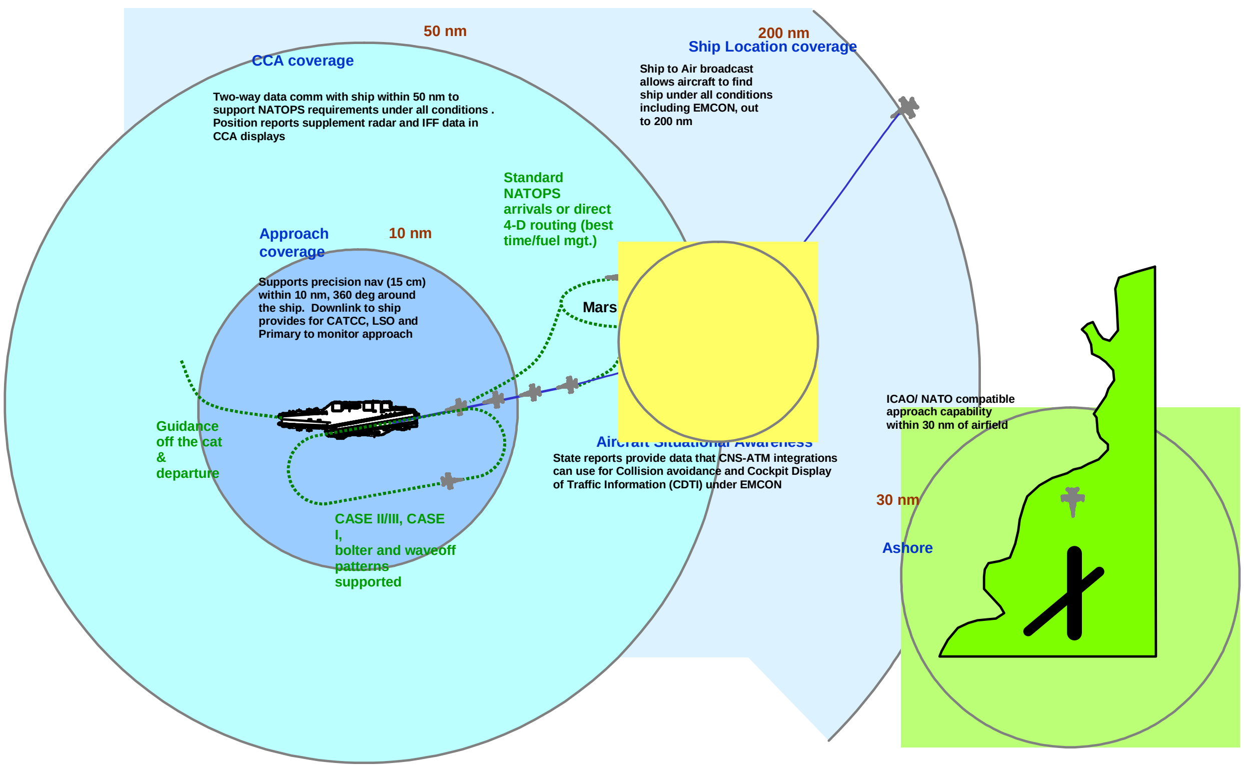

Figure 3-1: Sea Based JPALS Coverage Volume

The Sea Based JPALS coverage volumes are depicted in Figure 3-1.

All coverage requirements assume a clear line of sight and 360 degree coverage.

The Sea Based JPALS-Ship shall support non-precision navigation (Sea Based JPALS-Air Carrier Control Area (CCA) and Basic modes) when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height, has a clear line of sight to the ship and is within 200 nm from the ship.

The Sea Based JPALS-Ship shall be capable of providing non-precision navigation for all equipped aircraft in the coverage volume.

Sea Based JPALS-Ship shall support two-way communications with a Sea Based JPALS-Air equipped aircraft when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height, has a clear line of sight to the ship, and is within 50 nm of the ship.

Sea Based JPALS-Ship shall support precision navigation (Sea Based JPALS-Air Precision mode) when the aircraft is within a 360 degree cylinder from the deck altitude to 6,000 feet operating height, and is within 10 nm from the ship.

Sea Based JPALS-Ship shall provide basic monitoring for at least 50 aircraft within the coverage volume.

Sea Based JPALS-Ship shall support precision monitoring for a minimum of 10 aircraft within the coverage volume.

Sea Based JPALS-Ship shall provide the capability to supply INS Alignment Data (defined in section 6) to the air vehicle INS while the air vehicle is on the flight deck.

3.2.1.4.1.2 Signal Characteristics

Sea Based JPALS-Ship shall operate while precluding a hostile force's ability, when located beyond the distance specified in *Sea Based JPALS DL SIS Interface Specification* [16], to identify the presence of a signal and use that signal or the data in it to threaten the ship.

3.2.1.4.2 Initialization

The Sea Based JPALS DL shall accept input of initialization data, including mission planning and information security (INFOSEC) data.

Note: It is envisioned that mission planning initialization data will be available through the avionics bus on the aircraft and that INFOSEC initialization data will be provided through a fill port. Refer to the JPALS Ship Integration Guide [6] for additional guidance.

3.2.1.4.3 Tuning

3.2.1.4.3.1 Frequency Range

Sea Based JPALS-Ship shall operate over the frequency range of 225-400 MHz within the channels designated for 1.2 MHz wideband use by Frequency Plan for 225-400 MHz Band, MCEB-M-067, June 1999.

Sea Based JPALS-Ship shall operate with a bandwidth of 1.2 MHz.

3.2.1.4.3.2 Frequency Selection

Sea Based JPALS-Ship shall tune to the center frequency of any 1.2 MHz wideband channel as defined in Frequency Plan for 225-400 MHz Band, MCEB-M-067-99, June 1999.

3.2.1.4.3.3 Tuning Time

The Sea Based JPALS-Ship shall support a maximum tune time of 10 ms to settle within 1 kHz of final frequency.

3.2.1.4.3.4 Switching Times

Receive-to-Transmit (R/T) and Transmit-to- Receive (T/R) switching times shall be less than or equal to 100 μs.

3.2.1.4.3.5 Internal Timing Standard

Once the Sea Based JPALS-Ship has Universal Coordinated Time (UTC), it shall operate per specification for a period of at least 4 hours without resynchronization.

3.2.1.4.4 Information Security (INFOSEC)

Sea Based JPALS-Ship shall accept an alternate absolute Time of Day (TOD) source if GPS time is not available.

All application data over the Sea Based JPALS DL shall be encrypted. No cryptographic bypass capability is required.

3.2.1.4.4.1 Communication Security (COMSEC)

Sea Based JPALS-Ship shall use a TOD-based communication security (COMSEC) algorithm with no over the air COMSEC synchronization to protect all user data sent over the link.

TOD shall be based on UTC time.

3.2.1.4.4.2 Transmission Security (TRANSEC)

The Sea Based JPALS-Ship shall use a TOD-based TRANSEC algorithm with no over-the-air TRANSEC synchronization.

3.2.1.4.4.3 Time Slot Number Format

Sea Based JPALS INFOSEC will use a daily, non-multiple net TOD format for the time slot number (TSN). The TSN is used to initialize the INFOSEC algorithm for each INFOSEC operation. With a daily, non-multiple net TSN format, the 39-bit TSN is divided into a net number field that occupies the 7 Most Significant Bits, and a 32-bit TOD field. The net number field (TSN bits 39 to 33) is set to all 0s for Sea Based JPALS operation.

INFOSEC TSN format is identical to the TOD format for the network at the Time Division Multiple Access (TDMA) slot level as defined in the *Sea Based JPALS DL SIS Interface Specification* [6] (TSN bits 32 to 5). Below the TDMA slot level, bit 4 is used to denote COMSEC (bit 4 = 1) or TRANSEC (bit 4 = 0) operation. Bits 1-3 are currently being defined.

3.2.1.4.4.4 Rollover

At the beginning of the first TDMA epoch after midnight UTC, the crypto-variables in use will expire. The old crypto-variables will be erased and automatically replaced with new crypto-variables for the next 24 hour crypto period that were loaded as part of the pre-mission fill.

3.2.1.4.5 Message Quality and Integrity

The message error rate (MER) is defined as the portion of total transmitted messages that are not passed from the transmit function or passed with one or more errors.

The MER is computed after sync acquisition. Operating conditions that these rates are valid over are identified in paragraph 3.2.5.1.3.2 of this document.

The MER for application data shall be less than or equal to 0.5 (TBR) for Basic mode.

The MER for application data shall be less than or equal to 0.05 (TBR) for CCA mode.

The MER for application data shall be less than or equal to 10^{-3} (TBR) for Precision mode.

3.2.1.4.5.1 Integrity

The integrity is defined in terms of the probability of an undetected error in a message displayed to a user. The integrity shall be 1 x 10^{-6} (TBR) or better on a per message basis.

3.2.1.4.6 Receive Function

3.2.1.4.6.1 Sensitivity

The Sea Based JPALS-Ship shall achieve a MER per 3.2.1.4.5 with the following inputs at the RT:
-120 dBm for Basic mode
-108 dBm for CCA mode
-98 dBm for Precision mode

3.2.1.4.6.2 Selectivity

The Sea Based JPALS-Ship bandwidth shall be as follows:
+/- 185 kHz minimum at 3 dB point referenced to tuned frequency
+/- 450 kHz minimum at 20 dB points referenced to tuned frequency
+/- 670 kHz minimum at 60 dB points referenced to tuned frequency

3.2.1.4.6.3 Out-of-Band Rejection

Out-of-band rejection requirements are TBR.

3.2.1.4.6.4 Receive Signal Processing

The receiver subsystem shall incorporate measures to mitigate multi-path interference.

3.2.1.4.6.5 Data Latency

Data latency from input at the antenna to availability for output from the communication function shall not exceed TBR.

Note: The latency requirements in the Sea Based JPALS DL SIS Interface Specification [16] define end-to-end latency from data input to the transmitting DL to data availability at the output queue of the receiving DL. Transmit, receive, and network latencies will be allocated portions of the end-to-end latency specifications as part of the system design process and documented in the system/segment design document. Latencies including controller polling, bus transfer times, and application data processing will be allocated outside of the Sea Based JPALS Data Link Subsystem latency budget.

3.2.1.4.6.6 Data Format Decoding

Sea Based JPALS-Ship shall demodulate and decode the data link signal specified in the *Sea Based JPALS DL SIS Interface Specification [16]*.

3.2.1.4.6.6.1 Source Validation

Sea Based JPALS-Ship shall perform the Cyclic Redundancy Check (CRC) on all messages received, and ignore any message for which the CRC, as defined in the *Sea Based JPALS DL SIS Interface Specification* [16], does not pass.

3.2.1.4.6.7 Receiver-to-Antenna Interface

RF signal loss from input at the antenna to input at the RT shall not exceed 1 dB.

3.2.1.4.7 Transmit Function

3.2.1.4.7.1 Frequency Accuracy

The transmit frequency accuracy shall be within +/- 16 Hz. Rate of drift shall be less than 1 Hz per second.

3.2.1.4.7.2 Power Output

3.2.1.4.7.2.1 Power Control Enabled

During normal data link operation, power control per the *Sea Based JPALS DL SIS Interface Specification* [16] shall be employed to set the output power.

3.2.1.4.7.2.1.1 Power Control Reference

Under all service conditions, when power control is enabled and set for no turn down, normal mode transmit power at the RT output shall be +10 dBW (10 watts) +/- 1 dB.

3.2.1.4.7.2.1.2 Turn Down Range

Transmit power shall be able to be reduced 30 dB +/- 3 dB in 30 steps from the reference level. Each step shall be 1 +/- 0.5 dB.

3.2.1.4.7.2.1.3 Initial Power Control Setting

A means shall be provided to set an initial power control level as part of a pre-mission fill. If not specified in the pre-mission fill, the initial level shall be 4 dB turn down (+6 dBW).

3.2.1.4.7.2.1.4 Operational Power Limit Setting

A means shall be provided to set an upper limit for the automatic power control range as part of a pre-mission fill. If not specified in the pre-mission fill, the limit shall be 4 dB turn down (+6 dBW).

3.2.1.4.7.2.2 Power Control Disabled

A means shall be provided to disable the normal power control mode. With this selection, under all service conditions, the full radio frequency (RF) power output at the RT output shall not be less than 15 watts over the operating frequency range.

3.2.1.4.7.3 Transmit Noise Floor

The transmit broadband noise level shall be no more than -117 dBm/Hz at any frequency greater than 10 MHz, but less than 15 MHz from the carrier frequency.

Above 15 MHz, the transmit broadband noise level shall be no more than -120 dBm/Hz.

3.2.1.4.7.4 Transmit Energy Spectrum

3.2.1.4.7.4.1 Spectral Containment

For Sea Based JPALS operations, 95 percent of the transmitted energy shall be contained within the operating channel.

3.2.1.4.7.5 Transmit Spurious

The transmit function shall comply with the transmit spurious requirements of CE106 - Conducted Emissions, Antenna Terminal, 10 kHz to 8 Gigahertz (GHz) in MIL-STD-461 [12].

3.2.1.4.7.6 Transmit Signal Processing

The transmit function performs all necessary application data translation, encryption, error correction coding, modulation, network timing and frequency selection of the transmit signal. See the *Sea Based JPALS DL SIS Specification* [16] for specific transmit processing requirements.

3.2.1.4.7.7 Data Latency

Data latency from input to the communication function to output at the transmit antenna shall not exceed TBR, excluding any delays for slot alignment.

Note: The latency requirements in the Sea Based JPALS DL SIS Interface Specification [16] define end-to-end latency from data input to the transmitting DL to data availability at the output queue of the receiving DL. Transmit, receive, and network latencies will be allocated portions of the end-to-end latency specifications as part of the system design process and documented in the system/segment design document. Latencies including controller polling, bus transfer times, and application data processing will be allocated outside of the Sea Based JPALS Data Link Subsystem latency budget.

3.2.1.4.7.8 Data Format Encoding

The transmitter subsystem shall modulate and encode the DL signal specified in the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.7.9 Timing Accuracy

The Sea Based JPALS-Ship shall begin a slot transmission with an accuracy of +/- 10 microseconds from the nominal time specified by the waveform.

3.2.1.4.7.10 Transmit Rise Time

The Sea Based JPALS-Ship shall transition from 10% of power output to 90% of power output in 10 to 20 microseconds.

3.2.1.4.7.11 Transmit Fall Time

The Sea Based JPALS-Ship shall transition from 90% of power output to 10% of power output in 10 to 20 microseconds.

3.2.1.4.8 Message Processing Function

3.2.1.4.8.1 Broadcast Message Requirements

3.2.1.4.8.1.1 Sea Based JPALS Message Block

3.2.1.4.8.1.2 Ship State Messages

The following ship state messages are intended to provide the aircraft with sufficient information about the ships position, heading, speed and status to support the various operations required under worst case conditions.

3.2.1.4.8.1.2.1 Ship State 200

The Ship State 200 message is intended to provide aircraft entering the Sea Based JPALS coverage area sufficient information to perform TACAN-like navigation functions in terms of determining ship ID, Position and Intended Movement (PIM), and distance and bearing to the ship.

3.2.1.4.8.1.2.1.1 Rate

The Ship State 200 message shall be transmitted from the ship at the rate of every 5 seconds.

Note: Due to the technique of data cycling, the entire content of the message is not complete until three consecutive messages are received.

3.2.1.4.8.1.2.1.2 Latency

Broadcast of the ship state 200 message shall occur no later than 2 seconds after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.2.1.3 Format

The ship shall broadcast the ship state 200 message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.2.2 Ship State 50

The Ship State 50 message is an increase in resolution of the ship track and position information broadcast in the Ship State 200 message. It is intended as a refinement of location information for aircraft entering the CCA. It also contains a figure representing the NUC for the computed ship position.

3.2.1.4.8.1.2.2.1 Rate

The Ship State 50 message shall be transmitted from the ship at the rate of every second.

3.2.1.4.8.1.2.2.2 Latency

Broadcast of the Ship State 50 message shall occur no later than 1 second after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.2.2.3 Format

The ship shall broadcast the ship state 50 message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.2.3 Ship State 10

The Ship State 10 primarily contains increased bits of resolution of the Ship State 50 message as well as a heading, wind and ship attitude information. This last information contains ship ID, heading quadrant, and cant deck offset and is cycled to reduce bit count.

3.2.1.4.8.1.2.3.1 Rate

Ship state 10 messages shall be transmitted from the ship at the rate of twice per second.

3.2.1.4.8.1.2.3.2 Latency

Broadcast of the ship state 10 message shall occur no later than 0.5 seconds after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.2.3.3 Format

The ship shall broadcast the ship state 10 message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.3 Ship Motion Messages

The Ship Motion Messages are a series of three messages that contain three-dimensional information describing the movements of the ship in terms of acceleration, velocity, and position.

3.2.1.4.8.1.3.1 Ship Motion Low

3.2.1.4.8.1.3.1.1 Rate

Ship Motion Low messages shall be transmitted from the ship at the rate of 1 Hz.

3.2.1.4.8.1.3.1.2 Latency

Broadcast of the Ship Motion Low message shall occur no later than 1 second (TBR) after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.3.1.3 Format

The ship shall broadcast the Ship Motion Low message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.3.2 Ship Motion Medium

The Ship Motion Medium message refers to the Medium Update Rate of the information. This message contains velocity information related to changing ship attitude.

3.2.1.4.8.1.3.2.1 Rate

The Ship Motion Medium message shall be transmitted from the ship at the rate of 2 Hz.

3.2.1.4.8.1.3.2.2 Latency

Broadcast of the Ship Motion Medium message shall occur no later than 0.5 seconds (TBR) after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.3.2.3 Format

The ship shall broadcast the Ship Motion Medium message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.3.2.4 Ship Motion High

The Ship Motion High messages refer to the high update rate of the information. This message contains three-dimensional acceleration information.

3.2.1.4.8.1.3.2.5 Rate

The Ship Motion High messages shall be transmitted from the ship at the rate of 20 Hz.

3.2.1.4.8.1.3.2.6 Latency

Broadcast of the Ship Motion High message shall occur no later than 0.05 seconds (TBR) after the time indicated by the GPS time of applicability.

3.2.1.4.8.1.3.2.7 Format

The ship shall broadcast the Ship Motion High message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.4 ATM Messages

3.2.1.4.8.1.4.1 ATM Broadcast 50

The ATM Broadcast 50 data packet accommodates a number of messages as identified in the *Sea Based JPALS DL SIS Interface Specification* [16]. These messages shall provide general launch and recovery data, weather, and bingo fuels relevant for the current operations as identified below.

3.2.1.4.8.1.4.1.1 Rate

ATM Broadcast 50 messages shall be transmitted from the ship at the rate of 1 Hz.

3.2.1.4.8.1.4.1.2 Format

The ship shall broadcast ATM Broadcast message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.4.2 ATM Broadcast 10

The ATM Broadcast 10 messages are automatically generated messages that contain a variety of information relevant to an aircraft within the CCA and required prior to entering the Carrier Control Zone (CCZ). These messages shall provide Ship Survey Data, Touchdown Points (TDPs), and the ship Center of Motion (CM) location for Guidance and Control calculations performed by Sea Based JPALS-Air.

3.2.1.4.8.1.4.2.1 Rate

ATM Broadcast 50 messages shall be transmitted from the ship at the rate of 1 Hz.

3.2.1.4.8.1.4.2.2 Format

The ship shall broadcast ATM Broadcast message formatted in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.1.4.3 ATM Uplink Data Packets

The ATM Uplink data packets accommodate a variety of data as identified in the *Sea Based JPALS DL SIS Interface Specification* [16]. The actual data sets or messages implemented are dependent on both ship and aircraft integrations (refer to applicable integration guides).

These are not Sea Based JPALS messages, but the Sea Based JPALS-Ship shall receive those ATM messages designated by the *Sea Based JPALS DL SIS Interface Specification* [16] as "uplink" messages, from other ship systems in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

Sea Based JPALS-Ship shall prioritize transmission of ATM Uplink messages in accordance with the priority assigned in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16] by the message-generating function.

The Sea Based JPALS-Ship shall encode these ATM messages into ATM Uplink messages in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

The Sea Based JPALS-Ship shall send these ATM Uplink messages to participating aircraft via the data link.

3.2.1.4.8.1.5 GPS Data Messages

There shall be three basic GPS Data Messages derived by the shipboard system for broadcast to aircraft, with data format and fields defined in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16]. The three messages are: GPS Block ID, GPS pseudorange Data Block, and GPS Carrier Phase Data Block. The GPS Data Messages contain the GPS corrections information as well as data quality information.

3.2.1.4.8.1.5.1 GPS Block ID

3.2.1.4.8.1.5.1.1 Rate

The GPS Block ID shall be transmitted at a 1.0 Hz rate.

3.2.1.4.8.1.5.1.2 Time of Applicability

GPS Time of Applicability shall be derived from GPS time. This is needed for the receiving aircraft to apply the corrections to the proper GPS epoch measurements. The Time of Applicability shall roll over every 20.0 seconds, and have the values 0-19.9 (in 0.1 second increments) between 0 and 19.9 seconds after the top of a GPS minute, 0-19.9 during seconds 20-39.9 of a GPS minute, and 0-19.9 during seconds 40-59.9 of a GPS minute.

3.2.1.4.8.1.5.1.3 Number of Measurements

The number of measurements shall be defined as the number of correction blocks that will be broadcast following this message.

3.2.1.4.8.1.5.1.4 Ranging Source ID

The Ranging Source ID shall be defined as the GPS satellite (ranging source) ID as reported with the observables from the GPS receivers.

3.2.1.4.8.1.5.1.5 Ranging Source Block ID

The Ranging Source Block ID is a label for each set of ranging source.

3.2.1.4.8.1.5.1.6 Measurement Type

The Measurement Type is the type of GPS data corrections (C/A, L1Y, L2Y etc) that are being broadcast.

3.2.1.4.8.1.5.1.7 Issue of Data

The Issue of Data (IOD) is the Issue of Data Ephemeris (IODE) for the particular satellite Ephemeris CRC that is being broadcast in this epoch. The range is 0 to 255 with a resolution of 1. The IOD shall be derived from TBR.

3.2.1.4.8.1.5.1.8 Ephemeris CRC

The Ephemeris CRC is a 16-bit integrity check on the ephemeris that is performed on each GPS source for which corrections are broadcast. This allows the aircraft to verify the integrity of the ephemeris message being used. This field rotates each second through all the satellites that are being corrected. The range is 0 to 655335 with a resolution of 1. The CRC shall be derived from TBR.

3.2.1.4.8.1.5.2 GPS Pseudorange Data Block

The GPS pseudorange Data Block shall include the pseudorange correction information for each GPS satellite being tracked and corrected. A separate Data Block shall be set up for each satellite being corrected.

3.2.1.4.8.1.5.2.1 Rate

The GPS pseudorange Data Block shall be transmitted at a rate of 2.0 Hz.

Pseudorange Measurement Processing

The measurement processing scheme is nearly identical to Local Area Augmentation System (LAAS) with two distinctions:

1. The reference point for measurements is moving rather than stationary;
2. The reference point is broadcast to the aircraft to allow reconstruction of the measurement

The compressions for pseudorange and carrier phase differ slightly and are described separately.

Pseudorange Compression

The measurement model for pseudorange is:

$$\rho = H\left(x_{sv} - x\right) + H\left(\Delta x + Cr\right) + \varepsilon \qquad \textbf{(2)}$$

where

$\rho \equiv$ pseudorange measurement vector

$H \equiv$ direction cosine vector

$x \equiv$ position vector

$x_{sv} \equiv$ satellite position vector

$\Delta x \equiv$ delta position vector

$C \equiv$ body-to-inertial coordinate transform

$r \equiv$ survey offset from antenna to center of motion

$\varepsilon \equiv$ residual error, i.e., user clock, tropo, iono, etc.

The position vector represents the position of the Ship Reference Point (SRP), which denotes a stabilized ship CM. The delta state vector represents the instantaneous translation of the CM from the SRP. The survey offset is the vector from the CM to a GPS antenna location. Equation (2) is used to remove the unambiguous portion of the pseudorange measurement. The ambiguous portion is then transmitted as a correction. The reference position is an input to the algorithm.

The raw pseudorange correction is computed similar to LAAS using the reference point:

$$\rho_c = \rho - H(x_{sv} - x) - H(\Delta x + Cr) \qquad \textbf{(3)}$$

where

$\rho_c \equiv$ pseudorange correction

The second term in equation (3) removes the estimate of true range. The third term in equation (3) references the pseudoranges to the common point (SRP). Errors in the stabilizing vector (third term) are consistent between pseudoranges on a single receiver. Errors in the stabilizing vectors applied to different receivers in different locations show up as errors when comparing the pseudorange to the same satellite. These errors are accounted for as design parameters in the accuracy, integrity, and continuity allocations.

The pseudorange correction in equation (3) contains the residual errors of equation (2), i.e., user clock, tropo, iono, etc. An estimate of the user clock is removed by averaging for each receiver, the set of satellites common to all receivers:

$$\rho_{cc,i} = \rho_{c,i} - \frac{1}{n}\sum_{j=1}^{n} \rho_{c,j} \tag{4}$$

where

$\rho_{c,i} \equiv$ pseudorange correction, i^{th} satellite

$\rho_{c,j} \equiv$ pseudorange correction, j^{th} satellite common to all receivers

$\rho_{cc,i} \equiv$ pseudorange correction, clock - corrected, i^{th} satellite

$n \equiv$ number of measurements

The clock-corrected pseudoranges from each receiver are then averaged to produce the pseudorange correction to be broadcast:

$$\rho_{cca,i} = \frac{1}{M}\sum_{k=1}^{M} \rho_{cc,i,k} \tag{5}$$

where

$\rho_{cca,i} \equiv$ pseudorange, clock - corrected, average, i^{th} satellite

$\rho_{cc,i,k} \equiv$ pseudorange correction, clock - corrected, i^{th} satellite, k^{th} receiver

$M \equiv$ number of ship reference receivers

The B-values are computed by subtracting from each individual pseudorange measurement, the average of the corresponding pseudoranges measured on the other reference receivers:

$$B_{\rho,i,k} = \rho_{cc,i,k} - \frac{1}{M-1}\sum_{l=1, l \neq k}^{M-1} \rho_{cc,i,l} \tag{6}$$

where

$B_{\rho,i,k} \equiv$ B - value, pseudorange, i^{th} satellite, k^{th} receiver

The broadcast pseudorange correction and B-values are comparable to LAAS-derived corrections and B-values whenever the ship is stationary.

The number of bits required to send the pseudorange correction will depend on the size of the nominal residual error components and the size of any allowed satellite failure modes.

For example, a range of perhaps ± 50 meters would be required to account for a full range of nominal errors caused by troposphere, ionosphere, multipath, etc. This range can be reduced by using identical models for troposphere and ionosphere on each end of the compression-decompression process.

Allowing for satellite failure modes will on the other hand require a larger number of bits. To allow use of a satellite with a runaway clock for some period of time, the range might be expanded for example to the LAAS range of ± 327 m, or made even larger to allow the satellite to be used for an even longer period of time. The SV22 clock failure would be one example of a satellite that would be excluded from use quickly if the range represented by the bits available for transmit is small.

Pseudorange Decompression

The transmitted pseudorange correction is used to construct the pseudorange to the reference point:

$$\rho = \rho_{cca} + H(x_{sv} - x) \tag{7}$$

The functional requirement imposed is that the ship position vector (of the reference point) must be transmitted to the aircraft, and the satellite position vector must be calculated the same in the aircraft as on the ship using identical inputs. The reference point used in equation (7) must be the same reference point used in equation (3). This is accomplished by synchronizing mathematically the calculation of the reference point on the ship, with the calculation of the compressed pseudorange.

The individual pseudoranges from each ship reference receiver can be reconstructed in the aircraft (as in LAAS):

$$\rho_{i,k} = \rho_{cca,i} + \frac{M-1}{M} B_{\rho,i,k} \quad (8)$$

The information contained in equation (8) is redundant to that provided by the average pseudorange and B values.

The Carrier Phase data is defined below.

3.2.1.4.8.1.5.2.2 Ranging Source Block ID

The Ranging Source Block ID defines the data block so the receiving end can be certain to have a complete set of data. The Range Source Block ID shall be derived from TBR.

3.2.1.4.8.1.5.2.3 L1 Pseudorange Correction

The L1 pseudorange correction is a correction value to be added to that particular ranging source on the aircraft side. The units are meters with a range of +/- 8 meters and a resolution of 0.0625 meters. The L1 pseudorange correction shall have the following characteristics: TBR.

3.2.1.4.8.1.5.2.4 L1 Pseudorange Estimate Error

The Sea Based JPALS Shipboard System shall derive an estimate of the L1 pseudorange error. This estimate is derived from……TBR.

This estimate shall bound the pseudorange error……with a probability of TBR over a TBR exposure interval.

3.2.1.4.8.1.5.2.5 B1

The Sea Based JPALS Shipboard System shall derive a bias factor B1. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.6 B2

The Sea Based JPALS Shipboard System shall derive a bias factor B2. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.7 B3

The Sea Based JPALS Shipboard System shall derive a bias factor B3. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.8 B4

The Sea Based JPALS Shipboard System shall derive a bias factor B4. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.9 L2 Pseudorange Correction

The L2 pseudorange correction is a correction value to be added to that particular ranging source on the aircraft side. The units are meters with a range of +/- 8 meters and a resolution of 0.0625 meters. The L2 pseudorange correction shall have the following characteristics: TBR.

3.2.1.4.8.1.5.2.10 L2 Pseudorange Estimate Error

The Sea Based JPALS Shipboard System shall derive an estimate of the L2 pseudorange error. This estimate is derived from……TBR.

This estimate shall bind the pseudorange error……with a probability not to exceed TBR over a TBR exposure interval.

3.2.1.4.8.1.5.2.11 B1

The Sea Based JPALS Shipboard System shall derive a bias factor B1. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.12 B2

The Sea Based JPALS Shipboard System shall derive a bias factor B2. This bias factor shall be derived from…..TBR

3.2.1.4.8.1.5.2.13 B3

The Sea Based JPALS Shipboard System shall derive a bias factor B3. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.2.14 B4

The Sea Based JPALS Shipboard System shall derive a bias factor B4. This bias factor shall be derived from…..TBR.

3.2.1.4.8.1.5.3 GPS Carrier Phase Data Block

The GPS Carrier Phase Data Block shall include the Carrier phase correction information for each GPS satellite being tracked and corrected. A separate Data Block shall be sent up for each satellite being tracked.

3.2.1.4.8.1.5.3.1 Rate

The GPS Carrier Phase Data Block shall be transmitted at a rate of 5.0 Hz.

Note: The following needs to be re-written into the form of a specification.

Carrier Phase Compression

The measurement model for carrier phase is:

$$\phi = H(x_{sv} - x) + H(\Delta x + Cr) + N\lambda + \varepsilon_{\phi} \quad (9)$$

where

$\phi \equiv$ carrier phase measurement vector

$N \equiv$ integer ambiguity

$\lambda \equiv$ wavelength

$\varepsilon_{\phi} \equiv$ residual phase error, i.e., user clock, iono, tropo, etc.

Other terms are as previously defined.

The raw carrier phase correction is computed similar to LAAS using the reference point:

$$\phi_c = \phi - H(x_{sv} - x) - H(\Delta x + Cr) \quad (10)$$

where

$\phi_c \equiv$ carrier phase correction

The second term in equation (3) removes the estimate of true range. The third term in equation (3) references the carrier phases to the common point (the SRP). Errors in the stabilizing vector (third term) are consistent between carrier phases on a single receiver. Errors in the stabilizing vectors applied to different receivers in different locations show up as errors when comparing the carrier phase to the same satellite. These errors are accounted for as design parameters in the accuracy, integrity, and continuity allocations.

The carrier phase correction in equation (10) contains the residual errors of equation (9), i.e., user clock, tropo, iono, etc. An estimate of the user clock is removed by averaging for each receiver, the set of satellites common to all receivers:

$$\phi_{cc,i} = \phi_{c,i} - \frac{1}{n}\sum_{j=1}^{n} \phi_{c,j} \quad (11)$$

where

$\phi_{c,i} \equiv$ carrier phase correction, i^{th} satellite

$\phi_{c,j} \equiv$ carrier phase correction, j^{th} satellite common to all receivers

$\phi_{cc,i} \equiv$ carrier phase correction, clock - corrected, i^{th} satellite

$n \equiv$ number of measurements

An integer adjustment is applied to provide a common reference for the carrier phase measurements:

$$N_{0,i,k} = round\left(\frac{\phi_{cc,i}}{\lambda} - \frac{1}{\lambda M}\sum_{j=1}^{M} \phi_{cc,j}\right) \quad (12)$$

where

$N_{0,i,k} \equiv$ integer adjustment, i^{th} satellite, k^{th} receiver

The integer adjustment is recomputed whenever track on the satellite has been lost, in which case the channel being initialized is excluded from the average in equation (12). The integer adjustment is subtracted from the clock-corrected phase measurement:

$$\phi_{ccn,i,k} = \phi_{cc,i,k} - \lambda N_{0,i,k} \quad \textbf{(13)}$$

where

$\phi_{ccn,i,k} \equiv$ carrier phase correction, integer adjusted, i^{th} satellite, k^{th} receiver

$\phi_{cc,i,k} \equiv$ carrier phase correction, i^{th} satellite, k^{th} receiver

The clock-corrected, integer-adjusted carrier phases from each receiver are then averaged to produce the broadcast carrier phase correction:

$$\phi_{ccna,i} = \frac{1}{M}\sum_{k=1}^{M}\phi_{ccn,i,k} \quad \textbf{(14)}$$

where

$\phi_{ccna,i} \equiv$ carrier phase, clock - corrected, integer adjusted, average, i^{th} satellite

The B-values are then computed by subtracting from each individual carrier phase measurement, the average of the corresponding carrier phases measured on the other reference receivers:

$$B_{\phi,i,k} = \phi_{ccn,i,k} - \frac{1}{M-1}\sum_{l=1,l\neq k}^{M-1}\phi_{ccn,i,l} \quad \textbf{(15)}$$

where

$B_{\phi,i,k} \equiv$ B- value, carrier phase, i^{th} satellite, k^{th} receiver

The broadcast carrier phase correction and B-values are comparable to LAAS-derived corrections and B-values whenever the ship is stationary, i.e., as in port.

The number of bits required to send the carrier phase correction will depend on the size of the nominal residual error components and the size of any allowed satellite failure modes. A smaller range can be used for carrier phase than for pseudorange since the correction can be allowed to rotate through the bit range.

Carrier Phase Decompression

The transmitted carrier phase correction is used to construct the carrier phase to the reference point:

$$\phi = \phi_{cca} + H(x_{sv} - x) \quad \textbf{(16)}$$

The functional requirement imposed is that the ship position vector (of the reference point) must be transmitted to the aircraft, and the satellite position vector must be calculated the same in the aircraft as on the ship using identical inputs. The reference point used in equation (7) must be the same reference point used in equation (3). This is accomplished by synchronizing mathematically the calculation of the reference point on the ship, with the calculation of the compressed carrier phase. The residual user clock is removed when measurements are processed in the aircraft.

The individual carrier phases from each ship reference receiver can be reconstructed in the aircraft:

$$\phi_{i,k} = \phi_{ccna,i} + \frac{M-1}{M}B_{\phi,i,k} \quad \textbf{(17)}$$

The information contained in equation (17) is redundant to that provided by the average carrier phase and B values.

The Carrier Phase data is defined in sections 3.2.1.4.8.1.5.3.2 through 3.2.1.4.8.1.5.3.14.

3.2.1.4.8.1.5.3.2 Ranging Source Block ID

The ranging source block ID is TBR.

3.2.1.4.8.1.5.3.3 L1 Carrier Phase Correction

The L1 carrier phase correction is TBR.

3.2.1.4.8.1.5.3.4 L1 Carrier Phase Estimate Error

The L1 carrier phase estimate error is TBR.

3.2.1.4.8.1.5.3.5 B1

B1 is TBR.

3.2.1.4.8.1.5.3.6 B2

B2 is TBR.

3.2.1.4.8.1.5.3.7 B3

B3 is TBR.

3.2.1.4.8.1.5.3.8 B4

B4 is TBR.

3.2.1.4.8.1.5.3.9 L2 Carrier Phase Correction

The L2 carrier phase correction is TBR.

3.2.1.4.8.1.5.3.10 L2 Carrier Phase Estimate of Error

The L2 carrier phase estimate error is TBR.

3.2.1.4.8.1.5.3.11 B1

B1 is TBR.

3.2.1.4.8.1.5.3.12 B2

B2 is TBR.

3.2.1.4.8.1.5.3.13 B3

B3 is TBR.

3.2.1.4.8.1.5.3.14 B4

B4 is TBR.

3.2.1.4.8.2 Received Message Requirements

3.2.1.4.8.2.1 ATM Downlink Messages

The Sea Based JPALS-Ship shall receive those ATM messages designated by the *Sea Based JPALS DL SIS Interface Specification* [16] as ATM Downlink messages in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

The Sea Based JPALS-Ship shall output the application data contained in ATM Downlink messages as described in the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.2.2 Air State Report Messages

The Sea Based JPALS-Ship shall receive Air State Report messages from the Sea Based JPALS-Air of participating aircraft at a rate of once per second per aircraft. The messages primary function is to send position information for the controllers. The message content and format are in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.2.2.1 Air State Timing

Due to the large number of aircraft and the fact that each one broadcasts an Air State Report, this message contributes heavily to the system capacity. In effort to reduce the amount of data broadcast from each aircraft, the messages are decimated into 64 bit pieces. The data is cycled through in consecutive transmissions. Data that is more time critical is sent in each message. The structure of the data decimation and transmission is provided in the *Sea Based JPALS DL SIS Interface Specification* [16].

3.2.1.4.8.2.3 Air Monitor Report Messages

The Sea Based JPALS-Ship shall receive Air Monitor Report messages from the Sea Based JPALS-Air of participating aircraft at a 5 Hz rate. This information consists of high rate positioning information in relationship to approach path, aircraft status and attitude. The message content and format are in accordance with the *Sea Based JPALS DL SIS Interface Specification* [16].

The Sea-Based JPALS-Ship shall support a minimum of ten aircraft within the service volume.

3.2.1.4.9 Data Link Initialization Function

The Sea Based JPALS DL shall accept mission planning and INFOSEC initialization data as required.

3.2.1.4.10 Radio Frequency Broadcast Monitoring (TBR)

The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds when any of the following conditions exist:

1. 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,
2. A transmitted power offset of more than 3 dB from the on-channel assigned power for 3 seconds,
3. More than 0.2% of messages in the last hour are not transmitted,
4. No transmission for 3 seconds, or
5. Any transmitted data outside of the assigned TDMA time slots for 3 seconds.

Conditions 1 - 5 include the time to switch to redundant equipment, if available.

3.2.1.4.11 Communications Quality

3.2.1.4.11.1 Data Integrity

Note: Data integrity requirements are still being developed.

3.2.1.4.11.2 Data Transmission Continuity

The probability of an unscheduled interruption of the DL transmission, where messages are not transmitted in accordance with section 3.2.1.3 for a period equal to or greater than 3 seconds, shall not exceed $1x10^{-6}$ in any 15-second interval. On average, the Sea Based JPALS-Ship shall transmit at least 999 correctly formatted messages out of 1000 consecutive messages.

3.2.1.5 Control and Display Function

Operations and maintenance functions are provided via Sea Based JPALS-Ship components and interfaces to external systems. The interfaces to external systems are addressed in section 3.1.3 of this specification and in the *Sea Based JPALS Ship Integration Guide* [6]. This section addresses those functions available through the Sea Based JPALS-ship equipment.

All Sea Based JPALS-Ship control and display units shall be designed in accordance with Human Factors criteria in MIL-STD-1472 [3].

Sea Based JPALS display and control functions integrated in other shipboard systems shall be designed consistent with the human factors and human-interface design standards of those systems.

Note: The remainder of this section is TBR.

3.2.1.5.1 Sea Based JPALS Operations and Maintenance Station

User interface commands shall be designed to minimize operator performance errors and preclude operator errors on critical tasks through the use of error checking user validation, or other methods.

Note: The rest of Sea Based JPALS operations and maintenance station requirements are TBR.

3.2.1.5.2 Control Requirements

The Sea Based JPALS-Ship shall provide a means for the ship to select the desired TDP.

The Sea Based JPALS-Ship shall provide a means for the ship to select the desired glideslope.

For Vertical Takeoff and Landing (VTOL) and Short Takeoff Vertical Landing (STOVL) operations, Sea Based JPALS-Ship shall support the use of multiple TDP spots per ship.

The TDP to be used for landing shall be selectable by ID number (e.g. Spot 1, Spot 5, etc.)

The operator shall be able to override the automatic priority or selection of aircraft.

Note: The remainder of control requirements are TBR.

3.2.1.5.3 Display Requirements

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 visual display, readout, or operator message shall be compatible with the applicable night vision system.

Note: The rest of display requirements are TBR.

3.2.1.6 Data Recording

3.2.1.6.1 System Events

The Sea Based JPALS-Ship shall maintain a chronological record in Non-volatile Memory (NVM) of the previous 90 days of date, time, log-on, log-off, and alert and alarm events.

The Sea Based JPALS-Ship shall provide the capability to display and output to removable media the recorded system events.

3.2.1.6.2 Broadcast Recording

Broadcast data will be recorded by other ship systems in accordance with the *Sea Based JPALS Ship Integration Guide* [6].

3.2.1.6.3 Received Message Recording

Note: This section still under development.

3.2.1.6.4 GPS Reference Receiver Data

The Sea Based JPALS-Ship shall automatically record GPS Reference Receiver data for all Reference Receivers for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data is being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Recorded Reference Receiver data shall include at a minimum:

1. L1 and L2 carrier phase with a resolution of 0.01 cycles,
2. L1 and L2 pseudorange with a resolution of .01 meter or better,
3. Broadcast navigation data for all tracked GPS ranging sources, and
4. Time tags.

Upon command, the recording function shall be terminated for a period not to exceed 30 minutes.

3.2.1.6.5 Inertial Sensor Data

Note: Recording requirements for inertial sensor data are still being reviewed.

3.2.1.7 Alerts and Alarms

3.2.1.7.1 Executive Monitoring

Sea Based JPALS-Ship shall determine system suitability to support flight operations prior to launch, including predictive availability calculations for recovery.

Sea Based JPALS-Ship shall output system operational status at least once every 2 seconds.

Note: This section still under development.

3.2.1.7.2 Fault Monitoring

Sea Based JPALS-Ship shall exclude GPS ranging source from the TBR Message broadcast whenever a signal deformation fault is encountered.

Sea Based JPALS-Ship must terminate the data broadcast output whenever a fault indicating a disagreement between the transmitted data is encountered.

Sea Based JPALS-Ship shall exclude GPS ranging source from TBR Message broadcast when the GPS navigation data has a parity check fault.

Additional performance checks and system monitors may be required to meet the integrity requirements of Section 3.2.1.2.3.2.

3.2.1.7.3 Fault Recovery

Note: This section still under development(TBR).

3.2.1.7.4 Generation of Alerts

The Sea Based JPALS-Ship shall generate an alert upon detecting a fault that does not affect the ability of the system to meet the integrity requirements of Section 3.2.1.2.3.2. Faults shall include continuity and environmental faults. Alert thresholds shall be defined during the design process.

3.2.1.7.4.1 Generation of Service Alerts

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

3.2.1.7.4.2 Continuity Faults

A service alert shall be generated when the Sea Based JPALS-Ship is unable to insure that the guidance and communications continuity requirements can be met due to a fault in any of the following items:

1. Main and standby Line Replaceable Units (LRU)s,
2. Hardware components,
3. Internal firmware, and
4. Uninterruptible power supply.

3.2.1.7.4.3 Environmental Faults

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

1. Inside temperature (Section TBR), and
2. Ship's motion (excessive ship motion - Section TBR).

3.2.1.7.5 Generation of Alarms

The Sea Based JPALS-Ship shall generate an alarm when the integrity requirements of Section 3.2.1.2.3.2 or 3.2.1.4.5.1 cannot be guaranteed.

The Sea Based JPALS-Ship shall generate an alarm when the integrity attribute monitors have detected any fault identified in Section TBR. When an alarm is generated:

1. TBR
2. TBR

Note: Alarm thresholds will be defined during the design process.

3.2.1.7.5.1 Automatic Restart (TBR)

The Sea Based JPALS-Ship shall attempt an automatic restart within 3 minutes following an alarm.

If an alarm condition still exists following the restart attempt, the Sea Based JPALS-Ship restart shall be available only through a manual maintenance action.

3.2.1.8 Vulnerability to Disruption/Spoofing

Sea Based JPALS-Ship shall provide resistance to spoofing through the use of the military GPS signal (P/Y-Code, M-Code) and associated GPS security features as provided by the GPS Joint Program Office (JPO).

Per CJCSI 6130.01C [24], P(Y) code differential corrections shall be encrypted.

3.2.2 Physical Characteristics

3.2.2.1 Shipboard Compatibility

The Sea Based JPALS-Ship shall be compatible within itself and with other systems in its operating environment.

The Sea Based JPALS-Ship shall not degrade the effectiveness of the ship's defensive systems, nor restrict aircraft handling and aircraft parking.

The Sea Based JPALS-Ship will be electromagnetically compatible with command, control, communication, computers and intelligence infrastructure for all aircraft and ship-based components. To ensure this compatibility, the Sea Based JPALS-Ship unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in TBR.

3.2.2.2 Power

3.2.2.2.1 Primary Power

The Sea Based JPALS-Ship system shall conform to the Steady-state voltage and frequency power requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall conform to the transient frequency power requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall conform to the transient voltage power requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall conform to the spike voltage power requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall conform to the power interruption requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall conform to the power factor requirements as specified in MIL-STD-1399 [8], Section 300.

The Sea Based JPALS-Ship system shall be designed to operate from 440 V, 60-HZ, 3-phase, ungrounded, Type I electrical power as specified in Section 300 of MIL-STD-1399 [8]. The total power required by the shipboard system shall not exceed 10 KW.

Motor generators or equivalent, isolation transformers (NSN 6120-00-548-0482 or equivalent), and a power distribution panel shall be used to transform and distribute the ship-provided 440V, 60-Hz, 38 Kw, 3-phase, ungrounded, Type I electrical power into 115 V alternating current (AC), 60-Hz, 1-phase, Type I power.

3.2.2.2.2 Supplementary Power

The Sea Based JPALS-Ship shall include an uninterruptible supplementary power source.

The supplementary power source shall continuously power the Sea Based JPALS-Ship for a period of not less than four hours after a loss of primary power under nominal conditions.

Nominal conditions are defined to be a room temperature of 30° C and a Power Factor of 1.5:1.

3.2.2.2.3 Power Supply

The Sea Based JPALS-Ship shall automatically sense when the supplementary power discharge point is reached.

When operating on supplementary power, the Sea Based JPALS-Ship shall initiate facility shutdown if a critical discharge point is met.

The Sea Based JPALS-Ship shall have the capability to self-restore to operate on primary power upon restoration of primary power.

To maintain the supplementary power in operational readiness, a trickle charge shall be supplied to recharge the supplementary power during the period of available primary power.

Upon loss and subsequent restoration of primary power, the Sea Based JPALS-Ship supplementary power shall restore to a full charge condition from a 50% discharge condition within 8 hours.

The Sea Based JPALS-Ship shall continue at the same level of service upon restoration of primary power.

The Sea Based JPALS-Ship equipment shall be designed to preclude damage to any components if the ship's power source is interrupted. The system shall return to the normal mode of operation automatically within the warm-up time specified in section TBR.

3.2.2.2.4 Grounding

Grounding shall be in accordance with MIL-STD-1310 [6].

3.2.2.2.5 Main Power Switch

The Sea Based JPALS-Ship shall have a switch or circuit breaker to disconnect each unit from all external electrical power on the front panel of the unit, or as specified in the interface control documents. If a panel switch is used, a green power indicator light shall be mounted beside the switch to indicate when the equipment is energized.

3.2.2.2.6 System single-phase AC power connections

The system power connectors for 115 and 440 VAC single-phase input power and interconnecting power cable connectors between units shall have only three pins, designated A, B, and C. Black and white color coding shall be maintained from the input connector pins to all components having the same voltage and frequency as the input power.

Pin A for single-phase input power connections shall be the 440 or 115 VAC return and color coded white.

Pin B for single-phase input power connections shall be the safety ground and color coded green.

Pin C for single-phase input power connections shall be the 440 or 115 VAC high (HOT) and color coded black.

Color coding of the power conductors inside single-phase equipment shall conform to the above requirements when the equipment is hard-wired.

3.2.2.2.7 System three-phase AC power connections

The system power connectors for 115, 208 and 440 VAC three-phase input power and interconnecting power cable connectors between units shall have only four pins, designated A, B, C, and D.

Pin A for three-phase input power connections shall be for phase A and color coded orange.

Pin B for three-phase input power connections shall be for phase B and color coded orange.

Pin C for three-phase input power connections shall be for phase C and color coded orange.

Pin D for three-phase input power connections shall be the safety ground and color coded green.

3.2.2.2.8 Convenience Outlets

At least two convenience outlets shall be provided on the equipment cabinets.

3.2.2.2.9 Circuit Protection

Shorting of the output element of circuits to ground or complete power failure shall not cause damage to the assembly. The sudden application of normal loads to output amplifiers or circuits shall not cause overload protection circuits to operate. When printed circuit cards of modular construction are used, ground potential and operating voltages shall be assigned to pins of all plug-in assemblies in a uniform manner. With power applied to the equipment, removal or insertion of printed circuit assemblies shall not damage the assembly or any other part of the equipment. All plug-in assemblies shall be mechanically keyed to prevent incorrect insertion. All relay coils shall have diode suppression or equivalent.

3.2.2.2.10 Electrical Overload Protection

3.2.2.2.10.1 Current Overload Protection

The system shall have electrical overcurrent protection.

3.2.2.2.10.2 Circuit Breakers

Circuit breakers conforming to the requirements of paragraph A.5.1.5.5 of MIL-HDBK-2036 [9] are the preferred overcurrent protection. A visible status indication shall be provided on the front or side panel of each unit when circuit breakers are used.

3.2.2.2.10.3 Fuses and Fuse Holders

Fuse holders shall provide blown fuse indication. All fuses and circuit breakers shall be readily accessible from the front panel without removal of any panels. A minimum of two spare fuses shall be provided for each fuse used (that is, four spare fuses for each pair of fuses), mounted adjacent to the fuse holder for which the spare fuses are intended. When fuses are used, the fuses shall be electrically located on the load side of the ON-OFF switch. If extractor post type fuse holders are used, the fuse holders shall be connected in such a manner that the load is connected to the fuse terminal that terminates in the removable cap assembly.

3.2.2.2.10.4 Overcurrent Indicators

All overcurrent conditions shall have a visual indication. The following are acceptable overcurrent indicators listed in order of preference:

1. LED indicator activated by extra contact or circuit breaker**,**
2. Neon blown fuse indicators**, and**
3. Incandescent blown fuse indicators.

3.2.3 Reliability

The Sea Based JPALS-Ship shall have a mean time between failures (MTBF) of at least 4,000 hours. This MTBF refers to failures that render the system non-operational and does not include environmental service alerts.

3.2.3.1 Operational Availability

Operational availability (A_o) is the probability that the Sea Based JPALS-Ship is ready to perform its specified function, in its specified operational environment, when called for at a random point in time. A_o includes the effects of failures or outages of ship or space systems. It does not include avionics failures or the effects of scheduled Sea Based JPALS-Ship maintenance or training which can be scheduled to avoid an impact on operations. The A_o of the Sea Based JPALS-Ship shall be at least 99.7% (99.9% Objective) for the required operating environment. Sea Based JPALS shall maintain 95% minimum short-term availability under intentional interference or jamming conditions.

3.2.3.2 GPS Reference Receiver

The MTBF for the GPS Reference Receiver System, including antenna, antenna electronics, and cabling, shall be not less than 10,000 (TBR) hrs, as calculated using MIL-HDBK-217F [11] for operation at the appropriate ambient temperature for each piece of the Reference Receiver System.

The failure rate of those reference receiver components whose failure can result in pseudorange or carrier phase errors exceeding the requirements listed must be less than 1.82×10^{-6} / hr. (TBR)

3.2.3.3 Inertial Sensor

Note: Inertial Sensor requirements are TBR.

3.2.4 Maintainability

3.2.4.1 Maintenance Concept

The Sea Based JPALS-Ship shall provide for a site and depot concept of maintenance. This concept assumes the use of modular equipment that enables maintenance specialists to correct a majority of equipment failures on-site by replacing the faulty LRU.

Organic depot support equipment shall be that type of automatic test equipment approved by the Navy.

Operation and/or maintenance tasks on Sea Based JPALS-Ship equipment, including set-up/tear-down and pre-operational tasks shall be capable of being performed in full chemical warfare ensemble and/or cold weather gear.

Organizational level maintenance shall utilize BITE to the maximum extent possible.

3.2.4.2 Unscheduled Maintenance

Unscheduled Maintenance requirements are TBR.

3.2.4.3 Periodic Maintenance

Periodic maintenance for the Sea Based JPALS-Ship shall not interrupt service for more than eight hours per year of operation.

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

Periodic maintenance shall include the time required to complete the routine checks and inspections necessary to assure normal operation.

The capability to isolate latent faults affecting integrity and continuity shall be provided through the Sea Based JPALS-Ship equipment.

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

3.2.4.4 System Specialist Workload

Completion of corrective and periodic maintenance actions shall require no more than two system specialists.

3.2.4.5 Mean Time to Repair

The Mean-Time-to-Repair (MTTR) shall be less than 30 minutes. The repair time shall include:

1. diagnostic time,
2. removal of the failed LRU,
3. installation of the new LRU,
4. initialization of the new LRU, and
5. all adjustments required to return the Sea Based JPALS-Ship to Normal Mode.

Any maintenance action that requires the replacement of a failed LRU and does not require a re-certifying flight check can be replaced while the Sea Based JPALS-Ship is in Normal Mode.

3.2.4.6 Condition Based Monitoring (CBM)

The Sea Based JPALS-Ship BIT prognostics and diagnostics shall permit the CBM of system critical attributes to accurately predict remaining useful life before failure, alarm detection and isolation, LRU removal and replacement to avoid a critical failure, or actual removal of diagnosed faulty units.

A maintenance and CBM capability shall be provided at the Sea Based JPALS-Ship equipment for fault detection, isolation, and correction.

3.2.4.7 BIT and BITE Criteria

3.2.4.7.1 Protection from BIT and BITE Failures

The ability of the prime equipment to perform its intended function shall not be impaired by the malfunction of BIT and Built-in-Test Equipment (BITE).

3.2.4.7.2 BIT and BITE Indicators

BIT and BITE indicators shall provide a GO or NO-GO indication at the level for which it is intended and shall be made visible by removal of no more than one cover plate, if it is covered.

3.2.4.7.2.1 Class A Test Provisions

Class A test provisions shall be on the control panel of the system.

3.2.4.7.2.2 Class B Test Provisions

Class B test provisions shall be on the assembly front panel.

3.2.4.7.2.3 Class C Test Provisions

Class C test provisions shall be on the subassembly.

3.2.4.7.3 BIT and BITE Activation

3.2.4.7.3.1 Class A and B

BIT and BITE used in Class A and B test provisions shall be energized automatically without an operator's initiation.

3.2.4.7.3.2 Class C

BIT and BITE used in Class C test provisions may be energized automatically or manually. A pushbutton switch shall be incorporated when a manually energized test mode is to be employed.

3.2.4.8 Test Point Criteria

3.2.4.8.1 Signal Quality and Circuit Performance

Test points or test jacks shall be provided to permit the injection of signals and the monitoring of signals at the I/O terminals of the subassembly.

3.2.4.8.2 Fault Isolation

Test points or test jacks shall be provided to permit the injection or measurement of signals at I/O terminals of the subassembly for isolating all faults to the electrical functions. Test points and test jacks shall provide a means of performing fault isolation on the subassembly with subassembly removed from the prime equipment.

3.2.4.8.3 Calibration

Class A, B, and C test provisions shall be provided with test points or test jacks to permit calibration of the BIT and BITE functions of the equipment. Calibration of the Class A, B, and C BIT and BITE functions shall not exceed 2 hours.

3.2.4.9 Fault Diagnostics, Built in Test and Isolation Procedures

3.2.4.9.1 Fault Detection

The fraction of failures detected (FFD) using self-test shall be greater than 95%. 100% of critical failures shall be detected.

3.2.4.9.2 Fault Isolation

95% of the failures detected shall be isolated to a single line replaceable unit using BIT and self-test. 100% of failures detected shall be isolated to a single LRU using BIT, self-test, support equipment, and technical orders.

3.2.4.9.3 Failure Detection False Alarms

The mean time between BIT false alarms shall exceed 50,000 hours.

3.2.4.9.4 GPS Reference Receiver

The GPS Reference Receiver shall be provided with a BIT capability capable of performing fault isolation to the extent required to support the overall Sea Based JPALS Shipboard System availability requirements.

Continuous BIT of 100% of the critical components of the Reference Receiver System shall be performed on the Reference Receiver System, with an exposure (test time) not to exceed 5 minutes. The BIT must include a test of all memory and processor calls used. (TBR)

The BIT false alarm probability for the Reference Receiver shall not exceed 2.5×10^{-9} / 15 sec. (TBR)

Any BIT devices shall maintain their accuracy under all operating conditions required herein.

Any BIT devices shall be provided with connections or access for their operational checkout or calibration.

Provisions for testing shall be designed that any failure of BIT devices will not degrade equipment operation or cause equipment shutdown unless equipment is specifically designed to shut down in case of BIT device failure.

Reference Receiver BIT results shall be provided as an output message from the Reference Receiver System.

The GPS Reference Receiver shall be provided with connectors in such a way to support a remove/replace time to support the overall Sea Based JPALS Shipboard System availability requirements.

The minimum interval, and time required for preventive maintenance for the GPS Receiver System shall be adequate to support the Sea Based JPALS Shipboard System Availability requirement.

3.2.4.9.5 Inertial Sensor

The Inertial Sensor Test mode shall be designed to detect 99% of failures and correctly isolate to the failed shop replaceable assembly (SRA) 95% of the time.

3.2.4.10 Test Measurement and Diagnostic Equipment

The system shall contain the test provisions specified below.

3.2.4.10.1 Class A Test Provisions

Class A test provisions shall furnish a means to verify that the on-line equipment is operating properly. Class A provisions shall be accomplished by the use of BIT and BITE, and shall have the capability of detecting at least 96 percent of the equipment failures.

3.2.4.10.2 Class B Test Provisions

Class B test provisions shall furnish a means to locate the equipment failure to the assembly level. Class B test provisions shall be accomplished when the equipment is on-line. Class B provisions shall be accomplished by the use of BIT, BITE, or both, and shall have the capability of isolating at least 94 percent of the detected equipment failures to the assembly. In this instance, assembly is a major functional unit of the equipment. Some examples of assemblies that may be utilized in the system are the GPS antenna, the GPS receiver, the data link antenna, and the data link transceiver.

3.2.4.10.3 Class C Test Provisions

Class C test provisions shall furnish a means to isolate 92 percent of the equipment failures to the subassembly level as indicated. Class C test provisions shall be accomplished when the equipment is on-line both through the use of BIT and BITE. The subassembly could be a single component, PC board, or a group of items packaged as a unit. One channel shall be capable of being tested while the other channel is operational and landing aircraft. General purpose electronic test equipment (GPETE) shall be allowed, including logic probes as a preferable method of measuring digital signals, in conjunction with on-line diagnostic computer programs to fault isolate at this level in 5 minutes.

3.2.4.10.3.1 Isolation to a Single Subassembly

Test provisions shall isolate 82.8 percent of the equipment failures to a single subassembly.

3.2.4.10.3.2 Isolation to Three or Fewer Subassemblies

Test provisions shall isolate 92 percent of the equipment failures to no more than three subassemblies.

3.2.4.10.4 Class D Test Provisions

Class D test provisions shall provide a means to locate to electrical functions (that is, Standard Electronics Module (SEM), integrated circuit (IC) filter, mixer, voltage controlled oscillator (VCO), and so forth) and to align the system, unit, assembly, or subassembly. Class D test provisions may be accomplished by the use of test points in conjunction with automatic test equipment (ATE) or GPETE and shall have the capability to isolate all the failures to the electrical functional items on a repairable subassembly or to the LRU in the case of a throw-away or depot-repairable unit.

3.2.5 Environmental Conditions

Sea Based JPALS-Ship shall meet all performance requirements specified herein during the following environmental conditions.

3.2.5.1 Operating Conditions

Sea Based JPALS-Ship shall provide safe landing guidance in conditions of adverse weather (i.e., rain, humidity, snow, freezing rain, winds, turbulence, fog, sea spray, extreme temperature, lightning, ionospheric scintillation, sand, and dust) in which the ship may be expected to conduct launch and recovery operations.

Sea Based JPALS-Ship must physically survive the range of environmental conditions that ships are expected to encounter without experiencing significant physical damage.

3.2.5.1.1 Ship Airwake

This section is TBR.

3.2.5.1.2 Ship Dynamics

Sea Based JPALS-Ship shall perform within the requirements of this specification when operated under conditions of ship's motion up to and including Sea State 5.

Note 1: Sea Based JPALS-Ship should operate in conditions up to and including Sea State 6 (objective).

Note 2: Ship motion is dependent on both the ship type and the sea state. Furthermore, the operations performed, that Sea Based JPALS must support in a given sea state, are also dependent on the ship type. Therefore, the JPALS Ship Integration Guide [6] will tailor these requirements to the specific ship type.

Note 3: System operation will be possible outside these limits with a corresponding increase in touchdown dispersion or waveoff probability.

3.2.5.1.3 Interference Environment

Note: These requirements are only representative of the type of requirements that will be specified -using the civil GPS example. When completed for Sea Based JPALS PPS applications, many of these requirements may necessitate a classified appendix.

3.2.5.1.3.1 GPS

3.2.5.1.3.1.1 Out-of-Band CW Interference

The GPS Reference Receiver Subsystem shall meet all requirements with out-of-band continuous wave (CW) interfering signals resulting in the jammer-to-signal (J/S) levels below. The requirement shall be met with at any level below straight lines drawn between the following points:

1525 mHz, +92.5 dB J/S

1618 mHz, +94.5 dB J/S

1315 mHz, +110 dB J/S

2000 mHz, 106 dB J/S

+/-20 Mhz of L1; +25 dB J/S

+/- 10 Mhz, of L1; +14 dB J/S

Note 1: TBR pending further identification of the shipboard interference environment.

Note 2: L2 requirements are TBR.

3.2.5.1.3.1.2 Out-of-Band Pulse Interference

The GPS Reference Receiver Subsystem shall meet all requirements in the presence of Out-of-Band Pulse Interference of amplitude: Peak Pulse Power: +20 dBm, Pulse Width: 1 ms, Pulse Duty Cycle 10%, at frequencies of 1525 MHz, 1618 MHz, 1315 MHz, 2000 MHz, +/- 20 MHz of L1, and +/- 10 MHz of L1.

Note 1: TBR pending further identification of the shipboard interference environment.

Note 2: L2 requirements are TBR.

3.2.5.1.3.1.3 In-Band and Near-Band Interference

The GPS receiver system shall meet all requirements with the in-band and near-band interference level of 14 dB J/S for $0 \leq$ Bandwidth Interference (BWI) $\leq$ 700 Hz

The GPS receiver system shall meet all requirements with an in-band and near-band interference level of 15 dB J/S + 6 log10(BWI/1000) for 700 Hz $< BW_I \leq$ 10 KHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level of 21 dB J/S + 3 log10(BWI/10000) for 10 KHz $< BW_I \leq$ 100 KHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level of 24 dB J/S for 100 KHz $< BW_I \leq$ 1 MHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level linearly increasing from +24 dB to 37 dB J/S* for 1 MHz $< BW_I \leq$ 20 MHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level linearly increasing from +37 J/S -43 dB J/S* for 20 MHz $< BW_I \leq$ 30 MHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level Linearly increasing from 43 dB J/S to 45 dB J/S* for 30 MHz $< BW_I \leq$ 40 MHz.

The GPS receiver system shall meet all requirements with the in-band and near-band interference level of 45 dB J/S* for BW_I greater than 40 MHz.

*Interference levels will not exceed 24 dB J/S/MHz in the frequency range of 1575.42 ± 10 MHz.

Note: TBR pending further identification of the shipboard interference environment.

3.2.5.1.3.1.4 In-Band and Near-Band Pulse Interference

The GPS Reference Receiver Subsystem shall meet all requirements in the presence of In-Band and Near-Band Pulse Interference of amplitude: Peak Pulse Power: +20 dBm, Pulse Width: 1 ms, Pulse Duty Cycle 10%, at frequencies from 1525 MHz to 1618 MHz. The signal bandwidths are specified to be at least 100 kHz.

Note: TBR pending further identification of the shipboard interference environment.

3.2.5.1.3.2 UHF

UHF requirements are TBR.

3.2.5.1.4 Natural Environment

3.2.5.1.4.1 Precipitation (effects on signal)

Sea Based JPALS-Ship shall meet performance parameters in precipitation rates up to 16 mm/hr in 5 nm wide rain cell.

3.2.5.1.4.2 Fog (effects on signal)

Sea Based JPALS-Ship shall meet performance parameters in advection and radiation fogs.

3.2.5.1.4.3 Temperature (effects on equipment and signal)

Sea Based JPALS-Ship equipment shall meet performance parameters when operated in temperatures from -51 degrees Celsius to +49 degrees Celsius.

3.2.5.1.4.4 Wind (effects on equipment)

Sea Based JPALS-Ship equipment, when operating, shall meet performance parameters under wind velocities up to 75 knots. Sea Based JPALS-Ship equipment shall not be damaged when exposed to wind velocities up to 101 knots.

3.2.5.1.4.5 Snow (effects on signal and equipment)

Sea Based JPALS-Ship shall withstand up to two feet of snow accumulation without damage or signal degradation.

3.2.5.1.4.6 Ionospheric Scintillation (Effects on signal)

Sea Based JPALS-Ship shall operate without reduced integrity and continuity under ionospheric scintillation conditions.

3.2.5.1.4.7 Lightning (effects on signal and equipment)

Sea Based JPALS-Ship equipment shall withstand direct lightning strike and power surges in accordance with accepted capabilities for precision approach and landing equipment.

3.2.5.1.4.8 Altitude (effects on equipment)

Sea Based JPALS-Ship shall meet requirements when installed and operated at altitudes from -200 feet to 14,000 feet Mean Sea Level (MSL).

3.2.5.1.4.9 Ice and hail (effects on signal and equipment)

Sea Based JPALS-Ship shall withstand up to ½ inch accumulation of ice or ½ inch diameter size hail without damage or signal degradation.

3.2.5.1.4.10 Blowing Sand and Dust (effects on signal and equipment)

Sea Based JPALS-Ship shall withstand a sand concentration of 2.2 g/M3 in 40 kt wind without damage or signal degradation.

3.2.5.1.4.11 Nuclear, Biological, and Chemical Contamination

Sea Based JPALS-Ship equipment shall be able to withstand damaging environmental effects to include biological and chemical contamination and continue to provide reliable precision approach guidance information.

3.2.5.1.5 Electromagnetic Interference and Radiation

Electromagnetic environmental effects shall not degrade operational performance.

The Sea Based JPALS-Ship shall meet the applicable requirements of MIL-STD-461 [12].

3.2.5.2 Non-Operating Conditions

Equipment should withstand a non-operating temperature range of -51°C to +70°C.

3.2.6 Transportability

The Sea Based JPALS-Ship shall be capable of being transported by air (at altitudes up to 4.6 km, non-pressurized), ship, rail, vehicle, or helicopter lift.

3.3 Design and Construction

The Sea Based JPALS-Ship system shall employ modular construction for all new-designed equipment. All new assemblies and subassemblies shall be designed and constructed to permit repair by component replacement. SEMs shall be used when possible and cost effective over the equipment life cycle. SEMs shall be in accordance with the guidance in MIL-HDBK-246A [10]. Plug-in printed wiring cards shall be utilized whenever the use of SEMs is not feasible as approved by the procuring activity. Approval of modular and other replaceable assemblies, packaging and interconnecting techniques shall be obtained from the procuring activity. In addition, approval is required for all fixed or chassis-mounted electronic components. Fixed or chassis- mounted electronic components are undesirable. Prior approval from the procuring activity is required for all replaceable assemblies that are either not plug-in or do not use connectors for wiring connections.

3.3.1 Materials, Processes, and Parts

3.3.1.1 Design, Construction, and Workmanship

Workmanship on all electronic or electrical components shall, at a minimum, meet best commercial practices.

Mechanical components of the equipment shall be uniform in appearance and free from cross-threading, burrs, scratches, cracks, breaks, pits, dents, chips, sharp projections or edges, loose parts, or foreign material that may adversely affect equipment serviceability, performance, reliability, safety, endurance, or wear.

3.3.1.2 Design Assurance

3.3.1.2.1 Software Design Assurance

All Sea Based JPALS-Ship software shall comply with applicable certification requirements.

The Sea Based JPALS-Ship shall contain patch-free software with no unresolved mission critical problems.

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

3.3.1.3.1 General Markings

External and internal markings of equipment, assemblies, and component parts shall conform to the requirements of MIL-HDBK-454 Guideline 67 [2].

3.3.1.3.2 Radio Frequency Connectors

All radio frequency connectors furnished on the equipment for the purpose of making external connections shall be clearly identified on the plug-in side by labels descriptive of their specific function.

Labels on connectors shall be located directly on the connector, on plates permanently attached to the connector, or on tabs or tapes attached to the connector.

Labels on receptacles shall be located directly on the receptacle, on the surface or panel immediately adjacent to the receptacle, or, if recessed, adjacent to the access opening.

3.3.1.3.3 Safety Related Markings

Equipment shall be marked when safety hazards are present during the installation, operation, maintenance, repair, or replacement of equipment or parts thereof.

Guards, barriers or access doors, covers and plates shall be marked when they protect personnel from safety hazards.

Hazardous material and hazardous material containers shall be marked in accordance with 29 CFR 1910 [14].

Parts containing hazardous material shall be marked with appropriate hazard warning.

For equipment weighing in excess of 15 kilograms (30 pounds), the equipment weight shall be marked on the external surface of the equipment. Center-of-Gravity shall be marked on all equipment with a center-of-gravity 50% different from the center-of-volume of the chassis.

Safety markings should be in accordance with ANSI/NEMA Z535.1 [18], ANSI/NEMA Z535.2 [19], ANSI/NEMA Z535.3 [20], ANSI/NEMA Z535.4 [21], and ANSI C95.2 [22], as applicable. Safety markings shall be such that the safety markings will be legible for twice the normal life expectancy of the equipment to which the safety markings are affixed.

3.3.1.3.4 Serial Numbers

Serial numbers should be unique to each unit of equipment. Serial numbers should be furnished by the vendor for COTS and ruggedized equipment. Serial numbers may be furnished by the Government or vendor for militarized equipment.

3.3.1.4 Materials

The Sea Based JPALS-Ship should not contain toxic or hazardous substances in accordance with 29 CFR 1910 [14]. Unless otherwise specified, carcinogens, glass fibers, lithium and lithium compounds (except batteries approved for the intended service condition), magnesium or magnesium alloys, polyvinyl chloride (PVC) (except when used for part leads), radioactive commodities, and zinc or zinc alloys should not be used. The use of Class I Ozone Depleting Chemicals (ODC) is prohibited. The use of Class II ODCs, EPA-17 materials, and other toxic production and formulations shall be minimized and eliminated where feasible.

3.3.1.4.1 Glass Fibers

Glass fiber materials should not be used as the outside surface or covering on cables, wire, piping, cases, or other items where the glass fiber materials may cause irritation to personnel.

3.3.1.4.2 Radioactive Material

Use of radioactive materials should conform to Nuclear Regulatory Commission regulations and requires approval of the procuring activity. Radium shall not be used to achieve self-luminosity.

3.3.1.4.3 Mercury

Materials and parts containing mercury should not be used unless use of mercury is specifically required or approved by the procuring activity.

3.3.1.4.4 Asbestos

Asbestos shall not be used.

3.3.2 Interchangeability

N/A

3.3.3 Safety

Equipment should be such that systems (including personnel, aircraft, other equipment, interfaces, and ordnance) will not be exposed to safety hazards during the installation, operation, maintenance, repair, or replacement of equipment or parts thereof. Equipment should be such that systems will not be exposed to safety hazards should the equipment fail during the installation, operation, maintenance, repair, or replacement of equipment or parts thereof.

3.3.3.1 Electrical Safety

Equipment shall be configured so that personnel will not be exposed to voltages in excess of 30 volts rms (Vrms) or 60 volts direct current (VDC). Test points shall not exceed 30 Vrms or 60 VDC. High voltage circuits and devices internal to the equipment should discharge to 30 volts (V) or less within two seconds after power removal.

3.3.3.2 Radio Frequency Limits

Note: Still need to research. Will reference ANSI C95.1 or applicable DoD guidance.

3.3.4 Human Factors

Guidelines for the design of the human factor aspects of controls, displays, and operating procedures are available in MIL-STD-1472 [3].

Design of controls, displays, symbology, and operating procedures will promote smooth, expeditious and error free system operation.

Controls and control arrangement shall be designed to minimize inadvertent actuation.

Controls shall not interfere with the access or actuation of other controls on the Sea Based JPALS equipment.

Controls must be accessible under all mission conditions in the manner intended by a user wearing required equipment and clothing. This includes the ability to use the controls in all required positions, combinations, and sequences.

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 ship visual display, readout, or operator message shall be compatible with the applicable night vision system.

User interface commands shall be designed to minimize operator performance errors and preclude operator errors on critical tasks through the use of error checking user validation, or other methods.

Visual and aural information must be usable by a user wearing required equipment and clothing.

Visual and aural displays must not inappropriately distract the user or interfere with the ability to use other displays or hear other aural signals.

All alpha-numeric, symbology, and other visual information must be legible and understandable as presented under all lighting, mission, and environmental conditions from the normal operating position.

Aural messages (verbal or otherwise) must be distinguishable and understandable under all flight and non-flight noise conditions from the normal operating position.

3.3.5 Security

The internal and external Sea Based JPALS-Ship components shall provide for protection of internally stored information and information transfer.

3.3.5.1 Access Control

3.3.5.1.1 User Identification and Management

The Sea Based JPALS-Ship shall provide the ability to add, delete, and modify user IDs and passwords shall be preceded by a password confirmation prompt.

A user shall be able to change their password.

User ID and password lists shall be immediately and automatically updated to reflect changes entered at a Sea Based JPALS equipment station.

Each user ID shall be assigned a logical user access level to accommodate different types of users (e.g., system administrator, maintenance specialist, read only), providing control over varying levels of system parameters.

3.3.5.1.2 User Identification and Authentication

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

User IDs and passwords for the Sea Based JPALS-Ship shall accommodate a minimum combination of six alphanumeric characters and a maximum combination of eight alphanumeric characters.

Only authorized users shall have access to the Sea Based JPALS-Ship components

All users shall log-on at their authorized access level.

3.3.5.1.3 Invalid User ID or Password Entry

An invalid logon entry shall cause:

1. An error message to be displayed,
2. "Denial of access" for a default period of 15 minutes after three (3) consecutive invalid entries, and
3. Generation of an alert for each invalid access attempt.

3.3.5.1.4 Number of Users

Sea Based JPALS-Ship shall accommodate a minimum of 24 users.

3.3.5.2 Log-on Time Out

The system shall automatically logout any user session inactive for more than its assigned session idle time. Maintenance operations may require that maintenance personnel be able to adjust their own session duration.

Forced logouts of inactive users shall generate an alert for a nominal time of 5 minutes priors to automatic logout.

3.3.6 Computer Resource Reserve Requirements

The Sea Based JPALS-Ship shall provide a minimum of 50 percent spare memory capacity for each type of computer memory for each computer processor.

The Sea Based JPALS-Ship shall provide a minimum of 50 percent spare processing and throughput capacity for each computer processor including Input/Output processing capacity.

3.4 Logistics

All new technical manuals, electronic technical manuals, and interactive electronic technical manuals shall be in Extendable Markup Language format.

3.5 Personnel and Training

Operation and maintenance of Sea Based JPALS-Ship will not require an increase to current service manpower authorizations or skill level requirements.

Note: A decrease in operator and maintainer requirements will be sought (objective).

3.5.1 Personnel

The number of final controllers required to monitor/recover aircraft in the shipboard environment will not exceed 2 persons per shift.

Note 1: The number of final controllers required to monitor/recover aircraft in the shipboard environment should not exceed 1 person per shift (objective).

The total number of dedicated organizational level maintenance and logistics personnel needed to support Sea Based JPALS-Ship per shift will not exceed 1 person.

Note 2: No dedicated organizational level maintenance and/or logistics personnel should be needed to support Sea Based JPALS-Ship per shift. Maintenance should be considered additional duties within planned maintenance workforce capability and capacity (objective).

3.5.2 Training

The Sea Based JPALS-Ship training requirements shall be as defined and documented by the development contractor.

3.6 Documentation

At a minimum, the following documentation will be developed for Sea Based JPALS:

- Test plans and reports for qualification, flight, and production tests and evaluation
- Shipboard Installation and maintenance oriented documentation

4 Quality Assurance & Verification Requirements

This Section will define and describe the activities that ensure the system requirements in Section 3 are satisfied.

The following requirements may be included in this Section:

Responsibility for inspection - The assignment of the responsibility to perform inspections on delivered products, materials, or services to determine compliance with all specified requirements.

Special tests/examinations - Special tests and examinations required for sampling, qualification evaluation, or other tests or examinations, as necessary.

Requirements cross-reference - The correlation of each system requirement stated in Section 3 to the quality assurance provisions specified in this Section.

4.1 Verification Strategy

Verification strategy is TBR.

4.1.1 Responsibilities

Responsibilities are TBR.

4.1.2 Special Tests and Examinations

4.1.2.1 Development Test

Developmental Test activities shall be conducted to verify that the implemented hardware and software design meets the functional and performance requirements of the Sea Based JPALS-Ship specification. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.2.2 Production Acceptance Test

Production Acceptance Test (PAT) shall be performed on each end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.2.3 Site Acceptance Test

Site Acceptance Test (SAT) is conducted after completion of hardware installation and checkout and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system, and is repeated for each production system after PAT. Testing shall be performed at each field site to verify that the new system is installed and operating properly on site.

4.2 Verification Methodologies

4.2.1 Inspection

Inspection is a method of verification to determine compliance with specification requirements and consist primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-supported documentation.

4.2.2 Analysis

Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis may also include the use of modeling and simulation.

4.2.3 Demonstration

Demonstration is a method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the equipment. Demonstration activities are further characterized by the following:

1. If a requirement is validated by test during first article qualification testing and the requirement has enough significance that it is re-tested during acceptance test, then this acceptance testing can be indicated in the matrix as a Demonstration.
2. Software functional requirements are validated by demonstration since the functionality must be observed through secondary media.

4.2.4 Test

Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previously predicted success criteria, and evaluated to determine the degree of compliance.

4.2.5 Qualification by Similarity

Qualification by similarity consists of the review of certified/approved test data in conjunction with design evaluation data to substantiate the following:

1. A similar item of equipment has been previously qualified to the requirements of this specification, or a higher level, and
2. The new item does not incorporate differences that would invalidate the criteria of “a”.

4.3 Requirements Traceability Table

The requirements traceability table data is TBR and will be provided in a future version.

5 Terms and Acronyms

5.1 Terms

The following terms are used throughout this document:

Term	Definition
Availability	A measure of the degree to which an item is in an operable and committable state at the start of a mission when the mission is called for at an unknown (random) time.
Failure	An event, either software or hardware, inherent or inducted, or combination of events that prevents or degrades an item from performing a specified mission while in an operational environment.
Line Replacement 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.
Failure	An event, either software or hardware, inherent or inducted, or combination of events that prevents or degrades an item from performing a specified mission while in an operational environment.
Maintenance	All actions necessary for retaining an item in or restoring it to specified condition.
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.

5.2 Acronyms

The following abbreviations, acronyms, and mnemonics are used throughout this document:

Acronym	Description
A/J	Anti-Jam
AC	Alternating Current
Ao	Operational Availability
Ao	Application Specific Integrated Circuits
ATC	Air Traffic Control
ATE	Automatic Test Equipment
ATM	Air Traffic Management
BIT	Built-in-Test
BITE	Built-in-Test Equipment
BRC	Base Recovery Course

BW	Bandwidth
BWI	Bandwidth Interference
C/A	Coarse Acquisition
CATCC	Carrier Air Traffic Control Center
CBM	Condition Based Monitoring
CCA	Carrier Control Area
CCZ	Carrier Control Zone
CDD	Capability Development Document
CJCS	Chairman Joint Chiefs of Staff
cm	Centimeter
CM	Center of Motion
COMSEC	Communication Security
CONOPS	Concept of Operations
CRC	Cyclic Redundancy Check
CW	Continuous Wave
dB	Decibel
dBm	Decibel referenced to one milliwatt
DL	Data link
DoD	Department of Defense
FFD	Fraction of Failures Detected
FOM	Figure of Merit
g	Gravitational acceleration
GHz	Gigahertz
GPS	Global Positioning System
GPETE	General Purpose Electronic Test Equipment
hrs	Hours
Hz	Hertz
IC	Integrated Circuit
ICD	Interface Control Document
ID	Identification
INFOSEC	Information Security
INS	Inertial Navigation System
IOD	Issue of Data
IODE	Issue of Data Ephemeris
JPALS	Joint Precision Approach and Landing System
JPO	Joint Program Office
JTA	Joint Technical Architecture
J-UCAS	Joint Unmanned Combat Air System
J/S	Jammer-to-Signal (Ratio)
kHz	Kilohertz

LAAS	Local Area Augmentation System
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LRU	Line Replaceable Unit
LSB	Least Significant BIT
LSW	Least Significant Word
m	Meters
MER	Message Error Rate
MHz	Megahertz
ms	Millisecond
MSL	Mean Sea Level
MSW	Most Significant Word
MTBF	Mean Time Between Failures
MTBCF	Mean Time Between Critical Failures
MTTR	Mean Time To Repair
NATO	North Atlantic Treaty Organization
NED	North East Down
NGA	National Geospatial-Intelligence Agency
nm	Nautical Miles
ns	Nanosecond
NUC	Navigation Uncertainty Category
NVM	Non-Volatile Memory
ODC	Ozone Depleting Chemicals
ORD	Operational Requirements Document
PAT	Production Acceptance Test
PHM	Predictive Health and Maintenance
PIM	Position and Intended Movement
PLD	Programmable Logic Devices
PPS	Precise Positioning Service
PVC	Polyvinyl Chloride
RF	Radio Frequency
RMS	Root-Mean-Square
RNAV	Area Navigation
R/T	Receive-to-Transmit
SAT	System Acceptance Test
SEM	Standard Electronics Module
SIS	Signal-in-Space
SMS	Ship Motion Sensor
SOE	Shipboard Operating Environment
SPS	Standard Positioning Service

SRA	Shop Replaceable Assembly
SRD	System Requirements Document
SRGPS	Shipboard Relative Global Positioning System
SRP	Ship Reference Point
SSA	System Safety Assessment
STOVL	Short Takeoff Vertical Landing
SV	Satellite Vehicle
TACAN	Tactical Air Navigation
TBD	To Be Determined
TBP	To Be Provided
TBS	To Be Specified
TBR	To Be Reviewed
TDMA	Time Division / Demand Multiple Access
TDP	Touchdown Point
TOA	Time of Arrival
TOD	Time of Day
TOV	Time of Validity
T/R	Transmit-to-Receive
TRANSEC	Transmission Security
TSN	Time Slot Number
TTSF	Time to Subsequent Fix
UTC	Universal Coordinated Time
V	Volts
VCO	Voltage Controlled Oscillator
VDC	Volts Direct Current
Vrms	Volts Root Mean Square
VTOL	Vertical Takeoff and Landing
WGS 84	World Geodetic System 1984
WOD	Wind Over Deck

6 Interface Data Definition

6.1 Aircraft Approach Profile Changes

Data	Input	Output	Definition
Approach/Centerline Angle	X	X	Changes made by the aircrew or unmanned aircraft to these approach profile parameters must be made available to the ship's personnel
Glideslope	X	X	
TDP	X	X	

6.2 Aircraft Configuration Data

Data	Input	Output	Definition
Autopilot Engage	X	X	
Flaps/Slats	X	X	
Hook Position	X	X	
Launch Bar Command and Status	X	X	
Landing Gear Position	X	X	
Parking Brake Engage	X	X	
Weight on Wheels	X	X	
Wing Fold	X	X	

6.3 Aircraft ID

Data	Input	Output	Definition
Tail Number	X	X	

6.4 Aircraft Maintenance Data

Data	Input	Output	Definition
PHM Data	X	X	Platform defined
Maintenance Codes	X	X	

6.5 Aircraft Status

Data	Input	Output	Definition
Air Data - Airspeed	X	X	
Air Data - Angle of Attack	X	X	
Air Data - Barometric Altimeter	X	X	
Attitude Data - Heading and Heading Rate	X	X	

Attitude Data - Pitch and Pitch Rate	X	X	
Attitude Data - Roll and Roll Rate	X	X	
Direct Lift Control Status	X	X	
EAT	X	X	
Emergency and Priority Status	X	X	1=No emergency / Not reported, 2 =Hydraulic, 3 =Electric, 4=Fuel, 5 =Oxygen, 6=Engine, 7=Communications, 8=NAVAIDS, 9 =Other
Engine Data - Autothrottle Engage	X	X	
Engine Data - Engine Speed	X	X	In percent
Engine Data - Engine Throttle Position	X	X	In percent
Engine Data - Jet Pipe Temperature	X	X	
Engine Data - Nozzle / Nacelle Position	X	X	
Estimated Weight	X	X	
Fuel State	X	X	
Ordnance Loadout Code	X	X	

6.6 ATM Broadcast Data

Data	Input	Output	Definition
ATM Broadcast Data	X	X	Defined in CONOPS [7]

6.7 ATM Downlink Messages

Data	Input	Output	Definition
ATM Downlink Messages	X	X	Defined in CONOPS [7]

6.8 ATM Uplink Messages

Data	Input	Output	Definition
ATM Uplink Messages	X	X	Defined in CONOPS [7]

6.9 Environmental Data

Data	Input	Output	Definition
Ceiling	X	X	

Relative Humidity	X	X	
Sea State	X	X	
Visibility	X	X	

6.10 GPS Space Segment

Data	Input	Output	Definition
GPS Ranging Signals and Navigation Data	X		Per ICD-GPS-200C

6.11 INS Alignment Data

Data	Input	Output	Definition
East Velocity	X	X	Pass-through data from the Ship's INS for purposes of aligning the aircraft's INS that is available prior to departure from the ship.
East Acceleration	X	X	
Latitude and Longitude	X	X	
North Velocity	X	X	
North Acceleration	X	X	
Pitch, Pitch Rate, and Pitch Acceleration	X	X	
Roll, Roll Rate, and Roll Acceleration	X	X	
TOA	X	X	
True Heading	X	X	
Vertical Lever Arm	X	X	

6.12 J-UCAS Downlink Messages

Data	Input	Output	Definition
J-UCAS Downlink Messages	X	X	Vendor defined

6.13 J-UCAS Uplink Messages

Data	Input	Output	Definition
J-UCAS Uplink Messages	X	X	Vendor defined

6.14 Path Definition Data

Data	Input	Output	Definition
Altitude	X		

Approach Angle / Centerline Angle	X		Horizontal path to offset approach reference point or TDP
Approach Type	X		
BRC	X		
Cant Offset Angle	X		
Decision Altitude (DA)	X		
Glideslope	X		
Leg Type	X		
Operation ID	X		Input that identifies the current operation to Sea Based JPALS
Speed	X		
TDP	X		
Waypoint Position	X		Defined in North, East, Down (NED) for ship relative and geodetic frame for absolute.
Waypoint Type	X		Relative or absolute

6.15 Relative State Data

Data	Input	Output	Definition
Navigation State Data - Position		X	Relative vector defined in NED between the ship reference point and the aircraft GPS antenna.
Navigation State Data - Velocity		X	
Navigation State Data - Acceleration		X	Precision Relative State output only.
Navigation Status - Decision Altitude Indication		X	Indication when the aircraft is at the DA for the assigned approach type (precision only).
Navigation Status - Protection Levels		X	Indication of the estimated error in the state information provided by Sea Based JPALS.
NUC		X	
NUCR		X	

Position Data - Magnetic Bearing to Ship		X	
Position Data - Range to Ship		X	Distance from aircraft reference point to ship reference point
TOA		X	

6.16 Ship Geometry

Data	Input	Output	Definition
Cant Offset Angle	X		
CM to GPS Geometry	X		
CM to SMS Geometry	X		
CM to TDP Geometry	X		

6.17 Ship Status Data

Data	Input	Output	Definition
Ship Magnetic Variation	X	X	
PIM	X	X	
PIM TOA	X	X	
Ship Position		X	Latitude and Longitude
Ship True Heading		X	

6.18 Ship Wind Over Deck

Data	Input	Output	Definition
WOD Direction	X	X	
WOD Magnitude	X	X	