

# **Space Program Operations Contract**

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## **SPACE SHUTTLE ORBITER OPERATIONAL LEVEL C FUNCTIONAL SUBSYSTEM SOFTWARE REQUIREMENTS GUIDANCE, NAVIGATION AND CONTROL PART B**

### **ENTRY THROUGH LANDING NAVIGATION**

**PREPARED BY THE BOEING COMPANY  
Space Exploration**

**Under Subcontract 6000132079, PDRD P1433q**

December 14, 2007

DRD 1.4.3.3-q

Contract NNJ06VA01C



**STS 83-0004-34**  
**December 14, 2007**

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**STS 83-0004-34**

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FUNCTIONAL SUBSYSTEM SOFTWARE REQUIREMENTS  
GUIDANCE, NAVIGATION, AND CONTROL  
PART B  
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**NASA Contract No. NNJ06VA01C, DRD 1.4.3.3-q  
USA Subcontract 6000132079, PDRD P1433q  
WBS 2.4.3.2**

**The Boeing Company  
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G4.18	GPS REF STATE PROC
G4.21	GPS RCVR STATE PROC
G4.23	ENTRY UPP
G4.24	TAEM UPP
G4.25	A/L UPP
G4.123	D/L NAV SEQ
G4.124	ENT SITE LOOKUP
G4.127	ENT NAV
G4.144	PRELAND NAV
G4.214	D/L UPP SEQ
G4.220	ENT AREA NAV PROC
G4.223	ENT PREC PRED

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## FOREWORD

The primary avionics software system (PASS) requirements for the computer programs that execute in the Shuttle general-purpose computers (GPC's) are specified in the Computer Program Development Specifications (CPDS's) and the Functional Subsystem Software Requirements (FSSR) documents. The requirements are specified at three levels:

Level A CPDS – System-level constraints and capabilities

Level B CPDS – Functional requirements

Level C FSSR – Detailed-level requirements

The Level A CPDS specifies system-level constraints and capabilities that are not oriented toward any particular program end item. The Levels B CPDS specifies system-level requirements for guidance, navigation, and control (GN&C) and detailed requirements for systems management (SM) and vehicle utility (VU). The Level C FSSR's specify the detailed requirements for GN&C and display/controls. The Level C reconfigurable requirements are specified in the systems management and payload documents. The Level A, Level B, and Level C requirements documents are listed in Section 2, Applicable Documents.

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**DOCUMENT CHANGE RECORD**

The following tabulation summarizes the change activity associated with this document.

<b>DOCUMENT CHANGE RECORD</b>			
<b>Issue and Date</b>	<b>Change Summary/Effectivity</b>		
OI-34 Release December 14, 2007	This baseline release for effectivity OI-34 and subs includes:		
	<u>CR</u>	<u>OI</u>	<u>Title</u>
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
	93160B	32	Year End Roll Over (YERO) Reset
	93167A	34	Bearing Displays Documentation Clean-up
	93175	32	Expand Effectivity of SCR 93160B
	93181A	32	Altitude Initialization
	93194A	34	BFS HUD Additions
	93201	33	BFS GPS Auto Update Frequency
	93203B	33	Landing Sites and Alternate Sites Update on Bearing Displays

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**CHANGE REQUEST SUMMARY**

The following tabulation lists the paragraphs, tables (T), and figures (F) that have been changed as a result of approved change requests for this release. Changes incorporated prior to this release are listed in Appendix R. Changes from approved change requests (CRs) to this document are indicated by a change bar in the outer margin of the changed page.

<b>CHANGE REQUEST SUMMARY</b>			
<b>Paragraph</b>	<b>CR No.</b>	<b>OI</b>	<b>CR Title</b>
N/A	93175	32	Expand Effectivity of SCR 93160B
1.3-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.1.1	93160B	32	Year End Roll Over (YERO) Reset
4.1.1.1-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.1.1.1-2.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.1.1.1-3.(T)	93160B	32	Year End Roll Over (YERO) Reset
4.1.2.1-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.1.9-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.1.9-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.1.9-3.(T)	93201	33	BFS GPS Auto Update Frequency
4.3.2.9-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.2.9-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.2.9-3.(T)	93201	33	BFS GPS Auto Update Frequency
4.3.3.8-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.3.8-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.5.1.1-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.5.2.1	93203B	33	Landing Sites and Alternate Sites Update on Bearing
4.5.2.1-2.(T)	93203B	33	Landing Sites and Alternate Sites Update on Bearing
4.5.2.2	93167A	33	Bearing Displays Documentation Clean-up
	93203B	33	Landing Sites and Alternate Sites Update on Bearing
4.5.2.2-1.(T)	93167A	33	Bearing Displays Documentation Clean-up
	93203B	33	Landing Sites and Alternate Sites Update on Bearing
4.5.2.4-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
	93167A	33	Bearing Displays Documentation Clean-up
4.5.2.4-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.5.2.4-3.(T)	93194A	34	BFS HUD Additions
4.6.1.3	93167A	33	Bearing Displays Documentation Clean-up
4.6.1.3-1.(T)	93167A	33	Bearing Displays Documentation Clean-up

<b>CHANGE REQUEST SUMMARY</b>			
<b>Paragraph</b>	<b>CR No.</b>	<b>OI</b>	<b>CR Title</b>
4.6.1.3-2.(T)	93167A	33	Bearing Displays Documentation Clean-up
4.6.1.6-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
	93167A	33	Bearing Displays Documentation Clean-up
4.6.1.6-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
	93167A	33	Bearing Displays Documentation Clean-up
4.6.2.4-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.2.4-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.3.4-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.3.4-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.4.6-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.7.1-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
5.1-1.(T)	93181A	32	Altitude Initialization
5.2-2.(1)(F)	93160B	32	Year End Roll Over (YERO) Reset
5.3-1.(T)	93181A	32	Altitude Initialization
	93203B	33	Landing Sites and Alternate Sites Update on Bearing
5.3-23.(1)(F)	93203B	33	Landing Sites and Alternate Sites Update on Bearing
5.3-24.(F)	93167A	33	Bearing Displays Documentation Clean-up
	93203B	33	Landing Sites and Alternate Sites Update on Bearing
5.4-1.(T)	93181A	32	Altitude Initialization
5.6-1.(T)	93181A	32	Altitude Initialization

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## 1.0 INTRODUCTION

### 1.1 PURPOSE

The purpose of the subsystem operating program, the Entry Navigation Level C document is to present the detail level requirements for those navigation functions which are operative during the entry through landing portion of the orbital flight test (OFT).

### 1.2 SCOPE

This document contains the requirement details and the navigation functions which are specified in the GN&C Level B OFT functional level requirements document, SS-P-0002-510.

### 1.3 ORGANIZATION

This document is organized into the following sections:

- 1.0 Introduction
- 2.0 Applicable Documents
- 3.0 Overview
- 4.0 Detail Requirements
- 5.0 Supplemental Material

Section 1 defines the purpose, scope, and organization of this document. The applicable documents are listed in Section 2. An overview of the navigation program is described in Section 3, and Section 4 presents the detail-level requirements of the document. It also contains applicable tables (Interface Definition Document (IDD) inputs/outputs, I-Loads, K-Loads, and Constants) located at the end of each Principal Function.

The automated IDD tables provided herein define signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements. A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function, or an OPS display function. In the event of a conflict between the IDD tables and other internal text input/output tables, the SASCB data base-controlled IDD tables take precedence.

The following table defines the data elements found in the IDD input/output, I-Load, K-Load, and Constant tables for each principal function.

Table 1.3-1. Parameter Element Description		
Title	Definition	Valid Entries
CAT	Category of the I-Load (**Note)	Three alphanumeric characters: the first character must be alphabetic.
D	Dependency of the I-Load	D = Design M = Mission L = LRU
DESCRIPTION	Parameter description of the K-Load or Constant.	A string of ≤ 64 characters.
DESTINATION	Destination of the output parameter	Abbreviated functional titles. (***)Note)
DT or DATA TYPE	Data Type	* See reference (1) for valid I-Load, K-Load and Constant data types. * See reference (2) for valid IDD data types for parameters with destination TLM. * See reference (3) for valid IDD data types for all other parameters.
ENG UNITS or UNITS	Engineering Units	* See reference (1) for valid I-Load, K-Load and Constant units. * See reference (2) for valid IDD units for parameters with destination TLM. * See reference (3) for valid IDD units for all other parameters.
FSSR NAME	Requirements parameter name	A string (with no embedded blanks) of ≤ 32 characters consisting of alphanumerics, underscores, parenthesis, commas and slashes. Parenthesis are used for array elements. Commas separate the different indices of multidimensional arrays. Slashes are used to separate multiple names used for a single MSID.
LAST CR	The last CR affecting the parameter	5 digit number with an alphabetic revision letter.
MC	Memory Configuration	00=Generic                      05 = SM4 Orbit P/L 01=GN1 Ascent/GN6 RTLS    06 = P/L9 MMU 02=GN2 Orbit                 07 = Not Assigned 03=GN3 Entry                 08 = GN8 On-Orbit C/O 04=SM2 On-Orbit             09 = GN9 Preflight
MSID or M/S ID	Measurement/Stimulus Identification	Maximum of 10 alphanumeric characters. * See reference (3) for specifications
NOMENCLATURE	Parameter description of the IDD parameter.	String of ≤ 34 characters (including underscores and blank spaces).
PR or PREC	Precision	D, DP =Double                 S, SP = Single
SOURCE	Origin of the input parameter	Abbreviated functional titles.

Table 1.3-1. Parameter Element Description		
Title	Definition	Valid Entries
S	Software Utilization	C = Common                      B = BFS Unique P = Primary                      X = BFS Derived A = BFS Converted
PR FCTN	Cross reference of the principal function identifiers that are applicable to this parameter.	See Level B GN&C CPDS SS-P-0002-510
VALUE	The value of the K-Load or Constant	* See reference (1) for valid value formats.
REV	Revision indicator	An asterisk (*) indicates changes for the current OI version.
<p>* References: (1) JSC 19350 I-Load Requirements Document Volume I (2) SS-P-0002-140 Level A SS Downlist/Uplink CPDS (3) JSC 18206 Shuttle Data Integration Plan Volume III MAST II/STAR Deliverable Products.</p> <p>** Note For additional information on any I-Load, contact the I-Load owner defined in CR 98032, JSC, USA, and Boeing I-Load Owner Assignments</p> <p>*** Note IDD output (source) tables which reflect parameters going to input (destination) "TLM" shall not be interpreted as a signal actually being downlisted. The parameter is only available for downlist in COMPOOL and does not appear in a downlist format. Parameters actually on the downlist will be designated with a destination denoting the downlist Format with a Rate Code. The Rate Code legend appears at the end of each FSSR data table. To complete the downlist information, Parent MSIDs (indicated by a 'P' in the 9<sup>th</sup> character of the MSID) are now included in the software function output data tables in which a Child MSID already appears. A Parent MSID will have the same downlist destinations as its Child(ren) MSID(s).</p>		

Each subfunction described within each subsection of Section 4 which describes a principal function element is structured as follows:

- Text
- Input parameter table
- Output parameter table

Table 1.3-2 lists the symbols used in the internal subfunction tables.

Table 1.3-2. Symbols Used in Internal Subfunction Input/Output/Constants Tables	
Symbol	Description
CHAR	Character string
D	Discrete
DIP	Display interface processor
DP	Double precision
F	Scalar, floating point
I	Integer
M	Matrix
S	Single precision
V	Vector



## 2.0 APPLICABLE DOCUMENTS

### 2.1 LEVEL A DOCUMENTS

- SS-P-0002-140 Shuttle Downlist/Uplink Software Requirements
- SS-P-0002-150 Shuttle Launch Data Bus Software Interface Requirements
- SS-P-0002-170 Shuttle Systems Level Requirements, Software

### 2.2 LEVEL B DOCUMENTS

- SS-P-0002-510 Shuttle Functional Level Requirements, GN&C
- SS-P-0002-550 Shuttle Functional Level Requirements, Vehicle Utility
- SS-P-0002-580 Shuttle Functional Level Requirements, Systems Management

### 2.3 LEVEL C DOCUMENTS

- STS 83-0001 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Entry Through Landing Guidance
- STS 83-0002 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Guidance Ascent/RTLS
- STS 83-0003 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Guidance On-Orbit/Deorbit
- STS 83-0004 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, Entry Through Landing Navigation
- STS 83-0005 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, Navigation Ascent/RTLS
- STS 83-0006 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, On-Orbit Navigation
- STS 83-0007 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Entry—GRTLS
- STS 83-0008 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Volume 1, Ascent Flight Phase, Volume 2, Ascent
- STS 83-0009 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Orbit DAP
- STS 83-0010 Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part D, Redundancy Management

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**December 14, 2007**

STS 83-0013	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Inertial Measurement Unit Subsystem Operating Program
STS 83-0014	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Volume 1, Navigation Aids Subsystem Operating Program, Volume 2, Star Tracker Subsystem Operating Program
STS 83-0015	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Sensor/Controller
STS 83-0016	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Effector
STS 87-0017	Operational Flight Level C, Functional Subsystem Software Requirements; Remote Manipulator System
STS 83-0020	Operational Flight Level C, Functional Subsystem Software Requirements; Displays and Controls
STS 83-0026	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Sequencing
JSC-19350	Shuttle Flight Software Initialization Load <ul style="list-style-type: none"><li>• Volume I General Requirements</li><li>• Volume II Mission I-Load Requirements</li></ul>
JSC-19478	Payload Management, Level C Flight Software Requirements
JSC-19590	Systems Management, Level C Flight Software Requirements

## **2.4 INTERFACE CONTROL DOCUMENTS**

ICD 3-1011-02	GPC/DEU ICD
ICD 2-1F001	Orbiter Primary Flight Software System and Backup Flight System Software Interface

In the event of a conflict between the documents referenced herein and the contents of this specification, the precedence shall be determined as defined in paragraph 1.3 of CPDS SS-P-0002-170, Volume 1, System Level Requirements, Software.

## 3.0 OVERVIEW

### 3.1 SOFTWARE LEVEL REQUIREMENTS

For the Space Transportation System (STS), the software requirements are specified at three levels: system Level (A), functional Level (B), and detail Level (C). In addition, the Level B and C requirements are presented in separate documents for the four major functions: guidance, navigation, and control (GN&C); system management (SM); vehicle utility (VU) and payloads (PL). This document is part of the GN&C Level C requirements.

### 3.2 GN&C SOFTWARE FUNCTIONS

The software for the GN&C major function is composed of the following functions:

- Guidance (GUID)
- Navigation (NAV)
- Flight Control (FC)
- Redundancy management/moding, sequencing, and control (RM/MSC)
- Subsystem operation programs (SOP)
- Displays and controls (D&C)
- Other

This document specifies the software detail level requirements for the navigation function during the entry operational sequence (OPS-3) phase of the flight.

### 3.3 NAVIGATION SYSTEM OVERVIEW

The basic function of the orbiter navigation system is to provide and maintain an accurate current estimate of the orbiter navigation state. The navigation state consists of the three orbiter position components and the three orbiter velocity components expressed in the M50 inertial coordinate system. The time tag associated with this six dimensional navigation state defines the time of validity of its associated position and velocity estimate. The terms navigation state, state estimate and state vector are used interchangeably in this document.

The orbiter navigation system performs its basic function by utilizing two independent navigation capabilities, each of which provides and maintains an accurate current estimate of the orbiter state.

The first navigation capability consists of those navigation principle function software elements and NAVAIDS which provide and maintain the three orbiter filter state estimates for entry navigation and the resulting selected filter state estimate, and the single state estimate for preland navigation. The software elements perform the following functions for both entry and preland navigation: propagation of the filter state estimates to current time, using orbiter IMU data when appropriate; resetting or updating the filter state estimates to a ground uplink, manual inputs or a selected GPS navigation state, depending on the navigation system configuration; processing NAVAID measurements, when available, in the principal

function Kalman filter software to improve the accuracy of the orbiter filter state estimates; and for entry navigation, selection of a single filter state from the three filter state estimates for use by the orbiter navigation system. The terms NAVAID and sensors are used synonymously in this document and are used to describe the onboard navigation instruments which provide measurements for processing by the navigation principal function Kalman filter. These navigation instruments are associated with the following systems:

- MSBLS (Microwave Scanning Beam Landing System)
- TACAN (Tactical Air Navigation)
- Barometric Altimeter

This capability will be referred to as the baseline or IMU-NAVAID navigation capability.

As discussed above, three states are maintained by the baseline navigation capability for entry and a single state for preland. Thus use of the plural “states” and the singular “state” will be used interchangeably and the distinction for entry and preland is implied.

The second navigation capability utilized by the orbiter navigation system consists of the Global Positioning System (GPS) Line Replacement Units (LRUs) and those orbiter navigation principal function software elements which provide and maintain the GPS orbiter state estimates and the resulting selected GPS state estimate. The software elements perform the following functions: providing an aiding or reference state for each GPS receiver propagated to current time using orbiter IMU data, the aiding state being periodically reset to the orbiter navigation state estimate; propagation of the orbiter state estimates from the GPS LRUs to current time using orbiter IMU data; execution of a series of quality assessment checks on the propagated GPS state estimates; and selection of a single GPS state for use by the orbiter navigation system and for resetting the baseline navigation filter state estimates, depending on the navigation system configuration as specified by the crew.

Up to three GPS LRUs can be installed on the Orbiter, each LRU consisting of a receiver and navigation software. The LRU receiver provides GPS measurements to its navigation Kalman filter for improving accuracy of its orbiter state estimate. The state estimate from each of the GPS LRUs, along with its associated time tag, are then made available to the navigation system principal function software elements for processing.

Note that the GPS LRUs are not NAVAIDS. They do not provide sensor measurements for processing by the baseline navigation principal function Kalman filter as do the MSBLS, TACAN and Baro altimeter instruments. The GPS LRUs provide complete state estimates (position, velocity) and associated time tag to the orbiter navigation system after processing GPS measurements in their Kalman filter. For the purpose of this document, the terms GPS LRU and GPS receiver will be used interchangeably and will refer to the orbiter GPS navigation capability.

Depending on the navigation system configuration, either the selected baseline navigation filter state estimate or the selected GPS state estimate is used for calculating navigation state dependent parameters and for resetting the orbiter state estimate required by non-navigation functions. The selected GPS state estimate can also be used to reset the filter state estimate. The selected baseline navigation filter state can be used to initialize or restart the GPS LRU navigation process, again depending on the navigation system configuration.

### 3.3.1 Navigation Functions

In general, the orbiter navigation system software can be divided into four parts: part (a) baseline navigation with IMU-NAVAID processing; part (b) user parameter processing; part (c) GPS receiver state processing; and part (d) GPS reference state processing.

Part (a) is divided into the following functions:

- (1) Navigation Control. Performs the initialization of navigation function parameters and sets up the sequencing of functions to accomplish navigation requirements.
- (2) Measurement Scheduler. Selects the appropriate sensor measurements in accordance with selection criteria.
- (3) Data Handler. Prepares data for sensor measurement processing.
- (4) Navigation Reconfiguration. Initializes and resets the baseline navigation system filter state estimates to ground uplinked states, manual state updates or the selected GPS receiver state estimate, depending on the configuration of the navigation system. It also initializes and resets the navigation Kalman filter covariance matrix for sensor measurement processing in response to navigation state initialization and resets. The GPS state that is used for resetting the baseline navigation filter states is selected in the GPS receiver state processing principal function, based on pre-mission defined GPS state quality assessment criteria and is subject to crew control. Navigation reconfiguration also prepares site location data for changing sensor sites.
- (5) Navigation State and Covariance Propagation. Propagates state vector with IMU data and covariance matrix by means of the state transition matrix for subsequent sensor measurement processing.
- (6) Navigation State and Covariance Update. Determines and performs (by means of a Kalman filter scheme) state and covariance updates based on the measurements from barometric altimeter, TACAN, MSBLS and pseudo-altitude measurements derived from IMU data.
- (7) Execution of the GPS Receiver State Processing Function. Executes the GPS receiver state processing principal function to provide a selected GPS orbiter state estimate, associated time and IMU data, for use in resetting the baseline navigation system orbiter state estimate and for use in resetting the user parameter state.
- (8) User Parameter State Reset. Provides a navigation state, associated time and IMU data for periodically resetting the user parameter state. This state is either a navigation filter state estimate or the selected GPS state, depending on configuration of the navigation system. If a selected GPS state is available, the User Parameter State Reset function also provides the selected GPS state, associated time and IMU data for periodically resetting the GPS User Parameter Computation Display State. This function also provides the baseline navigation state, associated time and IMU data for initializing and reanchoring the GPS reference state, maintained by the GPS reference state processing principal function.
- (9) GPS Receiver State Vector Initialization. Provides a filter state estimate for initializing the onboard GPS receiver(s).

Part (b) is divided into the following two functions:

- (1) User Parameter State Propagation. Propagates the state at a faster rate than Nav for user parameter calculations. The user parameter state is updated with the most recent Nav updated state.
- (2) User Parameter Calculations. Computes state-related parameters for other GN&C functions.

Part (c) is divided into the following four basic functions:

- (1) GPS Receiver State Propagation. Propagates the state estimates from the GPS receivers to the current time of the navigation filter states using selected IMU data.
- (2) GPS Receiver State Quality Assessment. Performs quality assessments of the GPS receiver state estimates to determine if they are candidates for GPS receiver state selection.
- (3) GPS Receiver State Selection. Selects the receiver state estimate to be made available to reset the baseline navigation filter state(s) and the user parameter processing state.
- (4) Announced Reset Scheduling for GPS Reference State Processing Principal Function. Schedules GPS Reference State Processing to reanchor the reference state to the baseline navigation state. With the reanchored reference state, GPS Reference State processing will send a command to all the GPS receivers to perform either an INIT, a Filter Restart, or an announced reset as specified in FSSR 4 Section 4.6.4.4.

Part (d) is divided into the following two functions:

- (1) Reference State Initialization and Reanchor. Initializes the GPS Reference State to the baseline navigation state vector after an OPS transition and reanchors the GPS Reference state to the baseline navigation state vector when scheduled to perform an announced reset.
- (2) GPS Reference State Vector Propagation. Propagates a state vector for use as an aiding state by the GPS receivers.

In this document, the details of Part (a) are presented under three principal functions:

- (1) Deorbit/Landing Navigation Sequencer (Section 4.1.1).
- (2) Entry Navigation (Section 4.3.1).
- (3) Preland Navigation (Section 4.3.2).

The details of Part (b) are presented under four principal functions:

- (1) Deorbit/Landing User Parameter Processing Sequencer (Section 4.1.2).
- (2) Entry User Parameter Processing (Section 4.6.1).
- (3) TAEM User Parameter Processing (Section 4.6.2).
- (4) Autoland User Parameter Processing (4.6.3).

The details of parts (c) and (d) are presented under the following two principal functions respectively:

- (1) GPS Receiver State Processing (Section 4.3.3)
- (2) GPS Reference State Processing (Section 4.6.4)

In addition, the flow charts for each function are presented in Section 5.2 for parts (a) and (c) and in Section 5.6 for parts (b) and (d). These flow charts are not to be construed as requirements, but rather as examples of how the requirements stated in the text may be implemented.

### **3.3.2 Navigation-Related Functions**

The navigation-related function, area navigation, supports the horizontal situation indicator (a dedicated display device) by computing directions and distances to defined way points as well as nominal course and glidepath deviations.

### **3.3.3 General Requirements**

This section discusses software requirements in the categories of service, single-use, or multiple-use that are not uniquely related to the navigation function.

The general requirements include, but are not limited to, the following:

- Coordinate transformations (this publication contains transformations required for navigation)
- Entry precise predictor
- Entry site lookup

### **3.3.4 Requirements and Assumptions Overview**

The following sections present an overview of the requirements and assumptions of the STS entry through landing GN&C navigation system related software. The requirements and assumptions are presented according to the software functional breakdown discussed in Section 3.3.1: (1) IMU-NAVAID navigation system functions which maintain the orbiter filter state estimates using orbiter IMU data, NAVAIID measurement processing in the navigation principal function Kalman filter, and state resets using ground uplink data, manual inputs or the selected GPS state; (2) the user parameter processing functions; (3) the GPS receiver state processing functions which select the GPS receiver state estimate for use in resetting the navigation state and the user parameter state, depending on the configuration of the navigation system; and (4) the GPS reference state processing functions which initialize the GPS receiver state estimate and maintain a reference state using selected IMU data.

Sections 3.3.4.1 and 3.3.4.2 present the requirements and assumptions overview for the baseline or IMU-NAVAID navigation system functions and the user parameter processing functions which provide the capabilities in (1) and (2) above. Sections 3.3.4.3 and 3.3.4.4 present the requirements and assumptions overview for the orbiter navigation system GPS related software functions which provide the capabilities in (3) and (4) above.

The navigation software requirements and assumptions as presented make statements about the performance of non-navigation functions. Completion of the software requirements will require adequate definition of the timing and data time-tagging mechanization and the Input/Output Processor (IOP)

mechanization. Changes in the navigation software requirements may be necessary, depending on actual implementation of the non–navigation functions.

### **3.3.4.1 Requirements for IMU-NAVAID Navigation System and User Parameter Processing Software**

The following statements are grouped under six general categories and represent the navigation requirements which must not be violated. To illustrate the requirements, references are made to the flow charts in Section 5.2. Requirements concerning:

a. Definition of State Vector

- (1) The six elements of the navigated state vector consist of the position and the velocity of the Shuttle navigation base point in M50 coordinates.

b. Kalman Filter Equations

- (1) Filter statistics are in double precision so that the quadratic form of the Kalman filter can be used.

c. Input Data

- (1) Statements that snap data upon entry into navigation shall be such that a timewise consistent set of data is obtained before the set of data is used. The time tag is assumed to be in seconds from the beginning of the year in which the mission is launched.
- (2) The redundancy management selection filter must provide navigation with the total accumulated sensed velocity in M50 coordinates.
- (3) Selected sensed velocity data are used without reference to the IMU DATA GOOD flags.
- (4) Data from all sensors will be collected at the beginning of each filter cycle, so that they are timewise as close to each other as possible. The sensor data snap functions should not be interrupted by other programs until they are completed.

d. Output Data

- (1) During the time when a state vector is being read by non–navigation application software, that state vector or portions thereof will not be updated by the navigation software. The reset equations in the user parameter propagator shall be so protected.

e. Sensor Data Processing

- (1) Both automatic and manual capability will be available for selecting navigation sensors for navigation processing.
- (2) Sensor read boxes refer to picking up of sensor data from appropriate locations. The sensor data and the time tag must be consistent.
- (3) The navigation sensor read functions should not be interrupted by other programs until they are completed.



- (4) There will be a manual override of the filter residual edit for TACAN and barometric altimeter sensors and drag altitude measurement processing.

f. Update of State Vector and Covariance Matrix

- (1) The processing of a measurement to update the state vector and the covariance matrix must be completed before the processing of the next measurement is started (NAV\_FILTER).
- (2) Processing of all measurement available at a given filter cycle will be completed before starting the next filter cycle.

**3.3.4.2 Assumptions for IMU-NAVAID Navigation System and User Parameter Processing Software**

The following statements are grouped under four general categories and represent assumptions used for the navigation formulations; they are reflected in the flow charts given in Section 5.2. Assumptions concerning:

a. State Vector

- (1) All states will be integrated in entry navigation without regard to IMU failures.
- (2) A whole vector (M50 coordinates) update to the on-board state may be command uplinked from the ground during OPS-3.
- (3) A delta state vector (runway coordinates) correction update from ground calculated data may be performed either directly via ground command uplink or manually via keyboard entry by the crew during OPS- 3.
- (4) A capability shall be provided for resetting the navigation filter states to the selected GPS receiver state in OPS-3, either automatically or manually, depending on the configuration of the navigation system as set by the crew.

Resetting the navigation filter states to the selected GPS receiver state, should the appropriate checks be passed, must be completed before integrating the baseline navigation state to the current time. In this case, the covariance matrix will also be reinitialized to an I-Load set of values reflecting the quality of the selected GPS state estimate used in resetting the baseline navigation states.

- (5) The navigation state associated with a bypassed IMU shall be automatically reset to the selected Nav state during Entry Navigation if IMU upmoding occurs after the clearing of a bypass.

b. Majors Modes and Navigation Phases

- (1) Only during MM 301 (predeorbit coast) is there a provision for transition to OPS-2 from OPS-3. One state vector is provided for this transition.
- (2) During the entry navigation phase there is a provision for transition from MM 303 (preentry monitor) to MM 301 (predeorbit coast).

- (3) Three state vectors are maintained in OPS-3 by navigation until the preland phase; thereafter, one state vector is maintained.
- (4) The navigation sequencer never returns to entry nav (three states) once the preland nav (one state) has been selected.
- (5) Automatic criterion for the switch from entry nav to preland nav is that MSBLS is indicated to be available at the landing site and MSBLS range and azimuth data are indicated as valid.

MSBLS = Microwave Scanning Beam Landing System

c. Sensor Data Processing

General

- (1) No manual capability to override sensor data-good flags exists within the navigation software. Such override, if any, will be through the redundancy management or selection filter functions. Data will be presented to the filter for processing only if the data-good flag is set to ON.
- (2) Data presented to the filter will be incorporated into the state vector and covariance matrix only if the residual edit test is passed or if the sensor force switch is set.

IMU

- (1) The only IMU system malfunction for which a direct method of IMU state vector recovery exists is a commfault (or bypass). When IMU upmoding occurs after a bypass is cleared, knowledge of the event will be made available to Entry Navigation so that the upmoded IMU's state vector may be automatically reset to the selected navigation state vector. For all other failures, the state vector of the failed IMU is lost for the duration of entry. In these cases, an indirect method of transferring the state vectors associated with nonfailed IMU's to states associated with recovered IMU's exists through crew performance of a manual zero-delta state update. In the latter approach, all three IMU state vectors are reset to the selected navigation state vector and the navigation filter's covariance matrix is reset.
- (2) The change in IMU-sensed velocity is used to calculate the sensed acceleration due to aerodynamic forces. This acceleration is then employed to compute a pseudo-altitude measurement (drag altitude).

BARO

- (1) The BARO probe is assumed to be at the navigation base.
- (2) Barometric data processing may be performed with TACAN data processing.
- (3) Drag altitude measurement processing may be performed with barometric data processing; however, no more than one may be employed to update the state vectors.

TACAN

- (1) The capability exists to process only TACAN range or only TACAN bearing.

- (2) The RM will supply a separate data-good for TACAN range and bearing; RM will also set the appropriate data-good to bad if either range or bearing is not locked up.
- (3) Drag altitude measurement processing may be performed with TACAN data processing.
- (4) There is no on-board antenna location correction for TACAN range and bearing measurements.

#### MSBLS

- (1) The RM sets a data-good for each of the MSBLS measurements.
- (2) All MSBLS on-board antennas are assumed to be collocated.
- (3) There is no on-board antenna location correction for MSBLS range and azimuth measurements.

#### d. Site Lookup Data

- (1) Runway TACAN, and MSBLS site location data will be loaded prior to launch and will be based on the area concept. An area is defined as any potential landing site. A maximum of 45 areas and 15 MSBLS's have been allocated for OPS-3. Associated with each area are two runways, primary and secondary; two TACAN's, primary and secondary; and two MSBLS's (if existing). On entry to OPS-3, the default area will be Area 1 for nominal end-of-mission unless a TAL abort has been declared, in which case the default will be Area 2. Once in OPS-3, any of the 45 areas may be selected by way of an HSD item entry as would be the case for an abort-once-around (AOA) entry.

### 3.3.4.3 Requirements for the Navigation System GPS-Related Software

The following requirements are for the GPS receiver state processing and GPS reference state processing principal functions and are illustrated in Sections 5.2 and 5.6 respectively.

The terms center of mass and center of gravity are interchangeably when applied to the Shuttle navigation system.

#### (a) Phased GPS Receiver Installation Requirement

The implementation of GPS related software in the Entry, Ascent/RTLS and On-Orbit Navigation FSSRs, and the Navigation Aids Subsystem Operating Program FSSR, satisfies this requirement by processing data from up to three receivers as if three were installed, and bypassing relevant calculations if a particular receiver is not actually installed on the vehicle.

#### (b) Definition of Position and Velocity State Vector

- (1) For OPS-1, OPS-6 and OPS-3, the six elements of the GPS state shall consist of the position and velocity of the Shuttle navigation base in M50 coordinates.

For OPS-2 and OPS-8 the six elements of the GPS state shall consist of the position and velocity of the Shuttle center-of-mass in M50 coordinates.

(c) Input Data

- (1) Statements that snap GPS data for use by the GPS reference state processing function and the GPS receiver state processing function shall be such that a time consistent set of data is obtained before the set of data is used. The time tag of the data shall be in GMT seconds, measured from 12:00 am on the December 31 prior to the beginning of the year in which the mission is launched. GPS state data snapped from the GPS SOP by the navigation principal function for use by the GPS receiver state processing principal function shall be in World Geodetic Survey 1984 coordinates, and will be transformed to M50 inertial coordinates in the GPS receiver state processing function.
- (2) In all applicable GN&C operational sequences and major modes, selected IMU data shall be collected by the navigation principal function and provided to the GPS receiver state processing principal function for GPS state propagation purposes. For OPS-1, OPS-3 and OPS-6, the total accumulated sensed velocity shall be that at the navbase in M50 coordinates. For OPS-2 and OPS-8, the IMU RM function must provide total accumulated sensed velocity at the orbiter CG in M50 coordinates.
- (3) In all applicable GN&C operational sequences and major modes, data from the GPS receivers shall be collected at the beginning of the navigation principal function cycle from the GPS SOP and provided to the GPS receiver state processing principal function.

(d) Output data

- (1) When a GPS state is being read by applications other than GPS receiver state processing software, that state or portions thereof shall not be updated by the GPS receiver state processing software. The reset equations in the GPS receiver state processing software and in the GPS reference state processing software shall be so protected.

(e) Processing Requirements

- (1) The GPS receiver state processing function shall process up to three GPS receiver states during all applicable GN&C operational sequences and major modes for the operational GPS capability.
- (2) The GPS reference state processing function shall maintain a reference or aiding state during all GN&C operational sequences and major modes, except OPS 9.
- (3) A full-up GPS receiver capability shall be maintained in the presence of IMU failures, with the number of GPS receiver states available determined only by the number of non-failed GPS receivers.
- (4) Each GPS state shall be propagated using selected IMU velocity data.
- (5) The GPS receiver state processing function shall provide a selected GPS state for resetting the navigation filter states and the user parameter processing state.
- (6) Both an automatic and manual capability shall be provided for GPS state vector selection.
- (7) The states provided by the receivers shall be corrected in each receiver for the offset from their antenna to the appropriate OPS phase dependent vehicle reference point (vehicle navbase for

OPS-1, OPS-3 and OPS-6; vehicle center of mass for OPS-2 and OPS-8), so that the GPS state vectors obtained from the receivers are consistent with the navigation filter state definition.

- (8) There will be a manual override capability for the GPS state vector quality assessment functions.
- (9) Updating the navigation filter state(s) with the selected GPS receiver state estimate will be under manual control.
- (10) There will be manual control of the navigation state used for user parameter processing state resets. The reset states will come from either the selected state maintained by the baseline navigation principal function or from the selected GPS receiver state.
- (11) The GPS receiver state processing principal function shall be called from the navigation principal function currently active in each applicable flight OPS just prior to execution of the user parameter reset functions and shall be completed before the start of the next navigation cycle.
- (12) The data snap functions supporting GPS reference state processing shall not be interrupted by other programs. The data and time tag must be time homogeneous.

#### **3.3.4.4 Assumptions for the Navigation System GPS-Related Software**

The following statements are assumptions used for the GPS receiver state processing and GPS reference state processing principal function formulations, and are reflected in the flowcharts given in Section 5.2 and 5.6 respectively.

- (a) State and IMU Data
  - (1) During execution of the GPS receiver state processing and GPS reference state processing principal functions, selected IMU accumulated sensed velocity data shall be available.
- (b) Major Modes and Navigation Phases
  - (1) The GPS receiver state processing principal function shall be executed in all applicable GN&C operational sequences and major modes.
  - (2) The GPS reference state processing principal function shall be executed in all operational sequences and major modes except for OPS 9.
  - (3) The GPS receiver state processing principal function shall be executed from the applicable navigation principal function which is active during that operational sequence and major mode.
  - (4) For all major modes, the number of GPS states processed by the GPS-related software shall be determined by the number of receivers onboard the Shuttle (indicated by I-Load) and by the number of non-failed receivers capable of providing state estimates. The GPS-related software shall be capable of processing GPS data from a maximum of three receivers.
  - (5) The GPS reference state processing principal function shall be scheduled at the start of each operational sequence after navigation initialization in that OPS sequence has been completed. It

shall be initialized using state estimates from the navigation principal function active during that operational sequence.

- (6) Execution of the GPS reference state processing principal function software shall occur at the same rate for all operational sequences and major modes in which it is active. Execution must occur before execution of the GPS subsystem operating program on the same cycle to reduce the time lag in sending aiding data to the receiver.

The state aiding data provided to the receiver will be a reference state propagated using selected IMU velocity counts and it will be periodically reset to the navigation state estimate of the Orbiter. In OPS 9, the GPS SOP aids the receiver with state information.

### **3.4 OPS-3 OPERATION SEQUENCE MAJOR MODES**

Table 3.4-1 identifies the major modes for the OPS-3 operation sequence as referenced in Section 4, Detail-Level Requirements, and Sections 5.2 and 5.6. Detailed descriptions may be found in the Level B CPDS.

Table 3.4-1. OPS-3 Operation Sequence Major Modes	
Major Mode No.	Major Mode Name
301	Predeorbit coast
302	Deorbit execute
303	Preentry monitor
304	Entry
305	TAEM/landing

### **3.5 IMPLEMENTATION CONSTRAINTS**

The navigation subsystem design is capable of recovering from the effects of many transient-type errors. Accordingly, the software design shall not preclude this capability by causing a program halt, permanent discontinuance of navigation processing, or loss of protected data as a result of program check or error interrupts.

Check or error interrupts shall be prevented by software safeguards, or standard fixup and error returns shall be provided which are appropriate in the navigation function as described in Level A CPDS, Section 4.6.4.

The footnotes (F1, F2, etc.) specified in Section 4 of this document refer to the specific fixup described in the Level A CPDS.

### **3.6 TIMING**

Timing in this document is related to error-free processing conditions. See Level A CPDS, SS-P-0002-170, paragraph 4.4.2A, for timing related to error-processing conditions.

## 4.0 DETAIL-LEVEL REQUIREMENTS

The various subsections of this section specify the detail level requirements for the Shuttle navigation system flight software package.

When viewed in the larger context of the total Shuttle flight software, the navigation software package documented herein is, itself, a modular system whose function is to supply various parameters required by other major modular systems such as guidance, displays, flight control, and others. The requirements placed upon the navigation system by these various users often play a large role in determining the design structure and cyclic rate structure of the navigation system.

In the event of a conflict between the data in the function subtables and the standard principal function tables, the principal function tables shall take precedence.

### TRACEABILITY

Table 4.0–1 shows the traceability of the software paragraphs in this FSSR with respect to the corresponding Sections of the Level B CPDS' documentation. In addition, Table 4.0–2 shows the traceability of the PASS GN&C principal functions located in this FSSR with respect to the applicable BFS paragraphs in the Level C PRD specifications. These tables are provided for information only.

### SIGNAL INTERFACES

The automated Interface Definition Document (IDD) tables provided herein define signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements.<sup>1</sup> In the event of a conflict between the IDD tables and other internal text input/output tables, the SASCB data base–controlled IDD tables take precedence.

<sup>1</sup> A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function, or an OPS display function.

IDD output (source) tables which reflect parameters going to input (destination) "TLM" shall not be interpreted as a signal actually being downlisted. The parameter may only be available for downlist in COMPOOL and may not appear in a downlist format.

Table 4.0-1. Level B to Level C Traceability		
Level B PF No.	Level B PF Name (Acronym)	Level C FSSR Section No.
4.123	Deorbit/Landing Navigation Sequencer (D/L NAV SEQ)	4.1.1
4.214	Deorbit/Landing User Parameter Processing Sequencer (D/L UPP SEQ)	4.1.2
4.127	Entry Navigation (ENT NAV)	4.3.1
4.144	Preland Navigation (PRELAND NAV)	4.3.2
4.21	Global Positioning System Receiver State Processor (GPS RCVR STATE PROC)	4.3.3
4.223	Entry Precise Predictor (ENT PREC PRED)	4.5.1
4.124	Entry Site Lookup (ENT SITE LOOKUP)	4.5.2
4.23	Entry User Parameter Processing (ENT UPP)	4.6.1
4.24	TAEM User Parameter Processing (TAEM UPP)	4.6.2
4.25	Autoland User Parameter Processing (A/L UPP)	4.6.3
4.18	Global Positioning System Reference State Processor (GPS REF STATE PROC)	4.6.4
4.220	Entry Area Navigation Processing (ENT AREA NAV)	4.7



Table 4.0-2. Entry Navigation FSSR/PRD Correlation

Principal Function	FSSR Paragraph	FSSR Title	BFS PRD	PRD Paragraph	BFS Title
G4.18	4.6.4	Global Positioning System Reference State Processor	N/A	N/A	N/A
G4.21	4.3.3	Global Positioning System Receiver State Processor	N/A	N/A	N/A
G4.23	4.6.1	Entry User Parameter Processing	MG038104	3.2.2.3.8.2.2	Entry/TAEM/Landing Guidance Parameter Computations
G4.24	4.6.2	TAEM User Parameter Processing	MG038104	3.2.2.3.8.2.2	Entry/TAEM/Landing Guidance Parameter Computations
G4.25	4.6.3	Autoland User Parameter Processing	N/A	N/A	N/A
G4.123	4.1.1	Deorbit/Landing Navigation Sequencer	MG038104	3.2.2.3.3.3	Descent Navigation Sequencing
G4.124	4.5.2	Entry Site Lookup	MG038104	3.2.2.3.5.2	Site Lookup
G4.127	4.3.1	Entry Navigation	MG038104	3.2.2.3.3.3	Descent Navigation
G4.144	4.3.2	Preland Navigation	MG038104	3.2.2.3.3.3	Descent Navigation
G4.214	4.1.2	Deorbit/Landing User Parameter Processing Sequence	MG038104	3.2.2.3.4.1	Descent User Parameter Processing Sequencing
G4.220	4.7	Entry Area Navigation	MG038104	3.2.2.3.9	Area Navigation
G4.223	4.5.1	Entry Precise Predictor	MG038104	3.2.2.3.5.1	Ascent/Entry Precise Predictor

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## 4.1 NAVIGATION AND USER PARAMETER SEQUENCER PRINCIPAL FUNCTIONS

The sequencer principal functions shall initialize and sequence the proper navigation and user parameter principal functions to meet navigation and user requirements.

### 4.1.1 Deorbit/Landing Navigation Sequencer (4.123)

The deorbit/landing navigation sequencer principal function will initialize and sequence the navigation principal functions from the predeorbit coast major mode through the autoland major mode. Detailed requirements for each navigation principal function are identified in the specific principal function descriptions.

Cues for performing the proper navigation initialization and sequencing during OPS-3 may be available in the form of event flags as defined in the Level B GN&C CPDS. The particular events pertaining to the deorbit/landing navigation sequencer are shown in Table 4.1.1-1, together with associated navigation actions. For the purpose of discussion in this section, the action of canceling a function shall mean that the function is permitted to complete an in-progress execution and that subsequent initialization computations are not performed before the canceled function has completed final execution.

A. Detailed Requirements. For STS deorbit through landing (OPS-3), navigation requirements can be divided into four navigation phases: deorbit preparation, deorbit execute, entry, and preland.

1. Deorbit preparation navigation phase – The deorbit preparation navigation phase will begin upon entry to the predeorbit coast major mode (301). This will use the entry navigation principal function. If Major Mode 301 is entered through initiation of the entry operational sequence, the deorbit/landing navigation sequencer will provide the capability to initialize the three state vectors, covariance matrix, the GPS reference state vectors and other required navigation parameters on the basis of one-state data obtained from protected computer locations unaffected by the computer program reconfiguration from the ascent or on-orbit to entry operational sequence.

If Major Mode 301 was entered from OPS 000 following a Year End Rollover (YERO), such that a Major Function Base (MFB) overlay did not occur, the Deorbit/Landing Navigation Sequencer software shall reset appropriate parameters for the new year. The time tag of vectors to initiate next OPS (T\_FILT\_INIT), the GPS to GPC time reference conversion (T\_GPS\_OFFSET\_SECS) and the time of the last GPS update (T\_GPS\_LAST\_UPDATE) shall be reset. The Deorbit/Landing Navigation Sequencer software shall ensure that the RNP Matrix Computation Principal Function is called to initialize the RNP matrix (M\_M50TOEF\_AT\_EPOCH), its time tag (T\_EPOCH), and the Earth rotation vector (EARTH\_POLE).

If  $(T\_FILT\_INIT - CLOCKTIME) \geq 31,449,600$  and  $(MOD(LAUNCH\_YEAR,4) \neq 0)$ , then  
T\_FILT\_INIT = T\_FILT\_INIT - 31,536,000  
T\_GPS\_OFFSET\_SECS = T\_GPS\_OFFSET\_SECS + 31,536,000  
T\_GPS\_LAST\_UPDATE = T\_GPS\_LAST\_UPDATE - 31,536,000  
LAUNCH\_YEAR = LAUNCH\_YEAR + 1  
RNP\_DAY = 1  
Call the RNP Matrix Computation Principal Function (RNP MAT COMP).

If  $(T\_FILT\_INIT - CLOCKTIME) \geq 31,536,000$  and  $(MOD(LAUNCH\_YEAR,4) = 0)$ , then  
 $T\_FILT\_INIT = T\_FILT\_INIT - 31,622,400$   
 $T\_GPS\_OFFSET\_SECS = T\_GPS\_OFFSET\_SECS + 31,622,400$   
 $T\_GPS\_LAST\_UPDATE = T\_GPS\_LAST\_UPDATE - 31,622,400$   
 $LAUNCH\_YEAR = LAUNCH\_YEAR + 1$   
 $RNP\_DAY = 1$   
Call the RNP Matrix Computation Principal Function (RNP MAT COMP).

If Major Mode 301 was entered from OPS 000 such that a Major Function Base (MFB) overlay occurred, the Deorbit/Landing Navigation Sequencer software will ensure that the RNP Matrix Computation Principal Function is called to initialize the RNP matrix ( $M\_M50TOEF\_AT\_EPOCH$ ), its time tag ( $T\_EPOCH$ ), and the Earth rotation vector ( $EARTH\_POLE$ ). Otherwise, the RNP matrix,  $T\_EPOCH$ , and  $EARTH\_POLE$  data are assumed to be obtained from protected computer memory locations that are unaffected by the computer programs's reconfiguration from another operational sequence into OPS 3. [Note - A detailed description of the RNP Matrix Computation function can be found in section 4.11 of STS 83-0005 the Ascent/RTLS Navigation FSSR.]

Prior to the initialization of the three-state vectors, a capability will be provided to obtain past values for the total accumulated velocity sensed by the IMU's ( $\bar{V}\_LAST\_FILT\_ONE$ ,  $\bar{V}\_LAST\_FILT\_TWO$ ,  $\bar{V}\_LAST\_FILT\_THREE$ ), previous value of selected total accumulated sensed IMU velocity ( $\bar{V}\_LAST\_FILT$ ), and the associated time tag ( $T\_LAST\_FILT$ ). Then the input variables required by the entry precise predictor principal function will be equated as follows prior to its execution:

$GMD\_PRED = 4$   
 $GMO\_PRED = 4$   
 $DT\_MAX = DEL\_TIME\_STEP$   
 $\bar{R}\_INIT = \bar{R}\_FILT\_INIT$   
 $\bar{V}\_INIT = \bar{V}\_FILT\_INIT$   
 $T\_INIT = T\_FILT\_INIT$   
 $T\_FINAL = T\_LAST\_FILT$

Test the prediction time interval to determine if an OPS0 to OPS3 transition is in progress.

- a. If the transition to OPS3 was made from OPS0 such that the prediction time interval is greater than the K-load limit for the prediction time interval, set the final predictor position and velocity vectors to a premission hard-coded state vector and set the gravity vector to a premission hard-coded acceleration vector rather than calling the predictor.

$\bar{R}\_FINAL = \bar{R}\_TEMP$   
 $\bar{V}\_FINAL = \bar{V}\_TEMP$   
 $\bar{G}\_FINAL = \bar{G}\_TEMP$

The parameter DT\_LIM is a K-load. (Although this operation will not result in an accurate orbiter state vector, it will allow the OPS0 to OPS3 transition to complete so that a State vector uplink can be made in OPS3 to reinitialize the orbiter with a valid state vector.)

The time of the last GPS update is set equal to the last filter state time.

$$T\_GPS\_LAST\_UPDATE = T\_LAST\_FILT$$

The parameter GPS\_REF\_INIT\_VALID is then set to OFF, indicating that the final predictor states were set to pre-mission hard-coded states. This prevents the GPS Reference State Processing Principal Function from sending the pre-mission hard-coded state vector to a receiver if an announced reset is scheduled, or an initialization or filter restart of a receiver is commanded, before a state vector uplink occurs.

$$GPS\_REF\_INIT\_VALID = OFF$$

- b. If the transition to OPS3 was made such that the prediction time interval is less than the K-load time interval limit DT\_LIM, call the Entry Precise Predictor principal function (Section 4.5.1) to propagate the state vector from the previously exercised operational sequence to the current time.

$$CALL: ENTRY\_PRECISE\_PREDICTOR$$

The state vector  $\bar{R}_{FILT\_ONE}$ ,  $\bar{V}_{FILT\_ONE}$  and the gravity vector,  $\bar{G}_{RESET}$ , shall be equated to the propagation state vector and the total acceleration vector, respectively.

$$\bar{R}_{FILT\_ONE} = \bar{R}_{FINAL}$$

$$\bar{V}_{FILT\_ONE} = \bar{V}_{FINAL}$$

$$\bar{G}_{RESET} = \bar{G}_{FINAL}$$

The remaining two state vectors are to be initialized and the three state operation is to be indicated by

$$\bar{R}_{FILT\_TWO} = \bar{R}_{FILT\_ONE}$$

$$\bar{R}_{FILT\_THREE} = \bar{R}_{FILT\_ONE}$$

$$\bar{V}_{FILT\_TWO} = \bar{V}_{FILT\_ONE}$$

$$\bar{V}_{FILT\_THREE} = \bar{V}_{FILT\_ONE}$$

$$NAV\_THREE\_STATE = ON$$

The position vector associated with the current covariance matrix is to be initialized as

$$\bar{R}_{COV\_LAST} = \bar{R}_{FILT\_ONE}$$

The user parameter state propagation subfunction (Section 4.4.1) will be initialized as

$$\overline{R\_RESET} = \overline{R\_FILT\_ONE}, \overline{V\_RESET} = \overline{V\_FILT\_ONE}$$

$$\overline{V\_IMU\_RESET} = \overline{V\_LAST\_FILT}, T\_RESET = T\_LAST\_FILT$$

$$FILT\_UPDATE = ON$$

The GPS reference state processing subfunction will be initialized with the reset orbiter states and associated data (i.e.,  $\overline{R\_RESET}$ ,  $\overline{V\_RESET}$ ,  $\overline{G\_RESET}$  and  $T\_RESET$ ) described above. The selected IMU total accumulated velocities will be used to initialize the velocity counts for subsequent propagation of the GPS reference state. The initialization data for the GPS reference state processing principal function are initialized as follows:

$$\overline{R\_GPS\_INIT} = \overline{R\_RESET}$$

$$\overline{V\_GPS\_INIT} = \overline{V\_RESET}$$

$$\overline{G\_GPS\_INIT} = \overline{G\_RESET}$$

$$T\_GPS\_INIT = T\_RESET$$

$$\overline{V\_IMU\_GPS\_INIT} = \overline{V\_LAST\_FILT}$$

The flag which indicates that a GPS state has been selected by the GPS receiver state processing principal function in this operational sequence is initialized to OFF.

$$GPS\_SV\_SEL\_AVAIL = OFF$$

The data good indicators assigned to the previously selected GPS state by the GPS receiver state processing principal function are initialized to off at the OPS transition:

$$GPS\_DG\_SF\_PREV_1 = OFF$$

$$GPS\_DG\_SF\_PREV_2 = OFF$$

$$GPS\_DG\_SF\_PREV_3 = OFF$$

If an Abort Once Around (AOA) has been declared ( $S\_AOA = ON$ ) or a Transoceanic Abort Landing (TAL) has been declared ( $TAL\_ABORT\_DECLARED = ON$ ), then the time of the last GPS update to navigation ( $T\_GPS\_LAST\_UPDATE$ ) shall be biased by subtracting a pre-mission determined I-Load ( $QA2\_TIME\_BIAS$ ). This offset will expand the QA2 limits and help prevent GPS edits when OPS 3 is engaged following a TAL or AOA abort in OPS 1. The steps to be taken are:

IF ( $S\_AOA$  OR  $TAL\_ABORT\_DECLARED$ ) THEN

$$T\_GPS\_LAST\_UPDATE = T\_GPS\_LAST\_UPDATE - QA2\_TIME\_BIAS$$

The time which indicates when a selected GPS state was last made available by the GPS receiver state processing principal function in this OPS sequence is initialized to the last filter state time at the OPS transition. This prevents the alarm, which indicates that the time since the last GPS state was selected by the GPS receiver state processing principal function has exceeded the pre-mission I-Load constraint, from being issued at the OPS transition:

$$T\_GPS\_OFF = T\_LAST\_FILT$$

The value of the GPS lockout I-Load parameter, GPS\_LOCKOUT, is then checked to determine if the flag to inhibit GPS GAX messages (NOOP\_GPS\_GAX\_MSGS) is to be set:

```
IF GPS_LOCKOUT < 3 THEN  
    NOOP_GPS_GAX_MSGS = ON
```

Note that NOOP\_GPS\_GAX\_MSGS is set to OFF at OPS 3 transition so no explicit OFF assignment is necessary.

If the predeorbit coast major mode is entered from the on-orbit operational sequence, the 6 by 6 covariance matrix is to be initialized by exercising the subfunction covariance matrix initialization (Section 4.2.9) with variables required therein defined by

$$\bar{S}IG = \bar{S}IG\_DIAG\_UVW\_INIT$$

$$\bar{C}OR = \bar{C}ORR\_COEF\_INIT$$

$$\bar{R} = \bar{R}\_FILT\_ONE$$

$$\bar{V} = \bar{V}\_FILT\_ONE$$

where  $\bar{C}ORR\_COEF\_INIT$  are K-load values and  $\bar{S}IG\_DIAG\_UVW\_INIT$  are K-load values or values saved from the previous OPS-3 to OPS-2 transition.

If TAL abort is declared, the covariance matrix will be initialized as described above using  $\bar{S}IG\_DIAG\_UVW\_INIT$  and  $\bar{C}ORR\_COEF\_INIT$ . If AOA abort is declared ( $S\_AOA = ON$ ), the covariance matrix will be initialized as described above using  $\bar{S}IG\_DIAG\_AOA$  and  $\bar{C}ORR\_COEFF\_AOA$ .

Execution of the user parameter state propagation is to be enabled by setting

```
OPS_3_INITIALIZE_COMPLETE = ON
```

Finally, a flag is set to indicate OPS-3 initialization complete.

```
OPS_3_RECONFIGURE = ON
```

If Major Mode 301 is entered from Major Mode 302 or 303, the deorbit/ landing navigation sequencer shall provide the capability to cancel the current entry navigation principal function.

After completion of any in-progress execution, the capability will be provided for sequencing the entry navigation principal function at the designed repetition rate.

The capability also will exist to return to the on-orbit operational sequence (OPS-2) from the deorbit preparation navigation phase. In the event of a return to OPS-2, entry navigation will be cancelled and required OPS-2 single-state initialization will be obtained prior to data being transferred into or contained in computer locations that will be unaffected by this operational sequence transition:

$$\bar{R}\_FILT\_INIT = \bar{R}\_FILT$$

$$\bar{V}\_FILT\_INIT = \bar{V}\_FILT$$

The time associated with the current Shuttle state vector and covariance matrix will be defined as:

$$T\_FILT\_INIT = T\_LAST\_FILT$$

In addition to saving the required single state parameters, the covariance matrix of Orbiter position and velocity shall also be saved by conversion into UVW standard deviations and correlation coefficients, by calling the COV\_INIT\_UVW\_INVERSE subfunction

CALL: COV\_INIT\_UVW\_INVERSE  
 IN LIST: E,  $\bar{R}$ \_FILT\_INIT,  $\bar{V}$ \_FILT\_INIT  
 OUT LIST:  $\bar{SIG}$ \_DIAG\_UVW\_INIT,  $\bar{CORR}$ \_COEF\_INIT

The detailed requirements of the above subfunction are specified below:

- a. The input parameters are re-named for local usage

$$\text{IN LIST: } E\_TEMP, \bar{R}, \bar{V}$$

- b. Compute a transformation matrix from UVW to M50

$$M = UVW\_TO\_M50(\bar{R}, \bar{V})$$

- c. Transform the input covariance matrix from M50 to UVW coordinates

$$E\_TEMP_{1\text{ to }3, 1\text{ to }3} = M^T E_{TEMP_{1\text{ to }3, 1\text{ to }3}} M$$

$$E\_TEMP_{4\text{ to }6, 4\text{ to }6} = M^T E_{TEMP_{4\text{ to }6, 4\text{ to }6}} M$$

$$E\_TEMP_{1\text{ to }3, 4\text{ to }6} = M^T E_{TEMP_{1\text{ to }3, 4\text{ to }6}} M$$

- d. Compute standard deviations

$$SIG_I = \sqrt{E\_TEMP_{I,I}} \text{ for } I = 1,6 \quad F4$$

- e. Compute selected correlation coefficients

$$COR_1 = E\_TEMP_{1,2} / (SIG_1 SIG_2) \quad F3$$

$$COR_2 = E\_TEMP_{1,4} / (SIG_1 SIG_4) \quad F3$$

$$COR_3 = E\_TEMP_{1,5} / (SIG_1 SIG_5) \quad F3$$

$$COR_4 = E\_TEMP_{2,4} / (SIG_2 SIG_4) \quad F3$$

$$COR_5 = E\_TEMP_{2,5} / (SIG_2 SIG_5) \quad F3$$

$$COR_6 = E\_TEMP_{3,6} / (SIG_3 SIG_6) \quad F3$$

$$COR_7 = E\_TEMP_{4,5} / (SIG_4 SIG_5) \quad F3$$



- F4 This equation shall be protected against square roots of a negative number (Section 3.5).
- F3 This equation shall be protected against division by zero (Section 3.5).

f. The output parameters are defined

OUT LIST:  $\bar{SIG}$ ,  $\bar{COR}$

where  $\bar{SIG}$  is a 6 by 1 vector, and  $\bar{COR}$  a 7 by 1 vector, defined as follows:

- SIG<sub>1</sub>, U position standard deviation
- SIG<sub>2</sub>, V position standard deviation
- SIG<sub>3</sub>, W position standard deviation
- SIG<sub>4</sub>,  $\dot{U}$  velocity standard deviation
- SIG<sub>5</sub>,  $\dot{V}$  velocity standard deviation
- SIG<sub>6</sub>,  $\dot{W}$  velocity standard deviation
- COR<sub>1</sub>, U–V correlation coefficient
- COR<sub>2</sub>, U– $\dot{U}$  correlation coefficient
- COR<sub>3</sub>, U– $\dot{V}$  correlation coefficient
- COR<sub>4</sub>, V– $\dot{U}$  correlation coefficient
- COR<sub>5</sub>, V– $\dot{V}$  correlation coefficient
- COR<sub>6</sub>, W– $\dot{W}$  correlation coefficient
- COR<sub>7</sub>,  $\dot{U}$ – $\dot{V}$  correlation coefficient

The following protected variables will then be saved for initialization of the on-orbit navigation principal function:

OPS-2 Variable Definition	OPS-3 Variable Name
Current Shuttle position and velocity vectors used in filter update computations	$\bar{R}_{\text{FILT\_INIT}}$ $\bar{V}_{\text{FILT\_INIT}}$
Time of current Shuttle state vectors and covariance matrix	T_FILT_INIT
Square root of diagonal elements for covariance matrix initialization	$\bar{\text{SIG\_DIAG\_UVW\_INIT}}$

2. Deorbit execute navigation phase – The deorbit execute navigation phase will begin whenever the deorbit execute major mode (302) is active and the event flag E11A (indicating that the deorbit burn is to begin in BURN\_ENABLE\_WINDOW (K-load) seconds) is on. This phase uses the entry navigation principal function. The deorbit/landing navigation sequencer will provide the capability to cancel the current entry navigation principal function and to initialize the deorbit burn flag to ON to prevent measurement processing. The capability will also be provided for sequencing the entry navigation principal function at the designated repetition rate.
3. Major Mass Change Event – The drag constant parameter shall be recomputed using the current mass at transition from Major Mode 302 to Major Mode 301 (Event E10) and at transition from Major Mode 302 to Major Mode 303 (Event E15).

$$\text{DRAG\_CONST} = 0.5 \text{ REF\_AREA/VEH\_MASS}$$

This parameter is used in the entry navigation state propagation subfunction (drag acceleration task, see Section 4.2.1.2.2) and drag measurement processing (Section 4.3.1.7.1).

4. Entry navigation phase – The entry navigation phase will begin at initiation of the preentry monitor major mode (303). This phase will use the entry navigation principal function. The deorbit/ landing navigation sequencer will provide the capability to cancel the current entry navigation principal function.

The deorbit burn flag will be set to OFF to enable measurement processing.

The capability will be provided for sequencing the entry navigation principal function at the designated repetition rate.

5. Preland navigation phase – The preland navigation phase will begin whenever MSBLS is available at the landing site, Major Mode 305 is active, and the selected MSBLS range and azimuth data are valid.

This phase will use the preland navigation principal function.

Upon satisfaction of the transition criterion, repetition of the current entry navigation principal function will be cancelled. The flag indicating three-state-operation will be turned OFF.

$$\text{NAV\_THREE\_STATE} = \text{OFF}$$

The 2 X 0 gravity model and use of IMU data shall be established for the preland navigation phase:

GM\_DEG = 2

GM\_ORD = 0

USE\_IMU\_DATA = ON

Finally, a flag is to be set to indicate preland transition complete.

PRELAND\_TRANSITION = ON

The capability also will be provided for sequencing the preland navigation principal function at a premission-determined repetition rate.

B. Interface Requirements. The deorbit/landing navigation sequencer principal function will be sequenced at least once at the beginning of Major Modes 301 and 303. This principal function will be sequenced at a 0.52-Hertz rate upon entrance to Major Mode 302 until the requirements associated with the deorbit burn event flag are completed and upon entrance to Major Mode 304 and for Major Mode 305 until the requirements associated with valid MSBLS data are completed.

C. Processing Requirements. Before the OPS-2 initialization can be accomplished, entry navigation must be executed at least once.

D. Constraints. Calculation of DRAG\_CONST shall not interrupt operations of the entry navigation principal function. OPS\_3\_RECONFIGURE and PRELAND\_TRANSITION shall be initialized to 'OFF'. The OPS transition request flag (OTREQ) is initialized to 'OFF'.

E. Supplemental Information. A suggested implementation of these requirements is illustrated in Section 5.2, DEORBIT/LANDING\_NAV\_SEQUENCER.

T\_GPS\_LAST\_UPDATE shall be protected and carried across all GN&C OPS transitions.

GPS\_REF\_INIT\_VALID shall be initialized to 'ON', and shall be protected and carried across all GN&C OPS transitions.

Table 4.1.1-1. OPS-3 Level B Events			
Event No.	Event Name	Nav Criteria	Nav Action
85	OPS transition to OPS-3 (MM 301) from OPS-2	OPS transition to OPS-3 (MM 301) from OPS-2	OPS transition initialization. Initiate entry navigation (deorbit preparation phase).
59	OPS transition to OPS-3 (MM 301) from OPS-1 (MM 106)	OPS transition to OPS-3 (MM 301) from OPS-1 (MM 106)	Same as above.
E3A	Transition from OPS-00 to MM 301	OPS transition to OPS-3 from OPS-00	Initiate entry navigation (deorbit preparation phase).
60H	Transition from OPS-8 to MM 301	OPS transition to OPS-3 from OPS-8	Initiate entry navigation (deorbit preparation phase).
A16B	Transition from MM 104 to MM 301	Transition from ascent navigation to entry navigation	Initiate entry navigation (deorbit preparation phase).
A20	OPS transition to OPS-3 (MM 301) from OPS-1 (MM 105)	OPS transition to OPS-3 (MM 301) from OPS-1 (MM 105)	Same as above.
E1	OPS transition to OPS-2 from OPS-3	OPS transition to OPS-2 from OPS-3	Reduce three-state to one-state and save OPS-2 initialization data.
E11A	Initiate power flight navigation	Deorbit maneuver begins in BURN_ENABLE_WINDOW seconds	Cancel entry navigation (deorbit preparation phase). Initiate entry navigation (deorbit execute phase).
E10	Mode transition to 301 from 302	Mode transition to 301 from 302	Cancel entry navigation (deorbit execute phase). Initiate entry navigation (deorbit preparation phase). Compute drag constant with the current mass of the Shuttle.
E15	Mode transition to 303 from 302	Mode transition to 303 from 302	Cancel entry navigation (deorbit execute phase). Initiate entry navigation (entry phase). Compute drag constant with the current mass of the Shuttle.
E16B	Mode transition to 301 from 303	Mode transition to 301 from 303	Cancel entry navigation (entry phase). Initiate entry navigation (deorbit preparation phase).
E20	Three-state to one-state switch	MSBLS range and azimuth valid	Cancel entry navigation (entry phase). Initiate preland navigation.

\*Current Level B event numbers.

#### 4.1.1.1 Deorbit/Landing Navigation Sequencer (4.123) Principal Function Tables

This section contains the input and output parameter lists and the I-loads, K-loads, constants, and variable cross-reference for the deorbit/ landing navigation sequencer principal function, which are presented in the following table, and Tables 4.1.1.1-1 through 4.1.1.1-5.

Deorbit/Landing Navigation Sequencer (4.123) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
T_LAST_FILT	TIME_V
V_LAST_FILT	SEL_V_M50
V_LAST_FILT_ONE (1)	VELSUMM50X (1)
V_LAST_FILT_ONE (2)	VELSUMM50Y (1)
V_LAST_FILT_ONE (3)	VELSUMM50Z (1)
V_LAST_FILT_TWO (1)	VELSUMM50X (2)
V_LAST_FILT_TWO (2)	VELSUMM50Y (2)
V_LAST_FILT_TWO (3)	VELSUMM50Z (2)
V_LAST_FILT_THREE (1)	VELSUMM50X (3)
V_LAST_FILT_THREE (2)	VELSUMM50Y (3)
V_LAST_FILT_THREE (3)	VELSUMM50Z (3)
INITIATE_PWR_FLIGHT_NAV_EVENT	EVENT E11A

TABLE 4.1.1.1-1. INPUT FUNCTIONAL PARAMETERS FOR DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER(GMT)	FCOS	S			93160B	*
G_FINAL(1)	V90A0889C	X-COMP PREDICTED SHUTTLE GRAV VCTR	ENT PREC PRED	FT/S2				
G_FINAL(2)	V90A0890C	Y-COMP PREDICTED SHUTTLE GRAV VCTR	ENT PREC PRED	FT/S2				
G_FINAL(3)	V90A0891C	Z-COMP PREDICTED SHUTTLE GRAV VCTR	ENT PREC PRED	FT/S2				
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
LAUNCH_YEAR	V97U5383C	LAUNCH YEAR FOR RNP MATRIX CALC	UL	YEARS	HXS		93160B	*
M/CURR_ORB_MASS/MASS	V90U1961CC	CURRENT VEHICLE MASS	DEORB GUID	SLUGS			93090E	
MLSAZ_DATA_GOOD	V90X3003X	MSBLS AZIMUTH DATA GOOD	SF		BD		93017G	*
MLSRANGE_DATA_GOOD	V90X3063X	MSBLS RANGE DATA GOOD	SF		BD		93017G	*
MLS_AVAIL	V90X3720XA	MLS AVAILABILITY	ENT SITE LOOKUP					
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
NAV_PF_INIT_FLAG	V90X8188X	INITIATE POWERED FLIGHT NAV FLAG	MSC				89599C	
OTREQ	V90X0893XA	OPS TRANSITION REQUEST FLAG	ENT PREC PRED				90121B	
R_FILT(1)	V90H0584CE	X-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(2)	V90H0585CE	Y-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(3)	V90H0586CE	Z-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT_INIT(1)	V90H1276CB	X-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT				
R_FILT_INIT(1)	V90H1276CC	X-COMP POS VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT				
R_FILT_INIT(2)	V90H1277CB	Y-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT				
R_FILT_INIT(2)	V90H1277CC	Y-COMP POS VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT				
R_FILT_INIT(3)	V90H1278CB	Z-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT				
R_FILT_INIT(3)	V90H1278CC	Z-COMP POS VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT				
R_FINAL(1)	V90H0881CA	X-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT			89662B	
R_FINAL(2)	V90H0882CA	Y-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT				
R_FINAL(3)	V90H0883CA	Z-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT				
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
S_AOA	V90X8636X	AOA ABORT DECLARED	MSC		BD		92355B	
TAL_ABORT_DECLARED	V90X8658X	TAL ABORT DECLARED	MSC				93090E	
TIME_V/T_LAST_FILT	V90W2553CD	TIME OF SEL TOTAL M50 VEL	ENT NAV					
T_FILT_INIT	V90W1287CB	TIME TAG OF VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	S				
T_FILT_INIT	V90W1287CC	TIME TAG OF VCTR TO INIT NEXT OPS	ASC NAV SEQ	S				
T_GPS_LAST_UPDATE	V90W3556CF	TIME OF NAV RESET WITH SEL GPS	ASC NAV SEQ	S	DPL		92369B	
T_GPS_OFFSET_SECS	V91W0029C	GPS OFFSET SECONDS	GPS SOP	S	DPL		93160B	*
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
VELSUMM50X(1)/V_1(1)	V95L0065C	IMU 1 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50X(2)/V_2(1)	V95L1065C	IMU 2 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50X(3)/V_3(1)	V95L2065C	IMU 3 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(1)/V_1(2)	V95L0066C	IMU 1 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(2)/V_2(2)	V95L1066C	IMU 2 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(3)/V_3(2)	V95L2066C	IMU 3 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(1)/V_1(3)	V95L0067C	IMU 1 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(2)/V_2(3)	V95L1067C	IMU 2 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(3)/V_3(3)	V95L2067C	IMU 3 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
V_FILT(1)	V90L0624CE	X-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	

TABLE 4.1.1.1-1. INPUT FUNCTIONAL PARAMETERS FOR DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_FILT(2)	V90L0625CE	Y-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(3)	V90L0626CE	Z-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT_INIT(1)	V90L1279CB	X-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_INIT(1)	V90L1279CC	X-COMP VEL VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT/S				
V_FILT_INIT(2)	V90L1280CB	Y-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_INIT(2)	V90L1280CC	Y-COMP VEL VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT/S			89648A	
V_FILT_INIT(3)	V90L1281CB	Z-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_INIT(3)	V90L1281CC	Z-COMP VEL VCTR TO INIT NEXT OPS	ASC NAV SEQ	FT/S			89648A	
V_FINAL(1)	V90L0885CA	X-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
V_FINAL(2)	V90L0886CA	Y-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
V_FINAL(3)	V90L0887CA	Z-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
	V90X8081X	MM 301 FROM MM 302 FLAG	MSC		BD		93064D	
	V90X8082X	MM 301 FROM MM 303 FLAG	MSC		BD		89599C	
	V90X8083X	MM 301 FROM OPS 00 FLAG	MSC		BD		89599C	
	V90X8164X	MM 201 FROM MM 301 FLAG	MSC				92354	
	V90X8169X	MM 301 FROM MM 106 FLAG	MSC				89599C	
	V90X8180X	MM 301 FROM MM 201 FLAG	MSC				89599C	
	V90X8181X	MM 301 FROM MM 105 FLAG	MSC				89599C	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.1.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DEORBIT_BURN	V90X0535X	FLAG INDICATING THRUSTING FLIGHT	ENT NAV					
DT_MAX	V90U8500CD	MAX ALLOW TIME STEP SIZE	ENT PREC PRED	S				
E(1-1)	V90U0650CA	COVARIANCE MATRIX ELEMENT 1-1	DL FMT 23/1				93017G	*
			ENT NAV					
E(1-2)	V90U0651CA	COVARIANCE MATRIX ELEMENT 1-2	ENT NAV					
E(1-3)	V90U0652CA	COVARIANCE MATRIX ELEMENT 1-3	ENT NAV					
E(1-4)	V90U0653CA	COVARIANCE MATRIX ELEMENT 1-4	ENT NAV					
E(1-5)	V90U0654CA	COVARIANCE MATRIX ELEMENT 1-5	ENT NAV					
E(1-6)	V90U0655CA	COVARIANCE MATRIX ELEMENT 1-6	ENT NAV					
E(2-1)	V90U0656CA	COVARIANCE MATRIX ELEMENT 2-1	ENT NAV					
E(2-2)	V90U0657CA	COVARIANCE MATRIX ELEMENT 2-2	DL FMT 23/1				93017G	*
			ENT NAV					
E(2-3)	V90U0658CA	COVARIANCE MATRIX ELEMENT 2-3	ENT NAV					
E(2-4)	V90U0659CA	COVARIANCE MATRIX ELEMENT 2-4	ENT NAV					
E(2-5)	V90U0660CA	COVARIANCE MATRIX ELEMENT 2-5	ENT NAV					
E(2-6)	V90U0661CA	COVARIANCE MATRIX ELEMENT 2-6	ENT NAV					
E(3-1)	V90U0662CA	COVARIANCE MATRIX ELEMENT 3-1	ENT NAV					
E(3-2)	V90U0663CA	COVARIANCE MATRIX ELEMENT 3-2	ENT NAV					
E(3-3)	V90U0664CA	COVARIANCE MATRIX ELEMENT 3-3	DL FMT 23/1				93017G	*
			ENT NAV					
E(3-4)	V90U0665CA	COVARIANCE MATRIX ELEMENT 3-4	ENT NAV					
E(3-5)	V90U0666CA	COVARIANCE MATRIX ELEMENT 3-5	ENT NAV					
E(3-6)	V90U0667CA	COVARIANCE MATRIX ELEMENT 3-6	ENT NAV					
E(4-1)	V90U0668CA	COVARIANCE MATRIX ELEMENT 4-1	ENT NAV					
E(4-2)	V90U0669CA	COVARIANCE MATRIX ELEMENT 4-2	ENT NAV					
E(4-3)	V90U0670CA	COVARIANCE MATRIX ELEMENT 4-3	ENT NAV					
E(4-4)	V90U0671CA	COVARIANCE MATRIX ELEMENT 4-4	DL FMT 23/1				93017G	*
			ENT NAV					
E(4-5)	V90U0672CA	COVARIANCE MATRIX ELEMENT 4-5	ENT NAV					
E(4-6)	V90U0673CA	COVARIANCE MATRIX ELEMENT 4-6	ENT NAV					
E(5-1)	V90U0674CA	COVARIANCE MATRIX ELEMENT 5-1	ENT NAV					
E(5-2)	V90U0675CA	COVARIANCE MATRIX ELEMENT 5-2	ENT NAV					
E(5-3)	V90U0676CA	COVARIANCE MATRIX ELEMENT 5-3	ENT NAV					
E(5-4)	V90U0677CA	COVARIANCE MATRIX ELEMENT 5-4	ENT NAV					
E(5-5)	V90U0678CA	COVARIANCE MATRIX ELEMENT 5-5	DL FMT 23/1				93017G	*
			ENT NAV					
E(5-6)	V90U0679CA	COVARIANCE MATRIX ELEMENT 5-6	ENT NAV					
E(6-1)	V90U0680CA	COVARIANCE MATRIX ELEMENT 6-1	ENT NAV					
E(6-2)	V90U0681CA	COVARIANCE MATRIX ELEMENT 6-2	ENT NAV					
E(6-3)	V90U0682CA	COVARIANCE MATRIX ELEMENT 6-3	ENT NAV					
E(6-4)	V90U0683CA	COVARIANCE MATRIX ELEMENT 6-4	ENT NAV					
E(6-5)	V90U0684CA	COVARIANCE MATRIX ELEMENT 6-5	ENT NAV					
E(6-6)	V90U0685CA	COVARIANCE MATRIX ELEMENT 6-6	DL FMT 23/1				93017G	*
			ENT NAV					



TABLE 4.1.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
FILT_UPDATE	V90X0224XD	FLAG IND NAV FILTER PROC COMPLETE	A/L UPP ENT UPP TAEM UPP					
GMD_PRED	V90U8501CD	GRAVITY MODEL DEGREE	ENT PREC PRED PRELAND NAV				92297B	
GMO_PRED	V90U8502CD	GRAVITY MODEL ORDER	ENT PREC PRED PRELAND NAV				92297B	
GPS_DG_SF_PREV(1)	V90X3536XA	GPS 1 PREV DG SEL FILT	GPS RCVR STATE PROC		BD		91051K	
GPS_DG_SF_PREV(2)	V90X3537XA	GPS 2 PREV DG SEL FILT	GPS RCVR STATE PROC		BD		91051K	
GPS_DG_SF_PREV(3)	V90X3538XA	GPS 3 PREV DG SEL FILT	GPS RCVR STATE PROC		BD		91051K	
GPS_REF_INIT_VALID	V90X3642XA	GPS INIT REF STATE VALID FLAG	GPS REF STATE PROC		BD		92067D	
GPS_SV_SEL_AVAIL	V90X3081XA	GPS SEL STATE VCTR AVAIL FLAG	ENT NAV GPS RCVR STATE PROC		BD		91051K	
G_GPS_INIT(1)	V90A2619CA	X GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CA	Y GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CA	Z GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CD	SEL X-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
G_RESET(2)	V90A0244CD	SEL Y-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
G_RESET(3)	V90A0245CD	SEL Z-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
LAUNCH_YEAR	V97U5383CA	LAUNCH YEAR FOR RNP MATRIX CALC	RNP MAT COMP	YEARS	HXS		93160B	*
NAV_THREE_STATE	V90X0537X	THREE-STATE FLAG ON/OFF	DL FMT 23/A ENT NAV MSC PRELAND NAV		BD		93017G	*
NOOP_GPS_GAX_MSGS	V90X3547XA	NOOP GPS GAX MSGS	GPS RCVR STATE PROC		BD		91051K	
OPS_3_INIT_COMPLETE	V90X0539X	FLAG TO ENABLE CYCLIC EXEC OF UPSP	D/L UPP SEQ MSC					
OTREQ	V90X0893XC	OPS TRANSITION REQUEST FLAG	ENT PREC PRED		BD		90121B	
RNP_DAY	V97U5384CA	DAY OF YEAR FOR RNP MATRIX CALC	RNP MAT COMP	DAYS	HXS		93160B	*
R_COV_LAST(1)	V90H0581CA	X-COMP OF POS VCT W CURR COV MTRX	ENT NAV	FT				
R_COV_LAST(2)	V90H0582CA	Y-COMP OF POS VCT W CURR COV MTRX	ENT NAV	FT				
R_COV_LAST(3)	V90H0583CA	Z-COMP OF POS VCT W CURR COV MTRX	ENT NAV	FT				
R_FILT_INIT(1)	V90H1276CA	X-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ					
R_FILT_INIT(2)	V90H1277CA	Y-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ					
R_FILT_INIT(3)	V90H1278CA	Z-COMP POS VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ					
R_FILT_ONE(1)	V90H0587C	X-COMP OF FILTER CURR POS STATE 1	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_ONE(2)	V90H0588C	Y-COMP OF FILTER CURR POS STATE 1	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*

TABLE 4.1.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_FILT_ONE(3)	V90H0589C	Z-COMP OF FILTER CURR POS STATE 1	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_THREE(1)	V90H0593C	X-COMP OF FILTER CURR POS STATE 3	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_THREE(2)	V90H0594C	Y-COMP OF FILTER CURR POS STATE 3	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_THREE(3)	V90H0595C	Z-COMP OF FILTER CURR POS STATE 3	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_TWO(1)	V90H0590C	X-COMP OF FILTER CURR POS STATE 2	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_TWO(2)	V90H0591C	Y-COMP OF FILTER CURR POS STATE 2	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_FILT_TWO(3)	V90H0592C	Z-COMP OF FILTER CURR POS STATE 2	DL FMT 23/1 ENT NAV	FT	DPL		93017G	*
R_GPS_INIT(1)	V90H3476CD	GPS INIT POS VECTOR X-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CD	GPS INIT POS VECTOR Y-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CD	GPS INIT POS VECTOR Z-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_INIT(X)	V90H8508CI	X-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_INIT(Y)	V90H8509CI	Y-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_INIT(Z)	V90H8510CI	Z-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_RESET(1)	V90H0235CD	SEL X-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92214A	
R_RESET(2)	V90H0236CD	SEL Y-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92214A	
R_RESET(3)	V90H0237CD	SEL Z-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92214A	
TIME_V/T_LAST_FILT	V90W2553CC	TIME OF SEL TOTAL M50 VEL	ENT NAV	S			92297B	
T_FILT_INIT	V90W1287CA	TIME TAG OF VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	S				
T_FINAL	V90W8506CI	TIME AT WHICH STATE IS DESIRED	ENT PREC PRED	S				
T_GPS_INIT	V90W3482CD	GPS INIT STATE TIME TAG	GPS REF STATE PROC	S	DPL		92214A	
T_GPS_LAST_UPDATE	V90W3556CA	TIME OF NAV RESET WITH SEL GPS	ENT NAV GPS RCVR STATE PROC ORB/RND NAV PRELAND NAV	S	DPL		92369B	
T_GPS_OFF	V90W3543CA	TIME OF LAST SEL GPS BY SEL FILT	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS_OFFSET_SECS	V91W0029CA	GPS OFFSET SECONDS	GPS SOP	S	DPL		93160B	*
T_INIT	V90W8512CJ	TIME AT BEGINNING OF PRED	ENT PREC PRED	S				
T_RESET	V90W0534CD	TIME OF FILTER STATE VECTOR	A/L UPP DL FMT 23/1 ENT UPP GPS RCVR STATE PROC TAEM UPP	S			93017G	*

TABLE 4.1.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
USE_IMU_DATA	V90X0538XH	FLAG TO USE IMU ACCUM VEL OR NOT	DL FMT 23/A PRELAND NAV				93017G	*
V_FILT_INIT(1)	V90L1279CA	X-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_INIT(2)	V90L1280CA	Y-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_INIT(3)	V90L1281CA	Z-COMP VEL VCTR TO INIT NEXT OPS	ORB/RND NAV SEQ	FT/S				
V_FILT_ONE(1)	V90L0639C	X-COMP OF FILTER CURR VEL STATE 1	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_ONE(2)	V90L0640C	Y-COMP OF FILTER CURR VEL STATE 1	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_ONE(3)	V90L0641C	Z-COMP OF FILTER CURR VEL STATE 1	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_THREE(1)	V90L0645C	X-COMP OF FILTER CURR VEL STATE 3	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_THREE(2)	V90L0646C	Y-COMP OF FILTER CURR VEL STATE 3	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_THREE(3)	V90L0647C	Z-COMP OF FILTER CURR VEL STATE 3	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_TWO(1)	V90L0642C	X-COMP OF FILTER CURR VEL STATE 2	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_TWO(2)	V90L0643C	Y-COMP OF FILTER CURR VEL STATE 2	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_FILT_TWO(3)	V90L0644C	Z-COMP OF FILTER CURR VEL STATE 2	DL FMT 23/1 ENT NAV	FT/S	DPL		93017G	*
V_GPS_INIT(1)	V90L3495CD	GPS INIT VEL VECTOR X-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CD	GPS INIT VEL VECTOR Y-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CD	GPS INIT VEL VECTOR Z-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_IMU_GPS_INIT(1)	V90L3506CD	IMU ACCUM X VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CD	IMU ACCUM Y VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CD	IMU ACCUM Z VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_RESET(1)	V90L0247CD	SEL X-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(2)	V90L0248CD	SEL Y-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(3)	V90L0249CD	SEL Z-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_INIT(X)	V90L8513CI	X-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_INIT(Y)	V90L8514CI	Y-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_INIT(Z)	V90L8515CI	Z-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_LAST_FILT(1)	V90L0621CC	X-COMP VEL W COV MTRX & FLTR UPDTE	PRELAND NAV	FT/S				
V_LAST_FILT(2)	V90L0622CC	Y-COMP VEL W COV MTRX & FLTR UPDTE	PRELAND NAV	FT/S				
V_LAST_FILT(3)	V90L0623CC	Z-COMP VEL W COV MTRX & FLTR UPDTE	PRELAND NAV	FT/S				
V_LAST_FILT_ONE(1)	V90L0630C	X-COMP OF ACCUM SENSED VEL STATE 1	ENT NAV	FT/S				
V_LAST_FILT_ONE(2)	V90L0631C	Y-COMP OF ACCUM SENSED VEL STATE 1	ENT NAV	FT/S				

TABLE 4.1.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_LAST_FILT_ONE(3)	V90L0632C	Z-COMP OF ACCUM SENSED VEL STATE 1	ENT NAV	FT/S				
V_LAST_FILT_THREE(1)	V90L0636C	X-COMP OF ACCUM SENSED VEL STATE 3	ENT NAV	FT/S				
V_LAST_FILT_THREE(2)	V90L0637C	Y-COMP OF ACCUM SENSED VEL STATE 3	ENT NAV	FT/S				
V_LAST_FILT_THREE(3)	V90L0638C	Z-COMP OF ACCUM SENSED VEL STATE 3	ENT NAV	FT/S				
V_LAST_FILT_TWO(1)	V90L0633C	X-COMP OF ACCUM SENSED VEL STATE 2	ENT NAV	FT/S				
V_LAST_FILT_TWO(2)	V90L0634C	Y-COMP OF ACCUM SENSED VEL STATE 2	ENT NAV	FT/S				
V_LAST_FILT_TWO(3)	V90L0635C	Z-COMP OF ACCUM SENSED VEL STATE 2	ENT NAV	FT/S				
V_RESET(1)	V90L0239CD	SEL X-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92214A	
V_RESET(2)	V90L0240CD	SEL Y-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92214A	
V_RESET(3)	V90L0241CD	SEL Z-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92214A	
	V90M2852PH	CGEB_FLT_LG3_FLAG2_LFE	DL FMT 23/A				93017G	*
	V90M2946P	CGNB_NAV_FLAGS	DL FMT 23/A				93017G	*

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.1.1.1-3. DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CORR_COEFF_AOA(1)	V98U8886C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(2)	V98U8887C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(3)	V98U8888C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(4)	V98U8889C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(5)	V98U8890C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(6)	V98U8891C	ND	F	D	D	P	G4.123	00	AOA	89792E	
CORR_COEFF_AOA(7)	V98U8892C	ND	F	D	D	P	G4.123	00	AOA	89792E	
DRAG_CONST	V97U5317C	FT**2/SLUG	F	D	M	C	G4.123 G4.127 G4.144 G4.15 G4.223	01 03	DC1 DC3	92287B	
GPS_LOCKOUT	V97U3563C	ND	I	S	M	P	G4.123 G4.139 G4.148 G6.11 G6.21 G6.51	00	GPI	92292B	
LAUNCH_YEAR	V97U5383C	YEARS	I	S	D	C	G4.123 G4.16 G4.38 G4.72	00	GPT	93160B	*
QA2_TIME_BIAS	V97U3623C	SEC	F	S	D	C	G4.123	00	GP3	92370C	
SIG_DIAG_AOA(1)	V98U8880C	FT	F	D	D	P	G4.123	00	AOA	89792E	
SIG_DIAG_AOA(2)	V98U8881C	FT	F	D	D	P	G4.123	00	AOA	89792E	
SIG_DIAG_AOA(3)	V98U8882C	FT	F	D	D	P	G4.123	00	AOA	89792E	
SIG_DIAG_AOA(4)	V98U8883C	FT/SEC	F	D	D	P	G4.123	00	AOA	89792E	
SIG_DIAG_AOA(5)	V98U8884C	FT/SEC	F	D	D	P	G4.123	00	AOA	89792E	
SIG_DIAG_AOA(6)	V98U8885C	FT/SEC	F	D	D	P	G4.123	00	AOA	89792E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.1.1.1-4. DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
CORR_COEF_INIT(1)	V98U9814C	00	-7.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(2)	V98U8441C	00	+9.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(3)	V98U8442C	00	-8.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(4)	V98U8443C	00	-8.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(5)	V98U8444C	00	+9.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(6)	V98U8445C	00	+9.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
CORR_COEF_INIT(7)	V98U8446C	00	-9.0	E-01 ND	F	D	C	G4.123	89661A	
ARR COEF ASSOC W/SIG_DIAG_UVW_INIT										
DT_LIM	V96U9579C	00	+600	SEC	I	S	P	G4.123 G4.148	92080B	
REF_AREA	V99U5625C	00	+2.6900000	E+03 FT**2	F	S	C	G4.122 G4.123	89792E	
VEH REF AREA FOR DRAG COEF										
SIG_DIAG_UVW_INIT(1)	V97U5512CA	00	+2.5000000	E+03 FT	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										
SIG_DIAG_UVW_INIT(2)	V97U5513CA	00	+3.0000000	E+03 FT	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										
SIG_DIAG_UVW_INIT(3)	V97U5514CA	00	+7.0000000	E+03 FT	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										
SIG_DIAG_UVW_INIT(4)	V97U5515CA	00	+5.0000000	E+00 FT/SEC	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										
SIG_DIAG_UVW_INIT(5)	V97U5516CA	00	+3.0000000	E+00 FT/SEC	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										
SIG_DIAG_UVW_INIT(6)	V97U5517CA	00	+6.0000000	E+00 FT/SEC	F	D	C	G4.123	89661A	
SQ ROOTS DIAG ELE COVAR MATRIX										

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.1.1.1-5. DEORBIT/LANDING NAVIGATION SEQUENCER (G4.123) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
G_TEMP(1) DEFAULT ORB GRAV WHEN OPS TRANSITION VECTOR TOO STALE	V97U6263C	00	-2.874	E+01 FT/SEC**2	F		S	P G4.123	92080B	
G_TEMP(2) DEFAULT ORB GRAV WHEN OPS TRANSITION VECTOR TOO STALE	V97U6264C	00	+0.0	E+00 FT/SEC**2	F		S	P G4.123	92080B	
G_TEMP(3) DEFAULT ORB GRAV WHEN OPS TRANSITION VECTOR TOO STALE	V97U6265C	00	+0.0	E+00 FT/SEC**2	F		S	P G4.123	92080B	
R_TEMP(1) DEFAULT ORB POSITION OPS TRANSITION VECTOR TOO STALE	V97U6244C	00	+2.2166000	E+07 FT	F		S	P G4.123 G4.148	92080B	
R_TEMP(2) DEFAULT ORB POSITION OPS TRANSITION VECTOR TOO STALE	V97U6245C	00	+0.0	E+00 FT	F		S	P G4.123 G4.148	92080B	
R_TEMP(3) DEFAULT ORB POSITION OPS TRANSITION VECTOR TOO STALE	V97U6246C	00	+0.0	E+00 FT	F		S	P G4.123 G4.148	92080B	
V_TEMP(1) DEFAULT ORB VEL WHEN OPS TRANSITION VECTOR TOO STALE	V97U6247C	00	+0.0	E+00 FT/SEC	F		S	P G4.123 G4.148	92080B	
V_TEMP(2) DEFAULT ORB VEL WHEN OPS TRANSITION VECTOR TOO STALE	V97U6248C	00	+2.5270	E+04 FT/SEC	F		S	P G4.123 G4.148	92080B	
V_TEMP(3) DEFAULT ORB VEL WHEN OPS TRANSITION VECTOR TOO STALE	V97U6249C	00	+0.0	E+00 FT/SEC	F		S	P G4.123 G4.148	92080B	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

#### 4.1.2 Deorbit/Landing User Parameter Processing Sequencer (4.214)

This principal function shall provide a capability for initialization and control of those principal functions and subfunctions associated with the computations of user parameters during the deorbit through landing operational sequence. These consist of the entry, TAEM, and autoland user parameter processing principal functions. This sequencer also will provide initialization and control of the HSI processing principal function and the GPS reference state processing principal function (Section 4.1.4).

Events to be used as cues by the sequencer for performing the required initialization and sequencing are defined in the Level B GN&C CPDS. The particular events and a summary of the associated user parameter actions pertaining to the deorbit/landing user parameter sequencer are given in Table 4.1.2-1. Inputs and outputs to this principal function are listed in Tables 4.1.2.1-1 and 4.1.2.1-2 and a variable cross-reference in Section 4.1.2.1.

A. Detailed Requirements. The deorbit/landing user parameter processing sequencer shall be initiated upon the occurrence of any of the following events:

OPS transition to OPS-3 from OPS-2

OPS transition to OPS-3 from OPS-1

This sequencer shall be terminated upon transition from OPS-3 to OPS-2 or upon transition to OPS-9. The initiation and termination of this principal function are controlled by MSC.

The following paragraphs specify the detailed requirements summarized in Table 4.1.2-1. These requirements specify, for each of the event cues to be utilized by the sequencer, the actions that the sequencer is to initiate.

OPS-3 INITIALIZE COMPLETE – OPS transition to OPS-3. Based upon this cue, cyclic execution of the user parameter state propagation function (Section 4.6.1.1) shall commence at a repetition rate of 0.52 Hertz, and Earth-fixed coordinate system computations (Section 4.6.1.5) shall be initiated at a repetition rate of 0.52 Hertz. Initialize REL\_VEL\_MAG = 5,000 ft/sec.

Also, cyclic execution of the GPS reference state processing principal function shall be initiated with a repetition rate of 6.25 Hertz. This rate is maintained throughout the OPS-3 mission phase.

EVENT E11 – Guidance initiate. Based upon this cue, the current scheduling of user parameter state propagation is to be cancelled. Cyclic processing of the user parameter state propagation is to be rescheduled at a repetition rate of 1.04 Hertz.

EVENT E15 – Major mode transition from 302 to 303. Based upon this cue, the user parameter state propagation function shall be rescheduled at a repetition rate of 0.52 Hertz.

EVENT E16 – Major mode transition from 303 to 304 (entry). Based upon this cue, the user parameter state propagation function shall be rescheduled at a repetition rate of 6.25 Hertz, the basic guidance-related computations for entry, H\_HDOT\_ACCVERT and GUIDECOMP (Section 4.6.1.2), shall commence cyclic execution at a repetition rate of 1.04 Hertz, cyclic execution of the guidance and displays way point computations (Section 4.6.1.3) and TACAN and GPS display computations (Section 4.6.1.4) for entry shall commence at a repetition rate of 0.52 Hertz, and cyclic execution of the HSI processing function (Section 4.7) will commence at a repetition rate of 1.04 Hertz. The earth fixed coordinate system computations shall be cancelled.



EVENT E21 – Mode transition from 304 to 305 (TAEM). Based upon this cue, the guidance and displays way point computations for entry shall be cancelled and cyclic execution of the subfunction GUIDECOMP shall be rescheduled at a repetition rate of 6.25 Hertz.

TG END – TAEM guidance termination. Based upon this cue, the subfunction H\_DOT\_ACCVERT will be cancelled.

B. Interface Requirements. Input and output parameters for the sequencer are given in lists corresponding to the principal function input list and the principal function output list in Tables 4.1.2.1–1 and 4.1.2.1–2. A variable cross–reference list is presented in Section 4.1.2.1.

C. Processing Requirements. None.

D. Constraints. Cyclic execution of the user parameter propagator shall not be initiated until initialization of necessary state parameters has been accomplished within the D/L navigation sequencer.

E. Supplemental Information. A suggested implementation for these requirements is illustrated in Section 5.6, DEORB\_LAND\_UPP\_SEQ.

The purpose of cancelling and rescheduling the user parameter state propagator upon the guidance initiate signal is to get the execution of this module in “sync” with the execution of the deorbit guidance function which is to be initiated upon this signal. This cancelling and rescheduling process is to occur “y” seconds prior to OMS ignition such that a subsequent user state update will occur (as nearly as possible) at the time of OMS ignition.

Table 4.1.2-1.Event Flag for the Deorbit/Landing User Parameter Processing Sequencer		
Event Flag	Event Flag Description	Action Taken by Sequencer in Response to Event Flag
OPS_3_INITIALIZE_COMPLETE	Signal to enable cyclic execution of UPSP	Initiate performance of the (off-orbit) user parameter state propagation function at a repetition rate of 0.52 Hz. Initiate performance of the GPS reference state processing function at a repetition rate of 6.25 Hertz. Initiate performance of the Earth-fixed coordinate system computations at a repetition rate of 0.52 Hz. Initialize REL_VEL_MAG = 5,000 ft/sec.
EVENT_E11	Guidance initiate	Cancel and reschedule cyclic processing of the user parameter propagation function at a rate of 1.04 Hz.
EVENT_E15	Mode transition from 302 to 303	Reduce repetition rate of the user parameter state propagation function to 0.52 Hz.
EVENT_E16	Mode transition from 303 to 304 (304 = entry)	Increase repetition rate of the user parameter state propagation function to 6.25 Hz. Initiate performance of basic guidance related computations for entry at a repetition rate of 1.04 Hz. Initiate performance of guidance and displays way point computations for entry at a repetition rate of 0.52 Hz. Initiate performance of the HSI processing function at a repetition rate of 1.04 Hz. Initiate performance of TACAN display computations at a repetition rate of 0.52 Hz. Initiate performance of the GPS UPP display computation function at a repetition rate of 0.52 Hertz. Cancel Earth-fixed coordinate system computations.
EVENT_E21	Mode transition from 304 to 305 (305 = TAEM)	Cancel the guidance and displays way point computations for entry and increase repetition rate of the basic guidance-related computations submodule, GUIDECOMP to a repetition rate of 6.25 Hz.
TG_END	TAEM guidance termination	Cancel the basic guidance-related computations submodule, H_HDOT_ACCVERT.

**4.1.2.1 Deorbit/Landing User Parameter Processing Sequencer (4.214) Principal Function Tables**

The principal function interface parameters are given in Tables 4.1.2.1-1 and 4.1.2.1-2. I-loads are presented in Table 4.1.2.1-3, K-loads in Table 4.1.2.1-4, and constants in Table 4.1.2.1-5. The principal function variable cross-reference is given in the following table.

Deorbit/Landing User Parameter Processing Sequencer (4.214) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
EVENT_E11	N/G
EVENT_E15	N/G
EVENT_E16	N/G
EVENT_E21	N/G
N/G = Not given	

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TABLE 4.1.2.1-1. INPUT FUNCTIONAL PARAMETERS FOR DEORBIT/LANDING UPP SEQUENCER (G4.214)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
MM_CODE_303/MM_303	V90X8182X	MAJOR MODE 303 FLAG	MSC				92355B	
MM_CODE_305/MM_305	V90X8162X	MAJOR MODE 305 FLAG	MSC				92355B	
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
OPS_3_INIT_COMPLETE	V90X0539X	FLAG TO ENABLE CYCLIC EXEC OF UPSP	D/L NAV SEQ					
TG_END	V90X1108XA	TAEM GUIDANCE TERMINATION FLAG	TAEM GUID				93017G	*
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.1.2.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM DEORBIT/LANDING UPP SEQUENCER (G4.214)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
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NO REQUIREMENTS

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec**  
**(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.1.2.1-3. DEORBIT/LANDING UPP SEQUENCER (G4.214) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
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NO REQUIREMENTS

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.1.2.1-4. DEORBIT/LANDING UPP SEQUENCER (G4.214) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
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NO REQUIREMENTS

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.1.2.1-5. DEORBIT/LANDING UPP SEQUENCER (G4.214) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
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NO REQUIREMENTS

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

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## 4.2 SUBFUNCTIONS COMMON TO SEVERAL NAVIGATION PRINCIPAL FUNCTIONS

This section documents detailed requirements for subfunctions identified as being common to two or more navigation principal functions or their major subfunctions. The detailed requirements specified here will be referenced from the sections to which they are common and, when referenced, may be regarded as inserts to paragraph A, Detailed Requirements, in these sections.

### 4.2.1 State Propagation

This subfunction will perform a number of tasks related to propagation of the Shuttle state vector. The task of reading (snapping) the IMU's is performed when the total accumulated sensed velocity is required to account for nongravitational accelerations during integration of the equations of motion. Modeled drag acceleration is computed in those circumstances in which IMU accumulated sensed velocity is not used. The equations of motion are integrated with the use of a super-g algorithm designed primarily for powered-flight phases (i.e., those phases in which appreciable nongravitational accelerations are experienced); but also used for coasting-flight phases.

#### 4.2.1.1 IMU Data Snap

The IMU data snap task shall provide the capability to obtain the IMU-sensed accumulated velocities from each of the three IMUs, the selected sensed accumulated velocity and the GMT time tag associated with these data. The IMU data are obtained as indicated by the following:

$$\text{SNAP IMU } (\bar{V}_{\text{CURRENT\_FILT\_ONE}}, \bar{V}_{\text{CURRENT\_FILT\_TWO}}, \\ \bar{V}_{\text{CURRENT\_FILT\_THREE}}, \bar{V}_{\text{CURRENT\_FILT}}, \\ T_{\text{CURRENT\_FILT}})$$

The accumulated velocity from each IMU shall be that sensed by the IMUs at their locations on the orbiter navbase and shall be expressed in M50 coordinates. These data are used in the three state entry navigation principal function by the state propagation subfunction, and by the GPS receiver state processing principal function, which is executed by the entry and preland navigation principal functions.

The selected accumulated velocity is obtained from IMU RM and shall also be that sensed at the orbiter navbase. The selected accumulated velocity is used in the single state preland navigation principal function by the state propagation subfunction. It is also used to propagate the Kalman filter covariance matrix in both the entry and preland navigation modes.

The snap statement above implies the assignment of current values of the IMU data to the variable names shown in parentheses.

#### 4.2.1.2 Acceleration Models

The tasks that perform integration of the Shuttle equations of motion require models to compute either gravitational and/or nongravitational (drag) accelerations. If IMU accelerometer-sensed velocity data are used in the integration process, then only gravitational accelerations need be modeled. If accelerometer data are not used, then the drag acceleration needs to be modeled in addition to the gravitational acceleration.

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During entry and preland navigation phases, the acceleration function shall be called by its users with values of GMD, GMO,  $\bar{R}$ ,  $\bar{V}$ , and T. The input flags GMD and GMO control the degree and order of the gravitational potential model to be used.  $\bar{R}$  and  $\bar{V}$  are the position and velocity vectors of the vehicle in the M50 coordinate system and T is the time tag associated with both of these vectors.

First, the central force term of the Earth's gravitational acceleration shall be computed. This is to be accomplished by calling a special routine (CENTRAL), which is available for execution by functions other than the navigation function.

CALL: CENTRAL

IN LIST:  $\bar{R}$

OUT LIST:  $\bar{ACCEL}$ , R\_INV

The calculations performed within the routine CENTRAL are the following:

$$R\_INV = 1. / |\bar{R}|$$

$$\bar{ACCEL} = -EARTH\_MU R\_INV^3 \bar{R}$$

The parameter R\_INV must be output because it will be used later in computing the other (non-central force) terms of the gravitational acceleration, if so requested by the user function.

Next, the input flag GMD will be tested to see if only the central force term is requested or if additional acceleration calculations are desired.

If the central force alone is required (GMD = 0) then no other calculations need to be performed. If, however, perturbing accelerations are wanted (GMD > 0), the following gravity and drag perturbing acceleration vectors shall be initialized:

$$\bar{G} = 0.$$

$$\bar{D} = 0.$$

Next, the transformation matrix from Earth-fixed to M50 coordinates shall be obtained in order to find the Earth-fixed position vector and the corresponding unit vector:

$$FIFTY = EARTH\_FIXED\_TO\_M50\_COORD(T)$$

$$\bar{R}\_{EF} = FIFTY^T \bar{R}$$

$$\bar{U}\_R = R\_INV \bar{R}\_{EF}$$

The gravitational perturbation to ACCEL (Section 4.2.1.2.1) shall be calculated, and stored in the vector G. If GMD = 4, then the acceleration vector due to drag (Section 4.2.1.2.2) shall be obtained and stored in the vector  $\bar{D}$ . The total acceleration shall then be calculated:

$$\bar{ACCEL} = \bar{ACCEL} + \bar{G} + \bar{D}$$

A suggested implementation of this task is shown in the detailed flow chart, ACCEL, in Section 5.2.

#### 4.2.1.2.1 Gravity

The Earth's gravitational attraction will be modeled by using S. Pines' uniform formulation of the spherical harmonics development.

The following variables are to be set up to serve as starting values for the recursion relations used in the Pines formulation:

$$\begin{aligned} \text{AUXILIARY} &= 0. \\ \text{RO\_ZERO} &= \text{EARTH\_RADIUS\_GRAV R\_INV} \\ \text{RO\_N} &= \text{RO\_ZERO EARTH\_MU R\_INV}^2 \\ \text{A}_{1,2} &= 3. \text{ UR}_3 \\ \text{A}_{2,2} &= 3. \\ \text{L} &= 1 \\ \text{ZETA\_REAL}_1 &= 1. \\ \text{ZETA\_IMAG}_1 &= 0. \end{aligned}$$

A is a two-column array used for temporary storage of the Legendre polynomials and the derived Legendre functions (which are latitude-dependent terms), RO\_N is the distance-related term, and AUXILIARY is an intermediate scalar variable.

The recursive calculations then will proceed, using as many components of the one-column arrays  $\overline{\text{ZETA\_REAL}}$  and  $\overline{\text{ZETA\_IMAG}}$  as required to account for the effects of the tesseral harmonics.

Do for I = 1 to GMO:

$$\begin{aligned} \text{ZETA\_REAL}_{I+1} &= \text{UR}_1 \text{ZETA\_REAL}_I - \text{UR}_2 \text{ZETA\_IMAG}_I \\ \text{ZETA\_IMAG}_{I+1} &= \text{UR}_1 \text{ZETA\_IMAG}_I + \text{UR}_2 \text{ZETA\_REAL}_I \end{aligned}$$

The derived Legendre functions then will be obtained by means of recursion formulas, multiplied by the appropriate combinations of tesseral harmonics (the Legendre polynomials will be multiplied by the zonal harmonics coefficients), and stored as auxiliary variables – F1, F2, F3, and F4.

Do for N = 2 to GMD the following steps (1 through 5):

$$\begin{aligned} (1) \quad \text{A}_{N+1,1} &= 0. \\ \text{A}_{N+1,2} &= (2. \text{ N} + 1.) \text{ A}_{N,2} \\ \text{A}_{N,1} &= \text{A}_{N,2} \\ \text{A}_{N,2} &= \text{UR}_3 \text{ A}_{N+1,2} \\ \text{K} &= 2 \end{aligned}$$

(2) Do for J = 2 to N:

$$A_{N-J+1,1} = A_{N-J+1,2}$$

$$A_{N-J+1,2} = (UR_3 A_{N-J+2,2} - A_{N-J+2,1})/K$$

$$K = K + 1$$

(3) F1 = 0.

$$F2 = 0.$$

$$F3 = -A_{1,1} \text{ ZONAL}_N$$

$$F4 = -A_{1,2} \text{ ZONAL}_N$$

(These account for the zonal harmonics contributions.)

(4) If the maximum order of tesserals wanted has not been attained (i.e., if  $N \leq \text{GMO}$ ), do for N1 = 1 to N:

$$F1 = F1 + N1 A_{N1,1} (C_L \text{ ZETA\_REAL}_{N1} + S_L \text{ ZETA\_IMAG}_{N1})$$

$$F2 = F2 + N1 A_{N1,1} (S_L \text{ ZETA\_REAL}_{N1} - C_L \text{ ZETA\_IMAG}_{N1})$$

$$\text{DNM} = C_L \text{ ZETA\_REAL}_{N1+1} + S_L \text{ ZETA\_IMAG}_{N1+1}$$

$$F3 = F3 + \text{DNM} A_{N1+1,1}$$

$$F4 = F4 + \text{DNM} A_{N1+1,2}$$

$$L = L + 1$$

(These take into account the contributions of the tesseral and sectorial harmonics.)

(5) RO\_N = RO\_N RO\_ZERO

$$G_1 = G_1 + RO_N F1$$

$$G_2 = G_2 + RO_N F2$$

$$G_3 = G_3 + RO_N F3$$

$$\text{AUXILIARY} = \text{AUXILIARY} + RO_N F4$$

(These equations multiply the sum of the zonal and tesseral effects by the appropriate distance-related factors, store the results as the components of the acceleration vector  $\overline{G}$ , and prepare for final computation by obtaining the intermediate scalar variable AUXILIARY, which accounts for an additional effect proportional to the unit radius vector  $\overline{UR}$ .)

Once these calculations have been completed ( $N = \text{GMD}$ ) and stored, the Earth-fixed force vector will be obtained and rotated to the M50 coordinate system.

$$\bar{G} = \bar{G} - \text{AUXILIARY } \bar{U}R$$

$$\bar{G} = \text{FIFTY } \bar{G}$$

This is the perturbing gravitational acceleration vector needed for the equations of motion of the Shuttle. The values of GMD and of GMO may be set by the user independently. However, it is necessary that  $GMO \leq GMD$ . A maximum value of 4 for GMD will be used, which will make the array ZONAL have 4 components, the arrays  $\bar{C}$  and  $\bar{S}$  have 9 components each,  $\bar{ZETA\_REAL}$  and  $\bar{ZETA\_IMAG}$  have 5 each, and A has a maximum dimension of 5 by 2.

The terms shown in the Earth's gravity calculations as  $C_L$  and  $S_L$  are usually represented by  $C_{n,m}$  and  $S_{n,m}$ , respectively, but were renumbered for single subscript utilization; the terms called  $ZONAL_N$  correspond to  $J_N$ .

A suggested implementation of this task is shown in the detailed flow chart, ACCEL\_EARTH\_GRAV CODE, in Section 5.2.

The S. Pines formulation of the gravitational potential may be found, in condensed form, in the paper "Uniform Representation of the Gravitational Potential and its Derivatives," AIAA Journal, Vol. 11, No. 11, November 1973. In expanded form, and with an earlier draft of the computer program herein presented, it may be found in JSC Internal Note No. 75-FM-29, of May 27, 1975, "Use of a Nonsingular Potential."

#### 4.2.1.2.2 Drag

The computation of drag accelerations will vary according to the values of an input indicator, designated here as GMD.

The value  $\bar{D}$  of this acceleration will be set to zero when the acceleration function is called.

If  $GMD \neq 4$ , the value of  $\bar{D}$  shall not be changed.

If  $GMD = 4$ ,  $\bar{D}$  shall be computed as

$$\bar{D} = -CD \text{ RHO DRAG\_CONST } | \bar{V}_R | \bar{V}_R$$

where the CD is the vehicle's drag coefficient;  $\bar{V}_R = \bar{V\_REL}(\bar{V}, \bar{R})$ , where  $\bar{V}$  and  $\bar{R}$  are, respectively, the velocity and position vectors in M50 coordinates;  $\bar{V\_REL}$  is the function that computes the relative velocity of the vehicle with respect to the atmosphere (assuming no wind), described in Section 4.4.5.2; RHO is the density of the Earth's atmosphere; and DRAG\_CONST is one-half the cross-sectional area of the vehicle divided by the vehicle mass, a premission-stored constant, updated in value by the deorbit/landing nav sequencer principal function (Section 4.1.1).

The calculations will be performed in the following order: First, the altitude (needed for the computation of the atmospheric density, RHO) will be obtained from the expression

$$\text{ALT} = \text{H\_ELLIPSOID}(\bar{R})$$

H\_ELLIPSOID is the function that computes altitude above the reference ellipsoid, described in Section 4.4.5.1.

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The density then will be found, from different equations; the equation used will depend on the altitude range.

For  $ALT < 200,000$  ft,

$$RHO = 5.27039E-7$$

(1962 standard atmosphere atmospheric density for altitude of 200,000 ft)

For  $200,000 \text{ ft} \leq ALT \leq ALT\_ZONE\_CHANGE$ ,

$$RHO = SEA\_LEVEL\_DENSITY \text{ EXP } (DENSE_1 + DENSE_2 ALT + DENSE_3/ALT) \quad F1$$

For  $ALT > ALT\_ZONE\_CHANGE$ ,

$$RHO = SEA\_LEVEL\_DENSITY \text{ EXP } (DENSE_4 + DENSE_5 ALT + DENSE_6/ALT) \quad F1$$

F1 This equation shall be protected against floating point overflow (Section 3.5).

Once the atmospheric density has been obtained, the velocity  $\bar{V}_R$ , relative to the atmosphere but expressed in M50 coordinates, will be found.

After the vector  $\bar{V}_R$  has been calculated, the drag coefficient will be obtained from the square of the sine of the angle of attack (SA) and the absolute value of the sine of the sideslip angle (SB)

$$SA = [\text{SIN}(\text{ALPHA})]^2 \quad F9$$

$$SB = |\text{SIN}(\text{BETA})| \quad F9$$

F9 This equation shall be protected against return value of sine or cosine with magnitudes greater than unit (Section 3.5).

where the angle of attack (ALPHA) and the angle of sideslip (BETA) are available from the attitude applications calculation subfunction. The sine of double the sideslip angle is also needed

$$S2B = 2. SB \text{ SQRT}(1. - SB^2) \quad F4$$

F4 This equation shall be protected against square roots of a negative number (Section 3.5).

and the drag coefficient is given by

$$CD = (CDF + CDN SA^{\text{EXP\_SHAPE\_FACTOR}}) (1. - SB) + CDS SB + CDA S2B SA$$

where CDF, CDN, CDA, CDS and EXP\_SHAPE\_FACTOR are constants described in Section 4.9.

The altitude will be obtained from the expression

$$ALT = H\_ELLIPSOID (\bar{R})$$

H\_ELLIPSOID is the function that computes altitude above the reference ellipsoid, described in Section 4.4.5.1.



Next, a test on the altitude will be performed. If the current altitude is less than or equal to 600,000 feet, then a second test will be performed to see if the altitude is less than 300,000 feet. If the second test is true, then altitude will be assigned the value of 300,000 feet. Regardless of the outcome of the second test, the angle-of-attack effects on the drag coefficient will be modeled according to

$$\text{DIFF\_CD} = \text{DIFCD1 SIN}(\text{DIFCD2 ABS}(\text{ALPHA}) - \text{DIFCD3}) + \text{DIFCD4}$$

The altitude effects on the drag coefficient will then be calculated. If the altitude is less than 400,000 feet, a parameter reflecting this altitude dependence will be computed as

$$\text{LOG}_{10\_KN} = \text{KN1} + \text{KN2 ALT} + \text{KN3 ALT}^2$$

Otherwise, this parameter will take the form

$$\text{LOG}_{10\_KN} = 0.054287 \text{ LOG}(\text{KN4} + \text{KN5 ALT} + \text{KN6 ALT}^2)$$

The parameters, KN1 through KN6, are hard-codable constants.

The effects of angle-of-attack and altitude variation on the drag coefficient will then be combined according to

$$\text{DELCD} = \text{DIFF\_CD} (\text{COS}(\text{PI} (0.375 + \text{LOG}_{10\_KN})))^2$$

The drag coefficient will then be adjusted to reflect the effects of variations in angle of attack and altitude:

$$\text{CD} = \text{CD} - \text{DELCD}$$

If the altitude is greater than 600,000 feet, no variational effects are included in the computation of the drag coefficient.

Finally, the drag acceleration shall be obtained from the expression presented earlier

$$\bar{D} = - \text{CD RHO DRAG\_CONST} |\bar{V}_R| \bar{V}_R$$

A suggested implementation of this task is shown in the detailed flow charts, ACCEL, DENSITY and ACCEL\_DRAG CODE in Section 5.2.

#### 4.2.1.3 Integration of State Equations of Motion

The algorithm for integration of the Shuttle equations of motion can use either accumulated IMU-sensed velocity to represent the nongravitational accelerations, or model drag to compute this acceleration. Section 4.2.1.2 presents detailed requirements for the ACCEL function, which computes the Shuttle acceleration vector (gravitational only or with modeled drag). The super-g computational scheme will be performed as follows:

- (1) Test the flag (USE\_IMU\_DATA) which determines whether or not IMU data is to be used.

If USE\_IMU\_DATA = ON, then the IMU sensed velocity will be used:

set

$$\bar{D}\bar{V} = \bar{V}_{\text{CURRENT}} - \bar{V}_{\text{LAST}}.$$

otherwise set

$$\overline{DV} = 0.$$

- (2) Save the value of the current IMU-accumulated sensed velocity for the next cycle:

$$\overline{V}_{LAST} = \overline{V}_{CURRENT}$$

- (3) Evaluate the acceleration vector with the use of the previous values of position, velocity, time, and the indicators GM\_DEG and GM\_ORD as arguments of the ACCEL function:

$$\overline{G}_{ONE} = \overline{ACCEL}(GM\_DEG, GM\_ORD, \overline{R}, \overline{V}, T\_LAST\_FILT)$$

- (4) Advance the position vector with use of the previous position, velocity, and acceleration vector and the time interval DT\_FILT:

$$\overline{R} = \overline{R} + DT\_FILT (\overline{V} + 0.5 (\overline{DV} + DT\_FILT \overline{G}_{ONE}))$$

- (5) Reevaluate the acceleration vector with use of the new value of the position vector, the old value of velocity, and the final time:

$$\overline{G}_{TWO} = \overline{ACCEL}(GM\_DEG, GM\_ORD, \overline{R}, \overline{V}, T\_CURRENT\_FILT)$$

- (6) Advance the velocity vector with use of an average acceleration vector and IMU-sensed velocity change:

$$\overline{V} = \overline{V} + \overline{DV} + 0.5 DT\_FILT (\overline{G}_{ONE} + \overline{G}_{TWO})$$

- (7) Adjust the position vector with use of the new acceleration vector:

$$\overline{R} = \overline{R} + \frac{1}{6} (\overline{G}_{TWO} - \overline{G}_{ONE}) DT\_FILT^2$$

A suggested implementation of this task is shown in the detailed flow chart, SUPER\_G\_NAV, in Section 5.2.

#### 4.2.1.4 Integration of Equations of Motion for GPS States

The Super G GPS and Accel GPS subfunctions are used to propagate an input state over the desired time interval using IMU-sensed velocity and appropriately computed gravity, drag and vent accelerations. The Super G GPS subfunction is used by the GPS receiver state processing principal function for all OPS in which the principal function is active. The ACCEL GPS subfunction is used by the Super G GPS subfunction and also by the GPS reference state processing principal function to compute the acceleration vector of the vehicle at a desired position. The calls to the ACCEL subfunctions from the ACCEL GPS subfunctions as shown below are OPS dependent and as such the calls reflect different input parameter list variables. The requirements specified in Section 4.2.1.4.2 are intended to indicate that the ACCEL subfunction active in each operational sequence is to be used in the implementation of the ACCEL GPS subfunction.

#### 4.2.1.4.1 Super G GPS

The Super G GPS subfunction propagates the input states to the desired time using the input IMU-sensed velocity change, drag, vent and gravity acceleration values as computed by the Accel GPS subfunction (Section 4.2.1.4.2). It is similar to the Super G subfunction discussed in Section 4.2.1.3 except that IMU-sensed delta velocity, and drag and vent acceleration calculation flags are also an input.

GPS Super-g Integrator. The GPS super-g computations will be performed as follows:

The Super-G GPS function is called with inlist parameters consisting of the following: initial position and velocity, IMU-sensed deltav to be used in the propagation, the propagation time interval, the time tag of the input state, the gravity model degree and order, and the flags indicating whether drag and vent accelerations should be used in the propagation. The inlist parameters are:

INLIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{DV}$ , DT, T\_LAST, DEG, ORD, I\_DRAG, I\_VENT

The outlist parameters, after the propagation is completed are:

OUTLIST:  $\bar{R}_{OUT}$ ,  $\bar{V}_{OUT}$ ,  $\bar{G}_{TWO}$

Execute the following steps for propagating the input state to the final time.

Compute the time of the state at the end of the propagation interval:

$$T_{FINAL} = T_{LAST} + DT$$

Compute the acceleration vector at the input position with the ACCEL GPS subfunction, using the input position, velocity, and time, the input gravity model degree and order and the drag and vent acceleration calculation parameters:

$$\bar{G}_{ONE} = ACCEL\_GPS(DEG, ORD, I\_DRAG, I\_VENT, \bar{R}, \bar{V}, T_{LAST})$$

Advance the input position vector over the time interval DT using the input velocity, the IMU-sensed velocity change, and the acceleration computed in ACCEL GPS:

$$\bar{R}_{OUT} = \bar{R} + DT (\bar{V} + 0.5 (\bar{DV} + DT \bar{G}_{ONE}))$$

Reevaluate the acceleration vector using the new position vector, the input velocity, and the final time:

$$\bar{G}_{TWO} = ACCEL\_GPS(DEG, ORD, I\_DRAG, I\_VENT, \bar{R}_{OUT}, \bar{V}, T_{FINAL})$$

Advance the input velocity vector over the time interval DT using the IMU-sensed velocity change and the average gravitational acceleration:

$$\bar{V}_{OUT} = \bar{V} + \bar{DV} + 0.5 DT (\bar{G}_{ONE} + \bar{G}_{TWO})$$

Adjust the position vector using the latest gravitational acceleration:

$$\bar{R}_{OUT} = \bar{R}_{OUT} + (1./6.) (\bar{G}_{TWO} - \bar{G}_{ONE}) DT^2$$

#### 4.2.1.4.2 Accel GPS

The Accel GPS subfunction computes the acceleration vector acting on the vehicle at the input state using input values of gravity model degree and order, and, for OPS 2 and OPS 8, drag and vent calculation flag settings. The calls to the ACCEL subfunctions from the ACCEL GPS subfunctions as shown below are OPS dependent and as such the calls reflect different input parameter list variables depending on the OPS sequence. The requirements specified below are intended to indicate that the ACCEL subfunction active in each operational sequence is to be used in the execution of the ACCEL GPS subfunction.

Accel GPS: The ACCEL\_GPS subfunction computations will be performed as follows:

The input parameters to the ACCEL\_GPS function call are:

$$\text{DEG, ORD, DRAGI, VENTI, } \bar{R}, \bar{V}, T$$

Execute the following steps:

If the operational sequence is OPS 2 or OPS 8, compute the acceleration vector for the input vehicle position using the OPS 2 and OPS 8 on-orbit ACCEL subfunction. The input gravity model degree and order and the drag and vent calculation flags are used. In addition, the current value of the OPS 2 and OPS 8 ATFL\_OV parameter is used. The calculation is as follows:

$$\text{IF (NAV_MM_CODE = 201 or NAV_MM_CODE = 202 or NAV_MM_CODE = 801) THEN} \\ \bar{G} = \text{ACCEL\_ONORBIT}(\text{DEG, ORD, DRAGI, VENTI, ATFL\_OV, } \bar{R}, \bar{V}, T)$$

Note: The ACCEL\_ONORBIT function returns an acceleration vector in double precision.

Otherwise, if the operational sequence is not OPS 2 or OPS 8, compute the acceleration of the vehicle using the non OPS 2 and OPS 8 ACCEL function call:

$$\bar{G} = \text{ACCEL}(\text{DEG, ORD, } \bar{R}, \bar{V}, T)$$

Note: The ACCEL function returns an acceleration vector in single precision.

The value of the acceleration computed above,  $\bar{G}$ , is returned to the subfunction executing the ACCEL\_GPS subfunction.

#### 4.2.2 Covariance Matrix Propagation

The covariance matrix propagation subfunction will propagate the covariance matrix forward in time by using the state transition matrix. Additive process noise will be incorporated to account for unmodeled state and dynamic errors.

The components of the state transition matrix, PHI of dimension 6 by 6, are mathematically defined as the partials of the current state with respect to the previous state (old). An approximate formulation which makes use of a gravity gradient matrix (3 by 3) is to be used in construction of this matrix.

PHI<sub>1 to 6, 1 to 6</sub> is equal to the following submatrices.

$$\text{PHI}_{1 \text{ to } 3, 1 \text{ to } 3} = \text{ID\_MATRIX\_3X3} + (\text{DT\_FILT}^2/2) \text{GRAV\_GRAD\_OLD}$$

$$\text{PHI}_{1 \text{ to } 3, 4 \text{ to } 6} = (\text{DT\_FILT}) \text{ID\_MATRIX\_3X3}$$

$$\text{PHI}_{4 \text{ to } 6, 1 \text{ to } 3} = (\text{DT\_FILT}/2) (\text{GRAV\_GRAD\_OLD} + \text{GRAV\_GRAD\_NEW})$$

$$\text{PHI}_{4 \text{ to } 6, 4 \text{ to } 6} = \text{ID\_MATRIX\_3X3} + (\text{DT\_FILT}^2/2) (\text{GRAV\_GRAD\_NEW})$$

where

$$\text{GRAV\_GRAD\_OLD} = \text{GRAVITY\_GRADIENT}(\text{R\_COV\_LAST})$$

$$\text{GRAV\_GRAD\_NEW} = \text{GRAVITY\_GRADIENT}(\text{R\_FILT})$$

and  $\bar{\text{R}}_{\text{FILT}}$  is either the vector selection of  $\bar{\text{R}}_{\text{FILT\_ONE}}$ ,  $\bar{\text{R}}_{\text{FILT\_TWO}}$ , and  $\bar{\text{R}}_{\text{FILT\_THREE}}$  as defined in Section 4.3.1.1, paragraph A.6, during entry navigation ( $\text{NAV\_THREE\_STATE} = \text{ON}$ ), or the single-state filter position vector during preland navigation ( $\text{NAV\_THREE\_STATE} = \text{OFF}$ ).

The quantity  $\text{ID\_MATRIX\_3X3}$  is the 3-by-3 identity matrix, and the gravity gradient matrix function is defined in Section 4.4.5.4.

The covariance matrix, E, will be propagated using the following equation.

$$\text{E} = \text{PHI E PHI}^T + \text{STATE\_NOISE}$$

where the state noise covariance matrix,  $\text{STATE\_NOISE}$ , is used to account for unmodeled state errors and uncertainty in the propagation of the state. It will be formulated as shown in Figure 4.2.2-1.

During the nonpowered flight, i.e., when IMU data is not being used in state propagation (the flag  $\text{USE\_IMU\_DATA}$  is OFF), variables required in the state noise formulation will be defined as follows:

$$\text{VAR\_ACC\_QUANT} = \text{VAR\_ACC\_QUANT\_COAST}$$

$$\text{VAR\_UNMOD\_ACC\_DT} = \text{VAR\_UNMOD\_ACC\_DT\_COAST}$$

$$\text{STATE\_NOISE} = \left[ \begin{array}{ccc|ccc} \text{NOISE\_R} & 0 & 0 & \text{NOISE\_RV} & 0 & 0 \\ 0 & \text{NOISE\_R} & 0 & 0 & \text{NOISE\_RV} & 0 \\ 0 & 0 & \text{NOISE\_R} & 0 & 0 & \text{NOISE\_RV} \\ \hline \text{NOISE\_RV} & 0 & 0 & \text{NOISE} & 0 & 0 \\ 0 & \text{NOISE\_RV} & 0 & 0 & \text{NOISE} & 0 \\ 0 & 0 & \text{NOISE\_RV} & 0 & 0 & \text{NOISE} \end{array} \right]$$

WHERE

$$\text{NOISE} = \text{VAR\_ACC\_QUANT} + (\text{VAR\_UNMODE\_ACC\_DT}) \text{DT\_FILT}$$

$$\text{NOISE\_R} = \text{NOISE} (\text{DT\_FILT}^2) 0.25$$

$$\text{NOISE\_RV} = \text{NOISE} (\text{DT\_FILT}) 0.5$$

And during the powered flight when IMU data is being used in state propagation (i.e., the flag  $\text{USE\_IMU\_DATA}$  is ON), variables required in the state noise formulation will be defined as follows:

$$\text{VAR\_ACC\_QUANT} = \text{VAR\_ACC\_QUANT\_IMU}$$

$$\text{VAR\_UNMOD\_ACC\_DT} = \text{VAR\_UNMOD\_ACC\_DT\_IMU}$$

Finally, since the covariance matrix, E, must be symmetric, state noise terms need only be added to the upper triangular portion of the matrix triple product  $\text{PHI E PHI}^T$  and symmetry shall be maintained by

$$E_{J,I} = E_{I,J} \text{ for } \begin{cases} I = 1,6 \\ J = 1,6 \end{cases}$$

A suggested implementation of this task is shown in the detailed flow chart, COVEXTRAP\_PF, in Section 5.2.

### 4.2.3 State Vector Interpolation

The state vector interpolation subfunction will provide the capability to propagate the Shuttle's position vector over a small time increment. Propagation will be accomplished by using a simple, low-order integrator. This subfunction will be used to update the position vector from its current time to the time of a sensor measurement (either TACAN, MSBLS, or barometric altimeter), as required by the navigation filter to correctly compute an estimated measurement and residual. The error due to the use of the low-order integrator in calculating the position vector is not cumulative. Position propagation by this algorithm is done only if the difference between the sensor measurement time and the current time exceeds a predetermined value (EPS\_TAG). This value is a function of sensor accuracy.

The following steps will be followed (in the order specified) to accomplish this subfunction.

- (1) Data will be input according to the in list

$$\text{IN LIST: } T\_SENSORS, \bar{R}, \bar{V}, \bar{DV}, \bar{G}$$

where T\_SENSORS is the measurement time tag,  $\bar{R}$  and  $\bar{V}$  are the orbiter's position and velocity vectors in M50 coordinates,  $\bar{DV}$  is the IMU-sensed velocity change over the current navigation cycle, and  $\bar{G}$  is the gravitational acceleration vector in M50 coordinates (if using IMU data) or the modeled total acceleration vector in M50 coordinates (if not using IMU data).

- (2) The interpolation time interval will be computed as follows:

$$\text{DT\_INTERP} = T\_SENSORS - T\_LAST\_FILT$$

where T\_LAST\_FILT is the time associated with the recently propagated orbiter state vector.

- (3) If the absolute value of DT\_INTERP is less than or equal to a prestored epsilon (EPS\_TAG), then the output vector  $\bar{R\_RESID}$  is to be equated to the input position vector

$$\bar{R\_RESID} = \bar{R}$$

and thus, no interpolation is performed.

- (4) If the absolute value of DT\_INTERP is greater than EPS\_TAG, interpolation of the position vector will be accomplished according to the following equation:

$$\bar{R}_{RESID} = \bar{R} + DT\_INTERP (\bar{V} + 0.5 DT\_INTERP (\bar{D}V/DT\_FILT + \bar{G})) \quad F3$$

F3 This equation shall be protected against division by zero (Section 3.5).

A suggested implementation of this task is shown in the detailed flow chart, SV\_INTERP, of Section 5.2.

#### 4.2.4 State and Covariance Measurement Incorporation (Kalman Filter)

This subfunction will use a Kalman filter to incorporate the measurement data to update the covariance matrix and the state vectors. To perform these tasks, the Kalman filter uses the covariance matrix, measurement partials, measurement residuals, and the a-priori measurement variance. Nonlinear compensation will be included if required.

If the measurement data have been judged valid and the proper measurement subfunction has been executed, the following update equations will be computed. (Note: The measurement subfunction generates the partial vector, the residuals, and the a-priori variance.)

First, the scalar quantity BT\_E\_B will be calculated for the covariance matrix E and vector measurement partials  $\bar{B}$ :

$$\bar{E}B\_COPY = E \bar{B}$$

$$BT\_E\_B = \bar{B} \cdot \bar{E}B\_COPY$$

where the second equation requires a dot product. The three diagonal elements of the covariance matrix pertaining to the Shuttle position uncertainty will then be summed:  $E_{1,1} + E_{2,2} + E_{3,3}$ . If the sum is greater than the constant MS\_POS\_UND\_WGT, the a-priori variance will be compensated for nonlinear effects by

$$VAR = VAR + K\_UND\_WGT BT\_E\_B$$

This compensation underweights the measurement to prevent the state error covariance matrix from shrinking more rapidly than the actual errors. The quantity MS\_DELQ, which represents the expected variance in the measurement, will then be computed by

$$MS\_DELQ = BT\_E\_B + VAR$$

A residual edit will be performed. A flag corresponding to the appropriate measurement subfunction will be set to inform the crew if the edit fails, that is, if the square of the residual is greater than the quantity RESID\_TEST, where  $RESID\_TEST = K\_RES\_EDIT MS\_DELQ$  and K\_RES\_EDIT is a measurement-dependent multiplier established by the measurement subfunction. It should be noted that nonlinear compensation, when performed, also adjusts this edit; the larger the compensation, the larger will be the residual that passes the edit. The residual edit will be overridden or inhibited, however, if the manual edit override for the particular sensor being processed is active.

If there is no edit, the subfunction will compute the Kalman filter gain,

$$\bar{\Omega} = \bar{E}B\_COPY/MS\_DELQ$$

F3

F3 This equation shall be protected against division by zero (Section 3.5).

and update the covariance matrix,

$$E = E - \bar{\Omega} (\bar{E}B\_COPY^T)$$

If three state vectors are being maintained, this subfunction will update them with use of the following equations.

$$\bar{R}\_FILT\_ONE = \bar{R}\_FILT\_ONE + \bar{\Omega}A_{1\ to\ 3} DELQ\_ONE$$

$$\bar{V}\_FILT\_ONE = \bar{V}\_FILT\_ONE + \bar{\Omega}A_{4\ to\ 6} DELQ\_ONE$$

$$\bar{R}\_FILT\_TWO = \bar{R}\_FILT\_TWO + \bar{\Omega}A_{1\ to\ 3} DELQ\_TWO$$

$$\bar{V}\_FILT\_TWO = \bar{V}\_FILT\_TWO + \bar{\Omega}A_{4\ to\ 6} DELQ\_TWO$$

$$\bar{R}\_FILT\_THREE = \bar{R}\_FILT\_THREE + \bar{\Omega}A_{1\ to\ 3} DELQ\_THREE$$

$$\bar{V}\_FILT\_THREE = \bar{V}\_FILT\_THREE + \bar{\Omega}A_{4\ to\ 6} DELQ\_THREE$$

where DELQ\_ONE, DELQ\_TWO, and DELQ\_THREE correspond to the appropriate measurement residuals.

If one state vector is being maintained, this subfunction will update it with use of the following equations.

$$\bar{R}\_FILT = \bar{R}\_FILT + \bar{\Omega}A_{1\ to\ 3} DELQ$$

$$\bar{V}\_FILT = \bar{V}\_FILT + \bar{\Omega}A_{4\ to\ 6} DELQ$$

where DELQ corresponds to the appropriate measurement residual. The edit flag corresponding to the appropriate measurement subfunction will be set to indicate that the measurement data have been processed rather than edited.

This subfunction will also be used to compute the residual test quantity for manually selected sensor types whenever the filter is not incorporating data. This quantity, together with residuals calculated by the measurement subfunctions, will be required for display purposes. A flag corresponding to the appropriate measurement type will be set by the navigation sensor selection task to prevent Kalman filter gain computations and state and covariance matrix updates under this condition. The filter edit flag will be set, in this case, to indicate to Measurement Processing Statistics (Section 4.2.8) that the data have been computed for display purposes only.

It is required that the residual, the residual test quantity (RESID\_TEST), and the residual edit flag corresponding to each measurement subfunction be available for display purposes.

A suggested implementation of this task is shown in the detailed flow chart, NAV\_FILTER, in Section 5.2.



#### 4.2.5 Vector Selector

This subfunction will provide the capability to produce a single vector from three vectors, each of which possesses a status indicating that vector as “good” or “bad.” For example, the vector selector subfunction will be used to select a single valid position and velocity vector for users (guidance and display) and for Kalman gain calculation.

An IMU’s status (IMU\_STATUS) shall be determined through the combination of the IMU Selection Filter Command (IMU\_SFC) from IMU RM and the automatic IMU upmode status (NOT IMU\_REANCHOR). If an IMU’s state vector is in the process of being reanchored to the selected navigation state, that IMU’s state vector should not be considered for vector selection until the reanchor has occurred. Vector selection will occur as follows:

$$\text{IMU\_STATUS} = (\text{IMU\_SFC}_1 \text{ AND } (\text{NOT IMU\_REANCHOR}_1)) + \\ 3 (\text{IMU\_SFC}_2 \text{ AND } (\text{NOT IMU\_REANCHOR}_2)) + \\ 5 (\text{IMU\_SFC}_3 \text{ AND } (\text{NOT IMU\_REANCHOR}_3))$$

```
IF IMU_STATUS = 9
    DO FOR i = 1 to 3
        CALL:      MID_SELECT
        INLIST:    (R_MS_ONEi, R_MS_TWOi, R_MS_THREEi)
        OUTLIST:   (Ri)
```

```
Else If IMU_STATUS = 8
     $\bar{R} = .5 (\bar{R}_{MS\_TWO} + \bar{R}_{MS\_THREE})$ 
```

```
Else If IMU_STATUS = 6
     $\bar{R} = .5 (\bar{R}_{MS\_ONE} + \bar{R}_{MS\_THREE})$ 
```

```
Else If IMU_STATUS = 4
     $\bar{R} = .5 (\bar{R}_{MS\_ONE} + \bar{R}_{MS\_TWO})$ 
```

```
Else If IMU_STATUS = 5
     $\bar{R} = \bar{R}_{MS\_THREE}$ 
```

```
Else If IMU_STATUS = 3
     $\bar{R} = \bar{R}_{MS\_TWO}$ 
```

```
Else If IMU_STATUS = 1
     $\bar{R} = \bar{R}_{MS\_ONE}$ 
```

If all IMU’s are good, a middle selected vector will be generated, composed of component–by–component middle selected values. If one IMU is determined to be bad by the redundancy management logic, the selected vector will be generated by averaging the two good vectors on a component–by–component basis. If only one IMU is performing satisfactorily, then the associated vector will be selected.

A suggested implementation of this task is shown in the detailed flow chart, VECTOR\_SELECTION, in Section 5.2.

#### 4.2.6 Delta State Update

A capability will be provided for updating the position and velocity of the Shuttle in flight by using information conveyed via ground-originated command uplink or by voice from the ground to the crew for entry via the HSD. This capability will be provided by a task that corrects the Shuttle's position and velocity vectors by using state updates referenced to the current selected runway coordinate system. If this is accomplished in MM 303, the range to landing site task will be scheduled to update the range to landing site and time of free fall. (See STS 83-0003 for range to landing site task.)

The performance of a delta state update will require two difference vectors ( $\overline{DR}_{RW}$  and  $\overline{DV}_{RW}$ ) to be supplied. These vectors must be set to the desired values before the delta state update task is invoked. The appropriate navigation control subfunction (Entry or Preland) will invoke the delta state update task only when a flag (DO\_DELTA\_UPDATE) has been set to ON (the control subfunctions are described in Sections 4.3.1.1 (Entry) and 4.3.2.1 (Preland)).

$\overline{DR}_{RW}$  is the difference between the ground estimated position of the Shuttle and the onboard navigation system's estimate of the Shuttle's position (runway coordinates).  $\overline{DV}_{RW}$  is the difference between the ground estimated velocity of the Shuttle and the onboard navigation system's estimate of the Shuttle's velocity (runway coordinates).

The sense of these differences is: ground estimated minus onboard estimated. The onboard estimated vectors are downlinked to the ground at regular intervals (see Section 4.10 for downlist rates) and used by the ground to calculate these differences, which are then used to correct the onboard vectors.

The update will be performed as follows:

- (1) In three-state navigation (NAV\_THREE\_STATE = ON), a single Shuttle velocity vector will be obtained through the use of the vector selection subfunction (a single Shuttle position vector will be available, having been selected by the covariance propagation subfunction prior to the execution of the delta state update subfunction). Otherwise, the current one-state Shuttle position and velocity vectors will be used.
- (2) Using the Earth-fixed to M50 transformation matrix and the runway to Earth-fixed transformation matrix for the current selected runway (see Sections 4.4.3.2 and 4.4.3.5 for these transformations) the delta state update task will convert the difference vectors from the runway system to M50 coordinates. A new filter state will then be formed by adding the M50 difference vectors to the filter state with the same time tag as that used for the Earth-fixed to M50 transformation matrix. For the velocity part of the state vector, it will be necessary to take into account the rotation of the Earth.
- (3) In the next step, the covariance matrix E shall be set to zero, and reinitialized with the appropriate diagonal and off-diagonal elements obtained from premission loaded values. The parameters required to compute these elements will be premission loaded in the UVW coordinate system and rotated to M50 coordinates at the time of their incorporation into the covariance matrix. Detailed requirements for this covariance matrix reinitialization are described in Section 4.2.9. A flag (FILT\_UPDATE) will automatically be set to ON at the end of the navigation filter cycle following the formation of the new filter state, and will cause the user parameter state propagation subfunction (Section 4.4.1) to reinitialize itself to the updated filter state in the same manner as if sensor data were used by the filter to update the state.

The equations required to generate the new vectors  $\bar{R}_{\text{FILT}}$  and  $\bar{V}_{\text{FILT}}$  and to perform the required reinitialization of the navigation subsystem are detailed in the following description:

$$M_{\text{TEMP}} = \text{EARTH\_FIXED\_TO\_M50\_COORD}(T_{\text{LAST\_FILT}}) M_{\text{EFTORW}}^T$$

$$\bar{D}R = M_{\text{TEMP}} \bar{D}R_{\text{RW}}$$

$$\bar{R}_{\text{FILT}} = \bar{R}_{\text{FILT}} + \bar{D}R$$

$$\bar{V}_{\text{FILT}} = \bar{V}_{\text{FILT}} + M_{\text{TEMP}} \bar{D}V_{\text{RW}} + \text{EARTH\_RATE} (\bar{E}_{\text{ARTH\_POLE}} \times \bar{D}R)$$

In one-state navigation, the updated  $\bar{R}_{\text{FILT}}$  and  $\bar{V}_{\text{FILT}}$  become the current orbiter state vector. For three-state navigation, the state vectors are initialized as follows:

$$\bar{R}_{\text{FILT\_ONE}} = \bar{R}_{\text{FILT}}$$

$$\bar{R}_{\text{FILT\_TWO}} = \bar{R}_{\text{FILT}}$$

$$\bar{R}_{\text{FILT\_THREE}} = \bar{R}_{\text{FILT}}$$

$$\bar{V}_{\text{FILT\_ONE}} = \bar{V}_{\text{FILT}}$$

$$\bar{V}_{\text{FILT\_TWO}} = \bar{V}_{\text{FILT}}$$

$$\bar{V}_{\text{FILT\_THREE}} = \bar{V}_{\text{FILT}}$$

After computation of the updated state vector, the different vectors shall be set to zero and the DO\_DELTA\_UPDATE flag set to the OFF position to inhibit repeated state updates. The necessary equations are

$$\bar{D}R_{\text{RW}} = 0$$

$$\bar{D}V_{\text{RW}} = 0$$

$$\text{DO\_DELTA\_UPDATE} = \text{OFF}$$

If the current major mode is 303, then schedule the range to landing site task to compute a new range to landing site and time of free fall for display. (See STS 83-0003 for range to landing site task.)

A suggested implementation of this task is shown in the detailed flow chart OPS\_3\_DELTA\_UPDATE, in Section 5.2.

#### 4.2.7 Measurement Residuals and Partialials

This section documents detailed requirements for measurement subfunctions that have been identified as being common to more than one navigation principal function. The measurement subfunctions will provide the measurement residual, the measurement partials, and a-priori measurement variance per measurement type.

#### 4.2.7.1 TACAN Range Residual and Partial

This subfunction computes the estimated range from the Shuttle to the TACAN station, the range residual, and the range measurement partials, and selects the proper variance to model the instrument error.

- (1) TACAN Range Residual – The subfunction will compute the estimated Shuttle relative range by using the equation.

$$Q = |\bar{R}_{RESID} - \bar{R}_{SCANNER}|$$

where

$$M_{EFTOM50} = EARTH\_FIXED\_TO\_M50\_COORD(T\_TACAN)$$

$$\bar{R}_{SCANNER} = M_{EFTOM50} \bar{R}_{TACAN\_EF}$$

The state vector used,  $R_{RESID}$ , may have been interpolated to the sensor measurement time ( $T_{TACAN}$ ) if this time was different from the filter state vector time by a premission constant (Section 4.2.3). The TACAN station Earth-fixed position vector,  $R_{TACAN\_EF}$ , is obtained from the measurement reconfiguration subfunctions.

The residual shall then be calculated by

$$DQ = Q_{TAC\_R} - Q$$

- (2) TACAN Range Partial – The partial derivatives of the range measurement with respect to the state are to be computed as follows:

$$B_{1\ to\ 3} = \bar{UNIT} (\bar{R}_{RESID} - \bar{R}_{SCANNER})$$

$$B_{4\ to\ 6} = 0.$$

where the function  $\bar{UNIT}$  is to compute the unit vector, and the state vector used,  $\bar{R}_{RESID}$ , is middle selected from the three interpolated position vectors used in the computations of the residuals if in the three-state configuration or the interpolated state vector if in the one-state configuration.

The variance of the TACAN range measurement error is selected from premission determined constants as a function of the relative range from the station to the vehicle,  $RNG$ ,

$$RNG = |\bar{R}_{FILT} - \bar{R}_{SCANNER}|$$

where  $\bar{R}_{FILT}$  is the middle selected state vector if in the three-state configuration or the filter state vector if in the one-state configuration.

If the range,  $RNG$ , is greater than a premission constant,  $RNG\_VAR\_RNG\_STEP$ , then

$$VAR = VAR_{TAC\_R\_HIGH}$$

otherwise

$$VAR = VAR_{TAC\_R\_LOW}$$

where VAR\_TAC\_R\_HIGH and VAR\_TAC\_R\_LOW are design dependent parameters (Section 4.9.3).

#### 4.2.7.2 TACAN Bearing Residual and Partial

This subfunction computes the estimated bearing measurement with respect to the TACAN station, the measurement residual, and the bearing partials, and selects the proper variance to model the instrument error.

- (1) TACAN Bearing Residual – This subfunction shall compute the TACAN station location in M50 coordinates,  $\bar{R}_{SCANNER}$ , and the transformation matrix from M50 to topodetic coordinates by using the following equations:

$$\bar{M}_{EFTOM50} = \text{EARTH\_FIXED\_TO\_M50\_COORD}(T\_TACAN)$$

$$\bar{R}_{SCANNER} = \bar{M}_{EFTOM50} \bar{R}_{TACAN\_EF}$$

$$\bar{M}_{M50TOTD} = \bar{M}_{EFTOTD\_TACAN} \bar{M}_{EFTOM50}^T$$

where  $\bar{M}_{EFTOTD\_TACAN}$  and  $\bar{R}_{TACAN\_EF}$  are obtained from the measurement reconfiguration subfunctions. The estimated azimuth measurement shall then be computed as

$$Q = \text{ARCTAN2}(\text{REL\_R}_2, \text{REL\_R}_1)$$

$$- \text{ANGLE\_CORR\_TNTOMAG} + \text{PI}$$

where ANGLE\_CORR\_TNTOMAG is the correction from true north to magnetic north, and REL\_R, the relative position of the Shuttle in topodetic coordinates, is calculated by

$$\bar{\text{REL\_R}} = \bar{M}_{M50TOTD} (\bar{R}_{RESID} - \bar{R}_{SCANNER})$$

The state vector used,  $\bar{R}_{RESID}$ , may have been interpolated to the sensor measurement time if this time was different from the filter state vector time by a premission constant (Section 4.2.3).

The residual is then calculated as

$$DQ = Q\_TAC\_BRG - Q$$

This residual should be checked to ensure that its magnitude is less than  $\pi$ ; if not, the smaller of the two possible central angles is required:

$$\text{If } DQ > 0, DQ = DQ - 2 \text{ PI}$$

$$\text{If } DQ < 0, DQ = DQ + 2 \text{ PI}$$

- (2) TACAN Bearing Partial – The bearing partials shall be computed by invoking the utility subfunction ANGLE\_PARTIALS (described in Section 4.4.5.3) using as inputs the vector  $\bar{R}_{SCANNER}$  and the third row of the transformation matrix from M50 to topodetic coordinates:

$$\text{CALL: ANGLE\_PARTIALS}$$

IN LIST:  $\bar{R}_{SCANNER}$ ,  $M_{M50TOTD}_{3,1 \text{ to } 3}$

The state vector used in  $ANGLE\_PARTIALS$ ,  $\bar{R}_{RESID}$ , is middle selected from the three interpolated position vectors used in the computations of the residuals if in the three-state configuration or the interpolated state vector if in the one-state configuration.

The variance of the TACAN bearing measurement error is selected from premission determined constants as a function of the relative range from the station to the vehicle,  $RNG$ ,

$$RNG = |\bar{R}_{FILT} - \bar{R}_{SCANNER}|$$

where  $\bar{R}_{FILT}$  is the middle selected state vector if in the threestate configuration or the filter state vector if in the one-state configuration.

If the range,  $RNG$ , is greater than a premission constant,  $RNG\_VAR\ BEARING\_STEP$  then

$$VAR = VAR\_TAC\_BRG\_HIGH$$

otherwise

$$VAR = VAR\_TAC\_BRG\_LOW$$

where  $VAR\_TAC\_BRG\_HIGH$  and  $VAR\_TAC\_BRG\_LOW$  are design dependent parameters (Section 4.9.3).

A suggested implementation of these tasks is shown in the detailed flow charts  $TACAN\_NAV$ ,  $TACAN\_RANGE\_COMP$  and  $TACAN\_BRG\_COMP$ , in Section 5.2.

#### 4.2.7.3 Barometric Altimeter Residual and Partial

This subfunction computes the estimated altitude measurement, the altitude residual, the altitude measurement partials, and the variance that models the instrument error.

- (1) Barometric Altimeter Residuals. The estimated barometric altimeter measurement shall be calculated by the equation

$$Q = H\_ELLIPSOID(\bar{R}_{RESID}) + BIAS\_BARO \\ - DELH\_MSL\_ELLIPSOID\_RW$$

The state vector used in this equation,  $\bar{R}_{RESID}$ , may have been interpolated to the sensor measurement time, if required, as described in Section 4.2.3. Requirements for  $H\_ELLIPSOID$ , which is the function used to calculate the height above the reference ellipsoid, are contained in Section 4.4.5.1.

The residual will then be calculated by

$$DELQ = Q\_BARO - Q$$

If the navigation is in the one-state configuration, this will be done only once. If in the three-state configuration, it will be done three times, and the resulting values, locally called Q\_ONE, Q\_TWO, Q\_THREE, DELQ\_ONE, DELQ\_TWO, and DELQ\_THREE, will be presented to the vector selection subfunction (Section 4.2.5) from which a single value for each selected quantity will emerge, with the names Q and DELQ.

- (2) Barometric Altimeter Partials. The partial derivative of the barometric measurement with respect to the state vector is computed as follows:

$$B_{1\text{ to }3} = \overline{\text{UNIT}}(\overline{R\_FILT})$$

$$B_{4\text{ to }6} = 0.$$

where the function  $\overline{\text{UNIT}}$  computes the unit vector.

R\_FILT is the mid-selected position vector if in the three-state configuration, and the filter position vector if in the one-state configuration.

The variance of the barometric measurement error will be calculated as

$$\text{VAR} = \text{VAR\_H1} + \text{VAR\_H2} (Q - \text{ALT\_RW})^2$$

where ALT\_RW is the altitude of the runway threshold above the reference ellipsoid.

A suggested implementation of this task is shown in the flow charts BARO\_NAV and BARO\_COMP, in Section 5.2.

#### 4.2.8 Measurement Processing Statistics

During navigation phases that utilize external measurements, the measurement processing statistics subfunction will compute for display and downlist certain parameters that are indicative of the condition of the navigation filter and the external sensor measurements that it utilizes. The measurement processing statistics subfunction will be performed as a subfunction of each navigation processing principal function that utilizes an external sensor measurement. It will be performed after the corresponding state and covariance measurement incorporation subfunction has been performed. Filter edit indicators, which will have been initialized to a default value during the corresponding sensor measurement selection subfunction, will be redefined during the performance of the state and covariance measurement incorporation subfunction. This will indicate to the measurement processing statistics subfunction, for each measurement type being utilized, which of the following four cases has occurred:

- (1) Edit indicator = OFF – the filter was not configured for the measurement type, or the data were bad and the filter did not attempt to process data of that type,
- (2) Edit indicator = ON – the filter did attempt to process the measurement type but automatically edited the data,
- (3) Edit indicator = PROCESSED – the filter did process the measurement type, or
- (4) Edit indicator = STAT – the filter was used solely for producing the residual and ratio parameters for display.

Moreover, the state and covariance measurement incorporation subfunction will provide the measurement processing statistics subfunction with the value of each measurement residual and the square of the denominator of the display residual edit ratio, which is described in the following paragraphs. The data supplied to the measurement processing statistics subfunction can be used for two different purposes:

- (1) To calculate the status of the processing of the external sensor data.
- (2) To compute statistics for the sensor measurement type selected by the sensor measurement selection subfunction.

These two sets of calculations are described as follows:

#### **4.2.8.1 Sensors Status**

An indication of the status of external data processing by navigation is provided to the crew by the discretes NAV\_ALT\_FLAG, NAV\_TAC\_FLAG, and NAV\_MLS\_FLAG. (A discrete, RA\_FLAG, is also used to indicate status of the radar altimeter, as described in Section 4.6.) The sensor types are as follows:

- TACAN azimuth
- TACAN range
- Drag derived altitude
- BARO altitude
- MSBLS azimuth
- MSBLS range
- MSBLS elevation
- Radar altimeter altitude

Within the entry navigation measurement processing statistics subfunction, the setting of the discretes, NAV\_ALT\_FLAG and NAV\_TAC\_FLAG, will be based upon processing of TACAN range, TACAN azimuth, barometric altitude, and drag-derived altitude. The discrete, NAV\_MLS\_FLAG, will not be set in this subfunction, but will retain its initialized value of OFF. The two aforementioned discretes, NAV\_ALT\_FLAG and NAV\_TAC\_FLAG, will be set in this subfunction according to the following.

After the processing described in Section 4.2.8.2, Measurement Statistics, has been performed, a test on altitude will be performed to see if the vehicle is below a predetermined altitude. If  $ALT < ALT\_EL_1$ , a test will be performed to see if  $SENSOR\_EDIT_3$  has the value 'PROCESSED' or  $SENSOR\_EDIT_4 =$  'PROCESSED' or  $H\_INHIBIT = ON$ . If any of these are true, then the discrete, NAV\_ALT\_FLAG, will be set to OFF and the sequential counter, N\_SEQ\_ALT, will be set to the value N\_SEQ\_MAX-2. Otherwise, the sequential counter, N\_SEQ\_ALT, will be incremented by one, and a test will be performed to see if this counter has a value greater than the maximum allowable value, N\_SEQ\_MAX, or whether either of the discretes, DISP\_EDIT<sub>3</sub> or DISP\_EDIT<sub>4</sub>, has the "value" indicated as "↓." If  $N\_SEQ\_ALT > N\_SEQ\_MAX$ , or  $DISP\_EDIT_3 = "↓"$  or  $DISP\_EDIT_4 = "↓"$  then the discrete, NAV\_ALT\_FLAG, shall be set to ON.

If  $ALT < ALT\_EL_1$ , a test will also be performed to see if the condition ( $SENSOR\_EDIT_1 =$  'PROCESSED' or  $IN\_CONE\_FLAG = ON$ ) is true along with the added test to see if  $SENSOR\_EDIT_2$  has the value 'PROCESSED.' If this entire test is true, then the discrete, NAV\_TAC\_FLAG, will be set to OFF and the sequential counter, N\_SEQ\_TAC, will be given the value of one. Otherwise, the sequential counter, N\_SEQ\_TAC, will be incremented by one, and a test will be performed to determine whether the value of this counter is greater than the maximum allowable value, N\_SEQ\_MAX, and also to determine



whether either of the discretets, DISP\_EDIT<sub>1</sub> or DISP\_EDIT<sub>2</sub>, has as the “value” indicated by the symbol “↓.” If any of these three conditions are true, then the discrete, NAV\_TAC\_FLAG, will be set to ON.

Independent of altitude, a test will be performed to see if either of the discretets, NAV\_ALT\_FLAG or NAV\_TAC\_FLAG, has the value of ON. If the test is true, then the discrete, NAV\_EDIT\_IND will be set to ON.

Within the preland navigation measurement processing statistics subfunction, the setting of discretets NAV\_ALT\_FLAG, NAV\_TAC\_FLAG, and NAV\_MLS\_FLAG will be based upon the processing of MSBLS range, MSBLS azimuth, MSBLS elevation, TACAN range, TACAN azimuth, and baro altitude according to the following.

After the processing described in Section 4.2.8.2, Measurement Statistics, has been performed, a test on altitude will be performed. If  $ALT < ALT_{EL1}$ , then the discrete, DO\_MLS\_NAV, will be tested. If this flag has the value of OFF, then TACAN and baro/drag altitude processing will be tested. Otherwise, if DO\_MLS\_NAV has the value of ON, then the discretets, NAV\_ALT\_FLAG and NAV\_TAC\_FLAG, will be given the values of OFF.

The baro/drag altitude and TACAN data processing tests are as follows: First, if either SENSOR\_EDIT<sub>3</sub> or SENSOR\_EDIT<sub>4</sub> has the value ‘PROCESSED,’ or H\_INHIBIT has the value ‘ON,’ then the discrete, NAV\_ALT\_FLAG, will be set to OFF and the sequential counter, N\_SEQ\_ALT, will be reset to the value  $N_{SEQ\_MAX}-2$ . Otherwise, the sequential counter, N\_SEQ\_ALT, will be incremented by one. Then, if the value of this sequential counter exceeds the maximum allowable value, N\_SEQ\_MAX, or if either of the display edit history indicators, DISP\_EDIT<sub>3</sub> or DISP\_EDIT<sub>4</sub>, indicates the symbol “↓,” then the discrete, NAV\_ALT\_FLAG, will have the value of ON. Secondly, if SENSOR\_EDIT<sub>2</sub> = ‘PROCESSED’ and if either IN\_CONE\_FLAG = ON or SENSOR\_EDIT<sub>1</sub> = ‘PROCESSED,’ then the discrete, NAV\_TAC\_FLAG, will be given the value “OFF” and the sequential counter, N\_SEQ\_TAC, will be reset to one. Otherwise, the sequential counter, N\_SEQ\_TAC, will be incremented by one and its value tested to see if it exceeds the maximum allowable value, N\_SEQ\_MAX. If this is true, or if either of the indicators, DISP\_EDIT or DISP\_EDIT<sub>2</sub>, indicates the symbol “↓,” then the discrete, NAV\_TAC\_FLAG, will be set to ON.

If  $ALT < ALT_{EL1}$  but is independent of the value of DO\_MLS\_NAV, the processing of MSBLS data will be tested. If both SENSOR\_EDIT<sub>5</sub> and SENSOR\_EDIT<sub>6</sub> have the value ‘PROCESSED’ and SENSOR\_EDIT<sub>7</sub> has the value ‘PROCESSED’ or MSBLS\_EL\_INHIBIT = ON or if  $ALT\_WHEELS < ALT_{EL2}$  or  $MLS\_AVAIL = OFF$ , then the discrete, NAV\_MLS\_FLAG, will be given the value of OFF, and the sequential counter, N\_SEQ\_MLS, will be initialized to a value of  $N_{SEQ\_MAX}-2$ . Otherwise, the sequential counter, N\_SEQ\_MLS, will be incremented by one, and its value will be tested to see if it exceeds the maximum allowable value, N\_SEQ\_MAX. If the value of N\_SEQ\_MLS does exceed the maximum, then the discrete, NAV\_MLS\_FLAG, will be set to ON.

Independent of altitude, the values of the three discretets, NAV\_ALT\_FLAG, NAV\_TAC\_FLAG, and NAV\_MLS\_FLAG, will be tested and if any have the value ON, the value of the discrete, NAV\_EDIT\_IND, will be set to ON; otherwise it will be set to OFF.

The indexed variables have the following definitions:

SENSOR\_EDIT<sub>1</sub> is the edit indicator for the TACAN bearing measurement.

SENSOR\_EDIT<sub>2</sub> is the edit indicator for the TACAN range measurement.

SENSOR\_EDIT<sub>3</sub> is the edit indicator for the barometric altitude measurement.

SENSOR\_EDIT<sub>4</sub> is the edit indicator for the drag altitude measurement.

SENSOR\_EDIT<sub>5</sub> is the edit indicator for the MSBLS azimuth measurement.

SENSOR\_EDIT<sub>6</sub> is the edit indicator for the MSBLS range measurement.

SENSOR\_EDIT<sub>7</sub> is the edit indicator for the MSBLS elevation measurement.

A suggested implementation of these tasks is shown in the detailed flow charts, MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE and MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE, in Section 5.2.

#### **4.2.8.2 Measurement Statistics**

For each TACAN, drag altitude, barometric altimeter, and MSBLS measurement type, three parameters are to be computed to show how well the navigation filter is processing external measurements of that particular type. The three parameters to be computed for each measurement are as follows:

- (1) The display measurement residual is to be the actual measurement residual computed by the navigation filter for the particular type, provided the navigation filter has done the computation (i.e., provided that the filter was configured to attempt processing of that particular measurement type during the filter cycle just completed). If the filter was not configured for the measurement type, so that no residual was computed, then the display measurement residual for the particular measurement type shall be displayed as a BLANK in accordance with display requirements.
- (2) The display residual edit ratio is, for a particular measurement type, the absolute value of the actual measurement residual divided by the maximum magnitude that the residual for this measurement type may attain before automatic data editing in the filter occurs. Again, if the filter was not configured for the particular measurement, this display parameter shall be presented as BLANK.
- (3) The display edit history indicator, if displayed as the symbol “↓” on the cathode-ray tube, shall indicate that, for more than K\_MAX times out of the last 4 times that the filter attempted to process the particular measurement type, automatic data editing occurred. Otherwise, this indicator shall be displayed as a BLANK. K\_MAX is a pad loaded integer such that  $1 \leq K\_MAX \leq 4$ .

The actual calculation of the three parameters above shall be accomplished as follows. To compute the display edit history indicators, it is necessary to retain edit information about the last 4 cycles for each measurement type. This will be accomplished by the use of an MX4 matrix EDIT\_ARRAY where M represents the maximum number of measurement types to be managed by this subfunction during the various navigation phases. In the equations below, the following definitions are used.

DISP\_DELQ<sub>I</sub> = parameter (1) above for the I-th measurement type.

DISP\_SIG<sub>I</sub> = parameter (2) above for the I-th measurement type.

$DISP\_EDIT_I$  = parameter (3) above for the I–th measurement type.

$SENSOR\_EDIT_I$  = the filter edit indicator for the I–th measurement type.

$SENSOR\_DELQ_I$  = the filter measurement residual for the I–th measurement type.

$SENSOR\_RESID\_TEST_I$  = the square of the denominator of the display residual edit ratio for the I–th measurement type.

The correspondence between the subscript, I, and measurement type shall be as follows:

I = 1 – TACAN azimuth

I = 2 – TACAN range

I = 3 – barometric altitude

I = 4 – drag altitude

I = 5 – MSBLS azimuth

I = 6 – MSBLS range

I = 7 – MSBLS elevation

For each value of the integer I in the interval (1, M), the following procedure will be performed.

The indicator  $SENSOR\_EDIT_I$  shall be tested; and if found to have the value “OFF,” both  $DISP\_DELQ_I$  shall be given the value “BLANK” and the calculations shall cease at this point. If the value tested is not “OFF,” then  $DISP\_DELQ_I$  shall be given the value  $SENSOR\_DELQ_I$  and  $DISP\_SIG_I$  shall be calculated according to

$$DISP\_SIG_I = \frac{ABVAL(SENSOR\_DELQ_I)}{\sqrt{(SENSOR\_RESID\_TEST_I)}} \quad F3, F4$$

F3 This equation shall be protected against division by zero (Section 3.5).

F4 This equation shall be protected against square roots of a negative number (Section 3.5).

provided that  $SENSOR\_RESID\_TEST_I$ , is positive.

The  $SENSOR\_EDIT_I$  indicator shall again be tested; and if found to have the value “STAT,”  $DISP\_EDIT_I$  shall be given the value “BLANK” and the calculations shall cease at this point. If the value tested is not “STAT,” the column index,  $J_I$ , shall be incremented by 1 and reset to 1 if its value then should be 5. Next, the parameter  $SUM_I$  shall be determined as  $SUM_I = SUM_I - EDIT\_ARRAY_{I,COLUMN}$ , where  $COLUMN = J_I$ , and  $SENSOR\_EDIT_I$  shall again be tested. If its value is “ON,” then  $EDIT\_ARRAY_{I,COLUMN}$  shall be given the value one and  $SUM_I$  shall be incremented by one. If its value is not “ON,” then  $EDIT\_ARRAY_{I,COLUMN}$  shall be set to zero. Finally,  $SUM$  shall be tested; and if its value exceeds the value  $K\_MAX$ ,  $DISP\_EDIT_I$  shall be given the value “↓”; otherwise,  $DISP\_EDIT_I = BLANK$ .

The range residual, DISP\_DELQ<sub>2</sub>, will be tested and if not equal to BLANK, its dimension will be transformed from units of feet to units of nautical miles.

Thus,

if

$$\text{DISP\_DELQ}_2 \neq \text{BLANK}$$

then

$$\text{DISP\_DELQ}_2 = \text{DISP\_DELQ}_2 \text{ NAUTMI\_PER\_FT}$$

A suggested implementation of these tasks is shown in the detailed flow charts, MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE and MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE, in Section 5.2.

#### 4.2.9 Covariance Matrix Initialization

In circumstances in which the position and velocity elements of the onboard filter covariance matrix are to be initialized to UVW values (i.e., as a result of ground updates and entrance into operational Sequence 3 from either OPS-1 or OPS-2), the following steps must be performed (in the order indicated):

- (1) Data will be input to this subfunction as described by the in list below:

$$\text{IN LIST: } \bar{\text{SIG}}, \bar{\text{COR}}, \bar{\text{R}}, \bar{\text{V}}$$

where  $\bar{\text{SIG}}$  is a six-element vector of standard deviations in the UVW coordinate system

SIG<sub>1</sub>, U-position

SIG<sub>2</sub>, V-position

SIG<sub>3</sub>, W-position

SIG<sub>4</sub>, U-velocity ( $\dot{\text{U}}$ )

SIG<sub>5</sub>, V-velocity ( $\dot{\text{V}}$ )

SIG<sub>6</sub>, W-velocity ( $\dot{\text{W}}$ )

and where  $\bar{\text{COR}}$  is a seven element vector of correlation coefficients, also in the UVW coordinate system

COR<sub>1</sub>, correlation between U-V

COR<sub>2</sub>, correlation between U- $\dot{\text{U}}$

COR<sub>3</sub>, correlation between U- $\dot{\text{V}}$

COR<sub>4</sub>, correlation between V- $\dot{\text{U}}$

COR<sub>5</sub>, correlation between V- $\dot{\text{V}}$

$COR_6$ , correlation between  $\dot{W}-\dot{\bar{W}}$

$COR_7$ , correlation between  $\dot{U}-\dot{\bar{V}}$

and where  $\bar{R}$  and  $\bar{V}$  are the current orbiter position and velocity vectors respectively, in M50 coordinates.

- (2) The 6 by 6 covariance matrix temporary array will be zeroed

$$E\_TEMP = 0.$$

- (3) The diagonal elements of  $E\_TEMP$  will be computed

$$E\_TEMP_{i,i} = SIG_i SIG_i, \text{ for } i = 1, 6$$

- (4) Next, position and velocity submatrix elements, as well as the upper right position-velocity covariance elements, will be computed

$$E\_TEMP_{1,2} = COR_1 SIG_1 SIG_2$$

$$E\_TEMP_{1,4} = COR_2 SIG_1 SIG_4$$

$$E\_TEMP_{1,5} = COR_3 SIG_1 SIG_5$$

$$E\_TEMP_{2,4} = COR_4 SIG_2 SIG_4$$

$$E\_TEMP_{2,5} = COR_5 SIG_2 SIG_5$$

$$E\_TEMP_{3,6} = COR_6 SIG_3 SIG_6$$

$$E\_TEMP_{4,5} = COR_7 SIG_4 SIG_5$$

$$E\_TEMP_{2,1} = E\_TEMP_{1,2}$$

$$E\_TEMP_{5,4} = E\_TEMP_{4,5}$$

- (5) And, finally, a transformation matrix from UVW to M50 coordinate systems is acquired at current time, and used to rotate the  $E$ -matrix into the M50 system. The lower left position-velocity covariance is also defined

$$M = UVW\_TO\_M50(\bar{R}, \bar{V})$$

$$E\_TEMP_{1\ TO\ 3, 1\ TO\ 3} = M E\_TEMP_{1\ TO\ 3, 1\ TO\ 3} M^T$$

$$E\_TEMP_{4\ TO\ 6, 4\ TO\ 6} = M E\_TEMP_{4\ TO\ 6, 4\ TO\ 6} M^T$$

$$E\_TEMP_{1\ TO\ 3, 4\ TO\ 6} = M E\_TEMP_{1\ TO\ 3, 4\ TO\ 6} M^T$$

$$E\_TEMP_{4\ TO\ 6, 1\ TO\ 3} = (E\_TEMP_{1\ TO\ 3, 4\ TO\ 6})^T$$

- (6) The 6 by 6 covariance matrix  $E\_TEMP$  will be output from this subfunction.

A suggested implementation of this task is shown in the detailed flow chart, COVINIT, in Section 5.2.

#### **4.2.10 User Parameter Propagator Reset**

The user parameter propagator reset subfunction will store state data for use in resetting the user parameter state propagator, after all navigation updates have been completed for the current navigation cycle. Orbiter position, velocity, the associated time tag, the velocity counts, and the gravity acceleration will be stored. Either the baseline navigation filter state data or the selected GPS state data will be stored, depending on the configuration of the navigation system as set by the crew. The subfunction will also provide the GPS reference state processing principal function with the baseline navigation filter state so that the GPS reference state can be reanchored as needed. Reset parameters (position, velocity, gravity acceleration and accumulated IMU sensed velocity) are also provided for the GPS UPP display computations.

A parameter status indicator will also be set to notify the crew if their commanded use of the selected GPS state was not accomplished on this navigation cycle (down arrow).

The user parameter state propagator reset state is determined by first storing, in intermediate variables, state data (vehicle position, velocity, associated time tag, velocity counts, and the gravity acceleration) from either the selected baseline navigation state or the selected GPS state, depending on crew display inputs, availability of a selected GPS state, and, during preland, if Microwave Scanning Beam Landing System measurements are being processed by the navigation filter. The display indicator, which notifies the crew of the effectivity of their commanded use of the selected GPS state on this navigation cycle is also set (down arrow, if command not executed).

A metering function is then performed using the intermediate position and velocity variables to insure that the position and velocity transients introduced into the user parameter reset state do not cause metering limits to be exceeded. Pre-mission I-Load values of the maximum allowable state transients are used to determine the metering scale factor for scaling the position and velocity difference between the previous user parameter reset state propagated to current time and the current selected user parameter reset state. Metering is performed for three cases: when both the current and previous states for the user parameter state propagator reset are the selected GPS state; when the selected user parameter reset state changes from a GPS state to the selected navigation state; and when the navigation filter state is being used for the user parameter state reset and the navigation state has been reset to the selected GPS state. In the first case, metering is continuously performed. In the later two cases, the selected navigation state is metered until the difference between the previous cycles user parameter reset state propagated to current time and the current selected user parameter reset state becomes less than the I-Load state change limit for all position and velocity components. The intermediate state variables, appropriately metered, are then used for setting the reset state data sent to the user parameter state propagator.

The GPS reference state processing principal function initialization state data is then set to the selected baseline navigation filter state data.

Use of either the selected GPS state or the baseline navigation state to reset the user parameter propagator state is determined by the following: the configuration of the MLS auto/inhibit/force measurement processing command and the corresponding navigation software MLS force and MLS auto processing indicator variables; the configuration of the GPS to guidance and control auto/inhibit/force command; the availability and validity of MLS data; and, when TACAN receivers are installed on the vehicle, the configuration of the TACAN auto/inhibit/force measurement processing command. The reset user parameter propagator state is subsequently used by guidance.

The MLS auto/inhibit/force measurement processing command is initialized to AUTO and can be changed by the crew through display item entries only when three GPS receivers are installed on the vehicle and no TACAN receivers are installed. For the system configuration with three TACAN receivers and one GPS receiver installed, the MLS auto/inhibit/force measurement processing command will remain in the initialized AUTO setting. The GPS to guidance and control auto/inhibit/force command is initialized to INHIBIT and can be changed by the crew through display item entries. The TACAN auto/inhibit/force measurement processing command is initialized to INHIBIT and can be changed by crew display item entries only when TACAN receivers are installed.

Setting the MLS auto/inhibit/force measurement processing command to FORCE (which requires three GPS receivers to be installed on the vehicle) sets the MLS force processing indicator to ON, forcing the use of the baseline navigation state to reset the user parameter propagator state independent of the setting of the GPS to guidance and control auto/inhibit/force command and independent of the validity of MLS measurement data. If MLS data is not valid, indication will be given to the crew through the displays. Before the selected GPS state can be used to reset the user parameter state, the crew must take appropriate action to remove the MLS auto/inhibit/force command FORCE condition which removes the ON setting of the corresponding MLS force processing indicator. Note that the MLS force processing indicator can never be set to ON when three TACAN receivers are installed on the vehicle.

With the MLS force processing indicator set to OFF, the GPS state can be forced to reset the user parameter propagator state by setting the GPS to guidance and control auto/inhibit/force command, GPS\_TO\_GC\_AIF FORCE item entry on the display. The force is a continuous force.

With the MLS force processing indicator set to OFF and the GPS to guidance and control auto/inhibit/force command set to AUTO (enabled by setting the GPS\_TO\_GC\_AIF to AUTO through display item entry), the selected GPS state will be used to reset the user parameter propagator state when the MLS auto processing indicator is set to OFF.

The MLS auto processing indicator is set to ON under either one of the following two conditions: with three GPS receivers installed on the vehicle, when the MLS auto/inhibit/force measurement processing command is set to AUTO and the MLS measurement data is valid; or, when three TACAN receivers are installed on the vehicle, when the TACAN auto/inhibit/force command is not set to the FORCE condition and the MLS data is valid. The indicator is subsequently set to the OFF condition when the MLS auto/inhibit/force AUTO command is removed, or when the previously valid MLS data is invalid for more than the I-load specified period of time. Setting the TACAN auto/inhibit/force command to FORCE when TACAN receivers are installed on the vehicle will also set the MLS auto processing indicator to OFF.

With the GPS to guidance and control auto/inhibit/force command set to INHIBIT (enabled by setting the GPS\_TO\_GC\_AIF to INHIBIT through display item entry), the selected GPS state will be prohibited from resetting the user parameter propagator state.

Table 4.2.10-1 shows the relationship between the setting of the MLS auto/inhibit/force command (MLS\_AIF), the setting of the GPS to guidance auto/inhibit/force command (GPS\_TO\_GC\_AIF), the availability of MLS data, the setting of the TACAN auto/inhibit/force command (when TACAN receivers are installed on the vehicle) and the use of either the selected GPS or the baseline navigation state (metered) for the user parameter propagator reset state.

The detailed requirements for the user parameter propagator reset subfunction are as follows:

- 1.0 The flag indicating that the user parameter selected reset state data is to be metered is set to OFF.

METER\_FLAG = OFF

- 2.0 If a selected GPS state is available, GPS\_SV\_SEL\_AVAIL = ON, the following conditions are checked to determine if the selected GPS state data is to be stored for use in the intermediate state select variables as described in paragraph 2.1.

If the MLS force processing indicator (MLS\_FORCE\_PROC\_IND) is set to OFF, and the received GPS to GC Auto/Inhibit/Force command flag (GPS\_AIF\_RCVD) is set to FORCE or the received GPS to GC Auto/Inhibit/Force command flag is set to AUTO and the MLS auto processing indicator (MLS\_AUTO\_PROC\_IND) is set to OFF, then the selected GPS state data is stored for use in the intermediate state select variables as described in paragraph 2.1. Otherwise, step 2.2 is executed to store the baseline navigation state in the intermediate state select variables.

IF GPS\_SV\_SEL\_AVAIL = ON and  
MLS\_FORCE\_PROC\_IND = OFF and  
(GPS\_AIF\_RCVD = FORCE or  
(GPS\_AIF\_RCVD = AUTO and  
MLS\_AUTO\_PROC\_IND = OFF)) THEN

execute Step 2.1

ELSE

execute step 2.2

- 2.1 Storing of Selected GPS State Data in Intermediate State Select Variables.

The selected GPS state data (position, velocity, gravity and time) is stored in the intermediate state select variables, the flag indicating which state is to be used for UPP reset is set to 'GPS', and the metering flag is set to ON.

$\bar{R}_{SEL} = \bar{R}_{GPS\_SEL}$

$\bar{V}_{SEL} = \bar{V}_{GPS\_SEL}$

$\bar{G}_{SEL} = \bar{G}_{GPS\_SEL}$

$\bar{T}_{SEL} = \bar{T}_{GPS\_SEL}$

STATE\_FOR\_UPP\_PREV = 'GPS'

METER\_FLAG = ON

Go to step 3.0

- 2.2 If the baseline navigation state is to be stored in the intermediate state select variables, steps 2.2.1 through 2.2.3 are executed.



- 2.2.1 The selected navigation state data (position, velocity, time and gravity acceleration) is stored in the intermediate state select variables.

$$\bar{R}_{SEL} = \bar{R}_{FILT}$$

$$\bar{V}_{SEL} = \bar{V}_{FILT}$$

$$T_{SEL} = T_{LAST\_FILT}$$

$$\bar{G}_{SEL} = \bar{G}_{OLD}$$

If the flag indicating that the GPS state was used for the UPP state reset on the previous navigation cycle (STATE\_FOR\_UPP\_PREV = 'GPS'), or if the baseline state was metered on the previous navigation cycle (BL\_METER = ON), or if the navigation filter state was reset to the selected GPS state on the current navigation cycle (NAV\_RESET = ON), then the metering flag and baseline metering flag are set to ON so that the intermediate position and velocity variables will be sent to the UPP reset metering code.

```
IF STATE_FOR_UPP_PREV = 'GPS' or BL_METER = ON or  
NAV_RESET = ON THEN
```

```
METER_FLAG = ON
```

```
BL_METER = ON
```

- 2.2.2 The flag indicating which state is being used for UPP reset is set to 'BASELINE'.

```
STATE_FOR_UPP_PREV = 'BASELINE'
```

- 2.2.3 A check is then made to determine the setting of the GPS\_AIF\_EXEC status indicator. If the received GPS\_TO\_GC\_AIF flag (GPS\_AIF\_RCVD) is not set to INHIBIT, then the GPS auto/inhibit/force status indicator is set to a down arrow to indicate to the crew that the GPS to GC AIF command was not executed on this navigation cycle.

```
IF GPS_AIF_RCVD ≠ INHIBIT THEN  
GPS_AIF_EXEC = DOWN_ARROW
```

- 3.0 If the crew has not overridden the metering function (CREW\_METERING\_OVERRIDE = OFF) and if the metering flag is ON (METER\_FLAG = ON), then the user parameter reset metering code is executed using the intermediate selected states as described in Section 4.2.10.1.
- 4.0 The user parameter propagator reset state, time tag and gravitational acceleration are then set equal to the metered intermediate state data from the user parameter reset metering code and the filter update flag is set to ON to indicate that the current UPP reset state update is complete.

$$\bar{R}_{RESET} = \bar{R}_{SEL}$$

$$\bar{V}_{RESET} = \bar{V}_{SEL}$$

$$T_{RESET} = T_{SEL}$$

$$\overline{G\_RESET} = \overline{G\_SEL}$$

$$\overline{V\_IMU\_RESET} = \overline{V\_LAST\_FILT}$$

$$FILT\_UPDATE = ON$$

The navigation filter position vector will then be saved for navigation filter covariance matrix propagation on the subsequent navigation cycle.

$$\overline{R\_COV\_LAST} = \overline{R\_FILT}$$

- 5.0 If a selected GPS state is available and the major mode code is 304 or greater, the state data for the GPS User Parameter Display Computation function are set and the flag indicating that this data is available is also set.

```
IF (GPS_SV_SEL_AVAIL = ON and
    NAV_MM_CODE ≥ 304) THEN
     $\overline{R\_GPS\_UPP} = \overline{R\_GPS\_SEL}$ 
     $\overline{V\_GPS\_UPP} = \overline{V\_GPS\_SEL}$ 
     $\overline{G\_GPS\_UPP} = \overline{G\_GPS\_SEL}$ 
    T_GPS_UPP = T_GPS_SEL
     $\overline{V\_IMU\_GPS\_UPP} = \overline{V\_LAST\_FILT}$ 
```

$$GPS\_UPP\_UPDATE = ON$$

- 6.0 The parameters for providing the GPS reference state processing principal function with GPS reference state reanchor data will then be set.

$$\overline{V\_IMU\_GPS\_INIT} = \overline{V\_CURRENT\_FILT}$$

$$\overline{R\_GPS\_INIT} = \overline{R\_FILT}$$

$$\overline{V\_GPS\_INIT} = \overline{V\_FILT}$$

$$T\_GPS\_INIT = T\_LAST\_FILT$$

$$\overline{G\_GPS\_INIT} = \overline{G\_OLD}$$

- 7.0 If the flag indicating that a valid reference state exists for use by the GPS reference state processing principal function (GPS\_REF\_INIT\_VALID) is set to OFF, it is set to ON if the baseline navigation filter states have been reset with either a selected GPS state (NAV\_RESET = ON) or an uplink state (UPLINK\_NAV\_RESET = ON).

```
IF GPS_REF_INIT_VALID = OFF and
    (NAV_RESET = ON or
    UPLINK_NAV_RESET = ON) THEN
    GPS_REF_INIT_VALID = ON
```

8.0 Finally, the position and velocity root sum squared of the baseline navigation Kalman filter covariance matrix is computed for downlist as follows:

$$\text{COV\_POS\_SIG} = \text{SQRT}(E_{1,1} + E_{2,2} + E_{3,3})$$

$$\text{COV\_VEL\_SIG} = \text{SQRT}(E_{4,4} + E_{5,5} + E_{6,6})$$

Table 4.2.10-1 Baseline Navigation State (BL) or GPS State (GPS) to Guidance: Use of Baseline Navigation State or Selected GPS State to Reset the User Parameter State

MLS Auto/Inhibit/Force Measurement Processing Command  (MLS_AIF)	GPS to Guidance and Control Auto/Inhibit/Force Command  (GPS_TO_GC_AIF)		
	FORCE	AUTO	INHIBIT
FORCE	BL*	BL*	BL*
AUTO	GPS	BL** or GPS***	BL*
INHIBIT	GPS	GPS	BL*

\* Does not depend on validity of MLS data

\*\* Valid MLS data is available, or valid MLS data was available and has been subsequently lost for less than an I-load specified period of time, and TACAN auto/inhibit/force measurement processing command not set to FORCE, when TACAN receivers installed on the vehicle

\*\*\* Valid MLS data was available and has been subsequently lost for more than an I-load specified period of time or TACAN auto/inhibit/force measurement processing command set to FORCE, when TACAN receivers installed on the vehicle

Note: MLS\_AIF is initialized to AUTO. It cannot be changed from this setting when TACAN receivers are installed on the vehicle

#### 4.2.10.1 UPP Reset Metering Code

This section describes the steps to be executed to determine whether or not to meter the update to the user parameter state reset position and velocity and, if metering is to be performed, the metering scale factor to be applied to both the user parameter state reset position and velocity updates so that the metering limits are not violated.

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The metering scale factor will be computed for the following conditions: in major mode 304; and in major mode 305, if the current vehicle earth relative velocity computed by the user parameter processing functions is greater than the metering cutoff relative velocity I-load. The metering cutoff relative velocity I-load will prevent any problems with computing the M\_M50\_TO\_UVW transformation matrix with small earth relative velocities.

The altitude of the vehicle above the runway, used in the function to compute the metering scale factor, is snapped by the navigation principal function from the user parameter processing functions to provide a consistent altitude for use in the calculations.

The major mode logic checks also prevent the execution of this function until the altitude parameter is computed by the user parameter processing functions.

The steps are as follows:

- 1.0 If the major mode snapped by navigation is 304, or if the major mode is 305 and the current vehicle earth relative velocity is greater than the metering cutoff velocity I-load, execute steps 2.0 through 8.0.

IF NAV\_MM\_CODE = 304 or  
(NAV\_MM\_CODE = 305 and  
REL\_VEL\_MAG > METERING\_CUTOFF\_VEL THEN  
    execute Steps 2.0 through 8.0

- 2.0 The previous UPP reset state is propagated to the current navigation filter time, using the sensed deltav and degree and order of the gravity model set to 2 and 0 respectively. The drag and vent parameters are set to 0. No acceleration check is needed to determine if the deltav should be set to zero (and the gravity model parameters changed accordingly), since this propagated state will be subsequently modified by the metering logic using the computed difference between it and the current selected user parameter intermediate reset states.

The appropriate parameters for propagating the previous UPP state are set as follows:

GM\_DEG\_GPS\_UPP = 2  
GM\_ORD\_GPS\_UPP = 0  
IDRAG\_UPP = 0  
IVENT\_UPP = 0  
  
 $\bar{D}V = \bar{V}_{CURRENT\_FILT} - \bar{V}_{IMU\_RESET}$   
 $DT = T_{CURRENT\_FILT} - T_{RESET}$

- 3.0 Using the parameters set in step 2.0, the previous UPP state is propagated using Super G GPS as follows:

CALL: SUPER\_G\_GPS  
  
INLIST:  $\bar{R}_{RESET}$ ,  $\bar{V}_{RESET}$ ,  $\bar{D}V$ , DT, T\_RESET, GM\_DEG\_GPS\_UPP,  
          GM\_ORD\_GPS\_UPP, IDRAG\_UPP, IVENT\_UPP  
OUTLIST:  $\bar{R}_{RESET\_PREV\_PROP}$ ,  
           $\bar{V}_{RESET\_PREV\_PROP}$ ,  $\bar{D}UMMY\_GRAV$

- 4.0 The intermediate selected state position and velocity are then differenced with the propagated reset state position and velocity from step 3.

$$\begin{aligned}\bar{\mathbf{R}}_{\text{DIFF}} &= \bar{\mathbf{R}}_{\text{SEL}} - \bar{\mathbf{R}}_{\text{RESET\_PREV\_PROP}} \\ \bar{\mathbf{V}}_{\text{DIFF}} &= \bar{\mathbf{V}}_{\text{SEL}} - \bar{\mathbf{V}}_{\text{RESET\_PREV\_PROP}}\end{aligned}$$

- 5.0 The earth relative velocity is computed using the propagated reset states and the differenced position and velocity from step 4 are then rotated to a UVW coordinate frame determined from the propagated position and the earth relative velocity.

$$\bar{\mathbf{V}}_{\text{REL\_RESET\_PREV\_PROP}} = \mathbf{V}_{\text{REL}}(\bar{\mathbf{V}}_{\text{RESET\_PREV\_PROP}}, \bar{\mathbf{R}}_{\text{RESET\_PREV\_PROP}})$$

$$\begin{aligned}\mathbf{M}_{\text{M50\_TO\_UVW}} &= \text{TRANSPOSE}(\text{UVW\_TO\_M50} \\ &\quad (\bar{\mathbf{R}}_{\text{RESET\_PREV\_PROP}}, \bar{\mathbf{V}}_{\text{REL\_RESET\_PREV\_PROP}})) \\ \bar{\mathbf{R}}_{\text{DIFF\_UVW}} &= \mathbf{M}_{\text{M50\_TO\_UVW}} (\bar{\mathbf{R}}_{\text{DIFF}}) \\ \bar{\mathbf{V}}_{\text{DIFF\_UVW}} &= \mathbf{M}_{\text{M50\_TO\_UVW}} (\bar{\mathbf{V}}_{\text{DIFF}})\end{aligned}$$

- 6.0 The altitude above the runway parameter used in the metering limits code, ALTM, is set to the altitude of the vehicle above the runway snapped by navigation, ALT\_WHEELS\_NAV.

$$\text{ALTM} = \text{ALT\_WHEELS\_NAV}$$

- 7.0 The metering limits code is then executed as described in Section 4.2.10.2 to compute the position and velocity metering scale factors, POS\_METER\_SF and VEL\_METER\_SF, and the larger of the two metering scale factors, METER\_SF.

EXECUTE METERING\_LIMITS CODE

- 8.0 If both the position and velocity metering scale factors are equal to 1, then the baseline metering flag is set to OFF, indicating that if the selected state is the baseline navigation state on this and subsequent navigation cycles, it does not need to be metered in the UPP state reset function on subsequent cycles. Otherwise steps 8.1 and 8.2 are executed to compute the metered difference position and velocity vectors and the resultant metered intermediate selected states.

```
IF (POS_METER_SF = 1 and
    VEL_METER_SF = 1) THEN
    BL_METER = OFF
ELSE
```

execute Steps 8.1 and 8.2

- 8.1 Using the metering scale factor computed in the metering limits code from step 7, both the position and velocity difference vectors are divided by this scale factor to bring the difference vectors to within the desired UVW constraint volume defined by the UVW metering limits.

$$\begin{aligned}\bar{\mathbf{R}}_{\text{DIFF\_METERED}} &= \bar{\mathbf{R}}_{\text{DIFF}} / \text{METER\_SF} \\ \bar{\mathbf{V}}_{\text{DIFF\_METERED}} &= \bar{\mathbf{V}}_{\text{DIFF}} / \text{METER\_SF}\end{aligned}$$

The metering scale factor can be applied to both the inertial position and velocity difference vectors since the scale factor is being used to adjust the magnitude of the vector with the direction of the

vector unchanged from the original unmetered difference vector. Applying the same metering scale factor to both the position and velocity vectors ensures that the correlation between the position and velocity is the same both before and after the metering scale factor is applied.

- 8.2 The selected state for UPP reset is then computed by summing the propagated reset state with the metered difference position and velocity vector. A gravitational acceleration consistent with the metered selected reset state is also computed.

$$\begin{aligned}\bar{R}_{SEL} &= \bar{R}_{RESET\_PREV\_PROP} + \bar{R}_{DIFF\_METERED} \\ \bar{V}_{SEL} &= \bar{V}_{RESET\_PREV\_PROP} + \bar{V}_{DIFF\_METERED} \\ \bar{G}_{SEL} &= ACCEL\_GPS(GM\_DEG\_GPS\_UPP, GM\_ORD\_GPS\_UPP, \\ &\quad IDRAG\_UPP, IVENT\_UPP, \\ &\quad \bar{R}_{SEL}, \bar{V}_{SEL}, T\_CURRENT\_FILT)\end{aligned}$$

#### 4.2.10.2 Metering Limits Code

This section computes the position and velocity metering constraints and the resultant composite metering scale factor for scaling the change to the UPP reset state to insure that the metering limits are not violated. The metering constraints used in setting the metering scale factor are computed in the UVW coordinate system as a function of altitude above the runway and are applied to the UVW position and velocity components of the difference position and velocity vectors.

For each UVW position and velocity coordinate the metering constraint is computed as a linear function of altitude above the runway. Different linear equations are used depending on whether or not the vehicle altitude above the runway is above or below the metering constraint breakpoint altitude. The computed metering constraint is also constrained to be between a maximum and minimum value.

Each UVW position and velocity component of the difference vectors is divided by its metering constraint to produce the update limit in that component. The maximum position and maximum velocity metering scale factor is then computed from these component update limits. Since these metering scale factors will be less than one if all UVW vector components do not exceed its respective update limit, which indicates that metering does not need to occur, they are limited to a minimum value of 1. The single metering scale factor which will be applied to both the position and velocity difference vectors is then selected from the larger of the maximum position or maximum velocity metering scale factors.

The detailed computations are as follows:

- 1.0 For the U position coordinate, the metering constraint is computed as follows:

```
IF ALTM < UBKPOINT THEN
    MCU = UA1 ALTM + UB1
ELSE
    MCU = UA2 ALTM + UB2

IF MCU < UMETER_MIN THEN
    MCU = UMETER_MIN
ELSE
IF MCU > UMETER_MAX THEN
    MCU = UMETER_MAX
```

2.0 For the V position coordinate, the metering constraint is computed as follows:

```
IF ALTM < VBKPOINT THEN
    MCV = VA1 ALTM + VB1
ELSE
    MCV = VA2 ALTM + VB2

IF MCV < VMETER_MIN THEN
    MCV = VMETER_MIN
ELSE
IF MCV > VMETER_MAX THEN
    MCV = VMETER_MAX
```

3.0 For the W position coordinate, the metering constraint is computed as follows:

```
IF ALTM < WBKPOINT THEN
    MCW = WA1 ALTM + WB1
ELSE
    MCW = WA2 ALTM + WB2

IF MCW < WMETER_MIN THEN
    MCW = WMETER_MIN
ELSE
IF MCW > WMETER_MAX THEN
    MCW = WMETER_MAX
```

4.0 For the U velocity coordinate, UD, the metering constraint is computed as follows:

```
IF ALTM < UDBKPOINT THEN
    MCUD = UDA1 ALTM + UDB1
ELSE
    MCUD = UDA2 ALTM + UDB2

IF MCUD < UDMETER_MIN THEN
    MCUD = UDMETER_MIN

ELSE
IF MCUD > UDMETER_MAX THEN
    MCUD = UDMETER_MAX
```

5.0 For the V velocity coordinate, VD, the metering constraint is computed as follows:

```
IF ALTM < VDBKPOINT THEN
    MCVD = VDA1 ALTM + VDB1
ELSE
    MCVD = VDA2 ALTM + VDB2

IF MCVD < VDMETER_MIN THEN
    MCVD = VDMETER_MIN
ELSE
```

```
IF MCVD > VDMETER_MAX THEN  
    MCVD = VDMETER_MAX
```

6.0 For the W velocity coordinate, WD, the metering constraint is computed as follows:

```
IF ALTM < WDBKPOINT THEN  
    MCWD = WDA1 ALTM + WDB1  
ELSE  
    MCWD = WDA2 ALTM + WDB2  
  
IF MCWD < WDMETER_MIN THEN  
    MCWD = WDMETER_MIN  
ELSE  
IF MCWD > WDMETER_MAX THEN  
    MCWD = WDMETER_MAX
```

7.0 Each component of the position difference vector is then divided by the update constraint for that component to produce the update limit for that UVW position component.

```
UPDATE_LIMIT_U = ABS(R_DIFF_UVW1) / MCU  
UPDATE_LIMIT_V = ABS(R_DIFF_UVW2) / MCV  
UPDATE_LIMIT_W = ABS(R_DIFF_UVW3) / MCW
```

Note that this produces a ratio which indicates the multiplicative factor by which each position component exceeds its metering constraint.

8.0 Each component of the velocity difference vector is then divided by the update constraint for that component to produce the update limit for that UVW velocity components.

```
UPDATE_LIMIT_UDOT = ABS(V_DIFF_UVW1) / MCUD  
UPDATE_LIMIT_VDOT = ABS(V_DIFF_UVW2) / MCVD  
UPDATE_LIMIT_WDOT = ABS(V_DIFF_UVW3) / MCWD
```

Note that this produces a ratio which indicates the multiplicative factor by which each velocity component exceeds its metering constraint.

9.0 The position metering scale factor and velocity metering scale factor is then selected from the maximum of the individual UVW position and velocity constraints, indicating the largest value by which a position or velocity component exceeds its metering constraint, as follows:

```
POS_METER_SF = MAX(UPDATE_LIMIT_U,  
                   UPDATE_LIMIT_V,  
                   UPDATE_LIMIT_W)  
  
VEL_METER_SF = MAX(UPDATE_LIMIT_UDOT,  
                   UPDATE_LIMIT_VDOT,  
                   UPDATE_LIMIT_WDOT)
```



10.0 The position and velocity metering scale factors are limited to a minimum value of 1.

```
IF POS_METER_SF < 1 THEN
  POS_METER_SF = 1
IF VEL_METER_SF < 1 THEN
  VEL_METER_SF = 1
```

11.0 Finally, the metering scale factor which will be used to scale both the position and velocity difference vectors is set to the maximum of either the position or velocity metering scale factors.

```
METER_SF = MAX(POS_METER_SF, VEL_METER_SF)
```

#### **4.2.10.3 Supplementary Information**

The Super G GPS state integration routine was used in the UPP Reset metering code to propagate the previous user parameter reset state to current time for use in determining the metering scale factor. This propagation can also be accomplished using the OPS 3 Super G integration routine instead of the Super G GPS state integration routine, if required to facilitate software implementation.

A suggested implementation of this task is shown in the detailed flow charts, UPP\_STATE\_RESET, UPP\_RESET\_METERING\_CODE and METERING\_LIMITS\_CODE, in Section 5.2.

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### 4.3 NAVIGATION PROCESSING PRINCIPAL FUNCTIONS

The two principal navigation processing functions are entry and preland navigation. Each of these functions will be initialized and cyclically executed under the control of the deorbit/landing navigation sequencer principal function (Section 4.1.1). Detailed requirements for each of the principal navigation processing functions are discussed in the following sections.

#### 4.3.1 Entry Navigation (4.127)

The entry navigation principal function provides an up-to-date navigation state estimate of the orbiter position and velocity in the M50 inertial coordinate frame. Three current filter state estimates shall be maintained by this principal function from which is obtained the selected navigation filter state estimate. This principal function shall also call the GPS receiver state processing principal function which processes the state estimates provided by the GPS receivers installed on the Shuttle and which provides a selected GPS state for use by the orbiter navigation software. Either the single selected navigation filter state estimate or the selected GPS state, along with other parameters, shall be provided by the navigation principal function for software users such as user parameter processing, guidance and displays.

The entry navigation principal function shall be scheduled by the deorbit/landing navigation sequencer. Variables interfacing with this function are identified in Table 4.3.1.9-1.

Attitude information, IMU accumulated velocities, and navigation sensor data (TACAN and BARO altimeter) shall be acquired at the beginning of the navigation filter cycle for use in state propagation and improving the three navigation state estimates.

GPS receiver data shall also be acquired at the beginning of the navigation filter cycle for use by the GPS receiver state processing principal function which is called from the entry navigation principal function. The auto/inhibit/force flags for controlling the resetting of the navigation filter states to the selected GPS state and for controlling which state (the selected navigation filter state or the selected GPS receiver state) is provided for use by the user parameter processing principal function, guidance and displays, shall also be acquired.

If a selected GPS state is available from the GPS receiver state processing principal function execution on the previous entry navigation cycle, and if other requisite criteria (described in Section 4.3.1.1) are satisfied and if enabled by the crew, the three navigation filter states shall be reset to the selected GPS state. The navigation filter covariance matrix shall be then reinitialized to values representing the accuracy of the selected GPS state used in the navigation state reset.

If the RNP Matrix Time Parameters have been uplinked, the RNP MAT COMP function shall be called to recompute the RNP Matrix data.

If a delta-state uplink has occurred, the inputs for the delta-state update function, described in Section 4.2.6, shall be defined. If a whole state vector update is indicated, the navigation state estimates and associated time tags shall be set equal to the corresponding whole state vector update parameters. Provision has also been made to reset the QA2 (GPS minus navigation) difference tolerances whenever a whole state update, non-zero delta-time update, or non-zero delta state update occurs.

The three navigation state vectors shall be propagated to current time using data from three IMUs. Navigation state propagation shall not use accelerometer data, however, unless the sensed acceleration

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exceeds a pre-mission determined level. If IMU data are not used, drag acceleration shall be modeled and the degree and order of the gravity model increased for state propagation.

The three states shall then be reduced to a single selected position estimate, as described in Section 4.2.5, for computing the state transition matrix for covariance matrix propagation.

If the state vector prediction task has completed execution due to a whole state vector update (M50 position and velocity), the covariance matrix shall be reinitialized as described in Section 4.2.9. If a delta state update is indicated, however, the state vectors shall be updated and the covariance matrix reinitialized as described in Section 4.2.6. If no state updates have occurred (either a whole state or delta state), the state error covariance matrix shall be propagated in accordance with Section 4.2.2.

A Kalman filtering technique shall be used for updating the three navigation state vectors with TACAN, BARO altimeter, or pseudo DRAG altitude measurements (generated using IMU velocity data and an atmosphere model). The measurement partials and the Kalman filter gain vector shall be computed using the selected state estimate and the propagated covariance matrix. The filter shall then compute the three measurement residuals. The Kalman gain and the measurement residual shall then be used to update the navigation state estimate and the filter covariance matrix, if the residual passes the edit test or crew override of the residual edit test is indicated. The three navigation filter position and velocity state vectors shall again be reduced to a single selected position and velocity vector as described in Section 4.2.5.

The GPS receiver state processing principal function shall then be executed to process GPS receiver state estimates and to provide a selected GPS state for use by the navigation software (Section 4.3.3). This selected GPS state shall be made available to update the navigation filter states on the next navigation cycle and to reset the user parameter processing state on the current navigation cycle.

The user parameter processing reset state shall then be selected from either the navigation filter state or the selected GPS state. The choice of which state is used to reset the user parameter state is subject to manual control, conditional to the availability of GPS data. The reset state is provided to the user parameter propagator principal function for computing user parameters and display parameters. The navigation filter state shall also be continuously made available to the GPS reference state processing principal function for use in initializing GPS receiver states as needed.

The user parameter processing reset state will be metered, if necessary, to insure that metering limits are not violated.

Finally, Kalman filter measurement processing statistics shall be computed for display.

During entry navigation, the baseline navigation filter states can be reset on the current navigation cycle to the selected GPS state from the previous navigation cycle under either of the following two conditions: (1) the crew has set the GPS to navigation auto/inhibit/force command to FORCE; or (2) the crew has set the GPS to navigation auto/inhibit/force command to AUTO, the selected GPS residual ratio edit flag is OFF, the orbiter is above the I-Loaded minimum altitude for automatic GPS updates, the time since the selected GPS state was last updated with receiver data is less than an I-Load limit, and the time since the baseline navigation state was last set to the selected GPS state is greater than, or equal to the minimum time allowed between automatic GPS updates (based on pre-mission set I-Loads). The force is a one-time force, executed on the current navigation cycle.

#### 4.3.1.1 Entry Control

The entry navigation principal function will provide the capability to control state and covariance matrix propagation and filter updates; three state vectors will be maintained. This principal function also controls execution of the GPS receiver state processing principal function.

A. Detailed Requirements. Entry control will perform the following tasks in the order indicated. (For definitions of variables, see input and output Tables 4.3.1.1-1 and 4.3.1.1-2.)

1. An attitude parameters data snap will be performed as described in Section 4.3.1.2.1. The data snapped will be converted from degrees into radians for internal use.

ALPHA = ALPHAIN RAD\_PER\_DEG

BETA = BETAIN RAD\_PER\_DEG

2. The accumulated sensed velocities from three IMU's the selected sensed velocity and the corresponding time tag will be obtained as described in Section 4.3.1.5.
  - 2.1 User parameter data will be snapped from the user parameter processing functions as described in Section 4.3.1.2.3.
3. An external sensor data snap will be performed as described in Section 4.3.1.2.1.
4. A GPS data snap shall be performed as described in Section 4.3.1.2.2.

The received values of the GPS control flags shall be stored for use by the navigation function:

GPS\_AIF\_RCVD = GPS\_TO\_GC\_AIF  
GPS\_TO\_NAV\_RCVD = GPS\_TO\_NAV\_AI  
GPS\_TO\_NAV\_FORCE\_RCVD = GPS\_TO\_NAV\_FORCE

The major mode shall be stored for use by the GPS receiver state processing principal function:

NAV\_MM\_CODE = MM\_CODE

The flag indicating that the navigation states have been set equal to the selected GPS state is set to OFF:

NAV\_RESET = OFF

The parameter which will indicate to the displays if the received GPS\_TO\_GC\_AIF command can be executed by the navigation software on this cycle is set to BLANK:

GPS\_AIF\_EXEC = BLANK

If the copy of the GPS to navigation force flag (GPS\_TO\_NAV\_FORCE\_RCVD) set by the crew is ON, then the GPS to navigation force command flag (GPS\_TO\_NAV\_FORCE) set by the crew is set to OFF, providing a forcing of GPS data into the navigation system on this navigation cycle only. The GPS to navigation auto/inhibit/force flag, GPS\_TO\_NAV\_AIF, which is a composite flag representing the setting of both the GPS\_TO\_NAV\_RCVD and GPS\_TO\_NAV\_FORCE\_RCVD flags, is set to FORCE for this navigation cycle. If the copy

of the GPS to navigation force flag (GPS\_TO\_NAV\_FORCE\_RCVD) is not set to ON, however, then the GPS to navigation auto/inhibit/force flag is set to the GPS to navigation auto/inhibit flag setting. This is accomplished as follows:

```
IF GPS_TO_NAV_FORCE_RCVD = ON THEN
    GPS_TO_NAV_FORCE = OFF
    GPS_TO_NAV_AIF = FORCE

ELSE
    GPS_TO_NAV_AIF = INTEGER (GPS_TO_NAV_RCVD)
```

5. To determine if the baseline navigation filter states are to be reset to the selected GPS state on this navigation cycle, a check is first made to see if a selected GPS state is available. If one is available, indicated by GPS\_SV\_SEL\_AVAIL = ON, Step 5.1 will be performed.
- 5.1 Determine which of two pre-mission defined I-Load values shall be used for the minimum time interval (GPS\_CYCLE\_TIME) between automatic GPS updates to navigation. If the orbiter's altitude is less than the I-Loaded altitude for switching GPS update rates (GPS\_ALT\_FOR\_HIGH\_RATE\_NAV), set GPS\_CYCLE\_TIME to the I-Loaded value for high rate GPS updates (T\_GPS\_CYCLE\_FOR\_HIGH\_RATE\_NAV). Otherwise, set GPS\_CYCLE\_TIME to the I-Loaded value for low rate GPS updates (T\_GPS\_CYCLE). These steps are:

```
IF ALT_WHEELS_NAV < GPS_ALT_FOR_HIGH_RATE_NAV
THEN
    GPS_CYCLE_TIME = T_GPS_CYCLE_FOR_HIGH_RATE_NAV
ELSE
    GPS_CYCLE_TIME = T_GPS_CYCLE
```

The individual filter states shall be reset to the selected GPS state, the navigation reset flag shall be set ON, the time tag of the most recent GPS state incorporation into the navigation system shall be updated, and the navigation filter covariance matrix shall be reinitialized with values reflecting the quality of the GPS update if either of the following conditions are met: (1) the GPS to navigation auto/inhibit/force flag (GPS\_TO\_NAV\_AIF) is FORCE; or (2) the GPS to navigation auto/inhibit/force flag is set to AUTO, the selected GPS residual ratio edit flag (GPS\_RATIO\_FLAG) is OFF, the orbiter's altitude (ALT\_WHEELS\_NAV) is above the minimum altitude for GPS updates (GPS\_UPDATE\_ALT\_FLOOR), the time since the selected GPS state was last updated with receiver data is less than an I-Load limit (GPS\_SEL\_AGE\_MAX), and the time since the last navigation filter state update with the selected GPS state is greater than or equal to the minimum time interval (GPS\_CYCLE\_TIME) specified for GPS updates. These steps are as follows:

```
IF GPS_TO_NAV_AIF = FORCE or
   (GPS_TO_NAV_AIF = AUTO and
    GPS_RATIO_FLAG = OFF and
    (ALT_WHEELS_NAV > GPS_UPDATE_ALT_FLOOR) and
    (DT_GPS_OFF_MIN < GPS_SEL_AGE_MAX) and
    ((T_CURRENT_FILT - T_GPS_LAST_UPDATE) ≥ GPS_CYCLE_TIME))
THEN
```

$\overline{R\_FILT\_ONE} = \overline{R\_GPS\_SEL}$   
 $\overline{R\_FILT\_TWO} = \overline{R\_GPS\_SEL}$   
 $\overline{R\_FILT\_THREE} = \overline{R\_GPS\_SEL}$

$\overline{V\_FILT\_ONE} = \overline{V\_GPS\_SEL}$   
 $\overline{V\_FILT\_TWO} = \overline{V\_GPS\_SEL}$   
 $\overline{V\_FILT\_THREE} = \overline{V\_GPS\_SEL}$

NAV\_RESET = ON  
T\_GPS\_LAST\_UPDATE = T\_CURRENT\_FILT

CALL: COVINIT  
INLIST:  $\overline{SIG\_DIAG\_GPS}$ ,  $\overline{CORR\_COEFF\_GPS}$ ,  
 $\overline{R\_GPS\_SEL}$ ,  $\overline{V\_GPS\_SEL}$   
OUTLIST: E

Note that the T\_LAST\_FILT does not have to be set to T\_GPS\_SEL since the selected GPS state and the filter state have the same time tag at the completion of the previous navigation principal function execution cycle.

6. For each IMU, two tests will be performed to determine if an IMU state needs to be automatically re-anchored.

The first test will determine if an IMU bypass has been removed. This is done by comparing the IMU bypass indicator for the previous cycle (IMU\_BYPASS\_PREV<sub>i</sub>) and the IMU bypass indicator for the current cycle (IMU\_BYPASS<sub>i</sub>) received from the Flight Computer Operating System (FCOS). If a bypass is removed (indicated by IMU\_BYPASS\_PREV<sub>i</sub> = 1 and IMU\_BYPASS<sub>i</sub> = 0), then that IMU is marked accordingly (IMU\_BYPASS\_REMOVED<sub>i</sub> = ON).

The second test will determine if an IMU has become a selection filter candidate. This is done by comparing the values of the previous IMU selection filter (SF) command (IMU\_SFC\_PREV<sub>i</sub>) and the current IMU SF command (IMU\_SFC<sub>i</sub>). They are compared to determine if IMU upmoding has occurred. If upmoding has occurred (indicated by IMU\_SFC\_PREV<sub>i</sub> = 0 and IMU\_SFC<sub>i</sub> = 1) and an IMU bypass has been removed (IMU\_BYPASS\_REMOVED), then the flag IMU\_REANCHOR<sub>i</sub> is set to ON and IMU\_BYPASS\_REMOVED<sub>i</sub> is set to OFF. In order to hold the upmoded IMU out of the vector selection process for one nav cycle so a valid delta velocity can be calculated for use in propagating the recovered state, the IMU\_REANCHOR flag is used in conjunction with the IMU\_SFC flag in the vector selection subfunction.

Before checking the next IMU or exiting the loop, IMU\_BYPASS\_PREV<sub>i</sub> is set equal to IMU\_BYPASS<sub>i</sub> and IMU\_SFC\_PREV<sub>i</sub> is set equal to IMU\_SFC<sub>i</sub>. The necessary equations are:

```
DO FOR i = 1 to 3
  If IMU_BYPASS_PREVi > IMU_BYPASSi then
    IMU_BYPASS_REMOVEDi = ON
  If (IMU_SFC_PREVi < IMU_SFCi) and IMU_BYPASS_REMOVEDi = ON then
    IMU_REANCHORi = ON
```

$$\begin{aligned} \text{IMU\_BYPASS\_REMOVED}_i &= \text{OFF} \\ \text{IMU\_BYPASS\_PREV}_i &= \text{IMU\_BYPASS}_i \\ \text{IMU\_SFC\_PREV}_i &= \text{IMU\_SFC}_i \end{aligned}$$

7. A flag, RNP\_TIME\_UL, shall be tested to determine if the RNP Matrix Time parameters have been uplinked and the RNP Matrix data should be recomputed. If RNP\_TIME\_UL has been set ON, the RNP MAT COMP function shall be called to recompute the RNP Matrix (M\_M50TOEF\_AT\_EPOCH), its time tag (T\_EPOCH), and the EARTH\_POLE vector. The RNP\_TIME\_UL flag shall then be set OFF to preclude any further RNP calculations unless there is another uplink of the RNP time parameters. The required steps are:

IF RNP\_TIME\_UL = ON, then:  
CALL: RNP\_MAT\_COMP  
RNP\_TIME\_UL = OFF

8. A flag, DO\_DELTA\_UPDATE\_UP, shall be tested to determine if an uplink of data for a delta-state update has occurred. If DO\_DELTA\_UPDATE\_UP is ON (indicating an uplink has been received), the input parameters for the delta-state update subfunction (in Section 4.3.1.4.2) will be defined, the flag DO\_DELTA\_UPDATE set to indicate that a delta state update is to be performed and the flag DO\_DELTA\_UPDATE\_UP set to OFF, thus precluding the performance of multiple updates employing the same data. The necessary equations are:

IF DO\_DELTA\_UPDATE\_UP = ON, then:

$$\begin{aligned} \bar{D}R_{RW} &= \bar{D}R_{RW\_UP} \\ \bar{D}V_{RW} &= \bar{D}V_{RW\_UP} \\ DO\_DELTA\_UPDATE &= \text{ON} \\ DO\_DELTA\_UPDATE\_UP &= \text{OFF} \end{aligned}$$

9. A flag, STATE\_VECTOR\_UPDATE, shall be tested to determine if the state vector prediction task (executed as a result of either a whole vector uplink or a crew-initiated delta time tag update) has completed execution and has made available a replacement M50 state vector for use. If STATE\_VECTOR\_UPDATE has been set to ON, the three filter vectors shall be reinitialized to the replacement values and the flag indicating that the navigation states have been reset with a ground uplink state (UPLINK\_NAV\_RESET) is set to ON.

The value of STATE\_VECTOR\_UPDATE shall not be altered, since it will be tested again in step (11) below. The necessary equations are:

IF STATE\_VECTOR\_UPDATE = ON then;

$$\begin{aligned} \bar{R}_{FILT\_ONE} &= \bar{R}_{TO\_NAV} \\ \bar{R}_{FILT\_TWO} &= \bar{R}_{TO\_NAV} \\ \bar{R}_{FILT\_THREE} &= \bar{R}_{TO\_NAV} \\ \bar{V}_{FILT\_ONE} &= \bar{V}_{TO\_NAV} \end{aligned}$$



$\bar{V}_{\text{FILT\_TWO}} = \bar{V}_{\text{TO\_NAV}}$   
 $\bar{V}_{\text{FILT\_THREE}} = \bar{V}_{\text{TO\_NAV}}$   
 $T_{\text{LAST\_FILT}} = T_{\text{TO\_NAV}}$   
 $\text{UPLINK\_NAV\_RESET} = \text{ON}$

In addition, if the flag STATE\_VECTOR\_UPDATE is ON, and the flag ZERO\_DELTA\_T\_UPDATE is OFF, indicating that the source of the whole state vector update is not the result of a zero delta time entry on the Horizontal Situation Display (HSD), the time of the last GPS update to navigation (T\_GPS\_LAST\_UPDATE) shall be set equal to the previous filter time (T\_LAST\_FILT). This will cause the GPS QA2 (GPS minus navigation) limits to be reset near their minimum values. The flag ZERO\_DELTA\_T\_UPDATE shall then be set to OFF. The necessary steps are:

```
IF (ZERO_DELTA_T_UPDATE = OFF) THEN
    T_GPS_LAST_UPDATE = T_LAST_FILT
ENDIF

ZERO_DELTA_T_UPDATE = OFF
```

Note that the navigation states are reset to the ground uplink state after the GPS resetting of the navigation state logic has been executed. The ground uplink of the Orbiter state takes precedence over resetting the baseline navigation state with the selected GPS state.

10. The three state vectors will be propagated as described in Section 4.3.1.5. After propagation, the three position vectors shall be reduced to a single vector for use by either the state update computations or by the covariance propagation subfunction. The necessary equations are:

```
CALL: VECTOR_SELECTION

INLIST:  $\bar{R}_{\text{FILT\_ONE}}$ ,  $\bar{R}_{\text{FILT\_TWO}}$ ,  $\bar{R}_{\text{FILT\_THREE}}$ 

OUTLIST:  $\bar{R}_{\text{FILT}}$ 
```

where vector selection is performed as described in Section 4.2.5.

11. If the flag STATE\_VECTOR\_UPDATE has been set ON, (12) shall be bypassed, STATE\_VECTOR\_UPDATE shall be set to OFF to preclude repeated usage of the same data, DO\_DELTA\_T\_UPDATE shall be set to OFF to allow the display value of DELTA\_T to be zeroed, the three velocity vectors shall be reduced to a single vector as described in Section 4.2.5 and the covariance matrix reinitialized with the appropriate diagonal ( $\bar{\text{SIG\_DIAG\_UPDATE\_M50}}$ ) and off-diagonal (CORR\_COEFF\_UPDATE\_M50) elements obtained from premission-loaded values. These elements are premission loaded in the UVW coordinates at the time of their incorporation into the covariance matrix. Detailed requirements for this covariance matrix reinitialization are described in Section 4.2.9.

The necessary equations are:

$\text{DO\_DELTA\_T\_UPDATE} = \text{OFF}$

```
STATE_VECTOR_UPDATE = OFF  
CALL: VECTOR_SELECTION  
INLIST:  $\bar{V}$ _FILT_ONE,  $\bar{V}$ _FILT_TWO,  $\bar{V}$ _FILT_THREE  
OUTLIST:  $\bar{V}$ _FILT  
CALL: COVINIT  
INLIST:  $\bar{S}$ IG_DIAG_UPDATE_M50,  
CORR_COEFF_UPDATE_M50,  
 $\bar{R}$ _FILT,  $\bar{V}$ _FILT  
OUTLIST: E
```

12. If no whole state vector update has been performed, the flag DO\_DELTA\_UPDATE shall be tested to determine if a delta state update has been requested, either by keyboard entry or via a command uplink. If the flag DO\_DELTA\_UPDATE is ON, and at least one of the delta state update vectors ( $\bar{D}\bar{R}$ \_RW or  $\bar{D}\bar{V}$ \_RW) supplied for the delta state update is non-zero, the time of the last GPS update to navigation (T\_GPS\_LAST\_UPDATE) shall be set equal to the current filter time, reducing the GPS QA2 (GPS minus navigation) limits to their minimum values. Finally, the navigation state vectors shall be updated and the covariance matrix reinitialized as described in Section 4.3.1.4.2. The necessary steps are:

```
DELR = | $\bar{D}\bar{R}$ _RW|  
DELV = | $\bar{D}\bar{V}$ _RW|  
  
IF (DELR > 1.0E-08) OR (DELV > 1.0E-08) THEN  
    T_GPS_LAST_UPDATE = T_LAST_FILT  
ENDIF  
  
CALL: OPS_3_DELTA_UPDATE
```

If a delta state update was not requested, the covariance matrix propagation subfunction (COVEXTRAP\_PF) shall be called to propagate the covariance matrix as described in Section 4.3.1.6.

13. The entry sensor measurement selection subfunction will determine which measurements (drag altitude, TACAN range and bearing, BARO altitude) are to be presented to the filter for processing as described in Section 4.3.1.3.
14. The navigation reconfiguration subfunction will set up the proper state vectors and covariance matrix or TACAN site location data for use by the state and covariance matrix update task as described in Section 4.3.1.4.
15. The state and covariance measurement incorporation subfunction will update the state vectors and covariance matrix as described in Section 4.3.1.7. A counter, (DRAG\_MARK\_NUM, TACAN\_MARK\_NUM, or BARO\_MARK\_NUM), will be incremented for each measurement processed to indicate the mark number for post-mission analysis purposes.

16. The following parameters necessary for the user parameter propagation principal function will be reduced to single parameters as discussed in Section 4.2.5: the filter's position and velocity vector and the gravity vector.
17. The GPS receiver state processing principal function (Section 4.3.3) shall be executed.
18. The IMU\_REANCHOR flag described in step (6) shall be tested for each IMU. If IMU\_REANCHOR<sub>i</sub> is ON, the state vector associated with the upmoded IMU shall be set equal to the selected navigation state, and IMU\_REANCHOR<sub>i</sub> shall be set to OFF to indicate that the state vector has been reanchored.

If IMU\_REANCHOR<sub>1</sub> = ON, THEN:

$$\begin{aligned}\overline{\mathbf{R}}_{\text{FILT\_ONE}} &= \overline{\mathbf{R}}_{\text{FILT}} \\ \overline{\mathbf{V}}_{\text{FILT\_ONE}} &= \overline{\mathbf{V}}_{\text{FILT}} \\ \text{IMU\_REANCHOR}_1 &= \text{OFF}\end{aligned}$$

If IMU\_REANCHOR<sub>2</sub> = ON, THEN:

$$\begin{aligned}\overline{\mathbf{R}}_{\text{FILT\_TWO}} &= \overline{\mathbf{R}}_{\text{FILT}} \\ \overline{\mathbf{V}}_{\text{FILT\_TWO}} &= \overline{\mathbf{V}}_{\text{FILT}} \\ \text{IMU\_REANCHOR}_2 &= \text{OFF}\end{aligned}$$

If IMU\_REANCHOR<sub>3</sub> = ON, THEN:

$$\begin{aligned}\overline{\mathbf{R}}_{\text{FILT\_THREE}} &= \overline{\mathbf{R}}_{\text{FILT}} \\ \overline{\mathbf{V}}_{\text{FILT\_THREE}} &= \overline{\mathbf{V}}_{\text{FILT}} \\ \text{IMU\_REANCHOR}_3 &= \text{OFF}\end{aligned}$$

19. The position and velocity of either the selected baseline navigation state or the selected GPS state, and their associated time tag, gravity acceleration vector and the IMU velocity counts shall then be stored for use by the user parameter state propagator as described in Section 4.2.10. Parameters for use by the GPS reference state processing principal function shall also be stored.
20. Finally, the entry measurement processing statistics subfunction (Section 4.3.1.8) shall be performed.

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.1.1–1 and 4.3.1.1–2.

C. Processing Requirements. Entry control will be executed at a permission–determined rate when the entry navigation principal function is scheduled.

If simultaneous uplink and keyboard entry of a delta state update occurs the uplinked information will overwrite and take priority over the keyboard entries.

If both a delta state update is requested and a replacement M50 vector is received from the state vector prediction task, the replacement (M50) vector will be incorporated during the current cycle. The delta state update will be incorporated on the subsequent execution cycle.

The test to determine if an IMU bypass has been cleared and the IMU has been upmoded must be accomplished prior to navigation vector selection. Reanchoring the upmoded IMU's state to the selected navigation state must be performed after the selected position and velocity have been computed for the current nav cycle.

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D. Constraints. The attitude data SNAP statement implies the assignment of current values, to the variable names ALPHAIN and BETAIN which are assumed to be in units of degrees from the ATT PROC principal function.

E. Supplemental Information. A suggested implementation of entry control is illustrated by NAV\_ENTRY in Section 5.2.

The navigation copy of the GPS to navigation auto/inhibit command signal, GPS\_TO\_NAV\_RCVD, has the values of AUTO, indicating an OFF (or 0) command, and INHIBIT, indicating an ON (or 1) command. The navigation copy of the GPS to navigation force signal, GPS\_TO\_NAV\_FORCE\_RCVD, has the values of NO FORCE, indicating an OFF (or 0) command, and FORCE, indicating an ON (or 1) command. The composite signal, GPS\_TO\_NAV\_AIF, constructed from the navigation copy of the GPS to navigation auto/inhibit command signal, GPS\_TO\_NAV\_RCVD, and the navigation copy of the GPS to navigation force signal, GPS\_TO\_NAV\_FORCE\_RCVD, takes on the following values: AUTO, indicating a 0 value, INHIBIT indicating a 1 value and FORCE indicating a value of 2.

Table 4.3.1.1-1. Entry Control Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}_{\text{FILT\_ONE}}$	1,2,3,*	V	DP	—	ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}_{\text{FILT\_TWO}}$	1,2,3,*	V	DP	—	ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}_{\text{FILT\_THREE}}$	1,2,3,*	V	DP	—	ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}_{\text{FILT\_ONE}}$	1,2,3,*	V	S	—	ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}_{\text{FILT\_TWO}}$	1,2,3,*	V	S	—	ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	1,2,3,*	V	S	—	ft/sec	Filter rate
Time of the filter state vectors	$\bar{T}_{\text{LAST\_FILT}}$	Entry state propagation, *	F	DP	—	sec	Filter rate
Previous value of selected accumulated IMU velocity	$\bar{V}_{\text{LAST\_FILT}}$	Entry state propagation, *	V	S	—	ft/sec	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU 1	$\bar{G}_{\text{ONE\_OLD}}$	Entry state propagation	V	S	—	ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU 2	$\bar{G}_{\text{TWO\_OLD}}$	Entry state propagation	V	S	—	ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU 3	$\bar{G}_{\text{THREE\_OLD}}$	Entry state propagation	V	S	—	ft/sec <sup>2</sup>	Filter rate
Flag indicating (ON) that drag altitude data are to be processed	DO_DRAG_NAV	Entry measurement selection	D	—	OFF/ON	—	Filter rate

Table 4.3.1.1-1. Entry Control Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Flag indicating (ON) that TACAN data are to be processed	DO_TACAN_NAV	Entry measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that BARO data are to be processed	DO_BARO_NAV	Entry measurement selection	D	—	OFF/ON	—	Filter rate
Angle of attack	ALPHAIN	*	F	S		deg	Filter rate
Angle of sideslip	BETA IN	*	F	S		deg	Filter rate
Flag indicating (ON) that a delta state vector update shall be performed	DO_DELTA_UPDATE	*, delta state update	D	—	OFF/ON		Filter rate
Conversion factor from degrees to radians	RAD_PER_DEG	Constant	F	S	—	rad/deg	Filter rate
Flag indicating (ON) that a delta state date has been uplinked	DO_DELTA_UPDATE_UP	*	D	—	OFF/ON	—	Filter rate
Delta position vector uplinked	$\overline{DR}_{RW\_UP}$	*	V	S		ft	Filter rate
Delta velocity vector uplinked	$\overline{DV}_{RW\_UP}$	*	V	S		ft/sec	Filter rate
Flag indicating (ON) that a replacement M50 state vector prediction has been supplied by state vector prediction task	STATE_VECTOR_UPDATE	State vector prediction task, Entry control	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that new values for the RNP matrix time parameters have been uplinked	RNP_TIME_UL	*	D	—	OFF/ON	—	Filter rate
Replacement M50 position vector output by state vector prediction task	$\overline{R}_{TO\_NAV}$	State vector prediction task	V	DP		ft	Filter rate

Table 4.3.1.1-1. Entry Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Replacement M50 velocity vector output by state vector prediction task	$\bar{V}_{TO\_NAV}$	State vector prediction task	V	S		ft/sec	Filter rate
Time tag of replacement vector output by state vector prediction task	T_TO_NAV	State vector prediction task	S	DP		sec	Filter rate
Correlation coefficients to initialize covariance matrix for GPS update	$\bar{C}ORR\_COEFF\_GPS$	*	V(7)	S	--	--	Filter rate
GPS auto/inhibit/force flag	GPS_TO_GC_AIF	*	I	S	0 (AUTO) 1 (INHIBIT) 2 (FORCE)	--	Filter rate
GPS data good flags	GPS_DG <sub>1</sub> **	*	D	--	ON/OFF	--	Filter rate
Flag indicating (ON) selected GPS states are available for use	GPS_SV_SEL_AVAIL	*	D	--	ON/OFF	--	Filter rate
Flag indicating the GPS to Nav setting of auto or inhibit	GPS_TO_NAV_AI	*	D	--	OFF (AUTO) ON (INHIBIT)	--	Filter rate
Flag indicating (ON) the forcing of GPS states to Nav	GPS_TO_NAV_FORCE	*	D	--	ON (FORCE) OFF (NO FORCE)	--	Filter rate
Major mode code	MM_CODE	*	I	S		--	Filter rate
Selected GPS Position vector	$\bar{R}_{GPS\_SEL}$	*	V	DP		ft	Filter rate
Square root of diagonal elements for GPS update covariance matrix	$\bar{S}IG\_DIAG\_GPS$	*	V(6)	S	--	ft, ft/sec	Filter rate
Time tag of current Orbiter navigation state(s)	T_CURRENT_FILT	*	F	DP		sec	Filter rate
The minimum amount of time between consecutive GPS updates in low rate nav	T_GPS_CYCLE	I-Load	F	S		sec	Filter rate

Table 4.3.1.1-1. Entry Control Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Time of most recent navigation state update with the selected GPS state	T_GPS_LAST_UPDATE	Entry nav control	F	DP		sec	Filter rate
Minutes portion of the time since the last GPS state vector selection by the GPS state vector function	DT_GPS_OFF_MIN	*	F	S		min	Filter rate
Maximum allowable time since last update of selected GPS state with GPS receiver data	GPS_SEL_AGE_MAX	I-Load	F	S		min	Filter rate
Altitude at which automatic GPS updates to navigation switch from low to high rate	GPS_ALT_FOR_HIGH_RATE_NAV	I-Load	F	S	--	ft	Filter rate
Altitude limit below which automatic GPS updates to nav are not allowed	GPS_UPDATE_ALT_FLOOR	I-Load	F	S	--	ft	Filter rate
The minimum amount of time between consecutive GPS updates in high rate nav	T_GPS_CYCLE_FOR_HIGH_RATE_NAV	I-Load	F	S	--	sec	Filter rate
Current selected IMU velocity counts snapped by navigation	$\bar{V}$ _CURRENT_FILT	Entry external data snap, *	V	DP		ft/sec	Filter rate
Selected GPS Velocity vector	$\bar{V}$ _GPS_SEL	*	V	DP		ft/sec	Filter rate
GPS Selected state time tag	T_GPS_SEL	*	F	DP		sec	Filter rate
Gravity acceleration vector corresponding to the selected GPS state	$\bar{G}$ _GPS_SEL	*	V	S		ft/sec <sup>2</sup>	Filter rate
Crew command (ON) to override software metering of the user parameter reset state	CREW_METERING_OVERRIDE(I)	*	D	--	ON/OFF	--	Filter rate



Table 4.3.1.1-1. Entry Control Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	ALT_WHEELS_NAV	Entry external data snap	F	S	–	ft	Filter rate
Flag indicating (ON) that the selected GPS residual ratio exceeded its allowed limit	GPS_RATIO_FLAG	*	D	–	ON/OFF	–	Filter rate
Flag indicating (ON) that a zero delta time update has occurred	ZERO_DELTA_T_UPDATE	*	D	–	ON/OFF	–	Filter rate
IMU Selection Filter Command	IMU_SFC	*	BSU	S		–	Filter rate
IMU bypass indicator corresponding to the J <sup>th</sup> IMU	IMU_BYPASS <sub>J</sub> ***	*	D	–	ON/OFF	–	Filter rate
1. Entry state propagation 2. Delta state update 3. Entry nav state and covariance measurement incorporation * See principal function input list in Table 4.3.1.9–1. **I = 1, 2, 3, (1 to GPS_SW_CAP) *** J = 1,2,3 (IMU ID)							

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Vehicle position vector after all navigation updates reserved for reset of guidance integrator position vector	$\bar{R}_{RESET}$	*	V	DP		ft	Filter rate
Vehicle velocity vector after all navigation updates reserved for reset of guidance integrator velocity vector	$\bar{V}_{RESET}$	*	V	S		ft/sec	Filter rate
Time associated with reserved reset	T_RESET	*, State vector prediction task	F	DP		sec	Filter rate
Copy of $V_{LAST\_FILT}$ accumulated velocity counts reserved for reset of guidance integrator	$\bar{V}_{IMU\_RESET}$	*	V	DP		ft/sec	Filter rate
Switch indicating (ON) that current measurement processing is complete	FILT_UPDATE	*	D	—	OFF/ON	—	Filter rate
Updated vehicle position vector associated with current covariance matrix	$\bar{R}_{COV\_LAST}$	Entry covariance propagation	V	DP		ft	Filter rate
Angle of attack	ALPHA	State prop	F	S	—	rad	Filter rate
Angle of sideslip	BETA	State prop	F	S	—	rad	Filter rate
Counter indicating the particular drag measurement processed by the filter	DRAG_MARK_NUM	*	I	S		—	Filter rate
Flag indicating (ON) that a delta state update is to be performed	DO_DELTA_UPDATE	Entry control	D	—	OFF/ON	—	Filter rate

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector	$\bar{R}_{FILT}$	*, delta state update, entry covariance propagation, entry sensor selection, Tacan range measurement, Tacan bearing measurement	V	DP		ft	Filter rate
Counter indicating the particular TACAN measurement processed by the filter	TACAN_MARK_NUM	*	I	S			Filter rate
Gravitational acceleration vector reserved for reset of guidance integrator gravity vector	$\bar{G}_{RESET}$	*	V	S		ft/sec <sup>2</sup>	Filter rate
Flag indicating (ON) that BARO data are to be processed	DO_BARO_NAV	*	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that DRAG data are to be processed	DO_DRAG_NAV	*	D	—	OFF/ON		Filter rate
Flag indicating (ON) that TACAN data are to be processed	DO_TACAN_NAV	*	D	—	OFF/ON		Filter rate
Counter indicating the particular BARO altitude measurement processed by the filter	BARO_MARK_NUM	*	I	S		—	Filter rate
Flag indicating (ON) that a time-tag update is to be performed	DO_DELTA_T_UPDATE	*	D	—	OFF/ON	—	Filter rate
Ground-computed position deviations to update onboard state vector	$\bar{DR}_{RW}$	Delta state update	V	S		ft	Filter rate
Ground-computed velocity deviations to update onboard state vector	$\bar{DV}_{RW}$	Delta state	V	S		ft/sec	Filter rate

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Flag indicating (OFF) that an uplatched delta state update has been accepted	DO_DELTA_UPDATE_UP	Entry control	D	—	OFF/ON	—	Filter rate
Flag indicating (OFF) that a replacement M50 state vector is being incorporated	STATE_VECTOR_UPDATE	Entry control	D	—	OFF/ON	—	Filter rate
Filter covariance matrix	E	Entry covariance propagation	M (6X6)	DP	vary		Filter rate
Flag indicating if GPS auto/inhibit/force executed	GPS_AIF_EXEC	*	D	--	(0) BLANK (1) DOWN_ARROW	--	Filter rate
GPS auto/inhibit/force flag	GPS_AIF_RCVD	*	CHAR	--	(0) AUTO, (1) INHIBIT, (2) FORCE	--	Filter rate
Flag indicating a force of nav filter state reset with selected GPS state	GPS_TO_NAV_FORCE_RCVD	*	D	--	ON/OFF	--	Filter rate
GPS to navigation auto/inhibit/force flag, which contains the GPS to nav command and GPS to navigation force command settings	GPS_TO_NAV_AIF	*	I	S	(0) AUTO, (1) INHIBIT, (2) FORCE	--	Filter rate
Flag indicating the GPS to Nav setting of auto or inhibit	GPS_TO_NAV_RCVD	*	D	--	(OFF) AUTO (ON) INHIBIT	--	Filter rate
Major Mode	NAV_MM_CODE	*	I	S		--	Filter rate
Flag indicating nav filter states have been reset with the selected GPS state	NAV_RESET	UPP state reset	D	--	ON/OFF	--	Filter rate
Current selected Shuttle navigation position vector	$\bar{R}_{FILT}$	*	V	DP		ft	Filter rate
GPS restart position vector for initialization	$\bar{R}_{GPS\_INIT}$	*	V	DP		ft	Filter rate

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
MTU or clock time when IMU is read	T_CURRENT_FILT	*	F	DP		sec	Filter rate
GPS restart state time tag for initialization	T_GPS_INIT	*	F	DP		sec	Filter rate
Time of most recent reset of navigation states to the selected GPS state	T_GPS_LAST_UPDATE	*	F	DP		sec	Filter rate
Current selected Shuttle navigation velocity vector	$\bar{V}$ _FILT	*	V	S		ft/sec	Filter rate
Current selected IMU accumulated velocity counts from IMU RM	$\bar{V}$ _CURRENT_FILT	*	V	DP		ft/sec	Filter rate
Accumulated IMU velocity counts corresponding to GPS restart state for reinitialization	$\bar{V}$ _IMU_GPS_INIT	*	V	DP		ft/sec	Filter rate
GPS restart velocity vector for initialization	$\bar{V}$ _GPS_INIT	*	V	S		ft/sec	Filter rate
Gravity acceleration vector for propagation of reference state for GPS receiver I initialization	$\bar{G}$ _GPS_INIT	*	V	S		ft/sec <sup>2</sup>	Filter rate
Selected GPS position vector reserved for reset of GPS UPP display computations position vector	$\bar{R}$ _GPS_UPP	*	V	DP		ft	Filter rate
Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector	$\bar{V}$ _GPS_UPP	*	V	S		ft/sec	Filter rate
Time of selected GPS state reserved for reset of GPS UPP display computations position vector	T_GPS_UPP	*	F	DP		sec	Filter rate

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector	$\bar{G}_{GPS\_UPP}$	*	V	S		ft/sec <sup>2</sup>	Filter rate
IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity	$\bar{V}_{IMU\_GPS\_UPP}$	*	V	DP		ft/sec	Filter rate
Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset	GPS_UPP_UPDATE	*	D	—	ON/OFF	—	Filter rate
Square root of the trace of the position elements (E(1,1), E(2,2), E(3,3)) of the navigation Kalman filter covariance matrix for downlist	COV_POS_SIG	*	F	S		ft	Filter rate
Square root of the trace of the velocity elements (E(4,4), E(5,5), E(6,6)) of the navigation Kalman filter covariance matrix for downlist	COV_VEL_SIG	*	F	S		ft/sec	Filter rate
Flag indicating (ON) to GPS Reference State Processing principal function that a valid reference state exists for the GPS receivers	GPS_REF_INIT_VALID	*	D	—	ON/OFF	—	Filter rate
Flag indicating (ON) that the user parameter reset state is being metered	METER_FLAG	*	D		ON/OFF		Filter rate

Table 4.3.1.1-2. Entry Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Metering gain (the maximum of either the position or velocity metering gains) applied to scale the M50 position and velocity changes to the user parameter reset state on the current cycle so that metering constraints are not violated	METER_SF	*	F	S		—	Filter rate
* See principal function output list in Table 4.3.1.9-2.							

#### 4.3.1.2 Entry External Data Snap

The purpose of this subfunction during the entry navigation phase is to collect and store NAVAID data (TACAN, BARO altimeter), attitude data, user parameter data, and GPS LRU navigation data. TACAN and BARO data are subsequently used in the navigation state and Kalman filter measurement incorporation subfunction. Attitude parameters are subsequently used for calculating drag acceleration. GPS data are used by the GPS receiver state processing principal function. These data sets contain the latest values of the required sensor, attitude, and GPS parameters at the time of collection.

##### 4.3.1.2.1 External Sensor Data Snap

The sensor and attitude data snap task shall collect and store sensor data from the TACAN and Baro altimeter NAVAIDS and shall provide the capability to obtain the current attitude quaternion, along with the associated GMT time tags of this data. The purpose of the sensor and attitude data snap is to properly save the data sets used in the navigation Kalman filter processing by the appropriate navigation subfunction. The actual data will continue to be refreshed by hardware sensor readings, sensor SOP processing, and selection filtering.

Included in the sensor data intended for filter processing are the measurements, their data good flags (which indicate the validity of the measurement), and the measurements' time tags. Time tags of the data collected from TACAN and BARO are adjusted according to pre-mission determined biases.

A. Detailed Requirements. During the entry phase, the magnetic bearing of the TACAN station from the Shuttle and the slant range distance from the TACAN ground beacon, together with the data-good flags, will be collected and stored. The associated time tag will be collected, adjusted by a premission-loaded time bias, and stored. The current TACAN line replacement unit (LRU) number also will be collected and stored. The following equations define the parameters necessary to accomplish the above requirements:

$$\text{SNAP TACAN (Q\_TAC\_BRG, Q\_TAC\_R, TAC\_RNG\_DATA\_GOOD, TAC\_BRG\_DATA\_GOOD, T\_TACAN, SEL\_LRU\_ID)}$$
$$T\_TACAN = T\_TACAN - \text{TIME\_BIAS\_TACAN}$$

Barometric altimeter data is also collected and stored. This includes the Shuttle's barometric altitude, a flag indicating if the Shuttle is in the MACH jump region, its data-good flag and the associated time tag, adjusted by a premission-loaded time bias. The following equations define the parameters necessary to accomplish the above requirements:

$$\text{SNAP BARO ALTIMETER (Q\_BARO, MACH\_JUMP, BARO\_DATA\_GOOD, T\_BARO)}$$
$$T\_BARO = T\_BARO - \text{TIME\_BIAS\_BARO}$$

In addition, the angle of attack, sideslip angle, and the M50-to-body quaternion will be collected and stored. The following equation defines the parameters necessary to accomplish this requirement:

$$\text{SNAP ATTITUDE (ALPHAIN, BETAIN, Q\_M50\_BODY)}$$

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.1.2-1 and 4.3.1.2-2, respectively. The output time tag is assumed to have been associated with the sensor's measurement (the time FCOS commands the read, adjusted by applying a time bias correction).

C. Processing Requirements. It is required that the TACAN sensor data (measurements, ID's, validity flags, and time tags) be made available for the collection and storage processes. The collection rates (not



necessarily sensor interrogations) are indicated by the entry navigation sequencers. However, these rates assume that the available data are fresh. This implies that SOP's processing and selection filtering must be at a rate equal to or greater than the collection rate. This is also true for BARO altimeter data.

D. Constraints. The data collections should occur after a complete current set if available and just prior to use in navigation in order to supply current data.

E. Supplementary Information. A suggested implementation of the entry external sensor data snap subfunction, in the detailed flow chart NAV\_ENTRY, can be found in Section 5.2. The snap statement above implies the assignment of current values to the variable names shown in parentheses.

#### 4.3.1.2.2 GPS Data Snap

The GPS data snap task collects and stores homogeneous GPS receiver navigation data from the GPS SOP. The purpose of the GPS data snap is to properly save the data for use by the GPS receiver state vector processing principal function while the actual GPS data will continue to be refreshed by GPS LRU data readings and GPS SOP processing.

The homogeneous set of GPS receiver data shall be collected from the GPS SOP and stored. The data shall have the following characteristics: (1) it is the most current receiver navigation data from the GPS SOP that has been indicated by the receivers as valid (receiver data good is set on); (2) it is bracketed by IMU velocity counts which will be used in propagating these states to the current navigation filter time in the GPS Receiver State Processing principal function; (3) the velocity counts collected from the GPS SOP are from the IMU RM execution just prior to and closest to the GPS state time tag. The use of IMU accumulated velocity counts as close to the receiver state time tag minimizes the velocity transients introduced in the propagation of the GPS receiver states to current navigation filter time by providing the most accurate sensed velocity information across the GPS state propagation interval.

A. Detailed Requirements. A time homogeneous set of GPS data shall be collected from the GPS SOP and stored. Each set includes data from up to three receivers: GPS receiver state estimates, data good flags, figure-of-merit. Also included are the IMU velocity counts, associated with each receiver.

The data snaps are as follows:

SNAP GPS\_DATA (  $\bar{R}$ \_GPS\_ECEF,  $\bar{V}$ \_GPS\_ECEF, T\_GPS, GPS\_DG,  
GPS\_FAIL\_FOM, FOM,  
 $\bar{V}$ \_LAST\_GPS, T\_LAST\_GPS )

These GPS variables (vector, scalar arrays, character strings and discretets) correspond to data from three GPS receivers, which represents the maximum number of receivers for which the software is designed. The first component of each array will be a time homogeneous set of data for GPS receiver 1, and likewise, array components 2 and 3 will be a consistent set of data for GPS receivers 2 and 3 respectively. IMU velocity counts also have the same correspondence.

The IMU variables provided by the GPS SOP correspond to the values of the IMU counts closest to and just prior to each GPS state estimate time tag. They have been properly assigned to each receiver.

The snap statement implies the assignment of current GPS SOP data to the variables shown in parentheses. Time homogeneous data for each GPS receiver must be provided to the appropriate subfunctions. The time homogeneous data from one receiver may have a different time tag than the time homogeneous data from another receiver.

Note that data shall be snapped for up to three receivers regardless of the number of receivers actually installed on the vehicle.

- B. Interface Requirements. The input and output parameters are listed in Tables 4.3.1.2-1 and 4.3.1.2-2 respectively. The parameter cross-reference table between the GPS SOP names and their navigation variable copies is shown in Section 4.3.1.9.
- C. Processing Requirements. It is required that the GPS data be made available by the GPS SOP for the collection and storage process. The collection rates are indicated by the entry navigation sequencer rates. These rates assume that the available GPS data are the most recent GPS data available.
- D. Constraints. The GPS data collection should occur as close to the entry IMU data snap as possible.
- E. Suggested Implementation. A suggested implementation of the entry GPS data snap subfunction, in the detailed flow chart NAV\_ENTRY, can be found in Section 5.2. The snap statement implies the assignment of current values to the variable names shown in parentheses.

#### **4.3.1.2.3 User Parameter Data Snap**

The user parameter data snap task stores the vehicle altitude above the runway, computed by the user parameter processing functions, for use by the navigation user parameter reset metering function.

The purpose of the altitude data snap is to provide consistent altitude data for use throughout the user parameter reset metering calculations.

The data snap is as follows:

```
SNAP UPP_DATA(ALT_WHEELS_NAV)
```

The snap statement implies the assignment of the current data from the user parameter processing functions to the variable shown in parentheses.

- B. Interface Requirements. The input and output parameters are listed in Tables 4.3.1.2-1 and 4.3.1.2-2 respectively. The parameter cross-reference table between the user parameter processing name and the navigation variable is shown in Table 4.3.1.9.
- C. Processing Requirements. It is required that the vehicle altitude data be made available by the user parameter processing functions for the collection and storage process. The collection rates are indicated by the entry navigation sequencer rates. These rates assume that the available data are the most recent available.
- D. Constraints. The altitude data collection should occur close to the other entry data snaps as possible.
- E. Suggested Implementation. A suggested implementation of the entry altitude data snap subfunction, in the detailed flow chart NAV\_ENTRY, can be found in Section 5.2. The snap statement implies the assignment of current values to the variable name shown in parentheses.

Table 4.3.1.2-1. Entry External Data Snap Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
TACAN bearing sensor measurement	Q_TAC_BRG	*	F	DP		rad	Filter rate
TACAN range sensor measurement	Q_TAC_R	*	F	DP		ft	Filter rate
BARO altimeter sensor measurement	Q_BARO	*	F	DP		ft	Filter rate
Time at which TACAN was read	T_TACAN	*	F	DP		sec	Filter rate
Pad loaded bias used to correct TACAN time tag	TIME_BIAS_TACAN	K-load	F	DP		sec	Filter rate
Integer indicating which TACAN LRU (1, 2, or 3) is selected by RM for use by NAV filter for TACAN data processing	SEL_LRU_ID	*	I	S	1,2,3	—	Filter rate
Current range data-good flag reserved for measurement processing	TAC_RNG_DATA_GOOD	*	D		OFF/ON	—	Filter rate
Current bearing data-good flag reserved for measurement processing	TAC_BRG_DATA_GOOD	*	D		OFF/ON	—	Filter rate
Angle of attack	ALPHAIN	*	F	DP		rad	Filter rate
Sideslip angle	BETA_IN	*	F	DP		rad	Filter rate
M50-to-body coordinates quaternion	Q_M50_BODY	*	V(4)	DP			Filter rate
Flag indicating (ON) that the Shuttle is in the MACH jump region	MACH_JUMP	*	D		OFF/ON	—	Filter rate
Current BARO altimeter data-good flag reserved for measurement processing	BARO_DATA_	*	D		OFF/ON	—	Filter rate
Time at which BARO altimeter was read	T_BARO	*	F	DP		sec	Filter rate

Table 4.3.1.2-1. Entry External Data Snap Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Pad loaded bias used to correct BARO altimeter time tag	TIME_BIAS_BARO	K-load	F	DP		sec	Filter rate
Figure of merits for each GPS receiver	FOM <sub>I</sub> **	*	I	--			Filter rate
GPS data good flags	GPS_DG <sub>I</sub> **	*	D	--	ON/OFF	--	Filter rate
Flags indicating the FOM failure status for each GPS receiver	GPS_FAIL_FOM <sub>I</sub> **	*	D	--	ON/OFF	--	Filter rate
GPS receiver estimate of shuttle ECEF position	$\bar{R}$ _GPS_ECEF <sub>I</sub> **	*	V	DP		ft	Filter rate
Time associated with the current GPS receiver state estimates in GMT	T_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
Time of the IMU velocity counts nearest in time and prior to each GPS receiver state	T_LAST_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
GPS receiver estimate of shuttle ECEF velocity	$\bar{V}$ _GPS_ECEF <sub>I</sub> **	*	V	S		ft/sec	Filter rate
Accumulated velocity counts nearest in time and prior to each GPS receiver state	$\bar{V}$ _LAST_GPS <sub>I</sub> **	*	V	DP		ft/sec	Filter rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	ALT_WHEELS_NAV	*	F	S		ft	Filter rate
* See principal function input list in Table 4.3.1.9-1.							
** I = 1 to 3 (I to GPS_SW_CAP)							

Table 4.3.1.2-2. Entry External Data Snap Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN bearing sensor measurement	Q_TAC_BRG	Entry navigation TACAN brg meas incorp,*	F	DP		rad	Filter rate
TACAN range sensor measurement	Q_TAC_R	Entry navigation TACAN range meas incorp,*	F	DP		ft	Filter rate
BARO altimeter sensor measurement	Q_BARO	Entry navigation BARO meas incorp,*	F	DP		ft	Filter rate
Time at which TACAN was read	T_TACAN	Entry navigation TACAN range meas incorp, Entry navigation TACAN brg meas incorp,*	F	DP		sec	Filter rate
Integer indicating which TACAN LRU (1, 2, or 3) is selected by RM for use by navigation filter for TACAN data processing	SEL_LRU_ID	Entry navigation measurement reconfiguration,*	I	S	1,2,3	—	Filter rate
Current bearing data-good flag reserved for measurement processing	TAC_BRG_DATA_GOOD	Entry navigation TACAN bearing measurement incorp,*	D	—	OFF/ON	—	Filter rate
Current range data-good flag reserved for measurement processing	TAC_RNG_DATA_GOOD	Entry navigation TACAN range measurement incorp,*	D	—	OFF/ON	—	Filter rate
Angle of attack	ALPHAIN	Entry control	F	S		deg	Filter rate
Sideslip angle	BETA_IN	Entry control	F	S		deg	Filter rate
M50-to-body coordinates quaternion	Q_M50_BODY	Entry navigation drag measurement incorp	V(4)	DP		—	Filter rate
Time at which BARO altimeter was read	T_BARO	Entry navigation BARO meas incorp,*	F	DP		sec	Filter rate

Table 4.3.1.2-2. Entry External Data Snap Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) that the Shuttle is in the MACH jump region	MACH_JUMP	Entry measurement selection	D	—	OFF/ON	—	Filter rate
Current BARO altimeter data—good flag reserved for measurement processing	BARO_DATA_GOOD	Entry navigation BARO measurement incorp,*	D		OFF/ON	—	Filter rate
Figure of merits for each GPS receiver	FOM <sub>I</sub> **	*	I	--			Filter rate
GPS data good flags	GPS_DG <sub>I</sub> **	*	D	--	ON/OFF	--	Filter rate
Flags indicating the FOM failure status for each GPS receiver	GPS_FAIL_FOM <sub>I</sub> **	*	D	--	ON/OFF	--	Filter rate
GPS receiver estimate of shuttle ECEF position	$\bar{R}$ _GPS_ECEF <sub>I</sub> **	*	V	DP		ft	Filter rate
Time associated with the current GPS receiver state estimates in GMT	T_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
Time of the IMU velocity counts nearest in time and prior to each GPS receiver state	T_LAST_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
GPS receiver estimate of shuttle ECEF velocity	$\bar{V}$ _GPS_ECEF <sub>I</sub> **	*	V	S		ft/sec	Filter rate
Accumulated velocity counts nearest in time and prior to each GPS receiver state	$\bar{V}$ _LAST_GPS <sub>I</sub> **	*	V	DP		ft/sec	Filter rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	ALT_WHEELS_NAV	UPP state reset, Entry control	F	S		ft	Filter rate

\* See principal function output list in Table 4.3.1.9–2.  
\*\* I = 1 to 3 (I to GPS\_SW\_CAP)

### 4.3.1.3 Sensor Measurement Selection

A capability, designated as the entry sensor measurement selection subfunction, is required to determine whether sensor measurement data will be presented to the state and covariance measurement incorporation subfunction (Section 4.3.1.7) when the entry navigation principal function is active. Selection of sensor measurement data will also mean that knowledge of this data selection will be provided to the measurement reconfiguration subfunction (Section 4.3.1.4.1) to cause proper initialization of TACAN site data.

A. Detailed Requirements. The requirements for this subfunction are given as a set of necessary sensor selection capabilities. Only TACAN, BARO, and DRAG altitude measurement data will be considered for selection while the entry navigation principal function is active. The following capabilities will be provided.

- (1) There will be both manual (crew) and automatic control of sensor measurement selection.
- (2) The crew will be able to force or inhibit each measurement data type, or allow automatic selection.
- (3) For each measurement type, manual control (force or inhibit) overrides automatic selection. If a crewman forces valid TACAN data then these data will be presented to the state and covariance measurement incorporation subfunction. If a crewman inhibits valid TACAN or barometric altimeter data then these data will be processed for statistical display purposes only. The force or inhibit of sensor measurement data stays in effect across major mode transitions and is removed by reverting to automatic selection.
- (4) The forcing of a sensor measurement data type will override the residual edit of that data type if it is selected for processing.
- (5) If barometric altimeter data are indicated valid and are forced, then BARO data will be selected for processing provided the Shuttle is not in the MACH jump region (discontinuity region). If barometric altimeter data are indicated as valid and the automatic selection mode is employed, then BARO data will be selected for state update purposes provided the Shuttle is not in the MACH jump region and the magnitude of the orbiter relative velocity does not exceed a landing site dependent maximum and the orbiter is above an altitude cutoff. BARO data will be employed to provide a display of data processing statistics, if data are valid, the automatic selection mode is in effect, and the automatic selection criteria are not satisfied. Otherwise, the H\_INHIB flag is set to ON, to be used by the entry measurement processing statistics subfunction event lamp processing. If barometric altimeter data are not indicated as valid then BARO data will not be selected for processing.
- (6) DRAG data will be considered for processing if BARO data are not employed to update the state vectors, except DRAG data will not be considered if the Shuttle is in the MACH jump region. If barometric altimeter data are not indicated as valid, then DRAG data will be selected for processing provided DRAG data are forced; or, if the automatic selection mode for DRAG data is employed, the orbiter is above a premission-determined altitude, and the magnitude of sensed acceleration is larger than a premission-determined minimum value. If DRAG processing is in the automatic selection mode and the orbiter is above a premission-determined altitude and the magnitude of sensed acceleration is less than a premission-determined minimum value, then the H\_INHIB flag will be set to ON, to be used by the entry measurement processing statistics subfunction event lamp processing. If DRAG is below a premission-determined altitude and if either the magnitude of the orbiter's relative velocity is greater than a

landing site dependent maximum or the orbiter's altitude is below an altitude cutoff, then H\_HNHIB is set to ON, to be used by the entry measurement processing statistics event lamp processing.

- (7) If TACAN data selection is automatic, then TACAN data will be selected provided either TACAN range or bearing data are indicated valid.
- (8) MLS is not considered for processing in Entry navigation. MLS measurements are processed in Preland Navigation. However, to provide the same interface with the crew and the displays that exists in Preland navigation, the MLS auto/inhibit/force commands from the Horizontal Situation Display are snapped into a receiver MLS auto/inhibit/force feedback flag, MLS\_AIF\_RCVD. In addition, the parameter PROCESSING\_MLS is set to OFF to provide the processing MLS indicator to the Horizontal situation display and the MLS edit override (MLS\_EDIT\_OVERRIDE) and MLS status parameter (MLS\_STAT) are set to OFF. The latter three parameters do not change during execution of entry navigation and can be initialized appropriately so that they are not set during each execution of Entry Sensor Select. The feedback flag, MLS\_AIF\_RCVD, does have to be set every pass, however.
- (9) No sensor measurement data type shall be selected while the deorbit burn is in progress.

Also, this subfunction will initialize the measurement edit indicators to zero for subsequent use by the state and covariance measurement incorporation subfunction.

The result of selection of sensor measurements for processing of data or for computation of measurement statistics will be provided as indicated in Tables 4.3.1.3–3 and Figure 4.3.1.3–1. The terminology “process” means that the state and covariance measurement incorporation subfunction may incorporate the measurement data into the state estimation. The terminology “display” means that the state and covariance measurement incorporation subfunction may perform the processing of data for display of measurement statistics, but is prohibited from incorporating the data into the state estimation.

B. Interface Requirements. The input and output parameters for this subfunction are indicated in Tables 4.3.1.3–1 and 4.3.1.3–2.

C. Processing Requirements. This subfunction will be performed after sensor data have been saved and the covariance matrix propagated, and before the measurement reconfiguration subfunction (Section 4.3.1.4.1) is executed.

D. Constraints. None.

E. Supplemental Information. The foregoing requirements indicate the existence of a three–position software switch for each sensor measurement data type; that is, AUTO/INHIBIT/FORCE.

The minimum acceleration magnitude constraint upon processing of drag data is employed to prevent incorporation of “noise” from the accelerometers. The altitude constraint is employed because of modeling errors in atmospheric density and the vehicle's drag coefficient.

A candidate implementation of this subfunction is shown in ENTRY\_SENSOR\_SELECT code, Section 5.2. This code is executed by NAV\_ENTRY, the candidate implementation of the entry control subfunction.



Table 4.3.1.3-1. Entry Sensor Measurement Selection Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Drag auto/inhibit/force switch	DRAG_AIF	*	CHAR	S		—	Filter rate
Vehicle c.g. drag acceleration	ACC_DRAG	*	F	DP		ft/sec <sup>2</sup>	Filter rate
Minimum acceleration magnitude required for processing drag data in auto	ACC_DRAG_MIN	K-load	F	DP		ft/sec <sup>2</sup>	Filter rate
Current orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	Filter rate
Altitude below which the drag data are not processed in auto	H_DRAG_LOW	K-load	F	DP		ft	Filter rate
Flag indicating (ON) that major mode is deorbit maneuver execute	DEORBIT_BURN	*	D	—	OFF/ON	—	As needed
TACAN AUTO/INHIBIT/FORCE switch	TACAN_AIF	*	CHAR	S		—	Filter rate
Copy of current range data—good discrete reserved for measurement processing	TAC_RNG_DATA_GOOD	Entry external sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of current bearing data—good discrete reserved for measurement processing	TAC_BRG_DATA_GOOD	Entry external sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of current BARO data—good discrete reserved for measurement processing	BARO_DATA_GOOD	Entry external sensor data snap	D	—	OFF/ON	—	Filter rate
BARO AUTO/INHIBIT/FORCE switch	BARO_AIF	*	CHAR	—		—	Filter rate
Flag indicating (ON) that the Shuttle is in the MACH jump region	MACH_JUMP	*	D	—	OFF/ON	—	Filter rate

Table 4.3.1.3-1. Entry Sensor Measurement Selection Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Maximum relative velocity magnitude for BARO processing	RV_MAX	I-load	F	S		ft/sec	As needed
Magnitude of vehicle relative velocity	REL_VEL_MAG	*	F	S		ft/sec	As needed
Current orbiter altitude above runway altitude	ALT_WHEELS	*	F	S		ft	As needed
BARO processing cutoff altitude	ALT_BARO_CUTOFF	**	F	S		ft	Filter rate
MLS AUTO/INHIBIT/FORCE switch	MLS_AIF	*	CHAR				Filter rate
1. Entry control 2. Nav state propagation 3. Delta state update  * See principal function input list in Table 4.3.1.9-1. ** ALT_BARO_CUTOFF is initialized with I-load name ALT_BARO_CUTOFF_LOW.							

Table 4.3.1.3-2. Entry Sensor Measurement Selection Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) that drag altitude data are to be processed	DO_DRAG_NAV	Entry control,*	D	—	OFF/ON	—	Filter rate
Flag used (ON) to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	TACAN range data processing, TACAN azimuth data processing	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data are to be processed for statistical display only	TACAN_STAT	TACAN range data processing, TACAN azimuth data processing	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data are to be processed	DO_TACAN_NAV	Entry control,*	D	—	OFF/ON	—	Filter rate
General edit indicator for I-th measurement type, I = 1,7	SENSOR_EDIT(I)	Entry state and covariance measurement incorporation, entry measurement processing statistics	CHAR	S		—	Filter rate
Flag used (ON) to override drag residual edit test	DRAG_EDIT_OVERRIDE	Drag data processing	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that drag data are to be processed for statistical display only	DRAG_STAT	Drag data processing	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that BARO data are to be processed	DO_BARO_NAV	Entry control,*	D	—	OFF/ON	—	Filter rate
Flag used (ON) to override the BARO residual edit test	BARO_EDIT_OVERRIDE	Entry NAV BARO measurement incorp	D	—	OFF/ON	—	Filter rate

Table 4.3.1.3-2. Entry Sensor Measurement Selection Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) that BARO data are to be processed for statistical display purposes only	BARO_STAT	Entry NAV BARO measurement incorp	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that altitude data has been deselected based on an automatic selection constraint	H_INHIB	Entry meas processing statistics	D	—	OFF/ON	—	Filter rate
Flag indicating which MLS AIF command is in effect	MLS_AIF_RCVD	*	CHAR				Filter rate
Flag indicating (ON) that MLS data are being processed	PROCESSING_MLS	*	D	_	ON/OFF	_	Filter rate
* See principal function output list in Table 4.3.1.9-2.							

Table 4.3.1.3-3. TACAN Selection		
	Range and Bearing Data Bad	Range or Bearing Data Good
F O R C E	No Selection	Process
I N H I B I T	No Selection	Display
A U T O	No Selection	Process

<b>SYMBIOLOGY</b> NS = No Select P = Process (state update) P+ = P + EDIT Override D = Display Statistics (No State Update) H = H_INHIB is on ▴ = NAV EDIT Activity If Auto Process Criteria Are Satisfied			BARO DATA GOOD						BARO DATA BAD	
			MACH Jump = ON			MACH Jump = OFF				
			A u t o	I n h i b i t	F o r c e	Auto		I n h i b i t		F o r c e
						RV_MAG < RV_MAX AND ALTITUDE > ALT_BARO_ CUTOFF	RV_MAG > RV_MAX OR ALTITUDE < ALT_BARO_ CUTOFF			
DRAG	AUTO	Alt, Acc Criteria Not OK	N o S e l e c t H	D i s p l a y B A R O	N o S e l e c t H	P	D	D	P+	No Select H
		Alt, Acc Criteria OK				NS	NS	NS	NS	▴
	Inhibit	P				D	D	P+	Process Drag	
		NS				P	P	NS	▴	
	Force	P				D	D	P+	Display Drag	
		NS				D	D	NS	▴	
		P				D	D	P+	Process Drag	
		NS				P+	P+	NS	▴	

FIGURE 4.3.1.3-1 BARO/DRAG Selection

#### 4.3.1.4 Entry Navigation Reconfiguration

A capability will be provided for initialization or reinitialization of certain navigation variables when events occur that require configuration of the navigation software. These events include the initialization of TACAN station information when the TACAN ID changes, and ground updates to the onboard navigated state vector and associated covariance matrix reinitializations.

##### 4.3.1.4.1 Measurement Reconfiguration

A capability will be provided for initialization of the TACAN station information when TACAN processing begins or when the TACAN station ID has changed.

A. Detailed Requirements. The entry sensor measurement selection subfunction will provide a capability for determining when TACAN measurements are to be processed. The measurement reconfiguration subfunction will be executed when TACAN measurements are first available or when the TACAN station ID has changed. This subfunction shall obtain the following information from the site lookup principal function (Section 4.5.2) only if the selected TACAN channel is indicated valid.

TACAN station information:

$$TAC\_CHAN\_VALID = TACAN\_CHAN\_VALID\_SL_{SEL\_LRU\_ID}$$
$$\bar{R}\_TACAN\_EF = \bar{R}\_TACAN\_EF\_SL_{SEL\_LRU\_ID}$$
$$M\_EFTOTD\_TACAN = M\_EFTOTD\_TACAN\_SL_{SEL\_LRU\_ID}$$
$$ANGLE\_CORR\_TNTOMAG = ANGLE\_CORR\_TNTOMAG\_SL_{SEL\_LRU\_ID}$$
$$TACAN\_ID\_LAST = TACAN\_ID_{SEL\_LRT\_ID}$$

B. Interface Requirements. The input and output variables for this subfunction are described in Tables 4.3.1.4.1-1 and 4.3.1.4.1-2.

C. Processing Requirements. The measurement reconfiguration subfunction shall be performed prior to processing of TACAN measurements and after the execution of the entry sensor selection subfunction.

D. Constraints. It is required that the TACAN redundancy management and the entry navigation principal function execute in the following sequence:

TACAN RM

Entry navigation

The site lookup principal function TACAN-related output parameters may not be changed during the time interval starting with the initiation of TACAN RM selection filtering and ending with the completion of the entry navigation execution.

E. Supplementary Information. Although the detailed requirements show data being copied from the site lookup principal function into specific navigation variables; there is no reason why the site lookup data could not be used directly by the filter if the above constraint is realized. A suggested implementation of the measurement reconfiguration subfunction is illustrated by the flow chart NAV\_SENSOR\_INIT in Section 5.2.

Table 4.3.1.4.1-1. Entry Measurement Reconfiguration Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Integer indicating which TACAN LRU (1, 2, or 3) is selected by RM for use by nav filter for TACAN data processing	SEL_LRU_ID	Entry sensor data snap	I	S		—	As needed
Switch (each LRU) indicating (ON) a valid TACAN channel has been selected (site lookup output), I = 1,3	TACAN_CHAN_VALID_SL <sub>I</sub>	*	D	—	OFF/ON	—	As needed
Earth-fixed position vector of TACAN station (each LRU) output from site lookup, I = 1,3	$\bar{R}$ _TACAN_EF_SL <sub>I</sub>	*	V	DP		ft	As needed
Transformation matrix from earth-fixed to topodetic coordinates at TACAN site (each LRU) output from site lookup, I = 1,3	M_EFTOTD_TACAN_SL <sub>I</sub>	*	M	S		—	As needed
Variation of magnetic north from true north at TACAN side (each LRU) output from site lookup, I = 1, 3	ANGLE_CORR_TNTOMAG_SL <sub>I</sub>	*	F	S		rad	As needed
Current TACAN channel/mode identifier (each LRU) output from site lookup, I = 1,3	TACAN_ID <sub>I</sub>	*	I	S		—	As needed

\* See principal function input list in Table 4.3.1.9-1.

Table 4.3.1.4.1-2. Entry Measurement Reconfiguration Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Copy of R_TACAN_EF_SL for TACAN station used by nav filter	R_TACAN_EF	Entry nav state and covariance measurement incorporation, TACAN range measurement, TACAN bearing measurement	V	DP		ft	As needed
Copy of M_EFTOTD_TACAN_SL from site lookup	M_EFTOTD_TACAN	Entry nav state and covariance measurement incorporation, TACAN range measurement, TACAN bearing measurement	M	S		—	As needed
Copy of ANGLE_CORR_TNTOMAG_SL for navigation processing	ANGLE_CORR_TNTOMAG	Entry nav state and covariance measurement incorporation	F	S		rad	As needed
Copy of TACAN_CHAN_VALID_SL for TACAN station used by nav filter	TAC_CHAN_VALID	Entry nav state and covariance measurement incorporation, entry TACAN range measurement	D	—	OFF/ON	—	As needed



#### 4.3.1.4.2 Delta State Update

During operation of the entry navigation principal function, a capability for a delta state update of the Orbiter's onboard navigated state shall be provided.

A. Detailed Requirements. Detailed requirements for the performance of the delta state update task are described in Section 4.2.6.

B. Interface Requirements. Input and output requirements for the delta state update task are shown in Tables 4.3.1.4.2-1 and 4.3.1.4.2-2.

C. Processing Requirements. The delta state update task will be initiated from inputs supplied by either the HSD specialist function processing software or by ground uplink processing software. The delta state update subfunction (during operation of the entry navigation principal function) will be initiated after state propagation, and covariance propagation subfunctions have been completed, at a rate as specified by the navigation sequencer principal function. This task will be performed prior to the measurement selection subfunction if a whole vector update is not indicated ( $OP\_CODE \neq 0001001$ ), a time-tag update is not indicated ( $DO\_DELTA\_T\_UPDATE = OFF$ ), and if the  $DO\_DELTA\_UPDATE$  flag is detected to be in the ON position. This flag is checked by the NAV entry control subfunction in every cycle of the NAV entry principal function.

D. Constraints. None

E. Supplementary Information. Procedures will be established to inhibit redesignation of the runway and the incorporation of measurement data into the onboard state vector during the time interval between:

- (1) the time of the difference vectors computation and
- (2) the time of their application to the onboard state vector. Correction terms, rather than the total vector, are sent up by the ground because the correction terms are less sensitive to errors between the time of their computation and the time that they are actually applied to correct the onboard state vector.

A suggested implementation in the form of a detailed flow chart ( $OPS\_3\_DELTA\_UPDATE$ ) may be found in Section 5.2.

Table 4.3.1.4.2-1. Entry Delta State Update Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	As needed
Time of the filter state vectors	T_LAST_FILT	Entry navigation state propagation	F	DP		sec	As needed
Ground computed position deviations to update onboard state vector	$\bar{D}R_{RW}$	* Entry control	V	S		ft	As needed
Ground computed velocity deviations to update onboard state vector	$\bar{D}V_{RW}$	* Entry control	V	S		ft/sec	As needed
Earth fixed to prime RW transformation matrix	M_EFTORW	*	M	S		—	As needed
Earth rotation rate	EARTH_RATE	Constant	F	DP		rad/sec	As needed
Unit vector in direction of earth's axis of rotation	$\bar{E}ARTH\_POLE$	*	V	DP		—	As needed
Vehicle position and velocity standard deviations used when delta state update is invoked	$\bar{S}IG\_DIAG\_UPDATE$	K-load	V	DP		ft and ft/sec	As needed
Selected Shuttle position vector	$\bar{R}\_FILT$	Entry control	V	DP		ft	As needed
Covariance correlation coefficients	$\bar{C}ORR\_COEFF\_UPDATE$	K-load	V	DP		ft	As needed
Shuttle velocity vector, state one	$\bar{V}\_FILT\_ONE$	Entry navigation state propagation	V	S		ft/sec	As needed
Shuttle velocity vector, state two	$\bar{V}\_FILT\_TWO$	Entry navigation state propagation	V	S		ft/sec	As needed
Shuttle velocity vector, state three	$\bar{V}\_FILT\_THREE$	Entry navigation state propagation	V	S		ft/sec	As needed
Major Mode 303 flag	MM_CODE_303	MSC	D	—	OFF/ON	—	As needed

\* See principal function input list in Table 4.3.1.9-1.

Table 4.3.1.4.2-2. Entry Delta State Update Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}_{\text{FILT\_ONE}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	DP		ft	As needed
Current Shuttle position vector for three-state configuration, state two	$\bar{R}_{\text{FILT\_TWO}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	DP		ft	As needed
Current Shuttle position vector for three-state configuration, state three	$\bar{R}_{\text{FILT\_THREE}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	DP		ft	As needed
Shuttle velocity vector, state one	$\bar{V}_{\text{FILT\_ONE}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	S		ft/sec	As needed
Shuttle velocity vector, state two	$\bar{V}_{\text{FILT\_TWO}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	S		ft/sec	As needed
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	Entry navigation state propagation, entry state and covariance measurement incorporation, entry control	V	S		ft/sec	As needed
Filter covariance matrix	E	Entry covariance propagation	M(6)	DP		vary	As needed

Table 4.3.1.4.2-2. Entry Delta State Update Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Position deviations to update onboard state vector (zeroed out for display)	$\overline{DR\_RW}$	*	V	S		ft	As needed
Velocity deviations to update onboard state vector (zeroed out for display)	$\overline{DV\_RW}$	*	V	S		ft/sec	As needed
Flag indicating (OFF) that a delta 3 state update is not to be performed	DO_DELTA_UPDATE	Entry control	D	—	OFF/ON	—	As needed

\* See principal function output list in Table 4.3.1.9-2.

#### 4.3.1.4.3 State Vector Prediction Task

During operation of the entry navigation principal function, a capability shall be provided to predict the M50 position and velocity vector to current (cyclic) filter time. This capability is provided to time-synchronize an uplinked M50 whole vector with current filter state vector time tag and to time-synchronize an M50 vector with current filter state vector time in the case of a delta time tag update input from the keyboard. If this is accomplished in MM303, the range to landing site task will be scheduled to update the range to landing site and time of free fall. (See STS 83-0003 for range to landing site task.)

A. Detailed Requirements. A capability shall be provided for updating the position and velocity of the orbiter in flight by ground-originated command uplink or by keyboard entry of a delta time tag update.

The performance of either kind of update will require that the vectors  $\overline{R\_GND}$  and  $\overline{V\_GND}$  and the associated time tag  $T\_GND$  to be supplied. These variables must be set to the desired values before the state vector prediction task is initiated. The definition of input data and initiation of the state vector prediction task is accomplished by flight software external to the cyclic navigation function as described in Section 4.8.2 and Section 4.10.2.

$\overline{R\_GND}$  is the position vector of the Orbiter in M50 coordinates to be predicted to current time.

$\overline{V\_GND}$  is the velocity vector of the Orbiter in M50 coordinates to be predicted to current time.

$T\_GND$  is the time tag of the state vector to be predicted to current time.

The prediction shall be performed as follows:

- (1) Initialize input parameters required by the entry precise prediction:

$$GMD\_PRED = 4$$

$$GMO\_PRED = 4$$

$$DT\_MAX = DEL\_TIME\_STEP$$

$$\overline{R\_INIT} = \overline{R\_GND}$$

$$\overline{V\_INIT} = \overline{V\_GND}$$

$$T\_INIT = T\_GND$$

$$T\_FINAL = T\_RESET$$

- (2) Compare the length of the total prediction interval,  $|T\_INIT - T\_RESET|$ , to a permission determined parameter,  $MAX\_TIME\_TOL$ . If the prediction interval is greater than or equal to  $MAX\_TIME\_TOL$ , skip steps (3) and do nothing else.
- (3) Iteratively call the entry precise predictor until the result of the prediction agrees with current (cyclic) filter time to less than a permission determined value,  $SV\_TIME\_TAG\_DIFF$ , or an OPS transition request occurs ( $OTREQ = ON$ ). When the data returned from the prediction agree with current filter state vector time to within the tolerance, define the output position and velocity vectors and time tag and set  $STATE\_VECTOR\_UPDATE = ON$  indicating the availability of a replacement vector to the entry navigation principal function. The necessary equations are:

$$\text{Do until } |T\_INIT - T\_RESET| < SV\_TIME\_TAG\_DIFF \text{ or } (OTREQ = ON)$$

Call entry precise predictor

$$\bar{R}\_INIT = \bar{R}\_FINAL$$

$$\bar{V}\_INIT = \bar{V}\_FINAL$$

$$T\_INIT = T\_FINAL$$

$$T\_FINAL = T\_RESET$$

If  $OTREQ = OFF$ , then proceed:

$$\bar{R}\_TO\_NAV = \bar{R}\_FINAL$$

$$\bar{V}\_TO\_NAV = \bar{V}\_FINAL$$

$$T\_TO\_NAV = T\_INIT$$

$$STATE\_VECTOR\_UPDATE = ON$$

- (4) If the current major mode is 303, then schedule the range to landing site task to compute a new range to landing site and time of free fall for display. (See STS 83-0003 for range to landing site task.)

B. Interface Requirements. Input and output requirements for the state vector prediction task are shown in Tables 4.3.1.4.3-1 and 4.3.1.4.3-2, respectively.

C. Processing Requirements. The state vector prediction task is designed as a noncyclic, on-demand function whose execution is initiated by software external to the cyclic navigation function (see Sections 4.8 and 4.11). This task must execute in a manner that does not preclude or interface with execution of the cyclic navigation functions. The value of  $T\_RESET$  used in step (3) must be permitted to be updated by the cyclic navigation function execution during the course of a particular prediction setup.

D. Constraints. Initiation of this task is limited to uplink processing software (for the case of a whole vector command uplink) and keyboard processing software (for the case of a delta time tag update). It is

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also the responsibility of the initiating function to establish input data needed by this task before initiating execution. The OPS transition request flag (OTREQ) is initialized to 'OFF'.

E. Supplemental Information. The state vector prediction task should be performed only during periods of unperturbed coasting flight as any venting or thrusting will result in degraded performance. A suggested implementation in the form of a detailed flow chart (STATE\_VECTOR\_PRED\_TASK) may be found in Section 5.2.

Table 4.3.1.4.3-1. State Vector Prediction Task Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Step size for entry precise predictor	DEL_TIME_STEP	I-load	F	S		sec	As needed
M50 position vector to be predicted	$\bar{R}_{GND}$		V	DP		ft	As needed
M50 velocity vector to be predicted	$\bar{V}_{GND}$	*	V	S		ft/sec	As needed
Time tag of vectors to be predicted	T_GND	*	F	DP		sec	As needed
Time tag of filter state vectors	T_RESET	Entry control	F	DP		sec	As needed
Shuttle position at end of prediction step	$\bar{R}_{FINAL}$	*	V	DP		ft	As needed
Shuttle velocity at end of prediction step	$\bar{V}_{FINAL}$	*	V	S		ft/sec	As needed
NOTE: Input constants associated with the acceleration models are identified in Section 4.2.1.2 for the entry operations computer load.							
Max allowable total prediction interval	MAX_TIME_TOL	K-load	S	S		sec	As needed
Accuracy within which the output vector's time tag must match the current filter vector's time tag	SV_TIME_TAG_DIFF	Constant	S	S		sec	As needed
Major Mode 303 flag	MM_CODE_303	MSC	D	—	OFF/ON	—	As needed
OPS transition request flag	OTREQ	*	D	—	OFF/ON	N/A	As needed
* See principal function input list in Table 4.1.3.9-1.							

Table 4.3.1.4.3-2. Whole Vector Update Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector for three state configuration, state one	$\bar{R}_{\text{FILT\_ONE}}$	1,2,3	V	DP		ft	As needed
Current Shuttle position vector for three state configuration, state two	$\bar{R}_{\text{FILT\_TWO}}$	1,2,3	V	DP		ft	As needed
Current Shuttle position vector for three state configuration, state three	$\bar{R}_{\text{FILT\_THREE}}$	1,2,3	V	DP		ft	As needed
Shuttle velocity vector, state one	$\bar{V}_{\text{FILT\_ONE}}$	1,3,2,4	V	S		ft/sec	As needed
Shuttle velocity vector, state two	$\bar{V}_{\text{FILT\_TWO}}$	1,3,2,4	V	S		ft/sec	As needed
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	1,3,2,4	V	S		ft/sec	As needed
Gravitational acceleration vector	$\bar{G}_{\text{ONE\_OLD}}$	2	V	S		ft/sec <sup>2</sup>	As needed
Gravitational acceleration vector	$\bar{G}_{\text{TWO\_OLD}}$	2	V	S		ft/sec <sup>2</sup>	As needed
Gravitational acceleration vector	$\bar{G}_{\text{THREE\_OLD}}$	2	V	S		ft/sec <sup>2</sup>	As needed
State error covariance matrix	E	2,3	M	DP		—	As needed
Maximum allowable step size for entry precise predictor	DT_MAX	*	F	S		sec	As needed
Flag indicating the degree of the gravity model	GMD_PRED	*	I	S	0-4	—	As needed
Flag indicating the order of the gravity model	GMD_PRED	*	I	S	0-4	—	As needed
Time at beginning of prediction	T_INIT	*	F	DP		sec	As needed
Time at which state is desired	T_FINAL	*	F	DP		sec	As needed
Shuttle position vector at T_INIT	$\bar{R}_{\text{INIT}}$	*	V	DP		ft	As needed
Shuttle velocity vector at T_INIT	$\bar{V}_{\text{INIT}}$	*	V	S		ft/sec	As needed
Replacement position vector for NAV filter	$\bar{R}_{\text{TO\_NAV}}$	Entry control	V(3)	DP		ft	As needed
Replacement velocity vector for NAV filter	$\bar{V}_{\text{TO\_NAV}}$	Entry control	V(3)	S		ft/sec	As needed
Time tag for replacement vectors	T_TO_NAV	Entry control	S	D		sec	As needed
Flag indicating availability of replacement vectors	STATE_VECTOR_UPDATE	Entry control	D	—	OFF/ON	—	As needed
OPS transition request flag	OTREQ	*	D	—	OFF/ON	—	As needed

1 Nav state propagation.

2 Entry nav state and covariance measurement incorporation.

3 Entry nav covariance propagation.

4 Entry nav measurement selection.

\* See principal function output list in Table 4.3.1.9-2.



#### 4.3.1.5 State Propagation

The state propagation subfunction that is active during operation of the entry navigation principal function will be invoked for the operation of propagating orbiter position and velocity vectors. In portions of the entry phase in which appreciable nongravitational accelerations are present, IMU data are snapped and used along with modeled gravitational acceleration by the super-g integration task for position and velocity propagation. In the higher altitude coasting flight regions during which the entry navigation principal function is active, IMU data are ignored, and modeled gravitational and drag accelerations are used by the super-g integration task for position and velocity propagation. Since the entry navigation principal function requires a three-state configuration, all propagation will be performed separately for each of the three state vectors.

A. Detailed Requirements. Propagation of Shuttle position and velocity vectors will be performed as follows:

- (1) Acquire three sets of current, IMU-sensed, total accumulated velocity, and the selected sensed accumulated velocity along with the associated time tag:

$$\bar{V}_{CURRENT\_FILT\_ONE}$$

$$\bar{V}_{CURRENT\_FILT\_TWO}$$

$$\bar{V}_{CURRENT\_FILT\_THREE}$$

$$\bar{V}_{CURRENT\_FILT}$$

$$T_{CURRENT\_FILT}$$

Detailed requirements for this IMU data snap task are given in Section 4.2.1.1 (three-state configuration).

- (2) Compute the difference between the current and the previous time tags associated with the IMU snaps. This will be the interval over which state propagation is desired:

$$DT\_FILT = T_{CURRENT\_FILT} - T_{LAST\_FILT}$$

- (3) Determine whether drag modeling or IMU data shall be employed in computing vehicle acceleration. The decision to incorporate IMU data will be based upon the magnitude of sensed acceleration being larger than a premission-determined constant. The following equation is required for the implementation:

$$ACC\_SENSED = |\bar{V}_{CURRENT\_FILT} - \bar{V}_{LAST\_FILT}| / DT\_FILT \quad F3$$

F3 This equation shall be protected against division by zero (Section 3.5).

After computation of ACC\_SENSED, save the selected IMU velocity for use on the next cycle:

$$\bar{V}_{LAST\_FILT} = \bar{V}_{CURRENT\_FILT}$$

If  $ACC\_SENSED > ACC\_PROP\_MIN$ , then  $USE\_IMU\_DATA = ON$ ,  $GM\_DEG = 2$ , and  $GM\_ORD = 0$ ; otherwise  $USE\_IMU\_DATA = OFF$ ,  $GM\_DEG = 4$  and  $GM\_ORD = 4$ .

- (4) Perform three separate integrations of the position/velocity equations of motion with use of the super-g task (refer to Section 4.2.1.3 for detailed requirements), once for each state vector. The position/velocity vectors shall be propagated to the current time of IMU data collection  $T\_CURRENT\_FILT$ :

$$\bar{R}\_FILT\_ONE, \bar{R}\_FILT\_TWO, \bar{R}\_FILT\_THREE$$

$$\bar{V}\_FILT\_ONE, \bar{V}\_FILT\_TWO, \bar{V}\_FILT\_THREE$$

and the current IMU-accumulated, sensed velocity vectors will be saved for the next cycle (refer to Section 4.2.1.3):

$$\bar{V}\_LAST\_FILT\_ONE$$

$$\bar{V}\_LAST\_FILT\_TWO$$

$$\bar{V}\_LAST\_FILT\_THREE$$

The difference between accumulated sensed IMU readings on the present cycle and the previous cycle for all the IMU's along with the gravitational acceleration vectors will be saved:

$$\bar{D}V\_FILT\_ONE, \bar{D}V\_FILT\_TWO, \bar{D}V\_FILT\_THREE$$

$$\bar{G}\_ONE\_OLD, \bar{G}\_TWO\_OLD, \bar{G}\_THREE\_OLD$$

- (5) Save the current time tag for the next cycle:

$$T\_LAST\_FILT = T\_CURRENT\_FILT$$

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.1.5-1 and 4.3.1.5-2, respectively.

C. Processing Requirements. The state propagation subfunction will be performed before the covariance propagation subfunction. This subfunction will be performed each cycle at the entry navigation rate.

D. Constraints. None.

E. Supplementary Information. A suggested implementation in the form of the following detailed flow charts may be found in Section 5.2.

NAV\_ENTRY, IMU data snap

NAV\_STATE\_PROP

SUPER\_G\_NAV

ACCEL

Table 4.3.1.5-1. Entry State Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current accumulated IMU 1 velocity counts reserved for measurement processing	$\bar{V}_{CURRENT\_FIL1\_ONE}$	Entry control	V	S		ft/sec	Filter rate
Current accumulated IMU 2 velocity counts reserved for measurement processing	$\bar{V}_{CURRENT\_FIL1\_TWO}$	Entry control	V	S		ft/sec	Filter rate
Current accumulated IMU 3 velocity counts reserved for measurement processing	$\bar{V}_{CURRENT\_FIL1\_THREE}$	Entry control	V	S		ft/sec	Filter rate
MTU or clock time when IMU was read	$T_{CURRENT\_FIL1}$	Entry control	F	DP		sec	Filter rate
Flag indicating whether the mode of operation is single or three state	$NAV\_THREE\_STATE$	*	D	—	OFF/ON	—	Filter rate
Time of filter state vectors	$T_{LAST\_FIL1}$	Entry control, *	F	DP		sec	Filter rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}_{FIL1\_ONE}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}_{FIL1\_TWO}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	DP		ft	Filter rate
Current selected sensed accumulated IMU velocity	$\bar{V}_{CURRENT\_FIL1}$	Entry control	V	S		ft/sec	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}_{FIL1\_THREE}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}_{FIL1\_ONE}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}_{FIL1\_TWO}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	S		ft/sec	Filter rate

Table 4.3.1.5-1. Entry State Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	Entry state and covariance measurement incorporation, entry control, delta state update, *	V	S		ft/sec	Filter rate
Previously read accumulated IMU 1 velocity	$\bar{V}_{\text{LAST\_FILT\_ONE}}$	*	V	S		ft/sec	Filter rate
Acceleration function (force model) related constants		Constant					
Acceleration magnitude above which IMU data instead of drag modeling are employed in computing acceleration	ACC_PROP_MIN	K-load	F	DP		ft/sec <sup>2</sup>	Filter rate
Angle of attack used in computing drag coefficient	ALPHA	Entry control	F	DP		rad	Filter rate
Sideslip angle used in computing drag coefficient	BETA	Entry control	F	DP		rad	Filter rate
Previously read accumulated IMU 2 velocity	$\bar{V}_{\text{LAST\_FILT\_TWO}}$	*	V	S		ft/sec	Filter rate
Previously read accumulated IMU 3 velocity	$\bar{V}_{\text{LAST\_FILT\_THREE}}$	*	V	S		ft/sec	Filter rate
Previous value of mid selected accumulated IMU velocity	$\bar{V}_{\text{LAST\_FILT}}$	*, Entry control	V	S		ft/sec	Filter rate

\* See principal function input list in Table 4.3.1.9-1.

Table 4.3.1.5-2. Entry State Propagation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector for three state configuration, state one	$\bar{R}_{FILT\_ONE}$	Entry control, entry state and covariance measurement incorporation, entry navigation covariance prop	V	DP		ft	Filter rate
Current Shuttle position vector for three state configuration, state two	$\bar{R}_{FILT\_TWO}$	Entry control, entry state and covariance measurement incorporation, entry navigation covariance prop	V	DP		ft	Filter rate
Current Shuttle position vector for three state configuration, state three	$\bar{R}_{FILT\_THREE}$	Entry control, entry state and covariance measurement incorporation, entry navigation covariance prop	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}_{FILT\_ONE}$	Entry control, entry state and covariance measurement incorporation, delta state update, entry sensor selection	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}_{FILT\_TWO}$	Entry control, entry state and covariance measurement incorporation, delta state update, entry sensor selection	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}_{FILT\_THREE}$	Entry control, entry state and covariance measurement incorporation, delta state update, entry sensor selection	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU 1 during three-state configuration	$\bar{DV}_{FILT\_ONE}$	Entry state and covariance measurement incorporation	V	S		ft/sec	Filter rate

Table 4.3.1.5-2. Entry State Propagation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU 2 during three-state configuration	$\overline{DV\_FILT\_TWO}$	Entry state and covariance measurement incorporation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU 3 during three-state configuration	$\overline{DV\_FILT\_THREE}$	Entry state and covariance measurement incorporation	V	S		ft/sec	Filter rate
Time difference between T_CURRENT and T_LAST_FILT	DT_FILT	Entry covariance matrix propagation entry drag measurement	F	DP		sec	Filter rate
Gravitational acceleration vector	$\overline{G\_ONE\_OLD}$	Entry control TACAN range measurement, bearing measurement, BARO altimeter measurement incorp	V	S		ft/sec <sup>2</sup>	Filter rate
Gravitational acceleration vector	$\overline{G\_TWO\_OLD}$	Entry control TACAN range measurement, bearing measurement, BARO altimeter measurement incorp	V	S		ft/sec <sup>2</sup>	Filter rate
Gravitational acceleration vector	$\overline{G\_THREE\_OLD}$	Entry control TACAN range measurement, bearing measurement, BARO altimeter measurement incorp	V	S		ft/sec <sup>2</sup>	Filter rate
Time of the filter state vectors	T_LAST_FILT	Delta state update, *, entry control	F	DP		sec	Filter rate
Flag indicating (ON) that IMU data should be employed in computing acceleration	USE_IMU_DATA	Entry navigation covariance propagation, *	D	—	OFF/ON	—	Filter rate

\* See principal function output list in Table 4.3.1.9-2.

#### 4.3.1.6 Covariance Propagation

The covariance matrix propagation subfunction propagates the covariance matrix forward in time. The covariance matrix is propagated by utilizing the state transition matrix. Additive process noise is incorporated to account for unmodeled state and dynamic errors.

- A. Detailed Requirements. A 6 by 6 covariance matrix shall be propagated with the entry navigation principal function. This covariance matrix defines the uncertainty in the state vector, which consists of position and velocity of the vehicle. The method of propagation is described in Section 4.2.2.
- B. Interface Requirements. The input and output data are shown in Tables 4.3.1.6-1 and 4.3.1.6-2.
- C. Processing Requirements. This subfunction will be called after the IMU sensor data have been read and after the state propagation subfunction has been executed.
- D. Constraints. Prestored data are to be used for initialization. The propagated covariance matrix must remain symmetric.
- E. Supplementary Information. A possible implementation of this subfunction is shown in the flow charts COVEXTRAP\_PF and GRAVITY\_GRADIENT in Section 5.2.

Table 4.3.1.6-1. Entry Covariance Matrix Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Interval over which to propagate the covariance matrix	DT_FILT	Entry navigation state propagation	F	DP		sec	Filter rate
Filter covariance matrix	E	Entry covariance propagation entry state and covariance measurement incorporation, *	M	DP		vary	Filter rate
Gravitational constant of earth	EARTH_MU	Constant	F	S		ft <sup>3</sup> /sec <sup>2</sup>	Filter rate
Identity matrix (3x3)	ID_MATRIX_3x3	Constant	M	S		—	Filter rate
Updated vehicle position vector associated with current covariance matrix	R_COV_LAST	Entry control, *	V	DP		ft	Filter rate
Current Shuttle position vector	R_FILT	Entry control	V	DP		ft	Filter rate
State noise error variance during unpowered flight	VAR_ACC_QUANT_COAST	K-load	F	DP		ft <sup>2</sup> /sec <sup>2</sup>	Filter rate
Variance of unmodeled acceleration times scale time during unpowered flight	VAR_UNMOD_ACC_DT_COAST	K-load	F	S		ft <sup>2</sup> /sec <sup>3</sup>	Filter rate
Accelerometer quantization error variance during powered flight	VAR_ACC_QUANT_IMU	K-load	F	S		ft <sup>2</sup> /sec <sup>2</sup>	Filter rate
Variance of unmodeled acceleration times scale time during powered flight	VAR_UNMOD_ACC_DT_IMU	K-load	F	S		ft <sup>2</sup> /sec <sup>3</sup>	Filter rate
Flag indicating (ON) the IMU data is being used in state propagation	USE_IMU_DATA	Entry navigation state propagation	D	—	OFF/ON	—	Filter rate

\* See principal function input list in Table 4.3.1.9-1.



Table 4.3.1.6-2. Entry Covariance Matrix Propagation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Filter covariance matrix	E	Entry state and covariance measurement incorporation	M	DP		vary	Filter rate

#### 4.3.1.7 State and Covariance Measurement Incorporation

The state and covariance measurement incorporation subfunction updates the three-state vectors and covariance matrix with drag altitude pseudo-measurements or barometric altitude measurements and/or TACAN sensor measurements by using a six-state process noise Kalman filter. The six elements of the state vector are navigation base Shuttle position and velocity in M50 coordinates.

A. Detailed Requirements. The state and covariance measurement incorporation subfunction is exercised only if data are available for processing as determined by the sensor measurement selection subfunction (Section 4.3.1.3) and the respective measurement subfunctions (Sections 4.3.1.7.1 through 4.3.1.7.4). The sensor measurement selection subfunction determines which measurement types are to be considered for processing. The measurement subfunctions process sensor data that are labeled as valid.

The measurement subfunctions shall compute a measurement residual for each of three state vectors. The subfunction then calculates the first partial derivatives of the estimated measurement with respect to the middle selected state, as well as the appropriate variance to model instrument error. Drag altitude, barometric altimeter, and TACAN range and bearing measurements will be available with the ENTRY navigation principal function.

Once a particular measurement subfunction has completed processing valid data, the filter control flags shall be set as follows:

Drag:

MANUAL\_EDIT\_OVERRIDE = DRAG\_EDIT\_OVERRIDE

STAT\_FLAG = DRAG\_STAT

TACAN:

MANUAL\_EDIT\_OVERRIDE = TACAN\_EDIT\_OVERRIDE

STAT\_FLAG = TACAN\_STAT

BARO:

MANUAL\_EDIT\_OVERRIDE = BARO\_EDIT\_OVERRIDE

STAT\_FLAG = BARO\_STAT

The state and covariance measurement incorporation subfunction shall then update the state and covariance matrix provided that either the residual edit criterion is met or the crew edit override is active, as described in Section 4.2.4.

The following TACAN data shall then be stored after the particular measurement type has been processed for subsequent computation of measurement processing statistics as described in Section 4.3.1.8:

SENSOR\_EDIT<sub>1 and 2</sub> = EDIT\_FLAG

SENSOR\_RESID\_TEST<sub>1 and 2</sub> = RESID\_TEST

SENSOR\_DELQ<sub>1 and 2</sub> = DELQ

where the subscript 1 corresponds to bearing and 2 to range and each measurement type is set to its own respective flag or parameter value.

The following drag data shall be stored, after the drag altitude pseudo-measurement has been processed, for subsequent computation of measurement processing statistics:

SENSOR\_EDIT<sub>4</sub> =EDIT\_FLAG

SENSOR\_RESID\_TEST<sub>4</sub> =RESID\_TEST

SENSOR\_DELQ<sub>4</sub> =DELQ

Similarly, the barometric data shall be stored, after the barometric altimeter altitude measurement has been processed, for subsequent computation of measurement processing statistics:

SENSOR\_EDIT<sub>3</sub> =EDIT\_FLAG

SENSOR\_RESID\_TEST<sub>3</sub> =RESID\_TEST

SENSOR\_DELQ<sub>3</sub> =DELQ

B. Interface Requirements. The input and output for this function are given in Tables 4.3.1.7-1 and 4.3.1.7-2, respectively.

C. Processing Requirements. This subfunction is not exercised until the external sensor data snap, sensor measurement selection, navigation reconfiguration, and state and covariance propagation subfunctions have been performed. The measurement processing statistics subfunction cannot be initiated until this subfunction is completed.

D. Constraints. There is no requirement in the state and covariance measurement incorporation subfunction to perform updating if the data-validity flag indicates bad data. No manual override of this flag exists in this subfunction. If it is desired to process a particular measurement, the data-validity flag must be made to indicate that the data are valid.

E. Supplementary Information. A possible implementation of the state and covariance measurement incorporation subfunction is presented in the flow charts of Section 5.2, NAV\_ENTRY, NAV\_FILTER, and STATE\_UPDATE.

Table 4.3.1.7-1. Entry Measurement Incorporation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}_{\text{FILT\_ONE}}$	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}_{\text{FILT\_TWO}}$	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}_{\text{FILT\_THREE}}$	1,2,3,4	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}_{\text{FILT\_ONE}}$	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}_{\text{FILT\_TWO}}$	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	1,2,3,4	V	S		ft/sec	Filter rate
Filter covariance matrix	E	1,3, entry nav covariance prop	M	DP		vary	Filter rate
Value of filter mean squared position error below which no measurement underweighting is used	MS_POS_UND_WGT	I-load	F	S		ft**2	Filter rate
Scale factor used in measurement underweighting equation	K_UND_WGT	I-load	F	S		—	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Measurement sub-functions	F	S		—	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Measurement sub-functions	V(6)	DP		vary	Filter rate
General sensor variance	VAR	Measurement sub-functions	F	S		vary	Filter rate
Switch used to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating TACAN data processed only for statistical display	TACAN_STAT	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Middle selected measurement residual	DELQ	Measurement sub-functions	F	S		vary	Filter rate
Measurement residual corresponding to state one	DELQ_ONE	Measurement sub-functions	F	S		vary	Filter rate
Measurement residual corresponding to state two	DELQ_TWO	Measurement sub-functions	F	S		vary	Filter rate
Measurement residual corresponding to state three	DELQ_THREE	Measurement sub-functions	F	S		vary	Filter rate
Switch used to override drag residual edit test	DRAG_EDIT_OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that drag data were processed only for statistical display	DRAG_STAT	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Switch used to override BARO residual edit test	BARO_EDIT_OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate

Table 4.3.1.7-1. Entry Measurement Incorporation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Flag indicating (ON) that BARO data were processed for statistical display	BARO_STAT	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
1 Entry control. 2 Entry state propagation. 3 Delta state update. 4 Entry state and cov measurement incorporation.							

Table 4.3.1.7-2. Entry Measurement Incorporation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}_{\text{FILT\_ONE}}$	Entry state propagation, entry control, 4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}_{\text{FILT\_TWO}}$	Entry state propagation, entry control, 4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}_{\text{FILT\_THREE}}$	Entry state propagation, entry control, 4	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}_{\text{FILT\_ONE}}$	Entry state propagation, entry control, 4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}_{\text{FILT\_TWO}}$	Entry state propagation, entry control, 4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}_{\text{FILT\_THREE}}$	Entry state propagation, entry control, 4	V	S		ft/sec	Filter rate
Filter covariance matrix	E	Entry nav covariance propagation	M	DP		vary	Filter rate
Edit indicators for measurements	$\bar{S}_{\text{SENSOR\_EDIT}}$	Entry nav measurement processing statistics	V	S		vary	Filter rate
Value of criterion used in nav filter for residual edit tests for the sensor measurements	$\bar{S}_{\text{SENSOR\_RESID\_TEST}}$	Entry nav measurement processing statistics	V	S		vary	Filter rate
Measurement residuals	$\bar{S}_{\text{SENSOR\_DELQ}}$	Entry nav measurement processing statistics	V	S		vary	Filter rate
Residual edit test quantity	RESID_TEST	TACAN measurement subfunction	F	S		vary	Filter rate

4 Entry nav state and covariance measurement incorporation.

#### 4.3.1.7.1 Drag Altitude

The drag altitude measurement subfunction constructs a pseudo–altitude measurement, an estimated altitude measurement, and a measurement residual for each of three state vectors. The pseudo–altitude measurement is calculated from accelerometer outputs, a model of air density as a function of altitude, and a model of drag as a function of the angle of attack. The subfunction also calculates the first partial derivatives of the estimated measurement with respect to the middle selected state vector, as well as the appropriate variance to model the instrument error.

A. Detailed Requirements. A description of symbols used in the following equations may be found in Tables 4.3.1.7.1–1 and 4.3.1.7.1–2.

Drag Residual. The subfunction shall compute the drag altitude estimate by using the equation

$$Q = H\_ELLIPSOID(\bar{R})$$

where the function H\_ELLIPSOID generates the height above the reference ellipsoid, as described in Section 4.4.5.1.

A four–layer, atmospheric model shall be selected and used to compute the pseudo–altitude measurement. The variable ATM\_INDEX will be a crew–selectable software switch with a value of 0, 1, or 2, indicating which of the three models is to be used. The scale height, H\_S, and the density at the base, RHO\_ZERO, used in the equations of pseudo–altitude measurement shall be selected as a function of the model and the estimated altitude, Q. Also, the deterministic drag bias shall be selected as a function of the model and the altitude.

$$J = 4 \text{ ATM\_INDEX}$$

$$\text{LAYER} = J + 1$$

$$\text{DO FOR } I = J + 1, J + 4:$$

If  $Q > \text{DENSITY\_LIMIT}_i$ , then  $\text{LAYER} = I$ .

Then:

$$H\_S = \bar{SCALE\_HT}_{\text{LAYER}},$$

$$RHO\_ZERO = \bar{BASE\_DEN}_{\text{LAYER}} \text{ and}$$

$$BIAS\_DRAG = \bar{BIAS\_DRAG\_LAYER}_{\text{LAYER}}$$

where  $\bar{DENSITY\_LIMIT}$ ,  $\bar{SCALE\_HT}$ ,  $\bar{BASE\_DEN}$ , and  $\bar{BIAS\_DRAG\_LAYER}$  are premission–determined constants.

This subfunction shall then compute the pseudo–altitude measurement with the equations

$$\bar{V\_RHO} = \bar{V\_REL}(\bar{V}, \bar{R})$$

$$\bar{I\_V\_RHO} = \text{UNIT}(\bar{V\_RHO})$$

$$\bar{V\_RHO\_BODY} = M\_SBODYM50^T \bar{V\_RHO}$$

$$\text{ALPHAR} = \text{ARCTAN} (\text{V\_RHO\_BODY}_3 / \text{V\_RHO\_BODY}_1) \quad \text{F7, F3}$$

$$\text{C\_DRAG} = \text{C\_DRAG\_ZERO} + \text{ALPHAR} (\text{C\_DRAG\_ONE} + \text{ALPHAR} \text{C\_DRAG\_TWO})$$

$$\text{Q\_DRAG} = \text{H\_S} \ln (\text{C\_DRAG} \text{DRAG\_CONST} \text{RHO\_ZERO}$$

$$\text{DT\_FILT} (\bar{\text{V}}_{\text{RHO}} \cdot \bar{\text{V}}_{\text{RHO}}) / \quad \text{F3}$$

$$|\bar{\text{I}}_{\text{V\_RHO}} \cdot \bar{\text{D}}\text{V}|)$$

F3 This equation shall be protected against divide by zero (Section 3.5).

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

where

$\bar{\text{V}}_{\text{REL}}(\bar{\text{V}}, \bar{\text{R}})$  is described in Section 4.4.5.2.

and

$\text{M\_SBODYM50}$  is obtained by executing the coordinate transformation subfunction  $\text{SBODY\_TO\_M50}$  (Section 4.4.3.7)

$\text{DRAG\_CONST}$  will be defined as the vehicle reference area divided by twice the vehicle mass. Initially the  $\text{DRAG\_CONST}$  is premission loaded and recomputed, any time a major mass change occurs, by the deorbit/landing navigation sequencer (Section 4.1.1). The residual shall then be computed by

$$\text{DQ} = \text{Q\_DRAG} - \text{Q} - \text{BIAS\_DRAG}$$

The above calculations will be performed for each state vector. The variables used in these equations shall be set equal to the following parameters prior to execution of the calculations described herein:

$$\bar{\text{R}} = \bar{\text{R}}_{\text{FILT\_ONE}}, \bar{\text{R}}_{\text{FILT\_TWO}}, \text{ or } \bar{\text{R}}_{\text{FILT\_THREE}}$$

$$\bar{\text{V}} = \bar{\text{V}}_{\text{FILT\_ONE}}, \bar{\text{V}}_{\text{FILT\_TWO}}, \text{ or } \bar{\text{V}}_{\text{FILT\_THREE}}$$

$$\bar{\text{D}}\text{V} = \bar{\text{D}}\text{V}_{\text{FILT\_ONE}}, \bar{\text{D}}\text{V}_{\text{FILT\_TWO}}, \text{ or } \bar{\text{D}}\text{V}_{\text{FILT\_THREE}}$$

For each state vector, the resulting residual,  $\text{DQ}$ , will be saved as  $\text{DELQ\_ONE}$ ,  $\text{DELQ\_TWO}$ , or  $\text{DELQ\_THREE}$ . The vector selection subfunctions (Section 4.2.5) will reduce the three residuals to a single residual,  $\text{DELQ}$ , for subsequent use in the residual edit test.

Drag Partialials. The partial derivatives of the altitude measurement with respect to the state are to be computed as follows:

$$\bar{\text{R}}_{\text{FILT}} = \text{VECTOR SELECTION OF } (\bar{\text{R}}_{\text{FILT\_ONE}}, \bar{\text{R}}_{\text{FILT\_TWO}}, \bar{\text{R}}_{\text{FILT\_THREE}})$$

$$\bar{\text{B}}_{1 \text{ to } 3} = \text{UNIT } (\bar{\text{R}}_{\text{FILT}})$$

$$\bar{\text{B}}_{4 \text{ to } 6} = 0.$$



The variance of the drag altitude measurement error will be defined by

$$\text{VAR} = \text{VAR\_DRAG}$$

The scale factor on the filter mean square residual used in the residual edit test,  $K\_RES\_EDIT$ , is set equal to  $K\_EDIT\_DRAG$ , which is a premission load.

The state and covariance matrix will then be updated, provided that the residual edit criterion is met, as described in Section 4.2.4.

B. Interface Requirements. The input and output variables for the drag measurement subfunction are given in Tables 4.3.1.7.1-1 and 4.3.1.7.1-2.

C. Processing Requirements. This subfunction shall be performed after the state and covariance propagation (Sections 4.3.1.5 and 4.3.1.6), at the basic filter rate. This subfunction is performed as long as drag altitude measurements are being processed.

D. Constraints. None.

E. Supplementary Information. A suggested implementation of this subfunction is shown in flow charts DRAG\_NAV CODE, DRAG\_COMP, H\_ELLIPSOID,  $\bar{V}\_REL$  in Section 5.2. The drag residual computations are contained in a subroutine with input and output argument lists to facilitate use with three-state vectors. The flow charts contain a combination of the requirements described in this section with some that are described in Section 4.3.1.7, namely the setting of the filter control flags  $MANUAL\_EDIT\_OVERRIDE$  and  $STAT\_FLAG$  to  $DRAG\_EDIT\_OVERRIDE$  and to  $DRAG\_STAT$ , respectively, the call to  $NAV\_FILTER$  and the setting of the display parameters  $SENSOR\_EDIT_4$ ,  $SENSOR\_RESID\_TEST_4$  and  $SENSOR\_DELQ_4$  to  $EDIT\_FLAG$ ,  $RESID\_TEST$  and  $DELQ$ , respectively.

Table 4.3.1.7.1-1. Drag Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Interval over which to propagate the covariance matrix	DT_FILT	Entry state propagation	F	DP		sec	Filter rate
M50-to-body coordinates quaternion	Q_M50_BODY	Data snap	V(4)	DP		—	Filter rate
Polynomial term for computing drag coefficient as function of angle of attack	C_DRAG_ZERO	I-load	F	S		—	Filter rate
Polynomial term for computing drag coefficient as function of angle of attack	C_DRAG_ONE	I-load	F	S		1/rad	Filter rate
Polynomial term for computing drag coefficient as function of angle of attack	C_DRAG_TWO	I-load	F	S		1/ rad <sup>2</sup>	Filter rate
Earth rotation rate	EARTH_RATE	Constant	F	DP		rad/ sec	Filter rate
Vehicle reference area divided by twice the vehicle mass	DRAG_CONST	I-load	F	DP		ft**2/ slugs	Filter rate
Earth ellipticity constant	ELLIPT	Constant	F	S		—	Filter rate
Time of filter state vector	T_LAST_FILT	State prop	F	DP		sec	Filter rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}$ _FILT_ONE	2,3,4	V	DP		ft	Filter rate
Unit vector in the direction of earth's axis of rotation	EARTH_POLE	5	V	DP		—	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}$ _FILT_TWO	2,3,4	V	DP		ft	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	SP		sec	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}$ _FILT_THREE	2,3,4	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}$ _FILT_ONE	2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}$ _FILT_TWO	2,3,4	V	S		ft/sec	Filter rate
Earth equatorial radius	EARTH_RADIUS_EQUATOR	Constant	F	DP		ft	Filter rate
Shuttle velocity vector, state three	$\bar{V}$ _FILT_THREE	2,3,4	V	S		ft/sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for drag measurement	K_EDIT_DRAG	K-load	F	S		—	Filter rate

Table 4.3.1.7.1-1. Drag Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU-1 during three-state configuration	$\overline{DV\_FILT\_ONE}$	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU-2 during three-state configuration	$\overline{DV\_FILT\_TWO}$	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU-3 during three-state configuration	$\overline{DV\_FILT\_THREE}$	Entry state propagation	V	S		ft/sec	Filter rate
Vector of deterministic drag biases for each layer, I = 1,12	$\overline{BIAS\_DRAG\_LAYER}_I$	I-load	V	S		ft	Filter rate
Vector of scale heights for each layer, I = 1,12	$\overline{SCALE\_HT}_I$	I-load	V	S		ft	Filter rate
Vector of base densities for each layer, I = 1,12	$\overline{BASE\_DEN}_I$	I-load	V	S		slug/ft**3	Filter rate
Altitudes defining atmosphere model layers, I = 1,12	$\overline{DENSITY\_LIMIT}_I$	I-load	V	S		ft	Filter rate
Drag altitude measurement error variance	VAR_DRAG	I-load	F	S		ft**2	Filter rate
Filter covariance matrix	E	2, entry covariance propagation	M	DP		Vary	Filter rate
Flag used (ON) to override drag residual edit test	DRAG_EDIT_OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that drag data are to be processed for statistical display purposes only	DRAG_STAT	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Index indicating which of 3 atmosphere models to use	ATM_INDEX	Override display	I	—	0-2	—	Filter rate

2 Delta state update.  
3 Entry state propagation.  
4 Entry nav state and covariance measurement incorporation.  
5 See principal function input list in Table 4.3.1.9-1.

Table 4.3.1.7.1-2. Drag Measurement Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Drag altitude measurement residual	DELQ	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
General sensor variance	VAR	Entry nav state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Entry nav state and covariance measurement incorporation	V(6)	DP			Filter rate
Drag measurement residual associated with the first state vector	DELQ_ONE	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
Drag measurement residual associated with the second state vector	DELQ_TWO	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
Drag measurement residual associated with the third state vector	DELQ_THREE	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Entry nav state and covariance measurement incorporation	F	S		—	Filter rate

#### 4.3.1.7.2 TACAN Range

The TACAN range measurement subfunction computes an estimated range from the Shuttle to the TACAN station and a range residual for each of the three state vectors. The subfunction also calculates the first partial derivatives of the estimated measurement with respect to the middle selected state vector and selects the appropriate variance to model the instrument error. It is assumed that TACAN range data will be provided by the TACAN RM by way of the sensor data snap.

A. Detailed Requirements. A description of the symbols used in the following equations may be found in Tables 4.3.1.7.2-1 and 4.3.1.7.2-2.

The following calculations shall be performed for each state vector. The variables used in these calculations shall be set equal to the following parameters prior to execution of the calculations.

$$\bar{R} = \bar{R}_{\text{FILT\_ONE}}, \bar{R}_{\text{FILT\_TWO}}, \text{ or } \bar{R}_{\text{FILT\_THREE}}$$

$$\bar{V} = \bar{V}_{\text{FILT\_ONE}}, \bar{V}_{\text{FILT\_TWO}}, \text{ or } \bar{V}_{\text{FILT\_THREE}}$$

$$\bar{DV} = \bar{DV}_{\text{FILT\_ONE}}, \bar{DV}_{\text{FILT\_TWO}}, \text{ or } \bar{DV}_{\text{FILT\_THREE}}$$

$$\bar{G} = \bar{G}_{\text{ONE\_OLD}}, \bar{G}_{\text{TWO\_OLD}}, \text{ or } \bar{G}_{\text{THREE\_OLD}}$$

First, the position vector shall be interpolated to the time of the TACAN sensor measurement, if required, as described in Section 4.2.3. The range residual shall then be calculated as described in Section 4.2.7.1.

For each state vector, the interpolated position vector,  $\bar{R}_{\text{RESID}}$ , shall be saved as  $\bar{R}_{\text{RESID\_ONE}}$ ,  $\bar{R}_{\text{RESID\_TWO}}$ , or  $\bar{R}_{\text{RESID\_THREE}}$ , and the resulting residual, DQ, shall be saved as DELQ\_ONE, DELQ\_TWO, or DELQ\_THREE. The vector selection subfunction (Section 4.2.5) shall reduce the three interpolated position vectors to a single position vector,  $\bar{R}_{\text{RESID}}$ , for subsequent use in the partial computations and the three residuals to a single residual, DELQ, for subsequent use in the residual edit test.

The partial derivatives of the range measurement with respect to the state shall be computed, and the variance shall be selected as described in Section 4.2.7.1.

The scale factor on the filter mean square residual used in the residual edit test, K\_RES\_EDIT, shall be set equal to K\_EDIT\_TACR, which is a premission load.

The state vector and covariance matrix shall then be updated as described in Section 4.3.1.7.

The quantity RESID\_TEST, computed by the filter, shall be compared to the design dependent parameter TACAN\_RNG\_CONVERG\_TEST. Depending on the outcome of this comparison, the flag ONE\_RANGE\_LOCK shall be set to ON or OFF: ON if RESID\_TEST is less than TACAN\_RNG\_CONVERG\_TEST, OFF otherwise. The flag ONE\_RANGE\_LOCK shall then be output for use by the TACAN redundancy management.

B. Interface Requirements. The inputs and outputs for the TACAN range measurement subfunction are given in Tables 4.3.1.7.2-1 and 4.3.1.7.2-2.

C. Processing Requirements. This subfunction shall be performed after the measurement reconfiguration subfunction (Section 4.3.1.4.1) at the basic filter rate. This subfunction shall be performed as long as TACAN range measurements are being processed.

D. Constraints. This subfunction shall be executed only if the data are indicated valid (i.e., the TAC\_RNG\_DATA\_GOOD flag is ON) and the TACAN channel data as provided by TACAN site lookup (Section 4.5.2.2) are indicated valid (i.e. the TAC\_CHAN\_VALID flag is ON). ONE\_RANGE\_LOCK shall be initialized to 'OFF'.

E. Supplementary Information. The location of the TACAN antenna has been neglected in calculating the range measurement estimate since this error is less than that associated with the measurement. A possible implementation of this subfunction is shown in a portion of the flow chart TACAN\_NAV and the flow chart TACAN\_RANGE\_COMP in Section 5.2. The TACAN residual computations are contained in a

subroutine with input and output argument lists to facilitate use with either three state vectors or one state vector. The flow charts also show some of the requirements described in Section 4.3.1.7, namely, the setting of the filter control flags `MANUAL_EDIT_OVERRIDE` and `STAT_FLAG` to `TACAN_EDIT_OVERRIDE` and `TACAN_STAT`, respectively; the call to `NAV_FILTER`, and the setting of the display parameters `SENSOR_EDIT1 or 2`, `SENSOR_RESID_TEST1 or 2`, and `SENSOR_DELQ1 or 2` to `EDIT_FLAG`, `RESID_TEST`, and `DELQ`, respectively.

**Table 4.3.1.7.2-1. TACAN Range Measurement Subfunction Input Parameters**

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current range data good discrete for TACAN measurement processing	TAC_RNG_DATA_GOOD	Entry nav external sensor data snap	D	—	OFF/ON	—	Filter Rate
Copy of TACAN_CHAN_VALID_SL for TACAN station used by nav filter	TAC_CHAN_VALID	Entry nav measurement reconfigure	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read	T_TACAN	Entry nav external sensor data snap	F	DP		sec	Filter rate
Copy of $\bar{R}$ _TACAN_EF_SL for TACAN station used by nav filter	$\bar{R}$ _TACAN_EF	Entry nav measurement reconfigure	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}$ _FILT_ONE	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}$ _FILT_TWO	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}$ _FILT_THREE	1,2,3,4	V	DP		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}$ _FILT_ONE	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}$ _FILT_TWO	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}$ _FILT_THREE	1,2,3,4	V	S		ft/sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for TACAN range measurement	K_EDIT_TACR	K-load	F	S		—	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-1 during three-state configuration	$\bar{D}$ V_FILT_ONE	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-2 during three-state configuration	$\bar{D}$ V_FILT_TWO	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-3 during three-cycle configuration	$\bar{D}$ V_FILT_THREE	Entry state propagation	V	S		ft/sec	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU-1	$\bar{G}$ _ONE_OLD	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate

Table 4.3.1.7.2-1. TACAN Range Measurement Subfunction Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Gravity acceleration vector at end of integration interval associated with IMU-2	$\bar{G}_{TWO\_OLD}$	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU-3	$\bar{G}_{THREE\_OLD}$	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Current middle selected position vector	$\bar{R}_{FILT}$	Entry control	V	DP		ft	Filter rate
Range criterion to select TACAN range instrument variance	RNG_VAR_ RNG_STEP	K-load	F	S		ft	Filter rate
TACAN range sensor measurement	Q_TAC_R	Entry nav external sensor data snap	F	S		ft	Filter rate
TACAN range instrument variance at range > RNG_VAR_RNG_STEP	VAR_TAC_R_HIGH	K-load	F	S		ft**2	Filter rate
TACAN range instrument variance at range ≤ RNG_VAR_RNG_STEP	VAR_TAC_R_LOW	K-load	F	S		ft**2	Filter rate
Interpolated position vector associated with the first state vector	$\bar{R}_{RESID\_ONE}$	State vector interp	V	DP		ft	Filter rate
Interpolated position vector associated with the second state vector	$\bar{R}_{RESID\_TWO}$	State vector interp	V	DP		ft	Filter rate
Interpolated position vector associated with the third state vector	$\bar{R}_{RESID\_THREE}$	State vector interp	V	DP		ft	Filter rate
Vector selected from three interpolated position vectors	$\bar{R}_{RESID}$	Vector selection	V	DP		ft	Filter rate
Flag used (ON) to override TACAN residual edit test	TACAN_EDIT_ OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data are to be procured for statistical display only	TACAN_STAT_	Entry sensor measurement selection	D	-	OFF/ON	—	Filter rate
Copy of M_EFTOTD_TACAN_SL from site lookup	$\bar{M}_{EFTOTD\_TACAN}$	Entry sensor measurement selection	M	S		—	Filter rate
Filter covariance matrix	E	1,2, entry covariance propagation	F	DP		vary	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Threshold for residual test quantity, below which data from one LRU alone are accepted	TACAN_RNG_ CONVERG_TEST	K-load	F	S		ft <sup>2</sup>	Filter rate

Table 4.3.1.7.2-1. TACAN Range Measurement Subfunction Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	Filter rate
General residual test variable	RESID_TEST	State and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
1 Entry control. 2 Delta state update. 3 State propagation. 4 Entry nav state and covariance measurement incorporation. * See principal function input list in Table 4.3.1.9-1.							



Table 4.3.1.7.2-2. TACAN Range Measurement Subfunction Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN range measurement residual	DELQ	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
General sensor variance	VAR	Entry nav state and covariance measurement incorporation	F	S		ft**2	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Entry nav state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
TACAN range measurement residual associated with the first state vector	DELQ_ONE	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
TACAN range measurement residual associated with the second state vector	DELQ_TWO	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
TACAN range measurement residual associated with the third state vector	DELQ_THREE	Entry nav state and covariance measurement incorporation	F	S		ft	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Entry nav state and covariance measurement incorporation	F	S		—	Filter rate
Flag indicating the filter can accept data from one TACAN LRU	ONE_RANGE_LOCK	Entry nav state and covariance measurement incorporation	D	—	OFF/ON	—	Filter rate

### 4.3.1.7.3 TACAN Bearing

The TACAN bearing measurement subfunction computes an estimated bearing measurement with respect to the TACAN station and a measurement residual for each of the three state vectors. The subfunction also calculates the first partial derivatives of the estimated measurement with respect to the middle selected state vector and selects the appropriate variance to model the instrument error. It is assumed that the TACAN bearing data referenced to magnetic north are available from the TACAN RM by way of the sensor data snap.

A. Detailed Requirements. A description of the symbols used in the following equations may be found in Tables 4.3.1.7.3-1 and 4.3.1.7.3-2.

The position vector of the TACAN station in M50 coordinates  $\bar{R}_{SCANNER}$  is to be computed by

$$M\_EFTOM50 = EARTH\_FIXED\_TO\_M50\_COORD(T\_TACAN)$$

$$\bar{R}_{\_SCANNER} = M\_EFTOM50 \bar{R}_{\_TACAN\_EF}$$

The transformation from M50-to-topodetic coordinates is obtained by

$$M\_M50TOD = M\_EFTOD\_TACAN M\_EFTOM50^T$$

where  $M\_EFTOD\_TACAN$  and  $\bar{R}_{\_TACAN\_EF}$  were obtained from the measurement reconfiguration subfunction (Section 4.3.1.4.1).

The flags,  $IN\_CONE\_FLAG$  (which, when set to ON, indicates the vehicle is inside the TACAN's cone of confusion) and  $TAC\_BRG\_DATA\_GOOD$  (which indicates the validity of bearing data) shall be checked.

The following calculations shall be performed for each state vector only if the data are indicated valid (i.e., the  $TAC\_BRG\_DATA\_GOOD$  flag is ON and the  $IN\_CONE\_FLAG$  is OFF). The variables used in these calculations shall be set equal to the following parameters prior to execution of the calculations.

$$\bar{R} = \bar{R}_{\_FILT\_ONE}, \bar{R}_{\_FILT\_TWO}, \text{ or } \bar{R}_{\_FILT\_THREE}$$

$$\bar{V} = \bar{V}_{\_FILT\_ONE}, \bar{V}_{\_FILT\_TWO}, \text{ or } \bar{V}_{\_FILT\_THREE}$$

$$\bar{D}V = \bar{D}V_{\_FILT\_ONE}, \bar{D}V_{\_FILT\_TWO}, \text{ or } \bar{D}V_{\_FILT\_THREE}$$

$$\bar{G} = \bar{G}_{\_ONE\_OLD}, \bar{G}_{\_TWO\_OLD}, \text{ or } \bar{G}_{\_THREE\_OLD}$$

First, the position vector shall be interpolated to the time of the TACAN sensor measurement, if required, as described in Section 4.2.3. The bearing residual shall then be calculated as described in Section 4.2.7.2. For each state vector, the interpolated position vector,  $\bar{R}_{\_RESID}$ , shall be saved as  $\bar{R}_{\_RESID\_ONE}$ ,  $\bar{R}_{\_RESID\_TWO}$ , or  $\bar{R}_{\_RESID\_THREE}$ , and the resulting residual,  $DQ$ , shall be saved as  $DELQ\_ONE$ ,  $DELQ\_TWO$ , or  $DELQ\_THREE$ .

The vector selection subfunction (Section 4.2.5) shall reduce the three interpolated position vectors to a single position vector,  $R\_RESID$ , for subsequent use in the partial computations and the three residuals to a single residual,  $DELQ$ , for subsequent use in the residual edit test.

The partial derivatives of the bearing measurement with respect to the state shall be computed, and the variance shall be selected as described in Section 4.2.7.2.

The scale factor on the filter mean square residual used in the residual edit test,  $K\_RES\_EDIT$ , shall be set equal to  $K\_EDIT\_TACBR$ , which is a premission load.

The state vector and covariance matrix shall then be updated as described in Section 4.3.1.7.

The quantity  $RESID\_TEST$ , computed by the filter, shall be compared to the parameter  $TACAN\_BRG\_CONVERG\_TEST$ . Depending on the outcome of this comparison, the flag  $ONE\_BRG\_LOCK$  shall be set to ON or OFF: ON if  $RESID\_TEST$  is less than  $TACAN\_BRG\_CONVERG\_TEST$ , OFF otherwise. The flag  $ONE\_BRG\_LOCK$  shall then be output for use by the TACAN redundancy management.

B. Interface Requirements. The inputs and outputs for the TACAN range measurement subfunction are given in Tables 4.3.1.7.3-1 and 4.3.1.7.3-2.

C. Processing Requirements. This subfunction shall be performed after the measurement reconfiguration subfunction (Section 4.3.1.4.1) at the basic filter rate. This subfunction shall be performed as long as TACAN measurements are being processed.

D. Constraints. This subfunction shall be executed if the TACAN channel validity flag, as provided by TACAN site lookup (Section 4.5.2.2), is indicated valid (i.e., the TAC\_CHAN\_VALID flag is ON), and if the Shuttle is not in TACAN station's cone of confusion (i.e., the IN\_CONE\_FLAG is OFF) and if the data are indicated valid (i.e., the TAC\_BRG\_DATA\_GOOD flag is ON). ONE\_BRG\_LOCK shall be initialized to 'OFF.'

E. Supplementary Information. The location of the TACAN antenna has been neglected in calculating the bearing measurement estimate since this error is less than that associated with the error in the measurement itself. A possible implementation of this subfunction is shown in a portion of the flow chart TACAN\_NAV and the flow chart TACAN\_BRG\_COMP in Section 5.2. The TACAN residual computations are contained in a subroutine with input and output argument lists to facilitate use with either three state vectors or one state vector. The flow charts also show some of the requirements described in Section 4.3.1.7, namely, the setting of the filter control flag MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to TACAN\_EDIT\_OVERRIDE and TACAN\_STAT, respectively; the call to NAV\_FILTER, and the setting of the display parameters SENSOR\_EDIT<sub>1 or 2</sub>, SENSOR\_RESID\_TEST<sub>1 or 2</sub>, and SENSOR\_DELQ<sub>1 or 2</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.1.7.3-1. TACAN Bearing Measurement Subfunction Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current bearing data good discrete for TACAN measurement processing	TAC_BRG_DATA_GOOD	Entry nav external sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of TACAN_CHAN_VALID_SL for TACAN station used by nav filter	TAC_CHAN_VALID	Entry nav measurement reconfigure	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read	T_TACAN	Entry nav external sensor data snap	F	DP		sec	Filter rate
Copy of $\bar{R}$ _TACAN_EF_SL for TACAN station used by nav filter	$\bar{R}$ _TACAN_EF	Entry nav measurement reconfigure	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}$ _FILT_ONE	1,2,3	V	DP		ft	Filter rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}$ _FILT_TWO	1,2,3	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}$ _FILT_THREE	1,2,3	V	DP		ft	Filter rate
Flag indicating (ON) that the vehicle is in the cone of confusion of selected TACAN station	IN_CONE_FLAG	*	D	—	OFF/ON	—	Filter rate
Shuttle velocity vector, state one	$\bar{V}$ _FILT_ONE	1,2,3	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}$ _FILT_TWO	1,2,3	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}$ _FILT_THREE	1,2,3	V	S		ft/sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for TACAN BRG measurement	K_EDIT_TACBR	K-load	F	S		—	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-1 during three-state configuration	$\bar{D}$ V_FILT_ONE	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-2 during three-state configuration	$\bar{D}$ V_FILT_TWO	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-3 during three-state configuration	$\bar{D}$ V_FILT_THREE	Entry state propagation	V	S		ft/sec	Filter rate
Gravity acceleration vector at beginning of integration interval associated with IMU-1	$\bar{G}$ _ONE_OLD	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at beginning of integration interval associated with IMU-2	$\bar{G}$ _TWO_OLD	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at beginning of integration interval associated with IMU-3	$\bar{G}$ _THREE_OLD	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate

Table 4.3.1.7.3-1. TACAN Bearing Measurement Subfunction Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current middle selected position vector	$\bar{R}_{FILT}$	Entry control	V	DP		ft	Filter rate
Interpolated position vector associated with the first state vector	$\bar{R}_{RESID\_ONE}$	State vector interp	V	DP		ft	Filter rate
Interpolated position vector associated with the second state vector	$\bar{R}_{RESID\_TWO}$	State vector interp	V	DP		ft	Filter rate
Interpolated position vector associated with the third state vector	$\bar{R}_{RESID\_THREE}$	State vector interp	V	DP		ft	Filter rate
Vector selected from three interpolated position vectors	$\bar{R}_{RESID}$	Vector selection	V	DP		ft	Filter rate
Range criterion to select TACAN azimuth instrument variance	RNG_VAR_BEARING_STEP	K-load	F	S		ft	Filter rate
Copy of M_EFTOTD_TACAN_SL from site lookup	M_EFTOTD_TACAN	Entry nav measurement reconfigure	M	S		—	Filter rate
Switch used to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Copy of ANGLE_CORR_TNTOMAG_SL for navigation processing	ANGLE_CORR_TNTOMAG	Entry nav measurement reconfigure	F	S	0 to PI	rad	Filter rate
The constant PI	PI	Constant	F	S	—	—	Filter rate
TACAN bearing sensor measurement	Q_TAC_BRG	Entry nav external sensor data snap	F	S		rad	Filter rate
TACAN azimuth instrument variance at range > RNG_VAR_BEARING_STEP	VAR_TAC_BRG_HIGH	K-load	F	S		rad**2	Filter rate
TACAN azimuth instrument variance at $\leq$ RNG_VAR_BEARING_STEP	VAR_TAC_BRG_LOW	K-load	F	S		rad**2	Filter rate
Flag indicating (ON) that TACAN data are to be processed for statistical display only	TACAN_STAT	Entry sensor measurement selection	D	—	OFF/ON	—	Filter rate
Filter covariance matrix	E	1,2, entry covariance propagation	M	DP		Vary	Filter rate
Time of filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Threshold for residual test quantity, below which data from one LRU alone are accepted	TACAN_BRG_CONVERG_TEST	K-load	F	S		rad <sup>2</sup>	Filter rate

Table 4.3.1.7.3-1. TACAN Bearing Measurement Subfunction Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
General residual test variable	RESID_TEST	State and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
1 Entry control. 2 Delta state update. 3 State propagation. * See principal function input list in Table 4.3.1.9-1.							

Table 4.3.1.7.3-2. TACAN Bearing Measurement Subfunction Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN azimuth measurement residual	DELQ	Entry nav state and covariance measurement incorporation	F	S		rad	Filter rate
General sensor variance	VAR	Entry nav state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Entry nav state and covariance measurement incorporation	V(6)	DP		Vary	Filter rate
TACAN azimuth measurement residual associated with the first state vector	DELQ_ONE	Entry nav state and covariance measurement incorporation	F	S		rad	Filter rate
TACAN azimuth measurement residual associated with the second state vector	DELQ_TWO	Entry nav state and covariance measurement incorporation	F	S		rad	Filter rate
TACAN azimuth measurement residual associated with the third state vector	DELQ_THREE	Entry nav state and covariance measurement incorporation	F	S		rad	Filter rate
Scale factor on filter mean square residual used in residual edit test vector	K_RES_EDIT	Entry nav state and covariance measurement incorporation	F	S		—	Filter rate
Flag indicating the filter can accept data from one TACAN LRU	ONE_BRG_LOCK	Entry nav state and covariance measurement incorporation	D	—	OFF/ ON	—	Filter rate

#### 4.3.1.7.4 Barometric Altimeter

The barometric altimeter measurement subfunction calculates the estimated altitude and a residual for each of the three state vectors. The subfunction also calculates the first partial derivatives of the estimated measurement with respect to the selected state vector and the appropriate variance to model the instrument error. It is assumed that, the barometric altitude data will be provided by the ADTA SOP via the sensor data snap.

A. Detailed Requirements. The following calculations shall be performed for each state vector. The variables used in these calculations shall be set to the following parameters prior to execution of the calculations.

$$\bar{R} = \bar{R}_{\text{FILT\_ONE}}, \bar{R}_{\text{FILT\_TWO}}, \text{ or } \bar{R}_{\text{FILT\_THREE}}$$

$$\bar{V} = \bar{V}_{\text{FILT\_ONE}}, \bar{V}_{\text{FILT\_TWO}}, \text{ or } \bar{V}_{\text{FILT\_THREE}}$$

$$D\bar{V} = D\bar{V}_{\text{FILT\_ONE}}, D\bar{V}_{\text{FILT\_TWO}}, \text{ or } D\bar{V}_{\text{FILT\_THREE}}$$

$$\bar{G} = \bar{G}_{\text{ONE\_OLD}}, \bar{G}_{\text{TWO\_OLD}}, \text{ or } \bar{G}_{\text{THREE\_OLD}}$$

First, the position vector shall be interpolated to the time of the BARO altimeter sensor measurement, if required, as described in Section 4.2.3. The residual shall then be calculated as described in Section 4.2.7.3.

For each state vector, the residual DQ, shall be saved as DELQ\_ONE, DELQ\_TWO, or DELQ\_THREE. The vector selection subfunction (Section 4.2.5) shall reduce the three residuals to a single residual, DELQ, for subsequent use in the residual edit test. The estimated measurement, Q, will be saved for each state vector as Q\_ONE, Q\_TWO, and Q\_THREE and the vector selection subfunction will reduce the three measurements to one for subsequent use in the calculation of Q and the variance.

The vector selection subfunction is also invoked to reduce the three position vectors to one for use in the calculation of the partial derivatives. The partial derivatives of the range measurement with respect to the state and the variance shall be computed as described in Section 4.2.7.3.

The scale factor on the filter mean square residual used in the residual edit test, K\_RES\_EDIT, is set equal to K\_EDIT\_BARO, which is a premission load.

The state vector and covariance matrix shall then be updated as described in Section 4.3.1.7.

B. Interface Requirements. The input and output variables for the barometric measurement subfunction are given in Tables 4.3.1.7.4-1 and 4.3.1.7.4-2.

C. Processing Requirements. This subfunction will be performed after the navigation reconfiguration subfunction (Section 4.3.1.4) at the basic filter rate. This subfunction shall be performed as long as barometric altitude measurements are being processed.

D. Constraints. This subfunction will only be executed if the data are indicated valid (i.e., the BARO\_DATA\_GOOD flag is ON).



E. Supplementary Information. The assumption is made, for simplification, that the barometric probe is located at the navigation base. This is a valid assumption since the error involved in mislocating the probe is much less than the errors associated with the barometric measurement.

A possible implementation of this subfunction is shown in the flow charts BARO\_NAV, BARO\_COMP and H\_ELLIPSOID in Section 5.2. Note that the flow charts also contain some requirements described in Section 4.3.1.7 namely the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to BARO\_EDIT\_OVERRIDE and BARO\_STAT, respectively, the call to NAV\_FILTER, and the setting of the display parameters SENSOR\_EDIT<sub>3</sub>, SENSOR\_RESID\_TEST<sub>3</sub>, and SENSOR\_DELQ<sub>3</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.1.7.4-1. Barometric Altimeter Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Copy of current data good discrete reserved for measurement processing (navigation)	BARO_DATA_GOOD	Entry sensor data read	D	—	OFF/ON	—	Filter rate
Time tag associated with barometric measurement	T_BARO	Entry sensor data read	F	DP		sec	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}$ _RESID	State vector interpolation	V	DP		ft	Filter rate
Barometric deterministic bias	BIAS_BARO	K-load	F	S		ft	Filter rate
Altitude of mean sea level above reference ellipsoid at the runway	DELH_MSL_ELLIPSOID_RW	*	F	S		ft	Filter rate
Barometric altimeter sensor measurement	Q_BARO	Entry sensor data read	F	S		ft	Filter rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S		ft	Filter rate
Earth ellipticity constant	ELLIPT	Constant	F	S	—	—	Filter rate
Earth equatorial radius	EARTH_RADIUS_EQUATOR	Constant	F	DP	—	—	Filter rate
Barometric altimeter instrument variance constant	VAR_H1	I-load	F	S		ft**2	Filter rate
Barometric altimeter instrument variance constant	VAR_H2	I-load	F	S		ft**2	Filter rate
Unit vector in direction of Earth's axis of rotation	$\bar{E}$ ARTH_POLE	*	V	DP		—	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_EDIT_BARO	K-load	I	S		—	Filter rate
Time of the filter state vector	T_LAST_FILT	State prop	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State prop	F	DP		sec	Filter rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate

Table 4.3.1.7.4-1. Barometric Altimeter Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMT-1 during three-state configuration	$\bar{D}V\_FILT\_ONE$	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-2 during three-state configuration	$\bar{D}V\_FILT\_TWO$	Entry state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed-IMU readings on present cycle and previous cycle for IMU-3 during three-state configuration	$\bar{D}V\_FILT\_THREE$	Entry state propagation	V	S		ft/sec	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU-1	$\bar{G}\_ONE\_OLD$	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU-2	$\bar{G}\_ONE\_TWO$	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Gravity acceleration vector at end of integration interval associated with IMU-3	$\bar{G}\_ONE\_THREE$	Entry state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Current Shuttle position vector for three-state configuration, state one	$\bar{R}\_FILT\_ONE$	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state two	$\bar{R}\_FILT\_TWO$	1,2,3,4	V	DP		ft	Filter rate
Current Shuttle position vector for three-state configuration, state three	$\bar{R}\_FILT\_THREE$	1,2,3,4	V	S		ft	Filter rate
Shuttle velocity vector, state one	$\bar{V}\_FILT\_ONE$	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state two	$\bar{V}\_FILT\_TWO$	1,2,3,4	V	S		ft/sec	Filter rate
Shuttle velocity vector, state three	$\bar{V}\_FILT\_THREE$	1,2,3,4	V	S		ft/sec	Filter rate

\* See principal function input list in Table 4.3.1.9-1.

1 Entry control.

2 State propagation.

3 Delta state update.

4 Entry nav state and covariance measurement incorporation.

Table 4.3.1.7.4-2. Barometric Altimeter Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Barometric measurement residual	DELQ	Entry state and covariance measurement incorporation	F	S		ft	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Entry state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
General sensor variance	VAR	Entry state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Entry state and covariance measurement incorporation	F	S		—	Filter rate
BARO measurement residual associated with the first state vector	DELQ_ONE	Entry state and covariance measurement incorporation	F	S		ft	Filter rate
BARO measurement residual associated with the second state vector	DELQ_TWO	Entry state and covariance measurement incorporation	F	S		ft	Filter rate
BARO measurement residual associated with the third state vector	DELQ_THREE	Entry state and covariance measurement incorporation	F	S		ft	Filter rate

#### 4.3.1.8 Measurement Processing Statistics

During the entry navigation principal function, the measurement processing statistics subfunction will compute, for display to the crew and for downlist, certain parameters that are indicative of the health of the navigation filter.

A. Detailed Requirements. For both TACAN range and bearing, barometric altitude and drag derived altitude measurements, three parameters are to be computed to show how well the navigation filter is processing these measurements. The processing required is described fully in Section 4.2.8.2, Measurement Statistics. Since, during entry, MSBLS measurements will not be processed by the navigation filter, the processing described in Section 4.2.8.2 will be done for the case I = 1 through 4.

This subfunction will also evaluate edit flags for the three measurement types to compute the sensors' status discrete. Detailed requirements for this calculation may be found in Section 4.2.8.1.

A further capability will be provided by this subfunction to generate the residual and ratio parameters described in Section 4.2.8.2 for display under certain circumstances (determined by the entry sensor measurement selection subfunction) when the filter would not normally be attempting to process data. If the sensor edit indicators are found to have the value "STAT," this shall indicate to the measurement processing subfunction that this filter cycle was performed only for the production of filter statistics and that the calculations leading to the edit history indicator shall ignore this "statistics only" filter cycle.

B. Interface Requirements. Inputs and outputs are listed in Tables 4.3.1.8-1 and 4.3.1.8-2.

C. Processing Requirements. Prior to beginning the measurement processing statistics for the first time (prior to the entry navigation processing principal function), the following initialization must be performed.

$$\text{EDIT\_ARRAY} = 0 \quad (\text{matrix})$$

$$\bar{\text{SUM}} = 0 \quad (\text{vector})$$

$$\bar{\text{J}} = 0 \quad (\text{array})$$

D. Constraints. The discretets, NAV\_MLS\_FLAG, NAV\_ALT\_FLAG, and NAV\_TAC\_FLAG, are required to be premission loaded to values of OFF.

E. Supplementary Information. A suggested implementation for this subfunction may be found in the detailed flow chart of Section 5.2.

MEAS\_PROCESSING\_STATISTICS\_ENTRY\_CODE

Table 4.3.1.8-1. Entry Measurement Processing Statistics Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current Orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	0.25
Altitude regions for event lamp processing	$\bar{A}LT\_EL$	K-Load	V	S		ft	
Altitude of Orbiter nav base above runway altitude	ALT_WHEELS	*	F	S		ft	0.25
Flag indicating (ON) that altitude data have been inhibited	H_INHIB	Entry nav sensor selection	D	—	OFF/ON	—	0.25
Flag indicating (ON) that vehicle is in selected TACAN station's cone of confusion	IN_CONE_FLAG	*	D	—	OFF/ON	—	0.25
Value of criterion used to set the edit history indicators	K_MAX	I-load	I				
Flag indicating the availability of MSBLS transmitters at the runway	MLS_AVAIL	*	D	—	OFF/ON	—	0.25
Number of nautical miles per foot	NAUTMI_PER_FT	Constant	F	S		nm/ft	0.25
Number of sequential failures of the test criteria allowed before activating the nav event light	N_SEQ_MAX	I-load	I				0.25
Measurement residual for TACAN bearing data	SENSOR_DELQ(1)	Entry navigation state and covariance measurement incorporation	F	S		rad	0.25
Measurement residual for TACAN range data	SENSOR_DELQ(2)	Entry navigation state and covariance measurement incorporation	F	S		ft	0.25

Table 4.3.1.8-1. Entry Measurement Processing Statistics Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Four-valued flag defining use of TACAN bearing data by the navigation filler. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(1)	Entry navigation state and covariance measurement incorporation	CHAR	S			0.25
Four-valued flag defining use of TACAN range data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(2)	Entry navigation state and covariance measurement incorporation	CHAR	S			0.25
Value of criterion used in navigation filter for residual edit test for TACAN bearing measurement	SENSOR_RESID_TEST(1)	Entry navigation state and covariance measurement incorporation	F	S		rad <sup>2</sup>	0.25
Value of criterion used in navigation filter for residual edit test for TACAN range measurement	SENSOR_RESID_TEST(2)	Entry navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	0.25
Measurement residual for barometric altitude data	SENSOR_DELQ(3)	Entry navigation state and covariance measurement incorporation	F	S		ft	0.25

Table 4.3.1.8-1. Entry Measurement Processing Statistics Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Four-valued flag defining use of barometric altitude data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(3)	Entry navigation state and covariance measurement incorporation	CHAR	S			0.25
Value of criterion used in navigation filter for residual edit test for barometric altitude measurement	SENSOR_RESID_TEST(3)	Entry navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	0.25
Measurement residual for drag altitude data	SENSOR_DELQ(4)	Entry navigation state and covariance measurement incorporation	F	S		ft	0.25
Four-valued flag defining use of drag altitude data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(4)	Entry navigation state and covariance measurement incorporation	CHAR	S			0.25
Value of criterion used in navigation filter for residual edit test for drag altitude measurement	SENSOR_RESID_TEST(4)	Entry navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	0.25

\* See principal function input list in Table 4.3.1.9-1.



Table 4.3.1.8-2. Entry Measurement Processing Statistics Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Display measurement residual for TACAN bearing	DISP_DELQ(1)	*	F	S		rad	0.25
Display measurement residual for TACAN range	DISP_DELQ(2)	*	F	S		nmi	0.25
Display edit history indicator for TACAN bearing measurement	DISP_EDIT(1)	*	CHAR	S			0.25
Display edit history indicator for TACAN range measurement	DISP_EDIT(2)	*	CHAR	S			0.25
Display residual edit ratio for TACAN bearing	DISP_SIG(1)	*	F	S			0.25
Display residual edit ratio for TACAN range	DISP_SIG(2)	*	F	S			0.25
Display measurement residual for barometric altitude	DISP_DELQ(3)	*	F	S		ft	0.25
Display edit history indicator for barometric altitude measurement	DISP_EDIT(3)	*	CHAR	S			0.25
Display residual edit ratio for barometric altitude	DISP_SIG(3)	*	F	S			0.25
Display measurement residual for drag altitude	DISP_DELQ(4)	*	F	S		ft	0.25
Display edit history indicator for drag altitude measurement	DISP_EDIT(4)	*	CHAR	S			0.25
Display residual edit ratio for drag altitude	DISP_SIG(4)	*	F	S			0.25
NAV EDIT indicator flag	NAV_EDIT_IND	*	D		OFF/ ON		0.25
NAV EDIT altitude crew abort	NAV_ALT_FLAG	*	D		OFF/ ON		0.25
NAV EDIT TACAN crew abort	NAV_TAC_FLAG	*	D		OFF/ ON		0.25
NAV EDIT MSBLS crew abort	NAV_MLS_FLAG	*	D		OFF/ ON		0.25

\*See principal function output list Table 4.3.1.9-2.

**4.3.1.9 Entry Navigation (4.127) Principal Function Tables**

This section contains input/output, I–loads, K–loads, constants, and variable cross–reference tables for the entry navigation principal function, which are presented in the following table, and Tables 4.3.1.9–1 through 4.3.1.9–5.

Entry Navigation Principal Function Variable Cross–Reference	
FSSR Name	Source Name
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	ANGLE_CORR_TNTOMAG_S1
ANGLE_CORR_TNTOMAG_SL <sub>2</sub>	ANGLE_CORR_TNTOMAG_S2
ANGLE_CORR_TNTOMAG_SL <sub>3</sub>	ANGLE_CORR_TNTOMAG_S3
BARO_DATA_GOOD	ALT_DG
DRAG_AIF	N/G
M_EFTOTD_TACAN_SL <sub>1</sub>	M_EFTOTD_TACAN_SL1
M_EFTOTD_TACAN_SL <sub>2</sub>	M_EFTOTD_TACAN_SL2
M_EFTOTD_TACAN_SL <sub>3</sub>	M_EFTOTD_TACAN_SL3
MACH_JUMP	ADS_MJ
Q_B_I	Q_BOD_M50/Q_B_I
Q_BARO	HPC
Q_TAC_R	OUT_SEL_RNG
Q_TAC_BRG	OUT_SEL_BRG
R_TACAN_EF_SL <sub>1</sub>	R_TACAN_EFSL1
R_TACAN_EF_SL <sub>2</sub>	R_TACAN_EFSL2
R_TACAN_EF_SL <sub>3</sub>	R_TACAN_EFSL3
T_BARO	T_HPC
T_CURRENT_FILT	T_IMUS
TAC_BRG_DATA_GOOD	OUT_BRG_DG
TAC_RNG_DATA_GOOD	OUT_RNG_DG
TACAN_CHAN_VALID_SL <sub>1</sub>	TACAN_CHAN_VALID_SL1
TACAN_CHAN_VALID_SL <sub>2</sub>	TACAN_CHAN_VALID_SL2
TACAN_CHAN_VALID_SL <sub>3</sub>	TACAN_CHAN_VALID_SL3
V_CURRENT_FILT_ONE (1)	VELSUMM50X(1)/V_1(1)
V_CURRENT_FILT_ONE (2)	VELSUMM50Y(1)/V_1(2)
V_CURRENT_FILT_ONE (3)	VELSUMM50Z(1)/V_1(3)
V_CURRENT_FILT_TWO (1)	VELSUMM50X(2)/V_2(1)
V_CURRENT_FILT_TWO (2)	VELSUMM50Y(2)/V_2(2)
V_CURRENT_FILT_TWO (3)	VELSUMM50Z(2)/V_2(3)
V_CURRENT_FILT_THREE (1)	VELSUMM50X(3)/V_3(1)
V_CURRENT_FILT_THREE (2)	VELSUMM50Y(3)/V_3(2)

Entry Navigation Principal Function Variable Cross-Reference	
FSSR Name	Source Name
V_CURRENT_FILT_THREE (3)	VELSUMM50Z(3)/V_3(3)
V_CURRENT_FILT	SEL_V_M50
ALT_WHEELS_NAV	ALT_WHEELS
FOM	FOM_SOP
GPS_DG	GPS_DG_SOP
GPS_FAIL_FOM	GPS_FAIL_FOM_SOP
$\bar{R}$ _GPS_ECEF	$\bar{R}$ _GPS_ECEF_SOP
T_GPS	T_GPS_SOP
T_LAST_GPS	T_IMU_SAVE_SOP
$\bar{V}$ _GPS_ECEF	$\bar{V}$ _GPS_ECEF_SOP
$\bar{V}$ _LAST_GPS	$\bar{V}$ _IMU_SAVE_SOP

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ACC_DRAG	V95A0160CB	DRAG DECEL	ENT UPP	FT/S2			93017G	*
ACC_DRAG	V95A0160CC	DRAG DECEL	TAEM UPP	FT/S2			93017G	*
ACC_DRAG	V95A0160CD	DRAG DECEL	A/L UPP	FT/S2			93017G	*
ADS_MJ	V95X3112X	ADS MACH JUMP FLAG	ADTA SOP		BD		93017G	*
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
ALT	V95H0175CC	CURR ORB ALT ABOVE REF ELLIPSOID	ENT UPP	FT	SPL		93017G	*
ALT	V95H0175CD	CURR ORB ALT ABOVE REF ELLIPSOID	TAEM UPP	FT	SPL		93017G	*
ALT	V95H0175CE	CURR ORB ALT ABOVE REF ELLIPSOID	A/L UPP	FT	SPL		93017G	*
ALT_DG	V95X3111X	PRESSURE ALTITUDE DATA GOOD FLAG	ADTA SOP		BD		93017G	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ALT_WHEELS	V95H0165CB	ALT TO REAR WHEELS/NAV BASE(ENTRY)	ENT UPP	FT	DPL		93017G	*
ALT_WHEELS	V95H0165CC	ALT TO REAR WHEELS/NAV BASE(ENTRY)	TAEM UPP	FT	DPL		93017G	*
ALT_WHEELS	V95H0165CD	ALT TO REAR WHEELS/NAV BASE(ENTRY)	A/L UPP	FT	DPL		93017G	*
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
ATM_INDEX	V93J5353C	SELECTED ATMOSPHERE MODEL INDEX	OVERRIDE SPEC		HXS		93017G	*
BARO_AIF	V93J4473C	ADTA A/I/F EDIT CMD	HORIZ SIT DISP		HXS		93017G	*
BETA_N	V90H2249C	INERTIAL SIDESLIP ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
CORR_COEFF_GPS(1)	V90U3068C	GPS COV U V CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(2)	V90U3069C	GPS COV U UDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(3)	V90U3070C	GPS COV U VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(4)	V90U3071C	GPS COV V UDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(5)	V90U3072C	GPS COV V VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(6)	V90U3073C	GPS COV W WDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(7)	V90U3074C	GPS COV UDOT VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CREW_METERING_OVERRIDE	V93X1534X	CREW OVERRIDE UPP RESET MTRNG	GPS STATUS DISP		BD		92067D	
DEORBIT_BURN	V90X0535X	FLAG INDICATING THRUSTING FLIGHT	D/L NAV SEQ					
DO_DELTA_UPDATE	V93X5030X	UPDATE DELTAS CMD	HORIZ SIT DISP		BD			
DO_DELTA_UPDATE_UP	V91X8894X	DO DELTA STATE UPDATE UPLINK CMD	SYS S/W					
DR_RW(1)	V93H5010CA	NAV UPDATE DELTA X POSITION	HORIZ SIT DISP	FT				
DR_RW(2)	V93H5011CA	NAV UPDATE DELTA Y POSITION	HORIZ SIT DISP	FT				
DR_RW(3)	V93H5012CA	NAV UPDATE DELTA Z POSITION	HORIZ SIT DISP	FT				
DR_RW_UP(X)	V96U8554C	NAV UPDATE DELTA X POS UPLINK CMD	UL	FT			92237	
DR_RW_UP(Y)	V96U8555C	NAV UPDATE DELTA Y POS UPLINK CMD	UL	FT			92237	
DR_RW_UP(Z)	V96U8556C	NAV UPDATE DELTA Z POS UPLINK CMD	UL	FT			92237	
DT_GPS_OFF_MIN	V94W0981C	TIME SINCE LAST GPS SEL	GPS RCVR STATE PROC	MIN	SPL		93017G	*
DV_RW(1)	V93L5020CA	NAV UPDATE DELTA X VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(2)	V93L5021CA	NAV UPDATE DELTA Y VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(3)	V93L5022CA	NAV UPDATE DELTA Z VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW_UP(X)	V96U8557C	NAV UPDATE DELTA X VEL UPLINK CMD	UL	FT/S			92237	
DV_RW_UP(Y)	V96U8558C	NAV UPDATE DELTA Y VEL UPLINK CMD	UL	FT/S			92237	
DV_RW_UP(Z)	V96U8559C	NAV UPDATE DELTA Z VEL UPLINK CMD	UL	FT/S			92237	
E(1-1)	V90U0650CA	COVARIANCE MATRIX ELEMENT 1-1	D/L NAV SEQ				93017G	*
E(1-2)	V90U0651CA	COVARIANCE MATRIX ELEMENT 1-2	D/L NAV SEQ					
E(1-3)	V90U0652CA	COVARIANCE MATRIX ELEMENT 1-3	D/L NAV SEQ					

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
E(1-4)	V90U0653CA	COVARIANCE MATRIX ELEMENT 1-4	D/L NAV SEQ					
E(1-5)	V90U0654CA	COVARIANCE MATRIX ELEMENT 1-5	D/L NAV SEQ					
E(1-6)	V90U0655CA	COVARIANCE MATRIX ELEMENT 1-6	D/L NAV SEQ					
E(2-1)	V90U0656CA	COVARIANCE MATRIX ELEMENT 2-1	D/L NAV SEQ					
E(2-2)	V90U0657CA	COVARIANCE MATRIX ELEMENT 2-2	D/L NAV SEQ				93017G	*
E(2-3)	V90U0658CA	COVARIANCE MATRIX ELEMENT 2-3	D/L NAV SEQ					
E(2-4)	V90U0659CA	COVARIANCE MATRIX ELEMENT 2-4	D/L NAV SEQ					
E(2-5)	V90U0660CA	COVARIANCE MATRIX ELEMENT 2-5	D/L NAV SEQ					
E(2-6)	V90U0661CA	COVARIANCE MATRIX ELEMENT 2-6	D/L NAV SEQ					
E(3-1)	V90U0662CA	COVARIANCE MATRIX ELEMENT 3-1	D/L NAV SEQ					
E(3-2)	V90U0663CA	COVARIANCE MATRIX ELEMENT 3-2	D/L NAV SEQ					
E(3-3)	V90U0664CA	COVARIANCE MATRIX ELEMENT 3-3	D/L NAV SEQ				93017G	*
E(3-4)	V90U0665CA	COVARIANCE MATRIX ELEMENT 3-4	D/L NAV SEQ					
E(3-5)	V90U0666CA	COVARIANCE MATRIX ELEMENT 3-5	D/L NAV SEQ					
E(3-6)	V90U0667CA	COVARIANCE MATRIX ELEMENT 3-6	D/L NAV SEQ					
E(4-1)	V90U0668CA	COVARIANCE MATRIX ELEMENT 4-1	D/L NAV SEQ					
E(4-2)	V90U0669CA	COVARIANCE MATRIX ELEMENT 4-2	D/L NAV SEQ					
E(4-3)	V90U0670CA	COVARIANCE MATRIX ELEMENT 4-3	D/L NAV SEQ					
E(4-4)	V90U0671CA	COVARIANCE MATRIX ELEMENT 4-4	D/L NAV SEQ				93017G	*
E(4-5)	V90U0672CA	COVARIANCE MATRIX ELEMENT 4-5	D/L NAV SEQ					
E(4-6)	V90U0673CA	COVARIANCE MATRIX ELEMENT 4-6	D/L NAV SEQ					
E(5-1)	V90U0674CA	COVARIANCE MATRIX ELEMENT 5-1	D/L NAV SEQ					
E(5-2)	V90U0675CA	COVARIANCE MATRIX ELEMENT 5-2	D/L NAV SEQ					
E(5-3)	V90U0676CA	COVARIANCE MATRIX ELEMENT 5-3	D/L NAV SEQ					
E(5-4)	V90U0677CA	COVARIANCE MATRIX ELEMENT 5-4	D/L NAV SEQ					
E(5-5)	V90U0678CA	COVARIANCE MATRIX ELEMENT 5-5	D/L NAV SEQ				93017G	*
E(5-6)	V90U0679CA	COVARIANCE MATRIX ELEMENT 5-6	D/L NAV SEQ					
E(6-1)	V90U0680CA	COVARIANCE MATRIX ELEMENT 6-1	D/L NAV SEQ					
E(6-2)	V90U0681CA	COVARIANCE MATRIX ELEMENT 6-2	D/L NAV SEQ					
E(6-3)	V90U0682CA	COVARIANCE MATRIX ELEMENT 6-3	D/L NAV SEQ					
E(6-4)	V90U0683CA	COVARIANCE MATRIX ELEMENT 6-4	D/L NAV SEQ					
E(6-5)	V90U0684CA	COVARIANCE MATRIX ELEMENT 6-5	D/L NAV SEQ					
E(6-6)	V90U0685CA	COVARIANCE MATRIX ELEMENT 6-6	D/L NAV SEQ				93017G	*
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FOM_SOP(1)	V90H3009C	GPS 1 FIGURE OF MERIT	GPS SOP		HXS		92067D	
FOM_SOP(2)	V90H3010C	GPS 2 FIGURE OF MERIT	GPS SOP		HXS		92067D	
FOM_SOP(3)	V90H3011C	GPS 3 FIGURE OF MERIT	GPS SOP		HXS		92067D	
GPS_DG_SOP(1)	V90X3012X	GPS 1 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(2)	V90X3013X	GPS 2 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(3)	V90X3014X	GPS 3 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(1)	V90X3015X	GPS 1 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(2)	V90X3016X	GPS 2 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(3)	V90X3017X	GPS 3 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_RATIO_FLAG	V90X0440X	SEL GPS RESID RATIO EDIT FLAG	GPS RCVR STATE PROC		BD		92132C	

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_SV_SEL_AVAIL	V90X3081XA	GPS SEL STATE VCTR AVAIL FLAG	D/L NAV SEQ		BD		91051K	
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_TO_GC_AIF	V93J1200CA	GPS TO G&C A/I/F CMD	HORIZ SIT DISP		HXS		92067D	
GPS_TO_GC_AIF	V93J1200CB	GPS TO G&C A/I/F CMD	GPS STATUS DISP		HXS		92067D	
GPS_TO_NAV_AI	V93X1202XA	GPS TO NAV AUTO/INHIBIT CMD	HORIZ SIT DISP		BD		92067D	
GPS_TO_NAV_AI	V93X1202XB	GPS TO NAV AUTO/INHIBIT CMD	GPS STATUS DISP		BD		92067D	
GPS_TO_NAV_FORCE	V93X1201XA	GPS TO NAV FORCE CMD	HORIZ SIT DISP		BD		92067D	
GPS_TO_NAV_FORCE	V93X1201XB	GPS TO NAV FORCE CMD	GPS STATUS DISP		BD		92067D	
G_GPS_SEL(1)	V90A3637C	X-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
G_GPS_SEL(2)	V90A3638C	Y-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
G_GPS_SEL(3)	V90A3639C	Z-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
HPC	V95H3001C	ADS CORRECTED PRESSURE ALTITUDE	ADTA SOP	FT	SPL		93017G	*
IMU_BYBASS(1)	V91X2273X	FF1 IMU BYPASS(MFE)	FCOS		BD		93017G	*
IMU_BYPASS(2)	V91X2274X	FF2 IMU BYPASS(MFE)	FCOS		BD		93017G	*
IMU_BYPASS(3)	V91X2275X	FF3 IMU BYPASS(MFE)	FCOS		BD		93017G	*
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
IN_CONE_FLAG	V90X3598X	INSIDE CONE FLAG	TACAN RM					
MLS_AIF	V93J1629C	MLS A/I/F EDIT CMD	HORIZ SIT DISP		HXS		92571B	
MLS_AVAIL	V90X3720XA	MLS AVAILABILITY	ENT SITE LOOKUP					
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
MM_CODE_303/MM_303	V90X8182X	MAJOR MODE 303 FLAG	MSC				92355B	
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NAV_THREE_STATE	V90X0537X	THREE-STATE FLAG ON/OFF	D/L NAV SEQ		BD		93017G	*
OTREQ	V90X0893XA	OPS TRANSITION REQUEST FLAG	ENT PREC PRED		BD		90121B	
OUT_BRG_DG	V90X3591X	BEARING DATA GOOD	TACAN RM		BD		93017G	*
OUT_RNG_DG	V90X3593X	RANGE DATA GOOD	TACAN RM		BD		93017G	*
OUT_SEL_BRG	V90H3590C	SELECTED BEARING DATA	TACAN RM	DEG	DPL		93017G	*
OUT_SEL_RNG	V90H3592C	SELECTED RANGE DATA	TACAN RM	FT	DPL		93017G	*
Q_BOD_M50(1)/Q_B_I(1)	V90U2240CA	M50 TO BODY QUAT MEASURED ELEM 1	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(2)/Q_B_I(2)	V90U2241CA	M50 TO BODY QUAT MEASURED ELEM 2	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(3)/Q_B_I(3)	V90U2242CA	M50 TO BODY QUAT MEASURED ELEM 3	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(4)/Q_B_I(4)	V90U2243CA	M50 TO BODY QUAT MEASURED ELEM 4	A/E ATT PROC		SPL		93017G	*
REL_VEL_MAG/V	V95L0151CB	GND REL VEL MAGNITUDE IN M50 SYS	A/L UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CC	GND REL VEL MAGNITUDE IN M50 SYS	ENT UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CD	GND REL VEL MAGNITUDE IN M50 SYS	TAEM UPP	FT/S	SPL		93017G	*
RNP_TIME_UL	V90X0441X	RNP TIME PARAMETERS UPLINK CMD RCV	UL		BD		92392C	
RV_MAX	V90L3752CA	MAX REL VEL FOR BARO PROCESSING	ENT SITE LOOKUP	FT/S				
R_COV_LAST(1)	V90H0581CA	X-COMP OF POS VCT W CURR COV MTRX	D/L NAV SEQ	FT				
R_COV_LAST(2)	V90H0582CA	Y-COMP OF POS VCT W CURR COV MTRX	D/L NAV SEQ	FT				
R_COV_LAST(3)	V90H0583CA	Z-COMP OF POS VCT W CURR COV MTRX	D/L NAV SEQ	FT				
R_FILT_ONE(1)	V90H0587C	X-COMP OF FILTER CURR POS STATE 1	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_ONE(2)	V90H0588C	Y-COMP OF FILTER CURR POS STATE 1	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_ONE(3)	V90H0589C	Z-COMP OF FILTER CURR POS STATE 1	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_THREE(1)	V90H0593C	X-COMP OF FILTER CURR POS STATE 3	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_THREE(2)	V90H0594C	Y-COMP OF FILTER CURR POS STATE 3	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_THREE(3)	V90H0595C	Z-COMP OF FILTER CURR POS STATE 3	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_TWO(1)	V90H0590C	X-COMP OF FILTER CURR POS STATE 2	D/L NAV SEQ	FT	DPL		93017G	*
R_FILT_TWO(2)	V90H0591C	Y-COMP OF FILTER CURR POS STATE 2	D/L NAV SEQ	FT	DPL		93017G	*

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_FILT_TWO(3)	V90H0592C	Z-COMP OF FILTER CURR POS STATE 2	D/L NAV SEQ	FT	DPL		93017G	*
R_FINAL(1)	V90H0881CA	X-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT			89662B	
R_FINAL(2)	V90H0882CA	Y-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT				
R_FINAL(3)	V90H0883CA	Z-COMP PREDICTED SHUTTLE POS VECTR	ENT PREC PRED	FT				
R_GND(1)	V96H3500CA	UPLINKED ORBITER POS VECTOR X	UL	FT			92237	
R_GND(1)	V96H3500CC	UPLINKED ORBITER POS VECTOR X	HORIZ SIT DISP					
R_GND(2)	V96H3501CA	UPLINKED ORBITER POS VECTOR Y	UL	FT			92237	
R_GND(2)	V96H3501CC	UPLINKED ORBITER POS VECTOR Y	HORIZ SIT DISP					
R_GND(3)	V96H3502CA	UPLINKED ORBITER POS VECTOR Z	UL	FT			92237	
R_GND(3)	V96H3502CC	UPLINKED ORBITER POS VECTOR Z	HORIZ SIT DISP					
R_GPS_ECEF_SOP(1,1)	V90H3036C	GPS 1 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,2)	V90H3037C	GPS 1 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,3)	V90H3038C	GPS 1 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,1)	V90H3039C	GPS 2 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,2)	V90H3040C	GPS 2 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,3)	V90H3041C	GPS 2 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,1)	V90H3042C	GPS 3 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,2)	V90H3043C	GPS 3 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,3)	V90H3044C	GPS 3 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_SEL(1)	V90H3082C	X-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_GPS_SEL(2)	V90H3083C	Y-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_GPS_SEL(3)	V90H3084C	Z-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
SEL_LRU_ID	V90J3595C	SELECTED LRU ID	TACAN RM					
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SIG_DIAG_GPS(1)	V90H3094C	GPS NAV RESET COV DIAG ELEM 1	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(2)	V90H3095C	GPS NAV RESET COV DIAG ELEM 2	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(3)	V90H3096C	GPS NAV RESET COV DIAG ELEM 3	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(4)	V90L3097C	GPS NAV RESET COV DIAG ELEM 4	GPS RCVR STATE PROC	FT/S	SPL		92067D	
SIG_DIAG_GPS(5)	V90L3098C	GPS NAV RESET COV DIAG ELEM 5	GPS RCVR STATE PROC	FT/S	SPL		92067D	
SIG_DIAG_GPS(6)	V90L3099C	GPS NAV RESET COV DIAG ELEM 6	GPS RCVR STATE PROC	FT/S	SPL		92067D	
TACAN_AIF	V93J4470C	TAC A/I/F EDIT CMD	HORIZ SIT DISP		HXS		93017G	*
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACAN_ID(1)	V90U1802CA	TACAN 1 GND STA CHAN	ENT SITE LOOKUP					



TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
TACAN_ID(2)	V90U1803CA	TACAN 2 GND STA CHAN	ENT SITE LOOKUP					
TACAN_ID(3)	V90U1804CA	TACAN 3 GND STA CHAN	ENT SITE LOOKUP					
TIME_V/T_LAST_FILT	V90W2553CC	TIME OF SEL TOTAL M50 VEL	D/L NAV SEQ	S			92297B	
TOGHAC	V93X4477X	R/L CONE CHG CMD	HORIZ SIT DISP		BD		90302B	
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GND	V96W3520CA	UPLINKED ORB STATE VEC TIME TAG	UL	S			92237	
T_GND	V96W3520CC	UPLINKED ORB STATE VEC TIME TAG	HORIZ SIT DISP					
T_GPS_LAST_UPDATE	V90W3556CA	TIME OF NAV RESET WITH SEL GPS	D/L NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CD	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CE	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CF	TIME OF NAV RESET WITH SEL GPS	ASC NAV SEQ	S	DPL		92369B	
T_GPS_SEL	V90W3561C	GPS SEL SV TIME TAG	GPS RCVR STATE PROC	S	DPL		92067D	
T_GPS_SOP(1)	V90W3045C	GPS 1 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(2)	V90W3046C	GPS 2 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(3)	V90W3047C	GPS 3 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_HPC	V95W3400C	ADS CORRECTED PRESS ALT TIME TAG	ADTA SOP	S	DPL		93017G	*
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
T_IMU_SAVE_SOP(1)	V90W3048C	IMU TIME TAG FOR CURNT GPS 1 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(2)	V90W3049C	IMU TIME TAG FOR CURNT GPS 2 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(3)	V90W3050C	IMU TIME TAG FOR CURNT GPS 3 STATE	GPS SOP	S	DPL		92067D	
T_TACAN	V90W3596CB	TACAN TIME TAG	TACAN SOP	S				
VAR_H1	V90U3753CA	ADDITIVE BARO VARIANCE CONST	ENT SITE LOOKUP	FT2				
VAR_H2	V90U3754CA	MULTIPLICATIVE BARO VARIANCE CONST	ENT SITE LOOKUP					
VELSUMM50X(1)/V_1(1)	V95L0065C	IMU 1 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50X(2)/V_2(1)	V95L1065C	IMU 2 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50X(3)/V_3(1)	V95L2065C	IMU 3 ACCUM SENSED CHANGE X VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(1)/V_1(2)	V95L0066C	IMU 1 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(2)/V_2(2)	V95L1066C	IMU 2 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Y(3)/V_3(2)	V95L2066C	IMU 3 ACCUM SENSED CHANGE Y VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(1)/V_1(3)	V95L0067C	IMU 1 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(2)/V_2(3)	V95L1067C	IMU 2 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
VELSUMM50Z(3)/V_3(3)	V95L2067C	IMU 3 ACCUM SENSED CHANGE Z VEL	IMU INT PROC	FT/S	DPL		93017G	*
V_FILT_ONE(1)	V90L0639C	X-COMP OF FILTER CURR VEL STATE 1	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_ONE(2)	V90L0640C	Y-COMP OF FILTER CURR VEL STATE 1	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_ONE(3)	V90L0641C	Z-COMP OF FILTER CURR VEL STATE 1	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_THREE(1)	V90L0645C	X-COMP OF FILTER CURR VEL STATE 3	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_THREE(2)	V90L0646C	Y-COMP OF FILTER CURR VEL STATE 3	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_THREE(3)	V90L0647C	Z-COMP OF FILTER CURR VEL STATE 3	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_TWO(1)	V90L0642C	X-COMP OF FILTER CURR VEL STATE 2	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_TWO(2)	V90L0643C	Y-COMP OF FILTER CURR VEL STATE 2	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FILT_TWO(3)	V90L0644C	Z-COMP OF FILTER CURR VEL STATE 2	D/L NAV SEQ	FT/S	DPL		93017G	*
V_FINAL(1)	V90L0885CA	X-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
V_FINAL(2)	V90L0886CA	Y-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
V_FINAL(3)	V90L0887CA	Z-COMP PREDICTED SHUTTLE VEL VECTR	ENT PREC PRED	FT/S				
V_GND(1)	V96L3510CA	UPLINKED ORBITER VEL VECTOR X	UL	FT/S			92237	
V_GND(1)	V96L3510CC	UPLINKED ORBITER VEL VECTOR X	HORIZ SIT DISP					

TABLE 4.3.1.9-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GND(2)	V96L3511CA	UPLINKED ORBITER VEL VECTOR Y	UL	FT/S			92237	
V_GND(2)	V96L3511CC	UPLINKED ORBITER VEL VECTOR Y	HORIZ SIT DISP					
V_GND(3)	V96L3512CA	UPLINKED ORBITER VEL VECTOR Z	UL	FT/S			92237	
V_GND(3)	V96L3512CC	UPLINKED ORBITER VEL VECTOR Z	HORIZ SIT DISP					
V_GPS_ECEF_SOP(1,1)	V90L3051C	GPS 1 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,2)	V90L3052C	GPS 1 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,3)	V90L3053C	GPS 1 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,1)	V90L3054C	GPS 2 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,2)	V90L3055C	GPS 2 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,3)	V90L3056C	GPS 2 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,1)	V90L3057C	GPS 3 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,2)	V90L3058C	GPS 3 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,3)	V90L3059C	GPS 3 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_SEL(1)	V90L3108C	X-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_GPS_SEL(2)	V90L3109C	Y-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_GPS_SEL(3)	V90L3110C	Z-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_IMU_SAVE_SOP(1,1)	V95L0133C	IMU ACCUM X VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,2)	V95L0134C	IMU ACCUM Y VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,3)	V95L0135C	IMU ACCUM Z VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,1)	V95L0136C	IMU ACCUM X VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,2)	V95L0137C	IMU ACCUM Y VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,3)	V95L0138C	IMU ACCUM Z VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,1)	V95L0139C	IMU ACCUM X VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,2)	V95L0140C	IMU ACCUM Y VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,3)	V95L0141C	IMU ACCUM Z VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_LAST_FILT_ONE(1)	V90L0630C	X-COMP OF ACCUM SENSED VEL STATE 1	D/L NAV SEQ	FT/S				
V_LAST_FILT_ONE(2)	V90L0631C	Y-COMP OF ACCUM SENSED VEL STATE 1	D/L NAV SEQ	FT/S				
V_LAST_FILT_ONE(3)	V90L0632C	Z-COMP OF ACCUM SENSED VEL STATE 1	D/L NAV SEQ	FT/S				
V_LAST_FILT_THREE(1)	V90L0636C	X-COMP OF ACCUM SENSED VEL STATE 3	D/L NAV SEQ	FT/S				
V_LAST_FILT_THREE(2)	V90L0637C	Y-COMP OF ACCUM SENSED VEL STATE 3	D/L NAV SEQ	FT/S				
V_LAST_FILT_THREE(3)	V90L0638C	Z-COMP OF ACCUM SENSED VEL STATE 3	D/L NAV SEQ	FT/S				
V_LAST_FILT_TWO(1)	V90L0633C	X-COMP OF ACCUM SENSED VEL STATE 2	D/L NAV SEQ	FT/S				
V_LAST_FILT_TWO(2)	V90L0634C	Y-COMP OF ACCUM SENSED VEL STATE 2	D/L NAV SEQ	FT/S				
V_LAST_FILT_TWO(3)	V90L0635C	Z-COMP OF ACCUM SENSED VEL STATE 2	D/L NAV SEQ	FT/S				
ZERO_DELTA_T_UPDATE	V93X1041X	ZERO DELTA T UPDATE FLAG	HORIZ SIT DISP	ND	BD		92208C	
	V93J5013C	DRAG H A/I/F EDIT CMD	HORIZ SIT DISP		HXS		93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
BARO_MARK_NUM	V90J8843CC	COUNTER-BARO MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
COV_POS_SIG	V90H0438CA	RSS OF COVARIANCE POS ELEMENTS	DL FMT 23/1	FT	SPL		93017G	*
COV_VEL_SIG	V90L0439CA	RSS OF COVARIANCE VEL ELEMENTS	DL FMT 23/1	FT/S	SPL		93017G	*
DELTA_T	V93W5035CB	DELTA T UPDATE	HORIZ SIT DISP	S				
DISP_DELQ(1)	V90H0212CC	TAC AZ/OPTICS H/X/AZ MEAS RESIDUAL	DL FMT 23/A	RAD			93017G	*
			HORIZ SIT DISP					
DISP_DELQ(2)	V90H0214CC	TAC R/OPTICS V/Y/EL MEAS RESIDUAL	DL FMT 23/A	NM			93017G	*
			HORIZ SIT DISP					
DISP_DELQ(3)	V90H0221CC	BARO ALT/RR RNG MEAS RESIDUAL	HORIZ SIT DISP					
DISP_DELQ(4)	V90A0711CA	DRAG ALT/RR R DOT MEAS RESIDUAL	DL FMT 23/A	FT			93017G	*
			HORIZ SIT DISP					
DISP_EDIT(1)	V90X0213XC	TAC AZ/OPTICS H/X/AZ EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			HORIZ SIT DISP					
DISP_EDIT(2)	V90X0215XC	TAC R/OPTICS V/Y/EL EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			HORIZ SIT DISP					
DISP_EDIT(3)	V90X0223XC	BARO ALT/RR RNG EDIT HIST IND	HORIZ SIT DISP					
DISP_EDIT(4)	V90X0712XA	DRAG ALT/RR R DOT EDIT HIST IND	GAX					
			HORIZ SIT DISP					
			TLM					
DISP_SIG(1)	V90U0216CC	TAC AZ/OPTICS H/X/AZ RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
			TACAN RM					
DISP_SIG(2)	V90U0217CC	TAC R/OPTICS V/Y/EL RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
DISP_SIG(3)	V90U0222CC	BARO ALT/RR RNG RESID RATIO	HORIZ SIT DISP					
DISP_SIG(4)	V90U0713CA	DRAG ALT/RR R DOT RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
DO_BARO_NAV	V90X0259XC	FLAG IND BARO ALT BEING PROCESSED	DL FMT 23/1				93017G	*
DO_DRAG_NAV	V90U8847CB	FLAG IND DRAG ALT BEING PROCESSED	DL FMT 23/1				93017G	*
DO_TACAN_NAV	V90U8846CB	FLG IND TACAN DATA BEING PROCESSED	DL FMT 23/1				93017G	*
DRAG_MARK_NUM	V90J8844CB	COUNTER-DRAG MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
DR_RW(1)	V93H5010CB	NAV UPDATE DELTA X POSITION	HORIZ SIT DISP	FT				
DR_RW(2)	V93H5011CB	NAV UPDATE DELTA Y POSITION	HORIZ SIT DISP	FT				
DR_RW(3)	V93H5012CB	NAV UPDATE DELTA Z POSITION	HORIZ SIT DISP	FT				
DT_MAX	V90U8500CI	MAX ALLOW TIME STEP SIZE	ENT PREC PRED	S				
DV_RW(1)	V93L5020CB	NAV UPDATE DELTA X VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(2)	V93L5021CB	NAV UPDATE DELTA Y VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(3)	V93L5022CB	NAV UPDATE DELTA Z VELOCITY	HORIZ SIT DISP	FT/S				
ELEV_ANG	V90U0720CA	TACAN/SHUTTLE ELEV ANG	DL FMT 23/A				93017G	*
FILT_UPDATE	V90X0224XE	FLAG IND NAV FILTER PROC COMPLETE	A/L UPP					
			ENT UPP					
			TAEM UPP					
FOM(1)	V94H0982CA	GPS 1 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	
FOM(2)	V94H0983CA	GPS 2 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
FOM(3)	V94H0984CA	GPS 3 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	
GMD_PRED	V90U8501CJ	GRAVITY MODEL DEGREE	ENT PREC PRED					
GMO_PRED	V90U8502CJ	GRAVITY MODEL ORDER	ENT PREC PRED					
GPS_AIF_EXEC	V94X1041XA	GPS TO G&C EXEC STATUS	GPS STATUS DISP		BD		91051K	
GPS_AIF_RCVD	V94J1042CA	GPS TO G&C AUT/INH/FOR FLAG FDBK	HORIZ SIT DISP GPS RCVR STATE PROC GPS STATUS DISP		HXS		91051K	
GPS_DG(1)	V90X3450XA	GPS 1 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_DG(2)	V90X3451XA	GPS 2 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_DG(3)	V90X3452XA	GPS 3 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(1)	V90X3453XA	GPS 1 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(2)	V90X3454XA	GPS 2 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(3)	V90X3455XA	GPS 3 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_REF_INIT_VALID	V90X3642XB	GPS INIT REF STATE VALID FLAG	GPS REF STATE PROC		BD		92067D	
GPS_TO_NAV_AIF	V90J3463CA	GPS TO NAV AUTO/INHIBIT/FORCE FDBK	GPS RCVR STATE PROC GPS STATUS DISP HORIZ SIT DISP		HXS		92132C	
GPS_TO_NAV_FORCE_RCVD	V90X3461XA	GPS TO NAV FORCE FLAG FDBK	GPS RCVR STATE PROC		BD		91051K	
GPS_TO_NAV_RCVD	V90X3462XA	GPS TO NAV AUT/INH FLAG FDBK	GPS RCVR STATE PROC		BD		91051K	
GPS_UPP_UPDATE	V90X3643XA	GPS UPP DISP RES STATE AVAIL FLAG	A/L UPP ENT UPP TAEM UPP		BD		92067D	
G_GPS_INIT(1)	V90A2619CB	X GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CB	Y GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CB	Z GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_UPP(1)	V90A3630CA	SELECTED GPS STATE X GRAV	A/L UPP ENT UPP TAEM UPP	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CA	SELECTED GPS STATE Y GRAV	A/L UPP ENT UPP TAEM UPP	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CA	SELECTED GPS STATE Z GRAV	A/L UPP ENT UPP TAEM UPP	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CE	SEL X-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
G_RESET(2)	V90A0244CE	SEL Y-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
G_RESET(3)	V90A0245CE	SEL Z-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
METER_FLAG	V90X3678XA	UPP RES STTE METERING FLAG	GPS RCVR STATE PROC		BD		92067D	
METER_SF	V90U3677CA	UPP RES STTE METERING SCALE FACTOR	GPS RCVR STATE PROC		SPL		92067D	

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
MLS_AIF_RCVD	V94J6039CC	MLS AUTO/INH/FOR FLAG FDBK	GPS RCVR STATE PROC		HXS		92571B	
NAV_ALT_FLAG	V90X8901XA	NAV EDIT ALTITUDE CREW ALERT	E/L EV AN PROC HUD PROC					
NAV_EDIT_IND	V95X0305XA	NAV EDIT INDICATOR FLAG	DL FMT 23/A				93017G	*
NAV_MLS_FLAG	V90X8903XA	NAV EDIT MSBLS CREW ALERT	HUD PROC					
NAV_MM_CODE	V90J4263CA	NAV MM CODE	GPS RCVR STATE PROC		HXS		91051K	
NAV_TAC_FLAG	V90X8902XA	NAV EDIT TACAN CREW ALERT	E/L EV AN PROC HUD PROC					
ONE_BRG_LOCK	V90X0769XA	TACAN RM 1 LRU BRG LOCKON RQMT FLG	DL FMT 23/1 TACAN RM				93017G	*
ONE_RANGE_LOCK	V90X0768XA	TACAN RM 1 LRU RNG LOCKON RQMT FLG	DL FMT 23/1 TACAN RM				93017G	*
OTREQ	V90X0893XD	OPS TRANSITION REQUEST FLAG	ENT PREC PRED		BD		90121B	
PROCESSING_MLS	V94X6041XC	FLAG IND MLS BEING PROCESSED	HORIZ SIT DISP		BD		92067D	
Q_BARO	V90P8871CB	DATA SNAP-ADS CORR PRESSURE ALT	DL FMT 23/1				93017G	*
Q_DRAG	V90U8848CB	DRAG MEASUREMENT	DL FMT 23/1				93017G	*
Q_TAC_BRG	V90H8868CB	DATA SNAP-SELECTED TACAN BEARING	DL FMT 23/1				93017G	*
Q_TAC_R	V90H8867CB	DATA SNAP-SELECTED TACAN RANGE	DL FMT 23/1				93017G	*
R_FILT(1)	V90H0584CE	X-COMP OF FLTR'S CURR POS VECTOR	D/L NAV SEQ	FT			92281D	
			GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV					
R_FILT(2)	V90H0585CE	Y-COMP OF FLTR'S CURR POS VECTOR	D/L NAV SEQ	FT			92281D	
			GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV					
R_FILT(3)	V90H0586CE	Z-COMP OF FLTR'S CURR POS VECTOR	D/L NAV SEQ	FT			92281D	
			GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV					
R_GPS_ECEF(1,1)	V90H3467CA	GPS 1 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(1,2)	V90H3468CA	GPS 1 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(1,3)	V90H3469CA	GPS 1 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,1)	V90H3470CA	GPS 2 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,2)	V90H3471CA	GPS 2 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,3)	V90H3472CA	GPS 2 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,1)	V90H3473CA	GPS 3 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,2)	V90H3474CA	GPS 3 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,3)	V90H3475CA	GPS 3 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CA	GPS INIT POS VECTOR X-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CA	GPS INIT POS VECTOR Y-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CA	GPS INIT POS VECTOR Z-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_UPP(1)	V90H3624CA	SELECTED GPS STATE X POS	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_GPS_UPP(2)	V90H3625CA	SELECTED GPS STATE Y POS	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CA	SELECTED GPS STATE Z POS	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	
R_INIT(X)	V90H8508CJ	X-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_INIT(Y)	V90H8509CJ	Y-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_INIT(Z)	V90H8510CJ	Z-COMP SHUTTLE POS VECTR AT T_INIT	ENT PREC PRED	FT				
R_RESET(1)	V90H0235CE	SEL X-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92281D	
R_RESET(2)	V90H0236CE	SEL Y-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92281D	
R_RESET(3)	V90H0237CE	SEL Z-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL		92281D	
SEL_LRU_ID	V90J8864CB	DATA SNAP-TACAN LRU NUMBER	DL FMT 23/1				93017G	*
SENSOR_EDIT(1)	V90U8841CA	TAC AZ/OPTICS H/X/AZ FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(2)	V90J8880CA	TAC R/OPTICS V/Y/EL FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(3)	V90J8881CA	BARO ALT/RR RNG FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(4)	V90J8882CC	DRAG ALT/RR R DOT FILTER FLAG	DL FMT 23/A				93017G	*
TACAN_MARK_NUM	V90J8842CB	COUNTER-TACAN MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
TAC_BRG_DATA_GOOD	V90X0718XA	SNAPPED TAC BRG DATA GOOD	TLM					
TIME_V/T_LAST_FILT	V90W2553CD	TIME OF SEL TOTAL M50 VEL	D/L NAV SEQ PRELAND NAV					
T_CURRENT_FILT	V90W4749CC	SNAP TIME TAG CURR IMU/ATT DATA	GPS RCVR STATE PROC HORIZ SIT DISP	S	DPL		92281D	
T_FINAL	V90W8506CJ	TIME AT WHICH STATE IS DESIRED	ENT PREC PRED	S				
T_GPS(1)	V90W3479CA	GPS 1 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS(2)	V90W3480CA	GPS 2 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS(3)	V90W3481CA	GPS 3 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS_INIT	V90W3482CA	GPS INIT STATE TIME TAG	GPS REF STATE PROC	S	DPL		91051K	
T_GPS_LAST_UPDATE	V90W3556CB	TIME OF NAV RESET WITH SEL GPS	GPS RCVR STATE PROC ORB/RND NAV PRELAND NAV	S	DPL		92369B	
T_GPS_SEL	V90W3561CA	GPS SEL SV TIME TAG	PRELAND NAV	S	DPL		91051K	
T_GPS_UPP	V90W3636CA	TIME OF SELECTED GPS STATE	A/L UPP ENT UPP TAEM UPP	S	DPL		92067D	
T_INIT	V90W8512CH	TIME AT BEGINNING OF PRED	ENT PREC PRED	S				
T_LAST_GPS(1)	V90W3483CA	CURRENT GPS 1 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		92214A	
T_LAST_GPS(2)	V90W3484CA	CURRENT GPS 2 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		91051K	
T_LAST_GPS(3)	V90W3485CA	CURRENT GPS 3 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		91051K	

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
T_RESET	V90W0534CE	TIME OF FILTER STATE VECTOR	A/L UPP DL FMT 23/1 ENT UPP GPS RCVR STATE PROC TAEM UPP	S			93017G	*
USE_IMU_DATA	V90X0538XD	FLAG TO USE IMU ACCUM VEL OR NOT	DL FMT 23/A				93017G	*
V_CURRENT_FILT(1)	V90L8927CE	SNAPPED SEL TOTAL X VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_CURRENT_FILT(2)	V90L8928CE	SNAPPED SEL TOTAL Y VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_CURRENT_FILT(3)	V90L8929CE	SNAPPED SEL TOTAL Z VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_FILT(1)	V90L0624CE	X-COMP OF FLTR'S CURR VEL VECTOR	D/L NAV SEQ GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV	FT/S	SPL		92281D	
V_FILT(2)	V90L0625CE	Y-COMP OF FLTR'S CURR VEL VECTOR	D/L NAV SEQ GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV	FT/S	SPL		92281D	
V_FILT(3)	V90L0626CE	Z-COMP OF FLTR'S CURR VEL VECTOR	D/L NAV SEQ GPS RCVR STATE PROC HORIZ SIT DISP PRELAND NAV	FT/S	SPL		92281D	
V_GPS_ECEF(1,1)	V90L3486CA	GPS 1 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(1,2)	V90L3487CA	GPS 1 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(1,3)	V90L3488CA	GPS 1 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,1)	V90L3489CA	GPS 2 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,2)	V90L3490CA	GPS 2 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,3)	V90L3491CA	GPS 2 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,1)	V90L3492CA	GPS 3 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,2)	V90L3493CA	GPS 3 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,3)	V90L3494CA	GPS 3 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CA	GPS INIT VEL VECTOR X-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CA	GPS INIT VEL VECTOR Y-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CA	GPS INIT VEL VECTOR Z-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_UPP(1)	V90L3627CA	SELECTED GPS STATE X VEL	A/L UPP ENT UPP TAEM UPP	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CA	SELECTED GPS STATE Y VEL	A/L UPP ENT UPP TAEM UPP	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CA	SELECTED GPS STATE Z VEL	A/L UPP ENT UPP TAEM UPP	FT/S	SPL		92067D	
V_IMU_GPS_INIT(1)	V90L3506CA	IMU ACCUM X VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CA	IMU ACCUM Y VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CA	IMU ACCUM Z VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	

TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_IMU_GPS_UPP(1)	V90L3633CA	SELECTED GPS STATE X ACCUM VEL CNT	A/L UPP ENT UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CA	SELECTED GPS STATE Y ACCUM VEL CNT	A/L UPP ENT UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CA	SELECTED GPS STATE Z ACCUM VEL CNT	A/L UPP ENT UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_RESET(1)	V90L0247CE	SEL X-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(2)	V90L0248CE	SEL Y-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(3)	V90L0249CE	SEL Z-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_INIT(X)	V90L8513CJ	X-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_INIT(Y)	V90L8514CJ	Y-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_INIT(Z)	V90L8515CJ	Z-COMP SHUTTLE VEL VECTR AT T_INIT	ENT PREC PRED	FT/S				
V_LAST_GPS(1,1)	V90L3515CA	IMU ACCUM X VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(1,2)	V90L3516CA	IMU ACCUM Y VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(1,3)	V90L3517CA	IMU ACCUM Z VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,1)	V90L3518CA	IMU ACCUM X VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,2)	V90L3519CA	IMU ACCUM Y VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,3)	V90L3520CA	IMU ACCUM Z VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,1)	V90L3521CA	IMU ACCUM X VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,2)	V90L3522CA	IMU ACCUM Y VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,3)	V90L3523CA	IMU ACCUM Z VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_RESET(1)	V90L0239CE	SEL X-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92281D	
V_RESET(2)	V90L0240CE	SEL Y-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92281D	
V_RESET(3)	V90L0241CE	SEL Z-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S			92281D	
	V90M2852PD	CGEB_FLT_LG3_FLAG2_LFE	DL FMT 23/A				93017G	*
	V90M2932PC	CGNB_NAV_CONTROL_FLAGS	DL FMT 23/1				93017G	*
	V90M2933PC	CGNB_DISP_EDIT	DL FMT 23/A				93017G	*
	V90M2990PA	CGNB_ONE_LOCK_LFE\$(2:)	DL FMT 23/1				93017G	*
	V90M2991PA	CGNB_ONE_LOCK_LFE\$(1:)	DL FMT 23/1				93017G	*
	V90M2993PA	CGNB_MC163_FLAG2	DL FMT 23/A				93017G	*



TABLE 4.3.1.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY NAVIGATION (G4.127)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
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**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_BARO_CUTOFF_LOW	V99U8720C	FT	F	S	D	P	G4.127 G4.144 G4.17 G4.205	00	ZFT	91051K	
BASE_DEN(1)	V97U5235C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(10)	V99U9617C	SLUGS/FT**3	F	D	D	C	G4.127	00	PS4	DC0599	
BASE_DEN(11)	V99U9618C	SLUGS/FT**3	F	D	D	C	G4.127	00	PS4	DC0599	
BASE_DEN(12)	V99U9619C	SLUGS/FT**3	F	D	D	C	G4.127	00	PS4	DC0599	
BASE_DEN(2)	V97U5236C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(3)	V97U5237C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(4)	V97U5238C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(5)	V99U9600C	SLUGS/FT**3	F	D	D	C	G4.127	00	PN4	DC0599	
BASE_DEN(6)	V99U9601C	SLUGS/FT**3	F	D	D	C	G4.127	00	PN4	DC0599	
BASE_DEN(7)	V99U9602C	SLUGS/FT**3	F	D	D	C	G4.127	00	PN4	DC0599	
BASE_DEN(8)	V99U9603C	SLUGS/FT**3	F	D	D	C	G4.127	00	PN4	DC0599	
BASE_DEN(9)	V99U9616C	SLUGS/FT**3	F	D	D	C	G4.127	00	PS4	DC0599	
BIAS_DRAG_LAYER(1)	V97U5243C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(10)	V99U9621C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
BIAS_DRAG_LAYER(11)	V99U9622C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
BIAS_DRAG_LAYER(12)	V99U9623C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
BIAS_DRAG_LAYER(2)	V97U5244C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(3)	V97U5245C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(4)	V97U5246C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
BIAS_DRAG_LAYER(5)	V99U9604C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
BIAS_DRAG_LAYER(6)	V99U9605C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
BIAS_DRAG_LAYER(7)	V99U9606C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
BIAS_DRAG_LAYER(8)	V99U9607C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
BIAS_DRAG_LAYER(9)	V99U9620C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
C_DRAG_ONE	V97U5277C	RAD** -1	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	
C_DRAG_TWO	V97U5278C	RAD** -2	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	
C_DRAG_ZERO	V97U5279C	ND	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	
DEL_TIME_STEP	V97U6548C	SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.198 G4.205	01 03	ZFT ZFT	93045A	
DENSITY_LIMIT(1)	V97U5310C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(10)	V99U9625C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
DENSITY_LIMIT(11)	V99U9626C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
DENSITY_LIMIT(12)	V99U9627C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
DENSITY_LIMIT(2)	V97U5311C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(3)	V97U5312C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(4)	V97U5313C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(5)	V99U9608C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
DENSITY_LIMIT(6)	V99U9609C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
DENSITY_LIMIT(7)	V99U9610C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
DENSITY_LIMIT(8)	V99U9611C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
DENSITY_LIMIT(9)	V99U9624C	FT	F	S	D	C	G4.127	00	PS4	DC0599	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
DRAG_CONST	V97U5317C	FT**2/SLUG	F	D	M	C	G4.123 G4.127 G4.144 G4.15 G4.223 G4.236	01 03	DC1 DC3	92287B	
GPS_ALT_FOR_HIGH_RATE_NAV	V97U3621C	FT	F	S	D	C	G4.127 G4.144 G4.205	00	GP3	93201	*
GPS_SEL_AGE_MAX	V97U3672C	MIN	F	S	D	P	G4.127 G4.144 G4.205	00	GP3	92274	
GPS_UPDATE_ALT_FLOOR	V97U3622C	FT	F	S	D	P	G4.127 G4.144 G4.205	00	GP3	92178C	
K_MAX	V97U5348C	ND	I	S	D	C	G4.127 G4.144 G4.15 G4.205	00	ZFT	DC0617	
K_UND_WGT	V97U5350C	ND	F	S	M	X	G4.126 G4.127 G4.144 G4.15 G4.205	01 02 03	ZFT ZPA ZFT	DC0617	
METERING_CUTOFF_VEL	V97U3258C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	00	GPM	92469A	
MS_POS_UND_WGT	V97U5411C	FT**2	F	S	D	X	G4.126 G4.127 G4.144 G4.15 G4.205	01 02 03	ZFT ZPA ZFT	DC0617	
SCALE_HT(1)	V97U5501C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
SCALE_HT(10)	V99U9629C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
SCALE_HT(11)	V99U9630C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
SCALE_HT(12)	V99U9631C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
SCALE_HT(2)	V97U5502C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
SCALE_HT(3)	V97U5503C	FT	F	S	M	C	G4.127 G4.144 G4.15	01 03	PR4 PE4	DC0599	
SCALE_HT(4)	V97U5504C	FT	F	S	M	C	G4.205 G4.127 G4.144 G4.15	01 03	PR4 PE4	DC0599	
SCALE_HT(5)	V99U9612C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
SCALE_HT(6)	V99U9613C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
SCALE_HT(7)	V99U9614C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
SCALE_HT(8)	V99U9615C	FT	F	S	D	C	G4.127	00	PN4	DC0599	
SCALE_HT(9)	V99U9628C	FT	F	S	D	C	G4.127	00	PS4	DC0599	
T_GPS_CYCLE	V97U2926C	SEC	F	S	D	P	G4.126 G4.127 G4.144 G4.205	03 08 02 01	GP3 GP2 GP2 GP3	92178C	
T_GPS_CYCLE_FOR_HIGH_RATE_NAV	V97U3247C	SEC	F	S	D	C	G4.127 G4.144 G4.205	00	GP3	93201	*
UA(1)	V97U5951C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UA(2)	V97U5952C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UB(1)	V97U5953C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UB(2)	V97U5954C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UBKPOINT	V97U5955C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UDA(1)	V97U5972C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
UDA (2)	V97U5973C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDB (1)	V97U5974C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDB (2)	V97U5975C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDBKPOINT	V97U5976C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDMETER_MAX	V97U5977C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDMETER_MIN	V97U5978C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UMETER_MAX	V97U5956C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UMETER_MIN	V97U5957C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VA (1)	V97U5958C	ND	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VA (2)	V97U5959C	ND	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VB (1)	V97U5960C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
VB (2)	V97U5961C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VBKPOINT	V97U5962C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDA (1)	V97U5979C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDA (2)	V97U5980C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDB (1)	V97U5981C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDB (2)	V97U5982C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDBKPOINT	V97U5983C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDMETER_MAX	V97U5984C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDMETER_MIN	V97U5985C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VMETER_MAX	V97U5963C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VMETER_MIN	V97U5964C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	

TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
WA(1)	V97U5965C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WA(2)	V97U5966C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WB(1)	V97U5967C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WB(2)	V97U5968C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WBKPOINT	V97U5969C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDA(1)	V97U5986C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDA(2)	V97U5987C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDB(1)	V97U5988C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDB(2)	V97U5989C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDBKPOINT	V97U5990C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDMETER_MAX	V97U5991C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	



TABLE 4.3.1.9-3. ENTRY NAVIGATION (G4.127) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
WDMETER_MIN	V97U5992C	FT/SEC	F	S	D	P	G4.127	01	GPM	92469A	
							G4.144	03	GPM		
							G4.15				
WMETER_MAX	V97U5970C	FT	F	S	D	P	G4.205	01	GPM	92469A	
							G4.127	03	GPM		
							G4.144				
WMETER_MIN	V97U5971C	FT	F	S	D	P	G4.15	01	GPM	92469A	
							G4.205	03	GPM		
							G4.127				

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
A3_TOL	V98U9425C	00	-3.0	E-03 RAD	F	S	C	G4.127 G4.144 G4.19 G4.20 G4.205 G4.23 G5.27	93090E	
ACC_DRAG_MIN ACC_DRAG_MIN_REF	V97U5200C	00	+1.1000000	E+01 FT/SEC**2	F	S	C	G4.127 G4.144 G4.15 G4.205	59971	
ACC_PROP_MIN MIN ACCEL VENT DRAG NOT USED	V97U5586C	00	+3.2	E-02 FT/SEC**2	F	S	P	G4.127 G4.144	59971	
ALT_EL(1) ALT REGIONS NAV EV LAMP PROCESSING	V97U5212C	00	+1.4000000	E+05 FT	F	S	P	G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(2) ALT REGIONS NAV EV LAMP PROCESSING	V97U5213C	00	+1.2000000	E+04 FT	F	S	P	G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(3) ALT REGIONS NAV EV LAMP PROCESSING	V97U5214C	00	+5.0	E+03 FT	F	S	P	G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	90291B	
ALT_ZONE_CHANGE ALT MODEL ATMOS DEN CHANGED	V97U5718C	00	+5.0000000	E+05 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
BIAS_BARO BAROMETRIC DETERMINISTIC BIAS	V97U5242C	00	+0.0	E+00 FT	F	S	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(1) COVAR CORRELATION COEFFICIENTS	V97U5291C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
CORR_COEFF_UPDATE(2) COVAR CORRELATION COEFFICIENTS	V97U5292C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(3) COVAR CORRELATION COEFFICIENTS	V97U5293C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(4) COVAR CORRELATION COEFFICIENTS	V97U5294C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(5) COVAR CORRELATION COEFFICIENTS	V97U5295C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(6) COVAR CORRELATION COEFFICIENTS	V97U5296C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(7) COVAR CORRELATION COEFFICIENTS	V97U5297C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEF_UPDATE_M50(1) COVAR CORRELATION COEFFICIENTS	V98U9815C	00	+0.0	E+00 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(2) COVAR CORRELATION COEFFICIENTS	V98U9816C	00	+0.0	E+00 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(3) COVAR CORRELATION COEFFICIENTS	V98U9817C	00	-9.0	E-01 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(4) COVAR CORRELATION COEFFICIENTS	V98U9818C	00	-9.0	E-01 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(5) COVAR CORRELATION COEFFICIENTS	V98U9819C	00	+0.0	E+00 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(6) COVAR CORRELATION COEFFICIENTS	V98U9820C	00	+0.0	E+00 ND	F	D	C	G4.127	89661A	
CORR_COEF_UPDATE_M50(7) COVAR CORRELATION COEFFICIENTS	V98U9821C	00	+0.0	E+00 ND	F	D	C	G4.127	89661A	
DENSE(1) DENSITY MODEL CONST	V97U5304C	00	-3.9570	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(2) DENSITY MODEL CONST	V97U5305C	00	+1.0440	E-05 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DENSE(3) DENSITY MODEL CONST	V97U5306C	00	+6.9560000	E+06 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(4) DENSITY MODEL CONST	V97U5307C	00	-2.420	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(5) DENSITY MODEL CONST	V97U5308C	00	-2.8890	E-06 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(6) DENSITY MODEL CONST	V97U5309C	00	+2.6050000	E+06 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD1	V96U9743C	00	+3.9589	E-01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD2	V96U9744C	00	+3.3962	E+00 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD3	V96U9745C	00	+6.5414	E-01 RAD	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DIFCD4	V96U9746C	00	+8.3589	E-01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
H_DRAG_LOW	V97U5336C	00	+8.5200000	E+04 FT	F	S	C	G4.127 G4.205	89661A	
ALT BELOW DRAG DATA NOT PROC	V98U7977C	00	+4	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
K_EDIT_DRAG	V98U7978C	00	+64	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
K_EDIT_TACBR	V98U7976C	00	+1	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
K_EDIT_TACR	V98U7975C	00	+64	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
MAX_TIME_TOL MAX ALLOWABLE TOTAL PREDICTION INTERVAL	V96U8685C	00	+5.4	E+04 SEC	F	S	P	G4.126 G4.127 G4.148 G4.15 G6.11	92834C	
RNG_VAR_BEARING_STEP RNG CRIT SEL TACAN AZ INSTR	V97U5467C	00	+9.1141700	E+05 FT	F	S	C	G4.127 G4.144 G4.205	89661A	
RNG_VAR_RNG_STEP RNG CRIT SEL TACAN RNG VAR	V97U5468C	00	+3.0380500	E+05 FT	F	S	C	G4.127 G4.144 G4.205	89661A	
SEA_LEVEL_DENSITY SEA LEVEL ATOMOSPHERIC DENSITY	V97U5505C	00	+2.3768840	E-03 SLUGS/FT**3	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
SIG_DIAG_UPDATE(1) VEH POS & VEL DEVIATIONS	V97U5506C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(2) VEH POS & VEL DEVIATIONS	V97U5507C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(3) VEH POS & VEL DEVIATIONS	V97U5508C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
SIG_DIAG_UPDATE(4) VEH POS & VEL DEVIATIONS	V97U5509C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(5) VEH POS & VEL DEVIATIONS	V97U5510C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(6) VEH POS & VEL DEVIATIONS	V97U5511C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE_M50(1) VEH POS & VEL DEVIATIONS	V98U9822C	00	+1.000	E+03 FT	F	D	C	G4.127	89661A	
SIG_DIAG_UPDATE_M50(2) VEH POS & VEL DEVIATIONS	V98U9823C	00	+5.000	E+03 FT	F	D	C	G4.127	89661A	
SIG_DIAG_UPDATE_M50(3) VEH POS & VEL DEVIATIONS	V98U9824C	00	+1.000	E+03 FT	F	D	C	G4.127	89661A	
SIG_DIAG_UPDATE_M50(4) VEH POS & VEL DEVIATIONS	V98U9825C	00	+1.0	E+01 FT/SEC	F	D	C	G4.127	89661A	
SIG_DIAG_UPDATE_M50(5) VEH POS & VEL DEVIATIONS	V98U9826C	00	+1.0	E+00 FT/SEC	F	D	C	G4.127	89661A	
SIG_DIAG_UPDATE_M50(6) VEH POS & VEL DEVIATIONS	V98U9827C	00	+1.0	E+00 FT/SEC	F	D	C	G4.127	89661A	
TACAN_BRG_CONVERG_TEST	V98U9807C	00	+1.0	E-02 RAD**2	F	S	P	G4.127 G4.144 G4.205	89661A	
TACAN_RNG_CONVERG_TEST	V98U9808C	00	+4.0000000	E+07 FT**2	F	S	P	G4.127 G4.144 G4.205	89661A	
TIME_BIAS_BARO PAD BIAS CORR BARO TIME TAG	V97U5544C	00	+1.790	E-01 SEC	F	D	C	G4.127 G4.144 G4.17 G4.205	92069B	
TIME_BIAS_TACAN PAD LOADED CORR TACAN TIME LAG	V97U5543C	00	+2.90	E-02 SEC	F	D	P	G4.127 G4.144 G4.205	89661A	
VAR_ACC_QUANT_COAST NOISE ERROR VAR UNPOWERED FLIGHT	V97U5549C	00	+9.0	E-05 FT**2/SEC**2	F	S	C	G4.127 G4.144	59971	
VAR_ACC_QUANT_IMU ACCELEROMETER QUANTIZATION ERROR	V97U5550C	00	+9.0	E-05 FT**2/SEC**2	F	S	C	G4.127 G4.144	59971	
VAR_DRAG DRAG ALT MEASURE ERROR VARIANCE	V97U5552C	00	+1.0000000	E+08 FT**2	F	S	C	G4.127 G4.205	89661A	
VAR_TAC_BRG_HIGH TACAN BRG INSTR VAR AT RANGE	V97U5557C	00	+1.0	E-02 RAD**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_TAC_BRG_LOW VAR TACAN BRGN INSTRUMENT ERROR	V97U5558C	00	+1.0	E-02 RAD**2	F	S	C	G4.127 G4.144 G4.205	89661A	

TABLE 4.3.1.9-4. ENTRY NAVIGATION (G4.127) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
VAR_TAC_R_HIGH TACAN RNG INSTR VAR AT RANGE	V97U5559C	00	+3.6000000	E+05 FT**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_TAC_R_LOW VAR TACAN RANGE INSTR ERROR	V97U5560C	00	+3.6	E+05 FT**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_UNMOD_ACC_DT_COAST VAR ACCEL SCALE UNPOWRD FLIGHT	V97U5561C	00	+5.0	E-04 FT**2/SEC**3	F	S	C	G4.127 G4.144	59971	
VAR_UNMOD_ACC_DT_IMU VAR ACCEL SCALE POWERED FLIGHT	V97U5562C	00	+2.5000000	E-01 FT**2/SEC**3	F	S	C	G4.127 G4.144	59971	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
C(01) TESSERAL HARMONIC COEFFICIENT ELEM 1	V97U6104C	00	-2.7635957	E-10	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(02) TESSERAL HARMONIC COEFFICIENT ELEM 2	V97U6105C	00	+1.5711423	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(03) TESSERAL HARMONIC COEFFICIENT ELEM 3	V97U6106C	00	+2.1907694	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(04) TESSERAL HARMONIC COEFFICIENT ELEM 4	V97U6107C	00	+3.0466825	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(05) TESSERAL HARMONIC COEFFICIENT ELEM 5	V97U6108C	00	+9.7966803	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	



TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
C(06) TESSERAL HARMONIC COEFFICIENT ELEM 6	V97U6109C	00	-5.0552749	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(07) TESSERAL HARMONIC COEFFICIENT ELEM 7	V97U6110C	00	+7.8842515	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(08) TESSERAL HARMONIC COEFFICIENT ELEM 8	V97U6111C	00	+5.9073749	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(09) TESSERAL HARMONIC COEFFICIENT ELEM 9	V97U6112C	00	-4.1542493	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S	C A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_MU EARTH GRAVITATIONAL CONSTANT	V97U4378C	00	+1.40764487566E+16	FT**3/SEC**2	F	D	C	A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.2 G4.205 G4.209 G4.210 G4.211 G4.224 G4.236 G4.3 G4.4 G5.10 G5.24 G5.26 G5.27	93090E	
EARTH_RADIUS_EQUATOR EARTH EQUATORIAL RADIUS	V97U5324C	00	+2.09257414698E+07	FT	F	D	C	A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.19 G4.20 G4.205 G4.210 G4.211 G4.213 G4.23 G4.236 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RADIUS_GRAV EARTH RADIUS(GRAV ACCEL)	V97U5325C	00	+2.09256561680E+07	FT	F	D	C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
EARTH_RATE EARTH'S ROTATIONAL RATE	V97U4379C	00	+7.29211514646E-05	RAD/SEC	F	D	C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.17 G4.19 G4.20 G4.205 G4.21 G4.213 G4.22 G4.236 G4.237 G4.4 G5.26	93090E	
ELLIPT EARTH'S ELLIPTICITY CONSTANT	V97U5332C	00	+3.352329869 E-03	ND	F	D	C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.19 G4.20 G4.205 G4.213 G4.23 G4.236 G4.237 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EPS_TAG LIMIT FOR THE DIFFERENCE BETWEEN MEAS TIME TAG	V97U6122C	00	+5.0	E-04	SEC	F	S	C G4.127 G4.144 G4.205	90374C	
ID_MATRIX_3X3(01) COMPONENT OF 3X3 IDENTITY MATRIX (1,1)	V97U6196C	00	+1.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(02) COMPONENT OF 3X3 IDENTITY MATRIX (1,2)	V97U6197C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(03) COMPONENT OF 3X3 IDENTITY MATRIX (1,3)	V97U6198C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(04) COMPONENT OF 3X3 IDENTITY MATRIX (2,1)	V97U6199C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(05) COMPONENT OF 3X3 IDENTITY MATRIX (2,2)	V97U6200C	00	+1.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(06) COMPONENT OF 3X3 IDENTITY MATRIX (2,3)	V97U6201C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(07) COMPONENT OF 3X3 IDENTITY MATRIX (3,1)	V97U6202C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(08) COMPONENT OF 3X3 IDENTITY MATRIX (3,2)	V97U6203C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ID_MATRIX_3X3(09) COMPONENT OF 3X3 IDENTITY MATRIX (3,3)	V97U6204C	00	+1.0	E+00 ND	F	S	C	G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
KN1 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6206C	00	-1.7980000	E+00 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN2 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6207C	00	+6.6670000	E-06 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN3 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6208C	00	-5.7890000	E-12 FT**-2	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN4 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6209C	00	+2.7518150	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN5 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6210C	00	-1.4990900	E-04 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN6 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6211C	00	+2.0490000	E-10 FT**-2	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04	NMI/FT	F	S	C A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	
PI RATIO OF CIRCUMFERENCE TO DIAMETER	V98U8725C	00	+3.14159265358E+00	ND		F	D	C A6.9 G4.126 G4.127 G4.13 G4.144 G4.15 G4.158 G4.16 G4.19 G4.2 G4.20 G4.205 G4.209 G4.210 G4.213 G4.220 G4.236 G4.237 G4.3 G4.4 G4.5 G4.97 G5.10 G5.24 G5.26 G5.27	93090E	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	
S(01) TESSERAL HARMONIC COEFFICIENT ELEM 1	V97U5492C	00	-5.2357454	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	



TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
S(02) TESSERAL HARMONIC COEFFICIENT ELEM 2	V97U5493C	00	-9.0231337	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(03) TESSERAL HARMONIC COEFFICIENT ELEM 3	V97U5494C	00	+2.7267074	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(04) TESSERAL HARMONIC COEFFICIENT ELEM 4	V97U5495C	00	-2.1259298	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(05) TESSERAL HARMONIC COEFFICIENT ELEM 5	V97U5496C	00	+1.9681077	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(06) TESSERAL HARMONIC COEFFICIENT ELEM 6	V97U5497C	00	-4.4125015	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
S(07) TESSERAL HARMONIC COEFFICIENT ELEM 7	V97U5498C	00	+1.4818958	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(08) TESSERAL HARMONIC COEFFICIENT ELEM 8	V97U5499C	00	-1.2140873	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(09) TESSERAL HARMONIC COEFFICIENT ELEM 9	V97U5500C	00	+6.3163541	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
SV_TIME_TAG_DIFF TIME TOLERANCE FOR PREDICTION	V97U6132C	01 02 03 08	+1.0 +5.0 +1.0 +5.0	E+00 E-01 E+00 E-01	SEC	F	S	P G4.126 G4.127 G4.148 G4.15	90374C	
ZONAL(01) ZONAL HARMONICS COEFFICIENT ELEM 1	V97U5582C	00	+0.0	E+00	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.1.9-5. ENTRY NAVIGATION (G4.127) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ZONAL(02) ZONAL HARMONICS COEFFICIENT ELEM 2	V97U5583C	00	+1.0826271	E-03	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
ZONAL(03) ZONAL HARMONICS COEFFICIENT ELEM 3	V97U5584C	00	-2.5358868	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
ZONAL(04) ZONAL HARMONICS COEFFICIENT ELEM 4	V97U5585C	00	-1.6246180	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

### **4.3.2 Preland Navigation (4.144)**

The preland navigation principal function provides an up-to-date navigation state estimate of the orbiter position and velocity in the M50 inertial coordinate frame. A single navigation filter state estimate shall be maintained by this principal function. This principal function shall also call the GPS receiver state processing principal function which processes the state estimates provided by the GPS receivers installed on the Shuttle and which provides a selected GPS state for use by the orbiter navigation software. Either the single navigation filter state estimate or the selected GPS state, along with other parameters, shall be provided by the navigation principal function for software users such as user parameter processing, guidance and displays.

Before initiating this principal function, the multiple navigation state configuration that may exist from the exercise of the entry navigation principal function shall have been reduced to a single-state configuration. The preland navigation principal function shall be scheduled by the deorbit/landing navigation sequencer. Variables interfacing with this function are identified in Table 4.3.2.9-1.

IMU accumulated velocities, and navigation sensor data (TACAN, BARO altimeter and MSBLS) shall be acquired at the beginning of the navigation filter cycle for use in state propagation and improving the navigation state estimate.

GPS receiver data shall also be acquired at the beginning of navigation filter cycle for use by the GPS receiver state processing principal function which is called from the preland navigation principal function. The auto/inhibit/force flags for controlling the resetting of the navigation filter state to the selected GPS state and for controlling which state (the selected navigation filter state or the selected GPS receiver state) is provided for use by the user parameter processing principal function, guidance and displays, shall also be acquired.

If a selected GPS state is available from the GPS receiver state processing principal function execution on the previous preland navigation cycle, and if other requisite criteria (described in Section 4.3.2.1) are satisfied and if enabled by the crew, the navigation filter state shall be reset to the selected GPS state. The navigation filter covariance matrix shall be then reinitialized to values representing the accuracy of the selected GPS state used in the navigation state reset.

If a delta-state uplink has occurred, the inputs for the delta-state update function, described in Section 4.2.6, shall be defined.

The navigation state shall be propagated to current time using data from selected IMU data.

If a delta state update is indicated, the state vector shall be updated and the covariance matrix reinitialized as described in Section 4.2.6. Provision has also been made to reset the QA2 (GPS minus navigation) difference tolerances whenever a non-zero delta state update occurs. If no state update has occurred, the state error covariance matrix shall be propagated as described in Section 4.2.2.

A Kalman filtering technique shall be used for updating the navigation filter state with TACAN, BARO altimeter, or MSBLS measurements. The measurement partials and the Kalman filter gain vector shall be computed using the state estimate and the propagated covariance matrix. The filter shall then compute the measurement residual. The Kalman gain and the measurement residual shall then be used to update the navigation state estimate and the filter covariance matrix, if the residual passes the edit test or crew override of the residual edit test is indicated.

The GPS receiver state processing principal function shall then be executed to process GPS receiver state estimates and to provide a selected GPS state for use by the navigation software (Section 4.3.3). This selected GPS state shall be made available to update the navigation filter state on the next navigation cycle and to reset the user parameter processing state on the current navigation cycle.

The user parameter processing reset state shall then be selected from either the navigation filter state or the selected GPS state. The choice of which state is used to reset the user parameter state is subject to manual control, conditional to the availability of GPS data. The reset state is provided to the user parameter propagator principal function for computing user parameters and display parameters. The navigation filter state shall also be continuously made available to the GPS reference state processing principal function for use in initializing GPS receiver states as needed.

The user parameter processing reset state will be metered, if necessary, to insure that metering limits are not violated.

Finally, Kalman filter measurement processing statistics shall be computed for display.

During preland navigation, the resetting of the baseline navigation state on the current navigation cycle to the selected GPS state from the previous navigation cycle is determined by the following: the configuration of the MLS auto/inhibit/force measurement processing command and the corresponding navigation software MLS force and MLS auto processing indicator variables; the availability of a selected GPS state; the configuration of the GPS to navigation auto/inhibit/force crew command; the status of the selected GPS residual ratio flag; the orbiter altitude; the time since the selected GPS state was last updated with receiver data; the time since the last baseline navigation state update with the selected GPS state; the availability and validity of MLS data; and, when TACAN receivers are installed on the vehicle, the configuration of the TACAN auto/inhibit/force measurement processing command. In addition, if a Remote Control Orbiter (RCO) landing is being performed, the resetting of the baseline navigation state on the current navigation cycle to the selected GPS state from the previous navigation cycle is determined by the following parameters: the RCO enable indicator, the weight-on-main-wheels indicator, availability of the selected GPS state, configuration of the GPS to navigation auto/inhibit/force command, the MSBLS measurement processing indicator, the selected GPS Figure-of-Merit, time since the selected GPS state was last updated with receiver data, and the state of the GPS residual ratio flag.

The GPS to navigation auto/inhibit/force command consists of two crew commands, GPS to navigation auto/inhibit, GPS\_TO\_NAV\_AI, which contains the INHIBIT and AUTO commands, and the GPS to navigation force command, GPS\_TO\_NAV\_FORCE. The navigation software combines these two GPS to navigation commands into a composite GPS to navigation auto/inhibit/force command, GPS\_TO\_NAV\_AIF. The GPS to navigation force command, GPS\_TO\_NAV\_FORCE, is a one-time force on that navigation cycle only.

The MLS auto/inhibit/force measurement processing command is initialized to AUTO and can be changed by the crew through display item entries only when three GPS receivers are installed on the vehicle and no TACAN receivers are installed. For the system configuration with three TACAN receivers and one GPS receiver installed, the MLS auto/inhibit/force measurement processing command will remain in the initialized AUTO setting. The GPS to navigation auto/inhibit command is initialized to INHIBIT and the GPS to navigation force command is initialized to OFF. Both can be changed by the crew through display item entries. The TACAN auto/inhibit/force measurement processing command is initialized to INHIBIT and can be changed by crew display item entries only when TACAN receivers are installed.

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Setting the MLS auto/inhibit/force measurement processing command to FORCE (which requires three GPS receivers to be installed on the vehicle) sets the MLS force processing indicator to ON, preventing the resetting of the baseline navigation state to the selected GPS state independent of the setting of the GPS to navigation auto/inhibit/force command and independent of the validity of MLS measurement data. If MLS data is not valid, indication will be given to the crew through the displays. Before the selected GPS state can be used to reset the baseline navigation state, the crew must take appropriate action to remove the MLS auto/inhibit/force command FORCE condition which removes the ON setting of the corresponding MLS force processing indicator. Note that the MLS force processing indicator can never be set to ON when three TACAN receivers are installed on the vehicle.

With the MLS force processing indicator set to OFF, the baseline navigation state can be reset on the current navigation cycle to the selected GPS state from the previous navigation cycle (if one is available) by setting the GPS to navigation auto/inhibit/force command, GPS\_TO\_NAV\_AIF, to FORCE. This is accomplished by the crew executing the GPS\_TO\_NAV\_FORCE item entry on the display. The force is a one time force, executed on the current navigation cycle.

With the MLS force processing indicator set to OFF and the GPS to navigation auto/inhibit/force command set to AUTO (enabled by setting the GPS\_TO\_NAV\_AI to AUTO through display item entry), the selected GPS state will be used to reset the baseline navigation state when the MLS auto processing indicator is set to OFF, the selected GPS residual ratio edit flag (GPS\_RATIO\_FLAG) is OFF, the orbiter is above the I-Loaded minimum altitude for automatic GPS updates, the time since the selected GPS state was last updated with receiver data is less than an I-Load limit, and the time since the baseline navigation state was last set to the selected GPS state is greater than or equal to the minimum time allowed between GPS updates to navigation (determined by pre-mission defined I-Loads).

The MLS auto processing indicator is set to ON when the MLS auto/inhibit/force measurement processing command is set to AUTO, the MLS measurement data is valid and, when TACAN receivers are installed in the vehicle, when the TACAN auto/inhibit/force command is not set to the FORCE condition. The indicator is subsequently set to the OFF condition when the MLS auto/inhibit/force AUTO command is removed, or when the previously valid MLS data is invalid for more than the I-load specified period of time. Setting the TACAN auto/inhibit/force command to FORCE when TACAN receivers are installed on the vehicle will also set the auto processing indicator to OFF.

The selected GPS state will be used to reset the baseline navigation state on every preland navigation cycle when the RCO capability is enabled and the following conditions are satisfied: The vehicle's weight-on-main-wheels indicator is set to ON, GPS to navigation auto/inhibit/force is set to AUTO, MSBLS measurements are not processed, the selected GPS figure-of-merit is less than a predetermined I-Load value, the time since the selected GPS state was last updated with receiver data is less than a predetermined I-Load, and the selected GPS residual ratio does not violate the ratio limit.

With the GPS to navigation auto/inhibit/force command set to INHIBIT (enabled by setting the GPS\_TO\_NAV\_AI to INHIBIT through display item entry), the selected GPS state will be prohibited from resetting the baseline navigation state.

Table 4.3.2-1 shows the relationship between the setting of the MLS auto/inhibit/force command (MLS\_AIF), the setting of the GPS to navigation auto/inhibit/force command, GPS\_TO\_NAV\_AIF (the composite command using GPS\_TO\_NAV\_AI and GPS\_TO\_NAV\_FORCE), the availability of MLS data, the setting of the TACAN auto/inhibit/force command (when TACAN receivers are installed on the vehicle) and the capability to reset the baseline navigation state to the selected GPS state.

Table 4.3.2-1 BASELINE NAVIGATION (BL) RESET WITH SELECTED GPS STATE

MLS Auto/Inhibit/Force Measurement Processing Command (MLS_AIF)	GPS to Navigation Auto/Inhibit/Force Command  (GPS_TO_NAV_AIF)		
	FORCE	AUTO	INHIBIT
FORCE	NO*	NO*	NO*
AUTO	YES	NO** or YES*** †	NO*
INHIBIT	YES	YES †	NO*

\* Does not depend on validity of MLS data

\*\* Valid MLS data is available, or valid MLS data was available and has been subsequently lost for less than an I-load specified period of time, and TACAN auto/inhibit/force measurement processing command not set to FORCE, when TACAN receivers installed on the vehicle

\*\*\* Valid MLS data was available and has been subsequently lost for more than an I-load specified period of time or TACAN auto/inhibit/force measurement processing command set to FORCE, when TACAN receivers installed on the vehicle and an I-load period of time has elapsed since the last navigation state reset

† The selected GPS residual ratio edit flag is OFF, the orbiter is above the I-Loaded minimum altitude for automatic GPS updates, the time since the selected GPS state was last updated with receiver data is less than an I-Load limit, and the time since the baseline navigation state was last set to the selected GPS state is greater than or equal to the minimum time allowed between GPS updates to navigation (determined by pre-mission defined I-Loads).

- Notes: 1. MLS\_AIF is initialized to AUTO. It cannot be changed from this setting when TACAN receivers are installed on the vehicle.
2. GPS\_TO\_NAV\_AIF is a composite command computed from the two crew commands, GPS\_TO\_NAV\_AI, and GPS\_TO\_NAV\_FORCE

#### 4.3.2.1 Preland Control

The preland navigation principal function is to provide the capability to control state and covariance matrix propagation and filter updates. A single state vector will be maintained.

A. Detailed Requirements. Preland control will perform the following tasks in the order indicated. For definitions of variables, see input and output Tables 4.3.2.1-1 and 4.3.2.1-2.

- (1) The accumulated sensed velocities from three IMUS, the selected sensed velocity and the corresponding time tag will be obtained as described in Section 4.3.1.5.
- (1.1) User parameter data will be snapped from the user parameter functions as described in Section 4.3.2.2.3.
- (2) An external sensor data snap will be performed as described in Section 4.3.2.2.1.
- (3) A GPS data snap will be performed as described in Section 4.3.2.2.2.

The received values of the GPS control flags shall be stored for use by the navigation function:

GPS\_AIF\_RCVD = GPS\_TO\_GC\_AIF

GPS\_TO\_NAV\_RCVD = GPS\_TO\_NAV\_AI

GPS\_TO\_NAV\_FORCE\_RCVD = GPS\_TO\_NAV\_FORCE

The major mode shall be stored for use by the GPS receiver state processing principal function:

NAV\_MM\_CODE = MM\_CODE

The flag indicating that the navigation state has been set to the selected GPS state is set to OFF:

NAV\_RESET = OFF

The parameter which will indicate to the display if the navigation received GPS\_TO\_GC\_AIF command can be executed by the navigation software on this cycle, are set to on:

GPS\_AIF\_EXEC = BLANK

If the copy of the GPS to navigation force flag (GPS\_TO\_NAV\_FORCE\_RCVD) set by the crew is ON, then the GPS to navigation force command flag (GPS\_TO\_NAV\_FORCE) set by the crew is set to OFF, providing a forcing of GPS data into the navigation system on this navigation cycle only. The GPS to navigation auto/inhibit/force flag, GPS\_TO\_NAV\_AIF, which is a composite flag representing the setting of both the GPS\_TO\_NAV\_RCVD and GPS\_TO\_NAV\_FORCE\_RCVD flags, is set to FORCE for this navigation cycle. If the copy of the GPS to navigation force flag (GPS\_TO\_NAV\_FORCE\_RCVD) is not set to ON, however, then the GPS to navigation auto/inhibit/force flag is set to the GPS to navigation auto/inhibit flag setting. This is accomplished as follows:



```
IF GPS_TO_NAV_FORCE_RCVD = ON THEN
    GPS_TO_NAV_FORCE = OFF
    GPS_TO_NAV_AIF = FORCE
ELSE
    GPS_TO_NAV_AIF = INTEGER (GPS_TO_NAV_RCVD)
```

- (4) To determine if the baseline navigation filter state is to be reset to the selected GPS state on this navigation cycle, a check is first made to see if a selected GPS state is available. If one is available, indicated by GPS\_SV\_SEL\_AVAIL = ON, step 4.1 will be performed:

- (4.1) Determine which of two pre-mission defined I-Load values shall be used for the minimum time interval (GPS\_CYCLE\_TIME) between automatic GPS updates to navigation. If the orbiter's altitude is less than the I-Loaded altitude for switching GPS update rates (GPS\_ALT\_FOR\_HIGH\_RATE\_NAV), set GPS\_CYCLE\_TIME to the I-Loaded value for high rate GPS updates (T\_GPS\_CYCLE\_FOR\_HIGH\_RATE\_NAV). Otherwise, set GPS\_CYCLE\_TIME to the I-Loaded value for low rate GPS updates (T\_GPS\_CYCLE). These steps are:

```
IF ALT_WHEELS_NAV < GPS_ALT_FOR_HIGH_RATE_NAV
THEN
    GPS_CYCLE_TIME = T_GPS_CYCLE_FOR_HIGH_RATE_NAV
ELSE
    GPS_CYCLE_TIME = T_GPS_CYCLE
```

The navigation filter state shall be reset to the selected GPS state, the navigation reset flag shall be set ON, the time tag of the most recent GPS state incorporation into the navigation system shall be updated, and the navigation filter covariance matrix shall be reinitialized with values reflecting the quality of the GPS update if any of the following conditions are satisfied: (1) the MLS force processing indicator (MLS\_FORCE\_PROC\_IND) is set to OFF and the GPS to navigation auto/inhibit/force flag (GPS\_TO\_NAV\_AIF) is set to FORCE; or (2) the MLS force processing indicator (MLS\_FORCE\_PROC\_IND) is set to OFF, the GPS to navigation auto/inhibit/force flag is set to AUTO, the MLS auto processing indicator (MLS\_AUTO\_PROC\_IND) is set to OFF, the selected GPS residual ratio edit flag (GPS\_RATIO\_FLAG) is OFF, the orbiter's altitude (ALT\_WHEELS\_NAV) is above the minimum altitude for GPS updates (GPS\_UPDATE\_ALT\_FLOOR), the time since the selected GPS state was last updated with receiver data is less than an I-Load limit (GPS\_SEL\_AGE\_MAX), and the time since the last navigation filter state update with the selected GPS state is greater than or equal to the minimum time interval (GPS\_CYCLE\_TIME) for GPS updates; or (3) Remote Control Orbiter capability is enabled (RCO\_ENABLE = ON) and weight-on-main-wheels indicator is on (WOWLON\_IND = ON) and GPS to navigation auto/inhibit/force is set to auto (GPS\_TO\_NAV\_AIF = AUTO) and MSBLS measurements are not processed (PROCESSING\_MLS = OFF) and the selected GPS figure-of-merit is less than a predetermined I-Load value (FOM\_SV\_SEL < RCO\_FOM\_LIM) and the time since the selected GPS state was last updated with receiver data is less than a predetermined I-Load value (DT\_GPS\_OFF\_MIN < RCO\_SEL\_AGE\_MAX) and the selected GPS residual ratio does not violate the ratio limit (GPS\_RATIO\_FLAG = OFF). These steps are as follows:

```
IF (MLS_FORCE_PROC_IND = OFF and
    (GPS_TO_NAV_AIF = FORCE or
```

```

(GPS_TO_NAV_AIF = AUTO and
MLS_AUTO_PROC_IND = OFF and
GPS_RATIO_FLAG = OFF and
ALT_WHEELS_NAV > GPS_UPDATE_ALT_FLOOR and
DT_GPS_OFF_MIN < GPS_SEL_AGE_MAX and
(T_CURRENT_FILT - T_GPS_LAST_UPDATE) ≥ GPS_CYCLE_TIME))) or
(RCO_ENABLE = ON and
WOWLON_IND = ON and
GPS_TO_NAV_AIF = AUTO and
PROCESSING_MLS = OFF and
FOM_SV_SEL < RCO_FOM_LIM and
DT_GPS_OFF_MIN < RCO_SEL_AGE_MAX and
GPS_RATIO_FLAG = OFF)
THEN
 $\bar{R}_{FILT} = \bar{R}_{GPS\_SEL}$ 
 $\bar{V}_{FILT} = \bar{V}_{GPS\_SEL}$ 

NAV_RESET = ON
T_GPS_LAST_UPDATE = T_CURRENT_FILT

CALL: COVINIT
  INLIST:  $\bar{SIG\_DIAG\_GPS}$ ,  $\bar{CORR\_COEFF\_GPS}$ ,
           $\bar{R}_{GPS\_SEL}$ ,  $\bar{V}_{GPS\_SEL}$ 
  OUTLIST: E

```

The MLS force processing indicator, `MLS_FORCE_PROC_IND`, set to ON prohibits the GPS state from resetting the navigation state, independent of the setting of the GPS to navigation auto/inhibit/force command, `GPS_TO_NAV_AIF`, independent of the validity of MLS data.

The MLS auto processing indicator, `MLS_AUTO_PROC_IND`, prohibits the GPS state from resetting the navigation state, when the GPS to navigation auto/inhibit/force command, `GPS_TO_NAV_AIF`, is set to AUTO under two conditions: during MLS measurement processing due to the received MLS auto/inhibit/force command being set to AUTO with valid MLS data; when MLS measurement processing due to the received MLS auto/inhibit/force command being set to AUTO has occurred and valid MLS data has been lost for less than an I-load amount of time, suspending MLS measurement processing. Note that use of the MLS force processing indicator takes precedence over the use of the MLS auto processing indicator in the above logic check. Setting the GPS to navigation auto/inhibit/force flag to FORCE takes precedent over automatic MLS processing but does not take precedence over forced MLS processing.

- (5) If a delta state update has been command uplinked from the ground (indicated by the flag `DO_DELTA_UPDATE_UP` being in the ON position), input data needed by the delta state update subfunction will be established and the flag `DO_DELTA_UPDATE` set to the ON position to cause execution of the subfunction at the appropriate point in the computation sequence. The flag `DO_DELTA_UPDATE_UP` shall be returned to the OFF position to preclude multiple updates with the same data. The necessary equations are:

```
IF DO_DELTA_UPDATE_UP = ON,
```

$$\overline{DR}_{RW} = \overline{DR}_{RW\_UP}$$

$$\overline{DV}_{RW} = \overline{DV}_{RW\_UP}$$

$$DO\_DELTA\_UPDATE = ON$$

$$DO\_DELTA\_UPDATE\_UP = OFF$$

- (6) The state vector will be propagated as described in Section 4.3.2.5.
- (7) The covariance matrix propagation subfunction will propagate the covariance matrix as described in Section 4.3.2.6.
- (8) The preland sensor measurement selection subfunction will determine which measurements are to be presented to the filter for processing, as described in Section 4.3.2.3.
- (9) The flag DO\_DELTA\_UPDATE shall be tested to determine if a delta state update has been requested, either by keyboard entry or via a command uplink. If the flag DO\_DELTA\_UPDATE is ON, and at least one of the delta state update vectors ( $\overline{DR}_{RW}$  or  $\overline{DV}_{RW}$ ) supplied for the delta state update is non-zero, the time of the last GPS update to navigation (T\_GPS\_LAST\_UPDATE) shall be set equal to the current filter time, reducing the GPS QA2 (GPS minus navigation) limits to their minimum values. Finally, the navigation state vectors shall be updated and the covariance matrix reinitialized as described in Section 4.3.2.4.2. The necessary steps are:

$$DELR = |\overline{DR}_{RW}|$$

$$DELV = |\overline{DV}_{RW}|$$

IF (DELR > 1.0E-08) OR (DELV > 1.0E-08) THEN

    T\_GPS\_LAST\_UPDATE = T\_LAST\_FILTER

ENDIF

CALL: OPS\_3\_DELTA\_UPDATE

- (10) The state and covariance measurement incorporation subfunction will update the state vector and covariance matrix for each of the measurements being processed, as described in Section 4.3.2.7. This subfunction is exercised for each measurement type only if data are to be processed as determined by the preland sensor selection subfunction. In the case of TACAN, the current ground station identifier shall be tested to determine if a new station has been selected, and, if so, the measurement reconfiguration subfunction (Section 4.3.2.4.1) will supply the filter with the pertinent station information. A counter (MLS\_MARK\_NUM, TACAN\_MARK\_NUM, or BARO\_MARK\_NUM) will be incremented for each measurement processed to indicate the mark number for post mission analysis purposes. The MSBLS edit multiplier counter, MLS\_EDIT\_MUL\_COUNT will be tested and if it is greater than ten (10), then the scale factors, K\_EDIT\_MLSAZ, K\_EDIT\_MLSEL, and K\_EDIT\_MLSR will be set to K\_EDIT\_MLSAZ\_MIN, K\_EDIT\_MLSEL\_MIN, and K\_EDIT\_MLSR\_MIN; otherwise, K\_EDIT\_MLSAZ, K\_EDIT\_MLSEL, K\_EDIT\_MLSR are set to K\_EDIT\_MLSAZ\_MAX, K\_EDIT\_MLSEL\_MAX, and K\_EDIT\_MLSR\_MAX. Next, if IMU redundancy Management is not operating at the 3 IMU level, indicated by the integer of IMU\_SFC  $\neq$  7, and the NAV\_MLS\_FLAG has been turned on, indicating an

interruption of MSBLS processing, each of the scale factors will be set back to the initial values K\_EDIT\_MLSAZ\_MAX, K\_EDIT\_MLSEL\_MAX and K\_EDIT\_MLSR\_MAX.

- (11) The GPS receiver state processing principal function (Section 4.3.3) shall be executed.
- (12) The position and velocity of either the baseline navigation state or the selected GPS state, and their associated time tag, gravity acceleration vector and the IMU velocity counts will then be stored for use by the user parameter state propagator as described in Section 4.2.10. Parameters for use by the GPS reference state processing principal function will also be stored.
- (13) Finally, the measurement processing statistics subfunction will be performed as described in Section 4.3.2.8.

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.2.9-1 and 4.3.2.9-2.

C. Processing Requirements. Preland control will be executed at a premission determined rate when the preland navigation principal function is scheduled.

D. Constraints. None.

E. Supplemental Information. A suggested implementation of preland control is illustrated by NAV\_PRELAND in Section 5.2.

The navigation copy of the GPS to navigation auto/inhibit command signal, GPS\_TO\_NAV\_RCVD, has the values of AUTO, indicating an OFF (or 0) command, and INHIBIT, indicating an ON (or 1) command. The navigation copy of the GPS to navigation force signal, GPS\_TO\_NAV\_FORCE\_RCVD, has the values of NO FORCE, indicating an OFF (or 0) command, and FORCE, indicating an ON (or 1) command. The composite signal, GPS\_TO\_NAV\_AIF, constructed from the navigation copy of the GPS to navigation auto/inhibit command signal, GPS\_TO\_NAV\_RCVD, and the navigation copy of the GPS to navigation force signal, GPS\_TO\_NAV\_FORCE\_RCVD, takes on the following values: AUTO, indicating a 0 value, inhibit indicating a 1 value and FORCE indicating a value of 2.

Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Time of the filter state vector	T_LAST_FILT	Preland state propagation	F	DP		sec	Filter rate
Previously read selected accumulated IMU velocity	$\bar{V}$ _LAST_FILT	Preland state propagation	V	S		ft/sec	Filter rate
Flag indicating (ON) that MLS data is to be processed	DO_MLS_NAV	Preland sensor selector	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data are to be processed	DO_TACAN_NAV	Preland sensor selector	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that baro altimeter data are to be processed	DO_BARO_NAV	Preland sensor selector	D	—	OFF/ON	—	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}$ _FILT	Preland state and covariance measurement incorporation	V	DP		ft	Filter rate
Shuttle velocity vector	$\bar{V}$ _FILT	Preland state and covariance measurement incorporation	V	S		ft/sec	Filter rate
Conversion factor from degrees to radians	RAD_PER_DEG	Constant	F		—		Filter rate
Flag indicating (ON) that a delta state update is to be performed	DO_DELTA_UPDATE	*, Delta state update	D		OFF/ON	—	Filter rate
Acceleration vector in M50 coordinates	$\bar{G}$ _OLD	Preland state propagation	V	DP		ft/sec <sup>2</sup>	Filter rate
Position delta vector for uplinked delta state update	$\bar{DR}$ _RW_UP	*	V	S		ft	Filter rate

Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Velocity delta vector for uplinked delta state update	$\overline{DV\_RW\_UP}$	*	V	S		ft/sec	Filter rate
Command to perform a delta state update from uplinked data	DO_DELTA_UPDATE_UP	*, Preland control	D	—	OFF/ON	—	Filter rate
Maximum value of K_EDIT_MLSAZ	K-EDIT_MLSAZ_MAX	**	I	S	400	ND	Filter rate
Altitude at which automatic GPS updates to navigation switch from low to high rate	GPS_ALT_FOR_HIGH_RATE_NAV	I-Load	F	S	—	ft	Filter rate
Altitude limit below which automatic GPS updates to navigation are not allowed	GPS_UPDATE_ALT_FLOOR	I-Load	F	S	—	ft	Filter rate
Minimum amount of time between consecutive GPS updates in low rate nav	T_GPS_CYCLE	I-Load	F	S	—	sec	Filter rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	ALT_WHEELS_NAV	Preland external data snap	F	S	—	ft	Filter rate
Gravity acceleration vector corresponding to the selected GPS state	$\overline{G\_GPS\_SEL}$	*	V	DP		ft/sec <sup>2</sup>	Filter rate

Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Crew command (ON) to enable the GPS state from the I <sup>th</sup> GPS receiver to be a candidate for selection independent of the results of its passing or failing the quality assessment checks, if no dilemma condition exists for that receiver	CREW_METERING_OVERRIDE(I)	*	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are being processed through MLS AUTO command	MLS_AUTO_PROC_IND	Preland sensor measurement selection	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are being processed through MLS FORCE command	MLS_FORCE_PROC_IND	Preland sensor measurement selection	D		ON/OFF		Filter rate
The minimum amount of elapsed time between consecutive GPS updates to high rate nav	T_GPS_CYCLE_FOR_HIGH_RATE_NAV	I-load	F	S		sec	Filter rate
Flag indicating (ON) that the selected GPS residual ratio exceeded its allowed limit	GPS_RATIO_FLAG	*	D	–	ON/OFF	–	Filter rate
Maximum value of K_EDIT_MLSEL	K_EDIT_MLSEL_MAX	**	I	S	400	ND	Filter rate
Maximum value of K_EDIT_MLSR	K_EDIT_MLSR_MAX	**	I	S	400	ND	Filter rate
Minimum value of K_EDIT_MLSAZ	K_EDIT_MLSAZ_MIN	**	I	S	16	ND	Filter rate

Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Minimum value of K_EDIT_MLSEL	K-EDIT_MLSEL_MIN	**	I	S	9	ND	Filter rate
Minimum value of K_EDIT_MLSR	K-EDIT_MLSR_MIN	**	I	S	30	ND	Filter rate
IMU selection filter command	IMU_SFC	*	BSU	S		ND	Filter rate
NAV EDIT MSBLS crew alert	NAV_MLS_FLAG	Preland meas. proc. statistic	D		ON/OFF	ND	Filter rate
Counter indicating number of cycles that MSBLS meas. have been processed since the most recent selection	MLS_EDIT_MUL_COUNT	Preland Sensor Select	I	S		ND	Filter rate
Correlation coefficients to initialize covariance matrix for GPS update	$\bar{C}$ ORR_COEFF_GPS	I-Load	V(7)	S	--	--	Filter rate
GPS auto/inhibit/force flag	GPS_TO_GC_AIF	*	I	S	0 (AUTO) 1 (INHIBIT) 2 (FORCE)	--	Filter rate
GPS data good flags	GPS_DG <sub>1</sub> ***	*	D	--	ON/OFF	--	Filter rate
Flag indicating (ON) selected GPS states are available for use	GPS_SV_SEL_AVAIL	*	D	--	ON/OFF	--	Filter rate
Flag indicating the GPS to Nav setting of auto or inhibit	GPS_TO_NAV_AI	*	D	--	OFF (AUTO) ON (INHIBIT)	--	Filter rate
Flag indicating (ON) the forcing of GPS states to Nav	GPS_TO_NAV_FORCE	*	D	--	ON (FORCE) OFF (NO FORCE)	--	Filter rate



Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Major mode code	MM_CODE	*	I	S		--	Filter rate
Selected GPS Position vector	$\bar{R}_{GPS\_SEL}$	*	V	DP		ft	Filter rate
GPS restart position vector for initialization	$\bar{R}_{GPS\_INIT}$	*	V	DP		ft	Filter rate
Square root of diagonal elements for GPS update covariance matrix	$\bar{SIG\_DIAG\_GPS}$	*	V(6)	S	--	ft, ft/sec	Filter rate
Time tag of current Orbiter navigation state(s)	T_CURRENT_FILT	*	F	DP		sec	Filter rate
The minimum amount of time that must pass between consecutive GPS updates to nav	T_GPS_CYCLE	I-Load	F	S		sec	Filter rate
GPS restart state time tag for initialization	T_GPS_INIT	*	F	DP		sec	Filter rate
Time of most recent navigation state update with selected GPS state	T_GPS_LAST_UPDATE	Entry nav control	F	DP		sec	Filter rate
Current selected IMU accumulated velocity counts from IMU RM	$\bar{V}_{CURRENT\_FILT}$	*	V	DP		ft/sec	Filter rate
GPS restart velocity vector for initialization	$\bar{V}_{GPS\_INIT}$	*	V	S		ft/sec	Filter rate
Selected GPS velocity vector	$\bar{V}_{GPS\_SEL}$	*	V	DP		ft/sec	Filter rate
GPS selected state time tag	T_GPS_SEL	*	F	DP		sec	Filter rate

Table 4.3.2.1-1. Preland Control Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Minutes portion of the time since the last GPS state vector selection by the GPS state vector function	DT_GPS_OFF_MIN	*	F	S		min	Filter rate
Maximum allowable time since last update of selected GPS state with GPS receiver data	GPS_SEL_AGE_MAX	I-Load	F	S		min	Filter rate
RCO inhibit/enable command	RCO_ENABLE	*	BD				Filter rate
Weight-on-main wheels indicator	WOWLON_IND	*	BD				Filter rate
FOM limit for Remote Control Orbiter	RCO_FOM_LIM	I-Load	I	S		–	Filter rate
Max. allowable time since last update of selected GPS state with GPS receiver data during RCO landing	RCO_SEL_AGE_MAX	I-Load	F	S	0.0–1.0	min	Filter rate
Selected Figure-of-Merit	FOM_SV_SEL	*	HXS	S	1–9	–	Filter rate
* See principal function input list in Table 4.3.2.9–1.							
** See Table 4.3.2.9–4.							
*** I = 1, 2, 3 (1 to GPS_SW_CAP)							

Table 4.3.2.1-2. Preland Control Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Vehicle position vector after all navigation updates reserved for reset of guidance integrator position vector	$\bar{R}_{\_RESET}$	*	V	DP		ft	Filter rate
Vehicle velocity vector after all navigation updates reserved for reset of guidance integrator velocity vector	$\bar{V}_{\_RESET}$	*	V	S		ft/sec	Filter rate
Time associated with reserved reset state	T_RESET	*	F	DP		sec	Filter rate
Switch indicating (ON) that current measurement processing is complete	FILT_UPDATE	*	D	—	ON/OFF	—	Filter rate
Updated vehicle position vector associated with current covariance matrix	$\bar{R}_{\_COV\_LAST}$	Preland covariance propagation	V	DP		ft	Filter rate
Copy of V_LAST_FILT reserved as velocity count at start of extrapolation interval when guidance integrator is reset	$\bar{V}_{\_IMU\_RESET}$	*	V	S		ft/sec	Filter rate
Copy of G_OLD reserved for reset of guidance integrator acceleration vector	$\bar{G}_{\_RESET}$	*	V	S		ft/sec <sup>2</sup>	Filter rate
Counter indicating the particular MLS measurement processed by the filter	MLS_MARK_NUM	*	I	S		—	Filter rate

Table 4.3.2.1-2. Preland Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Counter indicating the particular TACAN measurement processed by the filter	TACAN_MARK_NUM	*	I	S		—	Filter rate
Counter indicating the particular BARO measurement processed by the filter	BARO_MARK_NUM	*	I	S		—	Filter rate
Position vector for delta state update	$\bar{D}R_{RW}$	Delta state update subfunction	V	S		ft	Filter rate
Velocity vector for delta state update	$\bar{D}V_{RW}$	Delta state update subfunction	V	S		ft/sec	Filter rate
Flag indicating (OFF) that an uplinked delta state update has been accepted	DO_DELTA_UPDATE_UP	Preland control	D	—	OFF/ON	—	Filter rate
Scale factor on filter mean square residual used in residual edit test for MSBLS azimuth measurement	K_EDIT_MLSAZ	MLS azimuth meas. subfunction	I	S	16, 400	ND	Filter rate
Gravity acceleration vector for propagation of reference state for GPS receiver I initialization	$\bar{G}_{GPS\_INIT}$	*	V	S		ft/sec <sup>2</sup>	Filter rate
Selected GPS position vector reserved for reset of GPS UPP display computations position vector	$\bar{R}_{GPS\_UPP}$	*	V	DP		ft	Filter rate

Table 4.3.2.1-2. Preland Control Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector	$\bar{V}_{GPS\_UPP}$	*	V	S		ft/sec	Filter rate
Time of selected GPS state reserved for reset of GPS UPP display computations position vector	T_GPS_UPP	*	S	DP		sec	Filter rate
Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector	$\bar{G}_{GPS\_UPP}$	*	V	S		ft/sec <sup>2</sup>	Filter rate
IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity	$\bar{V}_{IMU\_GPS\_UPP}$	*	V	DP		ft/sec	Filter rate
Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset	GPS_UPP_UPDATE	*	D	—	ON/OFF	—	Filter rate
Square root of the trace of the position elements (E1,1), E(2,2), E(3,3)) of the navigation Kalman filter covariance matrix for downlist	COV_POS_SIG	*	F	S		ft	Filter rate

Table 4.3.2.1-2. Preland Control Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Square root of the trace of the velocity elements (E(4,4), E(5,5), E(6,6)) of the navigation Kalman filter covariance matrix for downlist	COV_VEL_SIG	*	F	S		ft/sec	Filter rate
Flag indicating (ON) to GPS Reference State Processing principal function that a valid reference state exists for the GPS receivers	GPS_REF_INIT_VALID	GPS Reference State Processing	D		ON/OFF		
Flag indicating (ON) that the user parameter reset state is being metered	METER_FLAG	*	D		ON/OFF		Filter rate
Metering gain (the maximum of either the position or velocity metering gains) applied to scale the M50 position and velocity changes to the user parameter reset state on the current cycle so that metering constraints are not violated	METER_SF	*	F	S			Filter rate
Scale factor on filter mean square residual used in residual edit test for MSBLS elevation measurement	K_EDIT_MLSEL	MLS elevation meas. subfunction	I	S	9, 400	ND	Filter rate
Scale factor on filter mean square residual used in residual edit test for MSBLS range measurement	K_EDIT_MLSR	MLS range meas. subfunction	I	S	36, 400	ND	Filter rate

Table 4.3.2.1-2. Preland Control Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating if GPS auto/inhibit/force executed	GPS_AIF_EXEC	*	D	--	ON (DOWN-ARROW), OFF (BLANK)	--	Filter rate
GPS auto/inhibit/force flag	GPS_AIF_RCVD	*, Preland sensor select	I	S	0 (AUTO) 1 (INHIBIT) 2 (FORCE)	--	Filter rate
GPS to navigation auto/inhibit/force flag, which contains the GPS to nav command and GPS to navigation force command settings	GPS_TO_NAV_AIF	*	I	S	0 (AUTO) 1 (INHIBIT) 2 (FORCE)	--	Filter rate
Flag indicating a force of nav filter state reset with selected GPS state	GPS_TO_NAV_FORCE_RCVD	*	D	--	ON (FORCE) OFF (NO FORCE)	--	Filter rate
Flag indicating the GPS to Nav setting of auto or inhibit	GPS_TO_NAV_RCVD	*	D	--	OFF (AUTO) ON (INHIBIT)	--	Filter rate
Major Mode	NAV_MM_CODE	*	I	S		--	Filter rate
Flag indicating nav filter states have been reset with the selected GPS state	NAV_RESET	UPP state reset	D	--	ON/OFF	--	Filter rate
Current selected navigation filter state	$\bar{R}_{FILT}$	*	V	DP		ft	Filter rate
GPS restart position vector for initialization	$\bar{R}_{GPS\_INIT}$	*	V	DP		ft	Filter rate
MTU or clock time when IMU is read	T_CURRENT_FILT	*	F	DP		sec	Filter rate
GPS restart state time tag for initialization	T_GPS_INIT	*	F	DP		sec	Filter rate

Table 4.3.2.1-2. Preland Control Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Time of most recent reset of navigation states to the selected GPS state	T_GPS_LAST_UPDATE	*	F	DP		sec	Filter rate
Current selected Shuttle navigation velocity vector	$\bar{V}_{FILT}$	*	V	S		ft/sec	Filter rate
Current selected IMU accumulated velocity counts from IMU RM	$\bar{V}_{CURRENT\_FILT}$	*	V	DP		ft/sec	Filter rate
Accumulated IMU velocity counts corresponding to GPS restart state for reinitialization	$\bar{V}_{IMU\_GPS\_INIT}$	*	V	DP		ft/sec	Filter rate
GPS restart velocity vector for initialization	$\bar{V}_{GPS\_INIT}$	*	V	S		ft/sec	Filter rate
* See principal function output list in Table 4.3.2.9-2.							
** I = 1 to 3 (1 to GPS_SW_CAP)							

#### 4.3.2.2 Preland External Data Snap

The purpose of this subfunction is to collect and store NAVAID data (TACAN, BARO altimeter and MSBLS) user parameter data, and GPS LRU navigation data. TACAN, BARO, AND MSBLS data are subsequently used in the navigation state and Kalman filter measurement incorporation subfunction. GPS data are used by the GPS receiver state processing principal function. These data sets contain the latest values of the required sensor parameters at the time of collection.

##### 4.3.2.2.1 External Sensor Data Snap

The sensor data snap task shall collect and store sensor data from the TACAN, Baro altimeter and MSBLS NAVAIDS, along with the associated GMT time tags. The purpose of the sensor data snap is to properly save the data sets used in the navigation Kalman filter processing by the appropriate navigation subfunction. The actual data will continue to be refreshed by hardware sensor readings, sensor SOP processing, and selection filtering.

Included in the sensor data intended for filter processing are the measurements, their data good flags (which indicate the validity of the measurement), and the measurements' time tags. For the MSBLS elevation measurement, where the correction for antenna displacement from the navigation base is significant, the shuttle vehicle's pitch angle will be obtained from the attitude processing principal function and stored.



Time tags of the data collected from TACAN, BARO, and MSBLS are adjusted according to pre-mission determined biases.

A. Detailed Requirements. During the preland phase, external sensor data will be collected in three groups: (1) barometric altimeter data (air data system), (2) TACAN data, and (3) MSBLS data. Barometric altimeter and TACAN data collection are required at the navigation filter rate. Since the hardware refreshment rate for the MSBLS sensors is rather infrequent, it is desirable to sample the data frequently to determine whether the data have changed so that, if they have, the time of change may be assumed to be the time tag of a new measurement. (Mechanization of this process is in the MSBLS SOP.) The pertinent navigation sensors and their measurement sets are defined below:

- (1) Barometric altimeter – The Shuttle’s barometric altitude, the Mach discontinuity indicator, the data–good flag, and the associated time tag, adjusted by a premission–loaded time bias, will be collected and stored:

SNAP BARO ALTIMETER (Q\_BARO, MACH\_JUMP, BARO\_DATA\_GOOD,  
T\_BARO) T\_BARO = T\_BARO – TIME\_BIAS\_BARO

- (2) TACAN – The magnetic bearing of the TACAN station from the Shuttle and the slant range distance from the TACAN ground beacon, together with the data–good flags, shall be collected and stored. The associated time tag will be collected, adjusted by a premission–loaded time bias, and stored. The current TACAN line replacement unit (LRU) number will also be collected and stored. The following equations define the parameters necessary to accomplish the above requirements:

SNAP TACAN (Q\_TAC\_BRG, Q\_TAC\_R, TAC\_RNG\_DATA\_GOOD,  
TAC\_BRG\_DATA\_GOOD, T\_TACAN, SEL\_LRU\_ID)  
T\_TACAN = T\_TACAN – TIME\_BIAS\_TACAN

- (3) MSBLS – The Shuttle’s azimuth, slant–range distance from the DME antenna, and elevation (given as a wedge angle) will be collected and stored, together with the data–good flags. The associated time tags will be collected, adjusted by a premission–loaded time bias, and stored. The Shuttle’s pitch angle will also be collected, converted to radians, and stored. The following equations define the parameters necessary to accomplish the above requirements:

SNAP MSBLS (Q\_RANGE, Q\_AZMLS, Q\_ELMLS, MLSRANGE\_DATA\_GOOD,  
MLSAZ\_DATA\_GOOD, MLSEL\_DATA\_GOOD, T\_EF\_RMLS, T\_EF\_AZMLS,  
T\_EF\_ELMLS)  
T\_EF\_RMLS = T\_EF\_RMLS – TIME\_BIAS\_MLS,  
T\_EF\_AZMLS = T\_EF\_AZMLS – TIME\_BIAS\_MLS  
T\_EF\_ELMLS = T\_EF\_ELMLS – TIME\_BIAS\_MLS  
PITCH\_M = THETA\_RAD\_PER\_DEG

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.2.2-1 and 4.3.2.2-2. All output time tags are assumed to have been associated with the sensors' measurements (the time FCOS commands the read, adjusted by applying time bias corrections).

C. Processing Requirements. It is required that the navigation sensor data (measurements, validity flags, and time tags) be made available for the collection and storing processes. The collection rates (not necessarily sensor interrogations) are indicated by the navigation sequencers. However, these rates assume the available data are fresh. This implies that SOP's processing and RM selection filtering must be at a rate equal to or greater than the collection rate. It is also required that the vehicle pitch angle from the attitude processing principal function be available when MSBLS data are collected.

D. Constraints. The data collection should occur after a complete current set is available and just prior to use in navigation in order to supply current data.

E. Supplementary Information. A suggested implementation of the preland external sensor data snap subfunction, in the form of a detailed flow chart, may be found in Section 5.2 (NAV\_PRELAND). The SNAP statements above imply the assignment of current values to the variable names shown in parentheses.

#### 4.3.2.2.2 GPS Data Snap

The GPS data snap task collects and stores homogeneous GPS receiver navigation data from the GPS SOP. The purpose of the GPS data snap is to properly save the data for use by the GPS receiver state vector processing principal function while the actual GPS data will continue to be refreshed by GPS LRU data readings and GPS SOP processing.

The homogeneous set of GPS receiver data shall be collected from the GPS SOP and stored. The data shall have the following characteristics: (1) it is the most current receiver navigation data from the GPS SOP that has been indicated by the receivers as valid (receiver data good is set on); (2) it is bracketed by IMU velocity counts which will be used in propagating these states to the current navigation filter time in the GPS Receiver State Processing principal function; (3) the velocity counts collected from the GPS SOP are from the IMU RM execution just prior to and closest to the GPS state time tag. The use of IMU accumulated velocity counts as close to the receiver state time tag minimizes the velocity transients introduced in the propagation of the GPS receiver states to current navigation filter time by providing the most accurate sensed velocity information across the GPS state propagation interval.

A. Detailed Requirements. A time homogeneous set of GPS data shall be collected from the GPS SOP and stored. Each set includes data from up to three receivers: GPS receiver state estimates, data good flags, figure-of-merit. Also included are the IMU velocity counts, associated with each receiver.

The data snaps are as follows:

$$\text{SNAP GPS\_DATA } (\bar{R}\_GPS\_ECEF, \bar{V}\_GPS\_ECEF, T\_GPS, \text{GPS\_DG,} \\ \text{GPS\_FAIL\_FOM, FOM,} \\ \bar{V}\_LAST\_GPS, T\_LAST\_GPS)$$

These GPS variables (vector, scalar arrays, character strings and discretets) correspond to data from three GPS receivers, which represents the maximum number of receivers for which the software is designed. The

first component of each array will be a time homogeneous set of data for GPS receiver 1, and likewise, array components 2 and 3 will be a consistent set of data for GPS receivers 2 and 3 respectively.

The IMU variables provided by the GPS SOP correspond to the values of the IMU counts closest to and just prior to each GPS state estimate time tag. They have been properly assigned to each receiver.

The snap statement implies the assignment of current GPS SOP data to the variables shown in parentheses. Time-homogeneous data for each GPS receiver must be provided to the appropriate subfunctions. The time homogeneous data from one receiver may have a different time tag than the time homogeneous data from another receiver.

Note that data shall be snapped for up to three receivers regardless of the number of receivers actually installed on the vehicle.

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.2.2-1 and 4.3.2.2-2 respectively. The parameter cross-reference table between the GPS SOP names and their navigation variable copies is shown in Section 4.3.2.9.

C. Processing Requirements. It is required that the GPS data be made available by the GPS SOP for the collection and storage process. The collection rates are indicated by the preland navigation sequencer rates. These rates assume that the available GPS data are the most recent GPS data available.

D. Constraints. The GPS data collection should occur as close to the preland IMU data snap as possible.

E. Suggested Implementation. A suggested implementation of the entry GPS data snap subfunction, in the detailed flow chart NAV\_PRELAND can be found in Section 5.2. The snap statement implies the assignment of current values to the variable names shown in parentheses.

#### 4.3.2.2.3 User Parameter Data Snap

The user parameter data snap task stores the vehicle altitude above the runway, computed by the user parameter processing functions, for use by the navigation user parameter reset metering function.

The purpose of the altitude data snap is to provide consistent altitude data for use throughout the user parameter reset metering calculations.

The data snap is as follows:

SNAP UPP\_DATA(ALT\_WHEELS\_NAV)

The snap statement implies the assignment of the current data from the user parameter processing functions to the variable shown in parentheses.

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.2.2-1 and 4.3.2.2-2 respectively. The parameter cross-reference table between the user parameter processing name and the navigation variable is shown in Table 4.3.2.9.

C. Processing Requirements. It is required that the vehicle altitude data be made available by the user parameter processing functions for the collection and storage process. The collection rates are indicated by the preland navigation sequencer rates. These rates assume that the available data are the most recent available.

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- D. Constraints. The altitude data collection should occur close to the other preland data snaps as possible.
- E. Suggested Implementation. A suggested implementation of the preland altitude data snap subfunction, in the detailed flow chart NAV\_PRELAND, can be found in Section 5.2. The snap statement implies the assignment of current values to the variable name shown in parentheses.

Table 4.3.2.2-1. Preland External Data Snap Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Barometric altimeter sensor measurement	Q_BARO	*	F	S		ft	Filter rate
Copy of current data good discrete reserved for measurement processing (navigation)	BARO_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Time tag associated with barometric measurement	T_BARO	*	F	DP		sec	Filter rate
Pad loaded bias used to correct barometric time tag	TIME_BIAS_BARO	K-load	F	DP		sec	Filter rate
TACAN bearing sensor measurement	Q_TAC_BRG	*	F	S		ft	Filter rate
TACAN range sensor measurement	Q_TAC_R	*	F	S		ft	Filter rate
Current data good discrete for TACAN range measurement processing	TAC_RNG_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Current data good discrete for TACAN bearing measurement processing	TAC_BRG_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read	T_TACAN	*	F	DP		sec	Filter rate
Pad loaded bias used to correct TACAN time tag	TIME_BIAS_TACAN	K-load	F	DP		sec	Filter rate
MSBLS range sensor measurement	Q_RANGE	*	F	S		ft	Filter rate
MSBLS azimuth sensor measurement	Q_AZMLS	*	F	S		ft	Filter rate
MSBLS elevation sensor measurement	Q_ELMLS	*	F	S		ft	Filter rate

Table 4.3.2.2-1. Preland External Data Snap Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Copy of current data good discrete reserved for measurement processing	MLSRANGE_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSAZ_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSEL_DATA_GOOD	*	D	—	OFF/ON	—	Filter rate
Time at which MSBLS range measurement was read	T_EF_RMLS	*	F	DP		sec	Filter rate
Time at which MSBLS azimuth was read (adjusted)	T_EF_AZMLS	*	F	DP		sec	Filter rate
Time tag of current MSBLS elevation measurement	T_EF_ELMLS	*	F	DP		sec	Filter rate
Pad loaded bias used to correct MSBLS time tag	TIME_BIAS_MLS	K-load	F	DP		sec	Filter rate
Euler angle from body to TD frame (pitch)	THETA	*	F	S	-PI/2 PI/2	deg	Filter rate
LRU number which the selection filter picked, and which identifies the site parameter list (No. 1, 2, 3)	SEL_LRU_ID	*	I	S	1,2, or 3	—	Filter rate
Flag indicating (ON) that the velocity of the vehicle is in the MACH discontinuity region	MACH_JUMP	*	D	—	OFF/ON	—	Filter rate

Table 4.3.2.2-1. Preland External Data Snap Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Figure of merits for each GPS receiver	$FOM_I^{**}$	*	I	--			Filter rate
GPS data good flags	$GPS\_DG_I^{**}$	*	D	--	ON/OFF	--	Filter rate
Flags indicating the FOM failure status for each GPS receiver	$GPS\_FAIL\_FOM_I^{**}$	*	D	--	ON/OFF	--	Filter rate
GPS receiver estimate of shuttle ECEF position	$\bar{R}\_GPS\_ECEF_I^{**}$	*	V	DP		ft	Filter rate
Time associated with the current GPS receiver state estimates in GMT	$T\_GPS_I^{**}$	*	F	DP		sec	Filter rate
Time of the IMU velocity counts nearest in time and prior to each GPS receiver state	$T\_LAST\_GPS_I^{**}$	*	F	DP		sec	Filter rate
GPS receiver estimate of shuttle ECEF velocity	$\bar{V}\_GPS\_ECEF_I^{**}$	*	V	S		ft/sec	Filter rate
Accumulated velocity counts nearest in time and prior to each GPS receiver state	$\bar{V}\_LAST\_GPS_I^{**}$	*	V	DP		ft/sec	Filter rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	$ALT\_WHEELS\_NAV$	*	F	S		ft	Filter rate

\* See principal function input list in Table 4.3.2.9-1.

\*\* I = 1 to GPS\_SW\_CAP

Table 4.3.2.2-2. Preland External Data Snap Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Barometric altimeter sensor measurement	Q_BARO	Preland barometric altimeter meas incorp.*	F	S		ft	Filter rate
Copy of current data good discrete reserved for measurement processing (navigation)	BARO_DATA_GOOD	Preland sensor selection, Preland barometric altimeter meas incorp.*	D	—	OFF/ON	—	Filter rate
Time tag associated with barometric measurement (adjusted)	T_BARO	Preland barometric altimeter meas incorp.*	F	DP		sec	Filter rate
TACAN bearing sensor measurement	Q_TAC_BRG	Preland TACAN bearing meas incorp.*	F	S		ft	Filter rate
TACAN range sensor measurement	Q_TAC_R	Preland TACAN range meas incorp.*	F	S		ft	Filter rate
Current data good discrete for TACAN range measurement processing	TAC_RNG_DATA_GOOD	Preland sensor selection, Preland TACAN range data incorp.*	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read (adjusted)	T_TACAN	Preland TACAN range meas incorp, preland TACAN bearing meas incorp.*	F	DP		sec	Filter rate
Current data good discrete for TACAN bearing measurement processing	TAC_BRG_DATA_GOOD	Preland sensor selection, Preland TACAN bearing meas incorp.*	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that the velocity of the vehicle is in the MACH discontinuity region	MACH_JUMP	Preland sensor selection	D	—	OFF/ON	—	Filter rate
MSBLS range sensor measurement	Q_RANGE	Preland MSBLS range meas incorp.*	F	S		ft	Filter rate
MSBLS azimuth sensor measurement	Q_AZMLS	Preland MSBLS range meas incorp.*	F	S		ft	Filter rate



Table 4.3.2.2-2. Preland External Data Snap Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
MSBLS elevation sensor measurement	Q_ELMLS	Preland MSBLS range meas incorp,*	F	S		ft	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSRANGE_DATA_GOOD	Preland MSBLS range meas incorp,*	D	—	OFF/ON	—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSAZ_DATA_GOOD	Preland sensor selection, Preland MSBLS range meas incorp,*	D	—	OFF/ON	—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSEL_DATA_GOOD	Preland MSBLS range meas incorp,*	D	—	OFF/ON	—	Filter rate
Time at which MSBLS range measurement was read (adjusted)	T_EF_RMLS	Preland MSBLS range meas incorp,*	F	DP		sec	Filter rate
Time at which MSBLS azimuth was read (adjusted)	T_EF_AZMLS	Preland MSBLS azimuth meas incorp,*	F	DP		sec	Filter rate
Time tag of current MSBLS elevation measurement (adjusted)	T_EF_ELMLS	Preland MSBLS elevation meas incorp,*	F	DP		sec	Filter rate
Altitude of vehicle above the runway computed in UPP and snapped by navigation	ALT_WHEELS_NAV	UPP state reset, Preland control	F	S		ft	Filter rate
Copy of pitch–store reserved for MLS elevation processing	PITCH_M	Preland MSBLS elevation meas incorp,*	F	S		rad	Filter rate
LRU number which the selection filter picked, and which identifies the site parameter list (No. 1, 2, 3)	SEL_LRU_ID	Preland measurement reconfiguration,*	I	S	1, 2, or 3	—	Filter rate
Figure of merits for each GPS receiver	FOM <sub>i</sub> **	*	I	--			Filter rate
GPS data good flag	GPS_DG <sub>i</sub> **	*	D	--	ON/OFF	--	Filter rate

Table 4.3.2.2-2. Preland External Data Snap Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Flags indicating the FOM failure status for each GPS receiver	GPS_FAIL_FOM <sub>I</sub> **	*	D	--	ON/OFF	--	Filter rate
GPS receiver estimate of shuttle ECEF position	$\bar{R}_{GPS\_ECEF_I}$ **	*	V	DP		ft	Filter rate
Time associated with the current GPS receiver state estimates in GMT	T_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
Time of the IMU velocity counts nearest in time and prior to each GPS receiver state	T_LAST_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
GPS receiver estimate of shuttle ECEF velocity	$\bar{V}_{GPS\_ECEF_I}$ **	*	V	S		ft/sec	Filter rate
Accumulated velocity counts nearest in time and prior to each GPS receiver state	$\bar{V}_{LAST\_GPS_I}$ **	*	V	DP		ft/sec	Filter rate

\* See principal function output list in Table 4.3.1.9-2.  
\*\* I = 1 to GPS\_SW\_CAP

### 4.3.2.3 Sensor Measurement Selection

A capability, designated as the preland sensor measurement selection subfunction, is required for the selection of external sensor measurement data to be presented to the state and covariance measurement incorporation subfunction (Section 4.3.2.7) when the preland navigation principal function is active. Selection of a sensor data type will also mean that knowledge of this measurement data selection will be presented to the measurement reconfiguration subfunction (Section 4.3.2.4.1) to cause proper initialization of TACAN site data.

A. Detailed Requirements. The requirements for this subfunction are given as a set of necessary sensor measurement selection capabilities. Only the following measurement types will be employed while the preland navigation principal function is active: barometric altimeter, MSBLS, and TACAN. The following capabilities will be provided:

- (1) There will be both manual (crew) and automatic control of TACAN, barometric altimeter and MSBLS measurement selection.
- (2) The crew will be able to manually force or inhibit TACAN, barometric altimeter and MSBLS sensor data or select the automatic mode.
- (3) Manual control (force or inhibit) will override automatic sensor selection; that is, if a crewman desires to force TACAN or barometric altimeter or MSBLS data, then these data will be sent to the state and covariance measurement incorporation subfunction (data may not be incorporated if indicated to be invalid), with one exception (see Item 5 below). The force or inhibit will stay in effect across major modes and will be removed by reverting to automatic sensor measurement selection.
- (4) The forcing of sensor data will override the residual edit for that particular sensor type.
- (5) Neither the crew nor the automatic selection criteria will be able to simultaneously select any of the following combinations:
  - a. TACAN and MSBLS data
  - b. MSBLS and barometric altimeter data
- (6) If MSBLS is in the force selection mode ( $MLS\_AIF\_RCVD = FORCE$ ), then step 6.1 is executed, otherwise step 6.2 is executed. Note that MSBLS auto/inhibit/force is initialized in the auto selection mode and can be changed only when three GPS receivers are installed on the vehicle (no TACAN receivers installed). TACAN auto/inhibit/force is initialized in the inhibit selection mode and can be changed only when three TACAN receivers are installed on the vehicle (either zero or one GPS receiver installed).
- 6.1 MSBLS data will be selected ( $DO\_MLS\_NAV = ON$ ), and the MLS edit override ( $MLS\_EDIT\_OVERRIDE$ ) flag will be set to ON, independent of the validity of MSBLS range and azimuth data ( $MLS\_R\_AZ\_GOOD$ ). The following parameters shall also be set and made available for use by other functions: the parameter indicating that MSBLS data is being processed by the preland navigation Kalman filter ( $PROCESSING\_MLS$ ) will be set to ON if the MSBLS range and azimuth data is indicated as valid ( $MLS\_R\_AZ\_GOOD = ON$ ); the parameter indicating that MSBLS data is selected with MSBLS in the force selection

- mode (MLS\_FORCE\_PROC\_IND) will be set to ON; the parameter indicating that MSBLS data is selected with MSBLS in the auto selection mode (MLS\_AUTO\_PROC\_IND) will be set to OFF.
- 6.2 If MSBLS is not in the force selection mode (MLS\_AIF\_RCVD set to AUTO or INHIBIT) the MLS force processing indicator (MLS\_FORCE\_PROC\_IND) will be set to OFF. If TACAN is in the force selection mode (TACAN\_AIF set to FORCE), step 6.2.1 will be executed, otherwise step 6.2.2 will be executed.
- 6.2.1 TACAN data will be selected (DO\_TACAN\_NAV = ON) and the TACAN edit override (TACAN\_EDIT\_OVERRIDE) is set to ON. The parameter indicating that MSBLS data is being processed with MSBLS in the auto selection mode (MLS\_AUTO\_PROC\_IND) is set to OFF.
- 6.2.2 If MSBLS range and azimuth data are indicated as valid (MLS\_R\_AZ\_GOOD set to ON), step 6.2.2.1 will be executed, otherwise step 6.2.2.2 will be executed.
- 6.2.2.1 MSBLS data will be selected (DO\_MLS\_NAV = ON). If MSBLS is in the auto selection mode (MLS\_AIF\_RCVD set to AUTO), the following parameters shall be set and made available for use by other functions: the parameter indicating that MSBLS data is being processed and incorporated by the preland navigation Kalman filter (PROCESSING\_MLS) will be set to ON; the parameter indicating that MSBLS data is being processed with MSBLS in the auto selection mode (MLS\_AUTO\_PROC\_IND) will be set to ON; and the time of the MSBLS measurement processing (T\_LAST\_MLS\_PROC) will be set to the time of the current navigation state (T\_CURRENT\_FILT). If MSBLS is in the inhibit selection mode (MLS\_AIF\_RCVD set to INHIBIT), the MLS status parameter (MLS\_STAT) will be set to ON, and the parameter indicating that MSBLS data is being processed with MSBLS in the auto selection mode (MLS\_AUTO\_PROC\_IND) will be set to off.
- 6.2.2.2 If MSBLS range and azimuth data are indicated as invalid during the current execution cycle (MLS\_R\_AZ\_GOOD set to OFF), or no valid MSBLS range or no valid azimuth data have been snapped for the last two execution cycles (also indicated by MLS\_R\_AZ\_GOOD set to OFF), then the following steps are executed: if the parameter indicating that MSBLS data was being processed with MSBLS in the auto selection mode (MLS\_AUTO\_PROC\_IND) is set to ON and an I-load amount of time has elapsed since the last MSBLS measurement processing ( $T\_CURRENT\_FILT - T\_LAST\_MLS\_PROC > MLS\_DROPOUT\_DT\_LIM$ ), the auto selection mode processing indicator (MLS\_AUTO\_PROC\_IND) is set to OFF; if the TACAN auto/inhibit/force measurement processing command (TACAN\_AIF) is set to AUTO, and if TACAN range or bearing data is valid (TAC\_RNG\_DATA\_GOOD = ON or TAC\_BRG\_DATA\_GOOD = ON), TACAN data is selected (DO\_TACAN\_NAV = ON); if the TACAN auto/inhibit/force measurement processing command (TACAN\_AIF) is in the inhibit selection mode (TACAN\_AIF set to INHIBIT), TACAN data is selected (DO\_TACAN\_NAV = ON) and the TACAN status flag (TACAN\_STAT) is set to ON, independent of the validity of the TACAN range or bearing data.
- (7) When MSBLS data are first selected, or are reselected after having been deselected, portions of the covariance matrix shall be reinitialized by setting all the cross-correlation terms between position and velocity to zero. Also, the counter MLS\_EDIT\_MUL\_COUNT, which

records the number of cycles that MSBLS measurements have been processed since the most recent MSBLS selection, will be set to zero.

- (8) If MSBLS is not selected and barometric altimeter data are indicated as valid, baro data will be selected for processing (for statistics only) if the crew has inhibited the use of baro data for state updates. If baro has not been inhibited and the vehicle is not in the 'MACH jump' region or below a minimum altitude above the runway, baro will be selected for processing. The 'MACH jump' region shall override the auto and force modes of selection. The minimum altitude above the runway for processing barometric altimeter data shall be ALT\_BARO\_CUTOFF. If MSBLS is processed below ALT\_BARO\_CUTOFF\_HIGH, then the baro cutoff altitude, ALT\_BARO\_CUTOFF, shall be set to ALT\_BARO\_CUTOFF\_HIGH to preclude state updates with baro data if MSBLS data is lost at low vehicle altitudes. Otherwise state updates with baro data will continue to a vehicle altitude specified by the initial value of ALT\_BARO\_CUTOFF.
- (9) The state of the TACAN, barometric altitude and MSBLS measurement selection configuration will be indicated to the crew display.
- (10) If MSBLS is indicated as not available at the current (crew) selected landing site, MSBLS data will not be selected.

This subfunction will also perform sensor measurement selection when the data are employed only to compute TACAN, barometric altimeter and MSBLS statistics for display purposes. The following capabilities will be provided:

- (1) A maximum of three pieces of sensor measurement data (e.g., MSBLS range, azimuth, and elevation or TACAN range and azimuth and barometric altimeter) will be processed on any one execution of the preland navigation principal function.
- (2) Selection of TACAN and barometric altimeter measurements for computation of measurement statistics will be subordinate to selection of MSBLS for possible state and covariance incorporation.

The result of selection of TACAN and MSBLS sensor measurement for processing of data or for computation of measurement statistics will be provided as indicated in Table 4.3.2.3-1 when TACAN receivers are installed on the vehicle and Table 4.3.2.3-1A when no TACAN receivers are installed on the vehicle respectively. Table 4.3.2.3-2 shows results of BARO measurement selection, which is the same with TACAN and with no TACAN receivers installed. The term "process" means that the state and covariance measurement incorporation subfunction may incorporate the measurement data into the state estimation. The term "display" means that the state and covariance measurement incorporation subfunction may perform the processing of data for display of measurement statistics, but is prohibited from incorporating the data into the state estimation.

Finally, this subfunction will initialize the measurement edit indicators to off for subsequent use by the state and covariance measurement incorporation subfunction.

B. Interface Requirements. The input and output for this function are given in Tables 4.3.2.3-3 and 4.3.2.3-4.

C. Processing Requirements. This function will be performed after a complete set of the external sensor measurement data to be used (while the preland navigation principal function is active) has been saved and before the measurement reconfiguration subfunction is executed.

D. Constraints. None.

E. Supplemental Information. The foregoing requirements indicate the existence of a three-position software switch associated with the TACAN, baro altimeter and MSBLS sensor measurements; that is, an AUTO/INHIBIT/FORCE switch for each of these sensor measurement types.

When MSBLS is in the force selection mode (three GPS receivers installed), MSBLS data will be selected (DO\_MLS\_NAV = ON) regardless of the validity of any of the MSBLS data. No other measurement types will be selected, nor will GPS data be incorporated into navigation or guidance. Each MSBLS measurement will update navigation, based on its validity (DATA\_GOOD = ON), independent of the validity of the other MSBLS measurements. When MSBLS is in the auto selection mode (three GPS receivers installed), MSBLS data will be selected (DO\_MLS\_NAV = ON) only if both MSBLS range and azimuth data are valid. Range and azimuth measurements will update navigation, as will elevation if it is valid (DATA\_GOOD = ON). In either case, “MLS” will be displayed double overbright on the Horizontal Situation Display (PROCESSING\_MLS = ON) only if both MSBLS range and azimuth are valid. Otherwise, the “MLS” field on the Horizontal Situation Display will be blanked (PROCESSING\_MLS = OFF).

A candidate implementation of this subfunction is shown in PRELAND\_SENSOR\_SELECT code in Section 5.2. This code is executed by NAV\_PRELAND, the candidate implementation of the preland navigation control subfunction.

Table 4.3.2.3-1. MSBLS Versus TACAN - TACAN Receivers Installed

		MSBLS AVAILABLE		MSBLS NOT AVAILABLE
		DATA GOOD (Range and AZ)	DATA BAD (k Cycles)	
		TACAN	Auto	PROCESS MSBLS
Force	PROCESS TACAN*		PROCESS TACAN*	PROCESS TACAN*
Inhibit	PROCESS MSBLS		DISPLAY TACAN	DISPLAY TACAN

\* Will not result in update if DATA\_GOOD = OFF

Table 4.3.2.3-1A MSBLS with No Tacan Receivers Installed				
MSBLS		MSBLS AVAILABLE		MSBLS NOT AVAILABLE
		DATA GOOD (Range and AZ)	DATA BAD (for k Navigation Cycles)	
	AUTO	PROCESS MSBLS*	-	-
	FORCE	PROCESS MSBLS**	PROCESS MSBLS**	
INHIBIT	-	-	-	

Note: MSBLS is initialized to AUTO

- \* Will result in updates only if both MSBLS range and azimuth DATA\_GOOD=ON
- \*\* MSBLS range, azimuth and elevation will update navigation if corresponding DATA\_GOOD = ON, regardless of validity of others

Table 4.3.2.3-2. Barometric Altimeter*			
Auto		Inhibit	Force
In MACH Jump region	Outside MACH Jump region and above minimum altitude		
No Selection	Process***	Display	Process**

\* This table is used only if the outcome of Table 4.3.2.3-1 or 4.3.2.3-1A is to not process MSBLS.  
 \*\* Will not result in update if DATA\_GOOD = OFF or if MACH\_JUMP indicator = ON.  
 \*\*\* Display STATS below minimum altitude.

Table 4.3.2.3-3. Preland Sensor Measurement Selection Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Copy of current data good discrete reserved for measurement processing	MLSRANGE_DATA_GOOD	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
Running count of number of consecutive MLS azimuth and range measurements failing data good test	R_AZ_COUNT	Preland sensor measurement selection	I	S		—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSAZ_DATA_GOOD	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
Prescribed number of consecutive MLS azimuth measurement data good “fails” to force inhibit of MLS processing and allow TACAN processing	R_AZ_COUNT_MAX	K-load	I	S		—	Filter rate
Auto-inhibit-force switch for TACAN sensor selection	TACAN_AIF	*	CHAR	S		—	Filter rate
Auto-inhibit-force switch for barometric altimeter sensor selection	BARO_AIF	*	CHAR	S		—	Filter rate
Altitude above the Fisher ellipsoid	ALT	*	F	S		ft	Filter rate
Flag indicating (ON) that vehicle speed is in the MACH discontinuity region	MACH_JUMP	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
Flag indicating if ON that MSBLS data are available at the selected landing site	MLS_AVAIL	*	D	—	OFF/ON	—	Filter rate
BARO processing cutoff altitude	ALT_BARO_CUTOFF	**	F	S		ft	Filter rate



Table 4.3.2.3-3. Preland Sensor Measurement Selection Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
BARO processing cutoff altitude if MSBLS data processed below ALT_BARO_CUTOFF_HIGH	ALT_BARO_CUTOFF_HIGH	I-load	F	S		ft	Filter rate
Time associated with current selected navigation filter state	T_CURRENT_FILT	*	F	D		sec	Filter rate
Time limit for continuous dropout of MLS data prior to allowing switch over to GPS nav	MLS_DROPOUT_DT_LIM	I-load	F	S		sec	Filter rate
MLS AUTO/INHIBIT/FORCE switch	MLS_AIF	*	CHAR				Filter rate
Copy of current range data good discrete reserved for measurement processing	TAC_RNG_DATA_GOOD	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of current bearing data good discrete reserved for measurement processing	TAC_BRG_DATA_GOOD	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of current data good discrete reserved for measurement processing (navigation)	BARO_DATA_GOOD	Preland sensor data snap	D	—	OFF/ON	—	Filter rate
GPS auto/inhibit/force flag	GPS_AIF_RCVD	Preland Control	I	S	0 (AUTO) 1 (INHIBIT) 2 (FORCE)	--	Filter rate

\* See principal function input list in Table 4.3.2.9-1.

\*\* ALT\_BARO\_CUTOFF is initialized with I-load name ALT\_BARO\_CUTOFF\_LOW.

Table 4.3.2.3-4. Preland Sensor Measurement Selection Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) that barometric altimeter data is to be processed	DO_BARO_NAV	Preland baro measurement incorporation,*	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data is to be processed	DO_TACAN_NAV	Preland TACAN measurement incorporation and reconfiguration,*	D	—	OFF/ON	—	Filter rate
General edit indicator for I-th sensor measurement, I = 1, 7	SENSOR_EDIT(I)	Preland state and covariance measurement incorporation,*, preland measurement processing statistics	V	S			Filter rate
Switch used to force incorporation of barometric data regardless of residual edit test	BARO_EDIT_OVERRIDE	Preland barometric altimeter data processing	D	—	OFF/ON	—	Filter rate
Counter indicating number of cycles that MSBLS meas. have been processed since the most recent selection	MLS_EDIT_MUL_COUNT	Preland control	I	S		ND	Filter rate
Switch used to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	Preland TACAN range data processing preland TACAN bearing data processing	D	—	OFF/ON	—	Filter rate
Flag indicating stat-flag setting for barometric measurement	BARO_STAT	Preland barometric altimeter data processing	D	—	OFF/ON	—	Filter rate

Table 4.3.2.3-4. Preland Sensor Measurement Selection Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating TACAN data processed only for statistical display	TACAN_STAT	Preland TACAN range data processing preland TACAN bearing data processing	D	—	OFF/ON	—	Filter rate
Covariance matrix	E	Covariance matrix propagation state and covariance measurement incorporation	M	DP		Vary	Filter rate
Auto/inhibit/force switch for TACAN sensor selection	TACAN_AIF	*	CHAR	S		—	Filter rate
Auto/inhibit/force switch for barometric altimeter selection	BARO_AIF	*	CHAR	S		—	Filter rate
Flag indicating (ON) that MSBLS data are to be processed	DO_MLS_NAV	*, Preland measurement processing statistics	D	—	OFF/ON	—	Filter rate
Flag used (ON) to override MLS residual edit test	MLS_EDIT_OVERRIDE	MLS Az measurements, MLS Rng measurements, MLS Elev. measurements	D		ON/OFF		Filter rate
Flag indicating which MLS AIF command is in effect	MLS_AIF_RCVD	*	CHAR				Filter rate
Flag indicating (ON) that MLS data are being processed through MLS AUTO command	MLS_AUTO_PROC_IND	Preland control	D		ON/OFF		Filter rate

Table 4.3.2.3-4. Preland Sensor Measurement Selection Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) that MLS data are being processed through MLS FORCE command	MLS_FORCE_ PROC_IND	Preland control	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are to be processed for statistical display only	MLS_STAT	MLS Az measurements, MLS Rng measurements, MLS Elev. measurements	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are being processed	PROCESSING_MLS	*	D		ON/OFF		Filter rate

\* See principal function output list in Table 4.3.2.9-2.

#### 4.3.2.4 Preland Navigation Reconfiguration

A capability shall be provided for initialization or reinitialization of certain navigation variables when events occur which require reconfiguration of the navigation software. These events include the initialization of TACAN station information when the TACAN ID changes, and ground updates to the onboard navigated state vector and associated covariance matrix reinitializations.

##### 4.3.2.4.1 Measurement Reconfiguration

A capability will be provided for initialization of the TACAN station information when TACAN processing begins or when the TACAN station ID has changed.

A. Detailed Requirements. The preland sensor measurement selection subfunction will provide a capability for determining when TACAN measurements are to be processed. The measurement reconfiguration subfunction will be executed when TACAN measurements are first available and when the TACAN station ID has changed. This subfunction will obtain the following information from the site lookup principal function (Section 4.5.2) only if the selected TACAN channel is indicated valid.

TACAN station information:

$$\text{TACAN\_ID\_LAST} = \text{TACAN\_ID}_{\text{SEL\_LRU\_ID}}$$
$$\text{TAC\_CHAN\_VALID} = \text{TACAN\_CHAN\_VALID\_SL}_{\text{SEL\_LRU\_ID}}$$
$$\bar{\mathbf{R}}_{\text{TACAN\_EF}} = \bar{\mathbf{R}}_{\text{TACAN\_EF\_SL}_{\text{SEL\_LRU\_ID}}}$$
$$\text{M\_EFTOTD\_TACAN} = \text{M\_EFTOTD\_TACAN\_SL}_{\text{SEL\_LRU\_ID}}$$
$$\text{ANGLE\_CORR\_TNTOMAG} = \text{ANGLE\_CORR\_TNTOMAG\_SL}_{\text{SEL\_LRU\_ID}}$$

B. Interface Requirements. The input and output variables for this subfunction are described in Tables 4.3.2.4.1-1 and 4.3.2.4.1-2.

C. Processing Requirements. The measurement reconfiguration subfunction shall be performed prior to processing of TACAN measurements and after the execution of the preland sensor selection subfunction.

D. Constraints. It is required that the TACAN redundancy management selection filtering, and the preland navigation principal function execute in the following sequence:

- (1) TACAN RM selection filtering.
- (2) Preland navigation.

The site lookup principal function TACAN-related output parameters may not be changed during the time interval starting with the initiation of TACAN RM selection filtering and ending with the completion of the preland NAV execution.

E. Supplementary Information. Although the detailed requirements show data being copied from the site lookup principal function into specific navigation variables, there is no reason why the site lookup data could not be used directly by the filter if the above constraint is realized. A suggested implementation of the measurement reconfiguration subfunction is illustrated by the flow charts NAV\_SENSOR\_INIT in Section 5.2.

Table 4.3.2.4.1-1. Preland Measurement Reconfiguration Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
ID for TACAN LRU selected by RM	SEL_LRU_ID	External sensor data snap	I	S	1,2,3	—	As needed
Switch for each LRU indicating (ON) a valid TACAN channel has been selected. I = 1, 2, 3	TACAN_CHAN_VALID_SL <sub>I</sub>	*	D	S	OFF/ON	—	As needed
TACAN station position vector in earth-fixed coordinates for each LRU. I = 1, 2, 3	R_TACAN_EF_SL <sub>I</sub>	*	V	DP		ft	As needed
Transformation from earth-fixed to topodetic at TACAN station for each LRU. I = 1, 2, 3	M_EFTOTD_TACAN_SL <sub>I</sub>	*	M	S		—	As needed
Angle correction from true north to magnetic north for each LRU. I = 1, 2, 3	ANGLE_CORR_TNTOMAG_SL <sub>I</sub>	*	F	S		rad	As needed
TACAN channel/mode identifier for each LRU. I = 1, 2, 3	TACAN_ID <sub>I</sub>	*	I	S		—	As needed

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.4.1-2. Preland Measurement Reconfiguration Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN station position vector in earth-fixed coordinates	$\bar{R}_{TACAN\_EF}$	Preland state and covariance measurement incorporation	V	DP		ft	As needed
Transformation from earth-fixed to topodetic at TACAN station	M_EFTOTD_TACAN	Preland state and covariance measurement incorporation	M	S			As needed
Angle correction from true north to magnetic	ANGLE_CORR_TNTOMAG	Preland state and covariance measurement incorporation	F	S		rad	As needed
Flag indicating valid TACAN channel data	TAC_CHAN_VALID	Preland state and covariance measurement incorporation	D	—	OFF/ON	—	As needed

#### 4.3.2.4.2 Delta State Update

During operation of the preland navigation principal function, a capability for a delta state update of the orbiter's onboard navigated state and reconfiguration of the covariance matrix shall be provided.

A. Detailed Requirements. Detailed requirements for the performance of the delta state update task are described in Section 4.2.6. After execution of the delta state update task, the covariance initialization task described in Section 4.2.9 shall be invoked to reconfigure the onboard covariance matrix. Input values of sigmas and correlation coefficients are peculiar to and associated with the delta state update reconfiguration.

B. Interface Requirements. Input and output requirements for the delta state update task are shown in Tables 4.3.2.4.2-1 and 4.3.2.4.2-2 respectively.

C. Processing Requirements. The delta state update task and covariance matrix reconfiguration will be initiated from inputs supplied by either the HSD specialist function processing software or by the ground uplink processing software. The delta state update subfunction and the covariance matrix reconfiguration shall be performed after the state propagation and measurement selection subfunctions have been completed, and only upon detection of an ON value in the DO\_DELTA\_UPDATE flag. This flag is checked by the Preland Control subfunction in every cycle of the preland navigation principal function.

D. Constraints. None.

E. Supplementary Information. Procedures will be established to inhibit redesignation of the runway and the incorporation of measurement data into the onboard state vector during the time interval between (1) the time of the difference vectors computation and (2) the time of their application to the onboard state vector. Correction terms, rather than the total vector, are used because the correction terms are less sensitive to errors between the time of their computation and the time that they are actually applied to correct the onboard state vector during powered flight.

A suggested implementation in the form of the detailed flow charts OPS\_3\_DELTA\_UPDATE AND COVINIT may be found in Section 5.2.



Table 4.3.2.4.2-1. Delta State Update Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Flag indicating whether the mode of operation is single state or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	As needed
Time of the filter state vectors	T_LAST_FILT	Preland navigation state propagation	F	DP		sec	As needed
Ground computed position deviations to update on-board state vector	$\bar{D}R_{RW}$	Preland control	V	DP		ft	As needed
Ground computed velocity deviations to update on-board state vector	$\bar{D}V_{RW}$	Preland control	V	S		ft/sec	As needed
Earth fixed to prime RW transformation matrix	M_EFTORW	*	M	S		—	As needed
Earth rotation rate	EARTH_RATE	Constant	F	S		rad/sec	As needed
Unit vector in direction of Earth's axis of rotation	$\bar{E}ARTH\_POLE$	*	V	DP		—	As needed
Vehicle position and velocity standard deviations used when manual state update is invoked	$\bar{S}IG\_DIAG\_UPDATE$	K-load	V	DP		ft**2	As needed
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation	V	DP		ft	As needed
Filter current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state propagation	V	S		ft/sec	As needed
Covariance correlation coefficients	$\bar{C}ORR\_COEFF\_UPDATE$	K-load	V	DP		vary	As needed
Major Mode 303 flag	MM_CODE_303	MSC	D	—	OFF/ON	—	As needed

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.4.2-2. Delta State Update Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	DP		ft	As needed
Filter current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	S		ft/sec	As needed
Filter covariance matrix	E	Preland covariance propagation	S	DP		vary	As needed
Flag indicating (ON) that a delta update is to be performed	DO_DELTA_UPDATE	Preland control	D	—	OFF/ON	—	Filter rate
Ground computed deviations to update on-board position vector (zeroed out for display)	$\bar{DR}_{RW}$	*	V	S		ft	Filter rate
Ground computed deviations to update on-board velocity vector (zeroed out for display)	$\bar{DV}_{RW}$	*	V	S		ft/sec	As needed

\* See principal function output list in Table 4.3.2.9-2.

#### 4.3.2.5 State Propagation

The state propagation subfunction that is active during operation of the preland navigation principal function will be invoked for the purpose of propagating orbiter position and velocity vectors. This subfunction will also snap IMU-sensed accelerations to be used together with modeled gravitational accelerations by the super-g integration task.

A. Detailed Requirements. Propagation of position and velocity vectors will be performed as follows:

- (1) Acquire current IMU-sensed total accumulated velocity and associated time tag.

$$\bar{V}_{\text{CURRENT\_FILT}}$$

$$T_{\text{CURRENT\_FILT}}$$

Detailed requirements for this IMU data snap task are given in Section 4.2.1.1 (one-state configuration).

- (2) Compute the difference between the current and the previous time tag associated with the IMU data snap. This will be the interval over which state propagation is desired.

$$DT_{\text{FILT}} = T_{\text{CURRENT\_FILT}} - T_{\text{LAST\_FILT}}$$

- (3) Perform integration of the position/velocity equations of motion with use of the super-g task (see Section 4.2.1.3 for detailed requirements). Position/velocity vectors will be propagated to the current time of the IMU data snap ( $T_{\text{CURRENT\_FILT}}$ ),

$$\bar{R}_{\text{FILT}}$$

$$\bar{V}_{\text{FILT}}$$

and the current IMU accumulated sensed velocity vectors will be saved for the next cycle (see Section 4.2.1.3).

$$\bar{V}_{\text{LAST\_FILT}}$$

- (4) Save the current time tag for the next cycle.

$$T_{\text{LAST\_FILT}} = T_{\text{CURRENT\_FILT}}$$

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.2.5-1 and 4.3.2.5-2.

C. Processing Requirements. The state propagation subfunction will be performed before the sensor measurement selection subfunction and before the covariance propagation subfunction. This subfunction will be performed each cycle at the preland navigation rate.

D. Constraints. None.

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E. Supplementary Information. A suggested implementation in the form of detailed flow charts may be found in Section 5.2.

NAV\_PRELAND, IMU data snap

NAV\_STATE\_PROP

SUPER\_G\_NAV

ACCEL

Table 4.3.2.5-1. Preland State Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Copy of V_IMU_CURRENT raw velocity counts reserved for measurement processing	$\bar{V}$ _CURRENT_FILT	*	V	S		ft/sec	Filter rate
MTU or clock time when IMU was read	T_CURRENT_FILT	*	F	DP		sec	Filter rate
Time of the filter state vectors	T_LAST_FILT	Preland state propagation,*	F	DP		sec	Filter rate
Flag indicating whether the mode of operation is single state or three state	NAV_THREE_STATE	*	D	—	OFF/ ON	—	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}$ _FILT	Preland state propagation, preland delta state update, preland state and covariance measurement incorporation,*	V	DP		ft	Filter rate
Shuttle velocity vector	$\bar{V}$ _FILT	Preland state propagation, preland delta state update, preland state and covariance measurement incorporation,*	V	S		ft/sec	Filter rate
Previously read selected accumulated IMU velocity	$\bar{V}$ _LAST_FILT	Preland state propagation, *	V	S		ft/sec	Filter rate
Tesser al harmonic coefficient	C	Constant	V(9)			ND	Filter rate
Tesser al harmonic coefficient	S	Constant	V(9)			ND	Filter rate
Tesser al harmonic coefficient	Zonal	Constant	V(4)			ND	Filter rate
Minimum nongravitational acceleration magnitude to use IMU data	ACC_PROP_MIN	*	F	S		ft/sec <sup>2</sup>	Filter rate

\* See principal function input list in Table 4.3.2.9–1.

Table 4.3.2.5-2. Preland State Propagation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation, preland delta state update, preland state and covariance measurement incorporation, preland covariance propagation, preland MSBLS range meas incorp	V	DP		ft	Filter rate
Shuttle velocity vector	$\bar{V}_{FILT}$	Preland state propagation, preland delta state update, preland state and covariance measurement incorporation, preland covariance propagation, preland MSBLS range meas incorp	V	S		ft/sec	Filter rate
Gravitational acceleration vector	$\bar{G}_{OLD}$	Preland MSBLS range meas incorp	V	S		ft/sec <sup>2</sup>	Filter rate
Time of the filter state vectors	T_LAST_FILT	Preland NAV state prop, preland delta state update, preland MSBLS range meas incorp	F	DP		sec	Filter rate
Previously read selected accumulated IMU velocity	$\bar{V}_{LAST_FILT}$	Preland state propagation	V	S		ft/sec	Filter rate
Difference between present and previous accumulated sensed velocities	$\bar{DV}_{FILT}$	Preland covariance propagation, Preland MSBLS range meas incorp					

Table 4.3.2.5-2. Preland State Propagation Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag indicating (ON) to use IMU data in state propagation	USE_IMU_DATA	*	D	S	OFF/ ON	—	Filter rate
* See principal function output list in Table 4.3.2.9–2.							

#### 4.3.2.6 Covariance Propagation

The covariance matrix propagation subfunction propagates the covariance matrix forward in time. The covariance matrix is propagated by utilizing the state transition matrix. Additive process noise is incorporated to account for unmodeled state and dynamic errors.

A. Detailed Requirements. A 6 by 6 covariance matrix will be propagated with the preland navigation principal function. This covariance matrix defines the uncertainty in the state vector, which consists of position and velocity of the vehicle. The method of propagation is described in Section 4.2.2.

The preland navigation principal function maintains a single state vector; so the current filter position vector, R\_FILT, required in the covariance propagation is obtained directly from the state propagation subfunction.

B. Interface Requirements. The input and output data are shown in Tables 4.3.2.6–1 and 4.3.2.6–2.

C. Processing Requirements. This subfunction will be called after the IMU sensor data have been read and after the state propagation subfunction has been executed.

D. Constraints. Prestored data are to be used for initialization. The propagated covariance matrix must remain symmetric.

E. Supplementary Information. A possible implementation of this subfunction is shown in the flow chart COVEXTRAP\_PF and GRAVITY\_GRADIENT in Section 5.2.

Table 4.3.2.6-1. Preland Covariance Matrix Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Interval over which to propagate the covariance matrix	DT_FILT	Preland state propagation	F	S		sec	Filter rate
Filter covariance matrix	E	Preland state and covariance measurement incorporation, preland covariance propagation	M	DP		vary	Filter rate
Gravitational constant of earth	EARTH_MU	Constant	F	S		ft <sup>3</sup> /sec	Filter rate
Identity matrix (3 X 3)	ID_MATRIX_3x3	Constant	M	S		—	Filter rate
Updated vehicle position vector associated with current covariance matrix	R_COV_LAST	Preland control	V	DP		ft	Filter rate
Filter current Shuttle position vector in M50 coordinates	R_FILT	Preland state propagation	V	DP		ft	Filter rate
Accelerometer quantization error variance during powered flight	VAR_ACC_QUANT_IMU	K-load	F	S		ft <sup>2</sup> /sec <sup>4</sup>	Filter rate
Variance of unmodeled acceleration times scale time during powered flight	VAR_UNMOD_ACC_DT_IMU	K-load	F	S		ft <sup>2</sup> /sec <sup>3</sup>	Filter rate
Flag indicating (ON) that IMU data is being used in state propagation	USE_IMU_DATA	Preland state propagation	D	—	OFF/ON	—	Filter rate
Variance of unmodeled acceleration times scale time during unpowered flight	VAR_UNMOD_ACC_DT_COAST	K-load	F	S		ft <sup>2</sup> /sec <sup>3</sup>	Filter rate
State noise error variance during unpowered flight	VAR_ACC_QUANT_COAST	K-load	F	DP		ft <sup>2</sup> /sec <sup>4</sup>	Filter rate

\* See principal function input list in Table 4.3.2.9-1.



Table 4.3.2.6-2. Preland Covariance Matrix Propagation Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Filter covariance matrix	E	Preland state and covariance measurement incorporation, preland covariance propagation	M	DP		vary	Filter rate

#### 4.3.2.7 State and Covariance Measurement Incorporation

The state and covariance measurement incorporation subfunction updates the state vector and covariance matrix with navigation data with the use of a 6-state process noise Kalman filter. The six elements of the state vector are navigation base Shuttle position and velocity in M50 coordinates.

A. Detailed Requirements. The state and covariance measurement incorporation subfunction is exercised only if data are available for processing as determined by the sensor measurement selection subfunction (Section 4.3.2.3) and the respective measurement subfunctions (Sections 4.3.2.7.1 through 4.3.2.7.6). The sensor measurement selection subfunction determines which measurement types are to be considered for processing. The measurement subfunctions process sensor data that are labeled as valid.

The measurement subfunctions will compute the measurement residual and partials of the estimated measurement with respect to the state vector. The proper a priori measurement variance describing the error will also be selected. The following measurement types will be available with the preland navigation principal function: TACAN range and bearing, barometric altimeter, and MSBLS range, azimuth, and elevation.

Once a particular measurement subfunction has completed processing valid data, the filter control flags will be set as follows:

##### TACAN

MANUAL\_EDIT\_OVERRIDE = TACAN\_EDIT\_OVERRIDE

STAT\_FLAG = TACAN\_STAT

##### Barometric altimeter

MANUAL\_EDIT\_OVERRIDE = BARO\_EDIT\_OVERRIDE

STAT\_FLAG = BARO\_STAT

##### MSBLS

MANUAL\_EDIT\_OVERRIDE =MLS\_EDIT\_OVERRIDE

STAT\_FLAG =MLS\_STAT

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The state and covariance measurement incorporation subfunction shall then update the state vector covariance matrix provided that either the residual edit criterion is met or the crew edit override for the sensor type is active, as described in Section 4.2.4.

The following data shall then be stored after the particular measurement type has been processed for subsequent computation of measurement processing statistics as described in Section 4.3.2.8.

TACAN

$\text{SENSOR\_EDIT}_{1\text{and}2} = \text{EDIT\_FLAG}$

$\text{SENSOR\_RESID\_TEST}_{1\text{and}2} = \text{RESID\_TEST}$

$\text{SENSOR\_DELQ}_{1\text{and}2} = \text{DELQ}$

where the subscript 1 corresponds to bearing and 2 to range and each measurement type is set equal to its own respective flag or parameter value.

Barometric altimeter

$\text{SENSOR\_EDIT}_3 = \text{EDIT\_FLAG}$

$\text{SENSOR\_RESID\_TEST}_3 = \text{RESID\_TEST}$

$\text{SENSOR\_DELQ}_3 = \text{DELQ}$

MSBLS

$\text{SENSOR\_EDIT}_{5, 6, \text{and } 7} = \text{EDIT\_FLAG}$

$\text{SENSOR\_RESID\_TEST}_{5, 6, \text{and } 7} = \text{RESID\_TEST}$

$\text{SENSOR\_DELQ}_{5, 6, \text{and } 7} = \text{DELQ}$

where the subscripts 5, 6, and 7 correspond to azimuth, range, and elevation, respectively, and each measurement type is set equal to its own respective flag or parameter value.

B. Interface Requirements. The inputs and outputs for this subfunction are given in Tables 4.3.2.7–1 and 4.3.2.7–2.

C. Processing Requirements. This subfunction is not exercised until the external sensor data snap, sensor measurement selection, navigation reconfiguration, and state and covariance propagation subfunctions have been performed; and the measurement processing statistics subfunction cannot be initiated until this subfunction is completed.

D. Constraints. There is no requirement in the state and covariance measurement incorporation subfunction to perform updating if the data–validity flag indicates bad data. No manual override of this flag exists in this subfunction. If it is desired to process a particular measurement, the data–validity flag must be made to indicate that the data are valid.

E. Supplementary Information. A possible implementation of the state and covariance measurement incorporation subfunction is presented in the flow charts of Section 5.2, TACAN\_NAV, BARO\_NAV, MLS\_NAV, MLS\_RANGE\_NAV, MLS\_AZ\_NAV, and MLS\_EL\_NAV codes.

Table 4.3.2.7-1. Preland State and Covariance Measurement Incorporation Inputs

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Filter covariance matrix	E	Preland covariance propagation	M	DP		vary	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Measurement subfunctions	V(6)	DP		vary	Filter rate
Value of filter mean squared position error below which no measurement underweighting is used	MS_POS_UND_WGT	I-load	F	S		ft <sup>2</sup> **	Filter rate
General sensor variance	VAR	Measurement subfunctions	F	S			Filter rate
Scale factor used in measurement underweighting equation	K_UND_WGT	I-load	F	S		vary	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Measurement subfunctions	F	S			Filter rate
Switch used to force incorporation of barometric data regardless of residual edit test	BARO_EDIT_OVERRIDE	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate
Switch used to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate
General measurement residual	DELQ	Measurement subfunction	F	S		ft	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	DP		ft	Filter rate
Shuttle velocity vector	$\bar{V}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	S		ft/sec	Filter rate
Flag indicating state-flag setting for barometric measurements	BARO_STAT	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating TACAN data processed only for statistical display	TACAN_STAT	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate

Table 4.3.2.7-2. Preland State and Covariance Measurement Incorporation Outputs							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Filter covariance matrix	E	Preland covariance propagation	M	DP		vary	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	DP		ft	Filter rate
Shuttle velocity vector	$\bar{V}_{FILT}$	Preland state propagation, preland state and covariance measurement incorporation	V	S		ft/sec	Filter rate
Edit indicators for measurements	SENSOR_EDIT	Preland NAV measurement processing statistics	Char	S		—	Filter rate
Measurement residuals	$\bar{S}ENSOR\_DELQ$	Preland NAV measurement processing statistics	V	S		vary	Filter rate
Value of criterion used in NAV filter for residual edit tests for the sensor measurements	$\bar{S}ENSOR\_RESID\_TEST$	Preland NAV measurement processing statistics	V	S		vary	Filter rate
Residual edit test quantity	RESID_TEST	TACAN range and bearing measurement subfunctions	F	S		vary	Filter rate

#### 4.3.2.7.1 TACAN Range

The TACAN range measurement subfunction computes the estimated range from the Shuttle to the TACAN station, the range residual, and the range measurement partials, and selects the proper variance to model the uncorrelated instrument error. It is assumed that TACAN range data will be provided by the TACAN RM by way of the sensor data snap.

A. Detailed Requirements. The position vector,  $\bar{R}_{\text{FILT}}$ , will be interpolated to the time of the TACAN sensor measurement, if required, as described in Section 4.2.3, and saved as the variable  $\bar{R}_{\text{RESID}}$  for subsequent use in the partials computation. The range residual will then be calculated as described in Section 4.2.7.1 and saved as the variable DELQ for subsequent use in the residual edit test.

The partial derivatives of the range measurement with respect to the state vector will be computed and the variance will be selected as described in Section 4.2.7.1.

The scale factor on the filter mean square residual, used in the residual edit test,  $K_{\text{RES\_EDIT}}$ , shall be set equal to  $K_{\text{EDIT\_TACR}}$ .

The state vector and covariance matrix will then be updated as described in Section 4.3.2.7.

The quantity RESID\_TEST, computed by the filter (see Sections 4.3.2.7 and 4.2.4), shall be compared to the design dependent parameter TACAN\_RNG\_CONVERG\_TEST. Depending on the outcome of this comparison, the flag ONE\_RANGE\_LOCK shall be set to ON or OFF; ON if RESID\_TEST is less than TACAN\_RNG\_CONVERG\_TEST, OFF otherwise. The flag ONE\_RANGE\_LOCK shall then be output for use by the TACAN Redundancy Management.

B. Interface Requirements. The inputs and outputs for the TACAN range measurement subfunction are given in Tables 4.3.2.7.1-1 and 4.3.2.7.1-2.

C. Processing Requirements. This subfunction will be performed after the navigation reconfiguration subfunction (Section 4.3.2.4) at the basic filter rate. This subfunction will be performed as long as TACAN range measurements are being processed.

D. Constraints. This subfunction will only be executed if the data are indicated valid (i.e., the TAC\_RNG\_DATA\_GOOD flag is ON) and the TACAN channel data as provided by TACAN site lookup (Section 4.5.2.2) are indicated valid (i.e., the TAC\_CHAN\_VALID flag is ON).

E. Supplementary Information. The location of the TACAN antenna has been neglected in calculating the range measurement estimate, since this error is less than that associated with the measurement. A possible implementation of this subfunction is shown in a portion of the flow chart TACAN\_NAV\_CODE, in Section 5.2. This flow chart contains both TACAN range and TACAN bearing computations and also some of the requirements described in Section 4.3.2.7, namely the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to TACAN\_EDIT\_OVERRIDE and TACAN\_STAT, respectively, the call to NAV\_FILTER, and the setting of the parameters SENSOR\_EDIT<sub>1 and 2</sub>, SENSOR\_RESID\_TEST<sub>1 and 2</sub> and SENSOR\_DELQ<sub>1 and 2</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.2.7.1-1. TACAN Range Measurement Subfunction Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current range data—good flag reserved for measurement processing	TAC_RNG_ DATA_GOOD	Preland external sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of TACAN_CHAN_VALID_SL for TACAN station used by navigation filter	TAC_CHAN_VALID	Preland measurement reconfigure	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read	T_TACAN	Preland external sensor data snap	F	DP		sec	Filter rate
Copy of R_TACAN_EF_SL for TACAN station used by navigation filter	$\bar{R}$ _TACAN_EF	Preland measurement reconfigure	V	DP		ft	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}$ _RESID	State vector interpolate	V	DP		ft	Filter rate
TACAN range sensor measurement	Q_TAC_R	External sensor data snap	F	S		ft	Filter rate
Current Shuttle position vector in M50 coordinates	$\bar{R}$ _FILT	Preland state and covariance measurement incorporation, state propagation	V	DP		ft	Filter rate
Current Shuttle velocity vector in M50 coordinates	$\bar{V}$ _FILT	Preland state and covariance measurement incorporation, state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle	$\bar{D}$ V_FILT	Preland NAV state propagation	V	S		ft/sec	Filter rate
Gravity acceleration at end of previous Shuttle state integration interval	$\bar{G}$ _OLD	Preland NAV state propagation	V	S		ft	Filter rate
Range criterion to select TACAN instrument variance	RNG_VAR_ RNG_STEP	K-load	F	S		ft	Filter rate
Variance of TACAN range instrument error at range > RNG_VAR_RNG_STEP	VAR_TAC_R_HIGH	K-load	F	S		ft <sup>2</sup>	Filter rate

Table 4.3.2.7.1-1. TACAN Range Measurement Subfunction Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Variance of TACAN range instrument error at range $\leq$ RNG_VAR_RNG_STEP	VAR_TAC_R_LOW	K-load	F	S		ft <sup>2</sup>	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Scale factor on filter mean square residual edit test used for TACAN range measurement	K_EDIT_TACR	K-load	F	S		—	Filter rate
Threshold for residual test quantity, below which data from one LRU alone are acceptable	TACAN_RNG_CONVERG_TEST	K-load	F	S		ft	Filter rate
General residual test variable	RESID_TEST	State and covariance measurement incorporation	F	S		vary	Filter rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	Filter rate
Flag used (ON) to override TACAN residual edit test	TACAN_EDIT_OVERRIDE	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate
Flag indicating (ON) that TACAN data are to be procured for statistical display only	TACAN_STAT	Preland sensor measurement selection	D	—	OFF/ON	—	Filter rate
Copy of M_EFTOTD_TACAN_SD from site lookup	M_EFTOTD_TACAN	Preland measurement reconfiguration	M	S		—	Filter rate
Filter covariance matrix	E	Preland covariance propagation <sup>1</sup>	M	DP		vary	Filter rate

\* See principal function input list in Table 4.3.2.9-1.  
<sup>1</sup> Delta state update.



Table 4.3.2.7.1-2. TACAN Range Measurement Subfunction Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN range measurement residual	DELQ	Preland state and covariance measurement incorporation, preland measurement processing statistics	F	S		ft	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Preland state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
Scale factor on filter mean square residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S			Filter rate
Flag indicating the filter can accept data from one TACAN LRU	ONE_RANGE_LOCK	TACAN RM	D	—	OFF/ON	—	Filter rate

#### 4.3.2.7.2 TACAN Bearing

The TACAN bearing measurement subfunction computes the estimated bearing measurement with respect to the TACAN station, the measurement residual, and the bearing measurement partials, and selects the proper variance to model the instrument error. It is assumed that the TACAN bearing data referenced to magnetic north are available from the TACAN RM by way of the sensor data snap.

A. Detailed Requirements. A description of the symbols used in the following equations may be found in Tables 4.3.2.7.2-1 and 4.3.2.7.2-2.

The position vector of the TACAN station in M50 coordinates,  $\bar{R}_{SCANNER}$ , is to be computed by

$$M\_EFTOM50 = EARTH\_FIXED\_TO\_M50\_COORD(T\_TACAN)$$

$$\bar{R}_{SCANNER} = M\_EFTOM50 \bar{R}_{TACAN\_EF}$$

The transformation from M50 to topodetic coordinates is obtained by

$$M\_M50TOTD = M\_EFTOTD\_TACAN M\_EFTOM50^T$$

where  $M\_EFTOTD\_TACAN$  and  $\bar{R}_{TACAN\_EF}$  were obtained from the measurement reconfiguration subfunction (Section 4.3.2.4.1).

The flags  $IN\_CONE\_FLAG$  (which, when set to ON, indicates the vehicle is inside the TACAN station's cone of confusion) and  $TAC\_BRG\_DATA\_GOOD$  (which indicates the validity of the TACAN bearing data) shall be checked.

The following calculations shall be performed only if the bearing data are indicated valid ( $TAC\_BRG\_DATA\_GOOD = ON$ ) and the  $IN\_CONE\_FLAG$  is OFF.

First, the position vector shall be interpolated to the time of the TACAN measurement, if required, as described in Section 4.2.3 and saved as the variable  $\bar{R}_{RESID}$  for subsequent use in the partials computation. The bearing residual shall then be calculated as described in Section 4.2.7.2 and saved as the variable  $DELQ$  for subsequent use in the residual edit test.

The partial derivatives of the bearing measurement with respect to the state vector shall then be computed and the variance shall be selected as described in Section 4.2.7.2.

The scale factor on the filter mean square residual for use in the residual edit test,  $K\_RES\_EDIT$ , shall be set equal to  $K\_EDIT\_TACBR$ .

The state vector and covariance matrix will then be updated as described in Section 4.3.2.7.

The quantity  $RESID\_TEST$ , computed by the filter, shall be compared to the design dependent parameter  $TACAN\_BRG\_COVERG\_TEST$ . The flag  $ONE\_BRG\_LOCK$  shall be set to ON or OFF depending on the outcome of this comparison: ON if  $RESID\_TEST < TACAN\_BRG\_CONVERG\_TEST$ , OFF otherwise. The flag  $ONE\_BRG\_LOCK$  shall then be output for use by the TACAN redundancy management.

B. Interface Requirements. The inputs and outputs for the TACAN bearing measurement subfunction are given in Tables 4.3.2.7.2-1 and 4.3.2.7.2-2.

C. Processing Requirements. The subfunction will be performed after the navigation reconfiguration subfunction (Section 4.3.2.4) at the basic filter rate. This subfunction will be performed as long as TACAN measurements are being processed.

D. Constraints. This subfunction will only be executed if the data are indicated valid (i.e., the TAC\_BRG\_DATA\_GOOD flag is ON), if the TACAN channel data as provided by TACAN site lookup (Section 4.5.2.2) are indicated valid (i.e., the TAC\_CHAN\_VALID flag is ON), and if the Shuttle is not in the TACAN station's cone of confusion (i.e., the IN\_CONE\_FLAG is OFF). ONE\_BRG\_LOCK shall be initialized to 'OFF'.

E. Supplementary Information. The location of the TACAN antenna has been neglected in calculating the bearing measurement estimate, since this error is less than that associated with the error in the measurement itself. A possible implementation of this subfunction is shown in a portion of the flow chart TACAN\_NAV\_CODE in Section 5.2. In the flow chart, computations have been combined with TACAN range data processing and with requirements shown in Section 4.3.2.7, namely the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to TACAN\_EDIT\_OVERRIDE and TACAN\_STAT, respectively; the call to NAV\_FILTER and the setting of the display parameters SENSOR\_EDIT<sub>1and2</sub>, and SENSOR\_RESID\_TEST<sub>1and2</sub>, SENSOR\_DELQ<sub>1and2</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.2.7.2-1. TACAN Bearing Measurement Subfunction Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current bearing data—good flag reserved for measurement processing	TAC_BRG_ DATA_GOOD	Preland external sensor data snap	D	—	OFF/ON	—	Filter rate
Copy of TACAN_CHAN_VALID_SL for TACAN station used by navigation filter	TAC_CHAN_ VALID	Preland measurement reconfigure	D	—	OFF/ON	—	Filter rate
Time at which TACAN was read	T_TACAN	External sensor data snap	F	DP		sec	Filter rate
Copy of R_TACAN_EF_SL for TACAN station used by navigation filter	$\bar{R}$ _TACAN_EF	Preland measurement reconfigure	V	DP		ft	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}$ _RESID	State vector interpolation	V	DP		ft	Filter rate
Copy of M_EFTOTD_TACAN_SL from site lookup	M_EFTOTD_ TACAN	Preland measurement reconfigure	M	S		—	Filter rate
Flag indicating (ON) that the vehicle is in the cone of confusion of selected TACAN station	IN_CONE_FLAG	TACAN RM	D	—	OFF/ON	—	Filter rate
Copy of ANGLE_CORR_TNTOMAG_SL for navigation processing	ANGLE_CORR_ TNTOMAG	Preland measurement reconfigure	F	S	0–2PI	rad	Filter rate
The constant PI	PI	Constant	F	S			Filter rate
TACAN bearing sensor measurement	Q_TAC_BRG	External sensor data snap	F	S		rad	Filter rate
Range criterion to select TACAN bearing instrument variance	RNG_VAR_ BEARING_STEP	K-load	F	S		ft	Filter rate
Variance of TACAN bearing instrument error at range > RNG_VAR_BEARING_STEP	VAR_TAC_BRG_ HIGH	K-load	F	S		rad <sup>2</sup>	Filter rate
Variance of TACAN bearing instrument error at range ≤ RNG_VAR_BEARING_STEP	VAR_TAC_BRG_ LOW	K-load	F	S		rad <sup>2</sup>	Filter rate

Table 4.3.2.7.2-1. TACAN Bearing Measurement Subfunction Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	DP		ft	Filter rate
Current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present cycle and previous cycle	$\bar{DV}_{FILT}$	Preland navigation state propagation	V	S		ft/sec	Filter rate
Gravity acceleration at end of previous Shuttle state integration interval	$\bar{G}_{OLD}$	Preland navigation state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Scale factor on filter mean square residual edit test for TACAN bearing measurement	K_EDIT_TACBR	K-load	F	S		—	Filter rate
Threshold for residual test quantity, below which one LRU data are acceptable	TACAN_BRG_CONVERG_TEST	K-load	F	S		rad	Filter rate
General residual test variable	RESID_TEST	State and covariance measurement incorporation	F	S		vary	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Flag indicating whether the mode of operation is single or three state	NAV_THREE_STATE	*	D	—	OFF/ON	—	Filter rate

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.7.2-2. TACAN Bearing Measurement Subfunction Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN azimuth measurement residual	DELQ	Preland state and covariance measurement incorporation, preland measurement processing statistics	F	S		rad	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Preland state and covariance measurement incorporation	V	DP		vary	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S		—	Filter rate
Flag indicating the filter can accept data from one TACAN LRU	ONE_BRG_LOCK	TACAN RM	D	—	OFF/ON	—	Filter rate

#### 4.3.2.7.3 Barometric Altimeter

The barometric altimeter measurement subfunction calculates the estimated altitude measurement, the measurement residual, the measurement partials, and the variance that models the instrument error. It is assumed that the barometric altitude data will be provided by the ADTA SOP via the sensor data snap.

A. Detailed Requirements. In preland navigation the barometric altimeter estimated measurement, the residual, the measurement partials, and the variance shall be calculated as described in Section 4.2.7.3 for the one-state configuration.

The scale factor on the filter mean square residual used in the residual edit test, K\_RES\_EDIT, shall be set equal to K\_EDIT\_BARO, which is a premission load.

The state vector and covariance matrix will then be updated as described in Section 4.3.2.7.

B. Interface Requirements. The input and output variables for the barometric measurement subfunction are given in Tables 4.3.2.7.3-1 and 4.3.2.7.3-2.

C. Processing Requirements. This subfunction will be performed after the navigation reconfiguration subfunction (Section 4.3.2.4) at the basic filter rate. This subfunction is performed as long as barometric altitude measurements are being processed.

D. Constraints. This subfunction will only be executed if the data are indicated valid (i.e., the BARO\_DATA\_GOOD flag is ON).

E. Supplementary Information. The assumption is made, for simplification, that the barometric probe is located at the navigation base. This is a valid assumption since the error involved in mislocating the probe is less than the errors associated with the barometric measurement.

A possible implementation of this subfunction is shown in the flow chart BARO\_NAV CODE in Section 5.2. The flow chart also contains some requirements described in Section 4.3.2.7, namely the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to BARO\_EDIT\_OVERRIDE and BARO\_STAT, respectively, and the setting of the display parameters SENSOR\_EDIT<sub>3</sub>, SENSOR\_RESID\_TEST<sub>3</sub>, and SENSOR\_DELQ<sub>3</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.2.7.3-1. Barometric Altimeter Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Copy of current data good discrete reserved for measurement processing (navigation)	BARO_DATA_GOOD	Preland sensor data read	D	—	OFF/ON	—	Filter rate
Time tag associated with barometric measurement	T_BARO	Preland sensor data read	F	DP		sec	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}_{RESID}$	State vector interpolation	V	DP		ft	Filter rate
Barometric deterministic bias	BIAS_BARO	K-load	F	S		ft	Filter rate
Altitude of mean sea level above reference ellipsoid at the runway	DELH_MSL_ELLIPSOID_RW	*	F	S		ft	Filter rate
Barometric altimeter sensor measurement	Q_BARO	Preland sensor data read	F	S		ft	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	DP		ft	Filter rate
Altitude of the runway above the reference ellipsoid	ALT_RW	*	F	S		ft	Filter rate
Barometric altimeter instrument variance constant	VAR_H1	I-load	F	S		ft**2	Filter rate
Barometric altimeter instrument variance constant	VAR_H2	I-load	F	S			Filter rate
Current Shuttle velocity vector M50 coordinates	$\bar{V}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present and previous cycle	$\bar{DV}_{FILT}$	Preland state propagation	V	S		ft/sec	Filter rate
Gravity acceleration associated with current position vector	$\bar{G}_{OLD}$	Preland state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate



Table 4.3.2.7.3-1. Barometric Altimeter Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for baro measurement	K_EDIT_BARO	K-load	F	S		—	Filter rate

Table 4.3.2.7.3-2. Barometric Altimeter Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Barometric measurement residual	DELQ	Preland state and covariance measurement incorporation	F	S		ft	Filter rate
Measurement first partials with respect to filter state	$\bar{B}$	Preland state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		vary	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S		—	Filter rate

#### 4.3.2.7.4 MSBLS Range

The MSBLS range measurement subfunction calculates the estimated range from the Shuttle to the MSBLS station, the range residual, and the measurement partials; and it selects the proper variance that models the instrument error. It is assumed that the MSBLS range measurement data will be provided by the MSBLS RM to this subfunction by way of the sensor data snap.

A. Detailed Requirements. First, the estimated range will be calculated with use of the following equation:

$$Q = |\bar{R}_{RESID} - \bar{R}_{SCANNER}| + BIAS_{RMLS}$$

where

$$\bar{R}_{SCANNER} = EARTH\_FIXED\_TO\_M50\_COORD (T\_EF\_RMLS) \bar{R}_{RMLS\_EF}$$

and  $\bar{R}_{RMLS\_EF}$  is obtained from the runway/MSBLS site lookup subfunction (Section 4.5.2.2). The state vector,  $\bar{R}_{RESID}$ , may be interpolated to the sensor measurement time if required, as described in Section 4.2.3. The residual will then be computed by

$$DELQ = Q\_RANGE - Q$$

The variance of the MSBLS measurement error is then set equal to the design dependent parameter  $VAR_{RMLS}$  (Section 4.9.3):

$$VAR = VAR_{RMLS}$$

The MSBLS range measurement partials are to be computed by using the equations

$$B_{1\ to\ 3} = \bar{UNIT} (\bar{R}_{RESID} - \bar{R}_{SCANNER})$$

$$B_{4\ to\ 6} = 0.$$

The scale factor on the filter mean square residual used in the residual edit test,  $K_{RES\_EDIT}$ , shall be set equal to  $K_{EDIT\_MLSR}$ , which has two values. The large value (400) is used first to insure initial processing or reacquiring of MSBLS range measurement and the smaller value (36) is used to allow editing of MSBLS transients after the measurement processing has reduced the state error.

Finally, the state vector and the covariance matrix will be updated as described in Section 4.3.2.7.

B. Interface Requirements. The inputs and outputs for the MSBLS range measurement subfunction are given in Tables 4.3.2.7.4-1 and 4.3.2.7.4-2.

C. Processing Requirements. This subfunction will be performed after the state and covariance have been propagated, at the basic filter rate.

D. Constraints. This subfunction will be executed only if the MSBLS range data are labeled valid (i.e., the  $MLSRANGE\_DATA\_GOOD$  flag is ON and  $MLS\_R\_AZ\_GOOD$  is ON).

E. Supplementary Information. The location of the onboard MSBLS antenna may be neglected in calculating the range measurement estimate, since this error is much less than that associated with the measurement. A possible implementation of these requirements is illustrated in flow charts  $MLS\_NAV$  and  $MLS\_RANGE\_NAV$  CODE in Section 5.2. The flow chart  $MLS\_NAV$  also contains equations

described in Section 4.3.2.7, namely the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to MLS\_EDIT\_OVERRIDE and MLS\_STAT respectively. The flow chart MLS\_RANGE\_NAV also contains some requirements from Section 4.3.2.7: the call to NAV\_FILTER, and the setting of the display parameters SENSOR\_EDIT<sub>6</sub>, SENSOR\_RESID\_TEST<sub>6</sub>, and SENSOR\_DELQ<sub>6</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.

Table 4.3.2.7.4-1. MSBLS Range Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
MSBLS range measurement bias	BIAS_RMLS	I-load	F	S		ft	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSRANGE_DATA_GOOD	Preland sensor data read	D	—	OFF/ON	—	Filter rate
MSBLS range sensor measurement	Q_RANGE	Preland sensor data read	F	S		ft	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}_{RESID}$	State vector interpolate	V	DP		ft	Filter rate
Earth-fixed position vector of MLS range scanner	$\bar{R}_{RMLS\_EF}$	*	V	DP		ft	Filter rate
Time at which MSBLS range measurement was read	T_EF_RMLS	Preland sensor data read	F	DP		sec	Filter rate
MSBLS range measurement instrument variance	VAR_RMLS	K-load	F	S		ft <sup>2</sup>	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state propagation measurement incorp	V	DP		ft	Filter rate
Current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state propagation measurement incorp	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present and previous cycle	$\bar{D}V_{FILT}$	Preland state propagation	V	S		ft/sec	Filter rate
Gravity acceleration associated with current position vector	$\bar{G}_{OLD}$	Preland state propagation	V	S		ft/sec <sup>2</sup>	Filter rate

Table 4.3.2.7.4-1. MSBLS Range Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Scale factor on filter mean square residual used in residual edit test for MSBLS range measurement	K_EDIT_MLSR	Preland Control	I	S		—	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate
Interval over which the data is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Flag used (ON) to override MLS residual edit test	MLS_EDIT_OVERRIDE	Preland sensor measurement selection	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are to be processed for statistical display only	MLS_STAT	Preland sensor measurement selection	D		ON/OFF		Filter rate

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.7.4-2. MSBLS Range Measurement Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Measurement first partials with respect to filter state	$\bar{B}$	Preland state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
MLS range measurement residual	DELQ	Preland state and covariance measurement incorporation	F	S		ft	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S		—	Filter rate

#### 4.3.2.7.5 MSBLS Azimuth

The MSBLS azimuth measurement subfunction calculates the estimated MSBLS azimuth measurement, the residual, and the measurement partials, and ht selects the proper variance that models the instrument error. It is assumed that the MSBLS azimuth measurement data will be provided to this subfunction by the MSBLS RM by way of the sensor data snap.

A. Detailed Requirements. Descriptions of symbols used in the following equations may be found in Tables 4.3.2.7.5-1 and 4.3.2.7.5-2.

First, a transformation matrix from the M50 coordinates to the MSBLS azimuth radar coordinates will be computed at the time tag of the MSBLS azimuth measurement, T\_EF\_AZMLS.

$$M\_EFTOM50 = \text{EARTH\_FIXED\_TO\_M50\_COORD}(T\_EF\_AZMLS)$$

$$M\_M50\_TO\_SCANNER = M\_EFTORAD\_R\_AZ M\_EFTOM50^T$$

where M\_EFTORAD\_R\_AZ will be provided by the runway/MSBLS site lookup subfunction (Section 4.5.2.2). The relative position of the Shuttle with respect to the MSBLS azimuth station will then be computed by

$$\bar{R} = M_{50\_TO\_SCANNER}(\bar{R}_{RESID} - \bar{R}_{AZMLS})$$

where  $\bar{R}_{AZMLS}$  is computed by using the equation

$$\bar{R}_{AZMLS} = M_{EFTOM50} \bar{R}_{AZMLS\_EF}$$

and  $\bar{R}_{AZMLS\_EF}$  will be obtained from the runway/MSBLS site lookup subfunction. The state vector used,  $\bar{R}_{RESID}$ , may be interpolated to the sensor measurement time, if required, as described in Section 4.3.2.

The estimated MSBLS azimuth measurement will then be counted by

$$Q = \text{ARCTAN}(R_2/R_1) + \text{BIAS}_{AZMLS} \quad \text{F7, F3}$$

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

F3 This equation shall be protected against divisions by zero (Section 3.5).

and the residual will be computed by

$$\text{DELQ} = Q_{AZMLS} - Q$$

The variance of the MSBLS azimuth measurement error is then to be set equal to the mission dependent parameter  $\text{VAR}_{AZMLS}$  (Section 4.9)

$$\text{VAR} = \text{VAR}_{AZMLS}$$

The MSBLS azimuth partials are next to be computed by using the function  $\text{ANGLE\_PARTIALS}$  (described in Section 4.4.5.3), with  $\bar{R}_{AZMLS}$  and the third row of the transformation matrix from M50 to MSBLS azimuth radar coordinates as inputs:

CALL:  $\text{ANGLE\_PARTIALS}$

IN LIST:  $\bar{R}_{AZMLS}$ ,  $M_{M50\_TO\_SCANNER}_{3, 1 \text{ to } 3}$

The scale factor on the filter mean square residual used in the residual edit test,  $K_{RES\_EDIT}$ , shall be set equal to  $K_{EDIT\_MLSAZ}$ , which has two values. The large value (400) is used first to insure initial processing or reacquiring of MSBLS azimuth measurement and the smaller value (16) is used to allow editing of MSBLS transients after the measurement processing has reduced the state error.

Finally, the state vector and the covariance matrix will be updated as described in Section 4.3.2.7.

B. Interface Requirements. The inputs and outputs for the MSBLS azimuth measurement subfunction are given in Tables 4.3.2.7.5-1 and 4.3.2.7.5-2.

C. Processing Requirements. This subfunction will be performed after the state and covariance matrix have been propagated, at the basic filter rate.

D. Constraints. This subfunction will be executed only if the MSBLS azimuth data are labeled valid (i.e., the  $\text{MLSAZ\_DATA\_GOOD}$  flag is ON and the flag  $\text{MLS\_R\_AZ\_GOOD}$  is set to ON).

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E. Supplementary Information. The location of the onboard MSBLS antenna may be neglected in calculating the azimuth measurement estimate, since this error is much less than that associated with the measurement.

A possible implementation of these requirements is illustrated in flow charts MLS\_NAV and MLS\_AZ\_NAV CODE in Section 5.2. Note that these flow charts also contain equations described in Section 4.3.2.7. MLS\_NAV shows the setting of the filter control flags MANUAL\_EDIT\_OVERRIDE and STAT\_FLAG to MLS\_EDIT\_OVERRIDE and MLS\_STAT respectively. MLS\_AZ\_NAV contains the call to NAV\_FILTER and the setting of the display parameters SENSOR\_EDIT<sub>5</sub>, SENSOR\_RESID\_TEST<sub>5</sub>, and SENSOR\_DELQ<sub>5</sub> to EDIT\_FLAG, RESID\_TEST, and DELQ, respectively.



Table 4.3.2.7.5-1. MSBLS Azimuth Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
MSBLS azimuth measurement bias	BIAS_AZMLS	I-load	F	S		rad	Filter rate
Transformation matrix from earth-fixed to AZ/range MSBLS radar coordinate frame	M_EFTORAD_R_AZ	*	M	S		—	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSAZ_DATA_GOOD	Data snap	D	—	OFF/ON	—	Filter rate
MSBLS azimuth sensor measurement	Q_AZMLS	Data snap	F	S		rad	Filter rate
Earth-fixed MLS azimuth scanner position vector	$\bar{R}_{AZMLS\_EF}$	*	V	DP		ft	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}_{RESID}$	State vector Interpolate	V	DP		ft	Filter rate
Time at which MSBLS azimuth was read	T_EF_AZMLS	Data snap	F	DP		sec	Filter rate
MSBLS azimuth measurement instrument variance	VAR_AZMLS	K-load	F	S		rad <sup>2</sup>	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state and covariance measurement incorporation state propagation	V	DP		ft	Filter rate
Current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state and covariance measurement incorporation state propagation	V	S		ft/sec	Filter rate
Difference between accumulated sensed IMU readings on present and previous cycle	$\bar{DV}_{FILT}$	Preland state propagation	V	S		ft/sec	Filter rate
Gravity acceleration associated with current position vector	$\bar{G}_{OLD}$	Preland state propagation	V	S		ft/sec	Filter rate
Time of the filter state vector	T_LAST_FILT	State propagation	F	DP		sec	Filter rate

Table 4.3.2.7.5-1. MSBLS Azimuth Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Interval over which the state is propagated	DT_FILT	State propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for MSBLS azimuth measurement	K_EDIT_MLSAZ	Preland Control	I	S		—	Filter rate
Flag used (ON) to override MLS residual edit test	MLS_EDIT_OVERRIDE	Preland sensor measurement selection	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are to be processed for statistical display only	MLS_STAT	Preland sensor measurement selection	D		ON/OFF		Filter rate

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.7.5-2. MSBLS Azimuth Measurement Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Measurement first partials with respect to filter state	$\bar{B}$	Preland state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
MLS azimuth measurement residual	DELQ	Preland state and covariance measurement incorporation	F	S		rad	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S		—	Filter rate

#### 4.3.2.7.6 MSBLS Elevation

The MSBLS elevation measurement subfunction calculates the estimated MSBLS elevation measurement, the residual, and the measurement partials, and it selects the proper variance that models the instrument error. It is assumed that the MSBLS elevation measurement data will be provided to this subfunction by the MSBLS RM by way of the sensor data snap.

A. Detailed Requirements. Descriptions of symbols used in the following equations may be found in Tables 4.3.2.7.6-1 and 4.3.2.7.6-2.

First, a transformation matrix from M50 to MSBLS elevation radar coordinates will be computed at the time tag of the MSBLS elevation measurement, T\_EF\_ELMLS.

$$M\_EFTOM50 = EARTH\_FIXED\_TO\_M50\_COORD (T\_EF\_ELMLS)$$

$$M\_M50\_TO\_SCANNER = M\_EFTORAD\_EL M\_EFTOM50^T$$

where M\_EFTORAD\_EL will be provided by the runway/MSBLS site lookup subfunction (Section 4.5.2.2). The relative position of the Shuttle with respect to the MSBLS elevation radar will then be calculated as

$$\bar{R} = M\_M50\_TO\_SCANNER (\bar{R}\_RESID - \bar{R}\_ELMLS)$$

where  $\bar{R}\_ELMLS$  is computed by using the equation

$$\bar{R}\_ELMLS = M\_EFTOM50 \bar{R}\_ELMLS\_EF$$

and  $\bar{R}\_ELMLS\_EF$  will be obtained from the runway/MSBLS site lookup subfunction. The state vector,  $\bar{R}\_RESID$ , may be interpolated to the sensor measurement time, if required, as described in Section 4.2.3.

The subfunction will then compute the estimated elevation measurement by

$$Q = ARCTAN(R_3/R_1) + BIAS\_ELMLS \quad F3, F7$$

and will compensate for antenna displacement by

$$Q = Q + MLSANT\_NB\_DIST \sin(Q + PITCH\_M - MLSANT\_ANG)/R\_RHO \quad F3, F5$$

F3 This equation shall be protected against division by zero (Section 3.5).

F5 This equation shall be protected against arc sine of arguments with magnitudes greater than unity (Section 3.5).

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

where R\_RHO is equal to the magnitude of  $\bar{R}$ , MLSANT\_NB\_DIST is the distance from the navigation base to the MSBLS antenna location on the vehicle, MLSANT\_ANG is the angle between the navigation base to the MSBLS antenna vector and the vehicle's X body axis, and PITCH\_M is the pitch angle.

Finally, the residual will be computed by

$$DELQ = Q\_ELMLS - Q$$

If the estimated measurement,  $Q$ , is below a minimum angle cutoff,  $MSBLS\_EL\_ANGLE\_CUTOFF$ , then MSBLS elevation data will no longer be used to update the state vector. This termination of state updating will be communicated to the preland NAV measurement processing statistics subfunction by setting the flag  $MSBLS\_EL\_INHIBIT$  to ON.

The variance of the MSBLS elevation measurement is to be then set equal to the design dependent parameter  $VAR\_ELMLS$  (Section 4.9.3):

$$VAR = VAR\_ELMLS$$

The elevation measurement partials are to be computed by using the function  $ANGLE\_PARTIALS$  (described in Section 4.4.5.3) with  $\bar{R}\_ELMLS$  and the negative of the second row of the transformation matrix from M50 to the MSBLS elevation radar coordinates as inputs:

CALL:  $ANGLE\_PARTIALS$

IN LIST:  $\bar{R}\_ELMLS, -M\_M50\_TO\_SCANNER_{2,1\ to\ 3}$

The scale factor on the filter mean square residual used in the residual edit test,  $K\_RES\_EDIT$ , shall be set equal to  $K\_EDIT\_MLSEL$ , which has two values. The large value (400) is used first to insure initial processing or reacquiring of MSBLS elevation measurement and the smaller value (9) is used to allow editing of MSBLS transients after the measurement processing has reduced the state error. Next, test the status of the flag  $MSBLS\_EL\_INHIBIT$ . If the flag is ON then set  $STAT\_FLAG$  equal to ON.

Finally, the state vector and the covariance matrix will be updated as described in Section 4.3.2.7 and display data will be saved for use by preland measurement processing statistics.

B. Interface Requirements. The inputs and outputs for the MSBLS elevation measurement subfunction are given in Tables 4.3.2.7.6-1 and 4.3.2.7.6-2.

C. Processing Requirements. This subfunction will be performed after the state and covariance matrix have been propagated, at the basic filter rate.

D. Constraints. This subfunction will be executed only if MSBLS elevation data are labeled valid (i.e., the  $MLSEL\_DATA\_GOOD$  flag is ON) and the flag  $MLS\_R\_AZ\_GOOD$  is ON).

E. Supplementary Information. It is assumed that all vehicle-mounted MSBLS antennas are collocated.

A possible implementation of this subfunction is shown in flow charts  $MLS\_NAV$  and  $MLS\_EL\_NAV$  CODE in Section 5.2. These flow charts also contain equations described in Section 4.3.2.7.  $MLS\_NAV$  shows the setting of the filter control flags  $MANUAL\_EDIT\_OVERRIDE$  and  $STAT\_FLAG$  to  $MLS\_EDIT\_OVERRIDE$  and  $MLS\_STAT$  respectively;  $MLS\_EL\_NAV$  shows the call to  $NAV\_FILTER$ , and the setting of the display parameters  $SENSOR\_EDIT_7$ ,  $SENSOR\_RESID\_TEST_7$ , and  $SENSOR\_DELQ_7$  to  $EDIT\_FLAG$ ,  $RESID\_TEST$ , and  $DELQ$ , respectively.

Table 4.3.2.7.6-1. MSBLS Elevation Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
MSBLS elevation measurement bias	BIAS_ELMLS	I-load	F	S		rad	Filter rate
Transformation matrix from earth-fixed to MSBLS elevation radar coordinates	M_EFTORAD_EL	*	M	S			Filter rate
Distance from navigation base to MLS antenna	MLSANT_NB_DIST	K-load	F	S		ft	Filter rate
Angle between navigation base-to-MLS antenna vector and positive vehicle X body axis	MLSANT_ANG	K-load	F	S		rad	Filter rate
Copy of current data good discrete reserved for measurement processing	MLSEL_DATA_GOOD	Preland sensor data read	D	—	OFF/ON	—	Filter rate
Copy of pitch-store reserved for MLS elevation processing	PITCH_M	Preland sensor data read	F	S		rad	Filter rate
MSBLS elevation sensor measurement	Q_ELMLS	Preland sensor data read	F	S		rad	Filter rate
Vehicle position vector used in measurement residual calculation after interpolation to time of measurement	$\bar{R}_{RESID}$	State vector interpolation	V	DP		ft	Filter rate
Earth-fixed MLS elevation scanner position vector	$\bar{R}_{ELMLS\_EF}$	*	V	DP		ft	Filter rate
Time tag of current MSBLS elevation measurement	T_EF_ELMLS	Sensor data snap	F	DP		sec	Filter rate
MSBLS elevation instrument variance	VAR_ELMLS	K-load	F	S		rad <sup>2</sup>	Filter rate
Filter current Shuttle position vector in M50 coordinates	$\bar{R}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	DP		ft	Filter rate
Current Shuttle velocity vector in M50 coordinates	$\bar{V}_{FILT}$	Preland state and covariance measurement incorporation, state propagation	V	S		ft/sec	Filter rate

Table 4.3.2.7.6-1. MSBLS Elevation Measurement Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Difference between accumulated sensed IMU readings on present and previous cycle	$\overline{DV\_FILT}$	Preland state propagation	V	S		ft/sec	Filter rate
Gravity acceleration associated with current position vector	$\overline{G\_OLD}$	Preland state propagation	V	S		ft/sec <sup>2</sup>	Filter rate
Time of the filter state vector	T_LAST_FILT	Preland state propagation	F	DP		sec	Filter rate
Interval over which the state is propagated	DT_FILT	Preland state propagation	F	DP		sec	Filter rate
Criterion for difference between measurement time and state time, above which the filter state will be interpolated	EPS_TAG	Constant	F	DP		sec	Filter rate
Scale factor on filter mean square residual used in residual edit test for MSBLS elevation measurement	K_EDIT_MLSEL	Preland Control	I	S		—	Filter rate
Minimum angle below which MSBLS elevation data not used to update state vector.	MSBLS_EL_ANGLE_CUTOFF	I-load	F	S		rad	Filter rate
Flag used (ON) to override MLS residual edit test	MLS_EDIT_OVERRIDE	Preland sensor measurement selection	D		ON/OFF		Filter rate
Flag indicating (ON) that MLS data are to be processed for statistical display only	MLS_STAT	Preland sensor measurement selection	D		ON/OFF		Filter rate

\* See principal function input list in Table 4.3.2.9-1.

Table 4.3.2.7.6-2. MSBLS Elevation Measurement Output Variables							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Measurement first partials with respect to filter rate	$\bar{B}$	Preland state and covariance measurement incorporation	V(6)	DP		vary	Filter rate
MLS elevation measurement residual	DELQ	Preland state and covariance measurement incorporation	F	S		rad	Filter rate
General sensor variance	VAR	Preland state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Scale factor on filter mean square residual used in residual edit test	K_RES_EDIT	Preland state and covariance measurement incorporation	F	S		—	Filter rate
Flag indicating (ON) MSBLS data are not used to update state	MSBLS_EL_INHIBIT	Preland measurement processing statistics	D	—	OFF/ON	—	Filter rate

#### 4.3.2.8 Measurement Processing Statistics

During the preland navigation principal function, the measurement processing statistics subfunction will compute for downlist and for display to the crew certain parameters that are indicative of the health of the navigation filter.

A. Detailed Requirements. For each of the following external measurement types, three parameters are to be computed to show how well the navigation filter is processing external measurements of that particular type. The external measurement types for which processing statistics will be computed are as follows:

- TACAN bearing
- TACAN range
- Barometric altitude
- MSBLS azimuth
- MSBLS range
- MSBLS elevation

Additional detailed requirements concerning the three parameters to be computed for each measurement type above may be found in Section 4.2.8.2. Since, during preland navigation, drag derived altitude



measurements will not be processed by the navigation filter, the three display parameters associated with drag altitude measurements will be given the value “BLANK” in accordance with display requirements.

This subfunction also will evaluate edit flags for the six measurement types to compute the sensors’ status discrete. Detailed requirements for this calculation may be found in Section 4.2.8.1.

A further capability will be provided by this subfunction to generate the residual and ratio parameters described in Section 4.2.8.2 for display under certain circumstances (determined by the preland sensor measurement selection subfunction) when the filter would not normally be attempting to process data. If the sensor edit indicators are found to have the value “STAT,” this shall indicate to the measurement processing subfunction that this filter cycle was performed only for the production of filter statistics and that the calculations leading to the edit history indicator shall ignore this “statistics only” filter cycle.

B. Interface Requirements. Inputs and outputs are listed in Tables 4.3.2.8–1 and 4.3.2.8–2.

C. Processing Requirements. None.

D. Constraints. None.

E. Supplementary Information. A suggested implementation for this subfunction may be found in the detailed flow chart MEAS\_PROCESSING\_STATISTICS\_PRELAND code of Section 5.2.

Table 4.3.2.8-1. Preland Measurement Processing Statistics Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Value of criterion used to set the edit history indicators	K_MAX	**	I	S			Filter rate
Measurement residual for TACAN bearing data	SENSOR_DELQ(1)	Preland navigation state and covariance measurement incorporation	F	S		rad	Filter rate
Measurement residual for TACAN range data	SENSOR_DELQ(2)	Preland navigation state and covariance measurement incorporation	F	S		ft	Filter rate
Measurement residual for baro altitude	SENSOR_DELQ(3)	Preland navigation state and covariance measurement incorporation	F	S		ft	Filter rate
Measurement residual for MSBLS azimuth	SENSOR_DELQ(5)	Preland navigation state and covariance measurement incorporation	F	S		rad	Filter rate
Measurement residual for MSBLS range data	SENSOR_DELQ(6)	Preland navigation state and covariance measurement incorporation	F	S		ft	Filter rate
Measurement residual for MSBLS elevation	SENSOR_DELQ(7)	Preland navigation state and covariance measurement incorporation	F	S		ft	Filter rate
Four-valued flag defining use of TACAN bearing data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(1)	Preland navigation state and covariance measurement incorporation	CHAR	S		S	Filter rate
Four-valued flag defining use of TACAN range data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(2)	Preland navigation state and covariance measurement incorporation	CHAR	S		S	Filter rate

Table 4.3.2.8-1. Preland Measurement Processing Statistics Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Four-valued flag defining use of baro altimeter data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(3)	Preland navigation state and covariance measurement incorporation	CHAR	S		S	Filter rate
Four-valued flag defining use of MSBLS azimuth data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(5)	Preland navigation state and covariance measurement incorporation	CHAR	S		S	Filter rate
Four-valued flag defining use of MSBLS range data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(6)	Preland navigation state and covariance measurement incorporation	CHAR	S		S	Filter rate
Four-valued flag defining use of MSBLS elevation data by the navigation filter. OFF – no processing attempted. ON – rejected by residual edit test. PROCESSED – used to update state vector. STAT – used only for stat display purpose	SENSOR_EDIT(7)	Preland navigation state and covariance measurement incorporation	CHAR	S			Filter rate
Value of criterion used in navigation filter for residual edit test for TACAN bearing measurement	SENSOR_RESID_TEST(1)	Preland navigation state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Value of criterion used in navigation filter for residual edit test for TACAN range measurement	SENSOR_RESID_TEST(2)	Preland navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Value of criterion used in navigation filter for residual edit test for baro altimeter measurement	SENSOR_RESID_TEST(3)	Preland navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate

Table 4.3.2.8-1. Preland Measurement Processing Statistics Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Value of criterion used in navigation filter for residual edit test for MSBLS azimuth measurement	SENSOR_RESID_TEST(5)	Preland navigation state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Value of criterion used in navigation filter for residual edit test for MSBLS range measurement	SENSOR_RESID_TEST(6)	Preland navigation state and covariance measurement incorporation	F	S		ft <sup>2</sup>	Filter rate
Value of criterion used in navigation filter for residual edit test for MSBLS elevation measurement	SENSOR_RESID_TEST(7)	Preland navigation state and covariance measurement incorporation	F	S		rad <sup>2</sup>	Filter rate
Number of sequential failures of the test criteria allowed before activating the nav event lamp	M_SEQ_MAX	K-load	I				Filter rate
Number of nautical miles per foot	NAUTMI_PER_FT	Constant	F	S		nmi/ft	Filter rate
Flag indicating (ON) that MSBLS data are to be processed.	DO_MLS_NAV	Preland NAV sensor select	D		OFF/ON		Filter rate
Flag indicating (ON) MSBLS EL data processing inhibit.	MSBLS_EL_INHIBIT	Preland navigation state and covariance measurement incorporation	D	—	OFF/ON	—	Filter rate
Altitude region for NAV event lamp processing	ALT_EL	K-Load	V	S		ft	Filter rate

Table 4.3.2.8-2. Preland Measurement Processing Statistics Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Display measurement residual for TACAN bearing	DISP_DELQ(1)	*	F	S		rad	Filter rate
Display measurement residual for TACAN range	DISP_DELQ(2)	*	F	S		nmi	Filter rate
Display measurement residual for baro altimeter	DISP_DELQ(3)	*	F	S		ft	Filter rate
Display measurement residual for MSBLS bearing	DISP_DELQ(5)	*	F	S		rad	Filter rate
Display measurement residual for MSBLS range	DISP_DELQ(6)	*	F	S		ft	Filter rate
Display measurement residual for MSBLS elevation	DISP_DELQ(7)	*	F	S		rad	Filter rate
Display edit history indicator for TACAN bearing measurement	DISP_EDIT(1)	*	CHAR	S			Filter rate
Display edit history indicator for TACAN range measurement	DISP_EDIT(2)	*	CHAR	S			Filter rate
Display edit history indicator for baro altimeter measurement	DISP_EDIT(3)	*	CHAR	S			Filter rate
Display edit history indicator for MSBLS azimuth measurement	DISP_EDIT(5)	*	CHAR	S			Filter rate
Display edit history indicator for MSBLS range measurement	DISP_EDIT(6)	*	CHAR	S			Filter rate
Display edit history indicator for MSBLS elevation measurement	DISP_EDIT(7)	*	CHAR	S			Filter rate
Display residual edit ratio for TACAN bearing	DISP_SIG(1)	*	F	S			Filter rate
Display residual edit ratio for TACAN range	DISP_SIG(2)	*	F	S			Filter rate
Display residual edit ratio for baro altimeter	DISP_SIG(3)	*	F	S			Filter rate
Display residual edit ratio for MSBLS bearing	DISP_SIG(5)	*	F	S			Filter rate
Display residual edit ratio for MSBLS range	DISP_SIG(6)	*	F	S			Filter rate
Display residual edit ratio for MSBLS elevation	DISP_SIG(7)	*	F	S			Filter rate
NAV EDIT flag	NAV_EDIT_IND	*	D		OFF/ON		Filter rate
NAV EDIT altitude flag	NAV_ALT_FLAG	*	D		OFF/ON		Filter rate
NAV EDIT TACAN flag	NAV_TAC_FLAG	*	D		OFF/ON		Filter rate
NAV EDIT MSBLS flag	NAV_MLS_FLAG	*, Preland Control	D		OFF/ON		Filter rate

\* See principal function output list in Table 4.3.2.9-2.

**4.3.2.9 Preland Navigation (4.144) Principal Function Tables**

This section contains input parameters, output parameters, I-loads, K-loads, constants, and variables cross reference tables for the preland navigation principal function.

Preland Navigation (4.144) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	ANGLE_CORR_TNTOMAG_S1
ANGLE_CORR_TNTOMAG_SL <sub>2</sub>	ANGLE_CORR_TNTOMAG_S2
ANGLE_CORR_TNTOMAG_SL <sub>3</sub>	ANGLE_CORR_TNTOMAG_S3
BARO_AIF	N/G
BARO_DATA_GOOD	ADT_DG
D_RW_UP	N/G
DO_DELTA_UPDATE_UP	N/G
DO_DELTA_UPDATE	N/G
DR_RW	N/G
DR_RW_UP	N/G
DV_RW	N/G
FOM	FOM_SOP
GPS_DG	GPS_DG_SOP
GPS_FAIL_FOM	GPS_FAIL_FOM_SOP
M_EFTOTD_TACAN_SL <sub>1</sub>	M_EFTOTD_TACAN_SL1
M_EFTOTD_TACAN_SL <sub>2</sub>	M_EFTOTD_TACAN_SL2
M_EFTOTD_TACAN_SL <sub>3</sub>	M_EFTOTD_TACAN_SL3
MACH_JUMP	ADS_MJ
Q_AZMLS	SQ_AZMLS
Q_BARO	HPC
Q_ELMLS	SQ_ELMLS
Q_RANGE	SQ_RANGE
Q_TAC_BRG	OUT_SEL_BRG
Q_TAC_R	OUT_SEL_RNG
R_GPS_ECEF	R_GPS_ECEF_SOP
R_TACAN_EF_SL <sub>1</sub>	R_TACAN_EFSL1
R_TACAN_EF_SL <sub>2</sub>	R_TACAN_EFSL2
R_TACAN_EF_SL <sub>3</sub>	R_TACAN_EFSL3
T_BARO	T_HPC
T_CURRENT_FILT	T_IMUS
T_EF_AZMLS	MSBAZIMTIM
T_EF_ELMLS	MSBELEVTIM
T_EF_RMLS	MSBRANGTIM
T_GPS	T_GPS_SOP
T_LAST_GPS	T_IMU_SAVE_SOP
TAC_BRG_DATA_GOOD	OUT_BRG_DG
TAC_RNG_DATA_GOOD	OUT_RNG_DG

Preland Navigation (4.144) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
TACAN_AIF	N/G
TACAN_CHAN_VALID_SL <sub>1</sub>	TACAN_CHAN_VALID_SL1
TACAN_CHAN_VALID_SL <sub>2</sub>	TACAN_CHAN_VALID_SL2
TACAN_CHAN_VALID_SL <sub>3</sub>	TACAN_CHAN_VALID_SL3
V_CURRENT_FILT	SEL_V_M50
ALT_WHEELS_NAV	ALT_WHEELS
$\bar{V}$ _CURRENT_FILT	$\bar{S}$ EL_V_M50
$\bar{V}$ _GPS_ECEF	$\bar{V}$ _GPS_ECEF_SOP
$\bar{V}$ _LAST_GPS	$\bar{V}$ _IMU_SAVE_SOP

TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ADS_MJ	V95X3112X	ADS MACH JUMP FLAG	ADTA SOP		BD		93017G	*
ALT	V95H0175CC	CURR ORB ALT ABOVE REF ELLIPSOID	ENT UPP	FT	SPL		93017G	*
ALT	V95H0175CD	CURR ORB ALT ABOVE REF ELLIPSOID	TAEM UPP	FT	SPL		93017G	*
ALT	V95H0175CE	CURR ORB ALT ABOVE REF ELLIPSOID	A/L UPP	FT	SPL		93017G	*
ALT_DG	V95X3111X	PRESSURE ALTITUDE DATA GOOD FLAG	ADTA SOP		BD		93017G	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ALT_WHEELS	V95H0165CC	ALT TO REAR WHEELS/NAV BASE(ENTRY)	TAEM UPP	FT	DPL		93017G	*
ALT_WHEELS	V95H0165CD	ALT TO REAR WHEELS/NAV BASE(ENTRY)	A/L UPP	FT	DPL		93017G	*
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
BARO_AIF	V93J4473C	ADTA A/I/F EDIT CMD	HORIZ SIT DISP		HXS		93017G	*
BIAS_AZMLS	V90H1886CA	MSBLS AZIMUTH MEASUREMENT BIAS	ENT SITE LOOKUP	RAD				
BIAS_ELMLS	V90H1887CA	MSBLS ELEVATION MEASUREMENT BIAS	ENT SITE LOOKUP	RAD				
BIAS_RMLS	V90H1885CA	MSBLS RANGE MEASUREMENT BIAS	ENT SITE LOOKUP	FT				
CORR_COEFF_GPS(1)	V90U3068C	GPS COV U V CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(2)	V90U3069C	GPS COV U UDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(3)	V90U3070C	GPS COV U VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(4)	V90U3071C	GPS COV V UDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(5)	V90U3072C	GPS COV V VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(6)	V90U3073C	GPS COV W WDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CORR_COEFF_GPS(7)	V90U3074C	GPS COV UDOT VDOT CORR COEFF	GPS RCVR STATE PROC		SPL		92067D	
CREW_METERING_OVERRIDE	V93X1534X	CREW OVERRIDE UPP RESET MTRNG	GPS STATUS DISP		BD		92067D	
DELH_MSL_ELLIPSOID_RW	V90H1819CA	ALT OF MSL ABOVE REF ELLIP AT RW	ENT SITE LOOKUP	FT				
DO_DELTA_UPDATE	V93X5030X	UPDATE DELTAS CMD	HORIZ SIT DISP		BD			
DO_DELTA_UPDATE_UP	V91X8894X	DO DELTA STATE UPDATE UPLINK CMD	SYS S/W					
DR_RW(1)	V93H5010CA	NAV UPDATE DELTA X POSITION	HORIZ SIT DISP	FT				
DR_RW(2)	V93H5011CA	NAV UPDATE DELTA Y POSITION	HORIZ SIT DISP	FT				
DR_RW(3)	V93H5012CA	NAV UPDATE DELTA Z POSITION	HORIZ SIT DISP	FT				
DR_RW_UP(X)	V96U8554C	NAV UPDATE DELTA X POS UPLINK CMD	UL	FT			92237	
DR_RW_UP(Y)	V96U8555C	NAV UPDATE DELTA Y POS UPLINK CMD	UL	FT			92237	
DR_RW_UP(Z)	V96U8556C	NAV UPDATE DELTA Z POS UPLINK CMD	UL	FT			92237	
DT_GPS_OFF_MIN	V94W0981C	TIME SINCE LAST GPS SEL	GPS RCVR STATE PROC	MIN	SPL		93017G	*
DV_RW(1)	V93L5020CA	NAV UPDATE DELTA X VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(2)	V93L5021CA	NAV UPDATE DELTA Y VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(3)	V93L5022CA	NAV UPDATE DELTA Z VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW_UP(X)	V96U8557C	NAV UPDATE DELTA X VEL UPLINK CMD	UL	FT/S			92237	
DV_RW_UP(Y)	V96U8558C	NAV UPDATE DELTA Y VEL UPLINK CMD	UL	FT/S			92237	
DV_RW_UP(Z)	V96U8559C	NAV UPDATE DELTA Z VEL UPLINK CMD	UL	FT/S			92237	
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FOM_SOP(1)	V90H3009C	GPS 1 FIGURE OF MERIT	GPS SOP		HXS		92067D	
FOM_SOP(2)	V90H3010C	GPS 2 FIGURE OF MERIT	GPS SOP		HXS		92067D	
FOM_SOP(3)	V90H3011C	GPS 3 FIGURE OF MERIT	GPS SOP		HXS		92067D	
FOM_SV_SEL	V90H0834C	SELECTED FIGURE-OF-MERIT	GPS RCVR STATE PROC		HXS		93100C	



TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GMD_PRED	V90U8501CD	GRAVITY MODEL DEGREE	D/L NAV SEQ				92297B	
GMO_PRED	V90U8502CD	GRAVITY MODEL ORDER	D/L NAV SEQ				92297B	
GPS_DG_SOP(1)	V90X3012X	GPS 1 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(2)	V90X3013X	GPS 2 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(3)	V90X3014X	GPS 3 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(1)	V90X3015X	GPS 1 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(2)	V90X3016X	GPS 2 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_FAIL_FOM_SOP(3)	V90X3017X	GPS 3 FOM THRESH FAIL FLAG	GPS SOP		BD		92067D	
GPS_RATIO_FLAG	V90X0440X	SEL GPS RESID RATIO EDIT FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_TO_GC_AIF	V93J1200CA	GPS TO G&C A/I/F CMD	HORIZ SIT DISP		HXS		92067D	
GPS_TO_GC_AIF	V93J1200CB	GPS TO G&C A/I/F CMD	GPS STATUS DISP		HXS		92067D	
GPS_TO_NAV_AI	V93X1202XA	GPS TO NAV AUTO/INHIBIT CMD	HORIZ SIT DISP		BD		92067D	
GPS_TO_NAV_AI	V93X1202XB	GPS TO NAV AUTO/INHIBIT CMD	GPS STATUS DISP		BD		92067D	
GPS_TO_NAV_FORCE	V93X1201XA	GPS TO NAV FORCE CMD	HORIZ SIT DISP		BD		92067D	
GPS_TO_NAV_FORCE	V93X1201XB	GPS TO NAV FORCE CMD	GPS STATUS DISP		BD		92067D	
G_GPS_SEL(1)	V90A3637C	X-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
G_GPS_SEL(2)	V90A3638C	Y-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
G_GPS_SEL(3)	V90A3639C	Z-COMP OF SEL GPS GRAV VECTOR	GPS RCVR STATE PROC	FT/S2	SPL		92214A	
HPC	V95H3001C	ADS CORRECTED PRESSURE ALTITUDE	ADTA SOP	FT	SPL		93017G	*
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
IN_CONE_FLAG	V90X3598X	INSIDE CONE FLAG	TACAN RM					
MLSAZ_DATA_GOOD	V90X3003X	MSBLS AZIMUTH DATA GOOD	SF		BD		93017G	*
MLSEL_DATA_GOOD	V90X3033X	MSBLS ELEVATION DATA GOOD	SF		BD		93017G	*
MLSRANGE_DATA_GOOD	V90X3063X	MSBLS RANGE DATA GOOD	SF		BD		93017G	*
MLS_AIF	V93J1629C	MLS A/I/F EDIT CMD	HORIZ SIT DISP		HXS		92571B	
MLS_AVAIL	V90X3720XA	MLS AVAILABILITY	ENT SITE LOOKUP					
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
MSBAZIMTIM	V95W6010C	MSBLS AZIMUTH MEASUREMENT TIME	MSBLS SOP	S	DPL		93017G	*
MSBELEVTIM	V95W6020C	MSBLS ELEVATION MEASUREMENT TIME	MSBLS SOP	S	DPL		93017G	*
MSBRANGTIM	V95W6000C	MSBLS RANGE MEASUREMENT TIME	MSBLS SOP	S	DPL		93017G	*
M_EFTORAD_EL(1-1)	V90U1875CA	EF TO MSBLS EL COORD, ELE 1-1	ENT SITE LOOKUP					
M_EFTORAD_EL(1-2)	V90U1876CA	EF TO MSBLS EL COORD, ELE 1-2	ENT SITE LOOKUP					
M_EFTORAD_EL(1-3)	V90U1877CA	EF TO MSBLS EL COORD, ELE 1-3	ENT SITE LOOKUP					
M_EFTORAD_EL(2-1)	V90U1878CA	EF TO MSBLS EL COORD, ELE 2-1	ENT SITE LOOKUP					
M_EFTORAD_EL(2-2)	V90U1879CA	EF TO MSBLS EL COORD, ELE 2-2	ENT SITE LOOKUP					
M_EFTORAD_EL(2-3)	V90U1880CA	EF TO MSBLS EL COORD, ELE 2-3	ENT SITE LOOKUP					
M_EFTORAD_EL(3-1)	V90U1881CA	EF TO MSBLS EL COORD, ELE 3-1	ENT SITE LOOKUP					
M_EFTORAD_EL(3-2)	V90U1882CA	EF TO MSBLS EL COORD, ELE 3-2	ENT SITE LOOKUP					
M_EFTORAD_EL(3-3)	V90U1883CA	EF TO MSBLS EL COORD, ELE 3-3	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(1-1)	V90U1865CA	EF TO RNG/AZ MSBLS RDR COORD/1-1	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(1-2)	V90U1866CA	EF TO RNG/AZ MSBLS RDR COORD/1-2	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(1-3)	V90U1867CA	EF TO RNG/AZ MSBLS RDR COORD/1-3	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(2-1)	V90U1868CA	EF TO RNG/AZ MSBLS RDR COORD/2-1	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(2-2)	V90U1869CA	EF TO RNG/AZ MSBLS RDR COORD/2-2	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(2-3)	V90U1870CA	EF TO RNG/AZ MSBLS RDR COORD/2-3	ENT SITE LOOKUP					

TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORAD_R_AZ(3-1)	V90U1871CA	EF TO RNG/AZ MSBLS RDR COORD/3-1	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(3-2)	V90U1872CA	EF TO RNG/AZ MSBLS RDR COORD/3-2	ENT SITE LOOKUP					
M_EFTORAD_R_AZ(3-3)	V90U1873CA	EF TO RNG/AZ MSBLS RDR COORD/3-3	ENT SITE LOOKUP					
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	

TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NAV_THREE_STATE	V90X0537X	THREE-STATE FLAG ON/OFF	D/L NAV SEQ		BD		93017G	*
OUT_BRG_DG	V90X3591X	BEARING DATA GOOD	TACAN RM		BD		93017G	*
OUT_RNG_DG	V90X3593X	RANGE DATA GOOD	TACAN RM		BD		93017G	*
OUT_SEL_BRG	V90H3590C	SELECTED BEARING DATA	TACAN RM	DEG	DPL		93017G	*
OUT_SEL_RNG	V90H3592C	SELECTED RANGE DATA	TACAN RM	FT	DPL		93017G	*
RCO_ENABLE	V93X1112X	RCO INHIBIT/ENABLE CMD	RM SWITCH/SURF FB DISP		BD		93017G	*
REL_VEL_MAG/V	V95L0151CB	GND REL VEL MAGNITUDE IN M50 SYS	A/L UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CC	GND REL VEL MAGNITUDE IN M50 SYS	ENT UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CD	GND REL VEL MAGNITUDE IN M50 SYS	TAEM UPP	FT/S	SPL		93017G	*
RV_MAX	V90L3752CA	MAX REL VEL FOR BARO PROCESSING	ENT SITE LOOKUP	FT/S				
R_AZMLS_EF(1)	V90H1828CA	X-COMP EF POS VCT OF MLS AZ ANT	ENT SITE LOOKUP					
R_AZMLS_EF(2)	V90H1829CA	Y-COMP EF POS VCT OF MLS AZ ANT	ENT SITE LOOKUP					
R_AZMLS_EF(3)	V90H1830CA	Z-COMP EF POS VCT OF MLS AZ ANT	ENT SITE LOOKUP					
R_ELMLS_EF(1)	V90H1825CA	X-COMP EF POS VCT MLS ELEV ANT	ENT SITE LOOKUP	FT				
R_ELMLS_EF(2)	V90H1826CA	Y-COMP EF POS VCT MLS ELEV ANT	ENT SITE LOOKUP	FT				
R_ELMLS_EF(3)	V90H1827CA	Z-COMP EF POS VCT MLS ELEV ANT	ENT SITE LOOKUP	FT				
R_FILT(1)	V90H0584CE	X-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(2)	V90H0585CE	Y-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(3)	V90H0586CE	Z-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_GPS_ECEF_SOP(1,1)	V90H3036C	GPS 1 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,2)	V90H3037C	GPS 1 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,3)	V90H3038C	GPS 1 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,1)	V90H3039C	GPS 2 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,2)	V90H3040C	GPS 2 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,3)	V90H3041C	GPS 2 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,1)	V90H3042C	GPS 3 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,2)	V90H3043C	GPS 3 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,3)	V90H3044C	GPS 3 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_SEL(1)	V90H3082C	X-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_GPS_SEL(2)	V90H3083C	Y-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_GPS_SEL(3)	V90H3084C	Z-COMP OF SEL GPS POS VECTOR	GPS RCVR STATE PROC	FT	DPL		92067D	
R_RMLS_EF(1)	V90H1831CA	X-COMP EF POS VCT OF MLS RNG ANT	ENT SITE LOOKUP					
R_RMLS_EF(2)	V90H1832CA	Y-COMP EF POS VCT OF MLS RNG ANT	ENT SITE LOOKUP					
R_RMLS_EF(3)	V90H1833CA	Z-COMP EF POS VCT OF MLS RNG ANT	ENT SITE LOOKUP					
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				

TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
SEL_LRU_ID	V90J3595C	SELECTED LRU ID	TACAN RM					
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SIG_DIAG_GPS(1)	V90H3094C	GPS NAV RESET COV DIAG ELEM 1	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(2)	V90H3095C	GPS NAV RESET COV DIAG ELEM 2	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(3)	V90H3096C	GPS NAV RESET COV DIAG ELEM 3	GPS RCVR STATE PROC	FT	SPL		92067D	
SIG_DIAG_GPS(4)	V90L3097C	GPS NAV RESET COV DIAG ELEM 4	GPS RCVR STATE PROC	FT/S	SPL		92067D	
SIG_DIAG_GPS(5)	V90L3098C	GPS NAV RESET COV DIAG ELEM 5	GPS RCVR STATE PROC	FT/S	SPL		92067D	
SIG_DIAG_GPS(6)	V90L3099C	GPS NAV RESET COV DIAG ELEM 6	GPS RCVR STATE PROC	FT/S	SPL		92067D	
SQ_AZMLS	V95H6021C	SELECTED MSBLS AZIMUTH-SCLD	MSBLS SOP	RAD			89137C	
SQ_ELMLS	V95H6022C	SELECTED MSBLS ELEVATION-SCLD	MSBLS SOP	RAD			89137C	
SQ_RANGE	V95H6023C	SELECTED MSBLS RANGE-SCLD	MSBLS SOP	FT			89137C	
TACAN_AIF	V93J4470C	TAC A/I/F EDIT CMD	HORIZ SIT DISP		HXS		93017G	*
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACAN_ID(1)	V90U1802CA	TACAN 1 GND STA CHAN	ENT SITE LOOKUP					
TACAN_ID(2)	V90U1803CA	TACAN 2 GND STA CHAN	ENT SITE LOOKUP					
TACAN_ID(3)	V90U1804CA	TACAN 3 GND STA CHAN	ENT SITE LOOKUP					
THETA/THETA_TOPO	V90H2217C	BODY PITCH ATTITUDE EULER ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
TIME_V/T_LAST_FILT	V90W2553CD	TIME OF SEL TOTAL M50 VEL	ENT NAV					
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS_LAST_UPDATE	V90W3556CA	TIME OF NAV RESET WITH SEL GPS	D/L NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CB	TIME OF NAV RESET WITH SEL GPS	ENT NAV	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CD	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CE	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CF	TIME OF NAV RESET WITH SEL GPS	ASC NAV SEQ	S	DPL		92369B	
T_GPS_SEL	V90W3561C	GPS SEL SV TIME TAG	GPS RCVR STATE PROC	S	DPL		92067D	
T_GPS_SEL	V90W3561CA	GPS SEL SV TIME TAG	ENT NAV	S	DPL		91051K	
T_GPS_SOP(1)	V90W3045C	GPS 1 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(2)	V90W3046C	GPS 2 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(3)	V90W3047C	GPS 3 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_HPC	V95W3400C	ADS CORRECTED PRESS ALT TIME TAG	ADTA SOP	S	DPL		93017G	*
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
T_IMU_SAVE_SOP(1)	V90W3048C	IMU TIME TAG FOR CURNT GPS 1 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(2)	V90W3049C	IMU TIME TAG FOR CURNT GPS 2 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(3)	V90W3050C	IMU TIME TAG FOR CURNT GPS 3 STATE	GPS SOP	S	DPL		92067D	
T_TACAN	V90W3596CB	TACAN TIME TAG	TACAN SOP	S				
USE_IMU_DATA	V90X0538XH	FLAG TO USE IMU ACCUM VEL OR NOT	D/L NAV SEQ				93017G	*
VAR_H1	V90U3753CA	ADDITIVE BARO VARIANCE CONST	ENT SITE LOOKUP	FT2				
VAR_H2	V90U3754CA	MULTIPLICATIVE BARO VARIANCE CONST	ENT SITE LOOKUP					
V_FILT(1)	V90L0624CE	X-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(2)	V90L0625CE	Y-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(3)	V90L0626CE	Z-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_GPS_ECEF_SOP(1,1)	V90L3051C	GPS 1 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	

TABLE 4.3.2.9-1. INPUT FUNCTIONAL PARAMETERS FOR PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GPS_ECEF_SOP(1,2)	V90L3052C	GPS 1 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,3)	V90L3053C	GPS 1 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,1)	V90L3054C	GPS 2 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,2)	V90L3055C	GPS 2 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,3)	V90L3056C	GPS 2 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,1)	V90L3057C	GPS 3 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,2)	V90L3058C	GPS 3 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,3)	V90L3059C	GPS 3 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_SEL(1)	V90L3108C	X-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_GPS_SEL(2)	V90L3109C	Y-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_GPS_SEL(3)	V90L3110C	Z-COMP OF SEL GPS VEL VECTOR	GPS RCVR STATE PROC	FT/S	DPL		92244A	
V_IMU_SAVE_SOP(1,1)	V95L0133C	IMU ACCUM X VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,2)	V95L0134C	IMU ACCUM Y VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,3)	V95L0135C	IMU ACCUM Z VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,1)	V95L0136C	IMU ACCUM X VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,2)	V95L0137C	IMU ACCUM Y VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,3)	V95L0138C	IMU ACCUM Z VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,1)	V95L0139C	IMU ACCUM X VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,2)	V95L0140C	IMU ACCUM Y VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,3)	V95L0141C	IMU ACCUM Z VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_LAST_FILT(1)	V90L0621CC	X-COMP VEL W COV MTRX & FLTR UPDTE	D/L NAV SEQ	FT/S				
V_LAST_FILT(2)	V90L0622CC	Y-COMP VEL W COV MTRX & FLTR UPDTE	D/L NAV SEQ	FT/S				
V_LAST_FILT(3)	V90L0623CC	Z-COMP VEL W COV MTRX & FLTR UPDTE	D/L NAV SEQ	FT/S				
WOWLON_IND	V96X0050X	WEIGHT ON MAIN WHEELS INDICATOR	LANDING SOP		BD		93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
BARO_AIF	V90U0257C	BARO AUTO/INHIBIT/FORCE SWITCH	TLM					
BARO_MARK_NUM	V90J8843CB	COUNTER-BARO MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
COV_POS_SIG	V90H0438CB	RSS OF COVARIANCE POS ELEMENTS	DL FMT 23/1	FT	SPL		93017G	*
COV_VEL_SIG	V90L0439CB	RSS OF COVARIANCE VEL ELEMENTS	DL FMT 23/1	FT/S	SPL		93017G	*
DISP_DELQ(1)	V90H0212CB	TAC AZ/OPTICS H/X/AZ MEAS RESIDUAL	DL FMT 23/A	RAD			93017G	*
			HORIZ SIT DISP					
DISP_DELQ(2)	V90H0214CB	TAC R/OPTICS V/Y/EL MEAS RESIDUAL	DL FMT 23/A	NM			93017G	*
			HORIZ SIT DISP					
DISP_DELQ(3)	V90H0221CB	BARO ALT/RR RNG MEAS RESIDUAL	DL FMT 23/A	FT			93017G	*
			HORIZ SIT DISP					
DISP_DELQ(5)	V90U0231CA	MSBLS AZ/SHAFT RATE MEAS RESIDUAL	DL FMT 23/1				93017G	*
DISP_DELQ(6)	V90U0232CA	MSBLS R/TRUN RATE MEAS RESIDUAL	DL FMT 23/1				93017G	*
DISP_DELQ(7)	V90U0233CA	MSBLS EL MEAS RESIDUAL	DL FMT 23/1				93017G	*
DISP_EDIT(1)	V90X0213XB	TAC AZ/OPTICS H/X/AZ EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			HORIZ SIT DISP					
DISP_EDIT(2)	V90X0215XB	TAC R/OPTICS V/Y/EL EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			HORIZ SIT DISP					
DISP_EDIT(3)	V90X0223XB	BARO ALT/RR RNG EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			HORIZ SIT DISP					
DISP_EDIT(4)	V90X0712XC	DRAG ALT/RR R DOT EDIT HIST IND	TLM					
DISP_EDIT(5)	V90X0218XA	MSBLS AZ/SHAFT RATE EDIT HIST IND	DL FMT 23/A				93017G	*
			GAX					
			GAX					
DISP_EDIT(6)	V90X0219XA	MSBLS R/TRUN RATE EDIT HIST IND	GAX				93017G	*
DISP_EDIT(7)	V90X0220XA	MSBLS EL EDIT HIST IND	GAX				93017G	*
DISP_SIG(1)	V90U0216CB	TAC AZ/OPTICS H/X/AZ RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
			TACAN RM					
DISP_SIG(2)	V90U0217CB	TAC R/OPTICS V/Y/EL RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
DISP_SIG(3)	V90U0222CB	BARO ALT/RR RNG RESID RATIO	DL FMT 23/1				93017G	*
			HORIZ SIT DISP					
DISP_SIG(5)	V90U0253CA	MSBLS AZ/SHAFT RATE RESID RATIO	DL FMT 23/1				93017G	*
DISP_SIG(6)	V90U0254CA	MSBLS R/TRUN RATE RESID RATIO	DL FMT 23/1				93017G	*
DISP_SIG(7)	V90U0255CA	MSBLS EL RESID RATIO	DL FMT 23/1				93017G	*
DO_BARO_NAV	V90X0259XA	FLAG IND BARO ALT BEING PROCESSED	DL FMT 23/1				93017G	*
DO_MLS_NAV	V90X0234XA	FLAG IND MLS BEING PROCESSED	DL FMT 23/1				93017G	*
DO_TACAN_NAV	V90U8846CC	FLG IND TACAN DATA BEING PROCESSED	DL FMT 23/1				93017G	*
DR_RW(1)	V93H5010CC	NAV UPDATE DELTA X POSITION	HORIZ SIT DISP	FT				
DR_RW(2)	V93H5011CC	NAV UPDATE DELTA Y POSITION	HORIZ SIT DISP	FT				
DR_RW(3)	V93H5012CC	NAV UPDATE DELTA Z POSITION	HORIZ SIT DISP	FT				
DV_RW(1)	V93L5020CC	NAV UPDATE DELTA X VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(2)	V93L5021CC	NAV UPDATE DELTA Y VELOCITY	HORIZ SIT DISP	FT/S				
DV_RW(3)	V93L5022CC	NAV UPDATE DELTA Z VELOCITY	HORIZ SIT DISP	FT/S				

TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ELEV_ANGLE	V90U0720CB	TACAN/SHUTTLE ELEV ANG	DL FMT 23/A				93017G	*
FILT_UPDATE	V90X0224XC	FLAG IND NAV FILTER PROC COMPLETE	A/L UPP ENT UPP TAEM UPP					
FOM(1)	V94H0982CB	GPS 1 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	
FOM(2)	V94H0983CB	GPS 2 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	
FOM(3)	V94H0984CB	GPS 3 FOM SNAPPED	GPS RCVR STATE PROC		HXS		91051K	
GPS_AIF_EXEC	V94X1041XB	GPS TO G&C EXEC STATUS	GPS STATUS DISP HORIZ SIT DISP		BD		91051K	
GPS_AIF_RCVD	V94J1042CB	GPS TO G&C AUT/INH/FOR FLAG FDBK	GPS RCVR STATE PROC GPS STATUS DISP HORIZ SIT DISP		HXS		91051K	
GPS_DG(1)	V90X3450XB	GPS 1 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_DG(2)	V90X3451XB	GPS 2 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_DG(3)	V90X3452XB	GPS 3 DG SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(1)	V90X3453XB	GPS 1 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(2)	V90X3454XB	GPS 2 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_FAIL_FOM(3)	V90X3455XB	GPS 3 FAIL FOM SNAPPED	GPS RCVR STATE PROC		BD		91051K	
GPS_TO_NAV_AIF	V90J3463CB	GPS TO NAV AUTO/INHIBIT/FORCE FDBK	GPS RCVR STATE PROC GPS STATUS DISP HORIZ SIT DISP		HXS		92132C	
GPS_TO_NAV_FORCE_RCVD	V90X3461XB	GPS TO NAV FORCE FLAG FDBK	GPS RCVR STATE PROC		BD		91051K	
GPS_TO_NAV_RCVD	V90X3462XB	GPS TO NAV AUT/INH FLAG FDBK	GPS RCVR STATE PROC		BD		91051K	
GPS_UPP_UPDATE	V90X3643XB	GPS UPP DISP RES STATE AVAIL FLAG	A/L UPP TAEM UPP		BD		92067D	
G_GPS_INIT(1)	V90A2619CC	X GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CC	Y GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CC	Z GRAV ACC FOR GPS REF STATE INIT	GPS REF STATE PROC	FT/S2	SPL		92214A	
G_GPS_UPP(1)	V90A3630CB	SELECTED GPS STATE X GRAV	A/L UPP TAEM UPP	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CB	SELECTED GPS STATE Y GRAV	A/L UPP TAEM UPP	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CB	SELECTED GPS STATE Z GRAV	A/L UPP TAEM UPP	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CC	SEL X-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2				
G_RESET(2)	V90A0244CC	SEL Y-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2			92214A	
G_RESET(3)	V90A0245CC	SEL Z-COMP OF GRAV ACCEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S2				
METER_FLAG	V90X3678XB	UPP RES STTE METERING FLAG	GPS RCVR STATE PROC		BD		92067D	
METER_SF	V90U3677CB	UPP RES STTE METERING SCALE FACTOR	GPS RCVR STATE PROC		SPL		92067D	
MLS_AIF_RCVD	V94J6039CA	MLS AUTO/INH/FOR FLAG FDBK	GPS RCVR STATE PROC		HXS		92571B	

TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
MLS_MARK_NUM	V90J0242CA	COUNTER-MLS MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
NAV_ALT_FLAG	V90X8901XB	NAV EDIT ALTITUDE CREW ALERT	E/L EV AN PROC HUD PROC					
NAV_EDIT_IND	V95X0305XB	NAV EDIT INDICATOR FLAG	DL FMT 23/A				93017G	*
NAV_MLS_FLAG	V90X8903XB	NAV EDIT MSBLS CREW ALERT	HUD PROC					
NAV_MM_CODE	V90J4263CB	NAV MM CODE	GPS RCVR STATE PROC		HXS		91051K	
NAV_TAC_FLAG	V90X8902XB	NAV EDIT TACAN CREW ALERT	E/L EV AN PROC HUD PROC					
ONE_BRG_LOCK	V90X0769XB	TACAN RM 1 LRU BRG LOCKON RQMT FLG	DL FMT 23/1 TACAN RM				93017G	*
ONE_RANGE_LOCK	V90X0768XB	TACAN RM 1 LRU RNG LOCKON RQMT FLG	DL FMT 23/1 TACAN RM				93017G	*
PROCESSING_MLS	V94X6041XA	FLAG IND MLS BEING PROCESSED	HORIZ SIT DISP		BD		92067D	
Q_BARO	V90P8871CC	DATA SNAP-ADS CORR PRESSURE ALT	DL FMT 23/1				93017G	*
Q_TAC_BRG	V90H8868CC	DATA SNAP-SELECTED TACAN BEARING	DL FMT 23/1				93017G	*
Q_TAC_R	V90H8867CC	DATA SNAP-SELECTED TACAN RANGE	DL FMT 23/1				93017G	*
R_GPS_ECEF(1,1)	V90H3467CB	GPS 1 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(1,2)	V90H3468CB	GPS 1 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(1,3)	V90H3469CB	GPS 1 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,1)	V90H3470CB	GPS 2 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,2)	V90H3471CB	GPS 2 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(2,3)	V90H3472CB	GPS 2 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,1)	V90H3473CB	GPS 3 WGS84 POS X-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,2)	V90H3474CB	GPS 3 WGS84 POS Y-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_ECEF(3,3)	V90H3475CB	GPS 3 WGS84 POS Z-COMP	GPS RCVR STATE PROC	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CB	GPS INIT POS VECTOR X-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CB	GPS INIT POS VECTOR Y-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CB	GPS INIT POS VECTOR Z-COMP	GPS REF STATE PROC	FT	DPL		91051K	
R_GPS_UPP(1)	V90H3624CB	SELECTED GPS STATE X POS	A/L UPP TAEM UPP	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CB	SELECTED GPS STATE Y POS	A/L UPP TAEM UPP	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CB	SELECTED GPS STATE Z POS	A/L UPP TAEM UPP	FT	DPL		92067D	
R_RESET(1)	V90H0235CC	SEL X-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL			
R_RESET(2)	V90H0236CC	SEL Y-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL			
R_RESET(3)	V90H0237CC	SEL Z-COMP OF UPDATED POS VCTR RST	A/L UPP ENT UPP TAEM UPP	FT	DPL			
SEL_LRU_ID	V90J8864CC	DATA SNAP-TACAN LRU NUMBER	DL FMT 23/1				93017G	*
SENSOR_EDIT(1)	V90U8841CB	TAC AZ/OPTICS H/X/AZ FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(2)	V90J8880CB	TAC R/OPTICS V/Y/EL FILTER FLAG	DL FMT 23/A				93017G	*



TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
SENSOR_EDIT(3)	V90J8881CB	BARO ALT/RR RNG FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(5)	V90J8883CA	MSBLS AZ/SHAFT RATE FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(6)	V90J8884CA	MSBLS R/TRUN RATE FILTER FLAG	DL FMT 23/A				93017G	*
SENSOR_EDIT(7)	V90J8885CA	MSBLS EL-FILTER FLAG	DL FMT 23/A				93017G	*
TACAN_ID	V90U8850CB	DATA SNAP-SEL TAC CHANNEL W/MODE	DL FMT 23/1				93017G	*
TACAN_ID(1)	V90U1802CC	TACAN 1 GND STA CHAN	TLM					
TACAN_ID(2)	V90U1803CC	TACAN 2 GND STA CHAN	TLM					
TACAN_ID(3)	V90U1804CC	TACAN 3 GND STA CHAN	TLM					
TACAN_MARK_NUM	V90J8842CC	COUNTER-TACAN MEAS BEING PROCESSED	DL FMT 23/1				93017G	*
TAC_BRG_DATA_GOOD	V90X0718XB	SNAPPED TAC BRG DATA GOOD	TLM					
T_CURRENT_FILT	V90W4749CD	SNAP TIME TAG CURR IMU/ATT DATA	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS(1)	V90W3479CB	GPS 1 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS(2)	V90W3480CB	GPS 2 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS(3)	V90W3481CB	GPS 3 STATE TIME	GPS RCVR STATE PROC	S	DPL		91051K	
T_GPS_INIT	V90W3482CB	GPS INIT STATE TIME TAG	GPS REF STATE PROC	S	DPL		91051K	
T_GPS_LAST_UPDATE	V90W3556CC	TIME OF NAV RESET WITH SEL GPS	GPS RCVR STATE PROC	S	DPL		92214A	
T_GPS_UPP	V90W3636CB	TIME OF SELECTED GPS STATE	A/L UPP	S	DPL		92067D	
			TAEM UPP					
T_LAST_GPS(1)	V90W3483CB	CURRENT GPS 1 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		92214A	
T_LAST_GPS(2)	V90W3484CB	CURRENT GPS 2 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		91051K	
T_LAST_GPS(3)	V90W3485CB	CURRENT GPS 3 STATE IMU TIME TAG	GPS RCVR STATE PROC	S	DPL		91051K	
T_RESET	V90W0534CC	TIME OF FILTER STATE VECTOR	A/L UPP	S			93017G	*
			DL FMT 23/1					
			ENT UPP					
			GPS RCVR STATE PROC					
			TAEM UPP					
V_CURRENT_FILT(1)	V90L8927CF	SNAPPED SEL TOTAL X VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_CURRENT_FILT(2)	V90L8928CF	SNAPPED SEL TOTAL Y VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_CURRENT_FILT(3)	V90L8929CF	SNAPPED SEL TOTAL Z VEL M50	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_FILT(1)	V90L0624CF	X-COMP OF FLTR'S CURR VEL VECTOR	GPS RCVR STATE PROC	FT/S	SPL		92105B	
V_FILT(2)	V90L0625CF	Y-COMP OF FLTR'S CURR VEL VECTOR	GPS RCVR STATE PROC	FT/S	SPL		92105B	
V_FILT(3)	V90L0626CF	Z-COMP OF FLTR'S CURR VEL VECTOR	GPS RCVR STATE PROC	FT/S	SPL		92105B	
V_GPS_ECEF(1,1)	V90L3486CB	GPS 1 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(1,2)	V90L3487CB	GPS 1 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(1,3)	V90L3488CB	GPS 1 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,1)	V90L3489CB	GPS 2 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,2)	V90L3490CB	GPS 2 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(2,3)	V90L3491CB	GPS 2 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,1)	V90L3492CB	GPS 3 WGS84 VEL X-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,2)	V90L3493CB	GPS 3 WGS84 VEL Y-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_ECEF(3,3)	V90L3494CB	GPS 3 WGS84 VEL Z-COMP	GPS RCVR STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CB	GPS INIT VEL VECTOR X-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CB	GPS INIT VEL VECTOR Y-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CB	GPS INIT VEL VECTOR Z-COMP	GPS REF STATE PROC	FT/S	SPL		91051K	
V_GPS_UPP(1)	V90L3627CB	SELECTED GPS STATE X VEL	A/L UPP	FT/S	SPL		92067D	
			TAEM UPP					

TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GPS_UPP(2)	V90L3628CB	SELECTED GPS STATE Y VEL	A/L UPP TAEM UPP	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CB	SELECTED GPS STATE Z VEL	A/L UPP TAEM UPP	FT/S	SPL		92067D	
V_IMU_GPS_INIT(1)	V90L3506CB	IMU ACCUM X VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CB	IMU ACCUM Y VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CB	IMU ACCUM Z VEL FOR GPS INIT	GPS REF STATE PROC	FT/S	DPL		92369B	
V_IMU_GPS_UPP(1)	V90L3633CB	SELECTED GPS STATE X ACCUM VEL CNT	A/L UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CB	SELECTED GPS STATE Y ACCUM VEL CNT	A/L UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CB	SELECTED GPS STATE Z ACCUM VEL CNT	A/L UPP TAEM UPP	FT/S	DPL		92067D	
V_IMU_RESET(1)	V90L0247CC	SEL X-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(2)	V90L0248CC	SEL Y-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_IMU_RESET(3)	V90L0249CC	SEL Z-COMP OF ACCUM SENSED VEL RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_LAST_GPS(1,1)	V90L3515CB	IMU ACCUM X VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(1,2)	V90L3516CB	IMU ACCUM Y VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(1,3)	V90L3517CB	IMU ACCUM Z VEL FOR GPS 1	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,1)	V90L3518CB	IMU ACCUM X VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,2)	V90L3519CB	IMU ACCUM Y VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(2,3)	V90L3520CB	IMU ACCUM Z VEL FOR GPS 2	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,1)	V90L3521CB	IMU ACCUM X VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,2)	V90L3522CB	IMU ACCUM Y VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_LAST_GPS(3,3)	V90L3523CB	IMU ACCUM Z VEL FOR GPS 3	GPS RCVR STATE PROC	FT/S	DPL		91051K	
V_RESET(1)	V90L0239CC	SEL X-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_RESET(2)	V90L0240CC	SEL Y-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S				
V_RESET(3)	V90L0241CC	SEL Z-COMP OF UPDATED VEL VCTR RST	A/L UPP ENT UPP TAEM UPP	FT/S				
	V90M2932PA	CGNB_NAV_CONTROL_FLAGS	DL FMT 23/1				93017G	*
	V90M2933PB	CGNB_DISP_EDIT	DL FMT 23/A				93017G	*
	V90M2990PB	CGNB_ONE_LOCK_LFE\$(2:)	DL FMT 23/1				93017G	*
	V90M2991PB	CGNB_ONE_LOCK_LFE\$(1:)	DL FMT 23/1				93017G	*
	V90M2993PB	CGNB_MC163_FLAG2	DL FMT 23/A				93017G	*

TABLE 4.3.2.9-2. OUTPUT FUNCTIONAL PARAMETERS FROM PRELAND NAVIGATION (G4.144)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
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**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_BARO_CUTOFF_HIGH	V99U8719C	FT	F	S	D	P	G4.144	00	ZFT	DC0617	
ALT_BARO_CUTOFF_LOW	V99U8720C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.17 G4.205	00	ZFT	91051K	
BASE_DEN(1)	V97U5235C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(2)	V97U5236C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(3)	V97U5237C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BASE_DEN(4)	V97U5238C	SLUGS/FT**3	F	D	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(1)	V97U5243C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(2)	V97U5244C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(3)	V97U5245C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
BIAS_DRAG_LAYER(4)	V97U5246C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
C_DRAG_ONE	V97U5277C	RAD**-1	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	
C_DRAG_TWO	V97U5278C	RAD**-2	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
C_DRAG_ZERO	V97U5279C	ND	F	S	M	C	G4.127 G4.144 G4.15 G4.205	00	DRN	DC0599	
DEL_TIME_STEP	V97U6548C	SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.198 G4.205	01 03	ZFT ZFT	93045A	
DENSITY_LIMIT(1)	V97U5310C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(2)	V97U5311C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(3)	V97U5312C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DENSITY_LIMIT(4)	V97U5313C	FT	F	S	M	C	G4.127 G4.144 G4.15 G4.205	01 03	PR4 PE4	DC0599	
DRAG_CONST	V97U5317C	FT**2/SLUG	F	D	M	C	G4.123 G4.127 G4.144 G4.15 G4.223 G4.236	01 03	DC1 DC3	92287B	
GPS_ALT_FOR_HIGH_RATE_NAV	V97U3621C	FT	F	S	D	C	G4.127 G4.144 G4.205	00	GP3	93201	*
GPS_SEL_AGE_MAX	V97U3672C	MIN	F	S	D	P	G4.127 G4.144 G4.205	00	GP3	92274	
GPS_UPDATE_ALT_FLOOR	V97U3622C	FT	F	S	D	P	G4.127 G4.144 G4.205	00	GP3	92178C	
K_MAX	V97U5348C	ND	I	S	D	C	G4.127 G4.144 G4.15 G4.205	00	ZFT	DC0617	

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
K_UND_WGT	V97U5350C	ND	F	S	M	X	G4.126	01	ZFT	DC0617	
							G4.127	02	ZPA		
							G4.144	03	ZFT		
							G4.15				
METERING_CUTOFF_VEL	V97U3258C	FT/SEC	F	S	D	P	G4.127	00	GPM	92469A	
							G4.144				
							G4.15				
							G4.205				
MLS_DROPOUT_DT_LIM	V97U3246C	SEC	F	S	D	P	G4.144	00	GP3	92178C	
							G4.205				
MSBLS_EL_ANGLE_CUTOFF	V99U7593C	RAD	F	S	D	P	G4.144	00	ZFV	DC0617	
							G4.205				
MS_POS_UND_WGT	V97U5411C	FT**2	F	S	D	X	G4.126	01	ZFT	DC0617	
							G4.127	02	ZPA		
							G4.144	03	ZFT		
							G4.15				
RCO_FOM_LIM	V97U3402C	ND	I	S	D	P	G4.144	00	RCO	93100C	
							G4.144				
							G4.127				
							G4.144				
RCO_SEL_AGE_MAX	V97U3400C	MIN	F	S	D	P	G4.144	00	RCO	93100C	
							G4.127				
							G4.144				
							G4.15				
SCALE_HT(1)	V97U5501C	FT	F	S	M	C	G4.127	01	PR4	DC0599	
							G4.144	03	PE4		
							G4.15				
							G4.205				
SCALE_HT(2)	V97U5502C	FT	F	S	M	C	G4.127	01	PR4	DC0599	
							G4.144	03	PE4		
							G4.15				
							G4.205				
SCALE_HT(3)	V97U5503C	FT	F	S	M	C	G4.127	01	PR4	DC0599	
							G4.144	03	PE4		
							G4.15				
							G4.205				
SCALE_HT(4)	V97U5504C	FT	F	S	M	C	G4.127	01	PR4	DC0599	
							G4.144	03	PE4		
							G4.15				
							G4.205				
T_GPS_CYCLE	V97U2926C	SEC	F	S	D	P	G4.126	03	GP3	92178C	
							G4.127	08	GP2		
							G4.144	02	GP2		
							G4.205	01	GP3		
T_GPS_CYCLE_FOR_HIGH_RATE_NAV	V97U3247C	SEC	F	S	D	C	G4.127	00	GP3	93201	*
							G4.144				
							G4.205				
							G4.205				
UA(1)	V97U5951C	ND	F	S	D	P	G4.127	01	GPM	92469A	
							G4.144	03	GPM		
							G4.15				
							G4.205				

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
UA (2)	V97U5952C	ND	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UB (1)	V97U5953C	FT	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UB (2)	V97U5954C	FT	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UBKPOINT	V97U5955C	FT	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDA (1)	V97U5972C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDA (2)	V97U5973C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDB (1)	V97U5974C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDB (2)	V97U5975C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDBKPOINT	V97U5976C	FT	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDMETER_MAX	V97U5977C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
UDMETER_MIN	V97U5978C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
UMETER_MAX	V97U5956C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
UMETER_MIN	V97U5957C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VA(1)	V97U5958C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VA(2)	V97U5959C	ND	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VB(1)	V97U5960C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VB(2)	V97U5961C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VBKPOINT	V97U5962C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDA(1)	V97U5979C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDA(2)	V97U5980C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDB(1)	V97U5981C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
VDB(2)	V97U5982C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	



TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
VDBKPOINT	V97U5983C	FT	F	S	D	P	G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VDMETER_MAX	V97U5984C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VDMETER_MIN	V97U5985C	FT/SEC	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VMETER_MAX	V97U5963C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
VMETER_MIN	V97U5964C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WA(1)	V97U5965C	ND	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WA(2)	V97U5966C	ND	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WB(1)	V97U5967C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WB(2)	V97U5968C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WBKPOINT	V97U5969C	FT	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	
WDA(1)	V97U5986C	SEC**-1	F	S	D	P	G4.205 G4.127 G4.144 G4.15	01 03	GPM GPM	92469A	

TABLE 4.3.2.9-3. PRELAND NAVIGATION (G4.144) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
WDA (2)	V97U5987C	SEC**-1	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDB (1)	V97U5988C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDB (2)	V97U5989C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDBKPOINT	V97U5990C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDMETER_MAX	V97U5991C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WDMETER_MIN	V97U5992C	FT/SEC	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WMETER_MAX	V97U5970C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	
WMETER_MIN	V97U5971C	FT	F	S	D	P	G4.127 G4.144 G4.15 G4.205	01 03	GPM GPM	92469A	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
A3_TOL	V98U9425C	00	-3.0	E-03	RAD	F	S	C G4.127 G4.144 G4.19 G4.20 G4.205 G4.23 G5.27	93090E	
ACC_DRAG_MIN ACC_DRAG_MIN_REF	V97U5200C	00	+1.1000000	E+01	FT/SEC**2	F	S	C G4.127 G4.144 G4.15 G4.205	59971	
ACC_PROP_MIN MIN ACCEL VENT DRAG NOT USED	V97U5586C	00	+3.2	E-02	FT/SEC**2	F	S	P G4.127	59971	
ALT_EL(1) ALT REGIONS NAV EV LAMP PROCESSING	V97U5212C	00	+1.4000000	E+05	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(2) ALT REGIONS NAV EV LAMP PROCESSING	V97U5213C	00	+1.2000000	E+04	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(3) ALT REGIONS NAV EV LAMP PROCESSING	V97U5214C	00	+5.0	E+03	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	90291B	
ALT_ZONE_CHANGE ALT MODEL ATMOS DEN CHANGED	V97U5718C	00	+5.0000000	E+05	FT	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
BIAS_BARO BAROMETRIC DETERMINISTIC BIAS	V97U5242C	00	+0.0	E+00	FT	F	S	C G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(1) COVAR CORRELATION COEFFICIENTS	V97U5291C	00	+0.0	E+00	ND	F	D	C G4.127 G4.144 G4.205	89661A	

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
CORR_COEFF_UPDATE(2) COVAR CORRELATION COEFFICIENTS	V97U5292C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(3) COVAR CORRELATION COEFFICIENTS	V97U5293C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(4) COVAR CORRELATION COEFFICIENTS	V97U5294C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(5) COVAR CORRELATION COEFFICIENTS	V97U5295C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(6) COVAR CORRELATION COEFFICIENTS	V97U5296C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
CORR_COEFF_UPDATE(7) COVAR CORRELATION COEFFICIENTS	V97U5297C	00	+0.0	E+00 ND	F	D	C	G4.127 G4.144 G4.205	89661A	
DENSE(1) DENSITY MODEL CONST	V97U5304C	00	-3.9570	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(2) DENSITY MODEL CONST	V97U5305C	00	+1.0440	E-05 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(3) DENSITY MODEL CONST	V97U5306C	00	+6.9560000	E+06 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(4) DENSITY MODEL CONST	V97U5307C	00	-2.420	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DENSE(5) DENSITY MODEL CONST	V97U5308C	00	-2.8890	E-06	FT**-1	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(6) DENSITY MODEL CONST	V97U5309C	00	+2.6050000	E+06	FT	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD1	V96U9743C	00	+3.9589	E-01	ND	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD2	V96U9744C	00	+3.3962	E+00	ND	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD3	V96U9745C	00	+6.5414	E-01	RAD	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD4	V96U9746C	00	+8.3589	E-01	ND	F	S	C G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
K_EDIT_BARO	V98U7977C	00	+4		ND	I	S	X G4.127 G4.144 G4.205	89661A	
K_EDIT_DRAG	V98U7978C	00	+64		ND	I	S	X G4.127 G4.144 G4.205	89661A	
K_EDIT_MLSAZ_MAX MAXIMUM VALUE OF K_EDIT_MLSAZ	V98U7980C	00	+400		ND	I	S	P G4.144 G4.205	69451I	
K_EDIT_MLSAZ_MIN MINIMUM VALUE OF K_EDIT_MLSAZ	V98U8722C	00	+16		ND	I	S	P G4.144 G4.205	69451I	

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
K_EDIT_MLSEL_MAX MAXIMUM VALUE OF K_EDIT_MLSEL	V98U7981C	00	+400	ND	I	S	P	G4.144 G4.205	69451I	
K_EDIT_MLSEL_MIN MINIMUM VALUE OF K_EDIT_MLSEL	V98U8723C	00	+9	ND	I	S	P	G4.144 G4.205	69451I	
K_EDIT_MLSR_MAX MAXIMUM VALUE OF K_EDIT_MLSR	V98U7979C	00	+400	ND	I	S	P	G4.144 G4.205	69451I	
K_EDIT_MLSR_MIN MINIMUM VALUE OF K_EDIT_MLSR	V98U8724C	00	+36	ND	I	S	P	G4.144 G4.205	69451I	
K_EDIT_TACBR	V98U7976C	00	+1	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
K_EDIT_TACR	V98U7975C	00	+64	ND	I	S	X	G4.127 G4.144 G4.205	89661A	
MLSANT_ANG ANGLE MLS AND X-BODY AXIS	V98U7434C	00	+3.2686	E-01 RAD	F	S	P	G4.144 G4.205	89661A	
MLSANT_NB_DIST DIST FROM NB TO MLS ANTENNA	V98U7433C	00	+1.389	E+01 FT	F	S	P	G4.144 G4.205	89661A	
RNG_VAR_BEARING_STEP RNG CRIT SEL TACAN AZ INSTR	V97U5467C	00	+9.1141700	E+05 FT	F	S	C	G4.127 G4.144 G4.205	89661A	
RNG_VAR_RNG_STEP RNG CRIT SEL TACAN RNG VAR	V97U5468C	00	+3.0380500	E+05 FT	F	S	C	G4.127 G4.144 G4.205	89661A	
R_AZ_COUNT_MAX DATA GOOD FAILS INHIB MLS PROC	V97U5429C	00	+2	ND	I	S	P	G4.144 G4.205	89661A	
SEA_LEVEL_DENSITY SEA LEVEL ATOMOSPHERIC DENSITY	V97U5505C	00	+2.3768840	E-03 SLUGS/FT**3	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
SIG_DIAG_UPDATE(1) VEH POS & VEL DEVIATIONS	V97U5506C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(2) VEH POS & VEL DEVIATIONS	V97U5507C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(3) VEH POS & VEL DEVIATIONS	V97U5508C	00	+2.0	E+03 FT	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(4) VEH POS & VEL DEVIATIONS	V97U5509C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	
SIG_DIAG_UPDATE(5) VEH POS & VEL DEVIATIONS	V97U5510C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
SIG_DIAG_UPDATE(6) VEH POS & VEL DEVIATIONS	V97U5511C	00	+3.0	E+01 FT/SEC	F	D	C	G4.127 G4.144 G4.205	89661A	
TACAN_BRG_CONVERG_TEST	V98U9807C	00	+1.0	E-02 RAD**2	F	S	P	G4.127 G4.144 G4.205	89661A	
TACAN_RNG_CONVERG_TEST	V98U9808C	00	+4.0000000	E+07 FT**2	F	S	P	G4.127 G4.144 G4.205	89661A	
TIME_BIAS_BARO PAD BIAS CORR BARO TIME TAG	V97U5544C	00	+1.790	E-01 SEC	F	D	C	G4.127 G4.144 G4.17 G4.205	92069B	
TIME_BIAS_MLS PAD BIAS CORR MSBLS TIME TAG	V97U5545C	00	-1.0	E-01 SEC	F	D	P	G4.144 G4.205	89661A	
TIME_BIAS_TACAN PAD LOADED CORR TACAN TIME LAG	V97U5543C	00	+2.90	E-02 SEC	F	D	P	G4.127 G4.144 G4.205	89661A	
VAR_ACC_QUANT_COAST NOISE ERROR VAR UNPOWERED FLIGHT	V97U5549C	00	+9.0	E-05 FT**2/SEC**2	F	S	C	G4.127 G4.144	59971	
VAR_ACC_QUANT_IMU ACCELEROMETER QUANTIZATION ERROR	V97U5550C	00	+9.0	E-05 FT**2/SEC**2	F	S	C	G4.127 G4.144	59971	
VAR_AZMLS MSBLS AZIMUTH MEAS INSTRU VAR	V97U5551C	00	+1.0	E-05 RAD**2	F	S	P	G4.144 G4.205	89661A	
VAR_ELMLS MSBLS ELEV INSTR VARIANCE	V97U5553C	00	+1.0	E-05 RAD**2	F	S	P	G4.144 G4.205	89661A	
VAR_RMLS MSBLS RANGE MEASURE INSTR VAR	V97U5556C	00	+5.7500000	E+02 FT**2	F	S	P	G4.144 G4.205	89661A	
VAR_TAC_BRG_HIGH TACAN BRG INSTR VAR AT RANGE	V97U5557C	00	+1.0	E-02 RAD**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_TAC_BRG_LOW VAR TACAN BRGN INSTRUMENT ERROR	V97U5558C	00	+1.0	E-02 RAD**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_TAC_R_HIGH TACAN RNG INSTR VAR AT RANGE	V97U5559C	00	+3.6000000	E+05 FT**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_TAC_R_LOW VAR TACAN RANGE INSTR ERROR	V97U5560C	00	+3.6	E+05 FT**2	F	S	C	G4.127 G4.144 G4.205	89661A	
VAR_UNMOD_ACC_DT_COAST VAR ACCEL SCALE UNPOWRD FLIGHT	V97U5561C	00	+5.0	E-04 FT**2/SEC**3	F	S	C	G4.127 G4.144	59971	
VAR_UNMOD_ACC_DT_IMU VAR ACCEL SCALE POWERED FLIGHT	V97U5562C	00	+2.5000000	E-01 FT**2/SEC**3	F	S	C	G4.127 G4.144	59971	

TABLE 4.3.2.9-4. PRELAND NAVIGATION (G4.144) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
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**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
C(01) TESSERAL HARMONIC COEFFICIENT ELEM 1	V97U6104C	00	-2.7635957	E-10	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(02) TESSERAL HARMONIC COEFFICIENT ELEM 2	V97U6105C	00	+1.5711423	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(03) TESSERAL HARMONIC COEFFICIENT ELEM 3	V97U6106C	00	+2.1907694	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(04) TESSERAL HARMONIC COEFFICIENT ELEM 4	V97U6107C	00	+3.0466825	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(05) TESSERAL HARMONIC COEFFICIENT ELEM 5	V97U6108C	00	+9.7966803	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
C(06) TESSERAL HARMONIC COEFFICIENT ELEM 6	V97U6109C	00	-5.0552749	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(07) TESSERAL HARMONIC COEFFICIENT ELEM 7	V97U6110C	00	+7.8842515	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(08) TESSERAL HARMONIC COEFFICIENT ELEM 8	V97U6111C	00	+5.9073749	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
C(09) TESSERAL HARMONIC COEFFICIENT ELEM 9	V97U6112C	00	-4.1542493	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_MU EARTH GRAVITATIONAL CONSTANT	V97U4378C	00	+1.40764487566E+16	FT**3/SEC**2	F		D	C A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.2 G4.205 G4.209 G4.210 G4.211 G4.224 G4.236 G4.3 G4.4 G5.10 G5.24 G5.26 G5.27	93090E	
EARTH_RADIUS_EQUATOR EARTH EQUATORIAL RADIUS	V97U5324C	00	+2.09257414698E+07	FT	F		D	C A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.19 G4.20 G4.205 G4.210 G4.211 G4.213 G4.23 G4.236 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RADIUS_GRAV EARTH RADIUS(GRAV ACCEL)	V97U5325C	00	+2.09256561680E+07	FT	F		D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
EARTH_RATE EARTH'S ROTATIONAL RATE	V97U4379C	00	+7.29211514646E-05	RAD/SEC	F		D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.17 G4.19 G4.20 G4.205 G4.21 G4.213 G4.22 G4.236 G4.237 G4.4 G5.26	93090E	
ELLIPT EARTH'S ELLIPTICITY CONSTANT	V97U5332C	00	+3.352329869 E-03	ND	F		D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.19 G4.20 G4.205 G4.213 G4.23 G4.236 G4.237 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EPS_TAG LIMIT FOR THE DIFFERENCE BETWEEN MEAS TIME TAG	V97U6122C	00	+5.0	E-04	SEC	F	S	C G4.127 G4.144 G4.205	90374C	
ID_MATRIX_3X3(01) COMPONENT OF 3X3 IDENTITY MATRIX (1,1)	V97U6196C	00	+1.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(02) COMPONENT OF 3X3 IDENTITY MATRIX (1,2)	V97U6197C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(03) COMPONENT OF 3X3 IDENTITY MATRIX (1,3)	V97U6198C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(04) COMPONENT OF 3X3 IDENTITY MATRIX (2,1)	V97U6199C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(05) COMPONENT OF 3X3 IDENTITY MATRIX (2,2)	V97U6200C	00	+1.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(06) COMPONENT OF 3X3 IDENTITY MATRIX (2,3)	V97U6201C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(07) COMPONENT OF 3X3 IDENTITY MATRIX (3,1)	V97U6202C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
ID_MATRIX_3X3(08) COMPONENT OF 3X3 IDENTITY MATRIX (3,2)	V97U6203C	00	+0.0	E+00	ND	F	S	C G4.126 G4.127 G4.144 G4.15 G4.205	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ID_MATRIX_3X3(09) COMPONENT OF 3X3 IDENTITY MATRIX (3,3)	V97U6204C	00	+1.0	E+00 ND	F	S	C	G4.126 G4.127 G4.144 G4.15 G4.205	90374C	
KN1 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6206C	00	-1.7980000	E+00 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN2 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6207C	00	+6.6670000	E-06 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN3 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6208C	00	-5.7890000	E-12 FT**-2	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN4 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6209C	00	+2.7518150	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN5 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6210C	00	-1.4990900	E-04 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	
KN6 CONSTANTS USED TO COMPUTE LOG OF KNUDSEN NUMBER	V97U6211C	00	+2.0490000	E-10 FT**-2	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04	NMI/FT	F	S	C A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	
PI RATIO OF CIRCUMFERENCE TO DIAMETER	V98U8725C	00	+3.14159265358E+00	ND		F	D	C A6.9 G4.126 G4.127 G4.13 G4.144 G4.15 G4.158 G4.16 G4.19 G4.2 G4.20 G4.205 G4.209 G4.210 G4.213 G4.220 G4.236 G4.237 G4.3 G4.4 G4.5 G4.97 G5.10 G5.24 G5.26 G5.27	93090E	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	
S(01) TESSERAL HARMONIC COEFFICIENT ELEM 1	V97U5492C	00	-5.2357454	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	



TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
S(02) TESSERAL HARMONIC COEFFICIENT ELEM 2	V97U5493C	00	-9.0231337	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(03) TESSERAL HARMONIC COEFFICIENT ELEM 3	V97U5494C	00	+2.7267074	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(04) TESSERAL HARMONIC COEFFICIENT ELEM 4	V97U5495C	00	-2.1259298	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(05) TESSERAL HARMONIC COEFFICIENT ELEM 5	V97U5496C	00	+1.9681077	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(06) TESSERAL HARMONIC COEFFICIENT ELEM 6	V97U5497C	00	-4.4125015	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
S(07) TESSERAL HARMONIC COEFFICIENT ELEM 7	V97U5498C	00	+1.4818958	E-07	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(08) TESSERAL HARMONIC COEFFICIENT ELEM 8	V97U5499C	00	-1.2140873	E-08	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
S(09) TESSERAL HARMONIC COEFFICIENT ELEM 9	V97U5500C	00	+6.3163541	E-09	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
ZONAL(01) ZONAL HARMONICS COEFFICIENT ELEM 1	V97U5582C	00	+0.0	E+00	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
ZONAL(02) ZONAL HARMONICS COEFFICIENT ELEM 2	V97U5583C	00	+1.0826271	E-03	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

TABLE 4.3.2.9-5. PRELAND NAVIGATION (G4.144) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ZONAL(03) ZONAL HARMONICS COEFFICIENT ELEM 3	V97U5584C	00	-2.5358868	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	
ZONAL(04) ZONAL HARMONICS COEFFICIENT ELEM 4	V97U5585C	00	-1.6246180	E-06	ND	F	D	C A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.205 G4.236	90374C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

### 4.3.3 Global Positioning System (GPS) Receiver State Processing (4.21)

The purpose of the GPS receiver state processing principal function is to: (1) select a GPS receiver state estimate (position and velocity) which can be used to reset or update the navigation filter state (or states) and/or the user parameter processing (UPP) state; and (2) calculate the position and velocity Kalman filter covariance matrix diagonals which reflect the accuracy of the selected GPS state estimate.

The GPS receiver state processing principal function is executed from the baseline navigation principal function active in OPS 2, OPS 8, OPS 3, and major modes 602 and 603.

The operation of the GPS receiver state processing principal function is as follows.

Each valid GPS receiver state, which has been acquired from the GPS SOP by the navigation principal function data snap, is rotated to the M50 inertial coordinate frame and then propagated to the time of the current navigation filter state. The propagation uses the current velocity counts from the navigation principal function IMU data snap and the velocity counts from the last IMU RM execution just prior to the time of the GPS state, snapped by the navigation principal function from the GPS SOP. These current and previous IMU velocity counts assure the following: the GPS states are propagated to the current navigation filter time using a sensed acceleration over the smallest time interval consistent with the GPS state time tag and the navigation filter state time; and the calculation of the sensed acceleration uses IMU accumulated velocity counts which bracket the time of the GPS state. This propagation reduces velocity transients introduced in the propagation of the GPS state to current navigation filter time.

The GPS states provided by the GPS SOP are the most recent set of navigation states from each of the installed receivers that the receivers have designated as valid (that is, a receiver's data good indicator is set to ON and its state is bracketed by a set of accumulated IMU velocity counts). The GPS receiver state buffering scheme in the GPS SOP provides only valid state data to the GPS receiver state processing principal function, which has been bracketed by the IMU velocity counts assigned by the SOP and by the navigation principal function snap of current IMU velocity counts. In this manner, the navigation principal function is sent valid, non-commfaulted data at all times.

The GPS states propagated to current time are then used in a series of quality assessment checks to produce a set of candidate states for GPS state vector selection. A single state is then obtained from the set of GPS candidate states for use by the orbiter navigation system.

The quality assessment checks examine the receiver's estimated position error, as indicated by Figure of Merit ("QA1"), compare each GPS state to the selected navigation filter state ("QA2"), to their respective values from the previous cycle extrapolated to the current navigation filter time ("QA3"), and to the states from the other installed GPS receivers ("QA4"). Note, that the Figure of Merit (FOM) check, QA 1, is performed in the GPS SOP and that the comparison to the navigation filter state, QA2, is not used to determine selection filter candidacy but is computed for crew display, downlist and its potential use in the downstream navigation edit check.

Those GPS states whose components satisfy pre-mission defined constraints then become candidates for selection. If three states become candidates, a median value selection is performed to select the state whose position vector is closest to the other two. If only two states are available, the selected state is formed by averaging the components. If only one state passes the quality assessment checks, it becomes the selected state. If none of the GPS states are candidates and at least one of the GPS receivers is not deselected or bypassed, the selected GPS state will be the selected state from the previous navigation cycle propagated to the current filter time. If none of the GPS states are candidates and all three GPS receivers are not

available (each receiver is either deselected or bypassed), the selected GPS state will be reset to zero and designated as not available. A receiver state which fails the QA 1, QA3 or QA4 quality assessment check on a given navigation cycle will be removed as a candidate for selection on that navigation cycle. That receiver's state, though, will be a candidate for selection on the next navigation cycle if it passes the QA 1, QA3, QA4 quality assessment checks.

A manual force capability (GPS to G&C Force) is provided to force valid receiver states from non-deselected receivers and which are not in a dilemma condition to be candidates for selection independent of any QA 1/3/4 quality assessment failures. A manual quality assessment override capability is also provided to enable valid receiver states from non-deselected receivers to be candidates for selection independent of any QA 1/3/4 quality assessment failures, providing that a dilemma condition does not exist for that receiver.

The position and velocity Kalman filter covariance matrix diagonals which reflect the quality of the selected GPS state estimate are then calculated. Pre-mission determined I-loads and the selected state's figure of merit are used in the calculation.

This principal function also provides scheduling needed for the GPS reference state processing principal function to enable announced state resets of the receivers. GPS data is also provided to the displays.

The GPS receiver processing software is designed to process up to three GPS states independent of the number of receivers actually installed on the vehicle. The software will allow data to be processed from three receivers with appropriate software checks to insure that internal loop calculations are bypassed if a receiver is not actually installed.

#### 4.3.3.1 GPS Control

The GPS receiver state processing principal function will provide for GPS state vector propagation, quality assessment of the GPS states, GPS state vector selection and announced reset state parameter setting and setting of Downlist parameters.

A. Detailed Requirements. The following paragraphs describe the subfunctions comprising the GPS receiver state processing principal function and are listed in their order of execution:

1. The latest valid GPS states snapped in the navigation principal function from the GPS SOP, are rotated to the M50 inertial coordinate frame and then propagated to the current navigation filter time as described in Section 4.3.3.3. If one is available, the previous selected GPS state, time tagged to the last navigation cycle, is also propagated to current time. These states are used in the GPS state selection process and for the QA2, QA3 and QA4 checks. If the receiver had valid states on the previous navigation cycle, that state is also extrapolated to current time to be used in the QA3 check. The state vector propagations and extrapolations will use accelerometer data if the magnitude of the sensed acceleration exceeds pre-mission determined minimum acceleration magnitudes.
2. To determine if a GPS state is a candidate for GPS state vector selection, the propagated GPS state, now at the current navigation cycle time, undergoes two additional quality assessments (denoted QA3 and QA4), the first quality assessment having been performed in the GPS SOP using the receiver figure of merit.

An additional assessment, "QA2", is performed which computes the position and velocity vector differences between the GPS state and the current selected navigation filter state. This assessment is

not used to establish selection filter candidacy. It is performed for crew display, downlist, and potential use by the downstream navigation edit check.

The QA3 quality assessment check computes the position and velocity vector differences between the current GPS receiver state propagated to the navigation filter time and its valid state from the previous navigation cycle extrapolated to the current navigation filter time. If the magnitude of either the position or velocity vector differences exceeds pre-mission determined tolerances, the receiver state is considered to have failed the quality assessment, and, depending on the crew commanded GPS system configuration discussed below, is excluded as a candidate for the GPS receiver state selection function. Otherwise it is a candidate for selection. Note that the receiver must have valid states on two successive navigation cycles for the QA3 check to be executed. If the quality assessment check is not executed, the receiver is considered to have failed the quality assessment check.

The QA4 quality assessment check compares pairs of available valid receiver position and velocity states. At the three receiver level (three receivers with valid states and no receivers deselected by the crew), if only one receiver's position or velocity exceeds a premission-determined tolerance from the position or velocity states of the other two receivers, that receiver is removed as a candidate for the GPS receiver state selection function. Violation of the tolerances by all three receivers will result in a dilemma condition for all three receivers which will be displayed to the crew. All three receivers are removed as candidates for selection. At the two receiver level (either through receiver deselection by the crew or one receiver with invalid states), violation of the tolerances by the two receivers will result in a dilemma condition for both receivers which will be displayed to the crew. Both receivers are removed as candidates for selection.

The QA3 and QA4 quality assessment checks are performed on each navigation cycle. QA 1 is performed in the GPS SOP with results available each navigation cycle. If a quality assessment failure condition is indicated on a given cycle, it will exist for that navigation cycle only.

The state from a receiver is considered a candidate for state vector selection if the following four conditions are satisfied: (1) the receiver has a valid state; (2) it has not been deselected by crew item entry; (3) a dilemma condition does not exist for that receiver's state as determined by the QA4 function; (4) the state has (a) passed the QA1, 3, and 4 checks or (b) the quality assessment override for that receiver has been set by crew item entry or (c) the crew has set the GPS to guidance and control auto/inhibit/force command to FORCE\*.

\*Note that the setting of the GPS to guidance and control auto/inhibit/force command to FORCE forces all non-deselected receiver states which are valid and which do not have a dilemma condition to be considered as candidates for selection, independent of the outcome of their quality assessment results.

The detailed requirements for these functions are contained in the GPS state vector quality assessment subfunction described in Section 4.3.3.4.

3. The selected GPS state is chosen as follows. With three receivers as candidates for selection, the selected GPS position and velocity is that from the receiver with the smallest position vector differences from each of the other two receivers. With two receivers as candidates for selection, the selected GPS position and velocity is the average of the position and velocity vectors of the two candidate receivers. If one receiver is a candidate for selection, the selected GPS state is the state from that receiver. If none of the GPS states are candidates and at least one of the GPS receivers is not deselected or bypassed, the selected GPS state will be the state from the previous navigation cycle

propagated to the current filter time. However, if none of the GPS states are candidates and all three GPS receivers are not available (each receiver is either deselected or bypassed), the selected GPS state will be reset to zero and designated as not available.

A navigation edit check is then performed on the selected GPS state. The navigation edit check result is made available to the navigation principal functions. If the navigation edit check is failed, automatic GPS updates are precluded. A manual force capability is provided to override the navigation edit check.

The position and velocity Kalman filter covariance matrix diagonals which reflects the quality of the selected GPS state estimate are then calculated. The calculation uses pre-mission determined I-loads, and the selected state figure of merit.

If at least one GPS receiver is not deselected or bypassed and no candidate is selected by the GPS state selection process for a pre-mission defined time interval, a warning message is annunciated through GAX and the elapsed time from the last cycle which had at least one candidate for selection will be displayed.

The detailed requirements for these tasks are contained in the GPS state vector selection subfunction described in Section 4.3.3.5.

4. A scheduling function is performed for the GPS reference state processing principal function (Section 4.6.4). The scheduling function provides an announced reset request to reanchor the GPS receiver reference state. The detailed requirements to accomplish these tasks are found in the GPS reference state announced reset subfunction in Section 4.3.3.6.
5. Finally, GPS data and moding commands are scaled if necessary and stored for downlink. The detailed requirements to accomplish these tasks are found in the GPS downlink computation subfunction in Section 4.3.3.7.

B. Interface Requirements. None.

C. Processing Requirements. The GPS receiver state processing principal function is called by the active navigation principal function just prior to execution of the navigation user parameter state reset subfunction. IMU and GPS data snapped at the beginning of the navigation filter cycle will be used by the GPS receiver state processing principal function in addition to data from the navigation principal function. The GPS receiver processing software is designed to process up to three GPS states independent of the number of receivers actually installed on the vehicle. The software will allow data to be processed from three receivers with appropriate software checks to insure that internal loop calculations are bypassed if a receiver is not actually installed.

D. Constraints. None.

E. Supplementary Information. A suggested implementation in the form of a detailed flow chart (GPS\_RCVR\_STATE\_PROC) may be found in Section 5.2.

#### 4.3.3.2 Deleted

### 4.3.3.3 GPS Navigation State Propagation

The purpose of GPS navigation state propagation subfunction is to: propagate the latest valid GPS states snapped by the navigation principal function from the GPS SOP; propagate the previous selected GPS state to current navigation filter time; and propagate the valid receiver states from the previous navigation filter cycle to current navigation filter time. These propagated states are used in the receiver state quality assessment functions and the current GPS states are used in the GPS state selection process if the necessary criteria are satisfied.

The latest valid GPS states are first transformed from WGS84 coordinates to the M50 inertial coordinate frame. They are then propagated to the current navigation filter time using the GPS super-g integration method. The times of these latest GPS states before the propagation are each receiver's filter solution time and will not necessarily be the same time of the current IMU accumulated velocity counts. Since no IMU velocities are available at the receiver solution time, the velocity difference used to propagate these states to current filter time is computed assuming the sensed acceleration is constant from the GPS state time to current time. This acceleration is computed using IMU velocities at the current navigation filter time and the IMU velocity provided by the GPS SOP which is from the latest IMU RM execution just prior to the current receiver state time tag. This acceleration is then scaled such that the delta velocity from the receiver state time to current time is consistent with the constant acceleration assumption. The delta velocity is used in the propagation if it exceeds an I-load threshold along with the appropriate gravity model degree and order.

The valid GPS state of each receiver from the previous navigation filter cycle, if available, is also propagated to current navigation time. The delta velocity computed from the current and previous selected navigation IMU velocity counts is used, if the acceleration computed using this delta velocity exceeds the appropriate mission phase threshold. The previous valid state propagation uses the gravity accelerations already computed: the gravity acceleration associated with this receiver state from the previous navigation cycle, and the gravity acceleration from the current GPS state propagation. Note that for the previous state to be propagated both the current and previous GPS state from a given receiver must be valid.

The selected GPS state from the previous navigation cycle is then propagated to current time using the super-g integration method. Since it is time-tagged to the previous navigation filter time, it is propagated over the navigation filter cycle using the current selected IMU accumulated velocity, the selected IMU velocity from the previous navigation cycle, and the appropriately set gravity model order and degree.

#### A. Detailed Requirements.

1.0 Steps 1.1 through 1.1.2 are performed for  $I = 1$  to the software designed maximum capability of three receivers (GPS\_SW\_CAP), independent of whether three receivers are actually installed on the vehicle.

DO FOR  $I = 1$  to GPS\_SW\_CAP

1.1 If the latest state from the receiver is invalid, indicated by  $\text{GPS\_DG}_I = \text{OFF}$ , or the time of the state is less than the user parameter propagator reset time tag from the previous navigation cycle, set the data good flag for that receiver used in the GPS receiver state vector selection process to OFF.

IF ( $\text{GPS\_DG}_I = \text{OFF}$ ) or ( $T\_GPS_I < T\_RESET$ ) THEN

$\text{GPS\_DG\_SF}_I = \text{OFF}$



- 1.1.1 If the above check is not satisfied, that is the receiver indicated data good flag is on and the receiver state time tag is greater than or equal to the user parameter propagator reset time tag from the previous navigation cycle, the selection filter process data good flag is set to on,  $GPS\_DG\_SF_1 = ON$ . The receiver state is then transformed from WGS84 coordinates to M50 inertial frame coordinates and propagated to  $T\_CURRENT\_FILT$ . The propagation of the current valid receiver state is described in Section 4.3.3.3.1.
- 1.1.2 If the receiver had a valid state on the previous cycle, indicated by  $GPS\_DG\_SF\_PREV_1 = ON$ , that state is then propagated to current time as shown in Section 4.3.3.3.2.
- 2.0 If a GPS state vector has been selected on a previous navigation cycle, indicated by  $GPS\_SV\_SEL\_AVAIL = ON$ , the selected GPS state from the previous navigation cycle is propagated to current navigation filter time as shown in Section 4.3.3.3.3.
- 3.0 Prior to exiting this subfunction, the current IMU accumulated velocity is saved for use in propagating the GPS selected state and the previous valid receiver states on the next navigation cycle.  

$$\bar{V}\_LAST\_GPS\_SEL = \bar{V}\_CURRENT\_FILT$$

#### 4.3.3.3.1 Propagation of the Current Valid Receiver State

Transform the current valid receiver state from WGS84 coordinates to M50 inertial coordinates and propagate the state to the current navigation filter time by executing the following steps:

- 1.0 Transform the GPS receiver Orbiter position and velocity state estimates to M50 coordinates from World Geodetic Survey 1984 coordinates as follows:  

$$M\_WGS\_TO\_M50 = EARTH\_FIXED\_TO\_M50\_COORD(T\_GPS_1)$$

$$M\_WGS84\_TO\_EF$$

$$\bar{R}\_GPS_1 = M\_WGS\_TO\_M50 \bar{R}\_GPS\_ECEF_1$$

$$\bar{V}\_GPS_1 = V\_REL((M\_WGS\_TO\_M50 \bar{V}\_GPS\_ECEF_1), (-\bar{R}\_GPS_1))$$

Note that the  $V\_REL$  function is used to obtain the inertial velocity,  $\bar{V}\_GPS_1$ , by using the negative of the inertial position vector,  $-\bar{R}\_GPS_1$ , in the calling argument.

- 2.0 Compute the integration interval,  $DT$ , using current navigation time and the time tag of the receiver's state:  

$$DT = T\_CURRENT\_FILT - T\_GPS_1$$

- 3.0 If the integration interval is less than  $10^{-8}$  seconds, set the integration interval to 0, set the delta velocity to zero and do not execute steps 3.1 to 3.2.2.

$$\text{IF } DT < 10^{-8}$$

$$DT = 0$$

$$\bar{D}V = 0$$

If the integration interval is greater than or equal to  $10^{-8}$  seconds, execute steps 3.1 through 3.2.2.

- 3.1 Scale the IMU sensed delta velocity to appropriately reflect the delta velocity over the integration interval:

$$\text{SCALEF} = \text{DT} / (\text{T\_CURRENT\_FILT} - \text{T\_LAST\_GPS}_i)$$
$$\overline{\text{DV}} = \text{SCALEF} (\overline{\text{V\_CURRENT\_FILT}} - \overline{\text{V\_LAST\_GPS}}_i)$$

- 3.2 If the navigation major mode, NAV\_MM\_CODE, is 201, 202 or 801 execute Step 3.2.1, otherwise execute Step 3.2.2.

IF NAV\_MM\_CODE = 201 or NAV\_MM\_CODE = 202  
or NAV\_MM\_CODE = 801 THEN

- 3.2.1 Set the GPS propagation gravity model degree and order parameters to four:  
GM\_DEG\_GPS = 4  
GM\_ORD\_GPS = 4

If the magnitude of the scaled IMU sensed delta velocity is less than the GPS IMU velocity threshold, GPS\_IMU\_VEL\_THRESH, set the delta velocity equal to zero and set the drag and vent acceleration calculation parameters to one so that drag and vent accelerations will be included in the acceleration calculations:

IF ABVAL ( $\overline{\text{DV}}$ ) < GPS\_IMU\_VEL\_THRESH THEN  
 $\overline{\text{DV}} = 0$   
IDRAG\_GPS = 1  
IVENT\_GPS = 1

If the magnitude of the scaled IMU sensed delta velocity is greater than or equal to this threshold, set the drag and vent calculation parameters to zero, indicating that only the gravity acceleration acting on the vehicle will be computed in the call to the acceleration calculation subfunction:

ELSE  
IDRAG\_GPS = 0  
IVENT\_GPS = 0

- 3.2.2 For all other major modes perform the following calculations.

If the magnitude of the scaled IMU sensed delta velocity is less than the GPS IMU velocity threshold, GPS\_IMU\_VEL\_THRESH, set the delta velocity equal to zero and set the GPS propagation gravity model degree and order parameters to four

IF ABVAL ( $\overline{\text{DV}}$ ) < GPS\_IMU\_VEL\_THRESH THEN  
 $\overline{\text{DV}} = 0$   
GM\_DEG\_GPS = 4  
GM\_ORD\_GPS = 4

Otherwise, set the GPS propagation gravity model degree and order parameters to two and zero respectively:

ELSE  
GM\_DEG\_GPS = 2  
GM\_ORD\_GPS = 0

- 4.0 Propagate the receiver state to the current navigation time using GPS super-g, obtaining updated position, velocity and gravity acceleration, and reset the GPS state time tag to current navigation filter time. For the case where the DT = 0, the GPS super-g execution will return the input position and velocity and the gravity acceleration vector associated with this state.  
CALL: SUPER\_G\_GPS

INLIST:  $\bar{R}_{GPS_i}$ ,  $\bar{V}_{GPS_i}$ ,  $\bar{D}V$ ,  $DT$ ,  $T_{GPS_i}$ ,  $GM\_DEG\_GPS$ ,  $GM\_ORD\_GPS$ ,  
 $IDRAG\_GPS$ ,  $IVENT\_GPS$   
 OUTLIST:  $\bar{R}_{GPS_i}$ ,  $\bar{V}_{GPS_i}$ ,  $\bar{G}_{TWO_i}$   
 $T_{GPS_i} = T\_CURRENT\_FILT$

#### 4.3.3.3.2 Propagation of the Previous Valid Receiver State

The valid receiver state from the previous navigation cycle is propagated to current time by executing the following steps:

- 1.0 Compute the integration time step, and the IMU sensed delta velocity over the integration interval (Note that  $T_{GPS\_PREV_i}$  is set in the GPS state vector quality assessment function):

$$DT = T\_CURRENT\_FILT - T_{GPS\_PREV_i}$$

$$\bar{D}V = (\bar{V}_{CURRENT\_FILT} - \bar{V}_{LAST\_GPS\_SEL})$$

- 2.0 If the magnitude of the IMU sensed delta velocity is less than the GPS IMU velocity threshold,  $GPS\_IMU\_VEL\_THRESH$ , set the delta velocity equal to zero:

$$\text{IF } ABVAL(\bar{D}V) < GPS\_IMU\_VEL\_THRESH \text{ THEN}$$

$$\bar{D}V = 0$$

- 3.0 Propagate the previous receiver state to current time using this delta velocity and the gravity acceleration for this state from the previous navigation cycle,  $\bar{G}_{TWO\_PREV_i}$ , and the gravity acceleration at current navigation time from the propagation of this receiver's current valid state,  $\bar{G}_{TWO_i}$ .

$$\bar{G}_{AVE} = 0.5 (\bar{G}_{TWO_i} + \bar{G}_{TWO\_PREV_i})$$

$$\bar{R}_{GPS\_PREV_i} = \bar{R}_{GPS\_PREV_i} +$$

$$DT(\bar{V}_{GPS\_PREV_i} + 0.5 (\bar{D}V + DT \bar{G}_{AVE}))$$

$$\bar{V}_{GPS\_PREV_i} = \bar{V}_{GPS\_PREV_i} + \bar{D}V + DT \bar{G}_{AVE}$$

#### 4.3.3.3.3 Propagation of the Selected GPS State from the Previous Navigation Cycle

The selected state from the previous navigation cycle is propagated to current navigation time by executing the following steps:

- 1.0 Compute the integration time step, and the IMU sensed delta velocity over the integration interval:

$$DT = T\_CURRENT\_FILT - T_{GPS\_SEL}$$

$$\bar{D}V = (\bar{V}_{CURRENT\_FILT} - \bar{V}_{LAST\_GPS\_SEL})$$

- 2.0 If the navigation major mode,  $NAV\_MM\_CODE$ , is 201, 202 or 801 execute Steps 2.1, otherwise execute Step 2.2.

IF  $NAV\_MM\_CODE = 201$  or  $NAV\_MM\_CODE = 202$   
 or  $NAV\_MM\_CODE = 801$  THEN

- 2.1 Set the GPS propagation gravity model degree and order parameters to four:

$$GM\_DEG\_GPS = 4$$

$$GM\_ORD\_GPS = 4$$

If the magnitude of the IMU sensed delta velocity is less than the GPS IMU velocity threshold, GPS\_IMU\_VEL\_THRESH, set the delta velocity equal to zero and set the drag and vent acceleration calculation parameters to one so that drag and vent accelerations will be included in the acceleration calculations:

```
IF ABVAL ( $\overline{DV}$ ) < GPS_IMU_VEL_THRESH THEN  
     $\overline{DV} = 0$   
    IDRAG_GPS = 1  
    IVENT_GPS = 1
```

If the magnitude of the scaled IMU sensed delta velocity is greater than or equal to this threshold, set the drag and vent calculation parameters to zero, indicating that only the gravity acceleration acting on the vehicle will be computed in the call to the acceleration calculation subfunction:

```
ELSE  
    IDRAG_GPS = 0  
    IVENT_GPS = 0
```

2.2 For all other major modes perform the following calculations:

If the magnitude of the scaled IMU sensed delta velocity is less than the GPS IMU velocity threshold, GPS\_IMU\_VEL\_THRESH, set the delta velocity equal to zero and set the GPS propagation gravity model degree and order parameters to four

```
IF ABVAL ( $\overline{DV}$ ) < GPS_IMU_VEL_THRESH THEN  
     $\overline{DV} = 0$   
    GM_DEG_GPS = 4  
    GM_ORD_GPS = 4
```

Otherwise, set the GPS propagation gravity model degree and order parameters to two and zero respectively:

```
ELSE  
    GM_DEG_GPS = 2  
    GM_ORD_GPS = 0
```

3.0 Propagate the previous selected GPS state to current navigation time using the super-g method and reset the time tag to current filter time:

```
CALL: SUPER_G_GPS  
INLIST:  $\overline{R}_{GPS\_SEL}$ ,  $\overline{V}_{GPS\_SEL}$ ,  $\overline{DV}$ , DT, T_GPS_SEL,  
        GM_DEG_GPS, GM_ORD_GPS,  
        IDRAG_GPS, IVENT_GPS  
OUTLIST:  $\overline{R}_{GPS\_SEL}$ ,  $\overline{V}_{GPS\_SEL}$ ,  $\overline{G}_{GPS\_SEL}$ 
```

```
T_GPS_SEL = T_CURRENT_FILTER
```

B. Interface Requirements. This section defines the interfaces associated with the GPS navigation state propagation function. Tables 4.3.3.3-1 and 4.3.3.3-2 contain the inputs and outputs.

C. Processing Requirements. The GPS navigation state propagation subfunction shall be performed after the appropriate velocity counts have been assigned to each receiver and before state vector quality assessment is performed.

D. Constraints. None.

E. Supplementary Information. A suggested implementation in the form of detailed flow charts (GPS\_NAV\_STATE\_PROP) may be found in Section 5.2. See Section 4.2.1.4 for information on SUPER\_G\_GPS.

The parameters IDRAG\_GPS and IVENT\_GPS are initialized to zero at all OPS transitions. For all OPS except OPS2 and OPS8, these parameters remain at their initial zero value throughout the OPS. For OPS2 and OPS8, these parameters change according to the magnitude of the IMU-sensed velocity change over an integration interval as defined in the above requirements.

The V\_REL subfunction requirements can be found in the Entry Navigation FSSR, STS 83-0004.

For all transitions to major mode 602, T\_RESET has the value that was last updated by the Ascent Navigation Principal Function.

Table 4.3.3.3-1. GPS Navigation State Propagation Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Minimum Delta velocity magnitude needed to use IMU data for propagating current GPS state	GPS_IMU_VEL_THRESH	I-load	F	S	-	ft/sec	Filter rate
Matrix transformation between WGS84 and Shuttle earth-fixed coordinate frame	M_WGS84_TO_EF	I-load	F	DP			Filter rate
Gravity vector corresponding to the I <sup>th</sup> GPS receiver state from previous navigation cycle	$\bar{G}_{TWO\_PREV_I}^{**}$	GPS State Vector Quality Assess	V	DP		-	Filter rate
GPS data good flag	GPS_DG <sub>I</sub> **	*	D	-	ON/OFF	-	Filter rate
Data good for GPS state selection of each valid receiver state from previous navigation cycle	GPS_DG_SF_PREV <sub>I</sub> **	*, GPS SV quality assess	D	-	ON/OFF	-	Filter rate
Flag indicating (ON) a GPS selected state vector is available	GPS_SV_SEL_AVAIL	*, GPS SV select	D	-	ON/OFF	-	Filter rate
Maximum number of GPS receivers for which the GPS specific software is designed	GPS_SW_CAP	K-load	I	S	3	-	Filter rate
Snapped major mode flag	NAV_MM_CODE	*	I	S		-	Filter rate
Latest GPS receiver orbiter position estimate in WGS84 coordinates	$\bar{R}_{GPS\_ECEFI}^{**}$	*	V	DP		ft	Filter rate
Previous GPS positions	$\bar{R}_{GPS\_PREVI}^{**}$	GPS SV quality assess	V	DP		ft	Filter rate
Selected GPS position vector	$\bar{R}_{GPS\_SEL}$	GPS SV select	V	DP		ft	Filter rate
Time tag for filter state	T_CURRENT_FILT	*	F	DP		sec	Filter rate
Current GPS time	T_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate

Table 4.3.3.3-1. GPS Navigation State Propagation Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Previous filter state time tag	T_GPS_PREV <sub>I</sub> **	GPS SV quality assess	F	DP		sec	Filter rate
Selected GPS state time tag	T_GPS_SEL	GPS SV select	F	DP		sec	Filter rate
GPS receiver state time tags snapped by navigation	T_LAST_GPS <sub>I</sub> **	*	F	DP		sec	Filter rate
Time associated with reserved reset state	T_RESET	*	F	DP		sec	Filter rate
Current selected IMU accumulated velocity counts	$\bar{V}$ _CURRENT_FILT	*	V	DP		ft/sec	Filter rate
Latest GPS receiver orbiter velocity estimate in WGS84 coordinates	$\bar{V}$ _GPS_ECEF <sub>I</sub> **	*	V	S		ft/sec	Filter rate
Previous GPS velocities	$\bar{V}$ _GPS_PREV <sub>I</sub> **	GPS SV quality assess	V	S		ft/sec	Filter rate
Selected GPS velocity vector	$\bar{V}$ _GPS_SEL	GPS SV select	V	DP		ft/sec	Filter rate
IMU velocity counts nearest to current GPS states before propagation to current navigation filter time	$\bar{V}$ _LAST_GPS <sub>I</sub> **	*	V	DP		ft/sec	Filter rate

\* See principal function input list in Table 4.3.3.8-1.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Table 4.3.3.3-2. GPS Navigation State Propagation Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Data good of each valid receiver state for GPS state selection	GPS_DG_SF <sub>I</sub> **	*, GPS SV quality assess, GPS SV select, GPS D/L comp	D	-	ON/OFF	-	Filter rate
Gravity acceleration vector for each GPS receiver state at current time	$\bar{G}_{TWO_I}$ **	GPS SV quality assess, GPS SV select	V	DP		ft/sec <sup>2</sup>	Filter rate
GPS position at current nav filter time	$\bar{R}_{GPS_I}$ **	GPS SV quality assess, GPS SV select	V	DP		ft	Filter rate
GPS position at previous nav filter time	$\bar{R}_{GPS\_PREV_I}$ **	GPS SV quality assess	V	DP		ft	Filter rate
Selected GPS position vector	$\bar{R}_{GPS\_SEL}$	GPS SV select, GPS D/L comp, *	V	DP		ft	Filter rate
GPS state time tag	T_GPS <sub>I</sub> **	GPS SV quality assess, GPS SV select	F	DP		sec	Filter rate
Selected GPS state time tag	T_GPS_SEL	GPS SV select, GPS D/L comp,*	F	DP		sec	Filter rate
GPS velocity at current nav filter time	$\bar{V}_{GPS_I}$ **	GPS SV quality assess, GPS SV select	V	DP		ft/sec	Filter rate
GPS velocity at previous nav filter time	$\bar{V}_{GPS\_PREV_I}$ **	GPS SV quality assess	V	S		ft/sec	Filter rate
Selected GPS velocity vector	$\bar{V}_{GPS\_SEL}$	GPS SV select, GPS D/L comp,*	V	DP		ft/sec	Filter rate
Gravity acceleration vector for selected GPS state from the previous navigation cycle at the current cycle time.	$\bar{G}_{GPS\_SEL}$	*	V	S		ft/sec <sup>2</sup>	Filter rate

\* See principal function output list in Table 4.3.3.8-2.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)



#### 4.3.3.4 GPS State Vector Quality Assessment

This subfunction performs three of the four levels of receiver state quality assessment. The first level of quality assessment, or QA1, is performed in the GPS SOP using the receiver figure of merit (FOM).

The GPS state vector quality assessment subfunction identifies GPS state vectors that satisfy accuracy requirements governing 1) performance relative to the navigation filter state, 2) relative instrument performance and 3) comparative performance between each receiver. Each GPS state that meets the standards described in the following paragraphs will be identified as available candidates for processing by the GPS state vector selection subfunction (Section 4.3.3.5).

The relative performance of the GPS and navigation filter states is assessed by comparing each current GPS state (position and velocity) with the current selected navigation state. This assessment is referred to as the second level quality assessment or QA2. Obtained vector differences are transformed into UVW coordinates, and the components are then compared to position and velocity tolerances computed as time dependent functions of mission OPS phase configured I-Loads. The time quantity for these calculations reflects the elapsed time since the GPS and navigation state were last set equal to each other with one in-flight exception: the QA2 position and velocity elapsed time will effectively be reset to zero following a whole state vector uplink, non-zero delta time update, or non-zero delta state update. These computed tolerances represent the magnitudes of the maximum allowable UVW position and velocity errors between the position and velocity estimates from each GPS receiver and the current selected navigation filter states. The results are not used in determining selection filter candidacy, but are displayed to the crew, downlisted, and available for use to the downstream navigation edit check. The UVW coordinate frame is defined as follows: U is positive in the direction of the vehicle earth-centered position vector, W is in the direction of the vector cross-product of the vehicle position and velocity vectors, and V completes the right hand coordinate frame. Note that the velocity vector used to determine the UVW coordinate frame can be either an earth relative velocity vector or an inertial velocity vector depending on the current major mode of the orbiter.

The relative GPS receiver performance is characterized by two I-loads which represent the magnitudes of the maximum allowable errors between the position and velocity estimates from each GPS receiver's current state and its previous state extrapolated to current time. If the magnitude of either the position or velocity difference exceeds the I-load limits, the GPS state estimate from the associated GPS receiver is excluded as a candidate for selection. This third level quality assessment is referred to as QA3. Note that a receiver has to have valid states for two consecutive navigation cycles for it to be considered for the third level of quality assessment. If a valid state does not exist for two consecutive navigation cycles, then that receiver fails the third level of quality assessment and is not a candidate for selection for the current navigation cycle.

Comparative performance between pairs of GPS receivers is referred to as QA4. The comparative performance is characterized by two I-loads which represent the magnitudes of the maximum allowable position and velocity differences between the position and velocity estimates from a pair of GPS receivers. Execution of this quality assessment subfunction requires at least two receivers with valid states.

At the three receiver level (i.e., three valid receiver states and no receivers deselected by the crew): if two out of the three GPS receiver pairs produce vector differences whose magnitudes exceed I-load defined limits, the GPS state estimate from the receiver common to the offending pairs is declared to have failed QA4 and is removed as a candidate for selection. If all three GPS receiver pairs produce vector differences whose magnitudes exceed the I-load limits, a dilemma condition is declared on all three receiver states and all three states are removed as candidates for selection.

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At the two receiver level (i.e., two valid receiver states and neither receiver deselected by the crew): if the GPS receiver pair produces vector differences whose magnitudes exceed I-load defined limits, a dilemma condition is declared on both receiver states and both states are removed as candidates for selection.

If the dilemma conditions persist for either of the above receiver levels and conditions, the crew must take action to deselect the appropriate number of receivers to remove the QA4 dilemma conditions before a valid GPS receiver state estimate can be considered for selection.

Out of tolerance conditions, dilemmas and failures are displayed to the crew.

Note that all three GPS state vector quality assessment functions (QA2, QA3, and QA4) are executed on each navigation cycle and determine if any failure or dilemma conditions exist for that cycle. Valid receiver states that fail a quality assessment on a given cycle are not removed from consideration on succeeding cycles. All valid receiver states on a given cycle are considered for quality assessment on each navigation cycle independent of past failure or dilemma conditions for that receiver.

The receiver data good flags used in GPS state vector Quality Assessment subfunction are those set in the GPS Navigation State Propagation subfunction (Section 4.3.3.3). Since the setting of this data good flag is dependent on both the receiver data good flag and the staleness of the receiver data (greater than the navigation cycle rate) it can have a setting different than the receiver's data good indicator provided by the GPS SOP.

Selected data from each of these quality assessment subfunctions is also provided for display to the crew.

A. Detailed Requirements.

- 1.0 The three array elements of the crew receiver deselect commands and the quality assessment override commands are snapped for feedback to display and for use in determining the candidate receiver states for selection:

CREW\_DES\_RCVR\_RCVD<sub>1</sub> = CREW\_DESELECT\_RCVR<sub>1</sub>  
CREW\_DES\_RCVR\_RCVD<sub>2</sub> = CREW\_DESELECT\_RCVR<sub>2</sub>  
CREW\_DES\_RCVR\_RCVD<sub>3</sub> = CREW\_DESELECT\_RCVR<sub>3</sub>

CREW\_QA\_OVERRIDE\_RCVD<sub>1</sub> = QA\_OVERRIDE<sub>1</sub>  
CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub> = QA\_OVERRIDE<sub>2</sub>  
CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub> = QA\_OVERRIDE<sub>3</sub>

- 2.0 The M50 to UVW transformation is computed using the current navigation filter state as follows:

If the current major mode is 304, 305, 602 or 603, calculate the earth relative velocity required for the computation of the M50 to UVW transformation. Otherwise, the inertial velocity vector is used to compute the M50 to UVW transformation.

IF NAV\_MM\_CODE = 304 or NAV\_MM\_CODE = 305 or  
NAV\_MM\_CODE = 602 or NAV\_MM\_CODE = 603 THEN

$$\bar{V}_{\text{FILT\_TEMP}} = \bar{V}_{\text{REL}}(\bar{V}_{\text{FILT}}, \bar{R}_{\text{FILT}})$$

ELSE

$$\bar{V}_{\text{FILT\_TEMP}} = \bar{V}_{\text{FILT}}$$

Calculate the M50 to UVW transformation using the inertial position vector and the appropriate velocity vector.

$$M_{\text{M50\_TO\_UVW}} = \text{TRANSPPOSE}(\text{UVW\_TO\_M50}(\bar{R}_{\text{FILT}}, \bar{V}_{\text{FILT\_TEMP}}))$$

- 3.0 The GPS state vector QA4 quality assessment calculations are performed as shown in Section 4.3.3.4.3.

The computation of the QA2 tolerance levels to be used in the QA2 check are computed, as shown in Section 4.3.3.4.4. These tolerance levels are I-load derived and apply to all installed receivers.

- 4.0 The following calculations (steps 4.1 through 4.2) are performed for up to three receivers, independent of whether or not they are installed on the vehicle:

DO FOR I = 1 to GPS\_SW\_CAP

- 4.1 Set the flag in the GPS fail array, GPS\_FAIL\_QA<sub>I</sub>, which indicates that the receiver has failed at least one of the following quality assessment checks: FOM; performance relative to the navigation filter state (QA2); relative instrument performance (QA3); comparative performance between each receiver (QA4). The receiver fail QA2 and QA3 flags are set to ON, indicating failure of these quality assessment checks. Also, the individual position and velocity quality assessment fail flags for QA2 and QA3 are set to ON. These flags will be set to OFF when that receiver passes the associated quality assessment checks.

GPS\_FAIL\_QA<sub>I</sub> = ON

GPS\_FAIL\_QA2<sub>I</sub> = ON

GPS\_FAIL\_QA3<sub>I</sub> = ON

GPS\_FAIL\_QA2\_R<sub>I</sub> = ON

GPS\_FAIL\_QA2\_V<sub>I</sub> = ON

GPS\_FAIL\_QA3\_R<sub>I</sub> = ON

GPS\_FAIL\_QA3\_V<sub>I</sub> = ON

- 4.2 For each receiver state valid for selection filter quality assessment, indicated by GPS\_DG\_SF<sub>I</sub> = ON, steps 4.2.1 to 4.2.5 are executed.

- 4.2.1 The GPS state vector quality assessment code, designated QA2 and described in Section 4.3.3.4.1, is executed.

- 4.2.2 If the receiver state was also valid for processing on the previous navigation cycle, indicated by GPS\_DG\_SF\_PREV<sub>I</sub> = ON, the third level GPS state vector quality assessment code, designated QA3, is executed as shown in Section 4.3.3.4.2; otherwise, the QA3 blanking flag, QA3\_BLANKING<sub>I</sub>, is set to the ON state. Note that for the third level GPS state vector quality assessment code to be executed for the I'th receiver, the receiver must have valid states for two consecutive navigation cycles. If this condition does not exist, then that receiver is considered to have failed the QA3 quality assessment.

4.2.3 The quality assessment fail flags for the FOM (or QA1), QA3, and QA4 checks for the I'th receiver are then used to determine the setting of the I'th array element of the fail quality assessment array.. If any of the quality assessment checks indicate an out of tolerance condition, the receiver's state vector is then left in the failed condition. Otherwise, the state is indicated as available for selection filter candidacy.

IF (GPS\_FAIL\_FOM<sub>I</sub> = OFF and  
GPS\_FAIL\_QA3<sub>I</sub> = OFF and GPS\_FAIL\_QA4<sub>I</sub> = OFF ) THEN  
GPS\_FAIL\_QA<sub>I</sub> = OFF

4.2.4. The GPS quality assessment GAX message code, described in Section 4.3.3.4.6, is executed to determine if GAX alarms associated with GPS receiver state vector processing are to be annunciated.

4.2.5 Store the current GPS position, velocity, and gravity acceleration vectors and the state time tag for use on the next navigation cycle:

$\bar{R}_{GPS\_PREV_I} = \bar{R}_{GPS_I}$   
 $\bar{V}_{GPS\_PREV_I} = \bar{V}_{GPS_I}$   
 $\bar{G}_{TWO\_PREV_I} = \bar{G}_{TWO_I}$   
 $T_{GPS\_PREV_I} = T_{GPS_I}$

4.3 Store the receiver data good for the I'th receiver for use on the next navigation cycle:

$GPS\_DG\_SF\_PREV_I = GPS\_DG\_SF_I$

5.0 Calculations are then performed to determine the following: if the GAX quality assessment failure message indicator for the I'th receiver should be set (ON or OFF); if the GAX quality assessment fail indicators and associated GAX quality assessment fail message counters should be reset (to OFF and 1, respectively) due to a crew deselect of that receiver; if the GAX QA4 dilemma indicator and GAX QA4 dilemma message counter for the I'th receiver should be reset (to OFF and 1, respectively) due to a crew deselect of that receiver; and if the GAX dilemma message indicator should be set (ON or OFF).

The GAX quality assessment failure message indicator is receiver specific and indicates that the receiver has failed one or more of the three quality assessment checks (QA1,QA3, QA4) for an I-load minimum number of cycles. The GAX quality assessment failure message indicator will not be set OFF from an ON condition for a given receiver until all of its GAX quality assessment fail indicators are OFF on a given cycle.

The GAX dilemma message indicator indicates that a dilemma condition has been determined by the QA4 quality assessment function for an I-load minimum number of cycles: for all three receivers, at the three receiver level (valid state estimates and no receivers deselected); or for two receivers at the two receiver level (two valid receiver state estimates with neither receiver deselected). The GAX dilemma message indicator will not be set OFF from an ON condition until the GAX QA4 dilemma indicators for all receivers are OFF on a given cycle.

All three GAX quality assessment failure message indicators and the GAX dilemma message indicator will be set OFF if the vehicle altitude is less than or equal to an I-load minimum altitude in major mode 305 or 603. This avoids distracting the crew with an alarm at low altitude.

The steps are as follows.

If the variable denoting that GAX messages are not to be issued, NOOP\_GPS\_GAX\_MSGS, is set to OFF, execute steps 5.1 through 5.3.

If NOOP\_GPS\_GAX\_MSGS = OFF, execute steps 5.1 through 5.3.

5.1 Steps 5.1.1 and 5.1.2 are performed for each receiver up to a maximum of three receivers.

DO FOR I = 1 to GPS\_SW\_CAP  
execute steps 5.1.1 and 5.1.2

5.1.1 If the crew has deselected the I'th receiver, indicated by CREW\_DES\_RCVR\_RCVD<sub>I</sub> = ON, set all of its GAX quality assessment fail indicators to OFF and all GAX quality assessment fail message counters to one. Also set its GAX QA4 dilemma indicator, GPS\_QA4\_DILEMMA\_GAX<sub>I</sub>, to OFF, and set its GAX QA4 dilemma message counter, QA4\_DILEMMA\_GAX\_MSG\_CNT<sub>I</sub>, to 1.

IF CREW\_DES\_RCVR\_RCVD<sub>I</sub> = ON THEN  
GPS\_FAIL\_FOM\_GAX<sub>I</sub> = OFF  
FAIL\_FOM\_GAX\_MSG\_CNT<sub>I</sub> = 1  
GPS\_FAIL\_QA3\_GAX<sub>I</sub> = OFF  
QA3\_FAIL\_GAX\_MSG\_CNT<sub>I</sub> = 1  
GPS\_FAIL\_QA4\_GAX<sub>I</sub> = OFF  
QA4\_FAIL\_GAX\_MSG\_CNT<sub>I</sub> = 1  
GPS\_QA4\_DILEMMA\_GAX<sub>I</sub> = OFF  
QA4\_DILEMMA\_GAX\_MSG\_CNT<sub>I</sub> = 1

Setting the I'th receiver's GAX quality assessment fail indicators and GAX QA4 dilemma indicator to OFF and the associated GAX quality assessment fail message counters and GAX QA4 dilemma message counter to 1, when a crew deselects that receiver, enables the following: resetting of the GAX quality assessment failure message indicator for that receiver if failure conditions persist; resetting of a GAX dilemma message indicator for the remaining non-deselected valid receiver pairs, if a dilemma condition exists; resetting of a GAX dilemma message indicator when the I'th receiver is reselected.

5.1.2 Set the GAX quality assessment failure message indicator for the I'th receiver (GPS\_FAIL\_QA\_GAX<sub>I</sub>) to ON if: the GAX figure of merit fail indicator is ON; or the GAX QA3 fail indicator is ON; or the GAX QA4 fail indicator is ON. The GAX quality assessment failure message indicator is set to OFF when all of the GAX quality assessment fail indicators are set to OFF. The resetting of the GAX quality assessment failure message indicator to OFF permits the GAX quality assessment failure message to be reissued when the receiver goes from no quality assessment failures to a condition of a quality assessment failure as indicated by the GAX quality assessment failure message indicator subsequently being set to ON. The steps are as follows:

GPS\_FAIL\_QA\_GAX<sub>I</sub> = GPS\_FAIL\_FOM\_GAX<sub>I</sub> or  
GPS\_FAIL\_QA3\_GAX<sub>I</sub> or  
GPS\_FAIL\_QA4\_GAX<sub>I</sub>

5.2 The GAX dilemma message indicator (GPS\_DILEMMA\_ANNUN\_GAX) is then set to ON if the GAX QA4 dilemma indicator is ON for any combination of GPS receivers. Otherwise, it is set to OFF when all GAX QA4 dilemma indicators are set to OFF.

GPS\_DILEMMA\_ANNUN\_GAX = GPS\_QA4\_DILEMMA\_GAX<sub>1</sub> or  
GPS\_QA4\_DILEMMA\_GAX<sub>2</sub> or  
GPS\_QA4\_DILEMMA\_GAX<sub>3</sub>

- 5.3 If the major mode is 305 to 603, compare the altitude of the vehicle with the I-load value of the minimum altitude for GPS messages. If the vehicle altitude is less than or equal to this I-load, set the GAX quality assessment failure message indicators for each receiver (GPS\_FAIL\_QA\_GAX<sub>1</sub>, GPS\_FAIL\_QA\_GAX<sub>2</sub>, and GPS\_FAIL\_QA\_GAX<sub>3</sub>) and the GAX dilemma message indicator (GPS\_DILEMMA\_ANNUN\_GAX) to OFF to avoid distracting the crew with an alarm at low altitude.

IF NAV\_MM\_CODE = 305 OR  
NAV\_MM\_CODE = 603 THEN

IF ALT ≤ GPS\_MIN\_ALT\_MSG THEN  
GPS\_FAIL\_QA\_GAX<sub>1</sub> = OFF  
GPS\_FAIL\_QA\_GAX<sub>2</sub> = OFF  
GPS\_FAIL\_QA\_GAX<sub>3</sub> = OFF  
GPS\_DILEMMA\_ANNUN\_GAX = OFF

- 6.0 The GPS display dilemma flags (GPS\_DISP\_DILEMMA) used to interface with GAX (for the SYS SUM 1 display) and the various display (HORIZ SIT, REL NAV, and GPS STATUS) specialist functions shall be set equal to the local (i. e., unfiltered) QA4 dilemma indicator, as follows:

GPS\_DISP\_DILEMMA<sub>1</sub> = GPS\_QA4\_DILEMMA<sub>1</sub>  
GPS\_DISP\_DILEMMA<sub>2</sub> = GPS\_QA4\_DILEMMA<sub>2</sub>  
GPS\_DISP\_DILEMMA<sub>3</sub> = GPS\_QA4\_DILEMMA<sub>3</sub>

#### 4.3.3.4.1 Second Level of GPS Receiver State Quality Assessment, QA2

The Second level quality assessment code, GPS\_SV\_QA2, is accomplished for the I'th receiver by executing the following steps:

- 1.0 Call the GPS\_QA2\_DATA\_COMP subfunction (Section 4.3.3.4.5.) to obtain the following parameters: the magnitude of the position residual, DELR\_MAG<sub>I</sub>, the maximum residual ratio (position or velocity), DELTA\_RATIO\_QA2\_MAX<sub>I</sub>, the maximum position and velocity residual ratios, DELR\_RATIO\_QA2\_MAX<sub>I</sub>, DELV\_RATIO\_QA2\_MAX<sub>I</sub>, the parameter which indicates which residual ratio is the maximum, DELTA\_RATIO\_QA2\_IND<sub>I</sub> the QA2 position and velocity vector residuals, DELR\_GPS\_QA2\_UVW<sub>I</sub>, and DELV\_GPS\_QA2\_UVW<sub>I</sub>, the magnitude of the velocity residual, DELV\_MAG<sub>I</sub>, the status of the maximum position residual ratio, DELR\_RATIO\_QA2\_MAX\_ST<sub>I</sub>, the status of the maximum velocity residual ratio, DELV\_RATIO\_QA2\_MAX\_ST<sub>I</sub>. The status indicators for the maximum position and maximum velocity residual ratios indicate if they are less than or equal to 1 or are greater than one. This subfunction call is accomplished as follows:

```
CALL:      GPS_QA2_DATA_COMP
INLIST:    R_GPSI, V_GPSI
OUTLIST:   DELR_MAGI, DELTA_RATIO_QA2_MAXI,
           DELR_RATIO_QA2_MAXI, DELV_RATIO_QA2_MAXI,
           DELTA_RATIO_QA2_INDI, DELR_GPS_QA2_UVWI,
           DELV_GPS_QA2_UVWI, DELV_MAGI,
           DELR_RATIO_QA2_MAX_STI, DELV_RATIO_QA2_MAX_STI
```

- 2.0 If the maximum GPS-to-filter position residual ratio is less than or equal to one, the flag which indicates that the position residual ratio has failed (GPS\_FAIL\_QA2\_R<sub>I</sub>) is set to OFF. A similar check is made for the GPS-to-filter velocity residual ratio. If the maximum GPS-to-filter velocity residual ratio for that receiver is less than or equal to one, the flag which indicates that the velocity residual ratio has failed (GPS\_FAIL\_QA2\_V<sub>I</sub>) is set to OFF.

```
IF DELR_RATIO_QA2_MAXI ≤ 1, THEN
    GPS_FAIL_QA2_RI = OFF
IF DELV_RATIO_QA2_MAXI ≤ 1, THEN
    GPS_FAIL_QA2_VI = OFF
```

If both the position and velocity QA2 fail indicators are OFF, set the QA2 fail indicator to OFF:

```
IF (GPS_FAIL_QA2_RI = OFF and GPS_FAIL_QA2_VI = OFF) THEN
    GPS_FAIL_QA2I = OFF
```

- 3.0 Set the parameters for displaying the position and velocity residual ratios as follows:

```
DELR_RATIO_QA2_DISPLAYI = DELR_RATIO_QA2_MAXI
DELV_RATIO_QA2_DISPLAYI = DELV_RATIO_QA2_MAXI
```

#### 4.3.3.4.2 Third Level of GPS Receiver State Quality Assessment, QA3

The third level quality assessment code, GPS\_SV\_QA3, is accomplished for the I'th receiver by executing the following steps:

1.0 The QA3 blanking flag is set to OFF.

$$QA3\_BLANKING_1 = OFF$$

2.0 The magnitudes of the position and velocity differences between the I'th receiver's current state and its extrapolated previous state are computed and divided by corresponding premission defined I-LOAD tolerances to form a ratio. If the position ratio is less than or equal to one, the GPS fail QA3 position flag is set to OFF, indicating that the current GPS state vector has not exceeded expected position performance margins. A similar check is made for the velocity ratio. The steps are as follows:

$$DEL R\_RATIO\_QA3\_DISPLAY_1 = \frac{ABVAL(\bar{R}_{GPS_1} - \bar{R}_{GPS\_PREV_1})}{GPS\_QA3\_RTOL}$$
$$DEL V\_RATIO\_QA3\_DISPLAY_1 = \frac{ABVAL(\bar{V}_{GPS_1} - \bar{V}_{GPS\_PREV_1})}{GPS\_QA3\_VTOL}$$

IF DELR\_RATIO\_QA3\_DISPLAY<sub>1</sub> ≤ 1 THEN  
GPS\_FAIL\_QA3\_R<sub>1</sub> = OFF

IF DELV\_RATIO\_QA3\_DISPLAY<sub>1</sub> ≤ 1 THEN  
GPS\_FAIL\_QA3\_V<sub>1</sub> = OFF

If both the position and velocity QA3 fail indicators are OFF, set the QA3 fail indicator to OFF:

$$IF (GPS\_FAIL\_QA3\_R_1 = OFF \text{ and } GPS\_FAIL\_QA3\_V_1 = OFF) \text{ THEN}$$
$$GPS\_FAIL\_QA3_1 = OFF$$

#### 4.3.3.4.3 GPS State Vector Quality Assessment QA4

The fourth level quality assessment code, GPS\_SV\_QA4, is accomplished by executing the following steps:

1.0 A check is made on the numbers of receivers installed (NUM\_GPS\_INSTALLED). If more than one receiver is installed, NUM\_GPS\_INSTALLED > 1, steps 2.0 through 10.0 will be executed. This logic check is as follows:

$$IF \text{ NUM\_GPS\_INSTALLED} > 1 \text{ THEN}$$

execute steps 2.0 through 10.0

2.0 The number of receivers available for the QA4 quality assessment function, NUM\_GPS\_FOR\_QA4, and the number of receivers deselected by the crew, NUM\_GPS\_DES, are set to 0.

$$NUM\_GPS\_FOR\_QA4 = 0$$
$$NUM\_GPS\_DES = 0$$

3.0 The number of receivers available for the QA4 quality assessment function, NUM\_GPS\_FOR\_QA4, and the number of receivers deselected by the crew, NUM\_GPS\_DES, from the installed three receiver set are determined. At least two receivers need to be available to execute the QA4 function.

3.1 Perform the following for each of the three installed receivers. If the receiver has a valid state, indicated by GPS\_DG\_SF<sub>1</sub> = ON, and the receiver has not been deselected by the crew, indicated by CREW\_DES\_RCVR\_RCVD<sub>1</sub> = OFF, then increment the number of receivers available for the QA4 quality assessment function, NUM\_GPS\_FOR\_QA4, by 1. If the receiver has been deselected by the crew, increment the number of receivers deselected, NUM\_GPS\_DES, by 1.



```
DO FOR I = 1 TO GPS_SW_CAP
  IF (GPS_DG_SF1 = ON and CREW_DES_RCVR_RCVD1 = OFF) THEN
    NUM_GPS_FOR_QA4 = NUM_GPS_FOR_QA4 + 1.
```

```
IF CREW_DES_RCVR_RCVD1 = ON THEN
  NUM_GPS_DES = NUM_GPS_DES + 1
```

- 4.0 Set the three elements of the GPS fail QA4 array (GPS\_FAIL\_QA4) to OFF and set the six pairwise compare position and velocity fail flags to OFF.

```
GPS_FAIL_QA4 = (OFF, OFF, OFF)
GPS_FAIL_QA4_R_1_2 = OFF
GPS_FAIL_QA4_V_1_2 = OFF
GPS_FAIL_QA4_R_1_3 = OFF
GPS_FAIL_QA4_V_1_3 = OFF
GPS_FAIL_QA4_R_2_3 = OFF
GPS_FAIL_QA4_V_2_3 = OFF
```

- 5.0 If the number of GPS receivers is available for the QA4 quality assessment, NUM\_GPS\_FOR\_QA4, is less than or equal to one, execute the One Level Dilemma Reset code (Section 4.3.3.4.7), otherwise set the QA4 dilemma flag for each receiver, the dilemma pair flags, and the three level dilemma flag to OFF.

```
IF NUM_GPS_FOR_QA4 ≤ 1 THEN
  execute the One Level Dilemma Rest code in Section 4.3.3.4.7
ELSE
  GPS_QA4_DILEMMA1 = OFF
  GPS_QA4_DILEMMA2 = OFF
  GPS_QA4_DILEMMA3 = OFF

  DILEMMA_1_2 = OFF
  DILEMMA_1_3 = OFF
  DILEMMA_2_3 = OFF
  DILEMMA_1_2_3 = OFF
```

- 6.0 Deleted

- 7.0 If both LRU one and LRU two have valid states, indicated by GPS\_DG\_SF<sub>1</sub> = ON and GPS\_DG\_SF<sub>2</sub> = ON, perform the calculations in steps 7.1 through 7.2.

```
IF GPS_DG_SF1 = ON and
  GPS_DG_SF2 = ON THEN
  execute steps 7.1 through 7.2
```

- 7.1 Compute the associated position and velocity QA4 ratios using the magnitude of the vector position and velocity differences between the LRU states and I-load tolerances:

```
DELR_RATIO_QA4_1_2 = ABVAL( $\bar{R}_{GPS_1} - \bar{R}_{GPS_2}$ ) / GPS_QA4_RTOL
DELV_RATIO_QA4_1_2 = ABVAL( $\bar{V}_{GPS_1} - \bar{V}_{GPS_2}$ ) / GPS_QA4_VTOL
```

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- 7.2 If both LRU 1 and LRU 2 are eligible for participating in QA 4 failure/dilemma detection (as determined by the receivers not being deselected and either a) passing QA 1 or b) having a QA Override active) then the following processing is performed:

If the position QA4 ratio is greater than one, set the appropriate position fail QA4 flag to ON indicating that the LRU pair has failed the QA4 position quality assessment. Perform the same test for the velocity QA4 ratio. These steps are as follows:

IF CREW\_DES\_RCVR\_RCVD<sub>1</sub> = OFF and (GPS\_FAIL\_FOM<sub>1</sub> = OFF or CREW\_QA\_OVERRIDE\_RCVD<sub>1</sub> = ON) and  
CREW\_DES\_RCVR\_RCVD<sub>2</sub> = OFF and (GPS\_FAIL\_FOM<sub>2</sub> = OFF or CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub> = ON) then perform the following:

IF DELR\_RATIO\_QA4\_1\_2 > 1 THEN GPS\_FAIL\_QA4\_R\_1\_2 = ON  
IF DELV\_RATIO\_QA4\_1\_2 > 1 THEN GPS\_FAIL\_QA4\_V\_1\_2 = ON

Continue to step 7.2.1

- 7.2.1 To determine the settings of the GPS LRU fail flags and the dilemma indicators for these LRUs, perform the following logic check: If GPS LRU 3 has an invalid state (GPS\_DG\_SF<sub>3</sub> = OFF) or GPS LRU 3 has been deselected (CREW\_DES\_RCVR\_RCVD<sub>3</sub> = ON), or GPS LRU 3 is failing QA 1 (GPS\_FAIL\_FOM<sub>3</sub> = ON and CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub> = OFF) indicating that the QA4 quality assessment is being done at the two LRU level with LRUs 1 and 2, perform step 7.2.2. This check is as follows:

IF (GPS\_DG\_SF<sub>3</sub> = OFF or  
CREW\_DES\_RCVR\_RCVD<sub>3</sub> = ON, or  
(GPS\_FAIL\_FOM<sub>3</sub> = ON and CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub> = OFF)) THEN  
execute step 7.2.2

- 7.2.2 Check the position and velocity ratio fail flags for LRU 1 and 2 to see if the dilemma flag for these LRUs and the pairwise dilemma flag should be set to ON. At the two level, a dilemma exists if the two LRUs fail either the QA4 position or velocity compare check.

IF (GPS\_FAIL\_QA4\_R\_1\_2 = ON or GPS\_FAIL\_QA4\_V\_1\_2 = ON)  
THEN  
GPS\_QA4\_DILEMMA<sub>1</sub> = ON  
GPS\_QA4\_DILEMMA<sub>2</sub> = ON  
DILEMMA\_1\_2 = ON

- 8.0 If both LRU one and LRU three have valid states, indicated by GPS\_DG\_SF<sub>1</sub> = ON and GPS\_DG\_SF<sub>3</sub> = ON, perform the calculations in steps 8.1 through 8.2.

IF GPS\_DG\_SF<sub>1</sub> = ON and  
GPS\_DG\_SF<sub>3</sub> = ON THEN  
execute steps 8.1 through 8.2

- 8.1 Compute the associated position and velocity QA4 ratios using the magnitude of the vector position and velocity differences between the LRU states and I-load tolerances:

$DEL R\_RATIO\_QA4\_1\_3 = ABVAL(\bar{R}\_GPS_1 - \bar{R}\_GPS_3) / GPS\_QA4\_RTOL$

$$\text{DELV\_RATIO\_QA4\_1\_3} = \text{ABVAL}(\overline{\text{V\_GPS}}_1 - \overline{\text{V\_GPS}}_3) / \text{GPS\_QA4\_VTOL}$$

- 8.2 If both LRU 1 and LRU 3 are eligible for participating in QA 4 failure/dilemma detection (as determined by the receivers not being deselected and either a) passing QA 1 or b) having a QA Override active) then the following checks are performed:

If the position QA4 ratio is greater than one, set the appropriate position fail QA4 flag to ON indicating that the LRU pair has failed the QA4 position quality assessment. Perform the same test for the velocity QA4 ratio. These steps are as follows:

IF CREW\_DES\_RCVR\_RCVD<sub>1</sub> = OFF and (GPS\_FAIL\_FOM<sub>1</sub> = OFF or CREW\_QA\_OVERRIDE\_RCVD<sub>1</sub> = ON) and  
CREW\_DES\_RCVR\_RCVD<sub>3</sub> = OFF and (GPS\_FAIL\_FOM<sub>3</sub> = OFF or CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub> = ON) then perform the following:

IF DELR\_RATIO\_QA4\_1\_3 > 1 THEN GPS\_FAIL\_QA4\_R\_1\_3 = ON  
IF DELV\_RATIO\_QA4\_1\_3 > 1 THEN GPS\_FAIL\_QA4\_V\_1\_3 = ON

Continue to step 8.2.1

- 8.2.1 To determine the settings of the GPS LRU fail flags and the dilemma indicators for these LRUs, perform the following logic check: If GPS LRU 2 has an invalid state (GPS\_DG\_SF<sub>2</sub> = OFF), or GPS LRU 2 has been deselected (CREW\_DES\_RCVR\_RCVD<sub>2</sub> = ON), or GPS\_LRU 2 is failing QA 1 (GPS\_FAIL\_FOM<sub>2</sub> = ON and CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub> = OFF) indicating that the QA4 quality assessment is being done at the two LRU level with LRUs 1 and 3, perform step 8.2.2. This check is as follows:

IF (GPS\_DG\_SF<sub>2</sub> = OFF or  
CREW\_DES\_RCVR\_RCVD<sub>2</sub> = ON, or  
(GPS\_FAIL\_FOM<sub>2</sub> = ON and CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub> = OFF)) THEN  
execute step 8.2.2

- 8.2.2 Check the position and velocity ratio fail flags for LRU 1 and 3 to see if the dilemma flag for these LRUs and the pairwise dilemma flag should be set to ON. At the two level, a dilemma exists if the two LRUs fail either the QA4 position or velocity compare check.

IF (GPS\_FAIL\_QA4\_R\_1\_3 = ON or GPS\_FAIL\_QA4\_V\_1\_3 = ON)  
THEN  
GPS\_QA4\_DILEMMA<sub>1</sub> = ON  
GPS\_QA4\_DILEMMA<sub>3</sub> = ON  
DILEMMA\_1\_3 = ON

- 9.0 If both LRU two and LRU three have valid states, indicated by GPS\_DG\_SF<sub>2</sub> = ON and GPS\_DG\_SF<sub>3</sub> = ON, perform the calculations in steps 9.1 through 9.2.

IF GPS\_DG\_SF<sub>2</sub> = ON and  
GPS\_DG\_SF<sub>3</sub> = ON THEN  
execute steps 9.1 through 9.2

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- 9.1 Compute the associated position and velocity QA4 ratios using the magnitude of the vector position and velocity differences between the LRU states and I-load tolerances:

$$\text{DELR\_RATIO\_QA4\_2\_3} = \text{ABVAL}(\overline{\mathbf{R}}_{\text{GPS}_2} - \overline{\mathbf{R}}_{\text{GPS}_3}) / \text{GPS\_QA4\_RTOL}$$
$$\text{DELV\_RATIO\_QA4\_2\_3} = \text{ABVAL}(\overline{\mathbf{V}}_{\text{GPS}_2} - \overline{\mathbf{V}}_{\text{GPS}_3}) / \text{GPS\_QA4\_VTOL}$$

- 9.2 If both LRU 2 and LRU 3 are eligible for participating in QA 4 failure/dilemma detection (as determined by the receivers not being deselected and either a) passing QA 1 or b) having a QA Override active) then the following checks are performed:

If the position QA4 ratio is greater than one, set the appropriate position fail QA4 flag to ON indicating that the LRU pair has failed the QA4 position quality assessment. Perform the same test for the velocity QA4 ratio. These steps are as follows:

IF  $\text{CREW\_DES\_RCVR\_RCVD}_2 = \text{OFF}$  and ( $\text{GPS\_FAIL\_FOM}_2 = \text{OFF}$  or  $\text{CREW\_QA\_OVERRIDE\_RCVD}_2 = \text{ON}$ ) and  $\text{CREW\_DES\_RCVR\_RCVD}_3 = \text{OFF}$  and ( $\text{GPS\_FAIL\_FOM}_3 = \text{OFF}$  or  $\text{CREW\_QA\_OVERRIDE\_RCVD}_3 = \text{ON}$ ) then perform the following:

IF  $\text{DELR\_RATIO\_QA4\_2\_3} > 1$  THEN  $\text{GPS\_FAIL\_QA4\_R\_2\_3} = \text{ON}$   
IF  $\text{DELV\_RATIO\_QA4\_2\_3} > 1$  THEN  $\text{GPS\_FAIL\_QA4\_V\_2\_3} = \text{ON}$

Continue to step 9.2.1

- 9.2.1 To determine the settings of the GPS LRU fail flags and the dilemma indicators for these LRUs, perform the following logic check: If GPS LRU 1 has an invalid state ( $\text{GPS\_DG\_SF}_1 = \text{OFF}$ ), or has been deselected ( $\text{CREW\_DES\_RCVR\_RCVD}_1 = \text{ON}$ ), or GPS LRU 1 is failing QA 1 ( $\text{GPS\_FAIL\_FOM}_1 = \text{ON}$  and  $\text{CREW\_QA\_OVERRIDE\_RCVD}_1 = \text{OFF}$ ) indicating that the QA4 quality assessment is being done at the two LRU level with LRUs 2 and 3, perform step 9.2.2. This check is as follows:

IF ( $\text{GPS\_DG\_SF}_1 = \text{OFF}$  or  $\text{CREW\_DES\_RCVR\_RCVD}_1 = \text{ON}$ , or ( $\text{GPS\_FAIL\_FOM}_1 = \text{ON}$  and  $\text{CREW\_QA\_OVERRIDE\_RCVD}_1 = \text{OFF}$ )) THEN execute step 9.2.2

- 9.2.2 Check the position and velocity ratio fail flags for LRU 2 and 3 to see if the dilemma flag and the pairwise dilemma flag for these LRUs should be set to ON. At the two level, a dilemma exists if the two LRUs fail either the QA4 position or velocity compare check.

IF ( $\text{GPS\_FAIL\_QA4\_R\_2\_3} = \text{ON}$  or  $\text{GPS\_FAIL\_QA4\_V\_2\_3} = \text{ON}$ ) THEN  
     $\text{GPS\_QA4\_DILEMMA}_2 = \text{ON}$   
     $\text{GPS\_QA4\_DILEMMA}_3 = \text{ON}$   
     $\text{DILEMMA\_2\_3} = \text{ON}$

- 10.0 If the QA4 quality assessment is being executed at the three GPS LRU level,  $\text{NUM\_GPS\_FOR\_QA4} = 3$ , determine the settings of the dilemma and fail flags for each receiver as shown in step 10.1. The logic check is as follows:

IF NUM\_GPS\_FOR\_QA4 = 3  
THEN  
    execute step 10.1

10.1 The three sets of GPS position and velocity QA4 pairwise compare fail flags (one set between each LRU pair) are then used in a logic check to determine if a dilemma exists or if the fail flags for a given receiver should be set to ON. If all three LRUs have failed either a position or velocity pairwise compare relative to the other LRUs, set the QA4 dilemma flags for all three receivers and the three level dilemma flag to ON. Otherwise execute step 10.2 to determine which LRU GPS\_FAIL\_QA4 flags should be set to ON.

Note that dilemma exists at the three level if all three valid candidate LRU states have not passed the QA4 check. A dilemma indicates that all valid LRU states have failed either a position or velocity compare check relative to the other LRUs.

IF (GPS\_FAIL\_QA4\_R\_1\_2 = ON or GPS\_FAIL\_QA4\_V\_1\_2 = ON)  
    and  
    (GPS\_FAIL\_QA4\_R\_1\_3 = ON or GPS\_FAIL\_QA4\_V\_1\_3 = ON)  
    and  
    (GPS\_FAIL\_QA4\_R\_2\_3 = ON or GPS\_FAIL\_QA4\_V\_2\_3 = ON)  
THEN  
    GPS\_QA4\_DILEMMA<sub>1</sub> = ON  
    GPS\_QA4\_DILEMMA<sub>2</sub> = ON  
    GPS\_QA4\_DILEMMA<sub>3</sub> = ON  
    DILEMMA\_1\_2\_3 = ON  
ELSE  
    execute step 10.2

10.2 To determine which GPS\_FAIL\_QA4 flags should be set to ON, the position and velocity pairwise compare fail flags between each receiver and the other two LRUs are checked. If the position or velocity pairwise compare fail flags between each receiver and the other two LRUs is set to ON, the GPS\_FAIL\_QA4 flag for that LRU can be set to ON.

IF (GPS\_FAIL\_QA4\_R\_1\_2 = ON or GPS\_FAIL\_QA4\_V\_1\_2 = ON)  
    and  
    (GPS\_FAIL\_QA4\_R\_1\_3 = ON or GPS\_FAIL\_QA4\_V\_1\_3 = ON)  
THEN  
    GPS\_FAIL\_QA4<sub>1</sub> = ON  
ELSE  
    IF (GPS\_FAIL\_QA4\_R\_1\_2 = ON or GPS\_FAIL\_QA4\_V\_1\_2 = ON)  
        and  
        (GPS\_FAIL\_QA4\_R\_2\_3 = ON or GPS\_FAIL\_QA4\_V\_2\_3 = ON)  
    THEN  
        GPS\_FAIL\_QA4<sub>2</sub> = ON  
    ELSE  
        IF (GPS\_FAIL\_QA4\_R\_1\_3 = ON or  
            GPS\_FAIL\_QA4\_V\_1\_3 = ON)  
            and  
            (GPS\_FAIL\_QA4\_R\_2\_3 = ON or  
            GPS\_FAIL\_QA4\_V\_2\_3 = ON)

THEN  
GPS\_FAIL\_QA4<sub>3</sub> = ON

#### 4.3.3.4.4 Computation of QA2 Tolerance Values

The QA2 UVW tolerances are computed, using pre-mission determined I-loads and the time since the last navigation state was reset with the selected GPS state, as follows.

DT\_QA2 = T\_CURRENT\_FILT - T\_GPS\_LAST\_UPDATE

$$\overline{\text{GPS\_QA2\_RTOL\_UVW}} = \overline{\text{GPS\_QA2\_RTOL\_UVW\_A}} + \frac{\overline{\text{GPS\_QA2\_RTOL\_UVW\_B}}}{\text{DT\_QA2}} + \overline{\text{GPS\_QA2\_RTOL\_UVW\_C}} (\text{DT\_QA2})^2$$

$$\overline{\text{GPS\_QA2\_VTOL\_UVW}} = \overline{\text{GPS\_QA2\_VTOL\_UVW\_A}} + \frac{\overline{\text{GPS\_QA2\_VTOL\_UVW\_B}}}{\text{DT\_QA2}} + \overline{\text{GPS\_QA2\_VTOL\_UVW\_C}} (\text{DT\_QA2})^2$$

If any component of the UVW position and velocity tolerances exceeds its I-Loaded maximum value, that component shall be set equal to its I-Loaded maximum value.

$$\text{GPS\_QA2\_RTOL\_UVW}_1 = \text{MIN} (\text{GPS\_QA2\_RTOL\_UVW}_1, \text{GPS\_QA2\_RTOL\_MAX\_UVW}_1)$$

$$\text{GPS\_QA2\_RTOL\_UVW}_2 = \text{MIN} (\text{GPS\_QA2\_RTOL\_UVW}_2, \text{GPS\_QA2\_RTOL\_MAX\_UVW}_2)$$

$$\text{GPS\_QA2\_RTOL\_UVW}_3 = \text{MIN} (\text{GPS\_QA2\_RTOL\_UVW}_3, \text{GPS\_QA2\_RTOL\_MAX\_UVW}_3)$$

$$\text{GPS\_QA2\_VTOL\_UVW}_1 = \text{MIN} (\text{GPS\_QA2\_VTOL\_UVW}_1, \text{GPS\_QA2\_VTOL\_MAX\_UVW}_1)$$

$$\text{GPS\_QA2\_VTOL\_UVW}_2 = \text{MIN} (\text{GPS\_QA2\_VTOL\_UVW}_2, \text{GPS\_QA2\_VTOL\_MAX\_UVW}_2)$$

$$\text{GPS\_QA2\_VTOL\_UVW}_3 = \text{MIN} (\text{GPS\_QA2\_VTOL\_UVW}_3, \text{GPS\_QA2\_VTOL\_MAX\_UVW}_3)$$

#### 4.3.3.4.5 GPS QA2 Data Computations

This routine computes the residual, residual ratio, and associated parameters between the input state,  $\overline{\mathbf{R}}_{\text{GPS}}$  and  $\overline{\mathbf{V}}_{\text{GPS}}$  and the navigation filter state,  $\overline{\mathbf{R}}_{\text{FILT}}$ ,  $\overline{\mathbf{V}}_{\text{FILT}}$ . The routine outputs the following parameters: the magnitude of the position residual, DELR\_MAG; the maximum residual ratio, position or velocity, DELTA\_RATIO\_MAX; the maximum position and maximum velocity ratio, DELR\_RATIO\_MAX and DELV\_RATIO\_MAX; the indicator which defines the source of the maximum residual ratio, DELTA\_RATIO\_IND; the position and velocity residuals in UVW coordinates,  $\overline{\text{DELR\_GPS\_UVW}}$ , and  $\overline{\text{DELV\_GPS\_UVW}}$ ; the magnitude of the velocity residual, DELV\_MAG<sub>i</sub>; the status of the maximum position residual ratio, DELR\_RATIO\_MAX\_ST<sub>1</sub>; and the status of the maximum velocity residual ratio, DELV\_RATIO\_MAX\_ST<sub>1</sub>. The status is set to DOWN\_ARROW if the ratio is greater than 1.0 and set to BLANK if the ratio is less than or equal to 1.0.

The routine executes as follows:

- 1.0 Form the vector differences (hereafter referred to as GPS-to-filter residuals) between the GPS vector position and velocity and the navigation filter position and velocity.

$$\begin{aligned} \overline{\text{DELR}} &= \overline{\mathbf{R}}_{\text{GPS}} - \overline{\mathbf{R}}_{\text{FILT}} \\ \overline{\text{DELV}} &= \overline{\mathbf{V}}_{\text{GPS}} - \overline{\mathbf{V}}_{\text{FILT}} \end{aligned}$$

2.0 Convert the position and velocity GPS-to-filter residuals into UVW coordinates.

$$\begin{aligned}\overline{\text{DELR\_GPS\_UVW}} &= \text{M\_M50\_TO\_UVW} \overline{\text{DELR}} \\ \overline{\text{DELV\_GPS\_UVW}} &= \text{M\_M50\_TO\_UVW} \overline{\text{DELV}}\end{aligned}$$

3.0 Compute the position and velocity residual ratios by dividing the absolute values of each GPS-to-filter UVW residual components by the corresponding component of the QA2 position and velocity UVW error tolerance vectors. These ratios will be called GPS-to-filter position and velocity residual ratios for convenience:

$$\begin{aligned}\text{DELR\_RATIO}_1 &= |\text{DELR\_GPS\_UVW}_1| / \text{GPS\_QA2\_RTOL\_UVW}_1 \\ \text{DELR\_RATIO}_2 &= |\text{DELR\_GPS\_UVW}_2| / \text{GPS\_QA2\_RTOL\_UVW}_2 \\ \text{DELR\_RATIO}_3 &= |\text{DELR\_GPS\_UVW}_3| / \text{GPS\_QA2\_RTOL\_UVW}_3 \\ \text{DELV\_RATIO}_1 &= |\text{DELV\_GPS\_UVW}_1| / \text{GPS\_QA2\_VTOL\_UVW}_1 \\ \text{DELV\_RATIO}_2 &= |\text{DELV\_GPS\_UVW}_2| / \text{GPS\_QA2\_VTOL\_UVW}_2 \\ \text{DELV\_RATIO}_3 &= |\text{DELV\_GPS\_UVW}_3| / \text{GPS\_QA2\_VTOL\_UVW}_3\end{aligned}$$

4.0 Compute the maximum value of the GPS-to-filter position residual ratio and the maximum value of the velocity residual ratio:

$$\begin{aligned}\text{DELR\_RATIO\_MAX} &= \text{MAXIMUM} (\text{DELR\_RATIO}_1, \\ &\quad \text{DELR\_RATIO}_2, \\ &\quad \text{DELR\_RATIO}_3) \\ \text{DELV\_RATIO\_MAX} &= \text{MAXIMUM} (\text{DELV\_RATIO}_1, \\ &\quad \text{DELV\_RATIO}_2, \\ &\quad \text{DELV\_RATIO}_3)\end{aligned}$$

5.0 Set the individual status indicators for the maximum values or the GPS-to-filter position and velocity residual ratios to a down arrow if the ratios exceed the value of 1.0. If the position or velocity residual ratio value is less than or equal to 1.0, set the appropriate status indicator to blank. This is accomplished as follows:

```
IF DELR_RATIO_MAX > 1
THEN
    DELR_RATIO_MAX_ST = '↓'
ELSE
    DELR_RATIO_MAX_ST = '␣'
```

```
IF DELV_RATIO_MAX > 1
THEN
    DELV_RATIO_MAX_ST = '↓'
ELSE
    DELV_RATIO_MAX_ST = '␣'
```

6.0 Store the largest of the maximum position and velocity residual ratios for output and set the parameter indicating which residual ratio is the largest:

```
IF (DELR_RATIO_MAX > DELV_RATIO_MAX) THEN
    DELTA_RATIO_MAX = DELR_RATIO_MAX
    DELTA_RATIO_IND = P
ELSE
```

$$\begin{aligned} \text{DELTA\_RATIO\_MAX} &= \text{DELV\_RATIO\_MAX} \\ \text{DELTA\_RATIO\_IND} &= V \end{aligned}$$

7.0 Finally, compute the magnitude of the position and velocity residual vector for output:

$$\begin{aligned} \text{DELR\_MAG} &= \text{ABVAL}(\overline{\text{DELR}}) \\ \text{DELV\_MAG} &= \text{ABVAL}(\overline{\text{DELV}}) \end{aligned}$$

#### 4.3.3.4.6 GPS GAX Message Computations

This routine performs the calculations necessary to set the GAX FOM, QA3 and QA4 fail indicators and the QA4 dilemma indicator for the I'th receiver. A GAX message and alarm will be issued to the crew in response to one or more GAX quality assessment failure message indicators being set from an OFF to an ON condition. The GAX message and alarm will sound when a failure of one or more of the quality assessment checks occurs for an I-load specified minimum number of consecutive cycles.

This routine executes as follows:

1.0 Check if parameter NOOP\_GPS\_GAX\_MSGS, indicating that the GAX messages are not to be issued, is set to OFF. (This parameter is set in the navigation OPS initialize functions and is based on the GPS lockout I-load). If the value of NOOP\_GPS\_GAX\_MSGS is set to OFF, execute steps 2.0 through 6.0.

IF NOOP\_GPS\_GAX\_MSGS = OFF THEN  
    execute steps 2.0 through 6.0

2.0 The calculations performed in this step will set the GAX figure of merit fail indicator for the I'th receiver if the figure of merit failure condition has existed for more than an I-load minimum number of cycles. The minimum number of cycles before the indicator is set prevents nuisance alarm conditions.

2.1 If the I'th receiver has not failed the figure of merit check, indicated by GPS\_FAIL\_FOM<sub>I</sub> = OFF, set the GAX figure of merit fail indicator to OFF and set the GAX figure of merit fail message counter to one. Otherwise, execute step 2.2.

IF GPS\_FAIL\_FOM<sub>I</sub> = OFF THEN  
    GPS\_FAIL\_FOM\_GAX<sub>I</sub> = OFF  
    FAIL\_FOM\_GAX\_MSG\_CNT<sub>I</sub> = 1  
ELSE  
    execute step 2.2

2.2 If the GAX figure of merit fail message counter is greater than or equal to the I-load value of the minimum alarm issuance counter, set the GAX figure of merit fail indicator. Otherwise, increment the GAX figure of merit fail message counter.

IF FAIL\_FOM\_GAX\_MSG\_CNT<sub>I</sub> ≥  
    GPS\_FAIL\_FOM\_GAX\_MSG\_CNT\_MIN  
THEN  
    GPS\_FAIL\_FOM\_GAX<sub>I</sub> = ON  
ELSE  
    FAIL\_FOM\_GAX\_MSG\_CNT<sub>I</sub> =  
        FAIL\_FOM\_GAX\_MSG\_CNT<sub>I</sub> + 1



3.0 Deleted

4.0 The calculations performed in this step will set the GAX QA3 fail indicator for the I<sup>th</sup> receiver if the QA3 failure condition has existed for more than an I-load minimum number of cycles. The minimum number of cycles before the indicator is set prevents nuisance alarm conditions.

4.1 If the I<sup>th</sup> receiver has not failed the QA3 check, indicated by  $GPS\_FAIL\_QA3_I = OFF$ , set the GAX QA3 fail indicator to OFF and set the GAX QA3 fail message counter to one. Otherwise, execute step 4.2.

```
IF GPS_FAIL_QA3I = OFF THEN
    GPS_FAIL_QA3_GAXI = OFF
    QA3_FAIL_GAX_MSG_CNTI = 1
ELSE
    execute step 4.2
```

4.2 If the GAX QA3 fail message counter is greater than or equal to the I-load value of the minimum alarm issuance counter, set the GAX QA3 fail indicator. Otherwise, increment the GAX QA3 fail message counter.

```
IF QA3_FAIL_GAX_MSG_CNTI ≥ GPS_QA3_GAX_MSG_CNT_MIN
THEN
    GPS_FAIL_QA3_GAXI = ON
ELSE
    QA3_FAIL_GAX_MSG_CNTI = QA3_FAIL_GAX_MSG_CNTI + 1
```

5.0 The calculations performed in this step will set the GAX QA4 fail indicator of the I<sup>th</sup> receiver if the QA4 failure condition has existed for more than an I-load minimum number of cycles. The minimum number of cycles before the indicator is set prevents nuisance alarm conditions.

5.1 If the I<sup>th</sup> receiver has not failed the QA4 check, indicated by  $GPS\_FAIL\_QA4_I = OFF$ , set the GAX QA4 fail indicator to OFF and set the GAX QA4 fail message counter to one. Otherwise, execute step 5.2.

```
IF GPS_FAIL_QA4I = OFF THEN
    GPS_FAIL_QA4_GAXI = OFF
    QA4_FAIL_GAX_MSG_CNTI = 1
ELSE
    execute step 5.2
```

5.2 If the GAX QA4 fail message counter is greater than or equal to the I-load value of the minimum alarm issuance counter, set the GAX QA4 fail indicator. Otherwise, increment the GAX QA4 fail message counter.

```
IF QA4_FAIL_GAX_MSG_CNTI ≥
    GPS_QA4_GAX_MSG_CNT_MIN
THEN
    GPS_FAIL_QA4_GAXI = ON
ELSE
    QA4_FAIL_GAX_MSG_CNTI =
        QA4_FAIL_GAX_MSG_CNTI + 1
```

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- 6.0 The calculations performed in this step will set the GAX QA4 dilemma indicator for the I'th receiver if the QA4 dilemma condition has existed for more than an I-load minimum number of cycles. The minimum number of cycles before the indicator is set prevents nuisance alarm conditions.
- 6.1 If the I'th receiver does not have a dilemma condition, indicated by  $GPS\_QA4\_DILEMMA_I = OFF$ , set the GAX QA4 dilemma indicator to OFF and set the GAX QA4 dilemma message counter to one. Otherwise, execute step 6.2.

```
IF GPS_QA4_DILEMMA_I = OFF THEN
    GPS_QA4_DILEMMA_GAX_I = OFF
    QA4_DILEMMA_GAX_MSG_CNT_I = 1
ELSE
    execute step 6.2
```

- 6.2 If the GAX QA4 dilemma message counter is greater than or equal to the I-load value of the minimum alarm issuance counter, set the GAX QA4 dilemma indicator. Otherwise, increment the GAX QA4 dilemma message counter.

```
IF QA4_DILEMMA_GAX_MSG_CNT_I ≥
    GPS_QA4_DILEMMA_GAX_MSG_CNT_MIN
THEN
    GPS_QA4_DILEMMA_GAX_I = ON
ELSE
    QA4_DILEMMA_GAX_MSG_CNT_I =
        QA4_DILEMMA_GAX_MSG_CNT_I + 1
```

#### 4.3.3.4.7 One Level Dilemma Reset

This routine enables the crew to resolve an existing QA4 dilemma condition which is prohibiting receiver states from being considered as candidates for selection, either at the three receiver level (three receivers with valid states and no receivers deselected) or at the two receiver level (both receivers with valid state estimates and both not deselected). It also enable the crew to resolve an existing QA4 dilemma condition which cannot be resolved by the software where the dilemma was declared on one cycle and on the next cycle only a single receiver has a valid state. This could be the case if two receivers suddenly had invalid states on a cycle following a three dilemma indication or one receiver suddenly having an invalid state on a cycle following a two dilemma indication.

The existing dilemma condition prohibits the states from those receivers in dilemma from being considered as candidates for state vector selection. The dilemma is resolved by the crew deselecting receivers until only a single receiver remains selected.

At the three receiver level, crew deselection of one of the receivers in dilemma resets the position and velocity dilemma flags for all three receivers. This reduces the number of receivers available for the QA4 assessment on the next cycle to two.

At the two receiver level, crew deselection of one of the receivers in dilemma resets the position and velocity dilemma flags for that receiver and the receiver with which it is in dilemma, indicated by setting of the appropriate dilemma pair flag from the QA4 function.

The routine executes as follows:

- 1.0 If GPS receiver one has been deselected by the crew, indicated by  $CREW\_DES\_RCVR\_RCVD_1 = ON$ , reset the GPS QA4 dilemma flags for those receivers indicated by the setting of the dilemma pair flags.

If the dilemma pair flag for receivers one and two ( $DILEMMA_{1\_2}$ ) is ON, set the dilemma flag for receiver one ( $GPS\_QA4\_DILEMMA_1$ ) and the dilemma flag for receiver two ( $GPS\_QA4\_DILEMMA_2$ ) to OFF.

If the dilemma pair flag for receivers one and three ( $DILEMMA_{1\_3}$ ) is ON, set the dilemma flag for receiver one ( $GPS\_QA4\_DILEMMA_1$ ) and the dilemma flag for receiver three ( $GPS\_QA4\_DILEMMA_3$ ) to OFF.

This step is as follows:

```
IF CREW_DES_RCVR_RCVD1 = ON THEN
  IF DILEMMA1_2 = ON THEN
    GPS_QA4_DILEMMA1 = OFF
    GPS_QA4_DILEMMA2 = OFF
  IF DILEMMA1_3 = ON THEN
    GPS_QA4_DILEMMA1 = OFF
    GPS_QA4_DILEMMA3 = OFF
```

- 2.0 If GPS receiver two has been deselected by the crew, indicated by  $CREW\_DES\_RCVR\_RCVD_2 = ON$ , reset the GPS QA4 dilemma flags for those receivers indicated by the setting of the dilemma pair flags.

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If the dilemma pair flag for receivers one and two (DILEMMA\_1\_2) is ON, set the dilemma flag for receiver one (GPS\_QA4\_DILEMMA<sub>1</sub>) and the dilemma flag for receiver two (GPS\_QA4\_DILEMMA<sub>2</sub>) to OFF.

If the dilemma pair flag for receivers two and three (DILEMMA\_2\_3) is ON, set the dilemma flag for receiver two (GPS\_QA4\_DILEMMA<sub>2</sub>) and the dilemma flag for receiver three (GPS\_QA4\_DILEMMA<sub>3</sub>) to OFF.

This step is as follows:

```
IF CREW_DES_RCVR_RCVD2 = ON THEN
  IF DILEMMA_1_2 = ON THEN
    GPS_QA4_DILEMMA1 = OFF
    GPS_QA4_DILEMMA2 = OFF
  IF DILEMMA_2_3 = ON THEN
    GPS_QA4_DILEMMA2 = OFF
    GPS_QA4_DILEMMA3 = OFF
```

- 3.0 If GPS receiver three has been deselected by the crew, indicated by CREW\_DES\_RCVR\_RCVD<sub>3</sub> = ON, reset the GPS QA4 dilemma flags for those receivers indicated by the setting of the dilemma pair flags.

If the dilemma pair flag for receivers one and three (DILEMMA\_1\_3) is ON, set the dilemma flag for receiver one (GPS\_QA4\_DILEMMA<sub>1</sub>) and the dilemma flag for receiver three (GPS\_QA4\_DILEMMA<sub>3</sub>) to OFF.

If the dilemma pair flag for receivers two and three (DILEMMA\_2\_3) is ON, set the dilemma flag for receiver two (GPS\_QA4\_DILEMMA<sub>2</sub>) and the dilemma flag for receiver three (GPS\_QA4\_DILEMMA<sub>3</sub>) to OFF.

This step is as follows:

```
IF CREW_DES_RCVR_RCVD3 = ON THEN
  IF DILEMMA_1_3 = ON THEN
    GPS_QA4_DILEMMA1 = OFF
    GPS_QA4_DILEMMA3 = OFF
  IF DILEMMA_2_3 = ON THEN
    GPS_QA4_DILEMMA2 = OFF
    GPS_QA4_DILEMMA3 = OFF
```

- 4.0 If the number of GPS receivers deselected is greater than or equal to two and the three level dilemma flag (DILEMMA\_1\_2\_3) is ON, set the dilemma flags for all three receivers to OFF.

This step is as follows:

```
IF NUM_GPS_DES >= 2 and
  DILEMMA_1_2_3 = ON THEN
  GPS_QA4_DILEMMA1 = OFF
  GPS_QA4_DILEMMA2 = OFF
  GPS_QA4_DILEMMA3 = OFF
```

- B. Interface Requirements. Input and output parameters are listed in Tables 4.3.3.4-1 and 4.3.3.4-2.
- C. Processing Requirements. The GPS navigation state quality assessment subfunction shall be performed after the receiver state propagation subfunction and before the state vector selection subfunction.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of detailed flow charts (GPS\_SV\_QUALITY\_ASSESS, GPS\_SV\_QA2, GPS\_SV\_QA3, GPS\_SV\_QA4, ONE\_LEVEL\_DILEMMA\_RESET, COMP\_QA2\_TOL, GPS\_GAX\_MESSAGES\_ANNUN and GPS\_QA\_GAX\_MSGS) may be found in Section 5.2.

The parameter DELTA\_RATIO\_IND has the value of P, indicating ON, or a value of V, indicating OFF. P and V are used in place of ON or OFF for clarity of requirements.

Note that the number of failure passes in Steps 2.2, 3.2, 4.2, 5.2 and 6.2 of Section 4.3.3.4.6 for setting the associated indicator will be equal to the value of the associated message count minimum I-Load. This is accomplished by initializing and then resetting the counters to one, rather than zero.

Table 4.3.3.4-1. GPS State Vector Quality Assessment Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample rate
Data good for GPS state selection of each valid receiver state	GPS_DG_SF <sub>1</sub> **	GPS Nav state prop	D	–	ON/OFF	–	Filter rate
Data good for GPS state selection of each valid receiver state from previous navigation cycle	GPS_DG_SF_PREV <sub>1</sub> **	*	D	–	ON/OFF	–	Filter rate
Flags indicating the FOM failure status for each GPS receiver	GPS_FAIL_FOM <sub>1</sub> **	*	D	–	ON/OFF	–	Filter rate
Maximum I-load values of UVW position tolerances used in computation of QA2 position tolerance	$\overline{\text{GPS\_QA2\_RTOL\_MAX\_UVW}}$	I-load	V	S		ft	Filter rate
Maximum I-load values of UVW velocity tolerances used in computation of QA2 position tolerance	$\overline{\text{GPS\_QA2\_VTOL\_MAX\_UVW}}$	I-load	V	S		ft/sec	Filter rate
I-load used in computation of QA2 position tolerance	$\overline{\text{GPS\_QA2\_RTOL\_UVW\_A}}$	I-load	V	S		ft	Filter rate
I-load used in computation of QA2 position tolerance	$\overline{\text{GPS\_QA2\_RTOL\_UVW\_B}}$	I-load	V	S		ft/sec	Filter rate
I-load used in computation of QA2 position tolerance	$\overline{\text{GPS\_QA2\_RTOL\_UVW\_C}}$	I-load	V	S		ft/sec <sup>2</sup>	Filter rate
I-load used in computation of QA2 velocity tolerance	$\overline{\text{GPS\_QA2\_VTOL\_UVW\_A}}$	I-load	V	S		ft/sec	Filter rate
I-load used in computation of QA2 velocity tolerance	$\overline{\text{GPS\_QA2\_VTOL\_UVW\_B}}$	I-load	V	S		ft/sec <sup>2</sup>	Filter rate

Table 4.3.3.4-1. GPS State Vector Quality Assessment Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample rate
I-load used in computation of QA2 velocity tolerance	$\overline{\text{GPS\_QA2\_VTOL\_UVW\_C}}$	I-load	V	S		ft/sec <sup>3</sup>	Filter rate
QA3 position tolerance	GPS_QA3_RTOL	I-load	F	S		ft	Filter rate
QA3 velocity tolerance	GPS_QA3_VTOL	I-load	F	S		ft/sec	Filter rate
Maximum number of GPS receivers for which the GPS specific software is designed	GPS_SW_CAP	K-load	I	S	3	_	Filter rate
Gravity acceleration vector for each GPS receiver at current time	$\overline{\text{G\_TWO}}_1^{**}$	GPS nav state prop	V	SP		ft/sec <sup>2</sup>	Filter rate
Flag to inhibit GPS GAX messages	NOOP_GPS_GAX_MSGS	*	D	_	ON/OFF	_	Filter rate
Filter current shuttle position in M50	$\overline{\text{R\_FILT}}$	*	V	DP	_	ft	Filter rate
GPS position at previous nav filter time propagated to current nav filter time	$\overline{\text{R\_GPS\_PREV}}_1^{**}$	GPS nav state prop	V	DP		ft	Filter rate
Current GPS position	$\overline{\text{R\_GPS}}_1^{**}$	GPS nav state prop	V	DP	_	ft	Filter rate
Time associated with the current selected navigation filter state	T_CURRENT_FILT	*	F	DP		sec	Filter rate
Time associated with the current GPS receiver state estimates	T_GPS <sub>1</sub> **	GPS nav state prop	F	DP		sec	Filter rate
Time associated with the last resetting of the navigation filter state(s) with the selected GPS state	T_GPS_LAST_UPDATE	*	F	DP		sec	Filter rate

Table 4.3.3.4-1. GPS State Vector Quality Assessment Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample rate
Filter current shuttle velocity in M50	$\bar{V}_{\text{FILT}}$	*	V	S		ft/sec	Filter rate
GPS velocity at previous nav filter time propagated to current nav filter time	$\bar{V}_{\text{GPS\_PREV}_i^{**}}$	GPS nav state prop	V	S		ft/sec	Filter rate
GPS receiver estimated vehicle velocity vector	$\bar{V}_{\text{GPS}_i^{**}}$	GPS nav state prop	V	DP		ft/sec	Filter rate
Crew input Deselect/Select Flags	CREW_DESELECT_ RCVR <sub>i</sub> **	*	D	-	ON/OFF	-	Filter rate
Minimum number of consecutive cycles that a GPS receiver must fail the figure of merit (FOM) quality assessment check before setting the GPS fail FOM GAX flag for that receiver	GPS_FAIL_FOM_ GAX_MSG_CNT_MIN	I-Load	I	S		-	Filter rate
Minimum number of consecutive cycles that a GPS receiver must fail the third quality assessment (QA3) check before setting the GPS fail QA3 GAX flag for that receiver	GPS_QA3_GAX_ MSG_CNT_MIN	I-Load	I	S		-	Filter rate
Minimum number of consecutive cycles that a dilemma condition must exist for a GPS receiver, as a result of the fourth quality assessment (QA4) check, before setting the GPS fail dilemma GAX flag for that receiver	GPS_QA4_DILEMMA_ GAX_MSG_CNT_MIN	I-Load	I	S		-	Filter rate



Table 4.3.3.4-1. GPS State Vector Quality Assessment Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample rate
Minimum number of consecutive cycles that a GPS receiver must fail the fourth quality assessment (QA4) check before setting the GPS fail QA4 GAX flag for that receiver	GPS_QA4_GAX_MSG_CNT_MIN	I-Load	I	S		_	Filter rate
Position tolerance used in checking for pairwise compare QA4 position failure	GPS_QA4_RTOL	I-Load	F	S		ft	Filter rate
Velocity tolerance used in checking for pairwise compare QA4 velocity failure	GPS_QA4_VTOL	I-Load	F	S		ft/sec	Filter rate
Integer (0, 1 or 3) indicating the number of GPS receivers installed on the vehicle	NUM_GPS_INSTALLED	*	I	S		_	Filter rate
Crew command (ON) to enable the GPS state from the I <sup>th</sup> GPS receiver to be a candidate for selection independent of the results of its passing or failing the quality assessment checks, if no dilemma condition exists for that receiver	QA_OVERRIDE <sub>I</sub> **	*	D	_	ON/OFF	_	Filter rate
Snapped major mode code	NAV_MM_CODE	*	I	S		_	Filter rate
Current orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	Filter rate

Table 4.3.3.4-1. GPS State Vector Quality Assessment Input Parameters							
Description	Symbol	Input Source	Type	Prec	Range	Units	Sample rate
I-Load altitude below which GPS GAX messages will not be issued	GPS_MIN_ALT_MSG	I-Load	F	S		ft	Filter rate

\*See principal function input list in Table 4.3.3.8-1.

\*\*I=1,2,3 (1 to GPS\_SW\_CAP)

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
Magnitude of position difference between each GPS state and nav filter state	DEL <sub>R</sub> _MAG <sub>1</sub> **	GPS SV select	F	S	—	ft	Filter rate
Maximum component-wise QA2 GPS position residual ratio for each receiver	DEL <sub>R</sub> _RATIO_QA2_DISPLAY <sub>1</sub> **	*	F	S	—	—	Filter rate
Maximum component-wise QA2 GPS velocity residual ratio for each receiver	DEL <sub>V</sub> _RATIO_QA2_DISPLAY <sub>1</sub> **	*	F	S	—	—	Filter rate
Maximum component-wise GPS QA2 position residual ratio for each receiver	DEL <sub>R</sub> _RATIO_QA2_MAX <sub>1</sub> **	GPS D/L comp, GPS SV select	F	S	—	—	Filter rate
Maximum component-wise GPS QA2 velocity residual ratio for each receiver	DEL <sub>V</sub> _RATIO_QA2_MAX <sub>1</sub> **	GPS D/L comp, GPS SV select	F	S	—	—	Filter rate
GPS QA3 position magnitude residual ratio for each receiver	DEL <sub>R</sub> _RATIO_QA3_DISPLAY <sub>1</sub> **	*, GPS D/L comp	F	S	—	—	Filter rate
GPS QA3 velocity magnitude residual ratio for each receiver	DEL <sub>V</sub> _RATIO_QA3_DISPLAY <sub>1</sub> **	*, GPS D/L comp	F	S	—	—	Filter rate
Maximum component-wise GPS QA2 residual ratio (position or velocity) for each receiver	DELTA_RATIO_QA2_MAX <sub>1</sub> **	GPS SV select	F	S	—	—	Filter rate
Maximum GPS QA2 residual ratio indicator (position or velocity) for each receiver	DELTA_RATIO_QA2_IND <sub>1</sub> **	GPS SV select	Char	—	P, V	—	Filter rate
QA2 position residuals in UVW coordinates for each receiver	DEL <sub>R</sub> _GPS_QA2_UVW <sub>1</sub> **	GPS SV select	V	S	—	ft	Filter rate
QA2 velocity residuals in UVW coordinates for each receiver	DEL <sub>V</sub> _GPS_QA2_UVW <sub>1</sub> **	GPS SV select	V	S	—	ft/sec	Filter rate

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
Difference between time of current nav filter state and time of last GPS update	DT_QA2	GPS D/L comp	F	S		sec	Filter rate
Deselection command for GPS receiver I	CREW_DES_RCVR_RCVD <sub>I</sub> **	GPS SV select, GPS D/L comp, *	D	–	ON/OFF	–	Filter rate
Display flag reflecting crew input to override the quality assessment function for each receiver	CREW_QA_OVERRIDE_RCVD <sub>I</sub> **	GPS SV select, GPS D/L comp, *	D	–	ON/OFF	–	Filter rate
QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the I <sup>th</sup> GPS receiver	DELR_RATIO_QA2_MAX_ST <sub>I</sub> **	GPS SV select	D	–	DOWN_ARROW (1) BLANK (0)	–	Filter rate
QA4 pairwise compare position ratio between GPS receiver 1 and 2	DELR_RATIO_QA4_1_2	GPS D/L comp, *	F	S		–	Filter rate
QA4 pairwise compare position ratio between GPS receivers 1 and 3	DELR_RATIO_QA4_1_3	GPS D/L comp, *	F	S		–	Filter rate
QA4 pairwise compare position ratio between GPS receivers 2 and 3	DELR_RATIO_QA4_2_3	GPS D/L comp, *	F	S		–	Filter rate
QA2 GPS-to-filter velocity vector residual ratio status indicator (down arrow for ratio greater than 1) for the I <sup>th</sup> GPS receiver	DELV_RATIO_QA2_MAX_ST <sub>I</sub> **	GPS SV select	D	–	DOWN_ARROW (1) BLANK (0)	–	Filter rate
Magnitude of the vector difference between the procedure input GPS velocity estimate and the nav filter velocity	DELV_MAG <sub>I</sub> **	GPS SV select	F	S		ft/sec	Filter rate
QA4 pairwise compare velocity ratio between GPS receivers 1 and 2	DELV_RATIO_QA4_1_2	GPS D/L comp, *	F	S		–	Filter rate

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
QA4 pairwise compare velocity ratio between GPS receivers 1 and 3	DELV_RATIO_QA4_1_3	GPS D/L comp, *	F	S		_	Filter rate
QA4 pairwise compare velocity ratio between GPS receivers 2 and 3	DELV_RATIO_QA4_2_3	GPS D/L comp, *	F	S		_	Filter rate
Flag to issue GAX message annunciation indicating a dilemma condition exists for the GPS receivers	GPS_DILEMMA_ANNUN_GAX	*	D	_	ON/OFF	_	Filter rate
Flag to issue the GAX GPS quality assessment failure message for the I'th GPS receiver indicating that the receiver state has failed one or more of the three quality assessment checks	GPS_FAIL_QA_GAX <sub>I</sub> **	*	D	---	ON/OFF	_	Filter rate
Flag indicating (ON) that the I'th GPS receiver has failed the fourth quality assessment check (either the pairwise compare position or velocity vector magnitude differences between eligible receivers exceeds an I-Load tolerance) on the current cycle	GPS_FAIL_QA <sub>I</sub> **	GPS D/L comp	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in position	GPS_FAIL_QA4_R_1_2	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in position	GPS_FAIL_QA4_R_1_3	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in position	GPS_FAIL_QA4_R_2_3	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in velocity	GPS_FAIL_QA4_V_1_2	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in velocity	GPS_FAIL_QA4_V_1_3	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in velocity	GPS_FAIL_QA4_V_2_3	GPS D/L comp, *	D	---	ON/OFF	---	Filter rate
Flag indicating (ON) that a dilemma condition for the I'th GPS receiver exists on the current cycle as a result of the fourth quality assessment check	GPS_QA4_DILEMMA <sub>I</sub> **	GPS D/L comp, GPS SV select	D	---	ON/OFF	---	Filter rate

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
Flag indicating (ON) that a dilemma condition shall be displayed for the I'th GPS receiver as a result of the fourth quality assessment check	GPS_DISP_DILEMMA <sub>I</sub> **	*	D	---	ON/OFF	---	Filter rate
Data good for GPS state selection of each valid receiver state stored for use on the next navigation cycle as previous variable	GPS_DG_SF_PREV <sub>I</sub> **	GPS nav state prop	D	-	ON/OFF	-	Filter rate
Flag indicating at least one quality assessment was failed	GPS_FAIL_QA <sub>I</sub> **	GPS SV select, GPS D/L comp	D	-	ON/OFF	---	
Flag indicating (ON) quality assessment 2 was failed in position for i'th receiver	GPS_FAIL_QA2_R <sub>I</sub> **	GPS D/L comp	D	-	ON/OFF	-	Filter rate
Flag indicating (ON) quality assessment 2 was failed in velocity for i'th receiver	GPS_FAIL_QA2_V <sub>I</sub> **	GPS D/L comp	D	-	ON/OFF	-	Filter rate
Flag indicating (ON) quality assessment 3 was failed in position for i'th receiver	GPS_FAIL_QA3_R <sub>I</sub> **	*, GPS D/L comp	D	-	ON/OFF	-	Filter rate
Flag indicating (ON) quality assessment 3 was failed in velocity for i'th receiver	GPS_FAIL_QA3_V <sub>I</sub> **	*, GPS D/L comp	D	-	ON/OFF	-	Filter rate
QA2 UVW position tolerances used in calculating GPS to nav filter position residual ratio	$\overline{\text{GPS\_QA2\_RTOL\_UVW}}$	GPS D/L comp	V	S		ft	Filter rate
QA2 UVW velocity tolerances used in calculating GPS to nav filter position residual ratio	$\overline{\text{GPS\_QA2\_VTOL\_UVW}}$	GPS D/L comp	V	S		ft/sec	Filter rate

Table 4.3.3.4-2. GPS State Vector Quality Assessment Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample rate
Gravity acceleration vector for each valid receiver state stored for use on the next navigation cycle as previous variable	$\bar{G}_{TWO\_PREV_I}^{**}$	GPS nav state prop	V	S	—	ft/sec <sup>2</sup>	Filter rate
Flag indicating (ON) quality assessment 3 data is to be blanked	QA3_BLANKING <sub>I</sub> **	*	D	—	ON/OFF	—	Filter rate
Position vector for each valid receiver state stored for use on the next navigation cycle as previous variable	$\bar{R}_{GPS\_PREV_I}^{**}$	GPS nav state prop	V	DP	—	ft	Filter rate
Velocity vector for each valid receiver state stored for use on the next navigation cycle as previous variable	$\bar{V}_{GPS\_PREV_I}^{**}$	GPS nav state prop	V	S	—	ft/sec	Filter rate
Time of each valid receiver state stored for use on the next navigation cycle as previous variable	T_GPS_PREV <sub>I</sub> **	GPS nav state prop	F	DP	—	sec	Filter rate

\* See principal function output list in Table 4.3.3.8-2.

\*\* I=1,2,3 (1 to GPS\_SW\_CAP)



#### 4.3.3.5 GPS State Vector Selection

The purpose of the GPS state vector selection subfunction is to produce a single selected GPS state estimate from multiple candidate GPS state estimates, to compute a set of Kalman filter position and velocity covariance matrix diagonals which reflect the accuracy of the selected state, and to activate an alert when no GPS states have been available for state vector selection processing, even though at least one GPS receiver is not deselected or bypassed, for more than an I-load period of time. A figure of merit (FOM) for the selected GPS state, as well as the GPS to filter ratio and GPS to filter state difference magnitude, latitude, longitude and altitude and other relevant parameters are also assigned for output to displays.

Those states from GPS receivers that have not failed the receiver data good check (that is, the states are valid) and have not been deselected by the crew shall be considered in the selection process. Those GPS states that are considered in the selection process will be a candidate for selection if the following conditions are satisfied: no dilemma condition exists for that state; and it has not failed any quality assessment check (Section 4.3.3.4), or the quality assessment process for that receiver state has been manually overridden, or the crew has forced all receiver states to be candidates for selection.

The following selection methods would be utilized if there were more than one candidate state vectors: if three GPS state vectors are candidates for selection, the median value method is employed to select the state whose total pairwise position differences with the other two states are the smallest; when two GPS states are available for selection, the selected state is formed by averaging the components of the candidate states. In the latter case, the Figure of Merit displayed is the largest of those from the two candidate states.

If only one GPS state remains a candidate, that state then becomes the selected state. If no GPS states are available on a given cycle and at least one GPS receiver is not deselected or bypassed, the propagated selected GPS state, if available, becomes the selected state. QA2 type residuals, residual ratio and indicators are computed for display based on the propagated selected GPS state. However, if no GPS states are available and all three GPS receivers are not available (each receiver is either deselected or bypassed), the selected GPS state gets reset to zero and designated as not available.

During all major modes, if the time interval with no selected GPS state available, when at least one GPS receiver is not deselected or bypassed, exceeds a predetermined I-load limit, an alert condition is indicated. The time interval is always displayed. This condition is maintained until a selected GPS state becomes available.

##### A. Detailed Requirements.

1.0 The counter that indicates how many candidate states are available is cleared.

NUM\_GPS\_SEL = 0

2.0 Step 2.1 is performed for each receiver up to a maximum of three receivers:

DO FOR I = 1 to GPS\_SW\_CAP

2.1 The GPS state vector selection control variable for the I'th receiver is set to OFF, the selection indicator for the I'th receiver is set to OFF, and the crew quality assessment status indicator for the I'th receiver is also set to OFF:

SEL\_CMD<sub>I</sub> = OFF  
SEL\_RCVR<sub>I</sub> = OFF  
CREW\_QA\_OVRD\_STATUS\_IND<sub>I</sub> = OFF

For each GPS receiver that has a valid state (GPS\_DG\_SF<sub>I</sub> = ON), that has not been deselected by the crew (CREW\_DES\_RCVR\_RCVD<sub>I</sub> = OFF) and that does not have a dilemma condition (GPS\_QA4\_DILEMMA<sub>I</sub> = OFF) execute step 2.1.1. Otherwise, execute step 2.1.2

IF (GPS\_DG\_SF<sub>I</sub> = ON and  
CREW\_DES\_RCVR\_RCVD<sub>I</sub> = OFF and  
GPS\_QA4\_DILEMMA<sub>I</sub> = OFF) THEN  
execute step 2.1.1  
ELSE  
execute step 2.1.2

2.1.1 Specify that the state from the I'th receiver is a candidate for selection by setting the selection command (SEL\_CMD<sub>I</sub>) ON for that receiver and incrementing the counter of candidate states (NUM\_GPS\_SEL) if the following conditions are satisfied: all receivers have been forced to be candidates for selection (GPS\_AIF\_RCVD = FORCE) by the crew or the quality assessment override (CREW\_QA\_OVERRIDE\_RCVD<sub>I</sub>) for that receiver has been set to ON, or the receiver's state has passed all quality assessment tests (GPS\_FAIL\_QA<sub>I</sub> = OFF). The logic is as follows:

IF (GPS\_AIF\_RCVD = FORCE or  
CREW\_QA\_OVERRIDE\_RCVD<sub>I</sub> = ON or  
GPS\_FAIL\_QA<sub>I</sub> = OFF) THEN  
SEL\_CMD<sub>I</sub> = ON  
NUM\_GPS\_SEL = NUM\_GPS\_SEL+1

2.1.2 If the quality assessment override (CREW\_QA\_OVERRIDE\_RCVD<sub>I</sub>) for that receiver has been set to ON, set the override status indicator for that receiver, (CREW\_QA\_OVRD\_STATUS\_IND<sub>I</sub>) to ON:

IF CREW\_QA\_OVERRIDE\_RCVD<sub>I</sub> = ON THEN  
CREW\_QA\_OVRD\_STATUS\_IND<sub>I</sub> = ON

3.0 If three GPS states are identified as candidates (NUM\_GPS\_SEL = 3), steps 3.1 to 3.3 are performed, otherwise step 3.4 is performed.

3.1 The median value selection method is used to produce the selected GPS position and velocity ( $\bar{R}_{GPS\_SEL}$ ,  $\bar{V}_{GPS\_SEL}$ ) and the mid-value selected receiver indicator (MVS\_RCVR\_SEL). The steps are as follows:

The magnitudes (DIFF<sub>1</sub>, DIFF<sub>2</sub>, and DIFF<sub>3</sub>) of the three pairwise position difference vectors are computed, and the GPS state which is not in the pair forming the largest position difference becomes the selected GPS state.

DIFF<sub>1</sub> = ABVAL( $\bar{R}_{GPS_2} - \bar{R}_{GPS_3}$ )  
DIFF<sub>2</sub> = ABVAL( $\bar{R}_{GPS_1} - \bar{R}_{GPS_3}$ )  
DIFF<sub>3</sub> = ABVAL( $\bar{R}_{GPS_1} - \bar{R}_{GPS_2}$ )  
MID\_ELEM = 1

IF  $DIFF_2 > DIFF_{MID\_ELEM}$  then  $MID\_ELEM = 2$   
IF  $DIFF_3 > DIFF_{MID\_ELEM}$  then  $MID\_ELEM = 3$

$\bar{R}_{GPS\_SEL} = \bar{R}_{GPS_{MID\_ELEM}}$   
 $\bar{V}_{GPS\_SEL} = \bar{V}_{GPS_{MID\_ELEM}}$   
 $MVS\_RCVR\_SEL = MID\_ELEM$

- 3.2 The gravity acceleration consistent with the selected GPS state is buffered for use in providing selected GPS state data for user parameter processing functions:

$$\bar{G}_{GPS\_SEL} = \bar{G}_{TWO_{MVS\_RCVR\_SEL}}$$

- 3.3 The figure of merit ( $FOM_{SV\_SEL}$ ), the maximum GPS-to-filter position residual ( $DELR_{SV\_SEL}$ ), GPS-to-filter residual ratio ( $DELTA\_RATIO_{SV\_SEL}$ ), the GPS-to-filter residual ratio indicator, and the parameter indicating which receiver was selected are set to the appropriate parameters from the selection receiver for display:

$FOM_{SV\_SEL} = FOM_{MVS\_RCVR\_SEL}$   
 $DELR_{SV\_SEL} = (DELR\_MAG_{MVS\_RCVR\_SEL}) NAUTMI\_PER\_FT$   
 $DELTA\_RATIO_{SV\_SEL} = DELTA\_RATIO\_QA2\_MAX_{MVS\_RCVR\_SEL}$   
 $DELTA\_RATIO_{SV\_SEL\_IND} =$   
 $DELTA\_RATIO\_QA2\_IND_{MVS\_RCVR\_SEL}$   
 $SEL\_RCVR_{MVS\_RCVR\_SEL} = ON$

The selected position and velocity QA2 residuals, in UVW coordinates, are set to the selected GPS LRU position and velocity residuals:

$\bar{GPS\_SEL\_DELR\_UVW} = \bar{DELR\_GPS\_QA2\_UVW}_{MVS\_RCVR\_SEL}$   
 $\bar{GPS\_SEL\_DELV\_UVW} = \bar{DELV\_GPS\_QA2\_UVW}_{MVS\_RCVR\_SEL}$

The following parameters are then set to the corresponding parameters for the selected GPS LRU: the selected maximum position residual, the selected position residual ratio, the status parameter for the selected position residual ratio, the selected maximum velocity residual, the selected velocity residual ratio, the status indicator for the selected velocity residual ratio.

$DELR\_GPS\_SEL = DELR\_MAG_{MVS\_RCVR\_SEL}/1000$   
 $DELR\_RATIO\_GPS\_SEL = DELR\_RATIO\_QA2\_MAX_{MVS\_RCVR\_SEL}$   
 $DELV\_GPS\_SEL = DELV\_MAG_{MVS\_RCVR\_SEL}$   
 $DELV\_RATIO\_GPS\_SEL = DELV\_RATIO\_QA2\_MAX_{MVS\_RCVR\_SEL}$   
 $DELR\_RATIO\_GPS\_SEL\_ST =$   
 $DELR\_RATIO\_QA2\_MAX\_ST_{MVS\_RCVR\_SEL}$   
 $DELV\_RATIO\_GPS\_SEL\_ST =$   
 $DELV\_RATIO\_QA2\_MAX\_ST_{MVS\_RCVR\_SEL}$

- 3.4 If three GPS states have not been identified as candidates ( $NUM\_GPS\_SEL \neq 3$ ), in step 3.0 above, steps 3.4.1 through 3.4.3 are performed.

3.4.1 An intermediate array of variables, indicating which receivers have been identified as candidates, is set to the integer of the selection command:

$$\begin{aligned} \text{SEL\_IND}_1 &= \text{INTEGER}(\text{SEL\_CMD}_1) \\ \text{SEL\_IND}_2 &= \text{INTEGER}(\text{SEL\_CMD}_2) \\ \text{SEL\_IND}_3 &= \text{INTEGER}(\text{SEL\_CMD}_3) \end{aligned}$$

3.4.2 If the number of GPS states identified as candidates is greater than 0, ( $\text{NUM\_GPS\_SEL} > 0$ ), then the selected GPS states are formed from the eligible candidates.

If two GPS states are available ( $\text{NUM\_GPS\_SEL} = 2$ ), the position and velocity components of the selected GPS state ( $\bar{R}\_{\text{GPS\_SEL}}$  and  $\bar{V}\_{\text{GPS\_SEL}}$ ) are computed as the average of the corresponding components of the candidate states. A gravity acceleration is also computed as the average of the gravity accelerations consistent with the two GPS states. The selected figure of merit ( $\text{FOM\_SV\_SEL}$ ) is assigned the larger of the values associated from the two candidate states.

If only one GPS state is available ( $\text{NUM\_GPS\_SEL} = 1$ ), the selected GPS state, gravity acceleration and figure of merit are taken from the lone candidate.

The steps are as follows:

$$\begin{aligned} \text{IF\_NUM\_GPS\_SEL} > 0 \quad \text{THEN} \\ \bar{R}\_{\text{GPS\_SEL}} &= (\text{SEL\_IND}_1 \bar{R}\_{\text{GPS}_1} + \text{SEL\_IND}_2 \bar{R}\_{\text{GPS}_2} + \\ &\quad \text{SEL\_IND}_3 \bar{R}\_{\text{GPS}_3}) / \text{NUM\_GPS\_SEL} \\ \bar{V}\_{\text{GPS\_SEL}} &= (\text{SEL\_IND}_1 \bar{V}\_{\text{GPS}_1} + \text{SEL\_IND}_2 \bar{V}\_{\text{GPS}_2} + \\ &\quad \text{SEL\_IND}_3 \bar{V}\_{\text{GPS}_3}) / \text{NUM\_GPS\_SEL} \\ \bar{G}\_{\text{GPS\_SEL}} &= (\text{SEL\_IND}_1 \bar{G}\_{\text{TWO}_1} + \text{SEL\_IND}_2 \bar{G}\_{\text{TWO}_2} + \\ &\quad \text{SEL\_IND}_3 \bar{G}\_{\text{TWO}_3}) / \text{NUM\_GPS\_SEL} \\ \text{FOM\_SV\_SEL} &= \text{MAX} ((\text{SEL\_IND}_1 \text{FOM}_1), (\text{SEL\_IND}_2 \text{FOM}_2), \\ &\quad (\text{SEL\_IND}_3 \text{FOM}_3)) \end{aligned}$$

The array values indicating the selected receivers are set to the corresponding select command array parameters.

$$\begin{aligned} \text{SEL\_RCVR}_1 &= \text{SEL\_CMD}_1 \\ \text{SEL\_RCVR}_2 &= \text{SEL\_CMD}_2 \\ \text{SEL\_RCVR}_3 &= \text{SEL\_CMD}_3 \end{aligned}$$

3.4.3 Display parameters are computed using the selected GPS state from the current navigation cycle, or if none is available, from the previous navigation cycle which has been propagated to current time. The GPS QA2 data computation routine,  $\text{GPS\_QA2\_DATA\_COMP}$ , from Section 4.3.3.4.5 is used.

$$\begin{aligned} \text{IF NUM\_GPS\_SEL} > 0 \quad \text{or} \\ \text{GPS\_SV\_SEL\_AVAIL} = \text{ON} \quad \text{THEN} \\ \\ \text{CALL:} \quad &\text{GPS\_QA2\_DATA\_COMP} \\ \text{INLIST:} \quad &\bar{R}\_{\text{GPS\_SEL}}, \bar{V}\_{\text{GPS\_SEL}} \end{aligned}$$

OUTLIST: DELR\_SV\_SEL, DELTA\_RATIO\_SV\_SEL,  
DELTA\_RATIO\_SEL, DELV\_RATIO\_SEL,  
DELTA\_RATIO\_SV\_SEL\_IND,  
 $\overline{\text{DELR\_GPS\_QA2\_UVW\_SEL}}$ ,  
 $\overline{\text{DELV\_GPS\_QA2\_UVW\_SEL}}$ ,  
DELV\_GPS\_SEL,  
DELTA\_RATIO\_GPS\_SEL\_ST,  
DELTA\_RATIO\_GPS\_SEL\_ST

The selected position and velocity QA2 residuals, in UVW coordinates, are set to the respective values from the GPS\_QA2\_DATA\_COMP subfunction execution.

$$\overline{\text{GPS\_SEL\_DELTA\_UVW}} = \overline{\text{DELTA\_GPS\_QA2\_UVW\_SEL}}$$
$$\overline{\text{GPS\_SEL\_DELV\_UVW}} = \overline{\text{DELV\_GPS\_QA2\_UVW\_SEL}}$$

The position residual magnitude is scaled appropriately and stored for display:

$$\text{DELTA\_GPS\_SEL} = \text{DELTA\_SV\_SEL} / 1000$$
$$\text{DELTA\_SV\_SEL} = \text{DELTA\_SV\_SEL} \text{ NAUTMI\_PER\_FT}$$

The position and velocity residuals corresponding to the selected GPS state are then stored for display:

$$\text{DELTA\_RATIO\_GPS\_SEL} = \text{DELTA\_RATIO\_SEL}$$
$$\text{DELV\_RATIO\_GPS\_SEL} = \text{DELV\_RATIO\_SEL}$$

- 4.0 If a GPS state was selected on the current navigation cycle, the current navigation filter time, T\_CURRENT\_FILT is stored in T\_GPS\_OFF to indicate the time at which a selected state has been made available:

$$\text{IF NUM\_GPS\_SEL} > 0 \text{ THEN}$$
$$\text{T\_GPS\_OFF} = \text{T\_CURRENT\_FILT}$$

If no GPS state has been selected previously (GPS\_SV\_SEL\_AVAIL = OFF), set the flag indicating that a GPS state has been selected and set the initial value of the time tag of the selected state:

$$\text{IF GPS\_SV\_SEL\_AVAIL} = \text{OFF} \text{ THEN}$$
$$\text{GPS\_SV\_SEL\_AVAIL} = \text{ON}$$
$$\text{T\_GPS\_SEL} = \text{T\_CURRENT\_FILT}$$

- 4.1 If there are no GPS states available for selection (NUM\_GPS\_SEL = 0) on the current navigation cycle, perform the following check. If all three GPS receivers are not available (either deselected (CREW\_DES\_RCVR\_RCVD<sub>i</sub> = ON) or bypassed (GPS\_BYPASS<sub>i</sub> = ON)), set the selected GPS state available flag (GPS\_SV\_SEL\_AVAIL) to OFF, set T\_GPS\_OFF to the current navigation filter time, and reset the selected GPS state ( $\overline{\text{R\_GPS\_SEL}}$  and  $\overline{\text{V\_GPS\_SEL}}$ ) to zero.

$$\text{ELSE}$$
$$\text{IF } ((\text{CREW\_DES\_RCVR\_RCVD}_1 = \text{ON} \text{ or } \text{GPS\_BYPASS}_1 = \text{ON})$$
$$\text{and}$$
$$(\text{CREW\_DES\_RCVR\_RCVD}_2 = \text{ON} \text{ or } \text{GPS\_BYPASS}_2 = \text{ON})$$
$$\text{and}$$
$$(\text{CREW\_DES\_RCVR\_RCVD}_3 = \text{ON} \text{ or } \text{GPS\_BYPASS}_3 = \text{ON}))$$

```
THEN
  GPS_SV_SEL_AVAIL = OFF
  T_GPS_OFF = T_CURRENT_FILT
  R_GPS_SEL = VECTOR (0, 0, 0)
  V_GPS_SEL = VECTOR (0, 0, 0)
```

5.0 The time interval over which no GPS state has been a candidate for selection is computed as follows:

```
DT_GPS_OFF = T_CURRENT_FILT - T_GPS_OFF
DT_GPS_OFF_MIN = DT_GPS_OFF/60
```

6.0 Perform steps 6.1 to 6.3 to determine if the GPS off alert is to be set and if a GAX message is to be issued, alerting the crew that a GPS state has not been selected by the GPS receiver state processing principal function for the I-load period of time.

Also, set the appropriate parameters to enable a GPS off alert reminder message to be issued if necessary to remind the crew that a GPS state has not been selected for the I-Load specified period of time. The reminder message will be issued (see step 6.3.2) at an I-Load determined rate until a GPS state is selected following issuance of the initial GPS off alert message.

6.1 If the time interval over which no GPS state has been a candidate for selection, DT\_GPS\_OFF, is less than the pre-mission determined I-Load, set the GPS off alert indicator, GPS\_OFF\_ALERT, to OFF, set the GPS off alert GAX message indicator, GPS\_OFF\_ALERT\_GAX, to OFF, and set the GAX off alert reminder flag, GAX\_OFF\_ALERT\_RMNDR\_FLAG, to OFF, otherwise execute steps 6.2 through 6.3.

```
IF DT_GPS_OFF < GPS_ALERT_DT THEN
  GPS_OFF_ALERT = OFF
  GPS_OFF_ALERT_GAX = OFF
  GAX_OFF_ALERT_RMNDR_FLAG = OFF
ELSE
  execute steps 6.2 through 6.3
```

6.2 Since the time interval over which no GPS state has been a candidate for selection, DT\_GPS\_OFF, is greater than or equal to the pre-mission determined I-Load, set the GPS off alert indicator, GPS\_OFF\_ALERT, to ON.

```
GPS_OFF_ALERT = ON
```

6.3 If the NOOP GPS GAX message flag, NOOP\_GPS\_GAX\_MSGS, is set to OFF, set the GPS off alert GAX message indicator, GPS\_OFF\_ALERT\_GAX, to ON and perform steps 6.3.1 and 6.3.2.

```
GPS_OFF_ALERT_GAX = ON
```

6.3.1 If the GAX off alert reminder flag, GAX\_OFF\_ALERT\_RMNDR\_FLAG, is set to OFF, set the flag to ON and store the time the off alert was issued in the parameter TIME\_OFF\_ALERT\_ISSUED.

```
IF GAX_OFF_ALERT_RMNDR_FLAG = OFF THEN
  GAX_OFF_ALERT_RMNDR_FLAG = ON
  TIME_OFF_ALERT_ISSUED = T_CURRENT_FILT
```

- 6.3.2 If the GAX off alert reminder flag, GAX\_OFF\_ALERT\_RMNDR\_FLAG, is ON and the time since the GAX off alert message was issued is greater than the I-Load reminder time interval, GPS\_GAX\_OFF\_ALERT\_RMNDR\_DT, set the GPS off alert GAX message indicator to OFF and the GAX off alert reminder flag to OFF.

```
IF GAX_OFF_ALERT_RMNDR_FLAG = ON and
(T_CURRENT_FILT - TIME_OFF_ALERT_ISSUED) >
GPS_GAX_OFF_ALERT_RMNDR_DT THEN
    GPS_OFF_ALERT_GAX = OFF
    GAX_OFF_ALERT_RMNDR_FLAG = OFF
```

Note that if the condition that no GPS state has been selected for more than the I-Load specified time still exists on the next navigation cycle, the setting of the GAX off alert message indicator to OFF on this cycle will enable the software function that issues the GAX message to see the message indicator go from an OFF to an ON state, at which point the GAX off alert message will be reissued. The reminder flag and the time stored for issuing the next reminder message will then be reset on that navigation cycle.

- 7.0 This step deleted.

- 8.0 The figure of merit and the fail figure of merit from each receiver, which are consistent with the GPS receiver states being processed, are buffered as follows:

```
FOM_NAV1 = FOM1
FOM_NAV2 = FOM2
FOM_NAV3 = FOM3
```

```
GPS_FAIL_FOM_DISP1 = GPS_FAIL_FOM1
GPS_FAIL_FOM_DISP2 = GPS_FAIL_FOM2
GPS_FAIL_FOM_DISP3 = GPS_FAIL_FOM3
```

- 9.0 If a selected GPS state is available, indicated by GPS\_SV\_SEL\_AVAIL = ON, perform the calculations in Steps 9.1 through 9.6

- 9.1 If the selected maximum QA2 residual ratio is less than or equal to one execute step 9.1.1. Otherwise, if the selected maximum QA2 residual ratio is greater than 1 execute step 9.1.2

```
IF DELTA_RATIO_SV_SEL ≤ 1 THEN
    execute step 9.1.1
ELSE
    execute step 9.1.2
```

- 9.1.1 Set the parameter which indicates the status of the QA2 residual to blank and set the GPS ratio flag to OFF.

```
DELTA_RATIO_SV_SEL_STAT = 'Ø'
GPS_RATIO_FLAG = OFF
```

If the GPS to Nav command is not Inhibit, reset the GPS nav edit GAX flag to OFF and reset the GPS edit counter to one.

```
If GPS_TO_NAV_AIF ≠ INHIBIT THEN
    GPS_NAV_EDIT_GAX = OFF
    N_RATIOS_ABOVE_LIMIT = 1
```

- 9.1.2 Set the parameter which indicates the status of the QA2 residual to down arrow and set the GPS ratio flag to ON.

```
DELTA_RATIO_SV_SEL_STAT = “↓”
GPS_RATIO_FLAG = ON
```

- 9.2 If a GPS state was selected on this navigation cycle ( $NUM\_GPS\_SEL > 0$ ) and it was selected by the crew overriding the residual edit checks for at least one of the receiver states involved in the selection process ( $SEL\_RCVR_1 = ON$ ), indicated by the QA override for that receiver ( $CREW\_QA\_OVERRIDE\_RCVD_1$ ) being set to ON, then the residual ratio status parameter ( $DELTA\_RATIO\_SV\_SEL\_STAT$ ) is set to an up arrow and the position and velocity residual ratio status parameters ( $DELR\_RATIO\_GPS\_SEL\_ST$ , and  $DELV\_RATIO\_GPS\_SEL\_ST$ , respectively) are set to an up arrow:

```
IF NUM_GPS_SEL > 0 and
    ((SEL_RCVR1 = ON and
    CREW_QA_OVERRIDE_RCVD1 = ON) or
    (SEL_RCVR2 = ON and
    CREW_QA_OVERRIDE_RCVD2 = ON) or
    (SEL_RCVR3 = ON and
    CREW_QA_OVERRIDE_RCVD3 = ON)) THEN
    DELTA_RATIO_SV_SEL_STAT = ‘↑’

    DELR_RATIO_GPS_SEL_ST = ‘↑’
    DELV_RATIO_GPS_SEL_ST = ‘↑’
```

The parameter  $DELTA\_RATIO\_SV\_SEL\_STAT$  is used by the Horizontal Situation Display when only one GPS receiver (LRU2) is installed on the vehicle. The parameters  $DELR\_RATIO\_GPS\_SEL\_ST$  and  $DELV\_RATIO\_GPS\_SEL\_ST$  are used when three GPS receivers are installed on the vehicle.

- 9.3 The geodetic latitude, longitude and altitude of the selected GPS state are computed for display:

```
CALL EF_TO_GEODETTIC:
INLIST: (TRANSPPOSE (EARTH_FIXED_TO_M50_COORD (T_GPS_SEL))
        R_GPS_SEL)
OUTLIST: GPS_SEL_LAT, GPS_SEL_LON, GPS_SEL_ALT
```

- 9.4 Set the display indicators for latitude and longitude.

```
IF (GPS_SEL_LAT ≥ 0) THEN
    GPS_SEL_LAT_IND = ‘N’
```



```
ELSE  
    GPS_SEL_LAT_IND = 'S'  
  
IF (GPS_SEL_LON ≥ 0) THEN  
    GPS_SEL_LON_IND = 'E'  
ELSE  
    GPS_SEL_LON_IND = 'W'
```

Convert the latitude and longitude of the selected GPS state from radians to degrees. Store the absolute values of these parameters in the appropriate display variables.

```
GPS_SEL_LAT = GPS_SEL_LAT DEG_PER_RAD  
GPS_SEL_LON = GPS_SEL_LON DEG_PER_RAD  
  
GPS_SEL_LAT_DISP = ABS(GPS_SEL_LAT)  
GPS_SEL_LON_DISP = ABS(GPS_SEL_LON)
```

- 9.5 The altitude of the selected state is then converted to nautical miles or kilo feet for display. The units conversion is dependent on major mode as follows:

```
IF NAV_MM_CODE = 602 or  
    NAV_MM_CODE = 603 or  
    NAV_MM_CODE = 304 or  
    NAV_MM_CODE = 305 THEN  
    GPS_SEL_ALT_DISP = GPS_SEL_ALT/1000  
ELSE  
    GPS_SEL_ALT_DISP = GPS_SEL_ALT NAUTMI_PER_FT
```

- 9.6 If a GPS state has been selected on this navigation cycle, compute the position and velocity covariance matrix diagonal elements which reflect the accuracy of the selected GPS state, and set the covariance matrix correlation coefficients as follows:

```
IF NUM_GPS_SEL > 0 THEN
```

Determine the figure of merit scale factors from the I-load figure of merit scale factor table and the figure of merit of the selected GPS state:

```
FOM_POS_SF = FOM_COV_SF_TABLE1, FOM_SV_SEL  
FOM_VEL_SF = FOM_COV_SF_TABLE2, FOM_SV_SEL
```

Compute the position and velocity covariance matrix diagonal elements, using the I-load GPS covariance diagonal elements, and the position and velocity figure of merit scale factors as follows:

```
SIG_DIAG_GPS1 to 3 = FOM_POS_SF SIG_DIAG_GPS_NOM1 Tto 3  
SIG_DIAG_GPS4 to 6 = FOM_VEL_SF SIG_DIAG_GPS_NOM4 to 6
```

Set the reset covariance matrix correlation coefficients to the I-load values as follows:

```
CORR_COEFF_GPS = CORR_COEFF_GPS_NOM
```

10.0 The following calculations are performed to determine if a GPS navigation edit message and/or a GPS off alert message are to be issued to the crew.

The GPS navigation edit message will be issued by the GAX software in response to either of two GAX message indicators: GPS\_NAV\_EDIT\_ALT\_GAX, if no GPS state has been selected for an I-Load specified amount of time, indicated by GPS\_OFF\_ALERT set to ON (see step 6.0) on the first pass that the vehicle altitude (ALT) is below an I-Load minimum altitude (GPS\_SV\_SEL\_ALT\_LIMIT); or GPS\_NAV\_EDIT\_GAX, set if the maximum residual ratio (position or velocity) is greater than 1.0 (GPS\_RATIO\_FLAG set to ON) and the GPS to Nav command is set to Auto for an I-Load determined number of cycles. However, GPS\_NAV\_EDIT\_GAX will be set OFF and no GPS navigation edit message will be issued by the GAX software if the vehicle altitude is at or below another I-Load minimum altitude (GPS\_MIN\_ALT\_MSG) in major mode 305 or 603 to avoid distracting the crew with an alarm at low altitude.

GPS\_OFF\_ALERT\_GAX will be set OFF and no GPS off alert message will be issued by the GAX software if the vehicle altitude is at or below an I-Load minimum altitude (GPS\_MIN\_ALT\_MSG) in major mode 305 or 603 to avoid distracting the crew with an alarm at low altitude.

If the NOOP GPS GAX message flag, NOOP\_GPS\_GAX\_MSGS, is set to OFF, execute steps 10.1 through 10.3.

If the NOOP\_GPS\_GAX\_MSGS = OFF, execute steps 10.1 through 10.3.

10.1 If the maximum residual ratio is greater than one (GPS\_RATIO\_FLAG = ON) and the GPS to Nav command is Auto, then check for the number of consecutive cycles, N\_RATIOS\_ABOVE\_LIMIT, that these two conditions are true.

IF GPS\_RATIO\_FLAG = ON and  
GPS\_TO\_NAV\_AIF = AUTO THEN

If N\_RATIOS\_ABOVE\_LIMIT is greater than or equal to an I-load minimum number of cycles, N\_RATIOS\_ABOVE\_LIMIT\_MIN, set the GPS nav edit GAX flag to ON.  
Otherwise, increment N\_RATIOS\_ABOVE\_LIMIT by one.

IF N\_RATIOS\_ABOVE\_LIMIT  $\geq$  N\_RATIOS\_ABOVE\_LIMIT\_MIN THEN  
GPS\_NAV\_EDIT\_GAX = ON  
ELSE  
N\_RATIOS\_ABOVE\_LIMIT = N\_RATIOS\_ABOVE\_LIMIT + 1

10.2 If the major mode is 304, 305, 602 or 603, compare the altitude of the vehicle with the I-Load value of the GPS state vector selection altitude. If the vehicle altitude is less than this I-Load, and if this is the first pass that the vehicle altitude is below this I-Load, then set the first pass indicator for the GPS state vector selection altitude check to OFF and check to see if a GPS off alert condition exists. If a GPS off alert condition exists, set the GPS navigation edit altitude GAX message indicator to ON.

IF NAV\_MM\_CODE = 304 or  
NAV\_MM\_CODE = 305 or

```
NAV_MM_CODE = 602 or  
NAV_MM_CODE = 603 THEN
```

```
IF (ALT < GPS_SV_SEL_ALT_LIMIT) and  
(GPS_SV_SEL_ALT_LIM_FP = ON) THEN
```

```
GPS_SV_SEL_ALT_LIM_FP = OFF
```

```
IF GPS_OFF_ALERT = ON THEN  
GPS_NAV_EDIT_ALT_GAX = ON
```

10.3 If the major mode is 305 or 603, compare the altitude of the vehicle with the I-Load value of the minimum altitude for GPS messages. If the vehicle altitude is less than or equal to this I-Load, set the GPS navigation edit GAX message indicator and the GPS off alert GAX message indicator to OFF to avoid distracting the crew with an alarm at low altitude.

```
IF NAV_MM_CODE = 305 or  
NAV_MM_CODE = 603 THEN
```

```
IF ALT ≤ GPS_MIN_ALT_MSG THEN  
GPS_NAV_EDIT_GAX = OFF  
GPS_OFF_ALERT_GAX = OFF
```

B. Interface Requirements. Input and output parameters are listed in Tables 4.3.3.5-1 and 4.3.3.5-2.

C. Processing Requirements. This subfunction executes after the State Vector Quality Assessment subfunction.

D. Constraints. None.

E. Supplementary Information. The previous selected GPS state, propagated to current time by GPS\_NAV\_STATE\_PROP, becomes the selected state when no GPS candidate states are available on the current cycle.

A suggested implementation in the form of detailed flow charts (GPS\_SV\_SELECT, GPS\_MVS GPS\_NAV\_EDIT\_MSG) may be found in Section 5.2.

Note that the number of failure passes in step 10.1 for setting the associated indicators will be equal to the value of the associated I-Load. This is accomplished by initializing and then resetting the counters to one, rather than zero.

Table 4.3.3.5-1. GPS State Vector Selection Input Parameters

Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S		deg/rad	Filter rate
Magnitude of position difference between each GPS state and NAV filter state	DELR_MAG <sub>1</sub> **	GPS SV quality assess	F	SP	_	ft	Filter rate
Maximum component-wise GPS position residual ratio for each receiver	DELR_RATIO_QA2_MAX <sub>1</sub> **	GPS SV quality assess	F	S			Filter rate
Maximum GPS residual ratio indicator (position or velocity) for each receiver	DELTA_RATIO_QA2_IND <sub>1</sub> **	GPS SV quality assess	Char	_	P,V	_	Filter rate
QA2 position residuals in UVW coordinates for each receiver	$\overline{\text{DELR\_GPS\_QA2\_UVW}}_1^{**}$	GPS SV quality assess	V	S		ft	Filter rate
QA2 velocity residuals in UVW coordinates for each receiver	$\overline{\text{DELV\_GPS\_QA2\_UVW}}_1^{**}$	GPS SV quality assess	V	S		ft/sec	Filter rate
Vector (7) of Nominal values of the covariance matrix correlation coefficients to be used for reinitializing the navigation Kalman filter covariance at a GPS reset of the navigation filter state	CORR_COEFF_GPS_NOM	I-load	F Vector	_		_	Filter rate
Snapped GPS receiver figures of merit	FOM <sub>1</sub> **	*	I	S	_	_	Filter rate
Received GPS AUTO/INHIBIT/FORCE flag	GPS_AIF_RCVD	*	I	S	0(AUTO) 1(INHIBIT) 2(FORCE)	_	Filter rate

Table 4.3.3.5-1. GPS State Vector Selection Input Parameters

Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
Time interval without selecting a GPS state before a warning is issued to the crew	GPS_ALERT_DT	I-load	F	SP		_	Filter rate
Data good for GPS state selection of each valid receiver state	GPS_DG_SF <sub>I</sub> **	GPS NAV State Prop	D	_	ON/OFF	_	Filter rate
Flag indicating quality assessments have been passed	GPS_FAIL_QA <sub>I</sub> **	GPS SV quality assess	D	_	ON/OFF	_	Filter rate
Snapped FOM failure status of each GPS receiver	GPS_FAIL_FOM <sub>I</sub> **	*	D	_	ON/OFF	_	Filter rate
Current mode of each GPS receiver	GPS_MODE_RCVD <sub>I</sub> **	*	D	_		_	Filter rate
Maximum number of GPS receivers for which the GPS specific software is designed	GPS_SW_CAP	K-load	I	S	3	_	Filter rate
Flag indicating that a selected GPS state is available for resetting the navigation state and the user parameter state	GPS_SV_SEL_AVAIL	*	D		ON/OFF	_	Filter rate
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nm/ft	Filter rate
Flag to inhibit GPS GAX messages	NOOP_GPS_GAX_MSGS	*	D	_	ON/OFF	_	Filter rate
GPS position at current NAV filter time	R_GPS <sub>I</sub> **	GPS NAV State Prop	V	DP		ft	Filter rate

Table 4.3.3.5-1. GPS State Vector Selection Input Parameters

Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
Selected GPS position vector	$\bar{R}_{GPS\_SEL}$	GPS NAV State Prop	V	DP		ft	Filter rate
Time stamp of most recent GPS state vector selection	T_GPS_OFF	*	F	DP		sec	Filter rate
Diagonal values of the filter covariance matrix used for resetting the NAV principal function Kalman filter covariance at a GPS state reset	SIG_DIAG_GPS_NOM	I-Load	F	SP Vector (6)		ft, ft/sec	Filter rate
Current filter state time tag	T_CURRENT_FILT	*	F	DP		sec	Filter rate
Selected GPS state time tag	T_GPS_SEL	GPS NAV State Prop	F	DP		sec	Filter rate
GPS receiver estimated vehicle velocity vector	$\bar{V}_{GPS1}^{**}$	GPS NAV State Prop	V	DP		ft/sec	Filter rate
Selected GPS velocity vector	$\bar{V}_{GPS\_SEL}$	GPS NAV State Prop	V	DP		ft/sec	Filter rate
Current orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	Filter rate
Deselction command for GPS receiver	CREW_DES_RCVR_RCVD <sub>1</sub> **	GPS SV quality assess	D	_	ON/OFF	_	Filter rate

Table 4.3.3.5-1. GPS State Vector Selection Input Parameters

Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
Display flag reflecting crew input to override the quality assessment function for each receiver	CREW_QA_OVERRIDE_RCVD <sub>I</sub> **	GPS SV quality assess	D	–	ON/OFF	–	Filter rate
QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the I <sup>th</sup> GPS receiver	DELR_RATIO_QA2_MAX_ST <sub>I</sub> **	GPS SV quality assess	D	–	DOWN_ARROW (I) BLANK (0)	–	Filter rate
Maximum GPS QA2 residual ratio (position or velocity) for the I <sup>th</sup> receiver	DELTA_RATIO_QA2_MAX <sub>I</sub> **	GPS SV quality assess	F	S		–	Filter rate
Magnitude of the vector difference between the GPS velocity estimate from the I <sup>th</sup> GPS receiver and the NAV filter velocity	DELV_MAG <sub>I</sub> **	GPS SV quality assess	F	S		ft/sec	Filter rate
Maximum GPS QA2 velocity residual ratio for the I <sup>th</sup> receiver	DELV_RATIO_QA2_MAX <sub>I</sub> **	GPS SV quality assess	F	S		–	Filter rate
QA2 GPS-to-filter velocity residual ratio status (down arrow for ratio greater than 1) for the I <sup>th</sup> GPS receiver for display	DELV_RATIO_QA2_MAX_ST <sub>I</sub> **	GPS SV quality assess	D	–	DOWN_ARROW (1) BLANK (0)	–	Filter rate
Flag indicating (ON) GPS receiver I is to be bypassed	GPS_BYPASS <sub>I</sub> **	*	D	–	ON/OFF	–	Filter rate

Table 4.3.3.5-1. GPS State Vector Selection Input Parameters

Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
I-Load period of time after the issuance of a GAX OFF ALERT message at which the GAX OFF ALERT message will be returned if the GAX OFF ALERT condition still exists at that time.	GPS_GAX_OFF_ALERT_RMNDR_DT	I-Load	F	S		sec	Filter rate
Flag indicating (ON) that a dilemma condition exists for the I'th GPS receiver as a result of the fourth quality assessment check for an I-Load number of consecutive cycles	GPS_QA4_DILEMMA <sub>I</sub> **	GPS SV quality assess	D	_	ON/OFF	_	Filter rate
I-Load altitude below which the GAX GPS NAV edit message will be issued. If the vehicle altitude goes below this altitude with either no GPS state selected or GPS off alert condition existing	GPS_SV_SEL_ALT_LIMIT	I-Load	F	S		ft	Filter rate
Minimum number of consecutive cycles that the maximum QA2 residual ratio (either position or velocity) for the selected GPS state is greater than 1.0 before setting the GPS NAV edit GAX flag	N_RATIOS_ABOVE_LIMIT_MIN	I-Load	I	S		_	Filter rate



Table 4.3.3.5-1. GPS State Vector Selection Input Parameters							
Description	Symbol	Input source	Type	Prec	Range	Units	Sample Rate
Snapped major mode code	NAV_MM_CODE	*	I	S		-	Filter rate
I-Loaded altitude below which GPS GAX messages will not be issued	GPS_MIN_ALT_MSG	I-Load	F	S		ft	Filter rate
GPS Auto/Inhibit/Force command for GPS incorporation into navigation, formed from GPS_TO_NAV_AI and GPS_TO_NAV_FORCE commands	GPS_TO_NAV_AIF	*	I	S	(0)Auto, (1)Inhibit, (2)Force	-	Filter rate
Table which is used to scale the I-Load NAV filter reset position and velocity covariance values to reflect accuracy of the selected GPS state	FOM_COV_SF_TABLE	I-load	F Matrix (2,9)	S		-	Filter rate

\* See principal function input list in Table 4.3.3.8-1.

\*\* I = 1,2,3 (1 to GPS\_SW\_CAP)

Table 4.3.3.5-2. GPS State Vector Selection Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Covariance matrix correlation coefficients for reinitializing the NAV filter covariance matrix at a GPS state reset	CORR_COEFF_GPS	*	F vector (7)	S		—	Filter rate
Crew GPS receiver quality assessment override status indicator	CREW_QA_OVRD_STATUS_IND <sub>i</sub> **	*	D	—	ON/OFF	—	Filter rate
Maximum GPS-to-filter residual ratio (position or velocity) for the selected GPS state	DELTA_RATIO_SV_SEL	*	F	S	—		Filter rate
GPS-to-filter residual ratio indicator (“P” or “V”) for the selected GPS state	DELTA_RATIO_SV_SEL_IND	*	Char		P,V		Filter rate
GPS-to-filter residual ratio status for the selected GPS state	DELTA_RATIO_SV_SEL_STAT	*	Char		—		Filter rate
GPS-to-filter residual for the selected GPS state	DELR_SV_SEL	GPS D/L Comp,*	F	S		nm	Filter rate
Minutes portion of the time since the last GPS state vector selection by the GPS state vector select function	DT_GPS_OFF_MIN	*	F	S		min	Filter rate
Selected figure-of-merit	FOM_SV_SEL	*	HXS	S	1-9	—	Filter rate
Flags indicating the FOM failure status of each receiver for display to the crew	GPS_FAIL_FOM_DISP <sub>i</sub> **	*	D	—	ON/OFF	—	Filter rate

Table 4.3.3.5-2. GPS State Vector Selection Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Altitude of selected GPS state above Fischer ellipsoid	GPS_SEL_ALT	GPS D/L comp	F	S		ft	Filter rate
Latitude of selected GPS state	GPS_SEL_LAT	GPS D/L comp	F	S		deg	Filter rate
Longitude of selected GPS state	GPS_SEL_LON	GPS D/L comp	F	S		deg	Filter rate
Flag indicating an I-load number of consecutive NAV cycles have passed with no usable GPS data	GPS_OFF_ALERT	*, GPS D/L comp	D	—	ON/OFF	—	Filter rate
GPS GAX off alert indicator	GPS_OFF_ALERT_GAX	*	D	—	ON/OFF	—	Filter rate
Flag indicating (ON) a GPS selected state vector is available	GPS_SV_SEL_AVAIL	GPS NAV State Prop, *	D	—	ON/OFF	—	Filter rate
Latitude indicator of selected GPS state (N or S)	GPS_SEL_LAT_IND	*	Char		N,S		Filter rate
Longitude of selected GPS state (E OR W)	GPS_SEL_LON_IND	*	Char		E,W		Filter rate
Number of GPS receiver selection candidates	NUM_GPS_SEL	*	I	S	0 to 3	—	Filter rate
Selected GPS position vector	$\bar{R}_{GPS\_SEL}$	GPS D/L COMP, GPS NAV State Prop, *	V	DP		ft	Filter rate

Table 4.3.3.5-2. GPS State Vector Selection Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Position and velocity covariance diagonals for reinitializing the NAV filter covariance matrix at a GPS state reset	SIG_DIAG_GPS	*	F Vector (6)	S	ft ft/sec	_	Filter rate
Vector indicating GPS receiver I selection candidacy	SEL_CMD <sub>I</sub> **	*	D	—	ON/ OFF	_	Filter rate
Vector indicating GPS receiver(s) selected on current navigation cycle	SEL_RCVR <sub>I</sub> **	*, GPS_ DL_ COMP	D	—	ON/ OFF	_	Filter rate
GPS selected state time tag	T_GPS_SEL	GPS D/L COMP, GPS NAV State Prop, *	F	DP		sec	Filter rate
Selected GPS velocity vector	$\bar{V}$ _GPS_SEL	GPS D/L COMP, GPS NAV State Prop, *	V	DP		ft/sec	Filter rate
QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state	DELR_RATIO_GPS_ SEL_ST	GPS D/L comp, *	CHAR	_	↑, ↓, ∅	-	Filter rate

Table 4.3.3.5-2. GPS State Vector Selection Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Magnitude of the vector difference between the selected GPS position estimate and the NAV filter position	DELR_GPS_SEL	*	F	S		ft	Filter rate
QA2 GPS-to-filter position vector residual ratio for selected GPS state	DELR_RATIO_GPS_SEL	GPS D/L COMP,*	F	S		_	Filter rate
Magnitude of the vector difference between the selected GPS velocity estimate and the NAV filter velocity	DELV_GPS_SEL	GPS D/L comp,*	F	S		ft/sec	Filter rate
QA2 GPS-to-filter velocity vector residual ratio for selected GPS state	DELV_RATIO_GPS_SEL	GPS D/L COMP,*	F	S		_	Filter rate
QA2 GPS-to-filter velocity vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state	DELV_RATIO_GPS_SEL_ST	GPS D/L comp,*	CHAR	_	↑, ↓, ↯	-	Filter rate
Figure of merit for the I'th GPS receiver used in GPS receiver state processing	FOM_NAV <sub>I</sub> **	GPS D/L comp,*	I	S	0-9	_	Filter rate
Gravity acceleration vector corresponding to the selected GPS state	$\bar{G}$ _GPS_SEL	*	V	S		ft/sec <sup>2</sup>	Filter rate

Table 4.3.3.5-2. GPS State Vector Selection Output Parameters

Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) that GAX GPS NAV edit message is to be issued due to vehicle going below I-Load altitude with either no GPS state selected or GPS off alert condition existing	GPS_NAV_EDIT_ALT_GAX	*	D	_	ON/OFF	_	Filter rate
Flag indicating (ON) that GPS GAX NAV edit message is to be issued due to GPS ratio condition	GPS_NAV_EDIT_GAX	*	D	_	ON/OFF	-	Filter rate
Flag indicating (ON) that the selected GPS residual ratio exceeded its allowed limit	GPS_RATIO_FLAG	*	D	-	ON/OFF	-	Filter rate
Altitude of selected GPS state above Fischer ellipsoid for display to the crew	GPS_SEL_ALT_DISP	*	F	S		nm	Filter rate
Latitude of selected GPS state for display to the crew	GPS_SEL_LAT_DISP	*	F	S		deg	Filter rate
Longitude of selected GPS state for display to the crew	GPS_SEL_LON_DISP	*	F	S		deg	Filter rate
QA2 position residuals in UVW coordinates for selected GPS state	GPS_SEL_DELR_UVW	GPS D/L comp, *	V	S		ft	Filter rate
QA2 velocity residuals in UVW coordinates for selected GPS state	GPS_SEL_DELV_UVW	GPS D/L comp, *	V	S		ft/sec	Filter rate

\* See principal function output list in Table 4.3.3.8-2.

\*\* I = 1,2,3 (1 to GPS\_SW\_CAP)

#### 4.3.3.6 GPS Reference State Announced Reset

The purpose of the GPS reference state announced reset subfunction is to determine when to periodically initiate the GPS receiver announced reset process. Periodic announced resets are necessary to update the GPS reference state with the navigation filter state, and to inform the receiver that there has been a discontinuity in the reference state that is not attributed to vehicle dynamics (Section 4.6.4).

##### A. Detailed Requirements.

If the time of the previous announced reset, T\_ANNCD\_RESET, is equal to zero (it is set to zero at OPS transitions), set it equal to current time. Otherwise, monitor the magnitude of the elapsed time from the previous announced reference state reset to determine if another announced reset is to be performed. If the I-load time has been exceeded, set the receiver announced reset flag to ON

```
IF T_ANNCD_RESET = 0 THEN
    T_ANNCD_RESET = T_CURRENT_FILT
ELSE
    IF (T_CURRENT_FILT - T_ANNCD_RESET) > DT_ANNCD_RESET THEN
        T_ANNCD_RESET = T_CURRENT_FILT
        GPS_ANNCD_RESET = ON
```

B. Interface Requirements. The input and output parameters are listed in Tables 4.3.3.6-1 and 4.3.3.6-2.

C. Processing Requirements. T\_ANNCD\_RESET shall be initialized to zero. GPS\_ANNCD\_RESET shall be initialized to 'OFF'.

D. Constraints. None

E. Supplementary Information. A suggested implementation in the form of a detailed flow chart (GPS\_REF\_STATE\_ANNCD\_RESET) may be found in Section 5.2.

Table 4.3.3.6-1. GPS Reference State Announced Reset Input Parameters							
Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Time interval between successive reference state reset cycles	DT_ANNCD_RESET	I-load	F	_		sec	Filter rate
Time tag for filter state	T_CURRENT_FILT	*	F	DP		sec	Filter rate

\* See principal function input list in Table 4.3.3.8-1.

Table 4.3.3.6-2. GPS Reference State Announced Reset Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Flag indicating request for GPS announced resets and GPS reference state to be reanchored with navigation state	GPS_ANNCD_RESET	*	D		ON/OFF		Filter rate

\* See principal function output list in Table 4.3.3.8-2.



### 4.3.3.7 GPS Downlist Computation

The purpose of the GPS downlist processing function is to store GPS related navigation data for the downlist.

Data is stored in collection words or scaled and buffered as appropriate to reduce downlist requirements. Time homogeneous and time consistent downlist data requirements are specified as required.

Note that the metering data that is stored for downlist is from the previous navigation cycle, since the GPS Receiver State Processing principal function executes before the user parameter reset function (which executes the metering function). The crew metering override command that is stored for downlist, however, is from the current navigation cycle.

#### A. Functional Requirements.

The following steps are performed:

1. Store a set of time homogenous GPS data in the GPS\_COLLECTION\_WORD for downlist.

Pack GPS data in the GPS\_COLLECTION\_WORD as follows:

- 1.1 Zero bits 0 to 15 of the GPS\_COLLECTION\_WORD.

GPS\_COLLECTION\_WORD = 0

Set Bits 1 and 2 of GPS\_COLLECTION\_WORD according to the setting of MLS\_AIF\_RCVD as follows:

```
IF MLS_AIF_RCVD = AUTO THEN
    GPS_COLLECTION_WORD (BIT 1 = 0, BIT 2 = 1)
ELSE
    IF MLS_AIF_RCVD = INHIBIT
        GPS_COLLECTION_WORD (BIT 1 = 1, BIT 2 = 0)
    ELSE
        GPS_COLLECTION_WORD (BIT 1 = 1, BIT 2 = 1)
```

Set Bits 3 to 8 of GPS\_COLLECTION\_WORD as follows:

BIT 3 of GPS\_COLLECTION\_WORD = CREW\_DES\_RCVR\_RCVD<sub>1</sub>

BIT 4 of GPS\_COLLECTION\_WORD = CREW\_DES\_RCVR\_RCVD<sub>2</sub>

BIT 5 of GPS\_COLLECTION\_WORD = CREW\_DES\_RCVR\_RCVD<sub>3</sub>

BIT 6 of GPS\_COLLECTION\_WORD = GPS\_DG\_SF<sub>1</sub>

BIT 7 of GPS\_COLLECTION\_WORD = GPS\_DG\_SF<sub>2</sub>

BIT 8 of GPS\_COLLECTION\_WORD = GPS\_DG\_SF<sub>3</sub>

Bits 10 and 11 of GPS\_COLLECTION\_WORD are set according to the setting of GPS\_AIF\_RCVD as follows:

```
IF GPS_AIF_RCVD = AUTO THEN
```

```
GPS_COLLECTION_WORD(BIT 10 = 0, BIT 11 = 1)
ELSE
  IF GPS_AIF_RCVD = INHIBIT THEN
    GPS_COLLECTION_WORD(BIT 10 = 1, BIT 11 = 0)
  ELSE
    GPS_COLLECTION_WORD(BIT 10 = 1, BIT 11 = 1)
```

The setting of Bit 12 of GPS\_COLLECTION\_WORD is based on GPS\_OFF\_ALERT flag which indicates that GPS solutions have not been selected for an I-loaded amount of time:

```
IF GPS_OFF_ALERT = ON THEN
  BIT 12 of GPS_COLLECTION_WORD = 1
ELSE
  BIT 12 of GPS_COLLECTION_WORD = 0
```

The setting of Bit 13 of GPS\_COLLECTION\_WORD is based on GPS\_TO\_NAV\_RCVD flag.

```
IF GPS_TO_NAV_RCVD = AUTO THEN
  BIT 13 of GPS_COLLECTION_WORD = 1
ELSE
  BIT 13 of GPS_COLLECTION_WORD = 0
```

The setting of Bit 14 of GPS\_COLLECTION\_WORD is based on the flag GPS\_TO\_NAV\_FORCE\_RCVD.

```
IF GPS_TO_NAV_FORCE_RCVD = ON THEN
  BIT 14 of GPS_COLLECTION_WORD = 1
ELSE
  BIT 14 of GPS_COLLECTION_WORD = 0
```

- 2.0 Scale and buffer in a time homogeneous set the following selected GPS state parameters for downlist. The variables are scaled to reduce data requirements for downlist.

$$\overline{R\_GPS\_SEL\_DL} = \text{INTEGER}(\overline{R\_GPS\_SEL}/SF\_POS)$$

$$\overline{V\_GPS\_SEL\_DL} = \text{INTEGER}(\overline{V\_GPS\_SEL}/SF\_VEL)$$

$$T\_GPS\_SEL\_DL = T\_GPS\_SEL$$

- 3.0 Scale and buffer in a time homogeneous set the following variables for downlist. The variables are scaled to reduce data requirements for downlist.

$$\overline{GPS\_SEL\_DELR\_UVW\_DL} = \text{INTEGER}(\overline{GPS\_SEL\_DELR\_UVW}/DELR\_UVW\_POS\_SF)$$

$$\overline{GPS\_SEL\_DELV\_UVW\_DL} = \text{INTEGER}(\overline{GPS\_SEL\_DELV\_UVW}/DELV\_UVW\_VEL\_SF)$$

- 4.0 Scale and buffer in a time homogeneous set the following latitude, longitude and altitude parameters, derived from the selected GPS state, for downlist. The variables are scaled to reduce data requirements for downlist.

$$GPS\_SEL\_LAT\_DL = \text{INTEGER}(GPS\_SEL\_LAT / ANG\_SF)$$

GPS\_SEL\_LON\_DL = INTEGER(GPS\_SEL\_LON / ANG\_SF)

GPS\_SEL\_ALT\_DL = INTEGER(GPS\_SEL\_ALT NAUTMI\_PER\_FT / ALT\_SF)

5.0 Scale and buffer in a time consistent set the following parameters for downlist.

5.1 Buffer the variable which indicates the time interval over which the QA2 tolerances are being scaled. This is the time since the navigation filter state was last reset to the selected GPS state. The variable is buffered to provide time consistent GPS receiver state processing data for downlist:

DT\_QA2\_DL = INTEGER(DT\_QA2/DT\_QA2\_SF)

5.2 Scale and buffer the following QA2 tolerance variables for downlist. The variables are scaled to reduce data requirements for downlist.

$\overline{\text{GPS\_QA2\_RTOL\_UVW\_DL}} = \text{INTEGER}(\overline{\text{GPS\_QA2\_RTOL\_UVW}} / \text{QA2\_RTOL\_SF})$

$\overline{\text{GPS\_QA2\_VTOL\_UVW\_DL}} = \text{INTEGER}(\overline{\text{GPS\_QA2\_VTOL\_UVW}} / \text{QA2\_VTOL\_SF})$

6.0 Scale and buffer in a time homogeneous set the following QA2 and QA3 position and velocity ratio variables for downlist

DO FOR I = 1 TO GPS\_SW\_CAP

DEL\_R\_RATIO\_QA2\_DL<sub>i</sub> = INTEGER  
(DEL\_R\_RATIO\_QA2\_MAX<sub>i</sub>/QA2\_DELR\_RATIO\_SF)  
DEL\_V\_RATIO\_QA2\_DL<sub>i</sub> = INTEGER  
(DEL\_V\_RATIO\_QA2\_MAX<sub>i</sub>/QA2\_DELV\_RATIO\_SF)

DEL\_R\_RATIO\_QA3\_DL<sub>i</sub> = INTEGER  
(DEL\_R\_RATIO\_QA3\_DISPLAY<sub>i</sub>/QA3\_DELR\_RATIO\_SF)  
DEL\_V\_RATIO\_QA3\_DL<sub>i</sub> = INTEGER  
(DEL\_V\_RATIO\_QA3\_DISPLAY<sub>i</sub>/QA3\_DELV\_RATIO\_SF)

7.0 Scale and buffer in a time homogeneous set the following QA4 position and velocity pairwise compare variables for downlist

DEL\_R\_RATIO\_QA4\_1\_2\_DL = INTEGER (DEL\_R\_RATIO\_QA4\_1\_2/  
QA4\_DELR\_RATIO\_SF)

DEL\_V\_RATIO\_QA4\_1\_2\_DL = INTEGER (DEL\_V\_RATIO\_QA4\_1\_2/  
QA4\_DELV\_RATIO\_SF)

DEL\_R\_RATIO\_QA4\_1\_3\_DL = INTEGER (DEL\_R\_RATIO\_QA4\_1\_3/  
QA4\_DELR\_RATIO\_SF)

DEL\_V\_RATIO\_QA4\_1\_3\_DL = INTEGER (DEL\_V\_RATIO\_QA4\_1\_3/  
QA4\_DELV\_RATIO\_SF)

DEL\_R\_RATIO\_QA4\_2\_3\_DL = INTEGER (DEL\_R\_RATIO\_QA4\_2\_3/  
QA4\_DELR\_RATIO\_SF)

$$\text{DELV\_RATIO\_QA4\_2\_3\_DL} = \text{INTEGER} (\text{DELV\_RATIO\_QA4\_2\_3}/\text{QA4\_DELV\_RATIO\_SF})$$

- 8.0 Scale and buffer in a time homogeneous set the QA2 position and velocity residual magnitudes for the selected GPS state for downlist.

$$\text{DELR\_GPS\_SEL\_DL} = \text{INTEGER} (\text{DELR\_SV\_SEL}/\text{DELR\_SF})$$
$$\text{DELV\_GPS\_SEL\_DL} = \text{INTEGER} (\text{DELV\_GPS\_SEL}/\text{DELV\_SF})$$

Scale and buffer in a time homogeneous set the QA2 position and velocity residual ratios for the selected GPS state for downlist.

$$\text{DELR\_RATIO\_GPS\_SEL\_DL} = \text{INTEGER} (\text{DELR\_RATIO\_GPS\_SEL}/\text{QA2\_DELR\_RATIO\_SF})$$
$$\text{DELV\_RATIO\_GPS\_SEL\_DL} = \text{INTEGER} (\text{DELV\_RATIO\_GPS\_SEL}/\text{QA2\_DELV\_RATIO\_SF})$$

- 9.0 Scale and buffer the user parameter state reset metering scale factor for downlist.

$$\text{METER\_SF\_DL} = \text{INTEGER}(\text{METER\_SF}/\text{METER\_DL\_SF})$$

- 10.0 Store a set of time homogenous GPS quality assessment data for LRU2 in GPS\_COLLECTION\_WORD\_TWO for downlist.

Pack GPS data in the GPS\_COLLECTION\_WORD\_TWO as follows:

- 10.1 Zero bits 0 to 15 of the GPS\_COLLECTION\_WORD\_TWO.  
$$\text{GPS\_COLLECTION\_WORD\_TWO} = 0$$

- 10.2 The setting of Bit 0 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA<sub>2</sub>:

$$\text{IF GPS\_FAIL\_QA}_2 = \text{ON THEN}$$
$$\quad \text{BIT 0 of GPS\_COLLECTION\_WORD\_TWO} = 1$$
$$\text{ELSE}$$
$$\quad \text{BIT 0 of GPS\_COLLECTION\_WORD\_TWO} = 0$$

The setting of Bit 1 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA<sub>2</sub><sub>2</sub>:

$$\text{IF GPS\_FAIL\_QA}_2_2 = \text{ON THEN}$$
$$\quad \text{BIT 1 of GPS\_COLLECTION\_WORD\_TWO} = 1$$
$$\text{ELSE}$$
$$\quad \text{BIT 1 of GPS\_COLLECTION\_WORD\_TWO} = 0$$

The setting of Bit 2 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA<sub>2</sub><sub>R<sub>2</sub></sub>:

$$\text{IF GPS\_FAIL\_QA}_2_{R_2} = \text{ON THEN}$$
$$\quad \text{BIT 2 of GPS\_COLLECTION\_WORD\_TWO} = 1$$
$$\text{ELSE}$$
$$\quad \text{BIT 2 of GPS\_COLLECTION\_WORD\_TWO} = 0$$

The setting of Bit 3 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA2\_V<sub>2</sub>:

```
IF GPS_FAIL_QA2_V2 = ON THEN
    BIT 3 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 3 of GPS_COLLECTION_WORD_TWO = 0
```

The setting of Bit 4 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA3<sub>2</sub>:

```
IF GPS_FAIL_QA32 = ON THEN
    BIT 4 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 4 of GPS_COLLECTION_WORD_TWO = 0
```

The setting of Bit 5 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA3\_R<sub>2</sub>:

```
IF GPS_FAIL_QA3_R2 = ON THEN
    BIT 5 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 5 of GPS_COLLECTION_WORD_TWO = 0
```

The setting of Bit 6 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_QA3\_V<sub>2</sub>:

```
IF GPS_FAIL_QA3_V2 = ON THEN
    BIT 6 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 6 of GPS_COLLECTION_WORD_TWO = 0
```

The setting of Bit 7 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter GPS\_FAIL\_FOM<sub>2</sub>:

```
IF GPS_FAIL_FOM2 = ON
    BIT 7 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 7 of GPS_COLLECTION_WORD_TWO = 0
```

Bits 8 through 10 of GPS\_COLLECTION\_WORD\_TWO are set to the array elements of SEL\_RCVR as follows:

```
IF SEL_RCVR1 = ON
    BIT 8 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 8 of GPS_COLLECTION_WORD_TWO = 0
```

```
IF SEL_RCVR2 = ON
    BIT 9 of GPS_COLLECTION_WORD_TWO = 1
ELSE
    BIT 9 of GPS_COLLECTION_WORD_TWO = 0
```

```
IF SEL_RCVR3 = ON
    BIT 10 of GPS_COLLECTION_WORD_TWO = 1
```

ELSE

BIT 10 of GPS\_COLLECTION\_WORD\_TWO = 0

The setting of Bit 11 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter CREW\_METERING\_OVERRIDE:

IF CREW\_METERING\_OVERRIDE = ON

BIT 11 of GPS\_COLLECTION\_WORD\_TWO = 1

ELSE

BIT 11 of GPS\_COLLECTION\_WORD\_TWO = 0

The setting of Bit 12 of GPS\_COLLECTION\_WORD\_TWO is based on the parameter METER\_FLAG:

IF METER\_FLAG = ON

BIT 12 of GPS\_COLLECTION\_WORD\_TWO = 1

ELSE

BIT 12 of GPS\_COLLECTION\_WORD\_TWO = 0

11.0 Store a set of time homogeneous GPS quality assessment data for GPS LRUs 3 and 1 in GPS\_COLLECTION\_WORD\_THREE for downlist.

Pack GPS data in the GPS\_COLLECTION\_WORD\_THREE as follows:

11.1 Zero bits 0 to 15 of the GPS\_COLLECTION\_WORD\_THREE.

GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 0 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA<sub>3</sub>:

IF GPS\_FAIL\_QA3 = ON THEN

BIT 0 of GPS\_COLLECTION\_WORD\_THREE = 1

ELSE

BIT 0 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 1 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA<sub>23</sub>:

IF GPS\_FAIL\_QA<sub>23</sub> = ON THEN

BIT 1 of GPS\_COLLECTION\_WORD\_THREE = 1

ELSE

BIT 1 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 2 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA<sub>2R3</sub>:

IF GPS\_FAIL\_QA<sub>2R3</sub> = ON THEN

BIT 2 of GPS\_COLLECTION\_WORD\_THREE = 1

ELSE

BIT 2 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 3 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA<sub>2V3</sub>:

IF GPS\_FAIL\_QA<sub>2V3</sub> = ON THEN

BIT 3 of GPS\_COLLECTION\_WORD\_THREE = 1

ELSE  
BIT 3 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 4 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3<sub>3</sub>:

IF GPS\_FAIL\_QA3<sub>3</sub> = ON THEN  
BIT 4 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 4 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 5 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3\_R<sub>3</sub>:

IF GPS\_FAIL\_QA3\_R<sub>3</sub> = ON THEN  
BIT 5 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 5 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 6 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3\_V<sub>3</sub>:

IF GPS\_FAIL\_QA3\_V<sub>3</sub> = ON THEN  
BIT 6 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 6 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 7 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_FOM<sub>3</sub>:

IF GPS\_FAIL\_FOM<sub>3</sub> = ON THEN  
BIT 7 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 7 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 8 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA1:

IF GPS\_FAIL\_QA1 = ON THEN  
BIT 8 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 8 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 9 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA2<sub>1</sub>:

IF GPS\_FAIL\_QA2<sub>1</sub> = ON THEN  
BIT 9 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 9 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 10 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA2\_R<sub>1</sub>:

IF GPS\_FAIL\_QA2\_R<sub>1</sub> = ON THEN  
BIT 10 of GPS\_COLLECTION\_WORD\_THREE = 1

ELSE  
BIT 10 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 11 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA2\_V<sub>1</sub>:

IF GPS\_FAIL\_QA2\_V<sub>1</sub> = ON THEN  
BIT 11 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 11 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 12 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3<sub>1</sub>:

IF GPS\_FAIL\_QA3<sub>1</sub> = ON THEN  
BIT 12 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 12 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 13 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3\_R<sub>1</sub>:

IF GPS\_FAIL\_QA3\_R<sub>1</sub> = ON THEN  
BIT 13 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 13 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 14 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_QA3\_V<sub>1</sub>:

IF GPS\_FAIL\_QA3\_V<sub>1</sub> = ON THEN  
BIT 14 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 14 of GPS\_COLLECTION\_WORD\_THREE = 0

The setting of Bit 15 of GPS\_COLLECTION\_WORD\_THREE is based on the parameter GPS\_FAIL\_FOM<sub>1</sub>:

IF GPS\_FAIL\_FOM<sub>1</sub> = ON THEN  
BIT 15 of GPS\_COLLECTION\_WORD\_THREE = 1  
ELSE  
BIT 15 of GPS\_COLLECTION\_WORD\_THREE = 0

12.0 Store a set of time homogeneous GPS QA4 quality assessment data for GPS LRUs 1, 2 and 3 in GPS\_COLLECTION\_WORD\_FOUR for downlist.

Pack GPS data in the GPS\_COLLECTION\_WORD\_FOUR as follows:

12.1 Zero bits 0 to 15 of the GPS\_COLLECTION\_WORD\_FOUR.  
GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 0 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4<sub>1</sub>:

IF GPS\_FAIL\_QA4<sub>1</sub> = ON THEN  
BIT 0 of GPS\_COLLECTION\_WORD\_FOUR = 1



ELSE  
BIT 0 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 1 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4<sub>2</sub>:

IF GPS\_FAIL\_QA4<sub>2</sub> = ON THEN  
BIT 1 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 1 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 2 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4<sub>3</sub>:

IF GPS\_FAIL\_QA4<sub>3</sub> = ON THEN  
BIT 2 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 2 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 3 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_R\_1\_2:

IF GPS\_FAIL\_QA4\_R\_1\_2 = ON THEN  
BIT 3 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 3 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 4 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_V\_1\_2:

IF GPS\_FAIL\_QA4\_V\_1\_2 = ON THEN  
BIT 4 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 4 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 5 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_R\_1\_3:

IF GPS\_FAIL\_QA4\_R\_1\_3 = ON THEN  
BIT 5 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 5 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 6 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_V\_1\_3:

IF GPS\_FAIL\_QA4\_V\_1\_3 = ON THEN  
BIT 6 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 6 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 7 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_R\_2\_3:

IF GPS\_FAIL\_QA4\_R\_2\_3 = ON THEN  
BIT 7 of GPS\_COLLECTION\_WORD\_FOUR = 1

ELSE  
BIT 7 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 8 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_FAIL\_QA4\_V\_2\_3:

IF GPS\_FAIL\_QA4\_V\_2\_3 = ON THEN  
BIT 8 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 8 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 9 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_QA4\_DILEMMA<sub>1</sub>:

IF GPS\_QA4\_DILEMMA<sub>1</sub> = ON THEN  
BIT 9 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 9 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 10 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_QA4\_DILEMMA<sub>2</sub>:

IF GPS\_QA4\_DILEMMA<sub>2</sub> = ON THEN  
BIT 10 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 10 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bit 11 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter GPS\_QA4\_DILEMMA<sub>3</sub>:

IF GPS\_QA4\_DILEMMA<sub>3</sub> = ON THEN  
BIT 11 of GPS\_COLLECTION\_WORD\_FOUR = 1  
ELSE  
BIT 11 of GPS\_COLLECTION\_WORD\_FOUR = 0

The setting of Bits 12 through 13 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter DELR\_RATIO\_GPS\_SEL\_ST:

IF DELR\_RATIO\_GPS\_SEL\_ST = '↖' THEN  
BIT 12 through 13 of GPS\_COLLECTION\_WORD\_FOUR = (0,0)  
ELSE  
IF DELR\_RATIO\_GPS\_SEL\_ST = '↓' THEN  
BIT 12 through 13 of GPS\_COLLECTION\_WORD\_FOUR = (0,1)  
ELSE  
BIT 12 through 13 of GPS\_COLLECTION\_WORD\_FOUR = (1,0)

The setting of Bits 14 through 15 of GPS\_COLLECTION\_WORD\_FOUR is based on the parameter DELV\_RATIO\_GPS\_SEL\_ST:

IF DELV\_RATIO\_GPS\_SEL\_ST = '↖' THEN  
BIT 14 through 15 of GPS\_COLLECTION\_WORD\_FOUR = (0,0)  
ELSE  
IF DELV\_RATIO\_GPS\_SEL\_ST = '↓' THEN  
BIT 14 through 15 of GPS\_COLLECTION\_WORD\_FOUR = (0,1)

ELSE

BIT 14 through 15 of GPS\_COLLECTION\_WORD\_FOUR = (1,0)

13.0 Store a set of time homogeneous data for GPS LRUs 1, 2 and 3 in GPS\_COLLECTION\_WORD\_FIVE for downlist.

Pack GPS data in the GPS\_COLLECTION\_WORD\_FIVE as follows:

13.1 Zero bits 0 to 15 of the GPS\_COLLECTION\_WORD\_FIVE.

GPS\_COLLECTION\_WORD\_FIVE = 0

13.2 The setting of Bit 0 through 3 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter FOM\_NAV<sub>1</sub>:

BIT 0 through 3 of GPS\_COLLECTION\_WORD\_FIVE =  
BINARY (FOM\_NAV<sub>1</sub>)

The setting of Bit 4 through 7 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter FOM\_NAV<sub>2</sub>:

BIT 4 through 7 of GPS\_COLLECTION\_WORD\_FIVE =  
BINARY (FOM\_NAV<sub>2</sub>)

The setting of Bit 8 through 11 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter FOM\_NAV<sub>3</sub>:

BIT 8 through 11 of GPS\_COLLECTION\_WORD\_FIVE =  
BINARY (FOM\_NAV<sub>3</sub>)

The setting of Bit 12 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter CREW\_QA\_OVERRIDE\_RCVD<sub>1</sub>:

IF CREW\_QA\_OVERRIDE\_RCVD<sub>1</sub> = ON THEN  
BIT 12 of GPS\_COLLECTION\_WORD\_FIVE = 1  
ELSE  
BIT 12 of GPS\_COLLECTION\_WORD\_FIVE = 0

The setting of Bit 13 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub>:

IF CREW\_QA\_OVERRIDE\_RCVD<sub>2</sub> = ON THEN  
BIT 13 of GPS\_COLLECTION\_WORD\_FIVE = 1  
ELSE  
BIT 13 of GPS\_COLLECTION\_WORD\_FIVE = 0

The setting of Bit 14 of GPS\_COLLECTION\_WORD\_FIVE is based on the parameter CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub>:

IF CREW\_QA\_OVERRIDE\_RCVD<sub>3</sub> = ON THEN  
BIT 14 of GPS\_COLLECTION\_WORD\_FIVE = 1  
ELSE  
BIT 14 of GPS\_COLLECTION\_WORD\_FIVE = 0

B. Interface Requirements. The input and output parameters associated with the GPS\_DL\_COMP module are contained in Tables 4.3.3.7-1 and 4.3.3.7-2.

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C. Processing Requirements. The GPS downlist computation subfunction shall execute after the reference state announced reset subfunction.

D. Constraints. None.

E. Supplementary Information. A suggested implementation in the form of detailed flow charts (GPS\_DL\_COMP) may be found in Section 5.2.

The following GPS downlist parameters shall be protected against a single precision integer overflow: DELR\_RATIO\_QA2\_DL<sub>I</sub>, DELV\_RATIO\_QA2\_DL<sub>I</sub>, DELR\_RATIO\_QA3\_DL<sub>I</sub>, DELV\_RATIO\_QA3\_DL<sub>I</sub>, GPS\_SEL\_DELR\_UVW\_DL, GPS\_SEL\_DELV\_UVW\_DL, DELR\_GPS\_SEL\_DL, DELV\_GPS\_SEL\_DL, DELR\_RATIO\_GPS\_SEL\_DL, DELV\_RATIO\_GPS\_SEL\_DL, METER\_SF\_DL, DELR\_RATIO\_QA4\_1\_2\_DL, DELV\_RATIO\_QA4\_1\_2\_DL, DELR\_RATIO\_QA4\_1\_3\_DL, DELV\_RATIO\_QA4\_1\_3\_DL, DELR\_RATIO\_QA4\_2\_3\_DL, DELV\_RATIO\_QA4\_2\_3\_DL and DT\_QA2\_DL. The subscript I has values from 1 to 3.

The overflow protection shall consist of the following: if the unscaled GPS parameter divided by its scale factor exceeds the maximum allowable value of a single precision integer, then the value of the GPS downlist parameter shall be set to the maximum allowable value of a single precision integer with the appropriate sign.

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
GPS selected state altitude downlist scale factor	ALT_SF	I-load	F	S		--	1.04
GPS selected state latitude and longitude downlist scale factor	ANG_SF	I-load	F	S		--	1.04
Deselection Command for GPS receiver I	CREW_DES_RCVR_RCVD <sub>I</sub> **	GPS SV quality assess	D		ON/OFF		1.04
Crew command (ON) to override software metering of the user parameter reset state	CREW_METERING_OVERRIDE	*	D	_	ON/OFF	_	Filter rate
Display flag reflecting crew input to override the quality assessment function for each receiver	CREW_QA_OVERRIDE_RCVD <sub>I</sub> **	GPS SV quality assess	D		ON/OFF		1.04
QA2 GPS-to-filter position vector residual ratio for selected GPS state	DELR_RATIO_GPS_SEL	GPS SV select	F	S		_	Filter rate
QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state	DELR_RATIO_GPS_SEL_ST	GPS SV select	CHAR	_	↑, ↓, ∅	_	Filter rate
Maximum component-wise GPS QA2 position residual ratio for each receiver	DELR_RATIO_QA2_MA X <sub>I</sub> **	GPS SV quality assess	F	S		--	1.04
GPS QA3 position magnitude residual ratio for each receiver	DELR_RATIO_QA3_DISPLAY <sub>I</sub> **	GPS SV quality assess	F	S		--	1.04
QA4 pairwise compare position ratio between GPS receivers 1 and 2	DELR_RATIO_QA4_1_2	GPS SV quality assess	F	S		--	1.04
QA4 pairwise compare position ratio between GPS receivers 1 and 3	DELR_RATIO_QA4_1_3	GPS SV quality assess	F	S		--	1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
QA4 pairwise compare position ratio between GPS receivers 2 and 3	DELR_RATIO_QA4_2_3	GPS SV quality assess	F	S		--	1.04
Selected GPS position residual downlist scale factor (Note, the I-Load value must also include a nautical miles to feet conversion factor.)	DELR_SF	I-Load	F	S		--	1.04
GPS-to-filter residual for the selected GPS state	DELR_SV_SEL	GPS SV select	F	DP		nm	Filter rate
QA2 UVW position residuals downlist scale factor	DELR_UVW_POS_SF	I-load	F	S		--	1.04
Magnitude of the vector difference between the selected GPS velocity estimate and the NAV filter velocity	DELV_GPS_SEL	GPS SV select	F	S		ft/sec	Filter rate
QA2 GPS-to-filter velocity vector residual ratio for selected GPS state	DELV_RATIO_GPS_SEL	GPS SV select	F	S		_	Filter rate
QA2 GPS-to-filter velocity vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state	DELV_RATIO_GPS_SEL_ST	GPS SV select	CHAR	_	↑, ↓, ∅	_	Filter rate
Maximum component-wise GPS QA2 velocity residual ratio for each receiver	DELV_RATIO_QA2_MA $X_1^{**}$	GPS SV quality assess	F	S		--	1.04
GPS QA3 velocity magnitude residual ratio for each receiver	DELV_RATIO_QA3_DIS PLAY <sub>1</sub> **	GPS SV quality assess	F	S		--	1.04
QA4 pairwise compare velocity ratio between GPS receivers 1 and 2	DELV_RATIO_QA4_1_2	GPS SV quality assess	F	S		--	1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
QA4 pairwise compare velocity ratio between GPS receivers 1 and 3	DELV_RATIO_QA4_1_3	GPS SV quality assess	F	S		--	1.04
QA4 pairwise compare velocity ratio between GPS receivers 2 and 3	DELV_RATIO_QA4_2_3	GPS SV quality assess	F	S		--	1.04
Selected GPS velocity residual downlist scale factor	DELV_SF	I-Load	F	S		--	1.04
QA2 UVW velocity residuals downlist scale factor	DELV_UVW_VEL_SF	I-load	F	S		--	1.04
Difference between time of current NAV filter state and time of last GPS update	DT_QA2	GPS SV quality assess	F	S		sec	1.04
QA2 time difference downlist scale factor	DT_QA2_SF	I-load	F	S		--	1.04
Figure of merit for the I <sup>th</sup> GPS receiver used in GPS receiver state processing	FOM_NAV <sub>I</sub> **	GPS SV select	I	S	0-9	--	1.04
GPS Auto, Inhibit, Force setting for GPS usage by UPP and Guidance	GPS_AIF_RCVD	*	I	S	0(Auto), 1(Inhibit) 2(Force)	--	1.04
Data good flag for GPS receiver I	GPS_DG_SF <sub>I</sub> **	GPS NAV State Prop	D		ON/OFF		1.04
Snapped FOM failure status of each GPS receiver	GPS_FAIL_FOM <sub>I</sub> **	*	D	--	ON/ OFF	--	1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) that the I <sup>th</sup> GPS receiver has failed the fourth quality assessment check (either the pairwise compare position or velocity vector magnitude differences between eligible receivers exceeds an I-load tolerance) on the current cycle	GPS_FAIL_QA4 <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 2 was failed in position for I <sup>th</sup> receiver	GPS_FAIL_QA2_R <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 2 was failed in velocity for I <sup>th</sup> receiver	GPS_FAIL_QA2_V <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 2 was failed	GPS_FAIL_QA2 <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 3 was failed in position for I <sup>th</sup> receiver	GPS_FAIL_QA3_R <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 3 was failed in velocity for I <sup>th</sup> receiver	GPS_FAIL_QA3_V <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) quality assessment 3 was failed	GPS_FAIL_QA3 <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in position	GPS_FAIL_QA4_R_1_2	GPS SV quality assess	D	--	ON/OFF	--	1.04



Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in position	GPS_FAIL_QA4_R_1_3	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in position	GPS_FAIL_QA4_R_2_3	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in velocity	GPS_FAIL_QA4_V_1_2	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in velocity	GPS_FAIL_QA4_V_1_3	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in velocity	GPS_FAIL_QA4_V_2_3	GPS SV quality assess	D	--	ON/OFF	--	1.04
Flag indicating at least one quality assessment was failed	GPS_FAIL_QA1**	GPS SV quality assess	D	--	ON/OFF	--	1.04
No GPS State selected for an I-loaded period of time	GPS_OFF_ALERT	GPS SV select	D		ON/OFF		1.04
QA2 position tolerance used in calculating GPS to NAV filter position residual ratio	$\overline{\text{GPS\_QA2\_RTOL\_UVW}}$	GPS SV quality assess	V	S		ft	1.04
QA2 velocity tolerance used in calculating GPS to NAV filter velocity residual ratio	$\overline{\text{GPS\_QA2\_VTOL\_UVW}}$	GPS SV quality assess	V	S		ft/ sec	1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) that a dilemma condition for the I <sup>th</sup> GPS receiver exists on the current cycle as a result of the fourth quality assessment check	GPS_QA4_DILEMMA <sub>I</sub> **	GPS SV quality assess	D	--	ON/OFF	--	1.04
Altitude of selected GPS state above Fischer ellipsoid	GPS_SEL_ALT	GPS SV select	F	S		ft	1.04
QA2 position residuals in UVW coordinates for selected GPS state	$\overline{\text{GPS\_SEL\_DELR\_UVW}}$	GPS SV select	V	S		ft	1.04
QA2 velocity residuals in UVW coordinates for selected GPS state	$\overline{\text{GPS\_SEL\_DELV\_UVW}}$	GPS SV select	V	S		ft/ sec	1.04
Latitude of selected GPS state	GPS_SEL_LAT	GPS SV select	F	S		deg	1.04
Longitude of selected GPS state	GPS_SEL_LON	GPS SV select	F	S		deg	1.04
Maximum number of GPS receivers for which the GPS software is designed	GPS_SW_CAP	K-Load	I	S	3	--	1.04
Crew command for forcing GPS state to NAV state	GPS_TO_NAV_FORCE_RCVD	*	D		ON(Force), OFF (No Force)		1.04
Crew command for resetting NAV state to GPS state flag	GPS_TO_NAV_RCVD	*	D		OFF (Auto), ON (Inhibit)		1.04
Metering downlist scale factor	METER_DL_SF	I-Load	F	S		--	1.04
Flag indicating (ON) that the user parameter reset state is being metered	METER_FLAG	*	D		ON/OFF		1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Metering gain(the maximum of either the position or velocity metering gains) applied to scale the M50 position and velocity changes to the user parameter reset state on the current cycle so that metering constraints are not violated	METER_SF	*	F	S		--	1.04
Flag indicating which MLS_AIF command is in effect	MLS_AIF_RCVD	*	CHAR	_		_	Filter rate
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nm/ft	1.04
QA2 position residual ratio downlist scale factor	QA2_DELR_RATIO_SF	I-load	F	S		--	1.04
QA2 velocity residual ratio downlist scale factor	QA2_DELV_RATIO_SF	I-load	F	S		--	1.04
QA2 RTOL downlist position scale factor	QA2_RTOL_SF	I-load	F	S		--	1.04
QA2 RTOL downlist velocity scale factor	QA2_VTOL_SF	I-load	F	S		--	1.04
QA3 position residual ratio downlist scale factor	QA3_DELR_RATIO_SF	I-load	F	S		--	1.04
QA3 velocity residual ratio downlist scale factor	QA3_DELV_RATIO_SF	I-load	F	S		--	1.04
Scale factor for scaling QA4 pairwise compare position ratios between GPS receivers	QA4_DELR_RATIO_SF	I-Load	F	S		--	1.04
Scale factor for scaling QA4 pairwise compare velocity ratios between GPS receivers	QA4_DELV_RATIO_SF	I-Load	F	S		--	1.04

Table 4.3.3.7-1. GPS Downlist Computations Input Parameters							
Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Selected GPS position vector	$\bar{R}_{GPS\_SEL}$	GPS SV select, GPS NAV State PROP	V	DP		ft	1.04
Flag indicating (ON) that state from the I'th GPS receiver has been selected on current navigation cycle to determine selected GPS state	$SEL\_RCVR_I^{**}$	GPS SV select	D	--	ON/OFF	--	1.04
Selected GPS state downlist position scale factor	SF_POS	I-load	F	S		--	1.04
Selected GPS state downlist velocity scale factor	SF_VEL	I-load	F	S		--	1.04
Selected GPS time tag	$T_{GPS\_SEL}$	GPS SV select, GPS NAV State PROP	F	DP		sec	1.04
Selected GPS velocity vector	$\bar{V}_{GPS\_SEL}$	GPS SV select, GPS NAV State PROP	V	DP		ft/sec	1.04

\* See principal function input list in Table 4.3.3.8-1.

\*\* I = 1, 2, 3(1 to GPS\_SW\_CAP)

Table 4.3.3.7-2. GPS Downlist Computations Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Maximum component-wise QA2 position residual ratio for downlist	DELR_RATIO_QA2_DL	*	I	S		--	1.04
Maximum component-wise QA2 velocity residual ratio for downlist	DELV_RATIO_QA2_DL	*	I	S		--	1.04
QA3 position residual ratio for downlist	DELR_RATIO_QA3_DL	*	I	S		--	1.04
QA3 velocity residual ratio for downlist	DELV_RATIO_QA3_DL	*	I	S		--	1.04
Data word containing downlist data	GPS_COLLECTION_WORD	*	HMD	16 Bits			1.04
Data word 2 containing downlist data	GPS_COLLECTION_WORD_TWO	*	HMD	16 Bits			1.04
QA2 position residual for selected GPS state for downlist	GPS_SEL_DELR_UVW_DL	*	I	S		ft	
QA2 velocity residual for selected GPS state for downlist	GPS_SEL_DELV_UVW_DL	*	I	S		fps	
Scaled QA4 pairwise compare position ratio between GPS receivers 1 and 2 for downlist	DELR_RATIO_QA4_1_2_DL	*	I	S		—	1.04
Scaled QA4 pairwise compare position ratio between GPS receivers 1 and 3 for downlist	DELR_RATIO_QA4_1_3_DL	*	I	S		—	1.04
Scaled QA4 pairwise compare position ratio between GPS receivers 2 and 3 for downlist	DELR_RATIO_QA4_2_3_DL	*	I	S		—	1.04

Table 4.3.3.7-2. GPS Downlist Computations Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Scaled QA4 pairwise compare velocity ratio between GPS receivers 1 and 2 for downlist	DELV_RATIO_QA4_1_2_DL	*	I	S		—	1.04
Scaled QA4 pairwise compare velocity ratio between GPS receivers 1 and 3 for downlist	DELV_RATIO_QA4_1_3_DL	*	I	S		—	1.04
Scaled QA4 pairwise compare velocity ratio between GPS receivers 2 and 3 for downlist	DELV_RATIO_QA4_2_3_DL	*	I	S		—	1.04
Data collection word three containing downlist data	GPS_COLLECTION_WORD_THREE	*	HMD	16 bits		—	1.04
Data collection word four containing downlist data	GPS_COLLECTION_WORD_FOUR	*	HMD	16 bits		—	1.04
Data collection word five containing downlist data	GPS_COLLECTION_WORD_FIVE	*	HMD	16 bits		—	1.04
QA2 DT for downlist	DT_QA2_DL	*	I	S		sec	
Latitude of selected GPS state for downlist	GPS_SEL_LAT_DL	*	I	S		deg	
Longitude of selected GPS state for downlist	GPS_SEL_LON_DL	*	I	S		deg	
Altitude of selected GPS state for downlist	GPS_SEL_ALT_DL	*	I	S		nm	
QA2 RTOL UVW for downlist	$\bar{R}$ GPS_QA2_RTOL_UVW_DL	*	I array (3)	S		ft	
QA2 VTOL UVW for downlist	$\bar{R}$ GPS_QA2_VTOL_UVW_DL	*	I array (3)	S		fps	
Selected GPS position vector for downlist	$\bar{R}$ _GPS_SEL_DL	*	I array (3)	D		ft	

Table 4.3.3.7-2. GPS Downlist Computations Output Parameters							
Description	Symbol	Output Dest	Type	Prec	Range	Units	Sample Rate
Selected GPS state time tag for downlist	T_GPS_SEL_DL	*	F	DP		sec	1.04
Selected GPS velocity vector for downlist	$\bar{V}$ _GPS_SEL_DL	*	I array (3)	D		fps	
Magnitude of the vector difference between the selected GPS position estimate and the NAV filter position scaled for downlist	DELR_GPS_SEL_DL	*	I	S		ft	1.04
QA2 GPS-to-filter position vector residual ratio for selected GPS state scaled for downlist	DELR_RATIO_GPS_SEL_DL	*	I	S		_	1.04
Magnitude of the vector difference between the selected GPS velocity estimate and the NAV filter velocity scaled for downlist	DELV_GPS_SEL_DL	*	I	S		fps	1.04
QA2 GPS-to-filter velocity vector residual ratio for selected GPS state scaled for downlist	DELV_RATIO_GPS_SEL_DL	*	I	S		_	1.04
Metering gain applied to scale the user parameter reset state on the current cycle scaled for downlist	METER_SF_DL	*	I	S		_	1.04

\* See principal function output list in Table 4.3.3.8-2.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Table 4.3.3.7-3. Definition of GPS_COLLECTION_WORD					
Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
Spare		0			
MLS AUTO/INHIBIT/ FORCE command snapped by navigation	V94J0993C	1-2	0 1 1 0 1 1	MLS A/I/F set to AUTO MLS A/I/F set to INHIBIT MLS A/I/F set to FORCE	MLS_AIF_RCVD
Crew Deselect GPS 1 Command flag	V93X1232X	3	1	GPS receiver 1 deselected	CREW_DES_RCVR_RCVD(1)
Crew Deselect GPS 2 Command flag	V93X1148X	4	1	GPS receiver 2 deselected	CREW_DES_RCVR_RCVD(2)
Crew Deselect GPS 3 Command flag	V93X1233X	5	1	GPS receiver 3 deselected	CREW_DES_RCVR_RCVD(3)
GPS 1 Navigation Data Good flag	V93X1234X	6	1	Valid navigation data from GPS receiver 1	GPS_DG_SF(1)
GPS 2 Navigation Data Good flag	V93X1149X	7	1	Valid navigation data from GPS receiver 2	GPS_DG_SF(2)
GPS 3 Navigation Data Good flag	V93X1235X	8	1	Valid navigation data from GPS receiver 3	GPS_DG_SF(3)
Spare		9		Not used	
GPS to GC Auto/Inhibit/Force Setting	V93J1145C	10-11	0 1 1 0 1 1	GPS AIF in AUTO GPS AIF in INHIBIT GPS AIF in FORCE	GPS_AIF_RCVD
Flag indicating no GPS state selected for an I-loaded period of time	V94X1012X	12	1	No GPS states pass all the QA checks	GPS_OFF_ALERT
GPS to NAV Auto/Inhibit/	V93X1146X	13	1 0	GPS TO NAV in AUTO GPS TO NAV in INHIBIT	GPS_TO_NAV_RCVD



Table 4.3.3.7-3. Definition of GPS_COLLECTION_WORD					
Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS to NAV Force Setting	V93X1147X	14	1	GPS TO NAV FORCE is ON	GPS_TO_NAV_FORCE_RCVD
			0	GPS TO NAV FORCE is OFF	
Spare		15			

Table 4.3.3.7-4. Definition of GPS_COLLECTION_WORD_TWO					
Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS 2 fail QA	V93X1236X	0	1	GPS 2 has failed at least one of the quality assessment checks	GPS_FAIL_QA(2)
GPS 2 fail QA2	V93X1176X	1	1	GPS 2 has failed second quality assessment check	GPS_FAIL_QA2(2)
GPS 2 fail QA2 position check	V93X1177X	2	1	GPS 2 has failed second quality assessment position check	GPS_FAIL_QA2_R(2)
GPS 2 fail QA2 velocity check	V93X1178X	3	1	GPS 2 has failed second quality assessment velocity check	GPS_FAIL_QA2_V(2)
GPS 2 fail QA3	V93X1179X	4	1	GPS 2 has failed third quality assessment check	GPS_FAIL_QA3(2)
GPS 2 fail QA3 position check	V93X1180X	5	1	GPS 2 has failed third quality assessment position check	GPS_FAIL_QA3_R(2)

Table 4.3.3.7-4. Definition of GPS\_COLLECTION\_WORD\_TWO

Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS 2 fail QA3 velocity check	V93X1181X	6	1	GPS 2 has failed third quality assessment velocity check	GPS_FAIL_QA3_V(2)
Flag indicating GPS 2 failed the figure of merit check	V93X1153X	7	1 0	GPS 2 failed FOM check GPS 2 did not fail FOM check	GPS_FAIL_FOM(2)
GPS 1 state selected	V93X3560X	8	1	GPS 1 state has been used in obtaining selected GPS state	SEL_RCVR(1)
GPS 2 state selected	V93X3561X	9	1	GPS 2 state has been used in obtaining selected GPS state	SEL_RCVR(2)
GPS 3 state selected	V93X3562X	10	1	GPS 3 state has been used in obtaining selected GPS state	SEL_RCVR(3)
Crew metering override command	V93X3577X	11	1	Crew has commanded that UPP state not be metered by the UPP reset metering function	CREW_METERING_OVERRIDE
UPP reset state is being metered	V93X3581X	12	1	User parameter reset state is being metered	METER_FLAG

Table 4.3.3.7-5. Definition of GPS\_COLLECTION\_WORD\_THREE

Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS3 QA fail flag	V93X3200X	0	1	GPS 3 has failed at least one of the quality assessment checks	GPS_FAIL_QA(3)
GPS3 QA2 fail flag	V93X3201X	1	1	GPS 3 has failed second quality assessment check	GPS_FAIL_QA2(3)
GPS3 QA2 position fail flag	V93X3202X	2	1	GPS 3 has failed second quality assessment position check	GPS_FAIL_QA2_R(3)
GPS3 QA2 velocity fail flag	V93X3203X	3	1	GPS 3 has failed second quality assessment velocity check	GPS_FAIL_QA2_V(3)
GPS3 QA3 fail flag	V93X3204X	4	1	GPS 3 has failed third quality assessment check	GPS_FAIL_QA3(3)
GPS3 QA3 position fail flag	V93X3205X	5	1	GPS 3 has failed third quality assessment position check	GPS_FAIL_QA3_R(3)
GPS3 QA3 velocity fail flag	V93X3206X	6	1	GPS 3 has failed third quality assessment velocity check	GPS_FAIL_QA3_V(3)
GPS3 figure of merit fail flag	V93X3207X	7	1	GPS 3 has failed figure of merit check	GPS_FAIL_FOM(3)
GPS1 QA fail flag	V93X3208X	8	1	GPS 1 has failed at least one of the quality assessment check	GPS_FAIL_QA(1)
GPS1 QA2 fail flag	V93X3209X	9	1	GPS 1 has failed second quality assessment checks	GPS_FAIL_QA2(1)

Table 4.3.3.7-5. Definition of GPS\_COLLECTION\_WORD\_THREE

Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS1 QA2 position fail flag	V93X3210X	10	1	GPS 1 has failed second quality assessment position check	GPS_FAIL_QA2_R(1)
GPS1 QA2 velocity fail flag	V93X3211X	11	1	GPS 1 has failed second quality assessment velocity check	GPS_FAIL_QA2_V(1)
GPS1 QA3 fail flag	V93X3212X	12	1	GPS1 has failed third quality assessment check	GPS_FAIL_QA3(1)
GPS1 QA3 position fail flag	V93X3213X	13	1	GPS 1 has failed third quality assessment position check	GPS_FAIL_QA3_R(1)
GPS1 QA3 velocity fail flag	V93X3214X	14	1	GPS 1 has failed third quality assessment velocity check	GPS_FAIL_QA3_V(1)
GPS1 figure of merit fail flag	V93X3215X	15	1	GPS 1 has failed figure of merit check	GPS_FAIL_FOM(1)

Table 4.3.3.7-6. Definition of GPS\_COLLECTION\_WORD\_FOUR

Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS1 QA4 fail flag	V93X3236X	0	1	GPS 1 has failed QA4 quality assessment check	GPS_FAIL_QA4(1)
GPS2 QA4 fail flag	V93X3176X	1	1	GPS 2 has failed QA4 quality assessment check	GPS_FAIL_QA4(2)
GPS3 QA4 fail flag	V93X3177X	2	1	GPS 3 has failed QA4 quality assessment check	GPS_FAIL_QA4(3)
GPS QA4 LRU 1 and 2 position fail flag	V93X3178X	3	1	GPS LRUs 1 and 2 have failed position pairwise compare flag	GPS_FAIL_QA4_R_1_2
GPS QA4 LRU 1 and 2 velocity fail flag	V93X3179X	4	1	GPS LRUs 1 and 2 have failed velocity pairwise compare flag	GPS_FAIL_QA4_V_1_2
GPS QA4 LRU 1 and 3 position fail flag	V93X3180X	5	1	GPS LRUs 1 and 3 have failed position pairwise compare flag	GPS_FAIL_QA4_R_1_3
GPS QA4 LRU 1 and 3 velocity fail flag	V93X3181X	6	1	GPS LRUs 1 and 3 have failed velocity pairwise compare flag	GPS_FAIL_QA4_V_1_3
GPS QA4 LRU 2 and 3 position fail flag	V93X1631X	7	1	GPS LRUs 2 and 3 have failed position pairwise compare flag	GPS_FAIL_QA4_R_2_3
GPS QA4 LRU 2 and 3 velocity fail flag	V93X1632X	8	1	GPS LRUs 2 and 3 have failed velocity pairwise compare flag	GPS_FAIL_QA4_V_2_3
GPS1 QA4 dilemma flag	V93X3563X	9	1	GPS1 has a dilemma condition	GPS_QA4_DILEMMA(1)

Table 4.3.3.7-6. Definition of GPS\_COLLECTION\_WORD\_FOUR

Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS2 QA4 dilemma flag	V93X3564X	10	1	GPS2 has a dilemma condition	GPS_QA4_DILEMMA(2)
GPS3 QA4 dilemma flag	V93X3565X	11	1	GPS 3 has a dilemma condition	GPS_QA4_DILEMMA(3)
Selected GPS state QA2 position residual ratio status	V93J3571C	12-13	00	Selected GPS state QA2 position residual ratio is less than one (blank)	DELR_RATIO_GPS_SEL_ST
			01	Selected GPS state QA2 position residual ratio is greater than one (down arrow)	
			10	Selected GPS state has been chosen from a receiver whose quality assessment override has been set by the crew (up arrow)	
Selected GPS state QA2 velocity residual ratio status	V93J3573C	14-15	00	Selected GPS state QA2 velocity residual ratio is less than one (blank)	DELV_RATIO_GPS_SEL_ST
			01	Selected GPS state QA2 velocity residual ratio is greater than one (down arrow)	
			10	Selected GPS state has been chosen from a receiver whose quality assessment override has been set by the crew	

Table 4.3.3.7-7. Definition of GPS_COLLECTION_WORD_FIVE					
Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS1 figure of merit, FOM, used by navigation	V93U3567C	0-3	0000	FOM = 0	FOM_NAV (1)
			0001	FOM = 1	
			0010	FOM = 2	
			0011	FOM = 3	
			0100	FOM = 4	
			0101	FOM = 5	
			0110	FOM = 6	
			0111	FOM = 7	
			1000	FOM = 8	
			1001	FOM = 9	
GPS2 figure of merit, FOM, used by navigation	V93U3568C	4-7	0000	FOM = 0	FOM_NAV(2)
			0001	FOM = 1	
			0010	FOM = 2	
			0011	FOM = 3	
			0100	FOM = 4	
			0101	FOM = 5	
			0110	FOM = 6	
			0111	FOM = 7	
			1000	FOM = 8	
			1001	FOM = 9	
GPS3 figure of merit, FOM, used by navigation	V93U3569C	8-11	0000	FOM = 0	FOM_NAV(3)
			0001	FOM = 1	
			0010	FOM = 2	
			0011	FOM = 3	
			0100	FOM = 4	
			0101	FOM = 5	
			0110	FOM = 6	
			0111	FOM = 7	
			1000	FOM = 8	
			1001	FOM = 9	
GPS1 QA override flag	V93X3574X	12	1	GPS 1 quality assessment results have been overridden by the crew	CREW_QA_OVERRIDE_RCVD(1)

Table 4.3.3.7-7. Definition of GPS_COLLECTION_WORD_FIVE					
Parameter Description	MSID No.	Bit No.	Bit Value	Meaning	Related Parameter
GPS2 QA override flag	V93X3575X	13	1	GPS 2 quality assessment results have been overridden by the crew	CREW_QA_OVERRIDE_RCVD(2)
GPS3 QA override flag	V93X3576X	14	1	GPS 3 quality assessment results have been overridden by the crew	CREW_QA_OVERRIDE_RCVD(3)

#### 4.3.3.8 GPS Receiver State Processing (4.21) Principal Function Tables

This section contains input/output, I-loads, K-loads, and constants for the GPS receiver state processing principal function.



TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALT	V95H0175CA	CURR ORB ALT ABOVE REF ELLIPSOID	RTLS UPP	FT	SPL		93017G	*
ALT	V95H0175CC	CURR ORB ALT ABOVE REF ELLIPSOID	ENT UPP	FT	SPL		93017G	*
ALT	V95H0175CD	CURR ORB ALT ABOVE REF ELLIPSOID	TAEM UPP	FT	SPL		93017G	*
ALT	V95H0175CE	CURR ORB ALT ABOVE REF ELLIPSOID	A/L UPP	FT	SPL		93017G	*
CREW_DESELECT_RCVR(1)	V93X1205XA	DESELECT GPS 1 RCVR CMD	GPS STATUS DISP		BD		92817C	
CREW_DESELECT_RCVR(1)	V93X1205XB	DESELECT GPS 1 RCVR CMD	HORIZ SIT DISP		BD		92817C	
CREW_DESELECT_RCVR(1)	V93X1205XC	DESELECT GPS 1 RCVR CMD	REL NAV DISP		BD		92817C	
CREW_DESELECT_RCVR(2)	V93X1206XA	DESELECT GPS 2 RCVR CMD	GPS STATUS DISP		BD		92817C	
CREW_DESELECT_RCVR(2)	V93X1206XB	DESELECT GPS 2 RCVR CMD	HORIZ SIT DISP		BD		92817C	
CREW_DESELECT_RCVR(2)	V93X1206XC	DESELECT GPS 2 RCVR CMD	REL NAV DISP		BD		92817C	
CREW_DESELECT_RCVR(3)	V93X1207XA	DESELECT GPS 3 RCVR CMD	GPS STATUS DISP		BD		92817C	
CREW_DESELECT_RCVR(3)	V93X1207XB	DESELECT GPS 3 RCVR CMD	HORIZ SIT DISP		BD		92817C	
CREW_DESELECT_RCVR(3)	V93X1207XC	DESELECT GPS 3 RCVR CMD	REL NAV DISP		BD		92817C	
CREW_METERING_OVERRIDE	V93X1534X	CREW OVERRIDE UPP RESET MTRNG	GPS STATUS DISP		BD		92067D	
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FOM(1)	V94H0982CA	GPS 1 FOM SNAPPED	ENT NAV		HXS		91051K	
FOM(1)	V94H0982CB	GPS 1 FOM SNAPPED	PRELAND NAV		HXS		91051K	
FOM(1)	V94H0982CC	GPS 1 FOM SNAPPED	ORB/RND NAV		HXS		91051K	
FOM(1)	V94H0982CD	GPS 1 FOM SNAPPED	RTLS NAV		HXS		92067D	
FOM(2)	V94H0983CA	GPS 2 FOM SNAPPED	ENT NAV		HXS		91051K	
FOM(2)	V94H0983CB	GPS 2 FOM SNAPPED	PRELAND NAV		HXS		91051K	
FOM(2)	V94H0983CC	GPS 2 FOM SNAPPED	ORB/RND NAV		HXS		91051K	
FOM(2)	V94H0983CD	GPS 2 FOM SNAPPED	RTLS NAV		HXS		92067D	
FOM(3)	V94H0984CA	GPS 3 FOM SNAPPED	ENT NAV		HXS		91051K	
FOM(3)	V94H0984CB	GPS 3 FOM SNAPPED	PRELAND NAV		HXS		91051K	
FOM(3)	V94H0984CC	GPS 3 FOM SNAPPED	ORB/RND NAV		HXS		91051K	
FOM(3)	V94H0984CD	GPS 3 FOM SNAPPED	RTLS NAV		HXS		92067D	
GPS_AIF_RCVD	V94J1042CA	GPS TO G&C AUT/INH/FOR FLAG FDBK	ENT NAV		HXS		91051K	
GPS_AIF_RCVD	V94J1042CB	GPS TO G&C AUT/INH/FOR FLAG FDBK	PRELAND NAV		HXS		91051K	
GPS_AIF_RCVD	V94J1042CC	GPS TO G&C AUT/INH/FOR FLAG FDBK	ORB/RND NAV		HXS		91051K	
GPS_AIF_RCVD	V94J1042CD	GPS TO G&C AUT/INH/FOR FLAG FDBK	RTLS NAV		HXS		92067D	
GPS_BYPASS(1)	V91X0026X	FF1 GPS1 BYPASS (GPS)	FCOS		BD		92289A	
GPS_BYPASS(2)	V91X0027X	FF2 GPS2 BYPASS (GPS)	FCOS		BD		92289A	
GPS_BYPASS(3)	V91X0028X	FF3 GPS3 BYPASS (GPS)	FCOS		BD		92289A	
GPS_DG(1)	V90X3450XA	GPS 1 DG SNAPPED	ENT NAV		BD		91051K	
GPS_DG(1)	V90X3450XB	GPS 1 DG SNAPPED	PRELAND NAV		BD		91051K	
GPS_DG(1)	V90X3450XC	GPS 1 DG SNAPPED	ORB/RND NAV		BD		91051K	
GPS_DG(1)	V90X3450XD	GPS 1 DG SNAPPED	RTLS NAV		BD		92067D	
GPS_DG(2)	V90X3451XA	GPS 2 DG SNAPPED	ENT NAV		BD		91051K	
GPS_DG(2)	V90X3451XB	GPS 2 DG SNAPPED	PRELAND NAV		BD		91051K	
GPS_DG(2)	V90X3451XC	GPS 2 DG SNAPPED	ORB/RND NAV		BD		91051K	
GPS_DG(2)	V90X3451XD	GPS 2 DG SNAPPED	RTLS NAV		BD		92067D	
GPS_DG(3)	V90X3452XA	GPS 3 DG SNAPPED	ENT NAV		BD		91051K	
GPS_DG(3)	V90X3452XB	GPS 3 DG SNAPPED	PRELAND NAV		BD		91051K	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_DG(3)	V90X3452XC	GPS 3 DG SNAPPED	ORB/RND NAV		BD		91051K	
GPS_DG(3)	V90X3452XD	GPS 3 DG SNAPPED	RTLS NAV		BD		92067D	
GPS_DG_SF_PREV(1)	V90X3536XA	GPS 1 PREV DG SEL FILT	D/L NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(1)	V90X3536XB	GPS 1 PREV DG SEL FILT	ORB/RND NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(1)	V90X3536XC	GPS 1 PREV DG SEL FILT	ASC NAV SEQ		BD		92067D	
GPS_DG_SF_PREV(2)	V90X3537XA	GPS 2 PREV DG SEL FILT	D/L NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(2)	V90X3537XB	GPS 2 PREV DG SEL FILT	ORB/RND NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(2)	V90X3537XC	GPS 2 PREV DG SEL FILT	ASC NAV SEQ		BD		92067D	
GPS_DG_SF_PREV(3)	V90X3538XA	GPS 3 PREV DG SEL FILT	D/L NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(3)	V90X3538XB	GPS 3 PREV DG SEL FILT	ORB/RND NAV SEQ		BD		91051K	
GPS_DG_SF_PREV(3)	V90X3538XC	GPS 3 PREV DG SEL FILT	ASC NAV SEQ		BD		92067D	
GPS_FAIL_FOM(1)	V90X3453XA	GPS 1 FAIL FOM SNAPPED	ENT NAV		BD		91051K	
GPS_FAIL_FOM(1)	V90X3453XB	GPS 1 FAIL FOM SNAPPED	PRELAND NAV		BD		91051K	
GPS_FAIL_FOM(1)	V90X3453XC	GPS 1 FAIL FOM SNAPPED	ORB/RND NAV		BD		91051K	
GPS_FAIL_FOM(1)	V90X3453XD	GPS 1 FAIL FOM SNAPPED	RTLS NAV		BD		92067D	
GPS_FAIL_FOM(2)	V90X3454XA	GPS 2 FAIL FOM SNAPPED	ENT NAV		BD		91051K	
GPS_FAIL_FOM(2)	V90X3454XB	GPS 2 FAIL FOM SNAPPED	PRELAND NAV		BD		91051K	
GPS_FAIL_FOM(2)	V90X3454XC	GPS 2 FAIL FOM SNAPPED	ORB/RND NAV		BD		91051K	
GPS_FAIL_FOM(2)	V90X3454XD	GPS 2 FAIL FOM SNAPPED	RTLS NAV		BD		92067D	
GPS_FAIL_FOM(3)	V90X3455XA	GPS 3 FAIL FOM SNAPPED	ENT NAV		BD		91051K	
GPS_FAIL_FOM(3)	V90X3455XB	GPS 3 FAIL FOM SNAPPED	PRELAND NAV		BD		91051K	
GPS_FAIL_FOM(3)	V90X3455XC	GPS 3 FAIL FOM SNAPPED	ORB/RND NAV		BD		91051K	
GPS_FAIL_FOM(3)	V90X3455XD	GPS 3 FAIL FOM SNAPPED	RTLS NAV		BD		92067D	
GPS_SV_SEL_AVAIL	V90X3081XA	GPS SEL STATE VCTR AVAIL FLAG	D/L NAV SEQ		BD		91051K	
GPS_SV_SEL_AVAIL	V90X3081XB	GPS SEL STATE VCTR AVAIL FLAG	ORB/RND NAV SEQ		BD		91051K	
GPS_SV_SEL_AVAIL	V90X3081XD	GPS SEL STATE VCTR AVAIL FLAG	ASC NAV SEQ		BD		92067D	
GPS_TO_NAV_AIF	V90J3463CA	GPS TO NAV AUTO/INHIBIT/FORCE FDBK	ENT NAV		HXS		92132C	
GPS_TO_NAV_AIF	V90J3463CB	GPS TO NAV AUTO/INHIBIT/FORCE FDBK	PRELAND NAV		HXS		92132C	
GPS_TO_NAV_AIF	V90J3463CC	GPS TO NAV AUTO/INHIBIT/FORCE FDBK	ORB/RND NAV		HXS		92132C	
GPS_TO_NAV_AIF	V90J3463CD	GPS TO NAV AUTO/INHIBIT/FORCE/FDBK	RTLS NAV		HXS		92132C	
GPS_TO_NAV_FORCE_RCVD	V90X3461XA	GPS TO NAV FORCE FLAG FDBK	ENT NAV		BD		91051K	
GPS_TO_NAV_FORCE_RCVD	V90X3461XB	GPS TO NAV FORCE FLAG FDBK	PRELAND NAV		BD		91051K	
GPS_TO_NAV_FORCE_RCVD	V90X3461XC	GPS TO NAV FORCE FLAG FDBK	ORB/RND NAV		BD		91051K	
GPS_TO_NAV_FORCE_RCVD	V90X3461XD	GPS TO NAV FORCE FLAG FDBK	RTLS NAV		BD		92067D	
GPS_TO_NAV_RCVD	V90X3462XA	GPS TO NAV AUT/INH FLAG FDBK	ENT NAV		BD		91051K	
GPS_TO_NAV_RCVD	V90X3462XB	GPS TO NAV AUT/INH FLAG FDBK	PRELAND NAV		BD		91051K	
GPS_TO_NAV_RCVD	V90X3462XC	GPS TO NAV AUT/INH FLAG FDBK	ORB/RND NAV		BD		91051K	
GPS_TO_NAV_RCVD	V90X3462XD	GPS TO NAV AUT/INH FLAG FDBK	RTLS NAV		BD		92067D	
METER_FLAG	V90X3678XA	UPP RES STTE METERING FLAG	ENT NAV		BD		92067D	
METER_FLAG	V90X3678XB	UPP RES STTE METERING FLAG	PRELAND NAV		BD		92067D	
METER_FLAG	V90X3678XC	UPP RES STTE METERING FLAG	RTLS NAV		BD		92067D	
METER_SF	V90U3677CA	UPP RES STTE METERING SCALE FACTOR	ENT NAV		SPL		92067D	
METER_SF	V90U3677CB	UPP RES STTE METERING SCALE FACTOR	PRELAND NAV		SPL		92067D	
METER_SF	V90U3677CC	UPP RES STTE METERING SCALE FACTOR	RTLS NAV		SPL		92067D	
MLS_AIF_RCVD	V94J6039CA	MLS AUTO/INH/FOR FLAG FDBK	PRELAND NAV		HXS		92571B	
MLS_AIF_RCVD	V94J6039CB	MLS AUTO/INH/FOR FLAG FDBK	RTLS NAV		HXS		92571B	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
MLS_AIF_RCVD	V94J6039CC	MLS AUTO/INH/FOR FLAG FDBK	ENT NAV		HXS		92571B	
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NAV_MM_CODE	V90J4263C	NAV MM CODE	ORB/RND NAV		HXS		93017G	*
NAV_MM_CODE	V90J4263CA	NAV MM CODE	ENT NAV		HXS		91051K	
NAV_MM_CODE	V90J4263CB	NAV MM CODE	PRELAND NAV		HXS		91051K	
NAV_MM_CODE	V90J4263CD	NAV MM CODE	RTLS NAV		HXS		92067D	
NOOP_GPS_GAX_MSGS	V90X3547XA	NOOP GPS GAX MSGS	D/L NAV SEQ		BD		91051K	
NOOP_GPS_GAX_MSGS	V90X3547XB	NOOP GPS GAX MSGS	ORB/RND NAV SEQ		BD		91051K	
NOOP_GPS_GAX_MSGS	V90X3547XC	NOOP GPS GAX MSGS	ASC NAV SEQ		BD		92067D	
NUM_GPS_INSTALLED	V90U3671C	NUMBER OF GPS RCVR INSTALLED	GPS SOP		HXS		92067D	
QA_OVERRIDE(1)	V93X1227X	QA OVERRIDE RCVR 1 CMD	GPS STATUS DISP		BD		91051K	
QA_OVERRIDE(2)	V93X1228X	QA OVERRIDE RCVR 2 CMD	GPS STATUS DISP		BD		91051K	
QA_OVERRIDE(3)	V93X1229X	QA OVERRIDE RCVR 3 CMD	GPS STATUS DISP		BD		91051K	
R_FILT(1)	V90H0584CC	X-COMP OF FLTR'S CURR POS VECTOR	ORB/RND NAV	FT			91051K	
R_FILT(1)	V90H0584CE	X-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(1)	V90H0584CG	X-COMP OF FLTR'S CURR POS VECTOR	RTLS NAV	FT	DPL		92067D	
R_FILT(2)	V90H0585CC	Y-COMP OF FLTR'S CURR POS VECTOR	ORB/RND NAV	FT			91051K	
R_FILT(2)	V90H0585CE	Y-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(2)	V90H0585CG	Y-COMP OF FLTR'S CURR POS VECTOR	RTLS NAV	FT	DPL		92067D	
R_FILT(3)	V90H0586CC	Z-COMP OF FLTR'S CURR POS VECTOR	ORB/RND NAV	FT			91051K	
R_FILT(3)	V90H0586CE	Z-COMP OF FLTR'S CURR POS VECTOR	ENT NAV	FT			92281D	
R_FILT(3)	V90H0586CG	Z-COMP OF FLTR'S CURR POS VECTOR	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(1,1)	V90H3467CA	GPS 1 WGS84 POS X-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(1,1)	V90H3467CB	GPS 1 WGS84 POS X-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,1)	V90H3467CC	GPS 1 WGS84 POS X-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,1)	V90H3467CD	GPS 1 WGS84 POS X-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(1,2)	V90H3468CA	GPS 1 WGS84 POS Y-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(1,2)	V90H3468CB	GPS 1 WGS84 POS Y-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,2)	V90H3468CC	GPS 1 WGS84 POS Y-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,2)	V90H3468CD	GPS 1 WGS84 POS Y-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(1,3)	V90H3469CA	GPS 1 WGS84 POS Z-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(1,3)	V90H3469CB	GPS 1 WGS84 POS Z-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,3)	V90H3469CC	GPS 1 WGS84 POS Z-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(1,3)	V90H3469CD	GPS 1 WGS84 POS Z-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(2,1)	V90H3470CA	GPS 2 WGS84 POS X-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(2,1)	V90H3470CB	GPS 2 WGS84 POS X-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,1)	V90H3470CC	GPS 2 WGS84 POS X-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,1)	V90H3470CD	GPS 2 WGS84 POS X-COMP	RTLS NAV	FT	DPL		92067D	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_GPS_ECEF(2,2)	V90H3471CA	GPS 2 WGS84 POS Y-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(2,2)	V90H3471CB	GPS 2 WGS84 POS Y-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,2)	V90H3471CC	GPS 2 WGS84 POS Y-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,2)	V90H3471CD	GPS 2 WGS84 POS Y-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(2,3)	V90H3472CA	GPS 2 WGS84 POS Z-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(2,3)	V90H3472CB	GPS 2 WGS84 POS Z-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,3)	V90H3472CC	GPS 2 WGS84 POS Z-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(2,3)	V90H3472CD	GPS 2 WGS84 POS Z-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(3,1)	V90H3473CA	GPS 3 WGS84 POS X-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(3,1)	V90H3473CB	GPS 3 WGS84 POS X-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,1)	V90H3473CC	GPS 3 WGS84 POS X-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,1)	V90H3473CD	GPS 3 WGS84 POS X-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(3,2)	V90H3474CA	GPS 3 WGS84 POS Y-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(3,2)	V90H3474CB	GPS 3 WGS84 POS Y-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,2)	V90H3474CC	GPS 3 WGS84 POS Y-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,2)	V90H3474CD	GPS 3 WGS84 POS Y-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_ECEF(3,3)	V90H3475CA	GPS 3 WGS84 POS Z-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_ECEF(3,3)	V90H3475CB	GPS 3 WGS84 POS Z-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,3)	V90H3475CC	GPS 3 WGS84 POS Z-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_ECEF(3,3)	V90H3475CD	GPS 3 WGS84 POS Z-COMP	RTLS NAV	FT	DPL		92067D	
T_CURRENT_FILT	V90W4749CB	SNAP TIME TAG CURR IMU/ATT DATA	ORB/RND NAV	S	DPL		93017G	*
T_CURRENT_FILT	V90W4749CC	SNAP TIME TAG CURR IMU/ATT DATA	ENT NAV	S	DPL		92281D	
T_CURRENT_FILT	V90W4749CD	SNAP TIME TAG CURR IMU/ATT DATA	PRELAND NAV	S	DPL		91051K	
T_CURRENT_FILT	V90W4749CE	SNAP TIME TAG CURR IMU/ATT DATA	RTLS NAV	S	DPL		92067D	
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS(1)	V90W3479CA	GPS 1 STATE TIME	ENT NAV	S	DPL		91051K	
T_GPS(1)	V90W3479CB	GPS 1 STATE TIME	PRELAND NAV	S	DPL		91051K	
T_GPS(1)	V90W3479CC	GPS 1 STATE TIME	ORB/RND NAV	S	DPL		91051K	
T_GPS(1)	V90W3479CD	GPS 1 STATE TIME	RTLS NAV	S	DPL		92067D	
T_GPS(2)	V90W3480CA	GPS 2 STATE TIME	ENT NAV	S	DPL		91051K	
T_GPS(2)	V90W3480CB	GPS 2 STATE TIME	PRELAND NAV	S	DPL		91051K	
T_GPS(2)	V90W3480CC	GPS 2 STATE TIME	ORB/RND NAV	S	DPL		91051K	
T_GPS(2)	V90W3480CD	GPS 2 STATE TIME	RTLS NAV	S	DPL		92067D	
T_GPS(3)	V90W3481CA	GPS 3 STATE TIME	ENT NAV	S	DPL		91051K	
T_GPS(3)	V90W3481CB	GPS 3 STATE TIME	PRELAND NAV	S	DPL		91051K	
T_GPS(3)	V90W3481CC	GPS 3 STATE TIME	ORB/RND NAV	S	DPL		91051K	
T_GPS(3)	V90W3481CD	GPS 3 STATE TIME	RTLS NAV	S	DPL		92067D	
T_GPS_LAST_UPDATE	V90W3556CA	TIME OF NAV RESET WITH SEL GPS	D/L NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CB	TIME OF NAV RESET WITH SEL GPS	ENT NAV	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CC	TIME OF NAV RESET WITH SEL GPS	PRELAND NAV	S	DPL		92214A	
T_GPS_LAST_UPDATE	V90W3556CD	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CE	TIME OF NAV RESET WITH SEL GPS	ORB/RND NAV	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CF	TIME OF NAV RESET WITH SEL GPS	ASC NAV SEQ	S	DPL		92369B	
T_GPS_LAST_UPDATE	V90W3556CG	TIME OF NAV RESET WITH SEL GPS	RTLS NAV	S	DPL		92067D	
T_GPS_OFF	V90W3543CA	TIME OF LAST SEL GPS BY SEL FILT	D/L NAV SEQ	S	DPL		91051K	
T_GPS_OFF	V90W3543CB	TIME OF LAST SEL GPS BY SEL FILTER	ORB/RND NAV SEQ	S	DPL		91051K	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
T_GPS_OFF	V90W3543CC	TIME OF LAST SEL GPS BY SEL FILT	ASC NAV SEQ	S	DPL		92067D	
T_GPS_OFF	V90W3543CD	TIME OF LAST SEL GPS BY SEL FILT	A/RTLS NAV SEQ	S	DPL		92165A	
T_LAST_GPS(1)	V90W3483CA	CURRENT GPS 1 STATE IMU TIME TAG	ENT NAV	S	DPL		92214A	
T_LAST_GPS(1)	V90W3483CB	CURRENT GPS 1 STATE IMU TIME TAG	PRELAND NAV	S	DPL		92214A	
T_LAST_GPS(1)	V90W3483CC	CURRENT GPS 1 STATE IMU TIME TAG	ORB/RND NAV	S	DPL		91051K	
T_LAST_GPS(1)	V90W3483CD	CURRENT GPS 1 STATE IMU TIME TAG	RTLS NAV	S	DPL		92067D	
T_LAST_GPS(2)	V90W3484CA	CURRENT GPS 2 STATE IMU TIME TAG	ENT NAV	S	DPL		91051K	
T_LAST_GPS(2)	V90W3484CB	CURRENT GPS 2 STATE IMU TIME TAG	PRELAND NAV	S	DPL		91051K	
T_LAST_GPS(2)	V90W3484CC	CURRENT GPS 2 STATE IMU TIME TAG	ORB/RND NAV	S	DPL		91051K	
T_LAST_GPS(2)	V90W3484CD	CURRENT GPS 2 STATE IMU TIME TAG	RTLS NAV	S	DPL		92067D	
T_LAST_GPS(3)	V90W3485CA	CURRENT GPS 3 STATE IMU TIME TAG	ENT NAV	S	DPL		91051K	
T_LAST_GPS(3)	V90W3485CB	CURRENT GPS 3 STATE IMU TIME TAG	PRELAND NAV	S	DPL		91051K	
T_LAST_GPS(3)	V90W3485CC	CURRENT GPS 3 STATE IMU TIME TAG	ORB/RND NAV	S	DPL		91051K	
T_LAST_GPS(3)	V90W3485CD	CURRENT GPS 3 STATE IMU TIME TAG	RTLS NAV	S	DPL		92067D	
T_RESET	V90W0225CA	TIME OF FILTER STATE VCTR	ASC NAV	S			92132C	
T_RESET	V90W0225CF	TIME OF FILTER STATE VCTR	RTLS NAV	S			92132C	
T_RESET	V90W0534CC	TIME OF FILTER STATE VECTOR	PRELAND NAV	S			93017G	*
T_RESET	V90W0534CD	TIME OF FILTER STATE VECTOR	D/L NAV SEQ	S			93017G	*
T_RESET	V90W0534CE	TIME OF FILTER STATE VECTOR	ENT NAV	S			93017G	*
T_RESET	V90W0534CG	TIME OF FILTER STATE VCTR	ORB/RND NAV	S			92834C	
T_RESET	V90W0534CH	TIME OF FILTER STATE VCTR	ORB/RND NAV SEQ	S			92834C	
V_CURRENT_FILT(1)	V90L8927CD	SNAPPED SEL TOTAL X VEL M50	ORB/RND NAV	FT/S	DPL		93017G	*
V_CURRENT_FILT(1)	V90L8927CE	SNAPPED SEL TOTAL X VEL M50	ENT NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(1)	V90L8927CF	SNAPPED SEL TOTAL X VEL M50	PRELAND NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(1)	V90L8927CG	SNAPPED SEL TOTAL X VEL M50	RTLS NAV	FT/S	DPL		92067D	
V_CURRENT_FILT(2)	V90L8928CD	SNAPPED SEL TOTAL Y VEL M50	ORB/RND NAV	FT/S	DPL		93017G	*
V_CURRENT_FILT(2)	V90L8928CE	SNAPPED SEL TOTAL Y VEL M50	ENT NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(2)	V90L8928CF	SNAPPED SEL TOTAL Y VEL M50	PRELAND NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(2)	V90L8928CG	SNAPPED SEL TOTAL Y VEL M50	RTLS NAV	FT/S	DPL		92067D	
V_CURRENT_FILT(3)	V90L8929CD	SNAPPED SEL TOTAL Z VEL M50	ORB/RND NAV	FT/S	DPL		93017G	*
V_CURRENT_FILT(3)	V90L8929CE	SNAPPED SEL TOTAL Z VEL M50	ENT NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(3)	V90L8929CF	SNAPPED SEL TOTAL Z VEL M50	PRELAND NAV	FT/S	DPL		91051K	
V_CURRENT_FILT(3)	V90L8929CG	SNAPPED SEL TOTAL Z VEL M50	RTLS NAV	FT/S	DPL		92067D	
V_FILT(1)	V90L0624CC	X-COMP OF FLTR'S CURR VEL VECTOR	ORB/RND NAV	FT/S	SPL		91051K	
V_FILT(1)	V90L0624CE	X-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(1)	V90L0624CF	X-COMP OF FLTR'S CURR VEL VECTOR	PRELAND NAV	FT/S	SPL		92105B	
V_FILT(1)	V90L0624CG	X-COMP OF FLTR'S CURR VEL VECTOR	RTLS NAV	FT/S	SPL		92067D	
V_FILT(2)	V90L0625CC	Y-COMP OF FLTR'S CURR VEL VECTOR	ORB/RND NAV	FT/S	SPL		91051K	
V_FILT(2)	V90L0625CE	Y-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(2)	V90L0625CF	Y-COMP OF FLTR'S CURR VEL VECTOR	PRELAND NAV	FT/S	SPL		92105B	
V_FILT(2)	V90L0625CG	Y-COMP OF FLTR'S CURR VEL VECTOR	RTLS NAV	FT/S	SPL		92067D	
V_FILT(3)	V90L0626CC	Z-COMP OF FLTR'S CURR VEL VECTOR	ORB/RND NAV	FT/S	SPL		91051K	
V_FILT(3)	V90L0626CE	Z-COMP OF FLTR'S CURR VEL VECTOR	ENT NAV	FT/S	SPL		92281D	
V_FILT(3)	V90L0626CF	Z-COMP OF FLTR'S CURR VEL VECTOR	PRELAND NAV	FT/S	SPL		92105B	
V_FILT(3)	V90L0626CG	Z-COMP OF FLTR'S CURR VEL VECTOR	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(1,1)	V90L3486CA	GPS 1 WGS84 VEL X-COMP	ENT NAV	FT/S	SPL		91051K	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GPS_ECEF(1,1)	V90L3486CB	GPS 1 WGS84 VEL X-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,1)	V90L3486CC	GPS 1 WGS84 VEL X-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,1)	V90L3486CD	GPS 1 WGS84 VEL X-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(1,2)	V90L3487CA	GPS 1 WGS84 VEL Y-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,2)	V90L3487CB	GPS 1 WGS84 VEL Y-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,2)	V90L3487CC	GPS 1 WGS84 VEL Y-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,2)	V90L3487CD	GPS 1 WGS84 VEL Y-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(1,3)	V90L3488CA	GPS 1 WGS84 VEL Z-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,3)	V90L3488CB	GPS 1 WGS84 VEL Z-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,3)	V90L3488CC	GPS 1 WGS84 VEL Z-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(1,3)	V90L3488CD	GPS 1 WGS84 VEL Z-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(2,1)	V90L3489CA	GPS 2 WGS84 VEL X-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,1)	V90L3489CB	GPS 2 WGS84 VEL X-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,1)	V90L3489CC	GPS 2 WGS84 VEL X-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,1)	V90L3489CD	GPS 2 WGS84 VEL X-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(2,2)	V90L3490CA	GPS 2 WGS84 VEL Y-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,2)	V90L3490CB	GPS 2 WGS84 VEL Y-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,2)	V90L3490CC	GPS 2 WGS84 VEL Y-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,2)	V90L3490CD	GPS 2 WGS84 VEL Y-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(2,3)	V90L3491CA	GPS 2 WGS84 VEL Z-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,3)	V90L3491CB	GPS 2 WGS84 VEL Z-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,3)	V90L3491CC	GPS 2 WGS84 VEL Z-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(2,3)	V90L3491CD	GPS 2 WGS84 VEL Z-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(3,1)	V90L3492CA	GPS 3 WGS84 VEL X-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,1)	V90L3492CB	GPS 3 WGS84 VEL X-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,1)	V90L3492CC	GPS 3 WGS84 VEL X-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,1)	V90L3492CD	GPS 3 WGS84 VEL X-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(3,2)	V90L3493CA	GPS 3 WGS84 VEL Y-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,2)	V90L3493CB	GPS 3 WGS84 VEL Y-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,2)	V90L3493CC	GPS 3 WGS84 VEL Y-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,2)	V90L3493CD	GPS 3 WGS84 VEL Y-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_ECEF(3,3)	V90L3494CA	GPS 3 WGS84 VEL Z-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,3)	V90L3494CB	GPS 3 WGS84 VEL Z-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,3)	V90L3494CC	GPS 3 WGS84 VEL Z-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_ECEF(3,3)	V90L3494CD	GPS 3 WGS84 VEL Z-COMP	RTLS NAV	FT/S	SPL		92067D	
V_LAST_GPS(1,1)	V90L3515CA	IMU ACCUM X VEL FOR GPS 1	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,1)	V90L3515CB	IMU ACCUM X VEL FOR GPS 1	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,1)	V90L3515CC	IMU ACCUM X VEL FOR GPS 1	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,1)	V90L3515CD	IMU ACCUM X VEL FOR GPS 1	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(1,2)	V90L3516CA	IMU ACCUM Y VEL FOR GPS 1	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,2)	V90L3516CB	IMU ACCUM Y VEL FOR GPS 1	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,2)	V90L3516CC	IMU ACCUM Y VEL FOR GPS 1	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,2)	V90L3516CD	IMU ACCUM Y VEL FOR GPS 1	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(1,3)	V90L3517CA	IMU ACCUM Z VEL FOR GPS 1	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,3)	V90L3517CB	IMU ACCUM Z VEL FOR GPS 1	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(1,3)	V90L3517CC	IMU ACCUM Z VEL FOR GPS 1	ORB/RND NAV	FT/S	DPL		91051K	

TABLE 4.3.3.8-1. INPUT FUNCTIONAL PARAMETERS FOR GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_LAST_GPS(1,3)	V90L3517CD	IMU ACCUM Z VEL FOR GPS 1	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(2,1)	V90L3518CA	IMU ACCUM X VEL FOR GPS 2	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,1)	V90L3518CB	IMU ACCUM X VEL FOR GPS 2	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,1)	V90L3518CC	IMU ACCUM X VEL FOR GPS 2	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,1)	V90L3518CD	IMU ACCUM X VEL FOR GPS 2	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(2,2)	V90L3519CA	IMU ACCUM Y VEL FOR GPS 2	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,2)	V90L3519CB	IMU ACCUM Y VEL FOR GPS 2	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,2)	V90L3519CC	IMU ACCUM Y VEL FOR GPS 2	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,2)	V90L3519CD	IMU ACCUM Y VEL FOR GPS 2	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(2,3)	V90L3520CA	IMU ACCUM Z VEL FOR GPS 2	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,3)	V90L3520CB	IMU ACCUM Z VEL FOR GPS 2	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,3)	V90L3520CC	IMU ACCUM Z VEL FOR GPS 2	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(2,3)	V90L3520CD	IMU ACCUM Z VEL FOR GPS 2	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(3,1)	V90L3521CA	IMU ACCUM X VEL FOR GPS 3	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,1)	V90L3521CB	IMU ACCUM X VEL FOR GPS 3	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,1)	V90L3521CC	IMU ACCUM X VEL FOR GPS 3	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,1)	V90L3521CD	IMU ACCUM X VEL FOR GPS 3	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(3,2)	V90L3522CA	IMU ACCUM Y VEL FOR GPS 3	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,2)	V90L3522CB	IMU ACCUM Y VEL FOR GPS 3	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,2)	V90L3522CC	IMU ACCUM Y VEL FOR GPS 3	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,2)	V90L3522CD	IMU ACCUM Y VEL FOR GPS 3	RTLS NAV	FT/S	DPL		92067D	
V_LAST_GPS(3,3)	V90L3523CA	IMU ACCUM Z VEL FOR GPS 3	ENT NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,3)	V90L3523CB	IMU ACCUM Z VEL FOR GPS 3	PRELAND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,3)	V90L3523CC	IMU ACCUM Z VEL FOR GPS 3	ORB/RND NAV	FT/S	DPL		91051K	
V_LAST_GPS(3,3)	V90L3523CD	IMU ACCUM Z VEL FOR GPS 3	RTLS NAV	FT/S	DPL		92067D	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
CORR_COEFF_GPS(1)	V90U3068C	GPS COV U V CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(2)	V90U3069C	GPS COV U UDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(3)	V90U3070C	GPS COV U VDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(4)	V90U3071C	GPS COV V UDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(5)	V90U3072C	GPS COV V VDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(6)	V90U3073C	GPS COV W WDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CORR_COEFF_GPS(7)	V90U3074C	GPS COV UDOT VDOT CORR COEFF	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		SPL		92067D	
CREW_DES_RCVR_RCVD(1)	V94X0964X	DESELECT GPS RCVR 1 FDBK	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
CREW_DES_RCVR_RCVD(2)	V94X0965X	DESELECT GPS RCVR 2 FDBK	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
CREW_DES_RCVR_RCVD(3)	V94X0966X	DESELECT GPS RCVR 3 FDBK	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
CREW_QA_OVERRIDE_RCVD(1)	V94X0967X	GPS 1 QA OVERRIDE FDBK	GPS STATUS DISP		BD		91051K	
CREW_QA_OVERRIDE_RCVD(2)	V94X0968X	GPS 2 QA OVERRIDE FDBK	GPS STATUS DISP		BD		91051K	
CREW_QA_OVERRIDE_RCVD(3)	V94X0969X	GPS 3 QA OVERRIDE FDBK	GPS STATUS DISP		BD		91051K	
CREW_QA_OVRD_STATUS_IND(1)	V94X0970X	GPS 1 QA OVERRIDE STATUS IND	GPS STATUS DISP		BD		91051K	
CREW_QA_OVRD_STATUS_IND(2)	V94X0971X	GPS 2 QA OVERRIDE STATUS IND	GPS STATUS DISP		BD		91051K	
CREW_QA_OVRD_STATUS_IND(3)	V94X0972X	GPS 3 QA OVERRIDE STATUS IND	GPS STATUS DISP		BD		91051K	
DELR_GPS_SEL	V94H6046C	SEL GPS POS RESIDUAL KFT	REL NAV DISP	KFT	SPL		92067D	



TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DELR_GPS_SEL_DL	V93H3570C	SEL GPS QA2 POS RES MAG FOR DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1	FT	HXS		93017G	*
DELR_RATIO_GPS_SEL	V94H6047C	SEL GPS POS RES RATIO	HORIZ SIT DISP REL NAV DISP		SPL		92067D	
DELR_RATIO_GPS_SEL_DL	V93H3579C	SEL GPS QA2 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_GPS_SEL_ST	V94J6048C	SEL GPS POS RES RATIO STATUS	HORIZ SIT DISP REL NAV DISP		VAR		92067D	
DELR_RATIO_QA2_DISPLAY(1)	V94H1073C	GPS 1 DELR RATIO QA2 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA2_DISPLAY(2)	V94H0977C	GPS 2 DELR RATIO QA2 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA2_DISPLAY(3)	V94H1074C	GPS 3 DELR RATIO QA2 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA2_DL(1)	V93H3159C	GPS1 QA2 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA2_DL(2)	V93H1159C	GPS2 QA2 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA2_DL(3)	V93H9159C	GPS3 QA2 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA3_DISPLAY(1)	V94H1077C	GPS 1 DELR RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA3_DISPLAY(2)	V94H0979C	GPS 2 DELR RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA3_DISPLAY(3)	V94H1078C	GPS 3 DELR RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELR_RATIO_QA3_DL(1)	V94H3170C	GPS1 QA3 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA3_DL(2)	V94H1070C	GPS2 QA3 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA3_DL(3)	V94H6070C	GPS3 QA3 POSITION RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA4_1_2	V94H6084C	GPS QA4 POS DIFF RATIO 1 2	GPS STATUS DISP		SPL		92067D	

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DELR_RATIO_QA4_1_2_DL	V94H6093C	GPS QA4 POS DIFF RATIO 1 2 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA4_1_3	V94H6086C	GPS QA4 POS DIFF RATIO 1 3	GPS STATUS DISP		SPL		92067D	
DELR_RATIO_QA4_1_3_DL	V94H6095C	GPS QA4 POS DIFF RATIO 1 3 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_RATIO_QA4_2_3	V94H6085C	GPS QA4 POS DIFF RATIO 2 3	GPS STATUS DISP		SPL		92067D	
DELR_RATIO_QA4_2_3_DL	V94H6097C	GPS QA4 POS DIFF RATIO 2 3 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELR_SV_SEL	V94H0976C	SEL GPS MAX POS RESIDUAL	HORIZ SIT DISP	NM	SPL		91051K	
DELTA_RATIO_SV_SEL	V94U0973C	SEL GPS MAX RES RATIO	HORIZ SIT DISP		SPL		91051K	
DELTA_RATIO_SV_SEL_IND	V94X0974X	SEL GPS MAX RES RATIO IND	HORIZ SIT DISP		BD		91051K	
DELTA_RATIO_SV_SEL_STAT	V94J0975C	SEL GPS MAX RES RATIO STATUS	HORIZ SIT DISP		VAR		91051K	
DELV_GPS_SEL	V94L6049C	SEL GPS VEL RESIDUAL	HORIZ SIT DISP	FT/S	SPL		92067D	
DELV_GPS_SEL_DL	V93L3572C	SEL GPS QA2 VEL RES MAG FOR DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1	FT/S	HXS		93017G	*
DELV_RATIO_GPS_SEL	V94L6050C	SEL GPS VEL RES RATIO	HORIZ SIT DISP		SPL		92067D	
DELV_RATIO_GPS_SEL_DL	V93L3580C	SEL GPS QA2 VELOCITY RATIO DL	REL NAV DISP DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_GPS_SEL_ST	V94J6051C	SEL GPS VEL RES RATIO STATUS	HORIZ SIT DISP		VAR		92067D	
DELV_RATIO_QA2_DISPLAY(1)	V94L1075C	GPS 1 DELV RATIO QA2 DISP	REL NAV DISP		SPL		91051K	
DELV_RATIO_QA2_DISPLAY(2)	V94L0978C	GPS 2 DELV RATIO QA2 DISP	GPS STATUS DISP		SPL		91051K	
DELV_RATIO_QA2_DISPLAY(3)	V94L1076C	GPS 3 DELV RATIO QA2 DISP	GPS STATUS DISP		SPL		91051K	
DELV_RATIO_QA2_DL(1)	V93L3160C	GPS1 QA2 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA2_DL(2)	V93L1160C	GPS2 QA2 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DELV_RATIO_QA2_DL(3)	V93L9160C	GPS3 QA2 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA3_DISPLAY(1)	V94L1079C	GPS 1 DELV RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELV_RATIO_QA3_DISPLAY(2)	V94L0980C	GPS 2 DELV RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELV_RATIO_QA3_DISPLAY(3)	V94L1081C	GPS 3 DELV RATIO QA3 DISP	GPS STATUS DISP		SPL		91051K	
DELV_RATIO_QA3_DL(1)	V94L3171C	GPS1 QA3 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA3_DL(2)	V94L1071C	GPS2 QA3 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA3_DL(3)	V94L6071C	GPS3 QA3 VELOCITY RATIO DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA4_1_2	V94L6087C	GPS QA4 VEL DIFF RATIO 1 2	GPS STATUS DISP		SPL		92067D	
DELV_RATIO_QA4_1_2_DL	V94L6094C	GPS QA4 VEL DIFF RATIO 1 2 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA4_1_3	V94L6089C	GPS QA4 VEL DIFF RATIO 1 3	GPS STATUS DISP		SPL		92067D	
DELV_RATIO_QA4_1_3_DL	V94L6096C	GPS QA4 VEL DIFF RATIO 1 3 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DELV_RATIO_QA4_2_3	V94L6088C	GPS QA4 VEL DIFF RATIO 2 3	GPS STATUS DISP		SPL		92067D	
DELV_RATIO_QA4_2_3_DL	V94L6098C	GPS QA4 VEL DIFF RATIO 2 3 DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	ND	HXS		93017G	*
DT_GPS_OFF_MIN	V94W0981C	TIME SINCE LAST GPS SEL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1 ENT NAV GPS STATUS DISP PRELAND NAV RTLS NAV	MIN	SPL		93017G	*
DT_QA2_DL	V93W1167C	GPS QA2 DELTA T DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	S	HXS		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
FOM_NAV(1)	V94H1082CA	GPS 1 NAV FOM	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		HXS		92067D	
FOM_NAV(2)	V94H1083CA	GPS 2 NAV FOM	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		HXS		92067D	
FOM_NAV(3)	V94H1084CA	GPS 3 NAV FOM	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		HXS		92067D	
FOM_SV_SEL	V90H0834C	SELECTED FIGURE-OF-MERIT	PRELAND NAV		HXS		93100C	
GPC_COLLECTION_WORD_THREE	V93M3144P	GPS COLLECTION WORD THREE	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		HMD		93017G	*
GPS_ANNCD_RESET	V90X3075X	GPS ANNCD RESET FLAG	GPS REF STATE PROC		BD		92369B	
GPS_COLLECTION_WORD	V93M1144P	GPS COLLECTION WORD	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		HMD		93017G	*
GPS_COLLECTION_WORD_FIVE	V93M3566P	GPS COLLECTION WORD FIVE	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		HMD		93017G	*
GPS_COLLECTION_WORD_FOUR	V93M3175P	GPS COLLECTION WORD FOUR	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		HMD		93017G	*
GPS_COLLECTION_WORD_TWO	V93M1175P	GPS COLLECTION WORD TWO	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		HMD		93017G	*
GPS_DG_SF(1)	V94X0986X	GPS 1 DG NAV	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92369B	
GPS_DG_SF(2)	V94X0987X	GPS 2 DG NAV	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92369B	
GPS_DG_SF(3)	V94X0988X	GPS 3 DG NAV	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92369B	
GPS_DILEMMA_ANNUN_GAX	V94X1161X	QA4 DILEMMA GPS 1/2/3 GAX	GAX		BD		92067D	
GPS_DISP_DILEMMA(1)	V94X0022X	GPS 1 DISPLAY DILEMMA FLAG	GAX GPS STATUS SPEC HORIZ SIT SPEC REL NAV SPEC		BD		92208C	

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_DISP_DILEMMA(2)	V94X0023X	GPS 2 DISPLAY DILEMMA FLAG	GAX		BD		92208C	
			GPS STATUS SPEC					
			HORIZ SIT SPEC					
			REL NAV SPEC					
GPS_DISP_DILEMMA(3)	V94X0024X	GPS 3 DISPLAY DILEMMA FLAG	GAX		BD		92208C	
			GPS STATUS SPEC					
			HORIZ SIT SPEC					
			REL NAV SPEC					
GPS_FAIL_FOM_DISP(1)	V94X1155XA	GPS 1 FAIL FOM DISP	GPS STATUS DISP		BD		92067D	
			HORIZ SIT DISP					
GPS_FAIL_FOM_DISP(2)	V94X1156XA	GPS 2 FAIL FOM DISP	GPS STATUS DISP		BD		92067D	
			HORIZ SIT DISP					
GPS_FAIL_FOM_DISP(3)	V94X1157XA	GPS 3 FAIL FOM DISP	GPS STATUS DISP		BD		92067D	
			HORIZ SIT DISP					
GPS_FAIL_QA3_R(1)	V94X1118X	GPS 1 FAIL QA3 POS CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA3_R(2)	V94X0991X	GPS 2 FAIL QA3 POS CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA3_R(3)	V94X1119X	GPS 3 FAIL QA3 POS CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA3_V(1)	V94X1120X	GPS 1 FAIL QA3 VEL CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA3_V(2)	V94X0992X	GPS 2 FAIL QA3 VEL CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA3_V(3)	V94X1121X	GPS 3 FAIL QA3 VEL CHK	GPS STATUS DISP		BD		91051K	
GPS_FAIL_QA4_R_1_2	V94X6076X	GPS FAIL QA4 POS 1 2 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA4_R_1_3	V94X6078X	GPS FAIL QA4 POS 1 3 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA4_R_2_3	V94X6077X	GPS FAIL QA4 POS 2 3 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA4_V_1_2	V94X6079X	GPS FAIL QA4 VEL 1 2 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA4_V_1_3	V94X6081X	GPS FAIL QA4 VEL 1 3 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA4_V_2_3	V94X6080X	GPS FAIL QA4 VEL 2 3 CHK	GPS STATUS DISP		BD		92067D	
GPS_FAIL_QA_GAX(1)	V94X1158X	GPS 1 FAIL QA 1/3/4 CHK GAX	GAX		BD		92369B	
GPS_FAIL_QA_GAX(2)	V94X1159X	GPS 2 FAIL QA 1/3/4 CHK GAX	GAX		BD		92369B	
GPS_FAIL_QA_GAX(3)	V94X1160X	GPS 3 FAIL QA 1/3/4 CHK GAX	GAX		BD		92369B	
GPS_NAV_EDIT_ALT_GAX	V94X6099X	GPS OFF ALERT BELOW I-LOADED ALT	GAX		BD		92067D	
GPS_NAV_EDIT_GAX	V94X6017X	GPS NAV EDIT GAX	GAX		BD		92067D	
GPS_OFF_ALERT	V94X1134X	NO GPS SEL FOR MIN I-LOADED TIME	GPS STATUS DISP		BD		91051K	
GPS_OFF_ALERT_GAX	V94X1137X	NO GPS SEL FOR I-LOADED TIME GAX	GAX		BD		91051K	
GPS_QA2_RTOL_UVW_DL(1)	V93H1161C	GPS QA2 POSITION U THRESHOLD DL	DL FMT 23/1	FT	HXS		93017G	*
			DL FMT 32/1					
GPS_QA2_RTOL_UVW_DL(2)	V93H1162C	GPS QA2 POSITION V THRESHOLD DL	DL FMT 23/1	FT	HXS		93017G	*
			DL FMT 32/1					
GPS_QA2_RTOL_UVW_DL(3)	V93H1163C	GPS QA2 POSITION W THRESHOLD DL	DL FMT 23/1	FT	HXS		93017G	*
			DL FMT 32/1					
GPS_QA2_VTOL_UVW_DL(1)	V93L1164C	GPS QA2 VELOCITY U THRESHOLD DL	DL FMT 23/1	FT/S	HXS		93017G	*
			DL FMT 32/1					
GPS_QA2_VTOL_UVW_DL(2)	V93L1165C	GPS QA2 VELOCITY V THRESHOLD DL	DL FMT 23/1	FT/S	HXS		93017G	*
			DL FMT 32/1					
GPS_QA2_VTOL_UVW_DL(3)	V93L1166C	GPS QA2 VELOCITY W THRESHOLD DL	DL FMT 23/1	FT/S	HXS		93017G	*
			DL FMT 32/1					

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_RATIO_FLAG	V90X0440X	SEL GPS RESID RATIO EDIT FLAG	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV		BD		92132C	
GPS_SEL_ALT_DISP	V94H1011C	GPS SEL ALT DISP	GPS STATUS DISP	NM	SPL		91051K	
GPS_SEL_ALT_DL	V93H1184C	SELECTED GPS DERIVED ALT DL	DL FMT 23/1 DL FMT 32/1	NM	HXS		93017G	*
GPS_SEL_DELR_UVW(1)	V94H0099C	GPS SEL DELR UVW U COMP	GPS STATUS DISP	FT	SPL		92144C	
GPS_SEL_DELR_UVW(2)	V94H0994C	GPS SEL DELR UVW V COMP	GPS STATUS DISP	FT	SPL		91051K	
GPS_SEL_DELR_UVW(3)	V94H0995C	GPS SEL DELR UVW W COMP	GPS STATUS DISP	FT	SPL		91051K	
GPS_SEL_DELR_UVW_DL(1)	V93H1168C	SEL GPS QA2 POSITION U RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT	HXS		93017G	*
GPS_SEL_DELR_UVW_DL(2)	V93H1169C	SEL GPS QA2 POSITION V RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT	HXS		93017G	*
GPS_SEL_DELR_UVW_DL(3)	V93H1170C	SEL GPS QA2 POSITION W RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT	HXS		93017G	*
GPS_SEL_DELV_UVW(1)	V94L0996C	GPS SEL DELV UVW UDOT COMP	GPS STATUS DISP	FT/S	SPL		91051K	
GPS_SEL_DELV_UVW(2)	V94L0997C	GPS SEL DELV UVW VDOT COMP	GPS STATUS DISP	FT/S	SPL		91051K	
GPS_SEL_DELV_UVW(3)	V94L0998C	GPS SEL DELV UVW WDOT COMP	GPS STATUS DISP	FT/S	SPL		91051K	
GPS_SEL_DELV_UVW_DL(1)	V93L1171C	SEL GPS QA2 VELOCITY U RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	HXS		93017G	*
GPS_SEL_DELV_UVW_DL(2)	V93L1172C	SEL GPS QA2 VELOCITY V RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	HXS		93017G	*
GPS_SEL_DELV_UVW_DL(3)	V93L1173C	SEL GPS QA2 VELOCITY W RESIDUAL DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	HXS		93017G	*
GPS_SEL_LAT_DISP	V94H1008C	GPS SEL LAT DISP	GPS STATUS DISP	DEG	SPL		91051K	
GPS_SEL_LAT_DL	V93H1182C	SELECTED GPS DERIVED LAT DL	DL FMT 23/1 DL FMT 32/1	DEG	HXS		93017G	*
GPS_SEL_LAT_IND	V94J0999C	GPS SEL LAT IND	GPS STATUS DISP		VAR		91051K	
GPS_SEL_LON_DISP	V94H1010C	GPS SEL LON DISP	GPS STATUS DISP	DEG	SPL		91051K	
GPS_SEL_LON_DL	V93H1183C	SELECTED GPS DERIVED LON DL	DL FMT 23/1 DL FMT 32/1	DEG	HXS		93017G	*
GPS_SEL_LON_IND	V94J1009C	GPS SEL LON IND	GPS STATUS DISP		VAR		91051K	

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	A/L UPP ENT NAV ENT UPP GPS STATUS DISP HORIZ SIT DISP ORB/RND NAV PRELAND NAV REL NAV DISP RTLS NAV RTLS UPP TAEM UPP		BD		92132C	
G_GPS_SEL(1)	V90A3637C	X-COMP OF SEL GPS GRAV VECTOR	ENT NAV PRELAND NAV RTLS NAV	FT/S2	SPL		92214A	
G_GPS_SEL(2)	V90A3638C	Y-COMP OF SEL GPS GRAV VECTOR	ENT NAV PRELAND NAV RTLS NAV	FT/S2	SPL		92214A	
G_GPS_SEL(3)	V90A3639C	Z-COMP OF SEL GPS GRAV VECTOR	ENT NAV PRELAND NAV RTLS NAV	FT/S2	SPL		92214A	
METER_SF_DL	V93H3578C	METERING SCALE FACTOR FOR DL	DL FMT 21/1 DL FMT 23/1	ND	HXS		93017G	*
NUM_GPS_SEL	V94U1013C	NUMBER OF GPS SEL CANDIDATES	HORIZ SIT DISP REL NAV DISP		HXS		92067D	
QA3_BLANKING(1)	V94X0181X	GPS1 QA3 BLANKING FLAG	GPS STATUS DISP		BD		92049C	
QA3_BLANKING(2)	V94X0182X	GPS2 QA3 BLANKING FLAG	GPS STATUS DISP		BD		92049C	
QA3_BLANKING(3)	V94X0183X	GPS3 QA3 BLANKING FLAG	GPS STATUS DISP		BD		92049C	
R_GPS_SEL(1)	V90H3082C	X-COMP OF SEL GPS POS VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	DPL		92067D	
R_GPS_SEL(2)	V90H3083C	Y-COMP OF SEL GPS POS VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	DPL		92067D	
R_GPS_SEL(3)	V90H3084C	Z-COMP OF SEL GPS POS VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	DPL		92067D	
R_GPS_SEL_DL(1)	V93H1138C	SEL GPS POS X DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT	FXS		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_GPS_SEL_DL(2)	V93H1139C	SEL GPS POS Y DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1	FT	FXS		93017G	*
R_GPS_SEL_DL(3)	V93H1140C	SEL GPS POS Z DL	DL FMT 32/1 DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT	FXS		93017G	*
SEL_CMD(1)	V94X1034X	GPS 1 SEL FILTER CANDIDATE	GPS STATUS DISP GPS STATUS SPEC HORIZ SIT SPEC REL NAV SPEC		BD		92067D	
SEL_CMD(2)	V94X1035X	GPS 2 SEL FILTER CANDIDATE	GPS STATUS DISP GPS STATUS SPEC HORIZ SIT SPEC REL NAV SPEC		BD		92067D	
SEL_CMD(3)	V94X1036X	GPS 3 SEL FILTER CANDIDATE	GPS STATUS DISP GPS STATUS SPEC HORIZ SIT SPEC REL NAV SPEC		BD		92067D	
SEL_RCVR(1)	V94X1037X	GPS 1 SEL	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
SEL_RCVR(2)	V94X1038X	GPS 2 SEL	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
SEL_RCVR(3)	V94X1039X	GPS 3 SEL	GPS STATUS DISP HORIZ SIT DISP REL NAV DISP		BD		92067D	
SIG_DIAG_GPS(1)	V90H3094C	GPS NAV RESET COV DIAG ELEM 1	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	SPL		92067D	
SIG_DIAG_GPS(2)	V90H3095C	GPS NAV RESET COV DIAG ELEM 2	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	SPL		92067D	
SIG_DIAG_GPS(3)	V90H3096C	GPS NAV RESET COV DIAG ELEM 3	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT	SPL		92067D	
SIG_DIAG_GPS(4)	V90L3097C	GPS NAV RESET COV DIAG ELEM 4	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	SPL		92067D	



TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
SIG_DIAG_GPS(5)	V90L3098C	GPS NAV RESET COV DIAG ELEM 5	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	SPL		92067D	
SIG_DIAG_GPS(6)	V90L3099C	GPS NAV RESET COV DIAG ELEM 6	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	SPL		92067D	
T_GPS_SEL	V90W3561C	GPS SEL SV TIME TAG	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	S	DPL		92067D	
T_GPS_SEL_DL	V94W1069C	GPS SEL SV TIME TAG DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	S	DPL		93017G	*
V_GPS_SEL(1)	V90L3108C	X-COMP OF SEL GPS VEL VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	DPL		92244A	
V_GPS_SEL(2)	V90L3109C	Y-COMP OF SEL GPS VEL VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	DPL		92244A	
V_GPS_SEL(3)	V90L3110C	Z-COMP OF SEL GPS VEL VECTOR	ENT NAV ORB/RND NAV PRELAND NAV RTLS NAV	FT/S	DPL		92244A	
V_GPS_SEL_DL(1)	V93L1141C	SEL GPS VEL X DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	FXS		93017G	*
V_GPS_SEL_DL(2)	V93L1142C	SEL GPS VEL Y DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	FXS		93017G	*
V_GPS_SEL_DL(3)	V93L1143C	SEL GPS VEL Z DL	DL FMT 21/1 DL FMT 22/1 DL FMT 23/1 DL FMT 32/1	FT/S	FXS		93017G	*
	V93J1145C	GPS AUTO/INHIBIT/FORCE FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BSU		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93J3571C	SEL GPS POS RES RATIO STATUS	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V93J3573C	SEL GPS VEL RES RATIO STATUS	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V93U3567C	GPS1 FOM USED BY NAV	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V93U3568C	GPS2 FOM USED BY NAV	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V93U3569C	GPS3 FOM USED BY NAV	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V93X1146X	GPS TO NAV AUTO/INHIBIT FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1147X	GPS TO NAV FORCE FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1148X	CREW DES GPS2 RCVR FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1149X	GPS2 DATA GOOD FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1153X	GPS2 FIGURE OF MERIT FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1176X	GPS2 QA2 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93X1177X	GPS2 QA2 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1178X	GPS2 QA2 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1179X	GPS2 QA3 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1180X	GPS2 QA3 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1181X	GPS2 QA3 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1232X	CREW DES GPS1 RCVR FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1233X	CREW DES GPS3 RCVR FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1234X	GPS1 DATA GOOD FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1235X	GPS3 DATA GOOD FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1236X	GPS2 QA FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X1631X	GPS QA4 POS 2 3 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93X1632X	GPS QA4 VEL 2 3 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3176X	GPS2 QA4 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3177X	GPS3 QA4 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3178X	GPS QA4 POS 1 2 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3179X	GPS QA4 VEL 1 2 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3180X	GPS QA4 POS 1 3 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3181X	GPS QA4 VEL 1 3 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3200X	GPS3 QA FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3201X	GPS3 QA2 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3202X	GPS3 QA2 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3203X	GPS3 QA2 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93X3204X	GPS3 QA3 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3205X	GPS3 QA3 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3206X	GPS3 QA3 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3207X	GPS3 FIGURE OF MERIT FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3208X	GPS1 QA FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3209X	GPS1 QA2 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3210X	GPS1 QA2 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3211X	GPS1 QA2 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3212X	GPS1 QA3 FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3213X	GPS1 QA3 POSITION FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3214X	GPS1 QA3 VELOCITY FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93X3215X	GPS1 FIGURE OF MERIT FAIL FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3236X	GPS1 QA4 FAIL FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3560X	GPS1 SELECTION INDICATOR	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3561X	GPS2 SELECTION INDICATOR	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3562X	GPS3 SELECTION INDICATOR	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3563X	GPS1 QA4 DILEMMA FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3564X	GPS2 QA4 DILEMMA FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3565X	GPS3 QA4 DILEMMA FLAG	DL FMT 21/1 DL FMT 22/1 DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3574X	QA OVERRIDE RCVR 1 FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3575X	QA OVERRIDE RCVR 2 FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3576X	QA OVERRIDE RCVR 3 FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*

TABLE 4.3.3.8-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS RECEIVER STATE PROCESSING (G4.21)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93X3577X	METERING OVERRIDE FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V93X3581X	METER FLAG	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*
	V94J0993C	MLS A/I/F RCVD	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BSU		93017G	*
	V94X1012X	NO GPS SEL FOR I-LOAD DT	DL FMT 21/1 DL FMT 22/A DL FMT 23/A DL FMT 32/1		BD		93017G	*

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_SF	V97U3559C	ND	F	S	D	P	G4.21	00	GPF	92292B	
ANG_SF	V97U3648C	ND	F	S	D	P	G4.21	00	GPF	92292B	
CORR_COEFF_GPS_NOM(1)	V97U3462C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(2)	V97U3463C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(3)	V97U3464C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(4)	V97U3465C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(5)	V97U3466C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(6)	V97U3467C	ND	F	S	L	P	G4.21	00	GPS	92214A	
CORR_COEFF_GPS_NOM(7)	V97U3468C	ND	F	S	L	P	G4.21	00	GPS	92214A	
DELR_SF	V97U3255C	ND	F	S	D	P	G4.21	00	GPF	92292B	
DELR_UVW_POS_SF	V97U3555C	ND	F	S	D	P	G4.21	00	GPF	92292B	
DELV_SF	V97U3256C	ND	F	S	D	P	G4.21	00	GPF	92292B	
DELV_UVW_VEL_SF	V97U3556C	ND	F	S	D	P	G4.21	00	GPF	92292B	
DT_ANNCD_RESET	V97U3409C	SEC	F	S	D	C	G4.21	02	GPH	93000A	
								08	GPH		
								01	GPH		
								03	GPH		
DT_QA2_SF	V97U3644C	ND	F	S	D	P	G4.21	00	GPF	92292B	
FOM_COV_SF_TABLE(1,1)	V97U3470C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,2)	V97U3471C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,3)	V97U3472C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,4)	V97U3473C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,5)	V97U3474C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,6)	V97U3475C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,7)	V97U3476C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		



TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
FOM_COV_SF_TABLE(1,8)	V97U3477C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(1,9)	V97U3478C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,1)	V97U3479C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,2)	V97U3480C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,3)	V97U3481C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,4)	V97U3482C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,5)	V97U3483C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,6)	V97U3484C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,7)	V97U3485C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,8)	V97U3486C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		
FOM_COV_SF_TABLE(2,9)	V97U3487C	ND	F	S	L	P	G4.21	01	GP3	92132C	
								02	GP2		
								03	GP3		
								08	GP2		

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_ALERT_DT	V97U3488C	SEC	F	S	D	P	G4.21	01	GPD	92292B	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_FAIL_FOM_GAX_MSG_CNT_MIN	V97U5948C	ND	I	S	D	P	G4.21	01	GPD	92376	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_GAX_OFF_ALERT_RMNR_DT	V97U3248C	SEC	F	S	D	P	G4.21	01	GPD	92292B	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_IMU_VEL_THRESH	V97U3645C	FT/SEC	F	S	L	P	G4.21	00	GPS	92056D	
GPS_INSTALLED(1)	V97U2924C	ND	D		M	X	G4.17	00	GPI	92292B	
							G4.20				
							G4.21				
							G4.23				
							G4.24				
							G4.25				
							G6.11				
							G6.21				
							G6.31				
							G6.51				
							V5.1.4				
GPS_INSTALLED(2)	V97U2831C	ND	D		M	X	G4.17	00	GPI	92292B	
							G4.20				
							G4.21				
							G4.23				
							G4.24				
							G4.25				
							G6.11				
							G6.21				
							G6.31				
							G6.51				
							V5.1.4				
GPS_INSTALLED(3)	V97U2925C	ND	D		M	X	G4.17	00	GPI	92292B	
							G4.20				
							G4.21				
							G4.23				
							G4.24				
							G4.25				
							G6.11				
							G6.21				
							G6.31				
							G6.51				
							V5.1.4				
GPS_MIN_ALT_MSG	V97U3671C	FT	F	S	D	P	G4.21	00	GPD	92292B	

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_QA2_RTOL_MAX_UVW(1)	V97U3542C	FT	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
GPS_QA2_RTOL_MAX_UVW(2)	V97U3543C	FT	F	S	D	P	G4.21	01	GP3	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_RTOL_MAX_UVW(3)	V97U3544C	FT	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		
GPS_QA2_RTOL_UVW_A(1)	V97U3489C	FT	F	S	D	P	G4.21	03	GP3	92067D	
								02	GP2		
								01	GP3		
GPS_QA2_RTOL_UVW_A(2)	V97U3490C	FT	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
GPS_QA2_RTOL_UVW_A(3)	V97U3491C	FT	F	S	D	P	G4.21	01	GP3	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_RTOL_UVW_B(1)	V97U3492C	FT/SEC	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		
GPS_QA2_RTOL_UVW_B(2)	V97U3493C	FT/SEC	F	S	D	P	G4.21	03	GP3	92067D	
								02	GP2		
								01	GP3		
GPS_QA2_RTOL_UVW_B(3)	V97U3494C	FT/SEC	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
GPS_QA2_RTOL_UVW_C(1)	V97U3495C	FT/SEC**2	F	S	D	P	G4.21	01	GP3	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_RTOL_UVW_C(2)	V97U3496C	FT/SEC**2	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_QA2_RTOL_UVW_C(3)	V97U3497C	FT/SEC**2	F	S	D	P	G4.21	02	GP2	92067D	
								03	GP3		
								08	GP2		
GPS_QA2_VTOL_MAX_UVW(1)	V97U3545C	FT/SEC	F	S	D	P	G4.21	01	GP3	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_VTOL_MAX_UVW(2)	V97U3546C	FT/SEC	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		
GPS_QA2_VTOL_MAX_UVW(3)	V97U3547C	FT/SEC	F	S	D	P	G4.21	03	GP3	92067D	
								02	GP2		
								01	GP3		
GPS_QA2_VTOL_UVW_A(1)	V97U3498C	FT/SEC	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								01	GP3		
GPS_QA2_VTOL_UVW_A(2)	V97U3499C	FT/SEC	F	S	D	P	G4.21	02	GP2	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_VTOL_UVW_A(3)	V97U3500C	FT/SEC	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		
GPS_QA2_VTOL_UVW_B(1)	V97U3501C	FT/SEC**2	F	S	D	P	G4.21	03	GP3	92067D	
								02	GP2		
								01	GP3		
GPS_QA2_VTOL_UVW_B(2)	V97U3502C	FT/SEC**2	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
GPS_QA2_VTOL_UVW_B(3)	V97U3503C	FT/SEC**2	F	S	D	P	G4.21	01	GP3	92067D	
								08	GP2		
								03	GP3		
GPS_QA2_VTOL_UVW_C(1)	V97U3504C	FT/SEC**3	F	S	D	P	G4.21	02	GP2	92067D	
								01	GP3		
								08	GP2		

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_QA2_VTOL_UVW_C(2)	V97U3505C	FT/SEC**3	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
								01	GP3		
GPS_QA2_VTOL_UVW_C(3)	V97U3506C	FT/SEC**3	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
								01	GP3		
GPS_QA3_GAX_MSG_CNT_MIN	V97U5994C	ND	I	S	D	P	G4.21	01	GPD	92376	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_QA3_RTOL	V97U3578C	FT	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
								01	GP3		
GPS_QA3_VTOL	V97U3579C	FT/SEC	F	S	D	P	G4.21	08	GP2	92067D	
								03	GP3		
								02	GP2		
								01	GP3		
GPS_QA4_DILEMMA_GAX_MSG_CNT_MIN	V97U5996C	ND	I	S	D	P	G4.21	01	GPD	92376	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_QA4_GAX_MSG_CNT_MIN	V97U5995C	ND	I	S	D	P	G4.21	01	GPD	92376	
								02	GPD		
								03	GPD		
								08	GPD		
GPS_QA4_RTOL	V97U5999C	FT	F	S	D	P	G4.21	01	GP3	92067D	
								02	GP2		
								03	GP3		
								08	GP2		
GPS_QA4_VTOL	V97U6000C	FT/SEC	F	S	D	P	G4.21	01	GP3	92067D	
								02	GP2		
								03	GP3		
								08	GP2		
GPS_SV_SEL_ALT_LIMIT	V97U3249C	FT	F	S	D	P	G4.21	00	GPD	92292B	
	METER_DL_SF	V97U3257C	ND	F	S	D	P	G4.21	00	GPF	92292B
M_WGS84_TO_EF(1,1)	V97U2927C	ND	F	D	M	P	G4.17	00	WGS	92067D	
							G4.20				
							G4.21				
							G4.220				
							G4.23				
							G4.237				
							G4.24				
							G4.25				
V5.1.8											

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(1,2)	V97U2928C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(1,3)	V97U2929C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,1)	V97U2930C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,2)	V97U2931C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,3)	V97U2932C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(3,1)	V97U2933C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,2)	V97U2934C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,3)	V97U2935C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
N_RATIOS_ABOVE_LIMIT_MIN	V97U5997C	ND	I	S	D	P	G4.21	01 02 03 08	GPD GPD GPD GPD	92292B	
QA2_DELR_RATIO_SF	V97U3551C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA2_DELV_RATIO_SF	V97U3552C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA2_RTOL_SF	V97U3553C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA2_VTOL_SF	V97U3554C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA3_DELR_RATIO_SF	V97U3646C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA3_DELV_RATIO_SF	V97U3647C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA4_DELR_RATIO_SF	V97U3250C	ND	F	S	D	P	G4.21	00	GPF	92292B	
QA4_DELV_RATIO_SF	V97U3251C	ND	F	S	D	P	G4.21	00	GPF	92292B	
SF_POS	V97U2914C	ND	F	D	L	P	G4.17 G4.21	00	GPH	92067D	
SF_VEL	V97U2919C	ND	F	S	L	P	G4.17 G4.21	00	GPH	92067D	
SIG_DIAG_GPS_NOM(1)	V97U2936C	FT	F	S	L	P	G4.21	00	GPS	92214A	
SIG_DIAG_GPS_NOM(2)	V97U2937C	FT	F	S	L	P	G4.21	00	GPS	92214A	
SIG_DIAG_GPS_NOM(3)	V97U2938C	FT	F	S	L	P	G4.21	00	GPS	92214A	
SIG_DIAG_GPS_NOM(4)	V97U2939C	FT/SEC	F	S	L	P	G4.21	00	GPS	92214A	

TABLE 4.3.3.8-3. GPS RECEIVER STATE PROCESSING (G4.21) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
SIG_DIAG_GPS_NOM(5)	V97U2940C	FT/SEC	F	S	L	P	G4.21	00	GPS	92214A	
SIG_DIAG_GPS_NOM(6)	V97U2941C	FT/SEC	F	S	L	P	G4.21	00	GPS	92214A	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.3.3.8-4. GPS RECEIVER STATE PROCESSING (G4.21) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
GPS_SW_CAP MAX NUM OF GPS LRU THAT SOFTWARE CAN HANDLE	V97U2923C	00	+3	ND	I	S	P	G4.17 G4.18 G4.20 G4.21 G4.23 G4.24 G4.25	92069B	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.3.3.8-5. GPS RECEIVER STATE PROCESSING (G4.21) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ATFL_OV CONTROLS USE OF CURRENT ORB ATTITUDE IN DRAG COMPUTE	V97U6102C	00	+0	ND	I		S	C G4.126 G4.148 G4.18 G4.21 G4.22	91051K	
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S	C A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.3.3.8-5. GPS RECEIVER STATE PROCESSING (G4.21) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RATE EARTH'S ROTATIONAL RATE	V97U4379C	00	+7.29211514646E-05	RAD/SEC	F		D C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.17 G4.19 G4.20 G4.205 G4.21 G4.213 G4.22 G4.236 G4.237 G4.4 G5.26	93090E	
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884 E-04	NMI/FT	F		S C	A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

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#### 4.4 SUBFUNCTIONS COMMON TO SEVERAL NAVIGATION-RELATED PRINCIPAL FUNCTIONS

This section documents detailed requirements for subfunctions identified as being common to two or more navigation-related principal functions or their major subfunctions. The detailed requirements specified here will be referenced from the section to which they are common and, where referenced, may be regarded as inserts to paragraph A – Detailed Requirements – in these sections.

##### 4.4.1 User Parameter State Propagation

During the entry operational sequence (OPS-3), the navigation state propagation subfunction advances the navigation state vector at relatively large intervals, at the end of which external measurement data processed by the filter are incorporated when appropriate. Since users such as guidance and displays, require a knowledge of the state vector at shorter intervals, the user parameter state propagation subfunction will perform the integration of the equations of motion in a M50 coordinate system over shorter intervals than that of the navigation propagation. It will employ the most recent navigation-computed acceleration vector and the accumulated IMU-sensed velocity (snapped at each step from the accelerometers). During those periods when drag accelerations are being modeled, the accelerometer readings shall be ignored. In this case, the gravity acceleration vector  $\bar{G}_{OLD}$  is actually the total acceleration since it is the sum of the accelerations due to both gravitational forces and aerodynamic forces (Section 4.2.1.2). These integration processes shall be restarted at the completion of each navigation cycle with the navigation state.

The initial value of the state that is to be advanced (integrated forward in time) may be from either one of the following two sources:

1. If an update from the filter is not available (FILT\_UPDATE = OFF), the propagated state, saved from the previous cycle, is used as the initial value of the state to be advanced. On the previous cycle, the IMU-sensed velocity was also saved, whereas a constant value of gravity acceleration is used between updates.
2. If an update from the filter is available (FILT\_UPDATE = ON), the navigation filter updated state, together with its time tag and associated accumulated sensed velocity, replaces the previous user parameter propagated state, time tag, and accumulated velocity. A value of gravity acceleration computed with the filter state is available through COMPOOL. Advancement is to be the same as in Item 1.

This mechanization permits independent computation rates for the user parameter state propagator and the navigation state propagator. It also provides the necessary synchronization between these functions when required. For the case when an update from the filter is available, the filter update and reset equations are as follows: If FILT\_UPDATE = ON, then

$$\begin{aligned}\bar{G}_{OLD} &= \bar{G}_{RESET} \\ \bar{R}_{AVGG} &= \bar{R}_{RESET} \\ \bar{V}_{AVGG} &= \bar{V}_{RESET} \\ \bar{V}_{IMU\_OLD} &= \bar{V}_{IMU\_RESET} \\ T\_STATE &= T\_RESET \\ FILT\_UPDATE &= OFF \\ UPP\_UPDATE &= ON\end{aligned}$$

The FILT\_UPDATE flag is set to OFF to inhibit a reset until it is again set to ON by the navigation filter. The UPP\_UPDATE flag is set to ON to indicate that the UPP state has been updated by the navigation filter.

The computational sequence for state advancement follows:

1. Compute the interval over which advancement is required:

$$\text{SNAP IMU } (\bar{V}_{\text{IMU\_CURRENT}}, T_{\text{IMU}})$$

$$DT_{\text{IMU}} = T_{\text{IMU}} - T_{\text{STATE}}$$

2. Compute the change in IMU-sensed velocity:

$$\bar{D}V_S = \bar{V}_{\text{IMU\_CURRENT}} - \bar{V}_{\text{IMU\_OLD}}$$

3. Compute the advanced position vector:

$$\bar{R}_{\text{AVGG}} = \bar{R}_{\text{AVGG}} + DT_{\text{IMU}} (\bar{V}_{\text{AVGG}} + 0.5 (\bar{D}V_S + DT_{\text{IMU}} \bar{G}_{\text{OLD}}))$$

4. Compute the advanced velocity vector:

$$\bar{V}_{\text{AVGG}} = \bar{V}_{\text{AVGG}} + \bar{D}V_S + DT_{\text{IMU}} \bar{G}_{\text{OLD}}$$

5. Save the time tag for output and/or for use in the next cycle:

$$T_{\text{STATE}} = T_{\text{IMU}}$$

6. Determine the earth-relative velocity vector in M50 coordinates using the V\_REL subfunction:

$$\bar{V}_{\text{RHO}} = V_{\text{REL}}(\bar{V}_{\text{AVGG}}, \bar{R}_{\text{AVGG}})$$

7. Save the IMU-sensed velocity for output and for use in the next cycle:

$$\bar{V}_{\text{IMU\_OLD}} = \bar{V}_{\text{IMU\_CURRENT}}$$

#### 4.4.2 ENTRY/TAEM/AUTOLAND Guidance Parameters

Guidance and other systems require that certain navigation-related calculations be accomplished during the ENTRY and TAEM/Landing major modes. Since many of the required parameters are common to both modes, one subfunction called GUIDECOMP is designed to handle the calculations. It should be expected that the commonality existing in these two major modes is not perfect and therefore we find that certain parameters required during ENTRY are not needed in the TAEM/Landing major mode. In the same manner, the reverse is also true. The main differences between the two modes are basically two in nature:

- (a) Lift-to-drag ratio, total sensed acceleration and inertial speed are required for ENTRY but not for TAEM/Landing, while flight path angle is required for TAEM/Landing but not for ENTRY.
- (b) Calculation of  $\dot{h}$  and  $\ddot{h}$  is with reference to runway coordinates when Autoland guidance is active; while, for ENTRY and TAEM guidance, calculation is with respect to topodetic coordinates. The latter computations are made in a separate subfunction called H\_HDOT\_ACCVERT.

With these two differences in mind, the sequence of the calculations is fairly straightforward.

The subfunction, H\_HDOT\_ACCVERT, performs the computation of altitude, altitude rate, and altitude acceleration during the ENTRY major mode and the TAEM guidance phase of TAEM/Landing major mode. These parameters are calculated by employing position and velocity vectors in M50 coordinates as input data. First, the absolute value of the position vector  $\bar{R}_{AVGG}$  is computed and renamed for output purposes:

$$R\_VEH\_MAG = ABVAL(\bar{R}_{AVGG})$$

$$R\_VEH\_MAG\_UPP = R\_VEH\_MAG$$

Then, the parameters A\_0 and FLATCON, which are related to the earth's ellipticity, ELLIPT, are defined

$$A\_0 = (1.0 - ELLIPT)^2$$

$$FLATCON = 1.0 - A\_0$$

Next, a unit vector along the Shuttle position vector is determined:

$$\bar{V}NOR = -\bar{R}_{AVGG}/R\_VEH\_MAG$$

Then, certain quantities are computed in order to obtain a topodetic unit vector in the  $Z_{TD}$  - direction:

$$UK = \bar{V}NOR \cdot \bar{E}ARTH\_POLE$$

$$TEMP = (A\_0 + FLATCON UK^2)$$

$$RAD\_P = EARTH\_RADIUS\_EQUATOR (A\_0/TEMP)^{1/2}$$

The fourth quantity required varies slowly with time and hence is calculated only when the UPP state is updated by the navigation filter; that is, when

$$UPP\_UPDATE = ON$$

then

$$\bar{U}X = (\bar{E}ARTH\_POLE - UK \bar{V}NOR) (FLATCON UK RAD\_P)/(TEMP R\_VEH\_MAG)$$

If UPP\_UPDATE = OFF,  $\bar{U}X$  is held to its previous value.

The altitude and altitude rate are computed from:

$$ALT = R\_VEH\_MAG - RAD\_P$$

$$H\_DOT\_ELLIPSOID = -\bar{V}\_RHO \cdot (\bar{U}X + \bar{V}NOR)$$

and the altitude above the runway is determined by:

$$ALT\_WHEELS = ALT - ALT\_RW$$

A test will be made to determine if the major mode is TAEM/Landing, denoted by MM\_CODE\_305. If MM\_CODE\_305 = ON, then altitude and altitude rate will be modified to account for rotation about the pitch axis of the navigation base with respect to the c.g. as follows:

$$ALT\_WHEELS = ALT\_WHEELS - (X\_NB\_WH \text{ SINTH} + Z\_NB\_WH \text{ COSTH})$$

$$H\_DOT\_ELLIPSOID = H\_DOT\_ELLIPSOID$$

$$- WBR_2 \text{ RAD\_PER\_DEG} (X\_NB\_CG \text{ COSTH} - Z\_NB\_CG \text{ SINTH})$$

where X\_NB\_CG and Z\_NB\_CG are the (positive) X and Z structural body axis distances between the navigation base and the vehicle c.g. and X\_NB\_WH and Z\_NB\_WH are the (positive) X and Z structural body axis distances between the navigation base and the bottom of the rear wheels. The term WBR<sub>2</sub> is the vehicle pitch rate in degrees per second, and SINTH and COSTH are the sine and cosine of the pitch angle. If MM\_CODE\_305 = OFF, then these modifications to ALT\_WHEELS and H\_DOT\_ELLIPSOID are bypassed.

Next, the vertical acceleration will be determined in one of two ways:

- (a) If the navigation filter has updated the state, denoted by UPP\_UPDATE = ON, then the vertical acceleration will be computed by extrapolating the previous values:

$$ACC\_VERT = ACC\_VERT\_OLD + \frac{DELTA\_ACC\_VERT}{DELTA\_T} (T\_STATE - T\_STATE\_LAST)$$

where ACC\_VERT\_OLD is the previous value of ACC\_VERT, DELTA\_ACC\_VERT is the difference between the two most recent values of ACC\_VERT excluding any navigation filter update value, and DELTA\_T is the difference between the times associated with those values of ACC\_VERT employed to compute DELTA\_ACC\_VERT. The update flag, UPP\_UPDATE, is subsequently set to OFF.

- (b) If the update flag, UPP\_UPDATE = OFF, indicating no navigation update of the state, then, the vertical acceleration is computed as follows:

$$ACC\_VERT = (H\_DOT\_ELLIPSOID - -H\_DOT\_LAST) / (T\_STATE - T\_STATE\_LAST)$$

Also, when UPP\_UPDATE = OFF, the values of ACC\_VERT and T\_STATE are employed to calculate current values of DELTA\_ACC\_VERT and DELTA\_T as well as values of T\_STATE\_OLD and ACC\_VERT\_OLD

$$DELTA\_ACC\_VERT = ACC\_VERT - ACC\_VERT\_OLD$$

$$DELTA\_T = T\_STATE - T\_STATE\_OLD$$

$$T\_STATE\_OLD = T\_STATE$$

$$ACC\_VERT\_OLD = ACC\_VERT$$



Finally, the previous values of altitude rate and state time are set to current values

$$H\_DOT\_LAST = H\_DOT\_ELLIPSOID$$

$$T\_STATE\_LAST = T\_STATE$$

The subfunction, GUIDECOMP, is employed throughout ENTRY and TAEM/AUTOLAND major modes. First, the earth-fixed-to-M50 coordinate transformation will be transposed to form a M50-to-earth-fixed transformation:

$$M\_TEMP\_TXPOS = EARTH\_FIXED\_TO\_M50\_COORD(T\_STATE)^T$$

Then the Shuttle position vector and relative velocity will be transformed into EF coordinates

$$\bar{R}\_EF = M\_TEMP\_TXPOS \bar{R}\_AVGG$$

$$\bar{V}\_RHO\_EF = M\_TEMP\_TXPOS \bar{V}\_RHO$$

and the magnitude of the relative velocity will be calculated:

$$REL\_VEL\_MAG = ABVAL(\bar{V}\_RHO)$$

The Greenwich mean time associated with the position and velocity vectors is saved:

$$T\_SEC\_GMT = T\_STATE$$

Next, by using the earth-fixed-to-runway transformation, the position and velocity in runway coordinates will be computed:

$$\bar{P}OSITION\_WRT\_RUNWAY = M\_EFTORW (\bar{R}\_EF - \bar{R}\_LS\_EF)$$

$$\bar{V}ELOCITY\_WRT\_RUNWAY = M\_EFTORW \bar{V}\_RHO\_EF$$

where  $\bar{R}\_LS\_EF$  is the radius vector to the landing site reference point.

The components of these vectors are

$$\text{downrange position} = \text{POSITION\_WRT\_RUNWAY}_1$$

$$\text{crossrange position} = \text{POSITION\_WRT\_RUNWAY}_2$$

$$\text{altitude position} = -\text{POSITION\_WRT\_RUNWAY}_3$$

$$\text{downrange velocity} = \text{VELOCITY\_WRT\_RUNWAY}_1$$

$$\text{crossrange velocity} = \text{VELOCITY\_WRT\_RUNWAY}_2$$

$$\text{altitude rate} = -\text{VELOCITY\_WRT\_RUNWAY}_3$$

Because of targeting requirements, the sign of the vehicle side of the runway centerline for both the selected and secondary runway is next determined:

$SIGNY = SIGN (POSITION\_WRT\_RUNWAY_2)$

In order to target to the proper point in preparation for landing at the selected runway, it is necessary to determine which type of targeting (either overhead approach or straight-in approach) has been selected as well as the associated heading alignment cone (HAC). The nominal targeting is initially set to the overhead approach on the selected runway, which would therefore place the HAC on the opposite side of the runway centerline to that of the Shuttle. Since weather changes as well as energy level may cause the crew to select some combination of runway and approach type other than the nominal choice (by means of item entries on the HSD), it is necessary to monitor these changes and respond with the proper command both to guidance and the displays (HSD and HSI). Basically, there are five parts to the logic which handle the selection of the runway: (a) initialization of parameters, (b) response to crew item entry which changes the approach type, (c) response to crew item entry which causes a runway redesignation, (d) particular case of crossing the runway centerline for a straight-in approach, and (e) particular case of crossing the runway centerline for an overhead approach. Each part is now treated separately.

- (a) Initialization of Parameters – The parameter RW\_ID UPP will be initialized to zero and employed as a single pass flag in order to initialize the required variables. Since the nominal approach will be overhead to the selected runway, the overhead flag, OVHD, will be turned ON and the commanded HAC side for the selected runway, YSGNP, will be set equal to the negative of the Shuttle side of the runway centerline, that is,

$$OVHD = ON$$

$$YSGNP = - SIGNY$$

In addition, the runway parameter RW\_ID\_UPP will be set equal to the selected runway number, and the radius of the HAC, R\_NEP, as well as the turn angle along the cone, PSHA, will be initialized for the selected runway:

$$RW\_ID\_UPP = RW\_NAME$$

$$R\_NEP = RI$$

$$PSHA = PSHARS$$

The initial values of the radius, RI, and the turn angle, PSHARS, are design dependent constants.

Finally, one flag corresponding to TAEM guidance downmoding is initialized to OFF, and one flag corresponding to AREA NAV is initialized to ON:

$$OHALRT = OFF$$

$$FIRST\_PASS = ON$$

The flag, FIRST\_PASS, when turned ON, allows AREA NAV to initialize the HAC indicators to those used by guidance.

- (b) Response to Change of Approach Type – Since an item entry on the HSD commands a change in approach type, the flag TOGHAC is monitored in order to detect this crew request.

Whenever TOGHAC is turned ON by the HSD, the turn angle PSHA will be reinitialized; and the HSD flag TOGHAC is turned OFF, that is:

$$\text{PSHA} = \text{PSHARS}$$
$$\text{TOGHAC} = \text{OFF}$$

The next step is to determine the status of the overhead flag, OVHD, and the commanded HAC side, YSGNP. If the current status of the overhead flag, OVHD, is ON, then it is set to OFF, indicating a straight-in approach. The commanded HAC side for the selected runway is set equal to the vehicle side of the corresponding runway centerline; that is, if  $\text{OVHD} = \text{ON}$

then

$$\text{OVHD} = \text{OFF}$$
$$\text{YSGNP} = \text{SIGNY}$$

If the current status of the overhead flag, OVHD, is OFF, then it is set to ON, indicating an overhead approach. The commanded HAC side for the selected runway is set equal to the opposite sign of the vehicle side of the corresponding runway centerline; that is, if

$$\text{OVHD} \neq \text{ON}$$

then

$$\text{OVHD} = \text{ON}$$
$$\text{YSGNP} = -\text{SIGNY}$$

- (c) Response to Runway Change – Since two item entries on the HSD provide the crew with the capability to change the designated runway, the parameter RW\_NAME is monitored to detect this crew request. Since the variable RW\_ID\_UPP is set equal to the current runway number, it is employed to detect a change in runway designation. If RW\_ID\_UPP is not equal to the new value of RW\_NAME, then this indicates a change of selected runway, hence the value of the commanded HAC side must be once more determined. The rule for determining this parameter for runway redesignation is as follows: if the primary runway or the secondary runway is redesignated as selected, then the current status of the OVHD flag is to be retained and the value of the commanded HAC side will be determined based on this flag. Therefore, if:

$$\text{RW\_ID\_UPP} \neq \text{RW\_NAME}$$

then the current status of the OVHD flag is tested. If it is ON, the commanded HAC side is set equal to the negative of the vehicle side for the selected runway. Otherwise it is set equal to the vehicle side; that is, if

$$\text{OVHD} = \text{ON}$$

then

$$\text{YSGNP} = -\text{SIGNY}$$

Otherwise

YSGNP = SIGNY

Regardless of the current status of the OVHD flag, the flag FIRST\_PASS is turned ON, the runway parameter RW\_ID\_UPP is set equal to the current value of RW\_NAME, and the turn angle PSHA is reinitialized:

FIRST PASS = ON

RW\_ID\_UPP = RW\_NAME

PSHA = PSHARS

- (d) Particular Case for Straight-In Approach – Whenever the straight-in approach is required, it is necessary to change the commanded HAC side to be compatible with the vehicle side. A test is made on the overhead flag, OVHD, to determine if the approach is straight-in. If the OVHD is OFF, then a test is made on the major mode flag MM\_CODE\_305 to determine entry or TAEM mode. If the mode is entry, denoted by MM\_CODE\_305 not ON, then the commanded HAC side is set equal to the vehicle side for the selected runway; that is, if

MM\_CODE\_305 ≠ ON

then

YSGNP = SIGNY

If the mode is TAEM, denoted by MM\_CODE\_305 = ON, then for the vehicle not yet on the HAC (IPHASE < 2) the commanded HAC side is set equal to the vehicle side; that is, if:

MM\_CODE\_305 = ON

then make a test on the phase counter IPHASE.

If

IPHASE < 2

then

YSGNP = SIGNY

- (e) Particular Case for Overhead Approach – Whenever an overhead approach to the HAC is required, it may be necessary to update or change the commanded Y runway HAC position to be compatible with the vehicle's Y runway position (i.e., maintain opposite sign). A test is made on the overhead flag, OVHD, to determine if an overhead (vs. straight-in) approach is in progress. If OVHD = ON, then a test is made on relative velocity to determine if an "automatic" HAC (Y runway) redesignation may be processed. If REL\_VEL\_MAG is greater than the overhead correction termination velocity, RESELVE, then the commanded HAC Y runway position is set equal to the opposite sign of the vehicle's Y runway position for the designated landing site; that is

If OVHD = ON and REL\_VEL\_MAG > RESELVE

then YSGNP = -SIGNY

A test will be made to determine if the transition to AUTOLAND guidance has occurred. If TG\_END = ON, AUTOLAND guidance is in effect and all subsequent calculations will be done with respect to the landing runway coordinate system.

Radar altimeter data, consisting of the altitude of the Shuttle, the data-good flag, and the time tag (which will subsequently be adjusted by a premission-loaded time bias) will be collected:

SNAP RADAR ALTIMETER (Q\_RADALT, DG\_RADALT, RA\_TIME)

All data are to be saved in one uninterrupted operation by the transfer of the parameters from working locations that are constantly being updated by hardware data reads and other operations into special locations. It will then be determined whether the third component of the vector, POSITION\_WRT\_RUNWAY will be replaced with a value derived directly from the radar altimeter measurement of altitude. If RAW\_RA\_PROC = ON and if DG\_RADALT = ON, the following computations will be performed:

$$T\_RADALT = RA\_TIME - TIME\_BIAS\_RADALT$$

$$POSITION\_WRT\_RUNWAY_3 = -Q\_RADALT + BIAS\_RADALT$$

$$+ (T\_STATE - T\_RADALT) VELOCITY\_WRT\_RUNWAY_3$$

$$- SIN(RADALT\_ANG -$$

$$THETA\_RAD\_PER\_DEG) RADALT\_NB\_DIST$$

where DG\_RADALT is the data validity indicator for the radar altimeter altitude measurement and RAW\_RA\_PROC indicates whether the vehicle position is within the zone of radar altimeter use. If the first part of the test fails, that is, if RAW\_RA\_PROC = OFF, then the following test shall be made to determine whether the vehicle is close enough to the runway threshold to permit radar altimeter utilization:

$$\text{IF } POSITION\_WRT\_RUNWAY_1^2 + POSITION\_WRT\_RUNWAY_2^2 < R\_GO\_RAMP^2$$

then set

$$RAW\_RA\_PROC = ON.$$

For some sloping runways, the MSBLS will be aligned parallel with the sloping runway rather than horizontally. In these instances, it will be necessary to correct the vertical components of the position and velocity with reference to the runway vectors to account for this bias. These corrections will be made gradually beginning at the x-runway position, START\_POSITION. The amount of correction will increase linearly so that the components are fully corrected at the x-runway position, STOP\_POSITION. A small angle approximation will be used for the transformation from horizontal to sloping coordinates. The runway slope, BIAS\_ELMLS, is obtained from the site lookup principal function.

First, test to determine if MSBLS is available at the runway, that is, if

MLS\_AVAIL = ON

Then calculate the vertical components of the position and velocity vectors relative to the sloping runway:

$$\text{TEMP} = (\text{POSITION\_WRT\_RUNWAY}_1 - \text{START\_POSITION}) / (\text{STOP\_POSITION} - \text{START\_POSITION})$$

RAMP = MIDVAL (0, TEMP, 1)

TEMP = RAMP BIAS\_ELMLS

$$\text{POSITION\_WRT\_RUNWAY}_3 = \text{POSITION\_WRT\_RUNWAY}_3 + \text{TEMP POSITION\_WRT\_RUNWAY}_1$$

$$\text{VELOCITY\_WRT\_RUNWAY}_3 = \text{VELOCITY\_WRT\_RUNWAY}_3 + \text{TEMP VELOCITY\_WRT\_RUNWAY}_1$$

The altitude of the rear wheels (corrected for the pitch plane altitude difference between the navigation base and the rear wheels), the altitude above the ellipsoid and the altitude rate (corrected for pitch rate of the navigation base with respect to the c.g.) shall be calculated:

$$\text{ALT\_WHEELS} = -\text{POSITION\_WRT\_RUNWAY}_3 - (\text{X\_NB\_WH SINTH} + \text{Z\_NB\_WH\_COSTH})$$

$$\text{ALT} = \text{ALT\_WHEELS} + \text{ALT\_RW}$$

$$\text{H\_DOT\_ELLIPSOID} = -\text{VELOCITY\_WRT\_RUNWAY}_3 - \text{WBR}_2 \text{ RAD\_PER\_DEG} (\text{X\_NB\_CG COSTH} - \text{Z\_NB\_CG SINTH})$$

where X\_NB\_CG and Z\_NB\_CG are the (positive) X and Z structural body axis distances between the navigation base and the vehicle c.g. and X\_NB\_WH and Z\_NB\_WH are the (positive) X and Z structural body axis distances between the navigation base and the bottom of the rear wheels. The term WBR<sub>2</sub> is the vehicle pitch rate in degrees per second, and SINTH and COSTH are the sine and cosine at the pitch angle. These last three terms are obtained from the attitude processing principal function. The vertical acceleration is then obtained from

$$\text{ACC\_VERT} = (\text{H\_DOT\_ELLIPSOID} - \text{H\_DOT\_LAST}) / (\text{T\_STATE} - \text{T\_STATE\_LAST})$$

Subsequently, previous values are set equal to current values:

$$\text{H\_DOT\_LAST} = \text{H\_DOT\_ELLIPSOID}$$

$$\text{T\_STATE\_LAST} = \text{T\_STATE}$$

If TG\_END = OFF, Entry or TAEM guidance is in effect and a test will be made to establish the value of the LD\_GR\_HYDR flag. First, a flag, TEST\_LD\_GR, is tested; if it is ON, then a further test is made on the relative velocity. If the relative velocity is less than a prescribed threshold value LDGR\_VEL\_THRSH, then the landing gear hydraulic conditioning flag, LD\_GR\_HYDR, is turned ON and the flag, TEST\_LD\_GR, is subsequently turned OFF; that is, if TEST\_LD\_GR = ON, then test REL\_VEL\_MAG;

If REL\_VEL\_MAG < LDGR\_VEL\_THRSH

then

LD\_GR\_HYDR = ON

and

TEST\_LD\_GR = OFF

Returning now to calculations common to both modes, the heading of the Shuttle navigation base with respect to the runway centerline will be computed:

$$\text{COURSE\_WRT\_RW} = \text{ARCTAN2}(\text{VELOCITY\_WRT\_RUNWAY}_2, \text{VELOCITY\_WRT\_RUNWAY}_1)$$

A test will be made to determine if the computed course is a negative number:

$$\text{COURSE\_WRT\_RW} < 0$$

If this statement is true,  $2\pi$  radians will be added to the computed value:

$$\text{COURSE\_WRT\_RW} = \text{COURSE\_WRT\_RW} + 2 \text{ PI}$$

Finally the value is converted to degrees:

$$\text{COURSE\_WRT\_RW} = \text{COURSE\_WRT\_RW} \text{ DEG\_PER\_RAD}$$

Next, the vehicle groundspeed will be determined:

$$\text{V\_GROUNDSPEED} = (\text{REL\_VEL\_MAG}^2 - \text{H\_DOT\_ELLIPSOID}^2)^{1/2}$$

A test will be made to determine if there has been a change in status of the IMU's (for instance, an IMU failure). If the current value of IMU\_SFC is the same as the previous value, IMU\_SFC\_PREV, indicating no change in the status of the IMU's, that is, if

$$\bar{\text{IMU\_SFC}} = \bar{\text{IMU\_SFC\_PREV}}$$

then the total sensed acceleration vector,  $\bar{\text{TCG}}$ , is computed from the IMU-measured velocities:

$$\bar{\text{TCG}} = (\bar{\text{V}}_{\text{IMU\_OLD}} - \bar{\text{V}}_{\text{IMU\_PREV}}) / (\text{T\_STATE} - \text{T\_STATE\_PREV}).$$

Next, the drag acceleration magnitude follows from

$$\text{ACC\_DRAG} = -(\bar{\text{TCG}} \cdot \bar{\text{V}}_{\text{RHO}}) / \text{REL\_VEL\_MAG}$$

ACC\_DRAG should be limited to a positive number greater than or equal to  $1.0\text{E}-8$ .

Then the angle of attack is averaged over the last cycle in order to time synchronize this parameter with drag acceleration computations for use in the NAVDAD SOP (PF 4.122):

$$\text{ALPHA\_NAVDAD} = (\text{ALPHA\_OLD} + \text{ALPHA\_N}) / 2$$

$$\text{ALPHA\_OLD} = \text{ALPHA\_N}$$

Next, previous values are set equal to current values:

$$T\_STATE\_PREV = T\_STATE$$

$$\bar{V}\_IMU\_PREV = \bar{V}\_IMU\_OLD$$

$$\bar{I}MU\_SFC\_PREV = \bar{I}MU\_SFC$$

A test will be made to determine if the major mode is ENTRY or TAEM/Landing. If the major mode is ENTRY, that is, if

$$MM\_CODE\_305 = OFF$$

then the lift-to-drag ratio, magnitude of total sensed acceleration, and inertial speed are calculated.

In order to compute the lift-to-drag ratio, the lift acceleration and a +Y body axis unit vector in M50, coordinates must first be determined. The components of this unit vector are calculated from the M50 to body quaternion as follows:

$$Y\_BD\_UNIT_1 = Q\_B\_I_3 (Q\_B\_I_2 + Q\_B\_I_2) + Q\_B\_I_1 (Q\_B\_I_4 + Q\_B\_I_4)$$

$$Y\_BD\_UNIT_2 = 1 - Q\_B\_I_2 (Q\_B\_I_2 + Q\_B\_I_2) - Q\_B\_I_4 (Q\_B\_I_4 + Q\_B\_I_4)$$

$$Y\_BD\_UNIT_3 = Q\_B\_I_4 (Q\_B\_I_3 + Q\_B\_I_3) - Q\_B\_I_1 (Q\_B\_I_2 + Q\_B\_I_2)$$

Acceleration lift, lift-to-drag ratio, magnitude of the total sensed acceleration, and inertial speed will then be computed:

$$ACC\_LIFT = \bar{T}CG \cdot (\bar{Y}\_BD\_UNIT \times \bar{V}\_RHO) / ABVAL(\bar{Y}\_BD\_UNIT \times \bar{V}\_RHO)$$

$$LOD = ACC\_LIFT / ACC\_DRAG$$

$$LOAD\_TOTAL = ABVAL(\bar{T}CG)$$

$$V\_MAG = ABVAL(\bar{V}\_AVGG)$$

If the major mode is TAEM/Landing, that is, if

$$MM\_CODE\_305 = ON$$

the flight path angle shall be calculated as

$$FLT\_PATH\_ANG = DEG\_PER\_RAD \sin^{-1} (H\_DOT\_ELLIPSOID / REL\_VEL\_MAG)$$

Next, the value of the radar altimeter alert flag will be established. If  $ALT\_WHEELS < ALT\_NAV\_EL_3$ , then the value of the discrete,  $DG\_RADALT$ , shall be tested, and if the value is ON, then the value of the discrete,  $RA\_FLAG$ , shall be set to OFF, and the sequential counter,  $N\_SEQ\_RA$ , shall be reset to one. Otherwise, the sequential counter,  $N\_SEQ\_RA$ , shall be incremented by one, and its value tested to see if it exceeds the maximum allowable value,  $N\_SEQ\_MAX$ . If it does, then the discrete,  $RA\_FLAG$ , shall be set to the value ON. Whenever  $ALT\_WHEELS \geq ALT\_NAV\_EL_3$ , the discrete,  $RA\_FLAG$ , shall retain its initial value of OFF.



These calculations have been simplified to conserve memory locations and execution time. The assumptions are as follows:

1. Position and velocity are defined with respect to the vehicle navigation base rather than the c.g.
2. A correction factor has been applied to the altitude and altitude rate calculation to correct for pitch and pitch rate errors introduced because of the first assumption. Roll and roll rate are not included.
3. Flight path angle is computed at the navigation base. Thus, errors will be introduced whenever pitch rate is not zero.
4. The SNAP statement above implies the assignment of current values to the variable names shown in parentheses.

The terms  $X\_NB\_CG$  and  $Z\_NB\_CG$  used in the altitude rate correction are positive numbers equal to the X and Z structural body axis distance between the navigation base and the vehicle c.g.

$$X\_NB\_CG = X\_CG - X\_NB$$

$$Z\_NB\_CG = Z\_NB - Z\_CG$$

The terms  $X\_NB\_WH$  and  $Z\_NB\_WH$  used in the rear wheel altitude correction are positive numbers equal to the X and Z structural body axis distance between the navigation base and the bottom of the rear wheels.

$$X\_NB\_WH = X\_WHEELS - X\_NB$$

$$Z\_NB\_WH = Z\_NB - Z\_WHEELS$$

#### 4.4.3 Coordinate Transformations

These eight subfunctions provide the capability for transforming parameters specified (or computed) in one coordinate system to another coordinate system. Coordinate system definitions are provided in Section 5.3.

Each of the eight subfunctions described in Sections 4.4.3.2 through 4.4.3.9 may be executed separately. The subfunctions do not actually perform the coordinate transformation; only the rotation matrix is computed.

For consistency, it is assumed that all coordinate systems located on the surface of the earth are specified in terms of geodetic parameters (i.e., geodetic latitude, longitude, and altitude above the reference ellipsoid) and that all azimuth angles are referenced to true (not magnetic) north.

Input and output parameters for all subfunctions are listed in Tables 4.4.3-1 and 4.4.3-2.

Table 4.4.3-1. Coordinate Transformations Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
EARTH_FIXED_TO_M50_COORD							
Earth rotation rate	EARTH_RATE	Constant	F	DP			As needed
Time tag for M_M50TOEF_AT_EPOCH and EARTH_POLE measured in seconds from the beginning of the year-of-date	T_EPOCH	RNP MAT COMP	F	DP		sec	As needed
Transformation matrix from M50 to earth-fixed at T_EPOCH	M_M50TOEF_AT_EPOCH	RNP MAT COMP	M	DP			As needed
General time variable measured in seconds from beginning of the year-of-date	TIME	User sub-function	F	DP		sec	As needed
EF_TO_TOPDET							
Geodetic latitude of $\bar{R}_{EF}$	LAT_GEOD	User sub-function	F	S		rad	As needed
Geodetic longitude of Shuttle's position vector	LON	User sub-function	F	S		rad	As needed
EF_TO_RUNWAY							
Geodetic latitude of $\bar{R}_{EF}$	LAT_GEOD	User sub-function	F	S		rad	As needed
Geodetic longitude of Shuttle's position vector	LON	User sub-function	F	S		rad	As needed
Bearing from true north	AZ	User sub-function	F	S		rad	As needed
EF_TO_SCANNER							
Geodetic latitude of $\bar{R}_{EF}$	LAT_GEOD	User sub-function	F	S		rad	As needed
Geodetic longitude of Shuttle's position vector	LON	User sub-function	F	S		rad	As needed
Bearing from true north	AZ	User sub-function	F	S		rad	As needed
EF_TO_GEODETTIC							
General position vector in earth-fixed coordinates	$\bar{R}_{EF}$	User sub-function	V	DP		ft	As needed
Earth ellipticity constant	ELLIPT	Constant	F	DP			

Table 4.4.3-1. Coordinate Transformations Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Earth equatorial radius	EARTH_RADIUS_EQUATOR	Constant	F	DP		ft	As needed
GEODETIC_TO_EF Geodetic latitude of $\bar{R}_{EF}$	LAT_GEOD	User sub-function	F	S		rad	As needed
Geodetic longitude of Shuttle's position vector	LON	User sub-function	F	S		rad	As needed
Current orbiter altitude above reference ellipsoid	ALT	User sub-function	F	S		ft	As needed
Earth ellipticity constant	ELLIPT	Constant	F	DP			As needed
UVW_TO_M50 Input position vector in M50 coords	$\bar{R}$	User sub-function	V	DP		ft	As needed
Input velocity vector in M50 coords	$\bar{V}$	User sub-function	V	S		ft/sec	As needed
SBODY_TO_M50 Quaternion representing the orientation of the orbiter body with respect to M50 coordinates	Q_FIFTY_BODY	User sub-function	V	DP		—	As needed

Table 4.4.3-2.Coordinate Transformations Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
EARTH_FIXED_TO_M50_COORD							
Earth-fixed to M50 coordinate transformation matrix	M_EFTOM50	User sub-function	M	DP		—	As needed
EF_TO_TOPDET							
Transformation from earth-fixed to topodetic coordinates	M_EFTOTD	User sub-function	M	S		—	As needed
EF_TO_RUNWAY							
Earth-fixed to RW transformation matrix	M_EFTORW	User sub-function	M	S		—	As needed
EF_TO_SCANNER							
Transformation matrix from earth-fixed to scanner coordinates	M_EF_TO_SCANNER	User sub-function	M	S		—	As needed
EF_TO_GEODETTIC							
Geodetic latitude of $\bar{R}_{EF}$	LAT_GEOD	User sub-function	F	S		rad	As needed
Geodetic longitude of Shuttle's position vector	LON	User sub-function	F	S		rad	As needed
Current orbiter altitude above reference ellipsoid	ALT	User sub-function	F	S		ft	As needed
GEODETTIC_TO_EF							
General position vector in earth-fixed coordinates	$\bar{R}_{EF}$	User sub-function	V	S		ft	As needed
UVW_TO_M50							
UVW to M50 coordinate transformation matrix	M_UVW_TO_M50	User sub-function	M	S		—	As needed
SBODY_TO_M50							
Structural body to M50 coordinates transformation	MAT	User sub-function	M	S		—	As needed

#### 4.4.3.1 Deleted

#### 4.4.3.2 Earth-Fixed to M50

The purpose of this subfunction is to propagate the matrix M\_M50TOEF\_AT\_EPOCH from T\_EPOCH to the time of interest. This propagation accounts for the earth's rotation effects only.

The nutation/precession computations are lengthy, and it is assumed that suitable accuracy can be maintained by employing the approximation of earth motion described in this section. Note: M\_M50TOEF\_AT\_EPOCH is also referred to as the RNP matrix. It is the transformation from the mean equator and equinox of 1950 to the true equator and Greenwich meridian of date. The transformation accounts for the earth's rotation, nutation, and precession from the beginning of the Besselian year 1950 to the Julian date derived from T\_EPOCH and the year of launch. The RNP matrix and its T\_EPOCH are computed by the RNP Matrix Computation principal function (G4.16) during GN&C OPS 9 and made available to the remaining GN&C OPS sequences via the Major Function Base (MFB). The MFB contains data and code that are not part of an OPS overlay. If necessary, the RNP matrix and T\_EPOCH may be re-computed in GN&C OPS 9 following a MFB overlay, or during GN&C OPS 2 or GN&C OPS 3 initialization for inflight GPC recovery where the MFB has been overlaid. The RNP matrix data must also be recomputed by executing the RNP MAT COMP function following an uplink of the RNP Matrix Time parameters (see section 6.3.65 of SS-P-0002-140, the Downlist/Uplink CPDS). Section 4.11 of FSSR STS 83-0005 Ascent/RTLS Navigation contains a detailed description of the RNP MAT COMP principal function.

Formulation: A simple Z-axis rotation is performed through the angle defined by the product of the earth's mean rotational rate (EARTH\_RATE) relative to the mean-of-date system, and the difference between the time (T\_EPOCH) associated with the matrix (M\_M50TOEF\_AT\_EPOCH) and the time (TIME) of this requested matrix. Thus, for the defined

$$\text{DELT} = \text{TIME} - \text{T\_EPOCH}$$

the angle of rotation is

$$\text{LAM} = (\text{EARTH\_RATE}) \text{DELT}$$

and the rotation matrix, M, is defined by the equation

$$M = \begin{bmatrix} \cos(\text{LAM}) & -\sin(\text{LAM}) & 0 \\ \sin(\text{LAM}) & \cos(\text{LAM}) & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \text{F9}$$

F9 This equation shall be protected against return value of sine or cosine with magnitudes greater than unity (Section 3.5).

The variable TIME, provided by the user of the earth-fixed to M50 transformation, is a year-of-date time tag in seconds and is referenced to the beginning of the same year for which T\_EPOCH is referenced. The parameter EARTH\_RATE is a constant (see Section 4.9.1).

The matrix is then used to compute a current transformation matrix from earth-fixed to M50 coordinates:

$$\text{EARTH\_FIXED\_TO\_M50\_COORD} = \text{M\_M50TOEF\_AT\_EPOCH}^T M$$

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Because of the sparseness of the matrix  $M$ , both core and execution time will be conserved by use of the following formulation. For notational convenience, let  $N$  denote the matrix  $M\_M50TOEF\_AT\_EPOCH$ . The sine and cosine of  $LAM$  will be computed once and denoted by  $CLAM = \text{COS}(LAM)$  and  $SLAM = \text{SIN}(LAM)$ . Then  $EARTH\_FIXED\_TO\_M50\_COORD$  will be computed as follows:

$$EARTH\_FIXED\_TO\_M50\_COORD_{1,1} = N_{1,1} CLAM + N_{2,1} SLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{1,2} = -N_{1,1} SLAM + N_{2,1} CLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{1,3} = N_{3,1}$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{2,1} = N_{1,2} CLAM + N_{2,2} SLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{2,2} = -N_{1,2} SLAM + N_{2,2} CLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{2,3} = N_{3,2}$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{3,1} = N_{1,3} CLAM + N_{2,3} SLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{3,2} = -N_{1,3} SLAM + N_{2,3} CLAM$$

$$EARTH\_FIXED\_TO\_M50\_COORD_{3,3} = N_{3,3}$$

This subfunction may be executed as needed. The time ( $TIME$ ) at which the output transformation matrix ( $EARTH\_FIXED\_TO\_M50\_COORD$ ) is desired must be supplied by the user in elapsed seconds in the year of date consistent with the time  $T\_EPOCH$ .

A valid  $M\_M50TOEF\_AT\_EPOCH$  must be available before this subfunction can be executed.

The Aries mean of 1950 and the earth-fixed coordinate systems are shown in Section 5.3.

#### 4.4.3.3 Geodetic to Earth-Fixed

This submodule accepts the geodetic parameters of a point and computes the earth-fixed Cartesian coordinates of that point.

Formulation: The input angles must be in radians. The equations necessary to transform geodetic parameters to earth-fixed coordinates are as follows:

$$R\_EF_1 = \left[ \frac{EARTH\_RADIUS\_EQUATOR}{(\cos^2(LAT\_GEOD) + (1 - ELLIPT) \sin^2(LAT\_GEOD))^{1/2}} + ALT \right] \quad F9$$

$$\cos(LAT\_GEOD) \cos(LON) \quad F3, F4$$

$$R\_EF_2 = \left[ \frac{EARTH\_RADIUS\_EQUATOR}{(\cos^2(LAT\_GEOD) + (1 - ELLIPT) \sin^2(LAT\_GEOD))^{1/2}} + ALT \right] \quad F9$$

$$\cos(LAT\_GEOD) \sin(LON) \quad F3, F4$$

$$R\_EF_3 = \left[ \frac{(1 - ELLIPT)^2 EARTH\_RADIUS\_EQUATOR}{(\cos^2(LAT\_GEOD) + (1 - ELLIPT)^2 \sin^2(LAT\_GEOD))^{1/2}} + ALT \right] \quad F9$$

$$\sin(LAT\_GEOD) \quad F3, F4$$

F3 This equation shall be protected against division by zero (Section 3.5).

F4 This equation shall be protected against square roots of a negative number (Section 3.5).

F9 This equation shall be protected against return value of sine or cosine with magnitudes greater than unity (Section 3.5).

#### 4.4.3.4 Earth-Fixed to Topodetic

This subfunction accepts the geodetic latitude and longitude of a point and computes the rotation matrix from earth-fixed coordinates to a topodetic coordinate system for the input location.

Formulation: This subfunction creates the rotation matrix as an Euler Z, Y sequence through the longitude angle (LON) and the geodetic latitude angle plus 90 degrees (LAT\_GEOD +  $\pi/2$ ), respectively. The necessary equation is

$$M = \begin{bmatrix} -\cos(LON)\sin(LAT\_GEOD) & -\sin(LON)\sin(LAT\_GEOD) & \cos(LAT\_GEOD) \\ -\sin(LON) & \cos(LON) & 0 \\ -\cos(LON)\cos(LAT\_GEOD) & -\sin(LON)\cos(LAT\_GEOD) & -\sin(LAT\_GEOD) \end{bmatrix} \quad F9$$

F9 This equation shall be protected against return value of sine or cosine with magnitudes greater than unity (Section 3.5).

#### 4.4.3.5 Earth-Fixed to Runway

This subfunction accepts the geodetic latitude, longitude, and azimuth of the runway and computes the rotation matrix from the earth-fixed coordinate system to the runway coordinate system.

Formulation: The earth-fixed to topodetic subfunction is used to obtain an earth-fixed to topodetic rotation matrix. Then the earth-fixed to topodetic matrix is multiplied by an Euler Z rotation matrix through the runway azimuth angle (AZ). The equation is

$$M = \begin{bmatrix} (\text{COS AZ}) & (\text{sin AZ}) & 0 \\ (- \text{SIN AZ}) & (\text{cos AZ}) & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \text{F9}$$

F9 This equation shall be protected against return value of sine or cosine with magnitudes greater than unity (Section 3.5).

where AZ is the runway azimuth angle measured clockwise from true north to the +X-axis of the runway. Then the transformation matrix is computed by

$$\text{EF\_TO\_RUNWAY} = M \text{EF\_TO\_TOPDET}$$

Input angles must be in radians.

The runway and topodetic coordinate systems are shown in Section 5.3.

#### 4.4.3.6 Earth-Fixed to Scanner

The purpose of this subfunction is to compute the rotation matrix from earth-fixed to scanner coordinates.

Formulation: The earth-fixed to runway subfunction is executed, with use of the geodetic latitude and longitude of the scanner and the azimuth of the scanner boresight (AZ) from the true north to obtain a rotation matrix.

The rotation matrix is then multiplied by a rotation matrix representing a 180-degree rotation about the X-axis. The necessary equation is

$$\text{EF\_TO\_SCANNER} = M\_XROTPI \text{EF\_TO\_RUNWAY}$$

where

$$M\_XROTPI = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

and EF\_TO\_RUNWAY is the rotation matrix computed by the earth-fixed to runway subfunction.

All computations are performed in double precision.

Input angles must be in radians.

The scanner and earth-fixed coordinates systems are shown in Section 5.3.



#### 4.4.3.7 Body to M50

The transformation matrix from structural body to M50 coordinates (MAT) is computed by post-multiplying the transformation matrix from body to M50 coordinates by a matrix representing a 180-degree rotation about the Y-axis.

The transformation from body to M50 coordinates is derived from the quaternion Q\_FIFTY\_BODY, by employing the general purpose matrix function QUAT\_TO\_MAT.

QUAT\_TO\_MAT computes the transformation matrix, A, associated with a quaternion, Q, as QUAT\_TO\_MAT (Q) = A, where A is computed by

$$P2 = Q_2 + Q_2$$

$$P3 = Q_3 + Q_3$$

$$P4 = Q_4 + Q_4$$

$$P5 = P2 Q_2$$

$$P6 = P4 Q_4$$

$$\text{Temp} = 1.0 - P3 Q_3$$

$$A_{1,1} = \text{Temp} - P6$$

$$A_{2,2} = 1.0 - P5 - P6$$

$$A_{3,3} = \text{Temp} - P5$$

$$P5 = P2 Q_3$$

$$P6 = P4 Q_1$$

$$A_{1,2} = P5 - P6$$

$$A_{2,1} = P5 + P6$$

$$P5 = P2 Q_4$$

$$P6 = P3 Q_1$$

$$A_{1,3} = P5 + P6$$

$$A_{3,1} = P5 - P6$$

$$P5 = P3 Q_4$$

$$P6 = P2 Q_1$$

$$A_{2,3} = P5 - P6$$

$$A_{3,2} = P5 + P6$$

The structural body to M50 coordinates, MAT, is then computed as

$$\text{MATRIX} = \text{QUAT\_TO\_MAT} (\text{Q\_FIFTY\_BODY})$$

$$\text{MAT}_{1,1} = -\text{MATRIX}_{1,1}$$

$$\text{MAT}_{1,2} = \text{MATRIX}_{2,1}$$

$$\text{MAT}_{1,3} = -\text{MATRIX}_{3,1}$$

$$\text{MAT}_{2,1} = -\text{MATRIX}_{1,2}$$

$$\text{MAT}_{2,2} = \text{MATRIX}_{2,2}$$

$$\text{MAT}_{2,3} = -\text{MATRIX}_{3,2}$$

$$\text{MAT}_{3,1} = -\text{MATRIX}_{1,3}$$

$$\text{MAT}_{3,2} = \text{MATRIX}_{2,3}$$

$$\text{MAT}_{3,3} = -\text{MATRIX}_{3,3}$$

This subfunction may be executed as needed; however, no extrapolation or interpolation of Q\_FIFTY\_BODY is performed.

Coordinate system definitions and the suggested implementation are shown in Section 5.3.

#### 4.4.3.8 Earth-Fixed to Geodetic

This function is required to transform a Cartesian position vector in the earth-fixed (Greenwich) coordinate system to the geodetic parameters: Geodetic altitude, longitude, and geodetic latitude.

Formulation: The equations necessary to transform the Cartesian position vector to geodetic parameters are as follows:

The computation for longitude is:

$$\text{LON} = \text{ARCTAN2} (\text{R\_EF}_2, \text{R\_EF}_1) \quad -\pi \leq \text{LON} \leq \pi \quad \text{F3, F7}$$

F3 This equation shall be protected against division by zero (Section 3.5).

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5)

Computations for geodetic latitude, LAT\_GEOD, and height above the reference ellipsoid, ALT, are as follows:

$$R\_XY = R\_EF_1^2 + R\_EF_2^2$$

$$R = (R\_XY + R\_EF_3^2)^{1/2}$$

$$SIN\_P = R\_EF3/R$$

$$COS\_P = (R\_XY)^{1/2}/R$$

$$RAD\_P = \frac{EARTH\_RADIUS\_EQUATOR}{\sqrt{1 + FLATCON SIN\_P^2 / (1.0 - FLATCON)}} \quad F3, F4$$

$$DEL = \frac{FLATCON SIN\_P COS\_P}{1.0 - FLATCON COS\_P^2} \quad F3$$

$$DEL\_LAT = \frac{RAD\_P DEL}{R} \quad F3$$

F3 This equation shall be protected against division by zero (Section 3.5).

F4 This equation shall be protected against square roots of a negative number (Section 3.5).

$$PHI = ARCTAN (SIN\_P/COS\_P)$$

$$LAT\_GEOD = PHI + DEL\_LAT$$

$$ALT = (R - RAD\_P) (1.0 - 0.50 DEL DEL\_LAT)$$

where

LAT GEOD = geodetic latitude in radians

LON = geodetic longitude in radians

ALT = geodetic altitude in feet

ELLIPT = flattening of the reference ellipsoid

EARTH\_RADIUS\_EQUATOR = equatorial radius of the reference ellipsoid

FLATCON =  $1.0 - (1.0 - ELLIPT)^2$ , the eccentricity squared of the ellipsoid

This subfunction may be executed on demand.

The earth-fixed coordinate system and geodetic parameters are defined in Section 5.3.

#### 4.4.3.9 UVW to M50

The purpose of this subfunction is to compute the transformation matrix from UVW coordinates to Aries M50 coordinates, given the position and velocity of the vehicle.

Formulation: The orientation of the U, V, W system is determined by the orbiter inertial position and velocity vectors ( $\bar{R}$ ,  $\bar{V}$ ) at the point (or time) of interest. Define

$$\begin{aligned}\bar{U} &= \bar{R}/|\bar{R}| \\ \bar{W} &= (\bar{R} \times \bar{V})/|\bar{R} \times \bar{V}| \\ \bar{Z} &= \bar{W} \times \bar{U}\end{aligned}\tag{F3}$$

F3 This equation shall be protected against division by zero (Section 3.5).

The transformation matrix from UVW coordinated to Aries mean of 1950 is then given by

$$\begin{bmatrix} \bar{U} & \bar{Z} & \bar{W} \end{bmatrix}$$

#### 4.4.4 TACAN Display Computations

During the ENTRY, TAEM, and GLIDE RTLS portions of the Shuttle flight, the Horizontal Situation Display (HSD) provides the crew with spacecraft position and heading information with respect to the ground plane. In addition to the graphical display of the Shuttle's position with respect to the runway and heading alignment cone, other tabular data are displayed. This subfunction provides tabular data for the TACAN portion of the display when TACAN receivers are installed on the vehicle (NUM\_GPS\_INSTALLED <3). Data for each of the three TACAN LRU's is displayed.

For each TACAN there is a display of TAC AZ as either the absolute magnetic azimuth in degrees from the vehicle to the ground station as measured by the TACAN, or the delta azimuth in degrees formed by subtracting the nav derived azimuth to the ground station from the TACAN measured azimuth to the station. In addition, for each TACAN there is a display of range as either the absolute slant range in nautical miles from the vehicle to the ground station as measured by the TACAN, or the delta slant range in nautical miles formed by subtracting the nav derived range to the ground station from the TACAN measured range to the ground station. Two mutually exclusive items, ABS and DELTA, are provided on the HSD to allow the crew to select absolute or delta values of TACAN azimuth and range.

The computational sequence for the ABS mode is to convert data from the TACAN SOP to the proper units for display as follows:

$$TAC\_AZ_1 = TACBEARO_1 \text{ DEG\_PER\_RAD}$$

$$TAC\_RNG_1 = TACRANGE_1 \text{ NAUTMI\_PER\_FT}$$

If the TAC\_GPS\_MODE is not ABS and the TACAN\_CHAN\_VALID\_SL<sub>1</sub> is "off," then both TAC\_AZ<sub>1</sub> and TAC\_RNG<sub>1</sub> shall be set to "BLANK" for display. If the TAC\_GPS\_MODE is not ABS and the TACAN\_CHAN\_VALID\_SL<sub>1</sub> is "on," then the computational sequence is for the DELTA\_MODE and the differences between the nav derived range and azimuth and the TACAN measured range and azimuth are computed. The range difference for each TACAN is computed as follows:

$$\bar{R}_{EST} = \bar{R}_{EF} - \bar{R}_{TACAN\_EF\_SL_1}$$

$$\bar{R}_{TEMP} = M\_EFTOTD\_TACAN\_SL_1 \bar{R}_{EST}$$

$$TAC\_RNG_1 = (TACRANGE_0_1 - ABVAL(\bar{R}_{EST})) NAUTMI\_PER\_FT$$

The azimuth difference for each TACAN is computed as follows:

$$TEMP = (TACBEAR_0_1 - (ARCTAN2(R\_TEMP_2, R\_TEMP_1) - ANGLE\_CORR\_TNTOMAG\_SL_1 + PI)) DEG\_PER\_RAD$$

This delta azimuth (TEMP) is then adjusted for the event where the two angles span the 360 degrees or 0 degree radial as follows:

If  $ABS(TEMP) > 180$  degrees

then set

$$TAC\_AZ_1 = TEMP - SIGN(TEMP) 360 \text{ degrees}$$

If not, set

$$TAC\_AZ_1 = TEMP$$

Finally, independently of the status of the TAC\_GPS\_MODE flag, it is renamed for output purposes as TAC\_GPS\_MODE\_DISP.

#### 4.4.5 Utility Subfunctions

The following subfunctions are utilized by various users. They are mutually independent, that is, the execution of any one of these functions neither requires the previous execution nor precludes the future execution of another. They may be utilized at regular intervals or only upon request.

Input and output parameters for these subfunctions are contained in Tables 4.4.5-1 and 4.4.5-2, respectively.

##### 4.4.5.1 Altitude Above the Reference Ellipsoid

The purpose of this subfunction is to calculate the altitude, above the Fisher ellipsoid, of a point with M50 position vector  $\bar{R}$ . The altitude obtained is approximate, with the error increasing with altitude. The accuracy obtained in near earth work (and this covers the range of orbiter altitudes) is considered adequate. The equation is

$$H\_ELLIPSOID(\bar{R}) = |\bar{R}| - \frac{(1 - ELLIPT) EARTH\_RADIUS\_EQUATOR}{\sqrt{1 + ((1 - ELLIPT)^2 - 1) (1 - (\text{UNIT}(\bar{R}) \bullet \bar{EARTH\_POLE})^2)}}$$

where ELLIPT and EARTH\_RADIUS\_EQUATOR are the ellipticity constant (or “flattening”) and the equatorial radius of the 1960 Fisher ellipsoid respectively, and  $\bar{EARTH\_POLE}$  is the unit vector in the direction of the earth’s span axis, expressed in M50 coordinates.

A flow chart for this function may be found in Section 5.2, under the name H\_ELLIPSOID.

#### 4.4.5.2 Velocity Relative to the Windless, Rotating Atmosphere

This function computes the velocity, relative to the atmosphere, of a vehicle with M50 position and velocity vectors, respectively  $\bar{R}$  and  $\bar{V}$ . The following assumptions are made: there are no winds and the atmosphere rotates rigidly with the earth at all altitudes. The relative velocity is expressed in M50 coordinates.

The equation that accomplishes this is:

$$\bar{V}_{REL}(\bar{V}, \bar{R}) = \bar{V} - EARTH\_RATE(\bar{EARTH\_POLE} \times \bar{R})$$

where EARTH\_RATE is the earth's angular velocity with respect to the M50 (inertial) axes and  $\bar{EARTH\_POLE}$  is the unit vector in the direction of the earth's axis of rotation, expressed in M50 coordinates.

A flow chart for this function may be found in Section 5.2 under the name  $\bar{V}_{REL}$ .

#### 4.4.5.3 Partial Derivatives of an Angular Measurement With Respect to the State Vector

This routine calculates a 6-component vector,  $\bar{B}$ , the components of which are the partial derivatives of an angular measurement (a scalar) with respect to the components of the position and velocity vectors of the vehicle relative to the measurement device.

The function takes as inputs the M50 position vector of the vehicle at the time of the measurement ( $\bar{R}_{RESID}$ ), the M50 position vector of the measurement device at the same time ( $\bar{R}_{SENSOR}$ ) and a unit vector ( $\bar{I}_Z$ ) that represents, in the M50 coordinate system, the direction relative to which the angular measurement is taken (local north for azimuth, the zenith direction for the complement of elevation).

The following calculations are then made:

$$\bar{REL\_R} = \bar{R}_{RESID} - \bar{R}_{SENSOR}$$

$$\bar{REL\_R\_HORZ} = \bar{REL\_R} - (\bar{REL\_R} \cdot \bar{I}_Z) \bar{I}_Z$$

$$B_{1\text{ to }3} = (\bar{I}_Z \times \bar{REL\_R\_HORZ}) / |\bar{REL\_R\_HORZ}|^2$$

The other three components of the 6-vector  $\bar{B}$  are identically zero.

$$B_{4\text{ to }6} = 0$$

A flow chart for this function, with the name ANGLE\_PARTIALS, may be found in Section 5.2. The flow chart contains equations derived from those above but optimized for computation in that they eliminate the calculation of the intermediate vector REL\_R\_HORZ and thereby avoid the calculation of the zero vector obtained by the cross product of  $\bar{I}_Z$  and  $(\bar{REL\_R} \cdot \bar{I}_Z) \bar{I}_Z$ .

#### 4.4.5.4 Derivative of the Gravitational Acceleration With Respect to the Position Vector

This function calculates a 3 by 3 matrix, the components of which are the partial derivatives of the gravitational acceleration vector with respect to the position vector  $\bar{R}$ . This is used in the generation of the

state transition matrix, which is required for covariance matrix propagation. The dominant part of the gravitational acceleration vector is the central term, which computes the earth's attraction as if all its mass were concentrated at the center. This is the only term utilized in the calculation of the partial derivatives. A vehicle moving under the influence of such a gravity field would travel in a conic orbit. The state transition matrix obtained is based on Keplerian motion as the reference trajectory.

The equation is:

$$\text{GRAVITY\_GRADIENT}(\bar{\mathbf{R}}) = (\text{EARTH\_MU}/|\mathbf{R}|^5) (3 \bar{\mathbf{R}} \bar{\mathbf{R}}^T - |\bar{\mathbf{R}}|^2 \text{ID\_MATRIX\_3x3})$$

where EARTH\_MU is the earth's gravitational constant and ID\_MATRIX\_3x3 is the 3 by 3 identity matrix.

A flow chart for this function, with the name GRAVITY\_GRADIENT, may be found in Section 5.2.

Table 4.4.5-1. Utility Subfunctions Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Earth's gravitational constant	EARTH_MU	Constant	F	DP		ft <sup>3</sup> /sec <sup>2</sup>	As needed
Unit vector in the direction of the earth's axis of rotation	$\bar{E}$ ARTH_POLE	*	V	DP		—	As needed
Equatorial radius of the earth	EARTH_RADIUS_EQUATOR	Constant	F	DP		ft	As needed
Rotational rate of the earth	EARTH_RATE	Constant	F	DP		rad/sec	As needed
Earth's ellipticity constant	ELLIPT	Constant	F	DP		—	As needed
Identity matrix (3x3)	ID_MATRIX_3x3	Constant	M	S		—	As needed
Unit vector of reference direction	$\bar{I}_Z$	User function	V	S		—	As needed
Generic position vector	$\bar{R}$	User	V	DP		ft	As needed
Position vector of vehicle at time of measurement	$\bar{R}_{RESID}$	User function	V	DP		ft	As needed
Position vector of vehicle at time	$\bar{R}_{SENSOR}$	User function	V	DP		ft	As needed
Generic velocity vector	$\bar{V}$	User function	V	DP		ft/sec	As needed

\* See entry navigation principal function input parameter Table 4.3.1.9-1.



Table 4.4.5-2. Utility Subfunctions Output Parameters

Description	Symbol	Output Source	Type	Precision	Range	Units	Comp Rate
Partial derivative of angular measurement w.r.t. state vector	$\bar{B}$	User function	V(6)	DP		Vary	As needed
Gradient of central gravity w.r.t. position vector	GRAVITY_ GRADIENT	User function	M	DP		sec <sup>-2</sup>	As needed
Altitude above reference ellipsoid	H_ELLIPSOID	User function	F	DP		ft	As needed
Velocity relative to rotating, windless atmosphere	$\bar{V}_{REL}$	User function	V	DP		ft/	As needed

#### 4.4.6 GPS User Parameter Display Computation

During the ENTRY, TAEM, APPROACH/LAND, GRTLS TAEM and GRTLS APPROACH/LAND portions of the Shuttle flight, the Horizontal Situation Display (HSD) provides the crew with spacecraft position and heading information with respect to the ground plane. In addition to the graphical display of the Shuttle's position with respect to the runway and heading alignment cone, other tabular data are displayed. This subfunction provides tabular data for the GPS portions of the display.

The GPS user parameter display computation subfunction provides GPS derived data to the HSD.

When TACAN receivers are installed on the vehicle, the GPS data provided to the HSD are similar to that provided by the TACAN display computations described in Section 4.4.4.1, and contains range and azimuth from the single GPS LRU to the AUTO selected TACAN station. When no TACAN receivers are installed on the vehicle, the GPS data provided to the HSD contains azimuth, range and altitude relative to the runway, computed using the selected GPS state.

The following paragraph describes the GPS parameters being displayed when TACAN receivers are installed on the vehicle.

Azimuth, as either the absolute magnetic azimuth in degrees from the vehicle to the selected TACAN station as computed using the GPS states, or the delta azimuth in degrees formed by subtracting the navigation-derived azimuth to the ground station from the GPS derived azimuth to the station is displayed. Also, there is a display of range as either the absolute slant range in nautical miles from the vehicle to the ground station as derived from the GPS state, or the delta slant range in nautical miles formed by subtracting the navigation-derived range to the ground station. Two mutually exclusive items, ABS and DELTA, are provided on the HSD to allow the crew to select absolute or delta values of TACAN azimuth and range. The ABS and DELTA display commands are the same for the TACAN Display Computations (Section 4.4.4.1) and the GPS UPP display computations. Providing similar data computed or derived from both TACAN and GPS allows the crew to compare the outputs of the TACAN and GPS LRU's.

The selected TACAN station location used in the calculations is that obtained from the Entry Site Lookup Initialization subfunction.

When three GPS receivers are installed on the vehicle (no TACAN receivers installed), the data displayed on the HSD consists of the azimuth, range and altitude of the orbiter relative to the runway computed using the selected GPS state, and the earth relative velocities computed using the position and velocity states from each receiver.

The detailed requirements are as follows:

- 1.0 If no TACAN receivers are installed on the vehicle, indicated by NUM\_GPS\_INSTALLED = 3, the calculations shown in Section 4.4.6.2 are performed, otherwise the calculations shown in Section 4.4.6.1 are performed.

#### **4.4.6.1 GPS User Parameter Display Computation with TACAN Receivers Installed on the Vehicle**

The computational sequence converts GPS receiver position data from the GPS SOP to the proper quantities and units for display.

The steps are as follows:

- 1.0 Set the flag controlling the computation of navigation-derived range and bearing to ON:

COMPUTE\_NAV\_VALUES = ON

- 2.0 Perform the following calculations in Step 2.0 for up to three receivers:

DO FOR I = 1 TO GPS\_SW\_CAP

where GPS\_SW\_CAP is the maximum number of receivers for which the software is designed.

- 2.1 Test the GPS installation indicator for the I'th receiver. If the I'th receiver is installed, indicated by GPS\_INSTALLED<sub>I</sub> = ON, continue with the calculations in Step 2.2.
- 2.2 Set the GPS UPP data status indicator to a DOWN\_ARROW if the Orbiter state estimate from the I'th receiver is invalid, indicated by GPS\_DG\_SOP<sub>I</sub> = OFF, or if the time of the user parameter state minus the time of the receiver state is greater than an I-load DT limit, otherwise set the status indicator to BLANK:

IF GPS\_DG\_SOP<sub>I</sub> = OFF or (T\_STATE - T\_GPS\_SOP<sub>I</sub>) > GPS\_UPP\_TIME\_STALENESS\_LIM  
THEN

GPS\_RN\_AZ\_H\_STAT = DOWN\_ARROW

ELSE

GPS\_RN\_AZ\_H\_STAT = BLANK

The parameter GPS\_RN\_AZ\_H\_STAT has the values of DOWN\_ARROW which indicates an ON value, and BLANK which indicates an OFF value. DOWN\_ARROW and BLANK are shown for clarity of requirements.

- 2.3 If the Orbiter state estimate of the I'th receiver is valid, indicated by GPS\_DG\_SOP<sub>I</sub> = ON, perform the calculations in Step 2.4 through 2.8.

- 2.4 Convert the GPS receiver position and velocity to earth-fixed coordinates from WGS84 coordinates:

$$\bar{R}_{GPS\_ECEF} = M_{WGS84\_TO\_EF} \bar{R}_{GPS\_ECEF\_SOP_1}$$

$$\bar{V}_{GPS\_ECEF} = M_{WGS84\_TO\_EF} \bar{V}_{GPS\_ECEF\_SOP_1}$$

Extrapolate the GPS receiver position vector to the time of the user parameter state, using the receiver earth-fixed velocity vector:

$$DT = T\_STATE - T\_GPS\_SOP_1$$

$$\bar{R}_{GPS\_ECEF} = \bar{R}_{GPS\_ECEF} + DT \bar{V}_{GPS\_ECEF}$$

- 2.5 Compute the position of the vehicle relative to the TACAN station selected in the Entry Site Lookup Initialization subfunction:

$$\bar{R}_{WRT\_STA\_EF} = \bar{R}_{GPS\_ECEF} - \bar{R}_{TACAN\_EF\_AUTO}$$

Transform the station relative position from Earth-fixed coordinates to topodetic coordinates:

$$\bar{R}_{WRT\_STA\_TD} = M_{EFTOTD\_TACAN\_AUTO} \bar{R}_{WRT\_STA\_EF}$$

- 2.6 Convert the topodetic position into slant range in nautical miles and magnetic bearing in degrees:

$$GPS\_RNG_1 = |\bar{R}_{WRT\_STA\_TD}| NAUTMI\_PER\_FT$$

$$GPS\_AZ_1 = [ARCTAN2(\bar{R}_{WRT\_STA\_TD}(2), \bar{R}_{WRT\_STA\_TD}(1)) - ANGLE\_CORR\_TNTOMAG\_AUTO + PI] DEG\_PER\_RAD$$

Constrain the bearing measurement to be between 0 and 360 degrees:

$$\text{IF } GPS\_AZ_1 < 0^\circ \text{ or } GPS\_AZ_1 \geq 360^\circ$$

$$GPS\_AZ_1 = GPS\_AZ_1 - \text{SIGN}(GPS\_AZ_1) 360^\circ$$

- 2.7 If the TACAN/GPS display mode is DELTA, indicated by TAC\_GPS\_MODE = OFF, then the differences between the navigation-derived measurements and the GPS-derived measurements are computed as shown in Steps 2.7.1 through 2.7.2:

IF TAC\_GPS\_MODE = OFF THEN

- 2.7.1 If the flag COMPUTE\_NAV\_VALUES is ON, compute the navigation-derived measurements on the first pass through the logic:

IF COMPUTE\_NAV\_VALUES = ON

Compute the TACAN station-relative position of the vehicle in Earth-fixed coordinates:

$$\bar{R}_{WRT\_STA\_EF} = \bar{R}_{EF} - \bar{R}_{TACAN\_EF\_AUTO}$$

Transform the TACAN station-relative position from Earth-fixed coordinates to topodetic coordinates:

$$\bar{R}_{WRT\_STA\_TD} = M_{EFTOTD\_TACAN\_AUTO} \bar{R}_{WRT\_STA\_EF}$$

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Convert the topodetic position into slant range in nautical miles and magnetic bearing in degrees, and set the flag controlling computation of navigation-derived values to OFF:

$$\text{NAV\_RNG} = |\bar{R\_WRT\_STA\_TD}| \text{ NAUTMI\_PER\_FT}$$

$$\text{NAV\_AZ} = [ \text{ARCTAN2}(\text{R\_WRT\_STA\_TD}(2), \\ \text{R\_WRT\_STA\_TD}(1) - \\ \text{ANGLE\_CORR\_TNTOMAG\_AUTO} + \text{PI} ) \\ \text{DEG\_PER\_RAD}$$

$$\text{COMPUTE\_NAV\_VALUES} = \text{OFF}$$

Constrain the bearing measurement to be between 0 and 360 degrees:

$$\text{IF NAV\_AZ} < 0^\circ \text{ or NAV\_AZ} \geq 360^\circ$$

$$\text{NAV\_AZ} = \text{NAV\_AZ} - \text{SIGN}(\text{NAV\_AZ}) 360^\circ$$

2.7.2 Subtract the navigation-derived measurements from the measurements derived from each GPS receiver to form the delta quantities, adjusting the delta azimuth value for the event where the two bearing angles span the 360 degree or 0 degree radial:

Compute the GPS\_RNG and GPS\_AZ for the GPS receivers as follows:

$$\text{GPS\_RNG}_i = \text{GPS\_RNG}_i - \text{NAV\_RNG}$$

$$\text{TEMP} = \text{GPS\_AZ}_i - \text{NAV\_AZ}$$

$$\text{IF ABS}(\text{TEMP}) > 180^\circ$$

THEN

$$\text{GPS\_AZ}_i = \text{TEMP} - \text{SIGN}(\text{TEMP}) 360^\circ$$

ELSE

$$\text{GPS\_AZ}_i = \text{TEMP}$$

2.8 Compute the altitude to the runway using the GPS receiver state as follows:

CALL: EF\_TO\_GEODETTIC  
INLIST:  $\bar{R\_GPS\_ECEF}$   
OUTLIST: DUMMY\_LAT, DUMMY\_LON, ALT

$$\text{GPS\_ALT}_i = (\text{ALT} - \text{ALT\_RW}) / 1000$$

3.0 Finally, after the computations for the TACAN and GPS display parameters are completed, and independently of the status of the TACAN/GPS display mode, the display mode flag is renamed for output purposes:

$$\text{TAC\_GPS\_MODE\_DISP} = \text{TAC\_GPS\_MODE}$$

4.0 Store the range, bearing and altitude computed from the GPS state for downlist as follows:

$$\text{GPS\_UPP\_DL}_1 = \text{GPS\_RNG}_2$$

$$\text{GPS\_UPP\_DL}_2 = \text{GPS\_AZ}_2$$

$$\text{GPS\_UPP\_DL}_3 = \text{GPS\_ALT}_2$$

#### 4.4.6.2 GPS User Parameter Display Computation with Three GPS Receivers Installed on the Vehicle (No TACAN receivers)

The velocity of the vehicle relative to the runway is computed using the velocity data from each GPS LRU obtained from the GPS SOP. This velocity data is from the GPS LRU state that is bracketed by the selected IMU accumulated sensed velocity and is extrapolated to current time using the sensed velocity change.

The range, azimuth and altitude of the vehicle with respect to the runway threshold is also computed using the GPS state selected by the GPS Receiver State Processing principal function. This selected state is provided to the GPS user parameter display computation subfunction at the navigation principal function rate. The state is integrated to current time in this subfunction to provide accurate GPS computed parameters for the HSD.

1.0 Compute the velocity of the vehicle relative to the runway for each receiver as follows.

If the previous value of the time ( $T\_IMU\_GPS\_UPP\_PREV$ ) associated with the accumulated IMU velocity stored by the GPS user parameter computation ( $\bar{V}\_IMU\_GPS\_UPP\_PREV$ ) is equal to zero, set the earth fixed acceleration vector ( $\bar{A}CC\_GPS\_UPP\_EF$ ), used in propagating the GPS receiver state from the GPS SOP to current time, to zero.

```
IF T_IMU_GPS_UPP_PREV = 0 THEN
    ACC_GPS_UPP_EF = 0
```

In addition, initialize the GPS UPP display computation parameters as follows:

```
 $\bar{R}\_GPS\_UDC = \bar{R}\_AVGG$ 
 $\bar{V}\_GPS\_UDC = \bar{V}\_AVGG$ 
 $T\_GPS\_UDC = T\_STATE$ 
 $\bar{G}\_GPS\_UDC = \bar{G}\_OLD$ 
 $\bar{V}\_IMU\_GPS\_UDC = \bar{V}\_IMU\_OLD$ 
```

Otherwise, compute the earth fixed sensed acceleration over the current and past execution cycles. This is accomplished by first computing the inertial sensed velocity change, by differencing the current IMU accumulated velocity,  $\bar{V}\_IMU\_CURRENT$ , from the previous accumulated IMU velocity,  $\bar{V}\_IMU\_GPS\_UPP\_PREV$ , and dividing by the time interval associated with these IMU data. This inertial sensed acceleration is then rotated to the earth fixed frame. The calculations are as follows:

```
ELSE
 $\bar{A}CC\_GPS\_UPP = (\bar{V}\_IMU\_CURRENT - \bar{V}\_IMU\_GPS\_UPP\_PREV) /$ 
     $(T\_IMU - T\_IMU\_GPS\_UPP\_PREV)$ 
 $\bar{A}CC\_GPS\_UPP\_EF = M\_TEMP\_TXPOS \bar{A}CC\_GPS\_UPP$ 
```

The check for the previous accumulated IMU sensed velocity being equal to zero accomplishes a first pass initialization of the sensed acceleration, the accumulated IMU sensed velocity and the associated time tag.

- 2.0 Perform the calculations in step 2.1 for three receivers:

DO FOR I = 1 TO GPS\_SW\_CAP

where GPS\_SW\_CAP is the maximum number of receivers for which the software is designed.

- 2.1 If the time difference between the current user parameter propagator time (T\_STATE) and the I<sup>th</sup> receiver state from the GPS SOP (T\_GPS\_SOP<sub>I</sub>) is less than or equal to an I-load time staleness limit (GPS\_UPP\_TIME\_STALENESS\_LIM), perform the calculations in steps 2.1.1 through 2.1.4.

IF ((T\_STATE - T\_GPS\_SOP<sub>I</sub>) ≤ GPS\_UPP\_TIME\_STALENESS\_LIM)  
THEN  
    execute steps 2.1.1 through 2.1.4

- 2.1.1 Convert the GPS receiver velocity from WGS84 coordinates to earth-fixed coordinates:

$$\bar{V}_{GPS\_ECEF} = M_{WGS84\_TO\_EF} \bar{V}_{GPS\_ECEF\_SOP_I}$$

- 2.1.2 Compute the difference between the receiver state and the current user parameter time.

$$DT\_GPS\_UPP = T\_STATE - T\_GPS\_SOP_I$$

- 2.1.3 Extrapolate the velocity vector from the GPS receiver to the time of the user parameter state, using the receiver earth fixed acceleration vector and the DT\_GPS\_UPP time interval:

$$\bar{V}_{GPS\_ECEF} = \bar{V}_{GPS\_ECEF} + DT\_GPS\_UPP \bar{ACC\_GPS\_UPP\_EF}$$

- 2.1.4 Compute the vehicle velocity relative to the runway in thousands of feet per second as follows:

$$GPS\_VEL\_REL\_TO\_RW_I = ABVAL(\bar{V}_{GPS\_ECEF}) / 1000$$

- 3.0 Store the current IMU accumulated sensed velocity and the associated time tag for the next cycle.

$$\bar{V}_{IMU\_GPS\_UPP\_PREV} = \bar{V}_{IMU\_CURRENT}$$

$$T\_IMU\_GPS\_UPP\_PREV = T\_IMU$$

- 4.0 If a selected GPS state is available, compute the range, azimuth and altitude relative to the runway using the selected state from the GPS Receiver State Processing principal function by executing steps 4.1 through 4.12:

IF GPS\_SV\_SEL\_AVAIL THEN  
    execute steps 4.1 through 4.12

- 4.1 If the GPS UPP update flag has been set ON by the baseline navigation user parameter reset subfunction, copy the selected GPS data into GPS UPP display computation parameters and set the GPS UPP update flag to OFF.

```

IF GPS_UPP_UPDATE = ON THEN
  R_GPS_UDC = R_GPS_UPP
  V_GPS_UDC = V_GPS_UPP
  T_GPS_UDC = T_GPS_UPP
  G_GPS_UDC = G_GPS_UPP
  V_IMU_GPS_UDC = V_IMU_GPS_UPP
GPS_UPP_UPDATE = OFF

```

- 4.2 Compute the extrapolation time step.

$$DT\_UDC = T\_IMU - T\_GPS\_UDC$$

- 4.3 Compute the sensed velocity change.

$$\bar{D}V_S\_UDC = \bar{V}\_IMU\_CURRENT - \bar{V}\_IMU\_GPS\_UDC$$

- 4.4 Propagate the selected GPS state to current time.

$$\begin{aligned} \bar{R}\_GPS\_UDC &= \bar{R}\_GPS\_UDC + DT\_UDC ( \bar{V}\_GPS\_UDC + \\ &\quad .5 ( \bar{D}V_S\_UDC + DT\_UDC \bar{G}\_GPS\_UDC ) ) \\ \bar{V}\_GPS\_UDC &= \bar{V}\_GPS\_UDC + \bar{D}V_S\_UDC + DT\_UDC \bar{G}\_GPS\_UDC \end{aligned}$$

- 4.5 Store the IMU counts and time for extrapolation on the next execution cycle of the subfunction.

$$\begin{aligned} \bar{V}\_IMU\_GPS\_UDC &= \bar{V}\_IMU\_CURRENT \\ T\_GPS\_UDC &= T\_IMU \end{aligned}$$

- 4.6 Rotate the selected GPS position to earth fixed coordinates using the inertial to earth fixed transformation matrix from the guidance computation subfunction.

$$\bar{R}\_GPS\_EF = M\_TEMP\_TXPOS \bar{R}\_GPS\_UDC$$

- 4.7 Compute the earth fixed position of the vehicle with respect to the runway and transform the relative position to runway topodetic coordinates.

$$\begin{aligned} \bar{R}\_WRT\_RW\_EF &= \bar{R}\_GPS\_EF - \bar{R}\_LS\_EF \\ \bar{R}\_WRT\_RW\_TD &= M\_EFTOTD\_RW \bar{R}\_WRT\_RW\_EF \end{aligned}$$

- 4.8 Convert the topodetic position into slant range in nautical miles and the bearing in degrees to the runway threshold.

$$\begin{aligned} SEL\_GPS\_RNG &= ABVAL(\bar{R}\_WRT\_RW\_TD) NAUTMI\_PER\_FT \\ SEL\_GPS\_AZ &= ( ARCTAN2(R\_WRT\_RW\_TD_2, R\_WRT\_RW\_TD_1) \\ &\quad +PI) DEG\_PER\_RAD \end{aligned}$$

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4.9 Constrain the bearing measurement to be between 0 and 360 degrees.

```
IF SEL_GPS_AZ < 0 or SEL_GPS_AZ ≥ 360 THEN
    SEL_GPS_AZ = SEL_GPS_AZ - SIGN(SEL_GPS_AZ) 360
```

4.10 Call the earth fixed to geodetic subfunction to compute the altitude of the vehicle above the reference ellipsoid.

```
CALL:    EF_TO_GEODETTIC
INLIST:  R_GPS_EF
OUTLIST: DUMMY_LAT, DUMMY_LON,
         SEL_GPS_ALT_ABOVE_REF_ELLIP
```

4.11 Compute the altitude of the vehicle above the runway in thousands of feet.

```
SEL_GPS_ALT = (SEL_GPS_ALT_ABOVE_REF_ELLIP - ALT_RW)
              / 1000
```

4.12 Store the range, bearing and altitude computed from the selected GPS state for downlist as follows:

```
GPS_UPP_DL1 = SEL_GPS_RNG
```

```
GPS_UPP_DL2 = SEL_GPS_AZ
```

```
GPS_UPP_DL3 = SEL_GPS_ALT
```



## 4.5 GENERAL REQUIREMENT PRINCIPAL FUNCTIONS

This section delineates software requirements in the category of services available to single or multiple users, that are not specifically function related. The general requirement principal functions include, but are not limited to, the following:

1. Entry precise predictor principal function (Section 4.5.1)
2. Entry site lookup principal function (Section 4.5.2)

### 4.5.1 Entry Precise Predictor (4.223)

A capability will be provided for predicting the position and velocity of the orbiter at some time in the future or past when an initial state and time are given, provided an OPS transition has not been requested.

The entry precise predictor principal function will make no use of the IMU–accumulated sensed velocities and therefore is a free–flight prediction process even though it may be performed during periods of flight in which navigation is using accumulated sensed velocities.

A. Detailed Requirements. The position and velocity of the orbiter at the end of a given interval of time shall be computed in an M50 coordinate system by integration of the equations of motion, including gravity and drag accelerations (when appropriate).

The accuracy requirements and type of the atmosphere and gravity potential models used by this prediction function may vary according to the orbiter’s distance to the surface of the earth and utilization for the prediction being requested. The user of the entry predictor function specifies the environmental models desired by means of input arguments, as described in the paragraphs that follow.

The entry precise predictor function will be called after the following variables have been initialized:

1. T\_FINAL, the time at which the final state is desired.
2. GMD\_PRED, GMO\_PRED indicators of the gravitational and drag acceleration model that will be considered valid for the duration of the prediction interval.
3.  $\bar{R}_{INIT}$ ,  $\bar{V}_{INIT}$ , and T\_INIT, the initial state and time.
4. DT\_MAX, an upper bound for the integration step size.
5. OTREQ, OPS transition request flag.

It will then perform as follows:

1. Obtain  $\bar{R}_{INIT}$ ,  $\bar{V}_{INIT}$ , and rename them as  $\bar{R}_{FINAL}$ ,  $\bar{V}_{FINAL}$ .
2. Proceed only if an OPS transition has not been requested (OTREQ).
3. Obtain T\_INIT and rename as T.

4. Establish the fixed integration STEP\_SIZE by dividing the time interval into the smallest number (NUMBER\_STEPS) of subintervals consistent with DT\_MAX:

$$\text{NUMBER\_STEPS} = \text{MAX} \left( \text{ROUND} \left( \frac{|\text{T\_FINAL} - \text{T\_INIT}|}{\text{DT\_MAX}} \right), 1 \right)$$

$$\text{STEP\_SIZE} = \frac{\text{T\_FINAL} - \text{T\_INIT}}{\text{NUMBER\_STEPS}}$$

5. Check the input parameter GMD\_PRED. If the value of this parameter is zero (a setting which indicates the user wants to use a conic approximation), the acceleration vector  $\bar{\mathbf{G}}_{\text{PREVIOUS}}$  will contain only the central force term. This will be achieved by a call to a special routine, CENTRAL (which is documented in Section 4.2.1.2)

```
CALL:      CENTRAL
INLIST:     $\bar{\mathbf{R}}_{\text{FINAL}}$ 
OUTLIST:    $\bar{\mathbf{G}}_{\text{PREVIOUS}}, \mathbf{R\_INV}$ 
```

If GMD\_PRED has a non-zero value (a setting that indicates a more complete gravity model and possibly a drag model are desired by the user), the angles of attack and sideslip will be obtained from the attitude processing principal function and converted to radians:

```
SNAP ATTITUDE: ALPHAIN, BETAIN
ALPHA = ALPHAIN RAD_PER_DEG
BETA = BETAIN RAD_PER_DEG
```

and the acceleration vector  $\bar{\mathbf{G}}_{\text{PREVIOUS}}$  will be obtained by a call to the ACCEL function (instead of the function CENTRAL). Detailed requirements for the ACCEL function are contained in Section 4.2.1.2.

$$\bar{\mathbf{G}}_{\text{PREVIOUS}} = \text{ACCEL} (\text{GMD\_PRED}, \text{GMO\_PRED}, \bar{\mathbf{R}}_{\text{FINAL}}, \bar{\mathbf{V}}_{\text{FINAL}}, \text{T})$$

Next, for the necessary number of times to cover the whole prediction interval, this function will perform as follows:

1. A local variable, STEP\_COUNTER, is initialized to 10. The STEP\_COUNTER is decremented by 1 after each prediction integration step. If the STEP\_COUNTER is zero, then the OPS transition flag (OTREQ) is assigned the value of the MSC version of the flag (OPS\_TRANS\_REQUEST) and the STEP\_COUNTER is set to 10. Should the OPS transition flag (OTREQ) be ON, terminate the prediction.
2. Advance the time by an amount equal to STEP\_SIZE

$$(\text{T} = \text{T} + \text{STEP\_SIZE})$$

and advance the position by means of the equation

$$\begin{aligned} \bar{\mathbf{R}}_{\text{FINAL}} &= \bar{\mathbf{R}}_{\text{FINAL}} + \text{STEP\_SIZE} \bar{\mathbf{V}}_{\text{FINAL}} \\ &+ 0.5 (\text{STEP\_SIZE})^2 \bar{\mathbf{G}}_{\text{PREVIOUS}} \end{aligned}$$

3. Obtain a new value ( $\bar{G}_{FINAL}$ ) for the acceleration corresponding to the new position. Again, the subfunction called to provide this acceleration will depend on the value of the flag GMD\_PRED: if GMD\_PRED = 0, the function CENTRAL will be called. Otherwise, the function ACCEL will compute the acceleration. In this last case, if a drag acceleration is required, it will be computed on the basis of the ALPHA and BETA angles obtained previously. In other words, the model assumes a fixed attitude.

$$\bar{G}_{FINAL} = ACCEL (GMD\_PRED, GMO\_PRED, \bar{R}_{FINAL}, \bar{V}_{FINAL}, T)$$

4. Advance the velocity:

$$\bar{V}_{FINAL} = \bar{V}_{FINAL} + STEP\_SIZE \cdot 0.5 (\bar{G}_{PREVIOUS} + \bar{G}_{FINAL})$$

5. Obtain a corrected value for the position by the “super-g” algorithm:

$$\bar{R}_{FINAL} = \bar{R}_{FINAL} + STEP\_SIZE^2 (\bar{G}_{FINAL} - \bar{G}_{PREVIOUS}) / 6.$$

6. Save the value of  $\bar{G}$  for the next cycle:  $\bar{G}_{PREVIOUS} = \bar{G}_{FINAL}$ . The values of  $\bar{R}_{FINAL}$ ,  $\bar{V}_{FINAL}$ , and  $\bar{G}_{FINAL}$  after these operations have been performed the appropriate number of times (NUMBER\_STEPS), being the desired position, velocity and approximate acceleration vectors at T\_FINAL, will be output.

B. Interface Requirements. The input and output variables are listed in Tables 4.5.1.1–1 and 4.5.1.1–2.

C. Processing Requirements. None.

D. Constraints. If the precision prediction algorithm is not implemented as a reentrant procedure, execution of the algorithm may not be interrupted by calls from subsequent users. Users of the precision prediction algorithm are required to initialize the input parameters DT\_MAX, GMD\_PRED, GMO\_PRED,  $\bar{R}_{INIT}$ ,  $\bar{V}_{INIT}$ , T\_INIT, and T\_FINAL prior to the call, and are required to off-load or snap the output parameters  $\bar{R}_{FINAL}$ ,  $\bar{V}_{FINAL}$ , and  $\bar{G}_{FINAL}$  after execution is complete. The parameter DT\_MAX must be greater than zero.

The acceleration consisting of the central force term alone (required in conic prediction cases) could be obtained by calling the function ACCEL with the parameter GMD\_PRED set equal to zero. The reason for the existence of the special routine CENTRAL for conic prediction is that its use will optimize the predictor for CPU (if the ACCEL function is implemented as a reentrant procedure, additional CPU would be involved in a call to ACCEL instead of a call to CENTRAL). This CPU optimization is a requirement only in the conic prediction mode.

E. Supplementary Information. A suggested implementation in the form of a detailed flow chart may be found in Section 5.3.

The following table is intended for general information concerning how to set up the various flags for use of the predictor:

Type of Prediction Desired	GMD_PRED	GMO_PRED	DT_MAX (sec)
CONIC (central gravity, only)	0	0	4
SIMPLIFIED (central + J <sub>2</sub> gravity, only)	2	0	4
PRECISE (4x4 gravity plus drag)	4	4	4

**4.5.1.1 Entry Precise Predictor (4.223) Principal Function Tables**

The principal function input/output parameters are given in Tables 4.5.1.1-1 and 4.5.1.1-2. The I-load and K-load parameters are given in Tables 4.5.1.1-3 and 4.5.1.1-4. The constant parameters are given in Table 4.5.1.1-5. The variable cross-reference is presented in the table below.

Entry Precise Predictor (4.223) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
No requirements	

TABLE 4.5.1.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY PRECISE PREDICTOR (G4.223)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
BETA_N	V90H2249C	INERTIAL SIDESLIP ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
DT_MAX	V90U8500CD	MAX ALLOW TIME STEP SIZE	D/L NAV SEQ	S				
DT_MAX	V90U8500CF	MAX ALLOW TIME STEP SIZE	DEORB GUID	S				
DT_MAX	V90U8500CH	MAX ALLOW TIME STEP SIZE	DEORB MNVR DIP	S				
DT_MAX	V90U8500CI	MAX ALLOW TIME STEP SIZE	ENT NAV	S				
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
GMD_PRED	V90U8501CD	GRAVITY MODEL DEGREE	D/L NAV SEQ				92297B	
GMD_PRED	V90U8501CF	GRAVITY MODEL DEGREE	DEORB GUID					
GMD_PRED	V90U8501CG	GRAVITY MODEL DEGREE	DEORB MNVR DIP					
GMD_PRED	V90U8501CJ	GRAVITY MODEL DEGREE	ENT NAV					
GMO_PRED	V90U8502CD	GRAVITY MODEL ORDER	D/L NAV SEQ				92297B	
GMO_PRED	V90U8502CF	GRAVITY MODEL ORDER	DEORB GUID					
GMO_PRED	V90U8502CG	GRAVITY MODEL ORDER	DEORB MNVR DIP					
GMO_PRED	V90U8502CJ	GRAVITY MODEL ORDER	ENT NAV					
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
OPS_TRANS_REQUEST	V90X0892X	OPS TRANSITION REQUEST IND	MSC		BD		90121B	
OTREQ	V90X0893XC	OPS TRANSITION REQUEST FLAG	D/L NAV SEQ		BD		90121B	
OTREQ	V90X0893XD	OPS TRANSITION REQUEST FLAG	ENT NAV		BD		90121B	
OTREQ	V90X0893XE	OPS TRANSITION REQUEST FLAG	DEORB MNVR DIP		BD		90121B	
OTREQ	V90X0893XF	OPS TRANSITION REQUEST FLAG	DEORB GUID		BD		90121B	
OTREQ	V90X0893XG	OPS TRANSITION REQUEST FLAG	ASC NAV		BD		90121B	
R_INIT(X)	V90H8508CF	X-COMP SHUTTLE POS VECTR AT T_INIT	DEORB GUID	FT				
R_INIT(X)	V90H8508CG	X-COMP SHUTTLE POS VECTR AT T_INIT	DEORB MNVR DIP	FT				
R_INIT(X)	V90H8508CI	X-COMP SHUTTLE POS VECTR AT T_INIT	D/L NAV SEQ	FT				
R_INIT(X)	V90H8508CJ	X-COMP SHUTTLE POS VECTR AT T_INIT	ENT NAV	FT				
R_INIT(Y)	V90H8509CF	Y-COMP SHUTTLE POS VECTR AT T_INIT	DEORB GUID	FT				
R_INIT(Y)	V90H8509CG	Y-COMP SHUTTLE POS VECTR AT T_INIT	DEORB MNVR DIP	FT				
R_INIT(Y)	V90H8509CI	Y-COMP SHUTTLE POS VECTR AT T_INIT	D/L NAV SEQ	FT				
R_INIT(Y)	V90H8509CJ	Y-COMP SHUTTLE POS VECTR AT T_INIT	ENT NAV	FT				
R_INIT(Z)	V90H8510CF	Z-COMP SHUTTLE POS VECTR AT T_INIT	DEORB GUID	FT				
R_INIT(Z)	V90H8510CG	Z-COMP SHUTTLE POS VECTR AT T_INIT	DEORB MNVR DIP	FT				
R_INIT(Z)	V90H8510CI	Z-COMP SHUTTLE POS VECTR AT T_INIT	D/L NAV SEQ	FT				
R_INIT(Z)	V90H8510CJ	Z-COMP SHUTTLE POS VECTR AT T_INIT	ENT NAV	FT				
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_FINAL	V90W8506CC	TIME AT WHICH STATE IS DESIRED	DEORB MNVR DIP	S				

TABLE 4.5.1.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY PRECISE PREDICTOR (G4.223)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
T_FINAL	V90W8506CF	TIME AT WHICH STATE IS DESIRED	DEORB GUID	S				
T_FINAL	V90W8506CI	TIME AT WHICH STATE IS DESIRED	D/L NAV SEQ	S				
T_FINAL	V90W8506CJ	TIME AT WHICH STATE IS DESIRED	ENT NAV	S				
T_INIT	V90W8512CH	TIME AT BEGINNING OF PRED	ENT NAV	S				
T_INIT	V90W8512CJ	TIME AT BEGINNING OF PRED	D/L NAV SEQ	S				
T_INIT/TGD	V90W8512CF	TIME AT BEGINNING OF PRED	DEORB GUID	S				
T_INIT/TNAV, T1, TIG	V90W8512CC	TIME AT BEGINNING OF PRED	DEORB MNVR DIP	S				
V_INIT(X)	V90L8513CF	X-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB GUID	FT/S				
V_INIT(X)	V90L8513CG	X-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB MNVR DIP	FT/S				
V_INIT(X)	V90L8513CI	X-COMP SHUTTLE VEL VECTR AT T_INIT	D/L NAV SEQ	FT/S				
V_INIT(X)	V90L8513CJ	X-COMP SHUTTLE VEL VECTR AT T_INIT	ENT NAV	FT/S				
V_INIT(Y)	V90L8514CF	Y-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB GUID	FT/S				
V_INIT(Y)	V90L8514CG	Y-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB MNVR DIP	FT/S				
V_INIT(Y)	V90L8514CI	Y-COMP SHUTTLE VEL VECTR AT T_INIT	D/L NAV SEQ	FT/S				
V_INIT(Y)	V90L8514CJ	Y-COMP SHUTTLE VEL VECTR AT T_INIT	ENT NAV	FT/S				
V_INIT(Z)	V90L8515CF	Z-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB GUID	FT/S				
V_INIT(Z)	V90L8515CG	Z-COMP SHUTTLE VEL VECTR AT T_INIT	DEORB MNVR DIP	FT/S				
V_INIT(Z)	V90L8515CI	Z-COMP SHUTTLE VEL VECTR AT T_INIT	D/L NAV SEQ	FT/S				
V_INIT(Z)	V90L8515CJ	Z-COMP SHUTTLE VEL VECTR AT T_INIT	ENT NAV	FT/S				

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.5.1.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY PRECISE PREDICTOR (G4.223)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
G_FINAL(1)	V90A0889C	X-COMP PREDICTED SHUTTLE GRAV VCTR	D/L NAV SEQ	FT/S2				
G_FINAL(2)	V90A0890C	Y-COMP PREDICTED SHUTTLE GRAV VCTR	D/L NAV SEQ	FT/S2				
G_FINAL(3)	V90A0891C	Z-COMP PREDICTED SHUTTLE GRAV VCTR	D/L NAV SEQ	FT/S2				
OTREQ	V90X0893XA	OPS TRANSITION REQUEST FLAG	D/L NAV SEQ		BD		90121B	
R_FINAL(1)	V90H0881CA	X-COMP PREDICTED SHUTTLE POS VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT			89662B	
R_FINAL(2)	V90H0882CA	Y-COMP PREDICTED SHUTTLE POS VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT				
R_FINAL(3)	V90H0883CA	Z-COMP PREDICTED SHUTTLE POS VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT				
V_FINAL(1)	V90L0885CA	X-COMP PREDICTED SHUTTLE VEL VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT/S				
V_FINAL(2)	V90L0886CA	Y-COMP PREDICTED SHUTTLE VEL VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT/S				
V_FINAL(3)	V90L0887CA	Z-COMP PREDICTED SHUTTLE VEL VECTR	D/L NAV SEQ DEORB GUID DEORB MNVR DIP ENT NAV	FT/S				

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.5.1.1-3. ENTRY PRECISE PREDICTOR (G4.223) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CDA	V97U5281C	ND	F	D	D	X	G4.126	01	ZFJ	DC0617	
							G4.223	02	ZFJ		
							G4.224	03	ZFJ		
							G4.236	08	ZFJ		
CDF	V97U6002C	ND	F	D	D	X	G4.126	01	ZFJ	DC0617	
							G4.223	02	ZFJ		
							G4.224	03	ZFJ		
							G4.236	08	ZFJ		
CDN	V97U5282C	ND	F	D	D	X	G4.126	01	ZFJ	DC0617	
							G4.223	02	ZFJ		
							G4.224	03	ZFJ		
							G4.236	08	ZFJ		
CDS	V97U6010C	ND	F	D	D	X	G4.126	01	ZFJ	DC0617	
							G4.223	02	ZFJ		
							G4.224	03	ZFJ		
							G4.236	08	ZFJ		
DRAG_CONST	V97U5317C	FT**2/SLUG	F	D	M	C	G4.123	01	DC1	92287B	
							G4.127	03	DC3		
							G4.144				
							G4.15				
							G4.223				
EXP_SHAPE_FACTOR	V97U5334C	ND	F	D	D	X	G4.126	01	ZFJ	DC0617	
							G4.223	02	ZFJ		
							G4.224	03	ZFJ		
							G4.236	08	ZFJ		

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.



TABLE 4.5.1.1-4. ENTRY PRECISE PREDICTOR (G4.223) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ALT_ZONE_CHANGE ALT MODEL ATMOS DEN CHANGED	V97U5718C	00	+5.0000000	E+05 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(1) DENSITY MODEL CONST	V97U5304C	00	-3.9570	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(2) DENSITY MODEL CONST	V97U5305C	00	+1.0440	E-05 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(3) DENSITY MODEL CONST	V97U5306C	00	+6.9560000	E+06 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(4) DENSITY MODEL CONST	V97U5307C	00	-2.420	E+01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(5) DENSITY MODEL CONST	V97U5308C	00	-2.8890	E-06 FT**-1	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DENSE(6) DENSITY MODEL CONST	V97U5309C	00	+2.6050000	E+06 FT	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	

TABLE 4.5.1.1-4. ENTRY PRECISE PREDICTOR (G4.223) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DIFCD1	V96U9743C	00	+3.9589	E-01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD2	V96U9744C	00	+3.3962	E+00 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD3	V96U9745C	00	+6.5414	E-01 RAD	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
DIFCD4	V96U9746C	00	+8.3589	E-01 ND	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	
SEA_LEVEL_DENSITY SEA LEVEL ATOMOSPHERIC DENSITY	V97U5505C	00	+2.3768840	E-03 SLUGS/FT**3	F	S	C	G4.127 G4.144 G4.15 G4.205 G4.223 G4.236	89661A	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.5.1.1-5. ENTRY PRECISE PREDICTOR (G4.223) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

#### **4.5.2 Entry Site Lookup (4.124)**

This principal function provides the capability to retrieve specified information from an appropriate site location table and to perform necessary computations to obtain the site position vector(s) and/or associated transformation matrices and data. The design of the site data management principal function is based on an area concept. An area is defined as any potential landing site which is appropriate. Associated with each area are two runways called primary and secondary, two MSBLS's (if existing) each one supporting one of the two runways, and two TACAN's called primary and secondary. It is permissible to have more than one area associated with a given ground location such as Edwards Air Force Base, whenever more than two runways must be supported (for example, one area might have EDW 04 and EDW 22 runways while a second area might have EDW 17 and EDW 35 runways). A common runway and TACAN table of 45 landing areas will be supported for both OPS 1/6 and OPS 3. This means that a total of 90 runways and 90 TACANs exist in both OPS 1/6 and OPS 3. There will be a common table of 15 MSBLS sites to support both OPS 1/6 and OPS 3. There will also be a common table of 45 pairs of alternate landing area (site) indexes, one pair for each landing area (site), to support both OPS 1/6 and OPS 3.

There are three subfunctions which make up this principal function and are described in the following three sections: (1) Section 4.5.2.1 describes the site lookup initialization subfunction which provides initialization of the selected area, runway/MSBLS parameters for the selected runway, and auto TACAN channel command which is output to the TACAN SOP. Also, it provides for crew interface to support area redesignation, runway selection within a given area, and TACAN changes within a given area; (2) Section 4.5.2.2 describes the entry runway lookup subfunction which retrieves all necessary information related to a selected runway including runway parameters and MSBLS parameters (if existing); and (3) Section 4.5.2.3 describes the entry TACAN lookup subfunction which retrieves all necessary information related to a specified TACAN receiver (that is, information is output as a function of LRU number as well as TACAN station channel number). Notably, the TACAN site lookup function executes on the basis of which channel each of the three LRU's is actually tuned to receive, regardless of whether the LRU is tuned by GPC (auto) mode or by thumbwheel (manual) mode. There are, however, only two TACAN channels in any selected area, consequently, valid TACAN site data is restricted to either of two possible TACAN's in each selected area.

##### **4.5.2.1 Entry Site Lookup Initialization**

The purpose of this subfunction is to provide a crew interface to support selection of any of 45 landing areas and, further, to support the choice of either of two runways within that area. Appropriate landing aids (two TACAN's and up to two MSBLS's) are supported in each area. Upon OPS 3 and OPS 1 initialization, a default choice for area is automatically selected in order to support nominal end-of-mission (or TAL) and RTLS as appropriate. Furthermore, this subfunction provides runway/MSBLS site data value assignments by means of a call to the Entry Site Lookup subfunction. These data are used by all other software elements including CRT and dedicated displays, guidance, navigation and SOPs (subfunction operating programs). Next, auto TACAN channel commands are supported by initialization and crew requested changes. Finally, this subfunction calculates data corresponding to the auto selected TACAN station for usage by the GPS display computations subfunctions. MSC will invoke the site lookup initialization subfunction after transition to OPS 3 or OPS 1 or whenever a TAL abort is declared at such a time so that initialization of parameters is completed before first execution of any user of those parameters. This subfunction will also be invoked whenever the crew selects the current area or a new area, selects the current runway or the other runway, or switches TACAN's by means of item entries or thumbwheel switches.

A. Detailed Requirements. The design of this subfunction is based on the following considerations: whenever OPS 3 is entered and a TAL abort has not been declared, (1) the default value for the area will be one (AREA\_SEL= 1), (2) the default value for the selected runway will be one (the first of two choices) associated with the given area (PRIME\_RUNWAY\_INDEX = 1), and (3) the default value for the auto TACAN channel will be the primary TACAN (the first of two possible choices) associated with the given area. If a TAL abort has been declared, the area, selected runway and auto TACAN channel will be set to the values carried over from OPS 1 (AREA\_SEL = AREA\_SEL\_OPS1, PRIME\_RUNWAY\_INDEX = RW\_SEL\_OPS 1, and TAC\_SEL = TAC\_SEL\_OPS 1). Subsequent to the default initialization, the crew may select by means of an item entry on the HSD or Entry Bearing Display a new area at any time. For each new area selected, the values of the runway and TACAN will again be the primary runway and TACAN. Since each area contains two runways and two TACAN's, the crew may at any time, independently, select either runway and either TACAN by means of any of three item entries on the HSD.

With these design concepts in mind, the detailed requirements can be expressed under the following five headings: (1) first pass and/or TAL abort logic when entering OPS 3; (2) landing area redesignation; (3) runway selection; (4) TACAN switch; and (5) auto selected TACAN station data.

1. First pass and/or TAL abort logic when entering OPS 3. If the first pass flag, FIRST\_PASS, is set, then the selected area is set equal to one, the selected runway index, PRIME\_RUNWAY\_INDEX, is set equal to one, the auto TACAN channel selection, TAC\_SEL, is computed, and the first pass flag is reset. That is, if

FIRST\_PASS = ON

then

AREA\_SEL = 1

PRIME\_RUNWAY\_INDEX = 1

TAC\_SEL = 2 AREA\_SEL = -1

FIRST\_PASS = OFF

For OPS 3, the TAL abort declared flag is tested and, if set, then the selected area, runway, and auto TACAN channel are set equal to the values carried over from OPS 1, and the TAL alternate site initialization flag is set, that is, if

TAL\_ABORT\_DECLARED = ON

then

AREA\_SEL = AREA\_SEL\_OPS1

PRIME\_RUNWAY\_INDEX = RW\_SEL\_OPS1

TAC\_SEL = TAC\_SEL\_OPS1

TAL\_ALT\_SITE\_INIT = ON

The auto TACAN channel number, AUTO\_CHANNEL\_ID, is set to the selected channel number. Therefore, AUTO\_CHANNEL\_ID = TACAN\_ID\_MAXI(TAC\_SEL). Finally, the

entry runway site lookup subfunction is called in order to assign values to all necessary runway/MSBLS parameters used by other software functions, that is,

CALL ENTRY\_RUNWAY\_SITE\_LOOKUP

2. Landing area redesignation. Whenever the crew desires to select a new area they will make an item entry on the HSD or Entry Bearing Display along with the value for the desired area, AREA\_SEL. The HSD or Entry Bearing Display will in turn set NEW\_AREA = 1. In response to this request, the selected runway index, PRIME\_RUNWAY\_INDEX, will be set to the first of the two possible choices for the new area; the selected TACAN index, TAC\_SEL, will be set to the first of two possible choices; the overhead TAEM targeting initialization flag, RW\_ID\_UPP, will be set to zero; the auto TACAN channel number; AUTO\_CHANNEL\_ID, is set to the selected channel number; the TACAN SOP parameters, TAC\_CHAN\_OLD<sub>1</sub>, TAC\_CHAN\_OLD<sub>2</sub>, and TACAN\_CHAN\_OLD<sub>3</sub>, are set to zero in order to insure that the SOP will invoke the TACAN site lookup subfunction;\* and NEW\_AREA is reset to zero. Therefore, if

NEW\_AREA = 1

then

PRIME\_RUNWAY\_INDEX = 1

TAC\_SEL = 2 AREA\_SEL - 1

RW\_ID\_UPP = 0

AUTO\_CHANNEL\_ID = TACAN\_ID\_MAXI(TAC\_SEL)

TAC\_CHAN\_OLD<sub>1</sub> = 0

TAC\_CHAN\_OLD<sub>2</sub> = 0

TAC\_CHAN\_OLD<sub>3</sub> = 0

NEW\_AREA = 0

Finally, the entry runway site lookup subfunction is called to complete the runway/MSBLS value assignments, that is,

CALL ENTRY\_RUNWAY\_SITE\_LOOKUP

\* This is necessary in order to handle the case where a new uplinked TACAN channel number is identical to the current channel number of one of the LRU's. If the area which has this uplinked TACAN is requested by the crew, the TACAN SOP would not be able to recognize that the TACAN station had changed without this artifact.

3. Runway selection. For each given area, there are two runways which may be selected for landing. The primary, which is the first of two, is the default selection whenever a new area is requested, but either primary or secondary runway may be selected by the crew at any time. The appropriate item entry on the HSD will cause the setting of the flag, PRI\_SEL, which in turn will result in the selection of the secondary runway. If the flag, PRI\_SEL, is set ON, then the selected runway index,

PRIME\_RUNWAY\_INDEX, is set to one and the flag, PRI\_SEL, is reset OFF. Also, the alternate sites reset inhibit flag (ALT\_SITES\_RESET\_INH) is set ON. That is, if

PRI\_SEL = ON

then

PRIME\_RUNWAY\_INDEX = 1

PRI\_SEL = OFF

ALT\_SITES\_RESET\_INH = ON

Finally, the entry runway site lookup function is called in order to complete the runway/MSBLS value assignments, that is,

CALL ENTRY\_RUNWAY\_SITE\_LOOKUP

If, on the other hand, the flag, SEC\_SEL, is set ON, then the selected runway index, PRIME\_RUNWAY\_INDEX, is set to two and the flag, SEC\_SEL is reset OFF. Also, the alternate sites reset inhibit flag (ALT\_SITES\_RESET\_INH) is set ON. That is, if

SEC\_SEL = ON

then

PRIME\_RUNWAY\_INDEX = 2

SEC\_SEL = OFF

ALT\_SITES\_RESET\_INH = ON

Finally, the entry runway site lookup function is called in order to complete the runway/MSBLS value assignments; that is,

CALL ENTRY\_RUNWAY\_SITE\_LOOKUP

4. TACAN switch. For each given area, there are two TACAN stations which may be selected for the auto TACAN channel command. The first TACAN is the default selection whenever a new area is selected, but either one may be selected by the crew at any time. The appropriate item entry on the HSD will cause the setting of the flag, TAC\_CHANGE, which in turn will result in the selection of the other TACAN by testing on the current value of the selected TACAN index, TAC\_SEL. If TAC\_SEL is equal to the first TACAN index, denoted by  $2 \text{ AREA\_SEL} - 1$ , then TAC\_SEL is set equal to the second TACAN index, denoted by  $2 \text{ AREA\_SEL}$ ; otherwise, it is set equal to the first TACAN index,  $2 \text{ AREA\_SEL} - 1$ . The auto TACAN channel command, AUTO\_CHANNEL\_ID, is set to the selected TACAN channel number and the flag, TAC\_CHANGE, is reset OFF. Therefore, if

TAC\_CHANGE = ON

then, test the selected TACAN index. If

TAC\_SEL =  $2 \text{ AREA\_SEL} - 1$

then

TAC\_SEL = 2 AREA\_SEL

otherwise

TAC\_SEL = 2 AREA\_SEL -1

Finally,

AUTO\_CHANNEL\_ID = TACAN\_ID\_MAXI(TAC\_SEL)

TAC\_CHANGE = OFF

5. Auto selected TACAN station data. The earth-fixed position, magnetic variation and the corresponding earth-fixed to topodetic transformation matrix of the auto selected TACAN station ( $\bar{R}_{TACAN\_EF\_AUTO}$ , ANGLE\_CORR\_TNTOMAG\_AUTO and M\_EFTOTD\_TACAN\_AUTO) are to be obtained for usage by the GPS User Parameter Display Computation function.

If there is a change in the auto selected TACAN station, perform the following:

IF TAC\_SEL\_LAST  $\neq$  TAC\_SEL

Redefine the latitude, longitude, altitude and magnetic variation of the newly selected TACAN station:

LAT\_TACAN\_AUTO = LATITUDE\_GEODETTIC\_MAXI(TAC\_SEL)  
LONG\_TACAN\_AUTO = LONGITUDE\_EAST\_MAXI(TAC\_SEL)  
ALT\_TACAN\_AUTO = ALT\_ABOVE\_ELLIPSOID\_MAXI(TAC\_SEL)  
ANGLE\_CORR\_TNTOMAG\_AUTO =  
MAGNETIC\_VARIATION\_MAXI(TAC\_SEL)

Next, compute the earth-fixed position of the auto selected TACAN station and the corresponding earth-fixed to topodetic transformation matrix:

$\bar{R}_{TACAN\_EF\_AUTO}$  = GEODETTIC\_TO\_EF(LAT\_TACAN\_AUTO,  
LONG\_TACAN\_AUTO, ALT\_TACAN\_AUTO)

M\_EFTOTD\_TACAN\_AUTO = EF\_TO\_TOPDET(LAT\_TACAN\_AUTO,  
LONG\_TACAN\_AUTO)

Finally, save the current value of TAC\_SEL for future usage to determine when there is a change in selected TACAN station:

TAC\_SEL\_LAST = TAC\_SEL

- B. Interface Requirements. The input and output parameters are shown on Tables 4.5.2.1-1 and 4.5.2.1-2.

- C. Processing Requirements. All necessary initialization will be completed before execution of any user of site lookup data. The parameters, TAL\_ABORT\_DECLARED, RW\_SEL\_OPS1, TAC\_SEL\_OPS1,



and AREA\_SEL\_OPS1, must be protected and carried over during OPS transition from OPS 1 to OPS 3. TACAN\_SEL\_LAST shall be initialized to zero.

Additionally, site parameter updates or data for new areas, runways, MSBLS's, TACAN's, should be computed as a homogeneous set and not be available to users until the entire set is compatible.

D. Constraints. The OPS 3 and OPS 1/6 versions are identical with the following exceptions:

1. The OPS 1, the default value for the prime RTLS landing site area is an I-load value, RTLS\_PRIME\_AREA, whereas in OPS 3, the default value for a non-TAL landing site area is one. In OPS 1, the value of the TAL landing site area is initially an I-load value but subsequently can be changed by an item entry 40 on the HSD prior to the setting of the TAL abort declared flag. In OPS 3, the value of the TAL landing site area, selected runway, and selected AUTO TACAN CHANNEL are the values carried over from OPS 1, AREA\_SEL\_OPS1, RW\_SEL\_OPS1 and TAC\_SEL\_OPS1.
2. OPS 1 version sends the selected area, AREA\_SEL, and the landing site position vector, R\_LS\_EF, to guidance principal functions 4.2 and 4.4. The OPS 1 version also sends selected runway latitude and longitude, LAT\_RW and LON\_RW, respectively, to specialist function 5.26. The OPS 3 version does not require these interfaces.
3. The OPS 3 version uses the TAL\_ALT\_SITE\_INIT flag and OPS 1-to-OPS 3 carryover values of ALT\_SITE\_INDEX(1) and ALT\_SITE\_INDEX(2) during a TAL abort. TAL\_ALT\_SITE\_INIT shall be initialized to OFF.

E. Supplemental Information. A suggested implementation of these requirements is illustrated in Section 5.3 in the flow chart ENTRY\_SITE\_LOOKUP\_INIT.

A common runway and TACAN table of 45 landing areas will be supported for both OPS 1/6 and OPS 3. This means that a total of 90 runways and 90 TACANs exist in both OPS 1/6 and OPS 3. There will be a common table of 15 MSBLS sites to support both OPS 1/6 and OPS 3. There will also be a common table of 45 pairs of alternate landing area indexes, one pair for each landing area, to support both OPS 1/6 and OPS 3.

Table 4.5.2.1-1. Entry Site Lookup Initialization Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Selected area	AREA_SEL	*	INT	—	1–45	—	As needed
New landing area request flag	NEW_AREA	*	BIT	—	OFF/ON	—	As needed
Primary runway select command	PRI_SEL	*	BIT	—	OFF/ON	—	As needed
Secondary runway select command	SEC_SEL	*	BIT	—	OFF/ON	—	As needed
Three–digit channel/mode designation unique for each TACAN station	TACAN_ID_ MAXI(I)	**	I	—	±126	—	As needed
Primary/secondary TACAN select command	TAC_CHANGE	*	BIT	—	OFF/ON	—	As needed
TAL abort declared flag	TAL_ABORT_ DECLARED	*	BIT	—	OFF/ON	—	As needed
Value for PRIME_RUNWAY_ INDEX which is carried over from OPS 1 to OPS 3	RW_SEL_OPS1	*	INT	—	1–2	—	As needed
Value for TAC_SEL which is carried over from OPS 1 to OPS 3	TAC_SEL_OPS1	*	INT	—	1–90	—	As needed
Value for AREA_SEL which is carried over from OPS 1 to OPS 3	AREA_SEL_OPS1	*	INT	—	1–45	—	As needed
TACAN station altitude	ALT_ABOVE_ ELLIPSOID_ MAXI(I)	**	F	S	—	ft	As needed
TACAN site geodetic latitude	LATITUDE_ GEODETIC_ MAXI(I)	**	F	S	$-\pi/2, \pi/2$	rad	As needed
TACAN site longitude	LONGITUDE_ EAST_ MAXI(I)	**	F	S	$-\pi, \pi$	rad	As needed
Variation of magnetic north from true north at TACAN site	MAGNETIC_ VARIATION_ MAXI(I)	**	F	S	$0 - 2\pi$	rad	As needed

\* See principal function input list (Table 4.5.2.4–1).

\*\* See Table 4.5.2.4–2.

Table 4.5.2.1-2. Entry Site Lookup Initialization Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Selected area	AREA_SEL	ENTRY RUNWAY SITE LOOKUP, ENTRY TACAN SITE LOOKUP,*	INT	—	1–45	—	As needed
Channel/mode identifier for the automatically selected TACAN station	AUTO_CHANNEL_ID	*	INT	—	±126	—	As needed
Indicator of which landing site choice is selected	PRIME_RUNWAY_INDEX	ENTRY RUNWAY SITE LOOKUP	INT	—	1–2	—	As needed
Local runway index parameter; also first pass flag	RW_ID_UPP	*	INT	—	0–90	—	As needed
Primary/secondary TACAN select command	TAC_CHANGE	*	BIT	—	OFF/ON	—	As needed
Previous value of channel/mode indicator for each TACAN station	TAC_CHAN_OLD(I)	*	V(3)	—	±126	—	As needed
Transformation matrix from earth-fixed to topodetic coordinates of the auto selected TACAN site	M_EFTOTD_TACAN_AUTO	*	M	DP	—	—	As needed
Auto selected TACAN station earth-fixed position vector	$\bar{R}$ _TACAN_EF_AUTO	*	V	DP	—	ft	As needed
Variation of magnetic north from the true north at the auto selected TACAN site	ANGLE_CORR_TNTOMAG_AUTO	*	F	S	0 - $2\pi$	rad	As needed
Alternate sites reset inhibit flag	ALT_SITES_RESET_INH	ENTRY RUNWAY SITE LOOKUP	BIT	—	OFF/ON	—	As needed

\* See principal function output list, Table 4.5.2.4–2.

#### 4.5.2.2 Entry Runway/MSBLS Site Lookup

The purpose of this subfunction is to retrieve information related to a specified runway for a given selected area. For purposes of designation, there are 45 choices of areas and, for each area there are two choices of runways available referred to as the primary and the secondary. Either one of these two may be identified as the selected runway; however, the default designation will be the primary. The primary and secondary runway data shall include a parameter which is a pointer indicating which one of 15 MSBLS's is associated with the selected runway. The subfunction will also accept the alternate sites reset inhibit flag (ALT\_SITES\_RESET\_INH) from the entry site lookup initialization subfunction. This flag when set indicates the call to entry runway/MSBLS site lookup is for a runway selection. In this case, the alternate site indexes are to retain their values and not be reset.

A. Detailed Requirements. This subfunction will accept from the entry site lookup initialization subfunction a parameter, AREA\_SEL, whose value indicates the area that has been selected and a parameter, PRIME\_RUNWAY\_INDEX, which indicates which one of the two runway choices has been identified as the selected runway. If PRIME\_RUNWAY\_INDEX = 1, then the primary runway is selected. If PRIME\_RUNWAY\_INDEX = 2, then the secondary runway is selected.

First, the local area parameter, J, is set equal to the selected area, AREA\_SEL, the alternate site indexes are updated, and the primary and secondary runway names are defined for display on the HSD. Next, the local site table index parameter, L, is determined based on the value of the selected runway index. If PRIME\_RUNWAY\_INDEX is equal to one, then L is set equal to 2J-1, RW\_SELECT is set to ON, and RW\_NAME\_SEL is set to the primary runway name RW\_NAME\_PSL, otherwise, L is set to 2J, RW\_SELECT is set to OFF, and RW\_NAME\_SEL is set to the secondary runway name RW\_NAME\_SSL. Also, the values of ALT\_SITE\_INDEX(I), I = 1, 2, are determined.

```

                J = AREA_SEL

                RW_NAME_PSL = RUNWAY_NAME (2J-1)

                RW_NAME_SSL = RUNWAY_NAME (2J)

    If
        ALT_SITES_RESET_INH = OFF
    then
        If
            TAL_ALT_SITE_INIT = OFF
        then
            ALT_SITE_INDEX(1) = ALTERNATE_SITE_1(J)
            ALT_SITE_INDEX(2) = ALTERNATE_SITE_2(J)
        otherwise
            ALT_SITE_INDEX(1) and ALT_SITE_INDEX(2)
            retain their corresponding OPS 1-to-OPS 3 carryover values and set
            TAL_ALT_SITE_INIT = OFF
        otherwise
            ALT_SITES_RESET_INH = OFF

    if

                PRIME_RUNWAY_INDEX = 1
```

then

$$L = 2J - 1 \text{ and } RW\_SELECT = ON \text{ and } RW\_NAME\_SEL = RW\_NAME\_PSL$$

otherwise

$$L = 2J \text{ and } RW\_SELECT = OFF \text{ and } RW\_NAME\_SEL = RW\_NAME\_SSL$$

Once the site table index parameter, L, is determined, then the runway parameters are redefined for the selected runway

$$SEL\_SITE\_ID = RUNWAY\_NAME(L)$$

$$RW\_NAME = L$$

$$LAT = RW\_LAT(L)$$

$$LON = RW\_LON(L)$$

$$ALT\_RW = RUNWAY\_ALT(L)$$

$$AZIMUTH\_RW = RW\_AZIMUTH(L)$$

$$LENGTH\_RW = RW\_LENGTH(L)$$

$$DELH\_MSL\_ELLIPSOID\_RW = RW\_DELH(L)$$

$$ANGLE\_CORR\_TNTOMAG\_RW = RW\_MAG\_VAR(L)$$

$$K = RW\_MSBLS\_INDEX(L)$$

and the flag, MLS\_AVAIL, is initially reset OFF, that is

$$MLS\_AVAIL = OFF$$

Next, the earth-fixed position vector, earth-fixed to selected runway transformation matrix and the earth-fixed to runway topodetic transformation matrix shall be computed:

$$\bar{R}_{LS\_EF} = GEODETIC\_TO\_EF(LAT, LON, ALT\_RW)$$

$$M\_EFTORW = EF\_TO\_RUNWAY(LAT, LON, AZIMUTH\_RW)$$

$$M\_EFTOTD\_RW = EF\_TO\_TOPDET(LAT, LON)$$

Then the position vector (originating at the origin of the EF coordinate system) of the HAC center for both sides of the runway centerline will be determined in earth-fixed coordinates:

$$\bar{R}_{CC\_L\_PRI} = \bar{R}_{LS\_EF} + M\_EFTORW^T \bar{R}_{HAC\_RW\_L}$$

$$\bar{R}_{CC\_R\_PRI} = \bar{R}_{LS\_EF} + M\_EFTORW^T \bar{R}_{HAC\_RW\_R}$$

where  $\bar{R}_{HAC\_RW\_L}$  and  $\bar{R}_{HAC\_RW\_R}$  are the position vectors (originating at the origin of the RW coordinate system) of these two points in runway coordinates (see Section 4.9).

Then, the magnitude of these two position vectors will be determined:

$$R\_CC\_LMAG\_PRI = |\overline{R\_CC\_L\_PRI}|$$

$$R\_CC\_RMAG\_PRI = |\overline{R\_CC\_R\_PRI}|$$

Next, a test will be made to determine if the selected runway has a MSBLS. If the selected runway MSBLS pointer, K, is zero, then the runway has no MSBLS. However, if K is a positive integer ( $1 \leq K \leq 15$ ), then the parameters associated with the MSBLS site will be redefined for the designated selection and an earth-fixed position vector and an earth-fixed to scanner transformation matrix shall be computed for the MSBLS range-azimuth antenna and the MSBLS elevation antenna locations; therefore if

$$K > 0$$

then

$$LAT\_MLS\_R\_AZ = LAT\_MLS\_R\_AZ(K)$$

$$LONG\_MLS\_R\_AZ = LONG\_MLS\_R\_AZ(K)$$

$$ALT\_MLS\_R\_AZ = ALT\_MLS\_R\_AZ(K)$$

$$R\_AZ\_SCANNER\_BEARING = R\_AZ\_RADAR\_BEARING(K)$$

$$LAT\_MLSEL = LAT\_MLSEL(K)$$

$$LONG\_MLSEL = LONG\_MLSEL(K)$$

$$ALT\_MLSEL = ALT\_MLSEL(K)$$

$$EL\_SCANNER\_BEARING = EL\_SCANNER\_BEARING(K)$$

$$BIAS\_MLS\_RANGE = BIAS\_MLSRANGE(K)$$

$$BIAS\_ELMLS = BIAS\_ELMLS(K)$$

$$BIAS\_AZMLS = BIAS\_AZMLS(K)$$

$$X\_DMEAZ\_RW\_ = X\_DMEAZ\_RW(K)$$

$$X\_EL\_RW = X\_ELRW(K)$$

$$Y\_DMEAZ\_RW = Y\_DMEAZ\_RW(K)$$

$$MLS\_AVAIL = ON$$

$$M\_EFTORAD\_R\_AZ = EF\_TO\_SCANNER(LAT\_MLS\_R\_AZ, LONG\_MLS\_R\_AZ, R\_AZ\_SCANNER\_BEARING)$$

$$M\_EFTORAD\_EL = EF\_TO\_SCANNER(LAT\_MLSEL, LONG\_MLSEL, EL\_SCANNER\_BEARING)$$

$\bar{R}_{RMLS\_EF} = \text{GEODETTIC\_TO\_EF}(\text{LAT\_MLS\_R\_AZ}, \text{LONG\_MLS\_R\_AZ}, \text{ALT\_MLS\_R\_AZ})$

$\bar{R}_{AZMLS\_EF} = \bar{R}_{RMLS\_EF}$

$\bar{R}_{ELMLS\_EF} = \text{GEODETTIC\_TO\_EF}(\text{LAT})\text{MLSEL}, \text{LONG\_MLSEL}, \text{ALT\_MLSEL})$

B. Interface Requirements. The input and output parameters are shown in Tables 4.5.2.2–1 and 4.5.2.2–2.

C. Processing Requirements. Parameters output from this subfunction should be provided as a homogeneous set and not be available to users until the entire set is compatible. The parameter SEL\_SITE\_ID must be protected and carried across all GN&C OPS transitions.

D. Constraints. No error checking is performed. The selected runway must be indicated by an integer from 1 to 2 and the selected area by an integer from 1 to 45. Both must be properly derived and limited by software external to this subfunction.

ALT\_SITE\_INDEX(1) and ALT\_SITE\_INDEX(2) are specified to carry over their OPS 1 values to OPS 3 in the Ascent Bearing Specialist Function requirements of Section B.5.26 of the Displays and Controls Volume 3 FSSR, STS 83–0020V3.

E. Supplementary Information. A suggested implementation of these requirements is illustrated in Section 5.3, ENTRY\_RUNWAY\_SITE\_LOOKUP.

Table 4.5.2.2-1. Entry Runway Site Lookup Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current landing site selection	PRIME_RUNWAY_INDEX	ENTRY SITE LOOKUP INIT	INT	S	1–2	—	As needed
Selected area	AREA_SEL	ENTRY SITE LOOKUP INIT,*	INT	S	1–45	—	As needed
Bearing from true north of runway coordinate system +X axis	RW_AZIMUTH(L)	**	F	S	—	rad	As needed
Altitude above reference ellipsoid of runway reference point	RUNWAY_ALT(L)	**	F	S	—	ft	As needed
Altitude of mean sea-level above reference ellipsoid of the runway	RW_DELH(L)	**	F	S	—	ft	As needed
Variation of runway magnetic north from true north	RW_MAG_VAR(L)	**	F	S	—	rad	As needed

Table 4.5.2.2-1. Entry Runway Site Lookup Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Runway geodetic latitude	RW_LAT(L)	**	F	S	—	rad	As needed
Runway longitude	RW_LON(L)	**	F	S	—	rad	As needed
Length of runway	RW_LENGTH(L)	**	F	S	—	ft	As needed
Runway MSBLS pointer index	RW_MSBLBS_INDEX(L)	**	F	S	0–15	—	As needed
MSBLS azimuth antenna measurement bias	BIAS_AZMLS(K)	**	F	S	—	rad	As needed
MSBLS elevation antenna measurement bias	BIAS_ELMLS(K)	**	F	S	—	rad	As needed
MSBLS range antenna measurement bias	BIAS_MLSRANGE(K)	**	F	S	—	ft	As needed
X component of range/azimuth antenna in runway coordinates	X_DMEAZ_RW(K)	**	F	S	—	ft	As needed
Y component of range/azimuth antenna in runway coordinates	Y_DMEAZ_RW(K)	**	F	S	—	ft	As needed
X component of elevation antenna in runway coordinates	X_EL_RW(K)	**	F	S	—	ft	As needed
MSBLS range/azimuth geodetic latitude	LAT_MLS_R_AZ(K)	**	F	S	—	rad	As needed
MSBLS range/azimuth longitude	LONG_MLS_R_AZ(K)	**	F	S	—	rad	As needed
MSBLS range/azimuth geodetic altitude	ALT_MLS_R_AZ(K)	**	F	S	—	ft	As needed
MSBLS azimuth boresight relative to true north	R_AZ_RADAR_BEARING(K)	**	F	S	—	rad	As needed
MSBLS elevation geodetic latitude	LAT_MLSEL(K)	**	F	S	—	rad	As needed
MSBLS elevation longitude	LONG_MLS_EL(K)	**	F	S	—	rad	As needed
MSBLS elevation geodetic altitude	ALT_MLS_EL(K)	**	F	S	—	ft	As needed
MSBLS elevation boresight relative to true north	EL_SCANNER_BEARING(K)	**	F	S	—	rad	As needed



Table 4.5.2.2-1. Entry Runway Site Lookup Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Position vector of HAC center for the left-side of the runway centerline	R_HAC_RW_L	**	V	S	—	ft	As needed
Position vector of HAC center for the right-side of the runway centerline	R_HAC_RW_R	**	V	S	—	ft	As needed
Name of the selected landing site	RUNWAY_NAME(L)	**	CHAR	—	—	—	As needed
Alternate Landing Site 1	ALTERNATE_SITE_1(J)	*	INT	S	0-45	—	As needed
Alternate Landing Site 2	ALTERNATE_SITE_2(J)	*	INT	S	0-45	—	As needed
Alternate Site 1 index	ALT_SITE_INDEX(1)	*	I	S	0-45	—	As needed
Alternate Site 2 index	ALT_SITE_INDEX(2)	*	I	S	0-45	—	As needed
Alternate sites reset inhibit flag	ALT_SITES_RESET_INH	ENTRY SITE LOOKUP INIT	BIT	—	OFF/ON	—	As needed

\* See principal function input list in Table 4.5.2.4-1.

\*\* See Table 4.5.2.4-3, J = 1 to 45  
K = 1 to 15  
L = 1 to 90

Table 4.5.2.2-2. Entry Runway Site Lookup Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Current landing site selection index	RW_NAME	*	I	S	1–90	—	As needed
Alternate site 1 index	ALT_SITE_INDEX(1)	*	I	S	0–45	—	As needed
Alternate site 2 index	ALT_SITE_INDEX(2)	*	I	S	0–45	—	As needed
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S	—	ft	As needed
Bearing from true north of runway coordinate system +X axis	AZIMUTH_RW	*	F	S	—	rad	As needed
Length of runway	LENGTH_RW	*	F	S	—	ft	As needed
Altitude of mean sea-level above reference ellipsoid at the runway	DELH_MSL_ELLIPSOID_RW	*	F	S	—	ft	As needed
Variation of runway magnetic north from true north	ANGLE_CORR_TNTOMAG_RW	*	F	S	0–2 $\pi$	rad	As needed
Earth-fixed to selected runway transformation matrix	M_EFTORW	*	M	S	—	—	As needed
Position vector of landing site in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP	—	ft	As needed
Position vector of HAC center on the left-side of the runway centerline in earth-fixed coordinates	$\bar{R}_{CC\_L\_PRI}$	*	V	S	—	ft	As needed
Position vector of HAC center on the right-side of the runway centerline in earth-fixed coordinates	$\bar{R}_{CC\_R\_PRI}$	*	V	S	—	ft	As needed
Magnitude of $\bar{R}_{CC\_L\_PRI}$	R_CC_LMAG_PRI	*	F	S	—	ft	As needed
Magnitude of $\bar{R}_{CC\_R\_PRI}$	R_CC_RMAG_PRI	*	F	S	—	ft	As needed
Flag indicating (ON) the availability of MSBLS sites at the currently chosen runway	MLS_AVAIL	*	bit		OFF/ON		As needed

Table 4.5.2.2-2. Entry Runway Site Lookup Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
MSBLS azimuth antenna measurement bias	BIAS_AZMLS	*	F	S	—	rad	As needed
MSBLS elevation antenna measurement bias	BIAS_ELMLS	*	F	S	—	rad	As needed
MSBLS range antenna measurement bias	BIAS_MLSRANGE	*	F	S	—	ft	As needed
X component of range/azimuth antenna in runway coordinates	X_DMEAZ_RW	*	F	S	—	ft	As needed
Y component of range/azimuth antenna in runway coordinates	Y_DMEAZ_RW	*	F	S	—	ft	As needed
X component of elevation antenna in runway coordinates	X_EL_RW	*	F	S	—	ft	As needed
Earth-fixed position vector of MSBLS range scanner	$\bar{R}_{RMLS\_EF}$	*	V	DP	—	ft	As needed
Earth-fixed position vector of MSBLS azimuth scanner	$\bar{R}_{AZMLS\_EF}$	*	V	DP	—	ft	As needed
Earth-fixed position vector of MSBLS elevation scanner	$\bar{R}_{ELMLS\_EF}$	*	V	DP	—	ft	As needed
Transformation matrix from earth-fixed to MSBLS range/azimuth radar coordinate frame	M_EFTORAD_R_AZ	*	M	S	—	—	As needed
Transformation matrix from earth-fixed to MSBLS elevation radar coordinate frame	M_EFTORAD_EL	*	M	S	—	—	As needed
Runway Selection Indicator	RW_SELECT	*	BIT	—	—	—	As needed
Primary runway name for the selected area which is used for display	RW_NAME_PSL	*	CHAR	—	—	—	As needed
Secondary runway name for the selected area which is used for display	RW_NAME_SSL	*	CHAR	—	—	—	As needed

Table 4.5.2.2-2. Entry Runway Site Lookup Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Runway name for the selected area runway which is used for display	RW_NAME_SEL	*	CHAR	—	—	—	As needed
Runway name for the selected landing site	SEL_SITE_ID	*	CHAR	--	--	--	As needed
* See principal function output list in Table 4.5.2.4-2.							

### 4.5.2.3 Entry TACAN Site Lookup

The purpose of this subfunction is to retrieve information for a specified TACAN channel, NEW\_STATION\_ID, associated with a given TACAN receiver, LRU\_ID, from the TACAN site location table and to compute the corresponding geodetic radius at the site, and earth-fixed position vector, and an earth-fixed to topodetic transformation matrix. There will be maximum of two TACAN sites available for each selected area.

A. **Detailed Requirements.** This subfunction will accept from the entry site lookup initialization subfunction an index, AREA\_SEL, which indicates the selected area, and will accept from the TACAN SOP the current TACAN channel number, NEW\_STATION\_ID and its associated receiver number, LRU\_ID. First, the local area parameter, J, is set equal to the selected area, AREA\_SEL, the TACAN channel valid flag, TAC\_CHAN\_VALID\_SL<sub>LRU\_ID</sub>, is initially reset OFF and the local TACAN channel number, TACAN\_ID<sub>LRU\_ID</sub>, set equal to the current channel number, NEW\_STATION\_ID. Then a search is performed to determine if the specified channel, TACAN\_ID<sub>LRU\_ID</sub>, is one of the two possible choices which are fixed by means of the selected area, AREA\_SEL. If the channel, TACAN\_ID<sub>LRU\_ID</sub>, is not one of the two possible TACAN's, then the flag, TAC\_CHAN\_VALID\_SL<sub>LRU\_ID</sub>, remains OFF and the present TACAN information for this LRU is not updated. On the other hand, if the channel is one of the two possible choices, then the following parameters are redefined for the new TACAN from values supplied by the TACAN table.

$$\text{LAT\_TACAN\_SL}_{\text{LRU\_ID}} = \text{LATITUDE\_GEODETTIC\_MAXI(I)}$$

$$\text{LONG\_TACAN\_SL}_{\text{LRU\_ID}} = \text{LONGITUDE\_EAST\_MAXI(I)}$$

$$\text{ALT\_TACAN\_SL}_{\text{LRU\_ID}} = \text{ALT\_ABOVE\_ELLIPSOID\_MAXI(I)}$$

$$\text{DH\_TACAN\_SL}_{\text{LRU\_ID}} = \text{MSL\_ABOVE\_ELLIPSOID\_MAXI(I)}$$

$$\text{ANGLE\_CORR\_TNTOMAG\_SL}_{\text{LRU\_ID}} = \text{MAGNETIC\_VARIATION\_MAXI(I)}$$

Furthermore, the corresponding geodetic radius at the site, an earth-fixed position vector, and an earth-fixed to topodetic transformation matrix are computed

$$RD\_TAC\_MSL\_SL_{LRU\_ID} = (1.-ELLIPT)^2 EARTH\_RADIUS\_EQUATOR / \\ (1. + SIN^2 (LAT\_TACAN\_SL_{LRU\_ID}) ELLIPT \\ (ELLIPT-2))^{1/2} + DH\_TACAN\_SL_{LRU\_ID}$$

$$\bar{R}\_TACAN\_EF\_SL_{LRU\_ID} = GEODITIC\_TO\_EF(LAT\_TACAN\_SL_{LRU\_ID}, \\ LONG\_TACAN\_SL_{LRU\_ID}, ALT\_TACAN\_SL_{LRU\_ID})$$

$$M\_EFTOTD\_TACAN\_SL_{LRU\_ID} = EF\_TO\_TOPDET(LAT\_TACAN\_SL_{LRU\_ID}, \\ LONG\_TACAN\_SL_{LRU\_ID})$$

Finally, the TACAN channel valid flag is set ON, that is,

$$TAC\_CHAN\_VALID\_SL_{LRU\_ID} = ON$$

B. Interface Requirements. The input and output parameters are shown in Tables 4.5.2.3-1 and 4.5.2.3-2, respectively.

C. Processing Requirements. Output parameters from this subfunction are employed by a variety of users. Consequently, this subfunction is invoked only by the TACAN SOP. Parameters output from this subfunction should be provided as a homogeneous set and not be available to users until the entire set is compatible.

D. Constraints. None.

E. Supplementary Information. A suggested implementation of these requirements is illustrated in Section 5.3, ENTRY\_TACAN\_SITE\_LOOKUP. TACAN site constants: the TACAN transmitters/receivers (T/R) provide a selection of 126 X-mode channels and 126 Y-mode channels; the TACAN control head permits the crew to manually select any one of these 252 T/R frequency pairs. However, a selection is of no value to certain of the onboard software unless the ground station location for the tuned channel is also available. Consequently, a table of limited size is provided to supply this information for two unique channels/ modes for each area. The parameters, TAC\_CHAN\_VALID\_SL\_LRU\_ID serve as the indicators of whether the station location is known or not known.

Table 4.5.2.3-1. Entry TACAN Site Lookup Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Selected area	AREA_SEL	ENTRY SITE LOOKUP INIT,*	INT	S	1–45	—	As needed
Current TACAN channel/mode identifier	NEW_STATION_ID	*	INT	S	±126	—	As needed
LRU number for output parameters	LRU_ID	*	INT	S	1–3	—	As needed
TACAN channel/mode identifier	TACAN_ID_MAXI(I)	**	F	S	±126	—	As needed
TACAN site geodetic latitude	LATITUDE_GEODETTIC_MAXI(I)	**	F	S	$-\pi/2, \pi/2$	rad	As needed
TACAN site longitude	LONGITUDE_EAST_MAXI(I)	**	F	S	$-\pi$	rad	As needed
TACAN station altitude	ALT_ABOVE_ELLIPSOID_MAXI(I)	**	F	S	—	ft	As needed
Altitude of mean sea-level above reference ellipsoid at TACAN station	MSL_ABOVE_ELLIPSOID_MAXI(I)	**	F	S	—	ft	As needed
Variation of magnetic north from true north at TACAN site	MAGNETIC_VARIATION_MAXI(I)	**	F	S	$0 - 2\pi$	rad	As needed
Earth ellipticity constant	ELLIPT	***	F	DP	—	—	As needed
Earth equatorial radius	EARTH_RADIUS_EQUATOR	***	F	DP	—	ft	As needed

\* See principal function input list in Table 4.5.2.4–1.

\*\* See Table 4.5.2.4–2.

\*\*\* See Table 4.5.2.4–4.

Table 4.5.2.3-2. Entry TACAN Site Lookup Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
TACAN station identifier code	TACAN_ID <sub>LRU_ID</sub>	*	INT	S	$\pm 126$	—	As needed
TACAN site geodetic latitude	LAT_TACAN_ SL <sub>LRU_ID</sub>	*	F	S	$-\pi/2, \pi/2$	rad	As needed
TACAN site longitude	LONG_TACAN_ SL <sub>LRU_ID</sub>	*	F	S	$-\pi, \pi$	rad	As needed
TACAN station altitude	ALT_TACAN_ SL <sub>LRU_ID</sub>	*	F	S	—	ft	As needed
Altitude of mean sea-level above reference ellipsoid at TACAN station	DH_TACAN_ SL <sub>LRU_ID</sub>	*	F	S	—	ft	As needed
Variation of magnetic north from true north at TACAN site	ANGLE_CORR_ TNTOMAG_ SL <sub>LRU_ID</sub>	*	F	S	$0 - 2\pi$	rad	As needed
Geodetic radius at TACAN site	RD_TAC_MSL_ SL <sub>LRU_ID</sub>	*	F	DP	—	ft	As needed
TACAN station earth-fixed position vector	$\bar{R}$ _TACAN_EF_ SL <sub>LRU_ID</sub>	*	V	DP	—	ft	As needed
Transformation matrix from earth-fixed to topodetic coordinates of the TACAN site	M_EFTOTD_ TACAN_SL <sub>LRU_ID</sub>	*	M	S	—	—	As needed
TACAN channel validity flag	TAC_CHAN_ VALID_SL <sub>LRU_ID</sub>	*	BIT	—	OFF/ON	—	As needed

\* See principal function output list in Table 4.5.2.4-2.

**4.5.2.4 Entry Site Lookup (4.124) Principal Function Tables**

The principal function input/output parameters are given in Tables 4.5.2.4–1 and 4.5.2.4–2. The I–load parameters are given in Table 4.5.2.4–3 and the K–load parameters in Table 4.5.2.4–4. There are no constants or variable cross–references for this principal function.

Entry Site Lookup (4.124) Principal Function Variable Cross–Reference	
FSSR Name	Source Name
No requirements	



TABLE 4.5.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALT_SITE_INDEX(1)	V94U5524C	ALTERNATE SITE 1 INDEX	ASC BRG DISP	ND	HXS		93167A	*
ALT_SITE_INDEX(1)	V94U5524CB	ALTERNATE SITE 1 INDEX	ASC SITE LOOKUP	ND	HXS		93167A	*
ALT_SITE_INDEX(2)	V94U5525C	ALTERNATE SITE 2 INDEX	ASC BRG DISP	ND	HXS		93167A	*
ALT_SITE_INDEX(2)	V94U5525CB	ALTERNATE SITE 2 INDEX	ASC SITE LOOKUP	ND	HXS		93167A	*
AREA_SEL	V93J4392C	SELECTED AREA	HORIZ SIT DISP				93090E	
AREA_SEL	V93J4392CD	SELECTED AREA	ENT BRG DISP				93090E	
AREA_SEL_OPS1	V93U4389C	AREA-SEL CARRYOVER TO OPS 3	ASC SITE LOOKUP				90072	
LRU_ID	V95J5021C	TACAN LRU NUMBER	TACAN SOP					
NEW_AREA	V93J4396C	NEW LANDING AREA SELECT CMD	HORIZ SIT DISP		HXS		92354	
NEW_AREA	V93J4396CB	NEW LANDING AREA SELECT CMD	ENT BRG DISP		HXS		93090E	
NEW_STATION_ID	V95J5020CA	TACAN 1,2,OR 3 NEW STATION CHAN NO	TACAN SOP					
PRI_SEL	V93X4393X	PRIMARY RUNWAY SEL CMD	HORIZ SIT DISP		BD		90000E	
RW_SEL_OPS1	V93U4356C	RUNWAY SEL CARRYOVER TO OPS3	ASC SITE LOOKUP				79865D	
SEC_SEL	V93X4394X	SECONDARY RUNWAY SEL CMD	HORIZ SIT DISP		BD		90000E	
TAC_CHANGE	V93X4395X	PRI/SEC TACAN SELECT CMD	HORIZ SIT DISP		BD		90000E	
TAC_SEL_OPS1	V93U4359C	TACAN SEL CARRYOVER TO OPS3	ASC SITE LOOKUP				79865D	
TAL_ABORT_DECLARED	V90X8658X	TAL ABORT DECLARED	MSC				93090E	
TAL_SITE_SEL_CMD	V93J4399C	TAL SITE SELECT CMD	HORIZ SIT DISP		HXS		93017G	*
	V90H3760C	RUNWAY LENGTH	UL	FT	HXU		92237	
	V96H0081C	MSBLS AZ/RNG STATION GEODETIC LAT	UL	RAD	SPL		92237	
	V96H0082C	MSBLS AZ/RNG STATION GEODETIC LON	UL	RAD	SPL		92237	
	V96H0083C	MSBLS AZ/RNG STATION GEODETIC ALT	UL	FT	SPL		92237	
	V96H0084C	MSBLS AZ/RNG STATION ANT BORESIGHT	UL	RAD	SPL		92237	
	V96H0085C	MSBLS ELEV STATION GEODETIC LAT	UL	RAD	SPL		92237	
	V96H0086C	MSBLS ELEV STATION GEODETIC LON	UL	RAD	SPL		92237	
	V96H0087C	MSBLS ELEV STATION GEODETIC ALT	UL	FT	SPL		92237	
	V96H0088C	MSBLS ELEV STATION ANT BORESIGHT	UL	RAD	SPL		92237	
	V96H0089C	MSBLS RANGE BIAS	UL	FT	SPL		92237	
	V96H0090C	MSBLS AZIMUTH ANGLE BIAS	UL	RAD	SPL		92237	
	V96H0091C	MSBLS ELEVATION ANGLE BIAS	UL	RAD	SPL		92237	
	V96H0092C	MSBLS AZ/RNG STATION X-RW COORD	UL	FT	SPL		92237	
	V96H0093C	MSBLS ELEV STATION X-RW COORD	UL	FT	SPL		92237	
	V96H0094C	MSBLS AZ/RNG STATION Y-RW COORD	UL	FT	SPL		92237	
	V96H0096C	TACAN MAGNETIC VARIATION	UL	RAD	SPL		92237	
	V96H0097C	TACAN GEODETIC SEPARATION	UL	FT	SPL		92237	
	V96H0098C	TACAN ALT ABOVE REF. ELLIPSOID	UL	FT	SPL		92237	
	V96H0099C	TACAN GEODETIC LONGITUDE	UL	RAD	SPL		92237	
	V96H0100C	TACAN GEODETIC LATITUDE	UL	RAD	SPL		92237	
	V96H0102C	RUNWAY GEODETIC SEPARATION	UL	FT	SPL		92237	
	V96H1210C	RUNWAY GEODETIC LATITUDE	UL	DEG	SPL		92237	
	V96H1211C	RUNWAY GEODETIC LONGITUDE	UL	DEG	SPL		92237	
	V96H1212C	RUNWAY TRUE AZIMUTH	UL	DEG	SPL		92237	
	V96H1213C	RUNWAY MAGNETIC VARIATION	UL	DEG	SPL		92237	
	V96H1214C	RUNWAY ALT ABOVE REF. ELLIPSOID	UL	FT	SPL		92237	
	V96J0080C	MSBLS TABLE SLOT ID	UL		HXU		92237	
	V96J0095C	TACAN TABLE SLOT ID	UL		HXU		92237	

TABLE 4.5.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V96J0101C	TACAN CHANNEL/MODE	UL		HXU		92237	
	V96J0103C	RUNWAY MSBLS INDEX	UL		HXU		92237	
	V96J1207C	LDG SITE TABLE SLOT ID	UL		HXU		92237	
	V96J1208C	RUNWAY NAME ID	UL		VAR		92237	
	V96J1209C	RUNWAY NAME ID FILL	UL		VAR		92237	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	A/L UPP AVVI PROC ENT AREA NAV ENT BRG SPEC ENT NAV ENT UPP PRELAND NAV TAEM UPP	FT			93155B	
ALT_SITE_INDEX(1)	V94U5524CC	ALTERNATE SITE 1 INDEX	ENT BRG DISP ENT BRG SPEC ENT DIP	ND	HXS		93090E	
ALT_SITE_INDEX(2)	V94U5525CC	ALTERNATE SITE 2 INDEX	ENT BRG DISP ENT BRG SPEC ENT DIP	ND	HXS		93090E	
ALT_TACAN_SL(1)	V90H1846CA	ALTITUDE OF TACAN 1 STATION	ENT AREA NAV	FT				
ALT_TACAN_SL(2)	V90H1847CA	ALTITUDE OF TACAN 2 STATION	ENT AREA NAV	FT				
ALT_TACAN_SL(3)	V90H1848CA	ALTITUDE OF TACAN 3 STATION	ENT AREA NAV	FT				
ANGLE_CORR_TNTOMAG_AUTO	V90H0393CA	MAGNETIC VARIATION AT AUTO SEL TAC	A/L UPP ENT UPP TAEM UPP	RAD	SPL		92049C	
ANGLE_CORR_TNTOMAG_RW	V90H1820CA	MAGNETIC VARIATION OF RW	A/E ATT PROC ENT AREA NAV HSI PROC HUD PROC	RAD			92297B	
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP	RAD				
AREA_SEL	V93J4392CA	SELECTED AREA	ENT BRG DISP ENT BRG SPEC HORIZ SIT DISP TLM				93090E	

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
AUTO_CHANNEL_ID	V95J5022CA	AUTO TACAN CHANNEL SELECTION	HORIZ SIT DISP TACAN SOP					
AZIMUTH_RW	V90H1817CA	AZIMUTH OF RW FROM TRUE NORTH	ENT AREA NAV ENT BRG SPEC ENT UPP HSI PROC HUD PROC	RAD			93090E	
BIAS_AZMLS	V90H1886CA	MSBLS AZIMUTH MEASUREMENT BIAS	PRELAND NAV	RAD				
BIAS_ELMLS	V90H1887CA	MSBLS ELEVATION MEASUREMENT BIAS	A/L UPP PRELAND NAV	RAD				
BIAS_RMLS	V90H1885CA	MSBLS RANGE MEASUREMENT BIAS	PRELAND NAV	FT				
DELH_MSL_ELLIPSOID_RW	V90H1819CA	ALT OF MSL ABOVE REF ELLIP AT RW	AVVI PROC ENT AREA NAV PRELAND NAV	FT				
DH_TACAN_SL(1)	V90H1849CA	ALT OF MSL ABV REF ELLIP AT TAC 1	ENT AREA NAV	FT				
DH_TACAN_SL(2)	V90H1850CA	ALT OF MSL ABV REF ELLIP AT TAC 2	ENT AREA NAV	FT				
DH_TACAN_SL(3)	V90H1851CA	ALT OF MSL ABV REF ELLIP AT TAC 3	ENT AREA NAV	FT				
HUD_RW_LENGTH	V72H4163CA	HUD RUNWAY LENGTH	HUDE1 HUDE2	FT				
MLS_AVAIL	V90X3720XA	MLS AVAILABILITY	A/L UPP D/L NAV SEQ ENT NAV PRELAND NAV					
M_EFTORAD_EL(1-1)	V90U1875CA	EF TO MSBLS EL COORD, ELE 1-1	PRELAND NAV					
M_EFTORAD_EL(1-2)	V90U1876CA	EF TO MSBLS EL COORD, ELE 1-2	PRELAND NAV					
M_EFTORAD_EL(1-3)	V90U1877CA	EF TO MSBLS EL COORD, ELE 1-3	PRELAND NAV					
M_EFTORAD_EL(2-1)	V90U1878CA	EF TO MSBLS EL COORD, ELE 2-1	PRELAND NAV					
M_EFTORAD_EL(2-2)	V90U1879CA	EF TO MSBLS EL COORD, ELE 2-2	PRELAND NAV					
M_EFTORAD_EL(2-3)	V90U1880CA	EF TO MSBLS EL COORD, ELE 2-3	PRELAND NAV					
M_EFTORAD_EL(3-1)	V90U1881CA	EF TO MSBLS EL COORD, ELE 3-1	PRELAND NAV					
M_EFTORAD_EL(3-2)	V90U1882CA	EF TO MSBLS EL COORD, ELE 3-2	PRELAND NAV					
M_EFTORAD_EL(3-3)	V90U1883CA	EF TO MSBLS EL COORD, ELE 3-3	PRELAND NAV					
M_EFTORAD_R_AZ(1-1)	V90U1865CA	EF TO RNG/AZ MSBLS RDR COORD/1-1	PRELAND NAV					
M_EFTORAD_R_AZ(1-2)	V90U1866CA	EF TO RNG/AZ MSBLS RDR COORD/1-2	PRELAND NAV					
M_EFTORAD_R_AZ(1-3)	V90U1867CA	EF TO RNG/AZ MSBLS RDR COORD/1-3	PRELAND NAV					
M_EFTORAD_R_AZ(2-1)	V90U1868CA	EF TO RNG/AZ MSBLS RDR COORD/2-1	PRELAND NAV					
M_EFTORAD_R_AZ(2-2)	V90U1869CA	EF TO RNG/AZ MSBLS RDR COORD/2-2	PRELAND NAV					
M_EFTORAD_R_AZ(2-3)	V90U1870CA	EF TO RNG/AZ MSBLS RDR COORD/2-3	PRELAND NAV					
M_EFTORAD_R_AZ(3-1)	V90U1871CA	EF TO RNG/AZ MSBLS RDR COORD/3-1	PRELAND NAV					
M_EFTORAD_R_AZ(3-2)	V90U1872CA	EF TO RNG/AZ MSBLS RDR COORD/3-2	PRELAND NAV					
M_EFTORAD_R_AZ(3-3)	V90U1873CA	EF TO RNG/AZ MSBLS RDR COORD/3-3	PRELAND NAV					

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_RW(1,1)	V90U3644CA	EF TO TOPO COORD AT RW 1-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(1,2)	V90U3645CA	EF TO TOPO COORD AT RW 1-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(1,3)	V90U3646CA	EF TO TOPO COORD AT RW 1-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(2,1)	V90U3647CA	EF TO TOPO COORD AT RW 2-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(2-2)	V90U3648CA	EF TO TOPO COORD AT RW 2-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(2-3)	V90U3649CA	EF TO TOPO COORD AT RW 2-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(3-1)	V90U3650CA	EF TO TOPO COORD AT RW 3-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(3-2)	V90U3651CA	EF TO TOPO COORD AT RW 3-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_RW(3-3)	V90U3652CA	EF TO TOPO COORD AT RW 3-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,1)	V90U3566CA	EF TO TOPO COORD, AUTO SEL TAC 1-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,2)	V90U3567CA	EF TO TOPO COORD, AUTO SEL TAC 1-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_AUTO(1,3)	V90U3568CA	EF TO TOPO COORD, AUTO SEL TAC 1-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,1)	V90U3569CA	EF TO TOPO COORD, AUTO SEL TAC 2-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,2)	V90U3570CA	EF TO TOPO COORD, AUTO SEL TAC 2-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,3)	V90U3571CA	EF TO TOPO COORD, AUTO SEL TAC 2-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,1)	V90U3572CA	EF TO TOPO COORD, AUTO SEL TAC 3-1	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,2)	V90U3573CA	EF TO TOPO COORD, AUTO SEL TAC 3-2	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,3)	V90U3574CA	EF TO TOPO COORD, AUTO SEL TAC 3-3	A/L UPP ENT UPP TAEM UPP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					



TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
RD_TAC_SL(1)	V90H1861CA	GEODETIC RADIUS AT TACAN SITE 1	ENT AREA NAV	FT				
RD_TAC_SL(2)	V90H1862CA	GEODETIC RADIUS AT TACAN SITE 2	ENT AREA NAV	FT				
RD_TAC_SL(3)	V90H1863CA	GEODETIC RADIUS AT TACAN SITE 3	ENT AREA NAV	FT				
RUNWAY_NAME_PSL	V97U5681CA	RUNWAY NAME PRIME LND SITE	HORIZ SIT DISP					
RUNWAY_NAME_SSL	V97U5682CA	RUNWAY NAME SEC LND SITE	HORIZ SIT DISP					
RV_MAX	V90L3752CA	MAX REL VEL FOR BARO PROCESSING	ENT NAV PRELAND NAV TAEM UPP	FT/S				
RW_ID_UPP	V95X0234XA	OTT FIRST PASS FLAG	ENT UPP TAEM UPP				90072	
RW_NAME	V90U1916CA	CURRENT LANDING SITE SELECTED	ENT UPP TAEM UPP					
RW_NAME_SEL	V94U5528CA	RUNWAY NAME SELECTED LANDING SITE	ENT BRG DISP	ND	VAR		93090E	
RW_SELECT	V93X4523XA	RUNWAY SELECTION INDICATOR	HORIZ SIT DISP					
R_AZMLS_EF(1)	V90H1828CA	X-COMP EF POS VCT OF MLS AZ ANT	PRELAND NAV					
R_AZMLS_EF(2)	V90H1829CA	Y-COMP EF POS VCT OF MLS AZ ANT	PRELAND NAV					
R_AZMLS_EF(3)	V90H1830CA	Z-COMP EF POS VCT OF MLS AZ ANT	PRELAND NAV					
R_CC_LMAG_PRI	V90H1931CA	MAG OF POS VCT HAC LFT SIDE RW	ENT AREA NAV	FT				
R_CC_L_PRI(1)	V90H1925CA	X-COMP POS VCT HAC LFT SIDE RW	ENT AREA NAV	FT				
R_CC_L_PRI(2)	V90H1926CA	Y-COMP POS VCT HAC LFT SIDE RW	ENT AREA NAV	FT				
R_CC_L_PRI(3)	V90H1927CA	Z-COMP POS VCT HAC LFT SIDE RW	ENT AREA NAV	FT				
R_CC_RMAG_PRI	V90H1932CA	MAG OF POS VCT HAC RHT SIDE RW	ENT AREA NAV	FT				
R_CC_R_PRI(1)	V90H1928CA	X-COMP POS VCT HAC RHT SIDE RW	ENT AREA NAV	FT				
R_CC_R_PRI(2)	V90H1929CA	Y-COMP POS VCT HAC RHT SIDE RW	ENT AREA NAV	FT				
R_CC_R_PRI(3)	V90H1930CA	Z-COMP POS VCT HAC RHT SIDE RW	ENT AREA NAV	FT			89625A	
R_ELMLS_EF(1)	V90H1825CA	X-COMP EF POS VCT MLS ELEV ANT	PRELAND NAV	FT				
R_ELMLS_EF(2)	V90H1826CA	Y-COMP EF POS VCT MLS ELEV ANT	PRELAND NAV	FT				
R_ELMLS_EF(3)	V90H1827CA	Z-COMP EF POS VCT MLS ELEV ANT	PRELAND NAV	FT				
R_Ls_EF(1)	V90H1900CA	X-COMP LDG SITE POS VCT-EF COORD	A/L UPP DEORB MNVR DIP ENT AREA NAV ENT UPP TAEM UPP	FT				

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_LS_EF(2)	V90H1901CA	Y-COMP LDG SITE POS VCT-EF COORD	A/L UPP DEORB MNVR DIP ENT AREA NAV ENT UPP TAEM UPP	FT				
R_LS_EF(3)	V90H1902CA	Z-COMP LDG SITE POS VCT-EF COORD	A/L UPP DEORB MNVR DIP ENT AREA NAV ENT UPP TAEM UPP	FT				
R_RMLS_EF(1)	V90H1831CA	X-COMP EF POS VCT OF MLS RNG ANT	PRELAND NAV					
R_RMLS_EF(2)	V90H1832CA	Y-COMP EF POS VCT OF MLS RNG ANT	PRELAND NAV					
R_RMLS_EF(3)	V90H1833CA	Z-COMP EF POS VCT OF MLS RNG ANT	PRELAND NAV					
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TACAN RM TAEM UPP	FT				
R_TACAN_EF_AUTO(1)	V90H3575CA	X-COMP, EF POS VCTR, AUTO SEL TAC	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	
R_TACAN_EF_AUTO(2)	V90H3576CA	Y-COMP, EF POS VCTR, AUTO SEL TAC	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	
R_TACAN_EF_AUTO(3)	V90H3577CA	Z-COMP, EF POS VCTR, AUTO SEL TAC	A/L UPP ENT UPP TAEM UPP	FT	DPL		92067D	
SEL_SITE_ID	V90U0378CB	SELECTED LANDING SITE ID	GPS SOP MEDS FC GNC XFER				92522D	

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	A/L UPP ENT AREA NAV ENT NAV ENT UPP PRELAND NAV TAEM UPP					
TACAN_ID(1)	V90U1802CA	TACAN 1 GND STA CHAN	ENT NAV HORIZ SIT DISP PRELAND NAV TLM					
TACAN_ID(2)	V90U1803CA	TACAN 2 GND STA CHAN	ENT NAV HORIZ SIT DISP PRELAND NAV TLM					
TACAN_ID(3)	V90U1804CA	TACAN 3 GND STA CHAN	ENT NAV HORIZ SIT DISP PRELAND NAV TLM					
TAC_CHAN_OLD(1)	V95U5023CA	PREV VALUE TAC CHAN FOR LRU 1	TACAN SOP					
TAC_CHAN_OLD(2)	V95U5024CA	PREV VALUE TAC CHAN FOR LRU 2	TACAN SOP					
TAC_CHAN_OLD(3)	V95U5025CA	PREV VALUE TAC CHAN FOR LRU 3	TACAN SOP					
VAR_H1	V90U3753CA	ADDITIVE BARO VARIANCE CONST	ENT NAV PRELAND NAV	FT2				
VAR_H2	V90U3754CA	MULTIPLICATIVE BARO VARIANCE CONST	ENT NAV PRELAND NAV					
X_DMEAZ_RW	V90H1815CA	X-COMP RNG/AZ ANTENNA IN RW COORD	ENT AREA NAV	FT			89137C	
X_EL_RW	V90H1910CA	X-COMP OF ELEV ANTENNA IN RW COORD	ENT AREA NAV	FT			89137C	
Y_DMEAZ_RW	V90H1816CA	Y-COMP RNG/AZ ANTENNA IN RW COORD	ENT AREA NAV	FT			89137C	
	V90J0124C	TACAN CHANNEL SELECTION	DL FMT 23/1				93017G	*

TABLE 4.5.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY SITE LOOKUP (G4.124)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
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**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALTERNATE_SITE_1(01)	V98U8555C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(02)	V98U8556C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(03)	V98U8557C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(04)	V98U8558C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(05)	V98U8559C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(06)	V98U8560C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(07)	V98U8561C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(08)	V98U8562C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(09)	V98U8635C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(10)	V98U8636C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(11)	V98U8637C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(12)	V98U8638C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(13)	V98U8669C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(14)	V98U8670C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(15)	V98U8671C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(16)	V98U8672C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(17)	V98U8673C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(18)	V98U8674C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(19)	V98U8675C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(20)	V98U8676C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(21)	V98U8677C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(22)	V98U8678C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(23)	V98U8679C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALTERNATE_SITE_1(24)	V98U8680C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(25)	V98U8681C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(26)	V98U8682C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(27)	V98U8683C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(28)	V98U8684C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(29)	V98U8685C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(30)	V98U8686C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(31)	V98U8687C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(32)	V98U8688C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(33)	V98U8689C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(34)	V98U8690C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(35)	V98U8691C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(36)	V98U8733C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(37)	V98U8734C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(38)	V98U8735C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(39)	V98U8736C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(40)	V98U8737C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(41)	V98U8738C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(42)	V98U8739C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(43)	V98U8740C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(44)	V98U8741C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_1(45)	V98U8742C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(01)	V98U8743C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALTERNATE_SITE_2(02)	V98U8744C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(03)	V98U8745C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(04)	V98U8746C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(05)	V98U8747C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(06)	V98U8748C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(07)	V98U8749C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(08)	V98U8750C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(09)	V98U8751C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(10)	V98U8752C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(11)	V98U8753C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(12)	V98U8754C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(13)	V98U8755C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(14)	V98U8756C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(15)	V98U8757C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(16)	V98U8758C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(17)	V98U8759C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(18)	V98U8760C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(19)	V98U8761C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(20)	V98U8762C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(21)	V98U8763C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(22)	V98U8764C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(23)	V98U8765C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(24)	V98U8766C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALTERNATE_SITE_2(25)	V98U8856C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(26)	V98U8857C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(27)	V98U8858C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(28)	V98U8859C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(29)	V98U8860C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(30)	V98U8862C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(31)	V98U8863C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(32)	V98U8864C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(33)	V98U8865C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(34)	V98U8866C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(35)	V98U8867C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(36)	V98U8868C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(37)	V98U8869C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(38)	V98U8870C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(39)	V98U8871C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(40)	V98U8872C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(41)	V98U8873C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(42)	V98U8874C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(43)	V98U8875C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(44)	V98U8876C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALTERNATE_SITE_2(45)	V98U8877C	ND	I	S	D	P	G4.124 G4.238	00	ASI	93090E	
ALT_ABOVE_ELLIPSOID_MAXI(01)	V98U8021C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(02)	V98U8022C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_ABOVE_ELLIPSOID_MAXI(03)	V98U8023C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(04)	V98U8024C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(05)	V98U8025C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(06)	V98U8026C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(07)	V98U8027C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(08)	V98U8028C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(09)	V98U8029C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(10)	V98U8030C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(11)	V98U8031C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(12)	V98U8032C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(13)	V98U8033C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(14)	V98U8034C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(15)	V98U8035C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(16)	V98U8036C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(17)	V98U8037C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(18)	V98U8038C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(19)	V98U8039C	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(20)	V98U8040C	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(21)	V98U8041C	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(22)	V98U8042C	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(23)	V98U8043C	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(24)	V98U8044C	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
ALT_ABOVE_ELLIPSOID_MAXI(25)	V98U8045C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_ABOVE_ELLIPSOID_MAXI (26)	V98U8046C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (27)	V98U8047C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
ALT_ABOVE_ELLIPSOID_MAXI (28)	V98U8048C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
ALT_ABOVE_ELLIPSOID_MAXI (29)	V98U8049C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (30)	V98U8050C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (31)	V98U8001C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (32)	V98U8002C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (33)	V98U8003C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (34)	V98U8004C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (35)	V98U8005C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (36)	V98U8006C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (37)	V98U8007C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (38)	V98U8008C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (39)	V98U8009C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (40)	V98U8010C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (41)	V98U8011C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (42)	V98U8012C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (43)	V98U8013C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
ALT_ABOVE_ELLIPSOID_MAXI (44)	V98U8014C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
ALT_ABOVE_ELLIPSOID_MAXI (45)	V98U8015C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (46)	V98U8016C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (47)	V98U8017C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
ALT_ABOVE_ELLIPSOID_MAXI (48)	V98U8018C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_ABOVE_ELLIPSOID_MAXI (49)	V98U8019C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (50)	V98U8020C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	
ALT_ABOVE_ELLIPSOID_MAXI (51)	V97U5221C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (52)	V97U5222C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (53)	V97U5223C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (54)	V97U5224C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (55)	V97U5225C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (56)	V97U5226C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (57)	V97U5227C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (58)	V97U5228C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (59)	V97U5229C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (60)	V97U5230C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (61)	V97U5266C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (62)	V97U5267C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (63)	V97U5268C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (64)	V97U5269C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (65)	V97U5270C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (66)	V97U5271C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (67)	V97U5272C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (68)	V97U5273C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (69)	V97U5274C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (70)	V97U5275C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (71)	V97U5386C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_ABOVE_ELLIPSOID_MAXI (72)	V97U5387C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (73)	V97U5388C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (74)	V97U5389C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (75)	V97U5390C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (76)	V97U5391C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (77)	V97U5392C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (78)	V97U5393C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (79)	V97U5394C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (80)	V97U5395C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (81)	V97U5441C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (82)	V97U5442C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (83)	V97U5443C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (84)	V97U5444C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (85)	V97U5445C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (86)	V97U5446C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (87)	V97U5447C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (88)	V97U5448C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (89)	V97U5449C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
ALT_ABOVE_ELLIPSOID_MAXI (90)	V97U5450C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
ALT_MLSEL (01)	V98U8052C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL (02)	V98U8053C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL (03)	V98U8054C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL (04)	V98U8055C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_MLSEL(10)	V99U7656C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(11)	V98U7971C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(12)	V98U7973C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(13)	V98U7989C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(14)	V98U8000C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(15)	V98U8051C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(5)	V98U9258CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(6)	V98U9259CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(7)	V98U9258CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(8)	V98U9259CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLSEL(9)	V99U7642C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(01)	V98U8064C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(02)	V98U8065C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(03)	V98U8066C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(04)	V98U8067C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(10)	V99U7660C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(11)	V98U7925C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(12)	V98U7926C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(13)	V98U7968C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(14)	V98U7969C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(15)	V98U7970C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(5)	V98U8074CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(6)	V98U8075CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALT_MLS_R_AZ(7)	V98U8074CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(8)	V98U8075CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
ALT_MLS_R_AZ(9)	V99U7646C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(01)	V98U8268C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(02)	V98U8269C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(03)	V98U8270C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(04)	V98U8271C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(10)	V99U7662C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(11)	V98U8056C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(12)	V98U8057C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(13)	V98U8058C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(14)	V98U8059C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(15)	V98U8060C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(5)	V98U9264CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(6)	V98U9265CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(7)	V98U9264CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(8)	V98U9265CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_AZMLS(9)	V99U7648C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(01)	V98U8280C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(02)	V98U8281C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(03)	V98U8282C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(04)	V98U8283C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(10)	V99U7663C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
BIAS_ELMLS(11)	V98U8061C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(12)	V98U8062C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(13)	V98U8063C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(14)	V98U8068C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(15)	V98U8069C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(5)	V97U5248CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(6)	V97U5249CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(7)	V97U5248CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(8)	V97U5249CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_ELMLS(9)	V99U7649C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(01)	V98U8292C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(02)	V98U8293C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(03)	V98U8294C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(04)	V98U8295C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(10)	V99U7664C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(11)	V98U8070C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(12)	V98U8071C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(13)	V98U8072C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(14)	V98U8073C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(15)	V98U8076C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(5)	V98U9262CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(6)	V98U9263CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE(7)	V98U9262CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
BIAS_MLSRANGE (8)	V98U9263CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
BIAS_MLSRANGE (9)	V99U7650C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (01)	V98U8463C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (02)	V98U8464C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (03)	V98U8465C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (04)	V98U8466C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (10)	V99U7657C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (11)	V98U8077C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (12)	V98U8078C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (13)	V98U8079C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (14)	V98U8080C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (15)	V98U8081C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (5)	V98U9260CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (6)	V98U9261CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (7)	V98U9260CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (8)	V98U9261CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
EL_SCANNER_BEARING (9)	V99U7643C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LATITUDE_GEODETTIC_MAXI (01)	V98U8520C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
LATITUDE_GEODETTIC_MAXI (02)	V98U8521C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
LATITUDE_GEODETTIC_MAXI (03)	V98U8522C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
LATITUDE_GEODETTIC_MAXI (04)	V98U8523C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
LATITUDE_GEODETTIC_MAXI (05)	V98U8524C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
LATITUDE_GEODETTIC_MAXI (06)	V98U8525C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LATITUDE_GEODETTIC_MAXI (07)	V98U8526C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
LATITUDE_GEODETTIC_MAXI (08)	V98U8527C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
LATITUDE_GEODETTIC_MAXI (09)	V98U8528C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
LATITUDE_GEODETTIC_MAXI (10)	V98U8529C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
LATITUDE_GEODETTIC_MAXI (11)	V98U8530C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
LATITUDE_GEODETTIC_MAXI (12)	V98U8531C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
LATITUDE_GEODETTIC_MAXI (13)	V98U8532C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
LATITUDE_GEODETTIC_MAXI (14)	V98U8533C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
LATITUDE_GEODETTIC_MAXI (15)	V98U8534C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
LATITUDE_GEODETTIC_MAXI (16)	V98U8535C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
LATITUDE_GEODETTIC_MAXI (17)	V98U8536C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
LATITUDE_GEODETTIC_MAXI (18)	V98U8537C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
LATITUDE_GEODETTIC_MAXI (19)	V98U8538C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
LATITUDE_GEODETTIC_MAXI (20)	V98U8539C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
LATITUDE_GEODETTIC_MAXI (21)	V98U8540C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
LATITUDE_GEODETTIC_MAXI (22)	V98U8541C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
LATITUDE_GEODETTIC_MAXI (23)	V98U8542C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
LATITUDE_GEODETTIC_MAXI (24)	V98U8543C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
LATITUDE_GEODETTIC_MAXI (25)	V98U8544C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
LATITUDE_GEODETTIC_MAXI (26)	V98U8545C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
LATITUDE_GEODETTIC_MAXI (27)	V98U8546C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
LATITUDE_GEODETTIC_MAXI (28)	V98U8547C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
LATITUDE_GEODETTIC_MAXI (29)	V98U8548C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LATITUDE_GEODETTIC_MAXI (30)	V98U8549C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
LATITUDE_GEODETTIC_MAXI (31)	V98U8091C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
LATITUDE_GEODETTIC_MAXI (32)	V98U8092C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
LATITUDE_GEODETTIC_MAXI (33)	V98U8093C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
LATITUDE_GEODETTIC_MAXI (34)	V98U8094C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
LATITUDE_GEODETTIC_MAXI (35)	V98U8095C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
LATITUDE_GEODETTIC_MAXI (36)	V98U8096C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
LATITUDE_GEODETTIC_MAXI (37)	V98U8097C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
LATITUDE_GEODETTIC_MAXI (38)	V98U8098C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
LATITUDE_GEODETTIC_MAXI (39)	V98U8099C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
LATITUDE_GEODETTIC_MAXI (40)	V98U8100C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
LATITUDE_GEODETTIC_MAXI (41)	V98U8101C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
LATITUDE_GEODETTIC_MAXI (42)	V98U8102C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
LATITUDE_GEODETTIC_MAXI (43)	V98U8103C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
LATITUDE_GEODETTIC_MAXI (44)	V98U8104C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
LATITUDE_GEODETTIC_MAXI (45)	V98U8105C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
LATITUDE_GEODETTIC_MAXI (46)	V98U8106C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
LATITUDE_GEODETTIC_MAXI (47)	V98U8107C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
LATITUDE_GEODETTIC_MAXI (48)	V98U8108C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
LATITUDE_GEODETTIC_MAXI (49)	V98U8109C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
LATITUDE_GEODETTIC_MAXI (50)	V98U8110C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
LATITUDE_GEODETTIC_MAXI (51)	V97U5471C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
LATITUDE_GEODETTIC_MAXI (52)	V97U5472C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LATITUDE_GEODETTIC_MAXI (53)	V97U5473C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
LATITUDE_GEODETTIC_MAXI (54)	V97U5474C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
LATITUDE_GEODETTIC_MAXI (55)	V97U5475C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
LATITUDE_GEODETTIC_MAXI (56)	V97U5476C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
LATITUDE_GEODETTIC_MAXI (57)	V97U5477C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
LATITUDE_GEODETTIC_MAXI (58)	V97U5478C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
LATITUDE_GEODETTIC_MAXI (59)	V97U5479C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
LATITUDE_GEODETTIC_MAXI (60)	V97U5480C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
LATITUDE_GEODETTIC_MAXI (61)	V97U5481C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
LATITUDE_GEODETTIC_MAXI (62)	V97U5482C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
LATITUDE_GEODETTIC_MAXI (63)	V97U5483C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
LATITUDE_GEODETTIC_MAXI (64)	V97U5484C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
LATITUDE_GEODETTIC_MAXI (65)	V97U5485C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
LATITUDE_GEODETTIC_MAXI (66)	V97U5486C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
LATITUDE_GEODETTIC_MAXI (67)	V97U5487C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
LATITUDE_GEODETTIC_MAXI (68)	V97U5488C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
LATITUDE_GEODETTIC_MAXI (69)	V97U5489C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
LATITUDE_GEODETTIC_MAXI (70)	V97U5490C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
LATITUDE_GEODETTIC_MAXI (71)	V97U5518C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
LATITUDE_GEODETTIC_MAXI (72)	V97U5519C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
LATITUDE_GEODETTIC_MAXI (73)	V97U5520C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
LATITUDE_GEODETTIC_MAXI (74)	V97U5521C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
LATITUDE_GEODETTIC_MAXI (75)	V97U5522C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LATITUDE_GEODETTIC_MAXI (76)	V97U5523C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
LATITUDE_GEODETTIC_MAXI (77)	V97U5524C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
LATITUDE_GEODETTIC_MAXI (78)	V97U5525C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
LATITUDE_GEODETTIC_MAXI (79)	V97U5526C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
LATITUDE_GEODETTIC_MAXI (80)	V97U5527C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
LATITUDE_GEODETTIC_MAXI (81)	V97U5587C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
LATITUDE_GEODETTIC_MAXI (82)	V97U5588C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
LATITUDE_GEODETTIC_MAXI (83)	V97U5589C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
LATITUDE_GEODETTIC_MAXI (84)	V97U5590C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
LATITUDE_GEODETTIC_MAXI (85)	V97U5591C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
LATITUDE_GEODETTIC_MAXI (86)	V97U5592C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
LATITUDE_GEODETTIC_MAXI (87)	V97U5593C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
LATITUDE_GEODETTIC_MAXI (88)	V97U5594C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
LATITUDE_GEODETTIC_MAXI (89)	V97U5595C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
LATITUDE_GEODETTIC_MAXI (90)	V97U5596C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
LAT_MLSEL (01)	V98U8498C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (02)	V98U8499C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (03)	V98U8500C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (04)	V98U8501C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (10)	V99U7654C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (11)	V98U8087C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (12)	V98U8088C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL (13)	V98U8089C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LAT_MLSEL(14)	V98U8090C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(15)	V98U8266C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(5)	V98U9254CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(6)	V98U9255CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(7)	V98U9254CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(8)	V98U9255CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLSEL(9)	V99U7640C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(01)	V98U8486C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(02)	V98U8487C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(03)	V98U8488C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(04)	V98U8489C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(10)	V99U7658C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(11)	V98U8082C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(12)	V98U8083C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(13)	V98U8084C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(14)	V98U8085C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(15)	V98U8086C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(5)	V98U9246CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(6)	V98U9247CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(7)	V98U9246CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(8)	V98U9247CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LAT_MLS_R_AZ(9)	V99U7644C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONGITUDE_EAST_MAXI(01)	V98U8585C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONGITUDE_EAST_MAXI (02)	V98U8586C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
LONGITUDE_EAST_MAXI (03)	V98U8587C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
LONGITUDE_EAST_MAXI (04)	V98U8588C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
LONGITUDE_EAST_MAXI (05)	V98U8589C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
LONGITUDE_EAST_MAXI (06)	V98U8590C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
LONGITUDE_EAST_MAXI (07)	V98U8591C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
LONGITUDE_EAST_MAXI (08)	V98U8592C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
LONGITUDE_EAST_MAXI (09)	V98U8593C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
LONGITUDE_EAST_MAXI (10)	V98U8594C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
LONGITUDE_EAST_MAXI (11)	V98U8595C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
LONGITUDE_EAST_MAXI (12)	V98U8596C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
LONGITUDE_EAST_MAXI (13)	V98U8597C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
LONGITUDE_EAST_MAXI (14)	V98U8598C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
LONGITUDE_EAST_MAXI (15)	V98U8599C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
LONGITUDE_EAST_MAXI (16)	V98U8600C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
LONGITUDE_EAST_MAXI (17)	V98U8601C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
LONGITUDE_EAST_MAXI (18)	V98U8602C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
LONGITUDE_EAST_MAXI (19)	V98U8603C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
LONGITUDE_EAST_MAXI (20)	V98U8604C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
LONGITUDE_EAST_MAXI (21)	V98U8605C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
LONGITUDE_EAST_MAXI (22)	V98U8606C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
LONGITUDE_EAST_MAXI (23)	V98U8607C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
LONGITUDE_EAST_MAXI (24)	V98U8608C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONGITUDE_EAST_MAXI (25)	V98U8609C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
LONGITUDE_EAST_MAXI (26)	V98U8610C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
LONGITUDE_EAST_MAXI (27)	V98U8611C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
LONGITUDE_EAST_MAXI (28)	V98U8612C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
LONGITUDE_EAST_MAXI (29)	V98U8613C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
LONGITUDE_EAST_MAXI (30)	V98U8614C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
LONGITUDE_EAST_MAXI (31)	V98U8121C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
LONGITUDE_EAST_MAXI (32)	V98U8122C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
LONGITUDE_EAST_MAXI (33)	V98U8123C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
LONGITUDE_EAST_MAXI (34)	V98U8124C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
LONGITUDE_EAST_MAXI (35)	V98U8125C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
LONGITUDE_EAST_MAXI (36)	V98U8126C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
LONGITUDE_EAST_MAXI (37)	V98U8127C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
LONGITUDE_EAST_MAXI (38)	V98U8128C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
LONGITUDE_EAST_MAXI (39)	V98U8129C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
LONGITUDE_EAST_MAXI (40)	V98U8130C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
LONGITUDE_EAST_MAXI (41)	V98U8131C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
LONGITUDE_EAST_MAXI (42)	V98U8132C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
LONGITUDE_EAST_MAXI (43)	V98U8133C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
LONGITUDE_EAST_MAXI (44)	V98U8134C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
LONGITUDE_EAST_MAXI (45)	V98U8135C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
LONGITUDE_EAST_MAXI (46)	V98U8136C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
LONGITUDE_EAST_MAXI (47)	V98U8137C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONGITUDE_EAST_MAXI (48)	V98U8138C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
LONGITUDE_EAST_MAXI (49)	V98U8139C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
LONGITUDE_EAST_MAXI (50)	V98U8140C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
LONGITUDE_EAST_MAXI (51)	V97U5719C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
LONGITUDE_EAST_MAXI (52)	V97U5720C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
LONGITUDE_EAST_MAXI (53)	V97U5721C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
LONGITUDE_EAST_MAXI (54)	V97U5722C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
LONGITUDE_EAST_MAXI (55)	V97U5723C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
LONGITUDE_EAST_MAXI (56)	V97U5724C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
LONGITUDE_EAST_MAXI (57)	V97U5725C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
LONGITUDE_EAST_MAXI (58)	V97U5726C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
LONGITUDE_EAST_MAXI (59)	V97U5727C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
LONGITUDE_EAST_MAXI (60)	V97U5728C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
LONGITUDE_EAST_MAXI (61)	V97U5752C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
LONGITUDE_EAST_MAXI (62)	V97U5753C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
LONGITUDE_EAST_MAXI (63)	V97U5754C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
LONGITUDE_EAST_MAXI (64)	V97U5755C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
LONGITUDE_EAST_MAXI (65)	V97U5756C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
LONGITUDE_EAST_MAXI (66)	V97U5757C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
LONGITUDE_EAST_MAXI (67)	V97U5758C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
LONGITUDE_EAST_MAXI (68)	V97U5759C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
LONGITUDE_EAST_MAXI (69)	V97U5760C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
LONGITUDE_EAST_MAXI (70)	V97U5761C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONGITUDE_EAST_MAXI(71)	V97U5770C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
LONGITUDE_EAST_MAXI(72)	V97U5771C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
LONGITUDE_EAST_MAXI(73)	V97U5772C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
LONGITUDE_EAST_MAXI(74)	V97U5773C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
LONGITUDE_EAST_MAXI(75)	V97U5774C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
LONGITUDE_EAST_MAXI(76)	V97U5775C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
LONGITUDE_EAST_MAXI(77)	V97U5776C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
LONGITUDE_EAST_MAXI(78)	V97U5777C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
LONGITUDE_EAST_MAXI(79)	V97U5778C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
LONGITUDE_EAST_MAXI(80)	V97U5779C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
LONGITUDE_EAST_MAXI(81)	V97U6011C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
LONGITUDE_EAST_MAXI(82)	V97U6012C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
LONGITUDE_EAST_MAXI(83)	V97U6013C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
LONGITUDE_EAST_MAXI(84)	V97U6014C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
LONGITUDE_EAST_MAXI(85)	V97U6015C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
LONGITUDE_EAST_MAXI(86)	V97U6016C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
LONGITUDE_EAST_MAXI(87)	V97U6017C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
LONGITUDE_EAST_MAXI(88)	V97U6018C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
LONGITUDE_EAST_MAXI(89)	V97U6019C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
LONGITUDE_EAST_MAXI(90)	V97U6020C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
LONG_MLSEL(01)	V98U8563C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(02)	V98U8564C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(03)	V98U8565C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONG_MLSEL(04)	V98U8566C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(10)	V99U7655C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(11)	V98U8116C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(12)	V98U8117C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(13)	V98U8118C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(14)	V98U8119C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(15)	V98U8120C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(5)	V98U9256CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(6)	V98U9257CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(7)	V98U9256CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(8)	V98U9257CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLSEL(9)	V99U7641C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(01)	V98U8551C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(02)	V98U8552C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(03)	V98U8553C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(04)	V98U8554C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(10)	V99U7659C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(11)	V98U8111C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(12)	V98U8112C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(13)	V98U8113C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(14)	V98U8114C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(15)	V98U8115C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ(5)	V98U9248CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
LONG_MLS_R_AZ (6)	V98U9249CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ (7)	V98U9248CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ (8)	V98U9249CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
LONG_MLS_R_AZ (9)	V99U7645C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
MAGNETIC_VARIATION_MAXI (01)	V98U8639C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
MAGNETIC_VARIATION_MAXI (02)	V98U8640C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
MAGNETIC_VARIATION_MAXI (03)	V98U8641C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
MAGNETIC_VARIATION_MAXI (04)	V98U8642C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
MAGNETIC_VARIATION_MAXI (05)	V98U8643C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
MAGNETIC_VARIATION_MAXI (06)	V98U8644C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
MAGNETIC_VARIATION_MAXI (07)	V98U8645C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
MAGNETIC_VARIATION_MAXI (08)	V98U8646C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
MAGNETIC_VARIATION_MAXI (09)	V98U8647C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
MAGNETIC_VARIATION_MAXI (10)	V98U8648C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
MAGNETIC_VARIATION_MAXI (11)	V98U8649C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
MAGNETIC_VARIATION_MAXI (12)	V98U8650C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
MAGNETIC_VARIATION_MAXI (13)	V98U8651C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
MAGNETIC_VARIATION_MAXI (14)	V98U8652C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
MAGNETIC_VARIATION_MAXI (15)	V98U8653C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
MAGNETIC_VARIATION_MAXI (16)	V98U8654C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
MAGNETIC_VARIATION_MAXI (17)	V98U8655C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
MAGNETIC_VARIATION_MAXI (18)	V98U8656C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
MAGNETIC_VARIATION_MAXI (19)	V98U8657C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MAGNETIC_VARIATION_MAXI (20)	V98U8658C	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
MAGNETIC_VARIATION_MAXI (21)	V98U8659C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
MAGNETIC_VARIATION_MAXI (22)	V98U8660C	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
MAGNETIC_VARIATION_MAXI (23)	V98U8661C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
MAGNETIC_VARIATION_MAXI (24)	V98U8662C	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
MAGNETIC_VARIATION_MAXI (25)	V98U8663C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
MAGNETIC_VARIATION_MAXI (26)	V98U8664C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
MAGNETIC_VARIATION_MAXI (27)	V98U8665C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
MAGNETIC_VARIATION_MAXI (28)	V98U8666C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
MAGNETIC_VARIATION_MAXI (29)	V98U8667C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
MAGNETIC_VARIATION_MAXI (30)	V98U8668C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
MAGNETIC_VARIATION_MAXI (31)	V98U8141C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
MAGNETIC_VARIATION_MAXI (32)	V98U8142C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
MAGNETIC_VARIATION_MAXI (33)	V98U8143C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
MAGNETIC_VARIATION_MAXI (34)	V98U8144C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
MAGNETIC_VARIATION_MAXI (35)	V98U8145C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
MAGNETIC_VARIATION_MAXI (36)	V98U8146C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
MAGNETIC_VARIATION_MAXI (37)	V98U8147C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
MAGNETIC_VARIATION_MAXI (38)	V98U8148C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
MAGNETIC_VARIATION_MAXI (39)	V98U8149C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
MAGNETIC_VARIATION_MAXI (40)	V98U8150C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
MAGNETIC_VARIATION_MAXI (41)	V98U8151C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
MAGNETIC_VARIATION_MAXI (42)	V98U8152C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MAGNETIC_VARIATION_MAXI (43)	V98U8153C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
MAGNETIC_VARIATION_MAXI (44)	V98U8154C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
MAGNETIC_VARIATION_MAXI (45)	V98U8155C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
MAGNETIC_VARIATION_MAXI (46)	V98U8156C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
MAGNETIC_VARIATION_MAXI (47)	V98U8157C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
MAGNETIC_VARIATION_MAXI (48)	V98U8158C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
MAGNETIC_VARIATION_MAXI (49)	V98U8159C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
MAGNETIC_VARIATION_MAXI (50)	V98U8160C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
MAGNETIC_VARIATION_MAXI (51)	V97U6076C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
MAGNETIC_VARIATION_MAXI (52)	V97U6077C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
MAGNETIC_VARIATION_MAXI (53)	V97U6078C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
MAGNETIC_VARIATION_MAXI (54)	V97U6079C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
MAGNETIC_VARIATION_MAXI (55)	V97U6080C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
MAGNETIC_VARIATION_MAXI (56)	V97U6081C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
MAGNETIC_VARIATION_MAXI (57)	V97U6082C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
MAGNETIC_VARIATION_MAXI (58)	V97U6083C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
MAGNETIC_VARIATION_MAXI (59)	V97U6084C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
MAGNETIC_VARIATION_MAXI (60)	V97U6085C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
MAGNETIC_VARIATION_MAXI (61)	V97U6086C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
MAGNETIC_VARIATION_MAXI (62)	V97U6087C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
MAGNETIC_VARIATION_MAXI (63)	V97U6088C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
MAGNETIC_VARIATION_MAXI (64)	V97U6089C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
MAGNETIC_VARIATION_MAXI (65)	V97U6090C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MAGNETIC_VARIATION_MAXI (66)	V97U6091C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
MAGNETIC_VARIATION_MAXI (67)	V97U6092C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
MAGNETIC_VARIATION_MAXI (68)	V97U6093C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
MAGNETIC_VARIATION_MAXI (69)	V97U6094C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
MAGNETIC_VARIATION_MAXI (70)	V97U6095C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
MAGNETIC_VARIATION_MAXI (71)	V97U6342C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
MAGNETIC_VARIATION_MAXI (72)	V97U6343C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
MAGNETIC_VARIATION_MAXI (73)	V97U6344C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
MAGNETIC_VARIATION_MAXI (74)	V97U6345C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
MAGNETIC_VARIATION_MAXI (75)	V97U6346C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
MAGNETIC_VARIATION_MAXI (76)	V97U6347C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
MAGNETIC_VARIATION_MAXI (77)	V97U6348C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
MAGNETIC_VARIATION_MAXI (78)	V97U6349C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
MAGNETIC_VARIATION_MAXI (79)	V97U6350C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
MAGNETIC_VARIATION_MAXI (80)	V97U6351C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
MAGNETIC_VARIATION_MAXI (81)	V97U6352C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
MAGNETIC_VARIATION_MAXI (82)	V97U6353C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
MAGNETIC_VARIATION_MAXI (83)	V97U6354C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
MAGNETIC_VARIATION_MAXI (84)	V97U6355C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
MAGNETIC_VARIATION_MAXI (85)	V97U6356C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
MAGNETIC_VARIATION_MAXI (86)	V97U6357C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
MAGNETIC_VARIATION_MAXI (87)	V97U6358C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
MAGNETIC_VARIATION_MAXI (88)	V97U6359C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MAGNETIC_VARIATION_MAXI (89)	V97U6360C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
MAGNETIC_VARIATION_MAXI (90)	V97U6361C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (01)	V98U8692C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (02)	V98U8693C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (03)	V98U8694C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (04)	V98U8695C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (05)	V98U8696C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (06)	V98U8697C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (07)	V98U8698C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (08)	V98U8699C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (09)	V98U8700C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (10)	V98U8701C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (11)	V98U8702C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (12)	V98U8703C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (13)	V98U8704C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (14)	V98U8705C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (15)	V98U8706C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (16)	V98U8707C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (17)	V98U8708C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (18)	V98U8709C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (19)	V98U8710C	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (20)	V98U8711C	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (21)	V98U8712C	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MSL_ABOVE_ELLIPSOID_MAXI (22)	V98U8713C	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (23)	V98U8714C	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (24)	V98U8715C	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (25)	V98U8716C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (26)	V98U8717C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (27)	V98U8718C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
MSL_ABOVE_ELLIPSOID_MAXI (28)	V98U8719C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
MSL_ABOVE_ELLIPSOID_MAXI (29)	V98U8720C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (30)	V98U8721C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (31)	V98U8161C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (32)	V98U8162C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (33)	V98U8163C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (34)	V98U8164C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (35)	V98U8165C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (36)	V98U8166C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (37)	V98U8167C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (38)	V98U8168C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (39)	V98U8169C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (40)	V98U8170C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (41)	V98U8171C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (42)	V98U8172C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (43)	V98U8173C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
MSL_ABOVE_ELLIPSOID_MAXI (44)	V98U8174C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MSL_ABOVE_ELLIPSOID_MAXI (45)	V98U8175C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (46)	V98U8176C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (47)	V98U8177C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
MSL_ABOVE_ELLIPSOID_MAXI (48)	V98U8178C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
MSL_ABOVE_ELLIPSOID_MAXI (49)	V98U8179C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (50)	V98U8180C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	
MSL_ABOVE_ELLIPSOID_MAXI (51)	V97U6362C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (52)	V97U6363C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (53)	V97U6364C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (54)	V97U6365C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (55)	V97U6366C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (56)	V97U6367C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (57)	V97U6368C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (58)	V97U6369C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (59)	V97U6370C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (60)	V97U6371C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (61)	V97U6372C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (62)	V97U6373C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (63)	V97U6374C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (64)	V97U6375C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (65)	V97U6376C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (66)	V97U6377C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (67)	V97U6378C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MSL_ABOVE_ELLIPSOID_MAXI (68)	V97U6379C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (69)	V97U6380C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (70)	V97U6381C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (71)	V97U6382C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (72)	V97U6383C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (73)	V97U6384C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (74)	V97U6385C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (75)	V97U6386C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (76)	V97U6387C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (77)	V97U6388C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (78)	V97U6389C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (79)	V97U6390C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (80)	V97U6391C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (81)	V97U6526C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (82)	V97U6527C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (83)	V97U6528C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (84)	V97U6529C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (85)	V97U6530C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (86)	V97U6531C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (87)	V97U6532C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (88)	V97U6533C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (89)	V97U6534C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
MSL_ABOVE_ELLIPSOID_MAXI (90)	V97U6535C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(1)	V98U9795C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E01	93090E	
RUNWAY_ALT(10)	V97U6570C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RUNWAY_ALT(11)	V97U6574C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E06	93090E	
RUNWAY_ALT(12)	V97U6582C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RUNWAY_ALT(13)	V97U6589C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E07	93090E	
RUNWAY_ALT(14)	V97U6596C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RUNWAY_ALT(15)	V97U6603C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E08	93090E	
RUNWAY_ALT(16)	V97U6610C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RUNWAY_ALT(17)	V97U6617C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E09	93090E	
RUNWAY_ALT(18)	V97U6624C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RUNWAY_ALT(19)	V97U5684CC	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E10	93090E	
RUNWAY_ALT(2)	V97U6562C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RUNWAY_ALT(20)	V97U5685CC	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RUNWAY_ALT(21)	V97U5686CC	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E11	93090E	
RUNWAY_ALT(22)	V97U5684CB	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(23)	V97U5685CB	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E12	93090E	
RUNWAY_ALT(24)	V97U5686CB	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RUNWAY_ALT(25)	V99U7364C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E13	93090E	
RUNWAY_ALT(26)	V99U7371C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RUNWAY_ALT(27)	V99U7378C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E14	93090E	
RUNWAY_ALT(28)	V99U7685C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RUNWAY_ALT(29)	V99U7692C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E15	93090E	
RUNWAY_ALT(3)	V97U6563C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E02	93090E	
RUNWAY_ALT(30)	V99U7699C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RUNWAY_ALT(31)	V98U8181C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E16	93090E	
RUNWAY_ALT(32)	V98U8182C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RUNWAY_ALT(33)	V98U8183C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E17	93090E	
RUNWAY_ALT(34)	V98U8184C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RUNWAY_ALT(35)	V98U8185C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E18	93090E	
RUNWAY_ALT(36)	V98U8186C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(37)	V98U8187C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E19	93090E	
RUNWAY_ALT(38)	V98U8188C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RUNWAY_ALT(39)	V98U8189C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E20	93090E	
RUNWAY_ALT(4)	V97U6564C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
RUNWAY_ALT(40)	V98U8190C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RUNWAY_ALT(41)	V98U8191C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E21	93090E	
RUNWAY_ALT(42)	V98U8192C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RUNWAY_ALT(43)	V98U8193C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E22	93090E	
RUNWAY_ALT(44)	V98U8194C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RUNWAY_ALT(45)	V98U8195C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E23	93090E	
RUNWAY_ALT(46)	V98U8196C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RUNWAY_ALT(47)	V98U8197C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E24	93090E	
RUNWAY_ALT(48)	V98U8198C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RUNWAY_ALT(49)	V98U8199C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E25	93090E	
RUNWAY_ALT(5)	V97U6565C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E03	93090E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(50)	V98U8200C	FT	F	S	D	C	G4.124	00	E25	90000E	
RUNWAY_ALT(51)	V97U6536C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E26	93090E	
RUNWAY_ALT(52)	V97U6537C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RUNWAY_ALT(53)	V97U6538C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E27	93090E	
RUNWAY_ALT(54)	V97U6539C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RUNWAY_ALT(55)	V97U6540C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E28	93090E	
RUNWAY_ALT(56)	V97U6541C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RUNWAY_ALT(57)	V97U6542C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E29	93090E	
RUNWAY_ALT(58)	V97U6543C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RUNWAY_ALT(59)	V97U6544C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E30	93090E	
RUNWAY_ALT(6)	V97U6566C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RUNWAY_ALT(60)	V97U6545C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RUNWAY_ALT(61)	V97U7081C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E31	93090E	
RUNWAY_ALT(62)	V97U7082C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RUNWAY_ALT(63)	V97U7083C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E32	93090E	
RUNWAY_ALT(64)	V97U7084C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(65)	V97U7085C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E33	93090E	
RUNWAY_ALT(66)	V97U7086C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RUNWAY_ALT(67)	V97U7087C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E34	93090E	
RUNWAY_ALT(68)	V97U7088C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RUNWAY_ALT(69)	V97U7089C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E35	93090E	
RUNWAY_ALT(7)	V97U6567C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E04	93090E	
RUNWAY_ALT(70)	V97U7090C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RUNWAY_ALT(71)	V97U7091C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E36	93090E	
RUNWAY_ALT(72)	V97U7092C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RUNWAY_ALT(73)	V97U7093C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E37	93090E	
RUNWAY_ALT(74)	V97U7094C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RUNWAY_ALT(75)	V97U7095C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E38	93090E	
RUNWAY_ALT(76)	V97U7096C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RUNWAY_ALT(77)	V97U7097C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E39	93090E	
RUNWAY_ALT(78)	V97U7098C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_ALT(79)	V97U7099C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E40	93090E	
RUNWAY_ALT(8)	V97U6568C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RUNWAY_ALT(80)	V97U7100C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RUNWAY_ALT(81)	V97U7235C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E41	93090E	
RUNWAY_ALT(82)	V97U7236C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RUNWAY_ALT(83)	V97U7237C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E42	93090E	
RUNWAY_ALT(84)	V97U7238C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RUNWAY_ALT(85)	V97U7239C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E43	93090E	
RUNWAY_ALT(86)	V97U7240C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RUNWAY_ALT(87)	V97U7241C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E44	93090E	
RUNWAY_ALT(88)	V97U7242C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RUNWAY_ALT(89)	V97U7243C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E45	93090E	
RUNWAY_ALT(9)	V97U6569C	FT	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E05	93090E	
RUNWAY_ALT(90)	V97U7244C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RUNWAY_NAME(01)	V98U8767C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E01	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME(02)	V98U8768C	ND	CH		D	C	G4.124	00	E01	90000E	
RUNWAY_NAME(03)	V98U8769C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E02	93090E	
RUNWAY_NAME(04)	V98U8770C	ND	CH		D	C	G4.124 G4.238	00	E02	90000E	
RUNWAY_NAME(05)	V98U8771C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E03	93090E	
RUNWAY_NAME(06)	V98U8772C	ND	CH		D	C	G4.124 G4.238	00	E03	90000E	
RUNWAY_NAME(07)	V98U8773C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E04	93090E	
RUNWAY_NAME(08)	V98U8774C	ND	CH		D	C	G4.124 G4.238	00	E04	90000E	
RUNWAY_NAME(09)	V98U8775C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E05	93090E	
RUNWAY_NAME(10)	V98U8776C	ND	CH		D	C	G4.124 G4.238	00	E05	90000E	
RUNWAY_NAME(11)	V97U6571C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E06	93090E	
RUNWAY_NAME(12)	V97U6579C	ND	CH		D	C	G4.124 G4.238	00	E06	90000E	
RUNWAY_NAME(13)	V97U6586C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E07	93090E	
RUNWAY_NAME(14)	V97U6593C	ND	CH		D	C	G4.124 G4.238	00	E07	90000E	
RUNWAY_NAME(15)	V97U6600C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E08	93090E	
RUNWAY_NAME(16)	V97U6607C	ND	CH		D	C	G4.124 G4.238	00	E08	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME (17)	V97U6614C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E09	93090E	
RUNWAY_NAME (18)	V97U6621C	ND	CH		D	C	G4.124 G4.238	00	E09	90000E	
RUNWAY_NAME (19)	V97U5681CC	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E10	93090E	
RUNWAY_NAME (20)	V97U5682CC	ND	CH		D	C	G4.124 G4.238	00	E10	90000E	
RUNWAY_NAME (21)	V97U5683CC	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E11	93090E	
RUNWAY_NAME (22)	V97U5681CB	ND	CH		D	C	G4.124 G4.238	00	E11	90000E	
RUNWAY_NAME (23)	V97U5682CB	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E12	93090E	
RUNWAY_NAME (24)	V97U5683CB	ND	CH		D	C	G4.124 G4.238	00	E12	90000E	
RUNWAY_NAME (25)	V99U7363C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E13	93090E	
RUNWAY_NAME (26)	V99U7370C	ND	CH		D	C	G4.124 G4.238	00	E13	90000E	
RUNWAY_NAME (27)	V99U7377C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E14	93090E	
RUNWAY_NAME (28)	V99U7684C	ND	CH		D	C	G4.124 G4.238	00	E14	DC2123	
RUNWAY_NAME (29)	V99U7691C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E15	93090E	
RUNWAY_NAME (30)	V99U7698C	ND	CH		D	C	G4.124 G4.238	00	E15	90000E	
RUNWAY_NAME (31)	V98U8201C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E16	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME ( 32 )	V98U8202C	ND	CH		D	C	G4.124	00	E16	90000E	
RUNWAY_NAME ( 33 )	V98U8203C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E17	93090E	
RUNWAY_NAME ( 34 )	V98U8204C	ND	CH		D	C	G4.124 G4.238	00	E17	90000E	
RUNWAY_NAME ( 35 )	V98U8205C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E18	93090E	
RUNWAY_NAME ( 36 )	V98U8206C	ND	CH		D	C	G4.124 G4.238	00	E18	90000E	
RUNWAY_NAME ( 37 )	V98U8207C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E19	93090E	
RUNWAY_NAME ( 38 )	V98U8208C	ND	CH		D	C	G4.124 G4.238	00	E19	90000E	
RUNWAY_NAME ( 39 )	V98U8209C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E20	93090E	
RUNWAY_NAME ( 40 )	V98U8210C	ND	CH		D	C	G4.124 G4.238	00	E20	90000E	
RUNWAY_NAME ( 41 )	V98U8211C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E21	93090E	
RUNWAY_NAME ( 42 )	V98U8212C	ND	CH		D	C	G4.124 G4.238	00	E21	90000E	
RUNWAY_NAME ( 43 )	V98U8213C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E22	93090E	
RUNWAY_NAME ( 44 )	V98U8214C	ND	CH		D	C	G4.124 G4.238	00	E22	DC1923A	
RUNWAY_NAME ( 45 )	V98U8215C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E23	93090E	
RUNWAY_NAME ( 46 )	V98U8216C	ND	CH		D	C	G4.124 G4.238	00	E23	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME (47)	V98U8217C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E24	93090E	
RUNWAY_NAME (48)	V98U8218C	ND	CH		D	C	G4.124 G4.238	00	E24	DC1923A	
RUNWAY_NAME (49)	V98U8219C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E25	93090E	
RUNWAY_NAME (50)	V98U8220C	ND	CH		D	C	G4.124 G4.238	00	E25	90000E	
RUNWAY_NAME (51)	V97U7245C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E26	93090E	
RUNWAY_NAME (52)	V97U7246C	ND	CH		D	C	G4.124 G4.238	00	E26	92517C	
RUNWAY_NAME (53)	V97U7247C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E27	93090E	
RUNWAY_NAME (54)	V97U7248C	ND	CH		D	C	G4.124 G4.238	00	E27	92517C	
RUNWAY_NAME (55)	V97U7249C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E28	93090E	
RUNWAY_NAME (56)	V97U7250C	ND	CH		D	C	G4.124 G4.238	00	E28	92517C	
RUNWAY_NAME (57)	V97U7251C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E29	93090E	
RUNWAY_NAME (58)	V97U7252C	ND	CH		D	C	G4.124 G4.238	00	E29	92517C	
RUNWAY_NAME (59)	V97U7253C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E30	93090E	
RUNWAY_NAME (60)	V97U7254C	ND	CH		D	C	G4.124 G4.238	00	E30	92517C	
RUNWAY_NAME (61)	V97U7255C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E31	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME (62)	V97U7256C	ND	CH		D	C	G4.124	00	E31	92517C	
RUNWAY_NAME (63)	V97U7257C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E32	93090E	
RUNWAY_NAME (64)	V97U7258C	ND	CH		D	C	G4.124 G4.238	00	E32	92517C	
RUNWAY_NAME (65)	V97U7259C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E33	93090E	
RUNWAY_NAME (66)	V97U7260C	ND	CH		D	C	G4.124 G4.238	00	E33	92517C	
RUNWAY_NAME (67)	V97U7261C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E34	93090E	
RUNWAY_NAME (68)	V97U7262C	ND	CH		D	C	G4.124 G4.238	00	E34	92517C	
RUNWAY_NAME (69)	V97U7263C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E35	93090E	
RUNWAY_NAME (70)	V97U7264C	ND	CH		D	C	G4.124 G4.238	00	E35	92517C	
RUNWAY_NAME (71)	V97U7265C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E36	93090E	
RUNWAY_NAME (72)	V97U7266C	ND	CH		D	C	G4.124 G4.238	00	E36	92517C	
RUNWAY_NAME (73)	V97U7267C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E37	93090E	
RUNWAY_NAME (74)	V97U7268C	ND	CH		D	C	G4.124 G4.238	00	E37	92517C	
RUNWAY_NAME (75)	V97U7269C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E38	93090E	
RUNWAY_NAME (76)	V97U7270C	ND	CH		D	C	G4.124 G4.238	00	E38	92517C	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RUNWAY_NAME (77)	V97U7271C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E39	93090E	
RUNWAY_NAME (78)	V97U7272C	ND	CH		D	C	G4.124 G4.238	00	E39	92517C	
RUNWAY_NAME (79)	V97U7273C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E40	93090E	
RUNWAY_NAME (80)	V97U7274C	ND	CH		D	C	G4.124 G4.238	00	E40	92517C	
RUNWAY_NAME (81)	V97U7275C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E41	93090E	
RUNWAY_NAME (82)	V97U7276C	ND	CH		D	C	G4.124 G4.238	00	E41	92517C	
RUNWAY_NAME (83)	V97U7277C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E42	93090E	
RUNWAY_NAME (84)	V97U7278C	ND	CH		D	C	G4.124 G4.238	00	E42	92517C	
RUNWAY_NAME (85)	V97U7279C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E43	93090E	
RUNWAY_NAME (86)	V97U7280C	ND	CH		D	C	G4.124 G4.238	00	E43	92517C	
RUNWAY_NAME (87)	V97U7281C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E44	93090E	
RUNWAY_NAME (88)	V97U7282C	ND	CH		D	C	G4.124 G4.238	00	E44	92517C	
RUNWAY_NAME (89)	V97U7283C	ND	CH		D	C	G4.124 G4.238 G5.26 G5.27	00	E45	93090E	
RUNWAY_NAME (90)	V97U7284C	ND	CH		D	C	G4.124 G4.238	00	E45	92517C	
RW_AZIMUTH(01)	V98U8794C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E01	93090E	
RW_AZIMUTH(02)	V98U8795C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_AZIMUTH(03)	V98U8796C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E02	93090E	
RW_AZIMUTH(04)	V98U8797C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
RW_AZIMUTH(05)	V98U8798C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E03	93090E	
RW_AZIMUTH(06)	V98U8799C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_AZIMUTH(07)	V98U8800C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E04	93090E	
RW_AZIMUTH(08)	V98U8801C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_AZIMUTH(09)	V98U8802C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E05	93090E	
RW_AZIMUTH(10)	V98U8803C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_AZIMUTH(11)	V97U6575C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E06	93090E	
RW_AZIMUTH(12)	V97U6583C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_AZIMUTH(13)	V97U6590C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E07	93090E	
RW_AZIMUTH(14)	V97U6597C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_AZIMUTH(15)	V97U6604C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E08	93090E	
RW_AZIMUTH(16)	V97U6611C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_AZIMUTH(17)	V97U6618C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E09	93090E	
RW_AZIMUTH(18)	V97U6625C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_AZIMUTH(19)	V97U5687CC	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E10	93090E	
RW_AZIMUTH(20)	V97U5688CC	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_AZIMUTH(21)	V97U5689CC	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E11	93090E	
RW_AZIMUTH(22)	V97U5687CB	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_AZIMUTH(23)	V97U5688CB	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E12	93090E	
RW_AZIMUTH(24)	V97U5689CB	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_AZIMUTH(25)	V99U7367C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E13	93090E	
RW_AZIMUTH(26)	V99U7374C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_AZIMUTH(27)	V99U7381C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E14	93090E	
RW_AZIMUTH(28)	V99U7688C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_AZIMUTH(29)	V99U7695C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E15	93090E	
RW_AZIMUTH(30)	V99U7702C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_AZIMUTH(31)	V98U8221C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E16	93090E	
RW_AZIMUTH(32)	V98U8222C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_AZIMUTH(33)	V98U8223C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E17	93090E	
RW_AZIMUTH(34)	V98U8224C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RW_AZIMUTH(35)	V98U8225C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E18	93090E	
RW_AZIMUTH(36)	V98U8226C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_AZIMUTH(37)	V98U8227C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E19	93090E	
RW_AZIMUTH(38)	V98U8228C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_AZIMUTH(39)	V98U8229C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E20	93090E	
RW_AZIMUTH(40)	V98U8230C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_AZIMUTH(41)	V98U8231C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E21	93090E	
RW_AZIMUTH(42)	V98U8232C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_AZIMUTH(43)	V98U8233C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E22	93090E	
RW_AZIMUTH(44)	V98U8234C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_AZIMUTH(45)	V98U8235C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E23	93090E	
RW_AZIMUTH(46)	V98U8236C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_AZIMUTH(47)	V98U8237C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E24	93090E	
RW_AZIMUTH(48)	V98U8238C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_AZIMUTH(49)	V98U8239C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E25	93090E	
RW_AZIMUTH(50)	V98U8240C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
RW_AZIMUTH(51)	V97U7285C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E26	93090E	
RW_AZIMUTH(52)	V97U7286C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_AZIMUTH(53)	V97U7287C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E27	93090E	
RW_AZIMUTH(54)	V97U7288C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_AZIMUTH(55)	V97U7289C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E28	93090E	
RW_AZIMUTH(56)	V97U7290C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_AZIMUTH(57)	V97U7291C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E29	93090E	
RW_AZIMUTH(58)	V97U7292C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_AZIMUTH(59)	V97U7293C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E30	93090E	
RW_AZIMUTH(60)	V97U7294C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_AZIMUTH(61)	V97U7295C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E31	93090E	
RW_AZIMUTH(62)	V97U7296C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_AZIMUTH(63)	V97U7297C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E32	93090E	
RW_AZIMUTH(64)	V97U7298C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
RW_AZIMUTH(65)	V97U7299C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E33	93090E	
RW_AZIMUTH(66)	V97U7300C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_AZIMUTH(67)	V97U7301C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E34	93090E	
RW_AZIMUTH(68)	V97U7302C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_AZIMUTH(69)	V97U7303C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E35	93090E	
RW_AZIMUTH(70)	V97U7304C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_AZIMUTH(71)	V97U7349C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E36	93090E	
RW_AZIMUTH(72)	V97U7350C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_AZIMUTH(73)	V97U7351C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E37	93090E	
RW_AZIMUTH(74)	V97U7352C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_AZIMUTH(75)	V97U7353C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E38	93090E	
RW_AZIMUTH(76)	V97U7354C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_AZIMUTH(77)	V97U7355C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E39	93090E	
RW_AZIMUTH(78)	V97U7356C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_AZIMUTH(79)	V97U7357C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E40	93090E	
RW_AZIMUTH(80)	V97U7358C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_AZIMUTH(81)	V97U7359C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E41	93090E	
RW_AZIMUTH(82)	V97U7360C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_AZIMUTH(83)	V97U7361C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E42	93090E	
RW_AZIMUTH(84)	V97U7362C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_AZIMUTH(85)	V97U7363C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E43	93090E	
RW_AZIMUTH(86)	V97U7364C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_AZIMUTH(87)	V97U7365C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E44	93090E	
RW_AZIMUTH(88)	V97U7366C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_AZIMUTH(89)	V97U7367C	RAD	F	S	D	C	G4.124 G4.238 G5.27	00	E45	93090E	
RW_AZIMUTH(90)	V97U7368C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_DELH(01)	V98U8807C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_DELH(02)	V98U8808C	FT	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_DELH(03)	V98U8809C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_DELH(04)	V98U8810C	FT	F	S	D	C	G4.124 G4.238	00	E02	90000E	
RW_DELH(05)	V98U8811C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_DELH(06)	V98U8812C	FT	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_DELH(07)	V98U8813C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_DELH(08)	V98U8814C	FT	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_DELH(09)	V98U8815C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_DELH(10)	V98U8816C	FT	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_DELH(11)	V97U6576C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_DELH(12)	V97U6584C	FT	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_DELH(13)	V97U6591C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_DELH(14)	V97U6598C	FT	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_DELH(15)	V97U6605C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_DELH(16)	V97U6612C	FT	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_DELH(17)	V97U6619C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_DELH(18)	V97U6626C	FT	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_DELH(19)	V97U5690CC	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RW_DELH(20)	V97U5691CC	FT	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RW_DELH(21)	V97U5692CC	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_DELH(22)	V97U5690CB	FT	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_DELH(23)	V97U5691CB	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_DELH(24)	V97U5692CB	FT	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_DELH(25)	V99U7368C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_DELH(26)	V99U7375C	FT	F	S	D	C	G4.124 G4.238	00	E13	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_DELH(27)	V99U7382C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_DELH(28)	V99U7689C	FT	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_DELH(29)	V99U7696C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_DELH(30)	V99U7703C	FT	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_DELH(31)	V98U8241C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_DELH(32)	V98U8242C	FT	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_DELH(33)	V98U8243C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RW_DELH(34)	V98U8244C	FT	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RW_DELH(35)	V98U8245C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_DELH(36)	V98U8246C	FT	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_DELH(37)	V98U8247C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_DELH(38)	V98U8248C	FT	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_DELH(39)	V98U8249C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_DELH(40)	V98U8250C	FT	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_DELH(41)	V98U8251C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_DELH(42)	V98U8252C	FT	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_DELH(43)	V98U8253C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_DELH(44)	V98U8254C	FT	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_DELH(45)	V98U8255C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_DELH(46)	V98U8256C	FT	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_DELH(47)	V98U8257C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_DELH(48)	V98U8258C	FT	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_DELH(49)	V98U8259C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_DELH(50)	V98U8260C	FT	F	S	D	C	G4.124 G4.238	00	E25	90000E	
RW_DELH(51)	V97U7563C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_DELH(52)	V97U7564C	FT	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_DELH(53)	V97U7565C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_DELH(54)	V97U7566C	FT	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_DELH(55)	V97U7567C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_DELH(56)	V97U7568C	FT	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_DELH(57)	V97U7569C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_DELH(58)	V97U7570C	FT	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_DELH(59)	V97U7571C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_DELH(60)	V97U7572C	FT	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_DELH(61)	V97U7573C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_DELH(62)	V97U7574C	FT	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_DELH(63)	V97U7575C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
RW_DELH(64)	V97U7576C	FT	F	S	D	C	G4.124 G4.238	00	E32	92517C	
RW_DELH(65)	V97U7577C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_DELH(66)	V97U7578C	FT	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_DELH(67)	V97U7579C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_DELH(68)	V97U7580C	FT	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_DELH(69)	V97U7581C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_DELH(70)	V97U7582C	FT	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_DELH(71)	V97U7583C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_DELH(72)	V97U7584C	FT	F	S	D	C	G4.124 G4.238	00	E36	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_DELH(73)	V97U7585C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_DELH(74)	V97U7586C	FT	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_DELH(75)	V97U7587C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_DELH(76)	V97U7588C	FT	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_DELH(77)	V97U7589C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_DELH(78)	V97U7590C	FT	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_DELH(79)	V97U7591C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_DELH(80)	V97U7592C	FT	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_DELH(81)	V97U7697C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_DELH(82)	V97U7698C	FT	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_DELH(83)	V97U7699C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_DELH(84)	V97U7700C	FT	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_DELH(85)	V97U7701C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_DELH(86)	V97U7702C	FT	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_DELH(87)	V97U7703C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_DELH(88)	V97U7704C	FT	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_DELH(89)	V97U7705C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_DELH(90)	V97U7706C	FT	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_LAT(01)	V98U8820C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E01	93090E	
RW_LAT(02)	V98U8821C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_LAT(03)	V98U8822C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E02	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(04)	V98U8823C	RAD	F	S	D	C	G4.124	00	E02	90000E	
RW_LAT(05)	V98U8824C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E03	93090E	
RW_LAT(06)	V98U8825C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_LAT(07)	V98U8826C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E04	93090E	
RW_LAT(08)	V98U8827C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_LAT(09)	V98U8828C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E05	93090E	
RW_LAT(10)	V98U8829C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_LAT(11)	V97U6572C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E06	93090E	
RW_LAT(12)	V97U6580C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_LAT(13)	V97U6587C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E07	93090E	
RW_LAT(14)	V97U6594C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_LAT(15)	V97U6601C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E08	93090E	
RW_LAT(16)	V97U6608C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_LAT(17)	V97U6615C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E09	93090E	
RW_LAT(18)	V97U6622C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(19)	V97U5696CC	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E10	93090E	
RW_LAT(20)	V97U5697CC	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RW_LAT(21)	V97U5698CC	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E11	93090E	
RW_LAT(22)	V97U5696CB	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_LAT(23)	V97U5697CB	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E12	93090E	
RW_LAT(24)	V97U5698CB	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_LAT(25)	V99U7365C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E13	93090E	
RW_LAT(26)	V99U7372C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_LAT(27)	V99U7379C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E14	93090E	
RW_LAT(28)	V99U7686C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_LAT(29)	V99U7693C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E15	93090E	
RW_LAT(30)	V99U7700C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_LAT(31)	V98U8301C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E16	93090E	
RW_LAT(32)	V98U8302C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_LAT(33)	V98U8303C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E17	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(34)	V98U8304C	RAD	F	S	D	C	G4.124	00	E17	90000E	
RW_LAT(35)	V98U8305C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E18	93090E	
RW_LAT(36)	V98U8306C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_LAT(37)	V98U8307C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E19	93090E	
RW_LAT(38)	V98U8308C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_LAT(39)	V98U8309C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E20	93090E	
RW_LAT(40)	V98U8310C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_LAT(41)	V98U8311C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E21	93090E	
RW_LAT(42)	V98U8312C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_LAT(43)	V98U8313C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E22	93090E	
RW_LAT(44)	V98U8314C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_LAT(45)	V98U8315C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E23	93090E	
RW_LAT(46)	V98U8316C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_LAT(47)	V98U8317C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E24	93090E	
RW_LAT(48)	V98U8318C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(49)	V98U8319C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E25	93090E	
RW_LAT(50)	V98U8320C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
RW_LAT(51)	V97U7745C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E26	93090E	
RW_LAT(52)	V97U7746C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_LAT(53)	V97U7747C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E27	93090E	
RW_LAT(54)	V97U7748C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_LAT(55)	V97U7749C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E28	93090E	
RW_LAT(56)	V97U7750C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_LAT(57)	V97U7751C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E29	93090E	
RW_LAT(58)	V97U7752C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_LAT(59)	V97U7753C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E30	93090E	
RW_LAT(60)	V97U7754C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_LAT(61)	V97U8062C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E31	93090E	
RW_LAT(62)	V97U8063C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_LAT(63)	V97U8064C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E32	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(64)	V97U8065C	RAD	F	S	D	C	G4.124	00	E32	92517C	
RW_LAT(65)	V97U8066C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E33	93090E	
RW_LAT(66)	V97U8067C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_LAT(67)	V97U8068C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E34	93090E	
RW_LAT(68)	V97U8069C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_LAT(69)	V97U8070C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E35	93090E	
RW_LAT(70)	V97U8071C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_LAT(71)	V97U8143C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E36	93090E	
RW_LAT(72)	V97U8144C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_LAT(73)	V97U8145C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E37	93090E	
RW_LAT(74)	V97U8146C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_LAT(75)	V97U8147C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E38	93090E	
RW_LAT(76)	V97U8148C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_LAT(77)	V97U8149C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E39	93090E	
RW_LAT(78)	V97U8150C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LAT(79)	V97U8151C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E40	93090E	
RW_LAT(80)	V97U8152C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_LAT(81)	V97U8153C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E41	93090E	
RW_LAT(82)	V97U8154C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_LAT(83)	V97U8155C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E42	93090E	
RW_LAT(84)	V97U8156C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_LAT(85)	V97U8157C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E43	93090E	
RW_LAT(86)	V97U8158C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_LAT(87)	V97U8159C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E44	93090E	
RW_LAT(88)	V97U8160C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_LAT(89)	V97U8161C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E45	93090E	
RW_LAT(90)	V97U8162C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_LENGTH(1)	V99U7121C	FT	I	S	D	C	G4.124 G4.238	00	E01	93194A	*
RW_LENGTH(10)	V99U7130C	FT	I	S	D	C	G4.124 G4.238	00	E05	93194A	*
RW_LENGTH(11)	V99U7131C	FT	I	S	D	C	G4.124 G4.238	00	E06	93194A	*
RW_LENGTH(12)	V99U7132C	FT	I	S	D	C	G4.124 G4.238	00	E06	93194A	*
RW_LENGTH(13)	V99U7133C	FT	I	S	D	C	G4.124 G4.238	00	E07	93194A	*



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LENGTH(14)	V99U7134C	FT	I	S	D	C	G4.124 G4.238	00	E07	93194A	*
RW_LENGTH(15)	V99U7135C	FT	I	S	D	C	G4.124 G4.238	00	E08	93194A	*
RW_LENGTH(16)	V99U7136C	FT	I	S	D	C	G4.124 G4.238	00	E08	93194A	*
RW_LENGTH(17)	V99U7137C	FT	I	S	D	C	G4.124 G4.238	00	E09	93194A	*
RW_LENGTH(18)	V99U7138C	FT	I	S	D	C	G4.124 G4.238	00	E09	93194A	*
RW_LENGTH(19)	V99U7118CC	FT	I	S	D	C	G4.124 G4.238	00	E10	93194A	*
RW_LENGTH(2)	V99U7122C	FT	I	S	D	C	G4.124 G4.238	00	E01	93194A	*
RW_LENGTH(20)	V99U7119CC	FT	I	S	D	C	G4.124 G4.238	00	E10	93194A	*
RW_LENGTH(21)	V99U7120CC	FT	I	S	D	C	G4.124 G4.238	00	E11	93194A	*
RW_LENGTH(22)	V99U7118CB	FT	I	S	D	C	G4.124 G4.238	00	E11	93194A	*
RW_LENGTH(23)	V99U7119CB	FT	I	S	D	C	G4.124 G4.238	00	E12	93194A	*
RW_LENGTH(24)	V99U7120CB	FT	I	S	D	C	G4.124 G4.238	00	E12	93194A	*
RW_LENGTH(25)	V99U7668C	FT	I	S	D	C	G4.124 G4.238	00	E13	93194A	*
RW_LENGTH(26)	V99U7669C	FT	I	S	D	C	G4.124 G4.238	00	E13	93194A	*
RW_LENGTH(27)	V99U7670C	FT	I	S	D	C	G4.124 G4.238	00	E14	93194A	*
RW_LENGTH(28)	V99U7671C	FT	I	S	D	C	G4.124 G4.238	00	E14	93194A	*
RW_LENGTH(29)	V99U7672C	FT	I	S	D	C	G4.124 G4.238	00	E15	93194A	*
RW_LENGTH(3)	V99U7123C	FT	I	S	D	C	G4.124 G4.238	00	E02	93194A	*
RW_LENGTH(30)	V99U7673C	FT	I	S	D	C	G4.124 G4.238	00	E15	93194A	*
RW_LENGTH(31)	V98U8321C	FT	I	S	D	C	G4.124 G4.238	00	E16	93194A	*
RW_LENGTH(32)	V98U8322C	FT	I	S	D	C	G4.124 G4.238	00	E16	93194A	*
RW_LENGTH(33)	V98U8323C	FT	I	S	D	C	G4.124 G4.238	00	E17	93194A	*
RW_LENGTH(34)	V98U8324C	FT	I	S	D	C	G4.124 G4.238	00	E17	93194A	*

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LENGTH(35)	V98U8325C	FT	I	S	D	C	G4.124 G4.238	00	E18	93194A	*
RW_LENGTH(36)	V98U8326C	FT	I	S	D	C	G4.124 G4.238	00	E18	93194A	*
RW_LENGTH(37)	V98U8327C	FT	I	S	D	C	G4.124 G4.238	00	E19	93194A	*
RW_LENGTH(38)	V98U8328C	FT	I	S	D	C	G4.124 G4.238	00	E19	93194A	*
RW_LENGTH(39)	V98U8329C	FT	I	S	D	C	G4.124 G4.238	00	E20	93194A	*
RW_LENGTH(4)	V99U7124C	FT	I	S	D	C	G4.124 G4.238	00	E02	93194A	*
RW_LENGTH(40)	V98U8330C	FT	I	S	D	C	G4.124 G4.238	00	E20	93194A	*
RW_LENGTH(41)	V98U8331C	FT	I	S	D	C	G4.124 G4.238	00	E21	93194A	*
RW_LENGTH(42)	V98U8332C	FT	I	S	D	C	G4.124 G4.238	00	E21	93194A	*
RW_LENGTH(43)	V98U8333C	FT	I	S	D	C	G4.124 G4.238	00	E22	93194A	*
RW_LENGTH(44)	V98U8334C	FT	I	S	D	C	G4.124 G4.238	00	E22	93194A	*
RW_LENGTH(45)	V98U8335C	FT	I	S	D	C	G4.124 G4.238	00	E23	93194A	*
RW_LENGTH(46)	V98U8336C	FT	I	S	D	C	G4.124 G4.238	00	E23	93194A	*
RW_LENGTH(47)	V98U8337C	FT	I	S	D	C	G4.124 G4.238	00	E24	93194A	*
RW_LENGTH(48)	V98U8338C	FT	I	S	D	C	G4.124 G4.238	00	E24	93194A	*
RW_LENGTH(49)	V98U8339C	FT	I	S	D	C	G4.124 G4.238	00	E25	93194A	*
RW_LENGTH(5)	V99U7125C	FT	I	S	D	C	G4.124 G4.238	00	E03	93194A	*
RW_LENGTH(50)	V98U8340C	FT	I	S	D	C	G4.124 G4.238	00	E25	93194A	*
RW_LENGTH(51)	V97U8163C	FT	I	S	D	C	G4.124 G4.238	00	E26	93194A	*
RW_LENGTH(52)	V97U8164C	FT	I	S	D	C	G4.124 G4.238	00	E26	93194A	*
RW_LENGTH(53)	V97U8165C	FT	I	S	D	C	G4.124 G4.238	00	E27	93194A	*
RW_LENGTH(54)	V97U8166C	FT	I	S	D	C	G4.124 G4.238	00	E27	93194A	*
RW_LENGTH(55)	V97U8167C	FT	I	S	D	C	G4.124 G4.238	00	E28	93194A	*

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LENGTH(56)	V97U8168C	FT	I	S	D	C	G4.124 G4.238	00	E28	93194A	*
RW_LENGTH(57)	V97U8169C	FT	I	S	D	C	G4.124 G4.238	00	E29	93194A	*
RW_LENGTH(58)	V97U8170C	FT	I	S	D	C	G4.124 G4.238	00	E29	93194A	*
RW_LENGTH(59)	V97U8171C	FT	I	S	D	C	G4.124 G4.238	00	E30	93194A	*
RW_LENGTH(6)	V99U7126C	FT	I	S	D	C	G4.124 G4.238	00	E03	93194A	*
RW_LENGTH(60)	V97U8172C	FT	I	S	D	C	G4.124 G4.238	00	E30	93194A	*
RW_LENGTH(61)	V97U8173C	FT	I	S	D	C	G4.124 G4.238	00	E31	93194A	*
RW_LENGTH(62)	V97U8174C	FT	I	S	D	C	G4.124 G4.238	00	E31	93194A	*
RW_LENGTH(63)	V97U8175C	FT	I	S	D	C	G4.124 G4.238	00	E32	93194A	*
RW_LENGTH(64)	V97U8176C	FT	I	S	D	C	G4.124 G4.238	00	E32	93194A	*
RW_LENGTH(65)	V97U8177C	FT	I	S	D	C	G4.124 G4.238	00	E33	93194A	*
RW_LENGTH(66)	V97U8178C	FT	I	S	D	C	G4.124 G4.238	00	E33	93194A	*
RW_LENGTH(67)	V97U8179C	FT	I	S	D	C	G4.124 G4.238	00	E34	93194A	*
RW_LENGTH(68)	V97U8180C	FT	I	S	D	C	G4.124 G4.238	00	E34	93194A	*
RW_LENGTH(69)	V97U8181C	FT	I	S	D	C	G4.124 G4.238	00	E35	93194A	*
RW_LENGTH(7)	V99U7127C	FT	I	S	D	C	G4.124 G4.238	00	E04	93194A	*
RW_LENGTH(70)	V97U8182C	FT	I	S	D	C	G4.124 G4.238	00	E35	93194A	*
RW_LENGTH(71)	V97U8183C	FT	I	S	D	C	G4.124 G4.238	00	E36	93194A	*
RW_LENGTH(72)	V97U8184C	FT	I	S	D	C	G4.124 G4.238	00	E36	93194A	*
RW_LENGTH(73)	V97U8185C	FT	I	S	D	C	G4.124 G4.238	00	E37	93194A	*
RW_LENGTH(74)	V97U8186C	FT	I	S	D	C	G4.124 G4.238	00	E37	93194A	*
RW_LENGTH(75)	V97U8187C	FT	I	S	D	C	G4.124 G4.238	00	E38	93194A	*
RW_LENGTH(76)	V97U8188C	FT	I	S	D	C	G4.124 G4.238	00	E38	93194A	*

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LENGTH(77)	V97U8189C	FT	I	S	D	C	G4.124 G4.238	00	E39	93194A	*
RW_LENGTH(78)	V97U8190C	FT	I	S	D	C	G4.124 G4.238	00	E39	93194A	*
RW_LENGTH(79)	V97U8191C	FT	I	S	D	C	G4.124 G4.238	00	E40	93194A	*
RW_LENGTH(8)	V99U7128C	FT	I	S	D	C	G4.124 G4.238	00	E04	93194A	*
RW_LENGTH(80)	V97U8192C	FT	I	S	D	C	G4.124 G4.238	00	E40	93194A	*
RW_LENGTH(81)	V97U8193C	FT	I	S	D	C	G4.124 G4.238	00	E41	93194A	*
RW_LENGTH(82)	V97U8194C	FT	I	S	D	C	G4.124 G4.238	00	E41	93194A	*
RW_LENGTH(83)	V97U8195C	FT	I	S	D	C	G4.124 G4.238	00	E42	93194A	*
RW_LENGTH(84)	V97U8196C	FT	I	S	D	C	G4.124 G4.238	00	E42	93194A	*
RW_LENGTH(85)	V97U8197C	FT	I	S	D	C	G4.124 G4.238	00	E43	93194A	*
RW_LENGTH(86)	V97U8198C	FT	I	S	D	C	G4.124 G4.238	00	E43	93194A	*
RW_LENGTH(87)	V97U8199C	FT	I	S	D	C	G4.124 G4.238	00	E44	93194A	*
RW_LENGTH(88)	V97U8200C	FT	I	S	D	C	G4.124 G4.238	00	E44	93194A	*
RW_LENGTH(89)	V97U8201C	FT	I	S	D	C	G4.124 G4.238	00	E45	93194A	*
RW_LENGTH(9)	V99U7129C	FT	I	S	D	C	G4.124 G4.238	00	E05	93194A	*
RW_LENGTH(90)	V97U8202C	FT	I	S	D	C	G4.124 G4.238	00	E45	93194A	*
RW_LON(01)	V98U8833C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E01	93090E	
RW_LON(02)	V98U8834C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_LON(03)	V98U8835C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E02	93090E	
RW_LON(04)	V98U8836C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(05)	V98U8837C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E03	93090E	
RW_LON(06)	V98U8838C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_LON(07)	V98U8839C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E04	93090E	
RW_LON(08)	V98U8840C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_LON(09)	V98U8841C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E05	93090E	
RW_LON(10)	V98U8842C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_LON(11)	V97U6573C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E06	93090E	
RW_LON(12)	V97U6581C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_LON(13)	V97U6588C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E07	93090E	
RW_LON(14)	V97U6595C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_LON(15)	V97U6602C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E08	93090E	
RW_LON(16)	V97U6609C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_LON(17)	V97U6616C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E09	93090E	
RW_LON(18)	V97U6623C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_LON(19)	V98U9243CC	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E10	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(20)	V98U9244CC	RAD	F	S	D	C	G4.124	00	E10	90000E	
RW_LON(21)	V98U9245CC	RAD	F	S	D	C	G4.238 G4.124 G4.238 G5.26 G5.27	00	E11	93090E	
RW_LON(22)	V98U9243CB	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_LON(23)	V98U9244CB	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E12	93090E	
RW_LON(24)	V98U9245CB	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_LON(25)	V99U7366C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E13	93090E	
RW_LON(26)	V99U7373C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_LON(27)	V99U7380C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E14	93090E	
RW_LON(28)	V99U7687C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_LON(29)	V99U7694C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E15	93090E	
RW_LON(30)	V99U7701C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_LON(31)	V98U8341C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E16	93090E	
RW_LON(32)	V98U8342C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_LON(33)	V98U8343C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E17	93090E	
RW_LON(34)	V98U8344C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(35)	V98U8345C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E18	93090E	
RW_LON(36)	V98U8346C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_LON(37)	V98U8347C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E19	93090E	
RW_LON(38)	V98U8348C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_LON(39)	V98U8349C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E20	93090E	
RW_LON(40)	V98U8350C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_LON(41)	V98U8351C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E21	93090E	
RW_LON(42)	V98U8352C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_LON(43)	V98U8353C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E22	93090E	
RW_LON(44)	V98U8354C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_LON(45)	V98U8355C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E23	93090E	
RW_LON(46)	V98U8356C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_LON(47)	V98U8357C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E24	93090E	
RW_LON(48)	V98U8358C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_LON(49)	V98U8359C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E25	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(50)	V98U8360C	RAD	F	S	D	C	G4.124	00	E25	90000E	
RW_LON(51)	V97U8587C	RAD	F	S	D	C	G4.238 G4.124 G4.238 G5.26 G5.27	00	E26	93090E	
RW_LON(52)	V97U8588C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_LON(53)	V97U8589C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E27	93090E	
RW_LON(54)	V97U8590C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_LON(55)	V97U8591C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E28	93090E	
RW_LON(56)	V97U8592C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_LON(57)	V97U8593C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E29	93090E	
RW_LON(58)	V97U8594C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_LON(59)	V97U8595C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E30	93090E	
RW_LON(60)	V97U8596C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_LON(61)	V97U8695C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E31	93090E	
RW_LON(62)	V97U8696C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_LON(63)	V97U8697C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E32	93090E	
RW_LON(64)	V97U8698C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(65)	V97U8699C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E33	93090E	
RW_LON(66)	V97U8700C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_LON(67)	V97U8701C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E34	93090E	
RW_LON(68)	V97U8702C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_LON(69)	V97U8703C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E35	93090E	
RW_LON(70)	V97U8704C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_LON(71)	V97U8814C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E36	93090E	
RW_LON(72)	V97U8815C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_LON(73)	V97U8816C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E37	93090E	
RW_LON(74)	V97U8817C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_LON(75)	V97U8818C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E38	93090E	
RW_LON(76)	V97U8819C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_LON(77)	V97U8820C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E39	93090E	
RW_LON(78)	V97U8821C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_LON(79)	V97U8822C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E40	93090E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_LON(80)	V97U8823C	RAD	F	S	D	C	G4.124	00	E40	92517C	
RW_LON(81)	V97U8824C	RAD	F	S	D	C	G4.238 G4.124 G4.238 G5.26 G5.27	00	E41	93090E	
RW_LON(82)	V97U8825C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_LON(83)	V97U8826C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E42	93090E	
RW_LON(84)	V97U8827C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_LON(85)	V97U8828C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E43	93090E	
RW_LON(86)	V97U8829C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_LON(87)	V97U8830C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E44	93090E	
RW_LON(88)	V97U8831C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_LON(89)	V97U8832C	RAD	F	S	D	C	G4.124 G4.238 G5.26 G5.27	00	E45	93090E	
RW_LON(90)	V97U8833C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_MAG_VAR(01)	V98U8846C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_MAG_VAR(02)	V98U8847C	RAD	F	S	D	C	G4.124 G4.238	00	E01	90000E	
RW_MAG_VAR(03)	V98U8848C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
RW_MAG_VAR(04)	V98U8849C	RAD	F	S	D	C	G4.124 G4.238	00	E02	90000E	
RW_MAG_VAR(05)	V98U8850C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_MAG_VAR(06)	V98U8851C	RAD	F	S	D	C	G4.124 G4.238	00	E03	90000E	
RW_MAG_VAR(07)	V98U8852C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MAG_VAR(08)	V98U8853C	RAD	F	S	D	C	G4.124 G4.238	00	E04	90000E	
RW_MAG_VAR(09)	V98U8854C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_MAG_VAR(10)	V98U8855C	RAD	F	S	D	C	G4.124 G4.238	00	E05	90000E	
RW_MAG_VAR(11)	V97U6577C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_MAG_VAR(12)	V97U6585C	RAD	F	S	D	C	G4.124 G4.238	00	E06	90000E	
RW_MAG_VAR(13)	V97U6592C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_MAG_VAR(14)	V97U6599C	RAD	F	S	D	C	G4.124 G4.238	00	E07	90000E	
RW_MAG_VAR(15)	V97U6606C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_MAG_VAR(16)	V97U6613C	RAD	F	S	D	C	G4.124 G4.238	00	E08	90000E	
RW_MAG_VAR(17)	V97U6620C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_MAG_VAR(18)	V97U6627C	RAD	F	S	D	C	G4.124 G4.238	00	E09	90000E	
RW_MAG_VAR(19)	V97U5693CC	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RW_MAG_VAR(20)	V97U5694CC	RAD	F	S	D	C	G4.124 G4.238	00	E10	90000E	
RW_MAG_VAR(21)	V97U5695CC	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_MAG_VAR(22)	V97U5693CB	RAD	F	S	D	C	G4.124 G4.238	00	E11	90000E	
RW_MAG_VAR(23)	V97U5694CB	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_MAG_VAR(24)	V97U5695CB	RAD	F	S	D	C	G4.124 G4.238	00	E12	90000E	
RW_MAG_VAR(25)	V99U7369C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_MAG_VAR(26)	V99U7376C	RAD	F	S	D	C	G4.124 G4.238	00	E13	90000E	
RW_MAG_VAR(27)	V99U7383C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_MAG_VAR(28)	V99U7690C	RAD	F	S	D	C	G4.124 G4.238	00	E14	DC2123	
RW_MAG_VAR(29)	V99U7697C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	
RW_MAG_VAR(30)	V99U7704C	RAD	F	S	D	C	G4.124 G4.238	00	E15	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MAG_VAR(31)	V98U8361C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_MAG_VAR(32)	V98U8362C	RAD	F	S	D	C	G4.124 G4.238	00	E16	90000E	
RW_MAG_VAR(33)	V98U8363C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RW_MAG_VAR(34)	V98U8364C	RAD	F	S	D	C	G4.124 G4.238	00	E17	90000E	
RW_MAG_VAR(35)	V98U8365C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_MAG_VAR(36)	V98U8366C	RAD	F	S	D	C	G4.124 G4.238	00	E18	90000E	
RW_MAG_VAR(37)	V98U8367C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_MAG_VAR(38)	V98U8368C	RAD	F	S	D	C	G4.124 G4.238	00	E19	90000E	
RW_MAG_VAR(39)	V98U8369C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_MAG_VAR(40)	V98U8370C	RAD	F	S	D	C	G4.124 G4.238	00	E20	90000E	
RW_MAG_VAR(41)	V98U8371C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_MAG_VAR(42)	V98U8372C	RAD	F	S	D	C	G4.124 G4.238	00	E21	90000E	
RW_MAG_VAR(43)	V98U8373C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_MAG_VAR(44)	V98U8374C	RAD	F	S	D	C	G4.124 G4.238	00	E22	DC1923A	
RW_MAG_VAR(45)	V98U8375C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_MAG_VAR(46)	V98U8376C	RAD	F	S	D	C	G4.124 G4.238	00	E23	90000E	
RW_MAG_VAR(47)	V98U8377C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_MAG_VAR(48)	V98U8378C	RAD	F	S	D	C	G4.124 G4.238	00	E24	DC1923A	
RW_MAG_VAR(49)	V98U8379C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
RW_MAG_VAR(50)	V98U8380C	RAD	F	S	D	C	G4.124 G4.238	00	E25	90000E	
RW_MAG_VAR(51)	V97U8834C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_MAG_VAR(52)	V97U8835C	RAD	F	S	D	C	G4.124 G4.238	00	E26	92517C	
RW_MAG_VAR(53)	V97U8836C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MAG_VAR(54)	V97U8837C	RAD	F	S	D	C	G4.124 G4.238	00	E27	92517C	
RW_MAG_VAR(55)	V97U8838C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_MAG_VAR(56)	V97U8839C	RAD	F	S	D	C	G4.124 G4.238	00	E28	92517C	
RW_MAG_VAR(57)	V97U8840C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_MAG_VAR(58)	V97U8841C	RAD	F	S	D	C	G4.124 G4.238	00	E29	92517C	
RW_MAG_VAR(59)	V97U8842C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_MAG_VAR(60)	V97U8843C	RAD	F	S	D	C	G4.124 G4.238	00	E30	92517C	
RW_MAG_VAR(61)	V97U8851C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_MAG_VAR(62)	V97U8852C	RAD	F	S	D	C	G4.124 G4.238	00	E31	92517C	
RW_MAG_VAR(63)	V97U8853C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
RW_MAG_VAR(64)	V97U8854C	RAD	F	S	D	C	G4.124 G4.238	00	E32	92517C	
RW_MAG_VAR(65)	V97U8855C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_MAG_VAR(66)	V97U8856C	RAD	F	S	D	C	G4.124 G4.238	00	E33	92517C	
RW_MAG_VAR(67)	V97U8857C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_MAG_VAR(68)	V97U8858C	RAD	F	S	D	C	G4.124 G4.238	00	E34	92517C	
RW_MAG_VAR(69)	V97U8859C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_MAG_VAR(70)	V97U8860C	RAD	F	S	D	C	G4.124 G4.238	00	E35	92517C	
RW_MAG_VAR(71)	V97U9538C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_MAG_VAR(72)	V97U9539C	RAD	F	S	D	C	G4.124 G4.238	00	E36	92517C	
RW_MAG_VAR(73)	V97U9540C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_MAG_VAR(74)	V97U9541C	RAD	F	S	D	C	G4.124 G4.238	00	E37	92517C	
RW_MAG_VAR(75)	V97U9542C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	
RW_MAG_VAR(76)	V97U9543C	RAD	F	S	D	C	G4.124 G4.238	00	E38	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MAG_VAR(77)	V97U9544C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_MAG_VAR(78)	V97U9545C	RAD	F	S	D	C	G4.124 G4.238	00	E39	92517C	
RW_MAG_VAR(79)	V97U9546C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_MAG_VAR(80)	V97U9547C	RAD	F	S	D	C	G4.124 G4.238	00	E40	92517C	
RW_MAG_VAR(81)	V97U9548C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_MAG_VAR(82)	V97U9549C	RAD	F	S	D	C	G4.124 G4.238	00	E41	92517C	
RW_MAG_VAR(83)	V97U9550C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_MAG_VAR(84)	V97U9551C	RAD	F	S	D	C	G4.124 G4.238	00	E42	92517C	
RW_MAG_VAR(85)	V97U9552C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_MAG_VAR(86)	V97U9553C	RAD	F	S	D	C	G4.124 G4.238	00	E43	92517C	
RW_MAG_VAR(87)	V97U9554C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_MAG_VAR(88)	V97U9555C	RAD	F	S	D	C	G4.124 G4.238	00	E44	92517C	
RW_MAG_VAR(89)	V97U9556C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_MAG_VAR(90)	V97U9557C	RAD	F	S	D	C	G4.124 G4.238	00	E45	92517C	
RW_MSBLs_INDEX(01)	V99U7610C	ND	I	S	D	P	G4.124 G4.238	00	E01	90000E	
RW_MSBLs_INDEX(02)	V99U7611C	ND	I	S	D	P	G4.124 G4.238	00	E01	90000E	
RW_MSBLs_INDEX(03)	V99U7612C	ND	I	S	D	P	G4.124 G4.238	00	E02	90000E	
RW_MSBLs_INDEX(04)	V99U7613C	ND	I	S	D	P	G4.124 G4.238	00	E02	90000E	
RW_MSBLs_INDEX(05)	V99U7614C	ND	I	S	D	P	G4.124 G4.238	00	E03	90000E	
RW_MSBLs_INDEX(06)	V99U7615C	ND	I	S	D	P	G4.124 G4.238	00	E03	90000E	
RW_MSBLs_INDEX(07)	V99U7616C	ND	I	S	D	P	G4.124 G4.238	00	E04	90000E	
RW_MSBLs_INDEX(08)	V99U7617C	ND	I	S	D	P	G4.124 G4.238	00	E04	90000E	
RW_MSBLs_INDEX(09)	V99U7618C	ND	I	S	D	P	G4.124 G4.238	00	E05	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MSBLs_INDEX(10)	V99U7619C	ND	I	S	D	P	G4.124 G4.238	00	E05	90000E	
RW_MSBLs_INDEX(11)	V99U7620C	ND	I	S	D	P	G4.124 G4.238	00	E06	90000E	
RW_MSBLs_INDEX(12)	V99U7621C	ND	I	S	D	P	G4.124 G4.238	00	E06	90000E	
RW_MSBLs_INDEX(13)	V99U7622C	ND	I	S	D	P	G4.124 G4.238	00	E07	90000E	
RW_MSBLs_INDEX(14)	V99U7623C	ND	I	S	D	P	G4.124 G4.238	00	E07	90000E	
RW_MSBLs_INDEX(15)	V99U7624C	ND	I	S	D	P	G4.124 G4.238	00	E08	90000E	
RW_MSBLs_INDEX(16)	V99U7625C	ND	I	S	D	P	G4.124 G4.238	00	E08	90000E	
RW_MSBLs_INDEX(17)	V99U7626C	ND	I	S	D	P	G4.124 G4.238	00	E09	90000E	
RW_MSBLs_INDEX(18)	V99U7627C	ND	I	S	D	P	G4.124 G4.238	00	E09	90000E	
RW_MSBLs_INDEX(19)	V99U7628C	ND	I	S	D	P	G4.124 G4.238	00	E10	90000E	
RW_MSBLs_INDEX(20)	V99U7629C	ND	I	S	D	P	G4.124 G4.238	00	E10	90000E	
RW_MSBLs_INDEX(21)	V99U7630C	ND	I	S	D	P	G4.124 G4.238	00	E11	90000E	
RW_MSBLs_INDEX(22)	V99U7631C	ND	I	S	D	P	G4.124 G4.238	00	E11	90000E	
RW_MSBLs_INDEX(23)	V99U7632C	ND	I	S	D	P	G4.124 G4.238	00	E12	90000E	
RW_MSBLs_INDEX(24)	V99U7633C	ND	I	S	D	P	G4.124 G4.238	00	E12	90000E	
RW_MSBLs_INDEX(25)	V99U7634C	ND	I	S	D	P	G4.124 G4.238	00	E13	90000E	
RW_MSBLs_INDEX(26)	V99U7635C	ND	I	S	D	P	G4.124 G4.238	00	E13	90000E	
RW_MSBLs_INDEX(27)	V99U7636C	ND	I	S	D	P	G4.124 G4.238	00	E14	DC2123	
RW_MSBLs_INDEX(28)	V99U7637C	ND	I	S	D	P	G4.124 G4.238	00	E14	DC2123	
RW_MSBLs_INDEX(29)	V99U7638C	ND	I	S	D	P	G4.124 G4.238	00	E15	90000E	
RW_MSBLs_INDEX(30)	V99U7639C	ND	I	S	D	P	G4.124 G4.238	00	E15	90000E	
RW_MSBLs_INDEX(31)	V98U8381C	ND	I	S	D	P	G4.124 G4.238	00	E16	90000E	
RW_MSBLs_INDEX(32)	V98U8382C	ND	I	S	D	P	G4.124 G4.238	00	E16	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MSBLs_INDEX(33)	V98U8383C	ND	I	S	D	P	G4.124 G4.238	00	E17	90000E	
RW_MSBLs_INDEX(34)	V98U8384C	ND	I	S	D	P	G4.124 G4.238	00	E17	90000E	
RW_MSBLs_INDEX(35)	V98U8385C	ND	I	S	D	P	G4.124 G4.238	00	E18	90000E	
RW_MSBLs_INDEX(36)	V98U8386C	ND	I	S	D	P	G4.124 G4.238	00	E18	90000E	
RW_MSBLs_INDEX(37)	V98U8387C	ND	I	S	D	P	G4.124 G4.238	00	E19	90000E	
RW_MSBLs_INDEX(38)	V98U8388C	ND	I	S	D	P	G4.124 G4.238	00	E19	90000E	
RW_MSBLs_INDEX(39)	V98U8389C	ND	I	S	D	P	G4.124 G4.238	00	E20	90000E	
RW_MSBLs_INDEX(40)	V98U8390C	ND	I	S	D	P	G4.124 G4.238	00	E20	90000E	
RW_MSBLs_INDEX(41)	V98U8391C	ND	I	S	D	P	G4.124 G4.238	00	E21	90000E	
RW_MSBLs_INDEX(42)	V98U8392C	ND	I	S	D	P	G4.124 G4.238	00	E21	90000E	
RW_MSBLs_INDEX(43)	V98U8393C	ND	I	S	D	P	G4.124 G4.238	00	E22	DC1923A	
RW_MSBLs_INDEX(44)	V98U8394C	ND	I	S	D	P	G4.124 G4.238	00	E22	DC1923A	
RW_MSBLs_INDEX(45)	V98U8395C	ND	I	S	D	P	G4.124 G4.238	00	E23	90000E	
RW_MSBLs_INDEX(46)	V98U8396C	ND	I	S	D	P	G4.124 G4.238	00	E23	90000E	
RW_MSBLs_INDEX(47)	V98U8397C	ND	I	S	D	P	G4.124 G4.238	00	E24	DC1923A	
RW_MSBLs_INDEX(48)	V98U8398C	ND	I	S	D	P	G4.124 G4.238	00	E24	DC1923A	
RW_MSBLs_INDEX(49)	V98U8399C	ND	I	S	D	P	G4.124 G4.238	00	E25	90000E	
RW_MSBLs_INDEX(50)	V98U8400C	ND	I	S	D	P	G4.124 G4.238	00	E25	90000E	
RW_MSBLs_INDEX(51)	V97U9558C	ND	I	S	D	P	G4.124 G4.238	00	E26	92517C	
RW_MSBLs_INDEX(52)	V97U9559C	ND	I	S	D	P	G4.124 G4.238	00	E26	92517C	
RW_MSBLs_INDEX(53)	V97U9560C	ND	I	S	D	P	G4.124 G4.238	00	E27	92517C	
RW_MSBLs_INDEX(54)	V97U9561C	ND	I	S	D	P	G4.124 G4.238	00	E27	92517C	
RW_MSBLs_INDEX(55)	V97U9562C	ND	I	S	D	P	G4.124 G4.238	00	E28	92517C	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MSBLs_INDEX(56)	V97U9563C	ND	I	S	D	P	G4.124 G4.238	00	E28	92517C	
RW_MSBLs_INDEX(57)	V97U9564C	ND	I	S	D	P	G4.124 G4.238	00	E29	92517C	
RW_MSBLs_INDEX(58)	V97U9565C	ND	I	S	D	P	G4.124 G4.238	00	E29	92517C	
RW_MSBLs_INDEX(59)	V97U9566C	ND	I	S	D	P	G4.124 G4.238	00	E30	92517C	
RW_MSBLs_INDEX(60)	V97U9567C	ND	I	S	D	P	G4.124 G4.238	00	E30	92517C	
RW_MSBLs_INDEX(61)	V97U9568C	ND	I	S	D	P	G4.124 G4.238	00	E31	92517C	
RW_MSBLs_INDEX(62)	V97U9569C	ND	I	S	D	P	G4.124 G4.238	00	E31	92517C	
RW_MSBLs_INDEX(63)	V97U9570C	ND	I	S	D	P	G4.124 G4.238	00	E32	92517C	
RW_MSBLs_INDEX(64)	V97U9571C	ND	I	S	D	P	G4.124 G4.238	00	E32	92517C	
RW_MSBLs_INDEX(65)	V97U9572C	ND	I	S	D	P	G4.124 G4.238	00	E33	92517C	
RW_MSBLs_INDEX(66)	V97U9573C	ND	I	S	D	P	G4.124 G4.238	00	E33	92517C	
RW_MSBLs_INDEX(67)	V97U9574C	ND	I	S	D	P	G4.124 G4.238	00	E34	92517C	
RW_MSBLs_INDEX(68)	V97U9575C	ND	I	S	D	P	G4.124 G4.238	00	E34	92517C	
RW_MSBLs_INDEX(69)	V97U9576C	ND	I	S	D	P	G4.124 G4.238	00	E35	92517C	
RW_MSBLs_INDEX(70)	V97U9577C	ND	I	S	D	P	G4.124 G4.238	00	E35	92517C	
RW_MSBLs_INDEX(71)	V97U9591C	ND	I	S	D	P	G4.124 G4.238	00	E36	92517C	
RW_MSBLs_INDEX(72)	V97U9592C	ND	I	S	D	P	G4.124 G4.238	00	E36	92517C	
RW_MSBLs_INDEX(73)	V97U9593C	ND	I	S	D	P	G4.124 G4.238	00	E37	92517C	
RW_MSBLs_INDEX(74)	V97U9594C	ND	I	S	D	P	G4.124 G4.238	00	E37	92517C	
RW_MSBLs_INDEX(75)	V97U9595C	ND	I	S	D	P	G4.124 G4.238	00	E38	92517C	
RW_MSBLs_INDEX(76)	V97U9596C	ND	I	S	D	P	G4.124 G4.238	00	E38	92517C	
RW_MSBLs_INDEX(77)	V97U9597C	ND	I	S	D	P	G4.124 G4.238	00	E39	92517C	
RW_MSBLs_INDEX(78)	V97U9598C	ND	I	S	D	P	G4.124 G4.238	00	E39	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RW_MSBLs_INDEX(79)	V97U9599C	ND	I	S	D	P	G4.124 G4.238	00	E40	92517C	
RW_MSBLs_INDEX(80)	V97U9600C	ND	I	S	D	P	G4.124 G4.238	00	E40	92517C	
RW_MSBLs_INDEX(81)	V97U9877C	ND	I	S	D	P	G4.124 G4.238	00	E41	92517C	
RW_MSBLs_INDEX(82)	V97U9878C	ND	I	S	D	P	G4.124 G4.238	00	E41	92517C	
RW_MSBLs_INDEX(83)	V97U9879C	ND	I	S	D	P	G4.124 G4.238	00	E42	92517C	
RW_MSBLs_INDEX(84)	V97U9880C	ND	I	S	D	P	G4.124 G4.238	00	E42	92517C	
RW_MSBLs_INDEX(85)	V97U9881C	ND	I	S	D	P	G4.124 G4.238	00	E43	92517C	
RW_MSBLs_INDEX(86)	V97U9882C	ND	I	S	D	P	G4.124 G4.238	00	E43	92517C	
RW_MSBLs_INDEX(87)	V97U9883C	ND	I	S	D	P	G4.124 G4.238	00	E44	92517C	
RW_MSBLs_INDEX(88)	V97U9884C	ND	I	S	D	P	G4.124 G4.238	00	E44	92517C	
RW_MSBLs_INDEX(89)	V97U9885C	ND	I	S	D	P	G4.124 G4.238	00	E45	92517C	
RW_MSBLs_INDEX(90)	V97U9886C	ND	I	S	D	P	G4.124 G4.238	00	E45	92517C	
R_AZ_RADAR_BEARING(01)	V98U8729C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(02)	V98U8730C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(03)	V98U8731C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(04)	V98U8732C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(10)	V99U7661C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(11)	V98U8261C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(12)	V98U8262C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(13)	V98U8263C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(14)	V98U8264C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(15)	V98U8265C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(5)	V98U9252CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
R_AZ_RADAR_BEARING(6)	V98U9253CB	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(7)	V98U9252CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(8)	V98U9253CC	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_AZ_RADAR_BEARING(9)	V99U7647C	RAD	F	S	D	P	G4.124 G4.238	00	EML	90000E	
R_HAC_RW_L(1)	V98U9801C	FT	F	S	M	C	G4.124 G4.238	01 03	XS8 XS8	DC2748	
R_HAC_RW_R(1)	V98U9804C	FT	F	S	M	C	G4.124 G4.238	01 03	XS8 XS8	DC2748	
TACAN_ID_MAXI(01)	V98U8893C	ND	I	S	D	C	G4.124 G4.238	00	E01	90000E	
TACAN_ID_MAXI(02)	V98U8894C	ND	I	S	D	C	G4.124 G4.238	00	E01	90000E	
TACAN_ID_MAXI(03)	V98U8895C	ND	I	S	D	C	G4.124 G4.238	00	E02	90000E	
TACAN_ID_MAXI(04)	V98U8896C	ND	I	S	D	C	G4.124 G4.238	00	E02	90000E	
TACAN_ID_MAXI(05)	V98U8897C	ND	I	S	D	C	G4.124 G4.238	00	E03	90000E	
TACAN_ID_MAXI(06)	V98U8898C	ND	I	S	D	C	G4.124 G4.238	00	E03	90000E	
TACAN_ID_MAXI(07)	V98U8899C	ND	I	S	D	C	G4.124 G4.238	00	E04	90000E	
TACAN_ID_MAXI(08)	V98U8900C	ND	I	S	D	C	G4.124 G4.238	00	E04	90000E	
TACAN_ID_MAXI(09)	V98U8901C	ND	I	S	D	C	G4.124 G4.238	00	E05	90000E	
TACAN_ID_MAXI(10)	V98U8902C	ND	I	S	D	C	G4.124 G4.238	00	E05	90000E	
TACAN_ID_MAXI(11)	V98U8903C	ND	I	S	D	C	G4.124 G4.238	00	E06	90000E	
TACAN_ID_MAXI(12)	V98U8904C	ND	I	S	D	C	G4.124 G4.238	00	E06	90000E	
TACAN_ID_MAXI(13)	V98U8905C	ND	I	S	D	C	G4.124 G4.238	00	E07	90000E	
TACAN_ID_MAXI(14)	V98U8906C	ND	I	S	D	C	G4.124 G4.238	00	E07	90000E	
TACAN_ID_MAXI(15)	V98U8907C	ND	I	S	D	C	G4.124 G4.238	00	E08	90000E	
TACAN_ID_MAXI(16)	V98U8908C	ND	I	S	D	C	G4.124 G4.238	00	E08	90000E	
TACAN_ID_MAXI(17)	V98U8909C	ND	I	S	D	C	G4.124 G4.238	00	E09	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TACAN_ID_MAXI (18)	V98U8910C	ND	I	S	D	C	G4.124 G4.238	00	E09	90000E	
TACAN_ID_MAXI (19)	V98U8911C	ND	I	S	D	C	G4.124 G4.238	00	E10	90000E	
TACAN_ID_MAXI (20)	V98U8912C	ND	I	S	D	C	G4.124 G4.238	00	E10	90000E	
TACAN_ID_MAXI (21)	V98U8913C	ND	I	S	D	C	G4.124 G4.238	00	E11	90000E	
TACAN_ID_MAXI (22)	V98U8914C	ND	I	S	D	C	G4.124 G4.238	00	E11	90000E	
TACAN_ID_MAXI (23)	V98U8915C	ND	I	S	D	C	G4.124 G4.238	00	E12	90000E	
TACAN_ID_MAXI (24)	V98U8916C	ND	I	S	D	C	G4.124 G4.238	00	E12	90000E	
TACAN_ID_MAXI (25)	V98U8917C	ND	I	S	D	C	G4.124 G4.238	00	E13	90000E	
TACAN_ID_MAXI (26)	V98U8918C	ND	I	S	D	C	G4.124 G4.238	00	E13	90000E	
TACAN_ID_MAXI (27)	V98U8919C	ND	I	S	D	C	G4.124 G4.238	00	E14	DC2123	
TACAN_ID_MAXI (28)	V98U8920C	ND	I	S	D	C	G4.124 G4.238	00	E14	DC2123	
TACAN_ID_MAXI (29)	V98U8921C	ND	I	S	D	C	G4.124 G4.238	00	E15	90000E	
TACAN_ID_MAXI (30)	V98U8922C	ND	I	S	D	C	G4.124 G4.238	00	E15	90000E	
TACAN_ID_MAXI (31)	V98U8401C	ND	I	S	D	C	G4.124 G4.238	00	E16	90000E	
TACAN_ID_MAXI (32)	V98U8402C	ND	I	S	D	C	G4.124 G4.238	00	E16	90000E	
TACAN_ID_MAXI (33)	V98U8403C	ND	I	S	D	C	G4.124 G4.238	00	E17	90000E	
TACAN_ID_MAXI (34)	V98U8404C	ND	I	S	D	C	G4.124 G4.238	00	E17	90000E	
TACAN_ID_MAXI (35)	V98U8405C	ND	I	S	D	C	G4.124 G4.238	00	E18	90000E	
TACAN_ID_MAXI (36)	V98U8406C	ND	I	S	D	C	G4.124 G4.238	00	E18	90000E	
TACAN_ID_MAXI (37)	V98U8407C	ND	I	S	D	C	G4.124 G4.238	00	E19	90000E	
TACAN_ID_MAXI (38)	V98U8408C	ND	I	S	D	C	G4.124 G4.238	00	E19	90000E	
TACAN_ID_MAXI (39)	V98U8409C	ND	I	S	D	C	G4.124 G4.238	00	E20	90000E	
TACAN_ID_MAXI (40)	V98U8410C	ND	I	S	D	C	G4.124 G4.238	00	E20	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TACAN_ID_MAXI (41)	V98U8411C	ND	I	S	D	C	G4.124 G4.238	00	E21	90000E	
TACAN_ID_MAXI (42)	V98U8412C	ND	I	S	D	C	G4.124 G4.238	00	E21	90000E	
TACAN_ID_MAXI (43)	V98U8413C	ND	I	S	D	C	G4.124 G4.238	00	E22	DC1923A	
TACAN_ID_MAXI (44)	V98U8414C	ND	I	S	D	C	G4.124 G4.238	00	E22	DC1923A	
TACAN_ID_MAXI (45)	V98U8415C	ND	I	S	D	C	G4.124 G4.238	00	E23	90000E	
TACAN_ID_MAXI (46)	V98U8416C	ND	I	S	D	C	G4.124 G4.238	00	E23	90000E	
TACAN_ID_MAXI (47)	V98U8417C	ND	I	S	D	C	G4.124 G4.238	00	E24	DC1923A	
TACAN_ID_MAXI (48)	V98U8418C	ND	I	S	D	C	G4.124 G4.238	00	E24	DC1923A	
TACAN_ID_MAXI (49)	V98U8419C	ND	I	S	D	C	G4.124 G4.238	00	E25	90000E	
TACAN_ID_MAXI (50)	V98U8420C	ND	I	S	D	C	G4.124 G4.238	00	E25	90000E	
TACAN_ID_MAXI (51)	V97U9887C	ND	I	S	D	C	G4.124 G4.238	00	E26	92517C	
TACAN_ID_MAXI (52)	V97U9888C	ND	I	S	D	C	G4.124 G4.238	00	E26	92517C	
TACAN_ID_MAXI (53)	V97U9889C	ND	I	S	D	C	G4.124 G4.238	00	E27	92517C	
TACAN_ID_MAXI (54)	V97U9890C	ND	I	S	D	C	G4.124 G4.238	00	E27	92517C	
TACAN_ID_MAXI (55)	V97U9891C	ND	I	S	D	C	G4.124 G4.238	00	E28	92517C	
TACAN_ID_MAXI (56)	V97U9892C	ND	I	S	D	C	G4.124 G4.238	00	E28	92517C	
TACAN_ID_MAXI (57)	V97U9893C	ND	I	S	D	C	G4.124 G4.238	00	E29	92517C	
TACAN_ID_MAXI (58)	V97U9894C	ND	I	S	D	C	G4.124 G4.238	00	E29	92517C	
TACAN_ID_MAXI (59)	V97U9895C	ND	I	S	D	C	G4.124 G4.238	00	E30	92517C	
TACAN_ID_MAXI (60)	V97U9896C	ND	I	S	D	C	G4.124 G4.238	00	E30	92517C	
TACAN_ID_MAXI (61)	V97U9897C	ND	I	S	D	C	G4.124 G4.238	00	E31	92517C	
TACAN_ID_MAXI (62)	V97U9898C	ND	I	S	D	C	G4.124 G4.238	00	E31	92517C	
TACAN_ID_MAXI (63)	V97U9899C	ND	I	S	D	C	G4.124 G4.238	00	E32	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TACAN_ID_MAXI (64)	V97U9900C	ND	I	S	D	C	G4.124 G4.238	00	E32	92517C	
TACAN_ID_MAXI (65)	V97U9901C	ND	I	S	D	C	G4.124 G4.238	00	E33	92517C	
TACAN_ID_MAXI (66)	V97U9902C	ND	I	S	D	C	G4.124 G4.238	00	E33	92517C	
TACAN_ID_MAXI (67)	V97U9903C	ND	I	S	D	C	G4.124 G4.238	00	E34	92517C	
TACAN_ID_MAXI (68)	V97U9904C	ND	I	S	D	C	G4.124 G4.238	00	E34	92517C	
TACAN_ID_MAXI (69)	V97U9905C	ND	I	S	D	C	G4.124 G4.238	00	E35	92517C	
TACAN_ID_MAXI (70)	V97U9906C	ND	I	S	D	C	G4.124 G4.238	00	E35	92517C	
TACAN_ID_MAXI (71)	V97U9907C	ND	I	S	D	C	G4.124 G4.238	00	E36	92517C	
TACAN_ID_MAXI (72)	V97U9908C	ND	I	S	D	C	G4.124 G4.238	00	E36	92517C	
TACAN_ID_MAXI (73)	V97U9909C	ND	I	S	D	C	G4.124 G4.238	00	E37	92517C	
TACAN_ID_MAXI (74)	V97U9910C	ND	I	S	D	C	G4.124 G4.238	00	E37	92517C	
TACAN_ID_MAXI (75)	V97U9911C	ND	I	S	D	C	G4.124 G4.238	00	E38	92517C	
TACAN_ID_MAXI (76)	V97U9912C	ND	I	S	D	C	G4.124 G4.238	00	E38	92517C	
TACAN_ID_MAXI (77)	V97U9913C	ND	I	S	D	C	G4.124 G4.238	00	E39	92517C	
TACAN_ID_MAXI (78)	V97U9914C	ND	I	S	D	C	G4.124 G4.238	00	E39	92517C	
TACAN_ID_MAXI (79)	V97U9915C	ND	I	S	D	C	G4.124 G4.238	00	E40	92517C	
TACAN_ID_MAXI (80)	V97U9916C	ND	I	S	D	C	G4.124 G4.238	00	E40	92517C	
TACAN_ID_MAXI (81)	V97U9917C	ND	I	S	D	C	G4.124 G4.238	00	E41	92517C	
TACAN_ID_MAXI (82)	V97U9918C	ND	I	S	D	C	G4.124 G4.238	00	E41	92517C	
TACAN_ID_MAXI (83)	V97U9919C	ND	I	S	D	C	G4.124 G4.238	00	E42	92517C	
TACAN_ID_MAXI (84)	V97U9920C	ND	I	S	D	C	G4.124 G4.238	00	E42	92517C	
TACAN_ID_MAXI (85)	V97U9921C	ND	I	S	D	C	G4.124 G4.238	00	E43	92517C	
TACAN_ID_MAXI (86)	V97U9922C	ND	I	S	D	C	G4.124 G4.238	00	E43	92517C	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TACAN_ID_MAXI (87)	V97U9923C	ND	I	S	D	C	G4.124 G4.238	00	E44	92517C	
TACAN_ID_MAXI (88)	V97U9924C	ND	I	S	D	C	G4.124 G4.238	00	E44	92517C	
TACAN_ID_MAXI (89)	V97U9925C	ND	I	S	D	C	G4.124 G4.238	00	E45	92517C	
TACAN_ID_MAXI (90)	V97U9926C	ND	I	S	D	C	G4.124 G4.238	00	E45	92517C	
X_DMEAZ_RW(01)	V98U9207C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(02)	V98U9208C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(03)	V98U9209C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(04)	V98U9210C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(10)	V99U7666C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(11)	V98U8421C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(12)	V98U8422C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(13)	V98U8423C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(14)	V98U8424C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(15)	V98U8425C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(5)	V98U9266CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(6)	V98U9267CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(7)	V98U9266CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(8)	V98U9267CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_DMEAZ_RW(9)	V99U7652C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(01)	V98U9219C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(02)	V98U9220C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(03)	V98U9221C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(04)	V98U9222C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	

TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
X_EL_RW(10)	V99U7665C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(11)	V98U8426C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(12)	V98U8427C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(13)	V98U8428C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(14)	V98U8429C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(15)	V98U8430C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(5)	V98U9268CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(6)	V98U9269CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(7)	V98U9268CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(8)	V98U9269CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
X_EL_RW(9)	V99U7651C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(01)	V98U9231C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(02)	V98U9232C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(03)	V98U9233C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(04)	V98U9234C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(10)	V99U7667C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(11)	V98U8431C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(12)	V98U8432C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(13)	V98U8433C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(14)	V98U8434C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(15)	V98U8435C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(5)	V98U9270CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(6)	V98U9271CB	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	



TABLE 4.5.2.4-3. ENTRY SITE LOOKUP (G4.124) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
Y_DMEAZ_RW(7)	V98U9270CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(8)	V98U9271CC	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	
Y_DMEAZ_RW(9)	V99U7653C	FT	F	S	D	P	G4.124 G4.238	00	EML	90000E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

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TABLE 4.5.2.4-4. ENTRY SITE LOOKUP (G4.124) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
R_HAC_RW_L(2)	V98U9802C	00 01 03	-1.55	E+04 FT	F	S	C	G4.124 G4.238	89661A	
R_HAC_RW_L(3)	V98U9803C	00	+0.0	E+00 FT	F	S	C	G4.124 G4.238	59960	
R_HAC_RW_R(2)	V98U9805C	00 01 03	+1.55	E+04 FT	F	S	C	G4.124 G4.238	89661A	
R_HAC_RW_R(3)	V98U9806C	00	+0.0	E+00 FT	F	S	C	G4.124 G4.238	59960	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.5.2.4-5. ENTRY SITE LOOKUP (G4.124) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
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NO REQUIREMENTS

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

#### 4.6 USER PARAMETER PROCESSING PRINCIPAL FUNCTIONS

The purpose of the user parameter processing principal functions is to maintain an estimate of the vehicle state (position and velocity) and to derive from that state various related parameters required by systems such as guidance, displays, flight control, targeting, payloads, and navigation.

Within each user parameter processing principal function, the state is maintained by the user parameter state propagation subfunction. This subfunction utilizes a simple, fast-acting, single-step integrator to rapidly advance the user parameter state. The propagation interval is smaller than that used by the navigation principal functions, thus avoiding the need to wait for the next external sensor measurement processing to occur. At the end of each navigation propagation and external sensor measurement incorporation step, the navigation state is passed to the user parameter propagator, which then resets itself to that state. The value of the gravitational acceleration vector calculated by the navigation state propagator is used as a constant by the user parameter propagator between resets. Sensed changes in velocity are rapidly incorporated in the user parameter state at each integration step. In this way, the user parameter state propagation function maintains an accurate current state between navigation filter state computations.

The user parameters that are derived from the user parameter state typically provide expressions of the vehicle state in frames of reference dictated by the user; for example, (a) positions expressed in non-Cartesian frames related to landmarks, radar beacons, or selected way points for easy crew interpretation and (b) aerodynamic parameters derived from the state through the use of environment models for guidance, displays, and flight control.

The systems that require user parameters vary as a function of mission phase, major mode, and event cues, all of which are recognized by the user parameter processing sequencer. The rates at which user parameters must be calculated also vary according to these criteria. This forces the user parameter state propagation subfunction to be performed at a rate supportive of the user parameter having the highest rate requirement during any particular user parameter phase.

The user parameter processing principal functions that perform the computations of the user parameters correspond to the major entry operations mission phases: entry, TAEM, and autoland. The detailed requirements for these phase-related principal functions are provided in their individual subsections.

Because the user parameter propagator supports all phases, the rate requirements of these phase-related user parameter processing principal functions implicitly place scheduling the rate requirements upon the user parameter state propagation subfunction. These scheduling and rate requirements are defined in Section 4.1.2, Deorbit/Landing User Parameter Processing Sequencer Principal Function.

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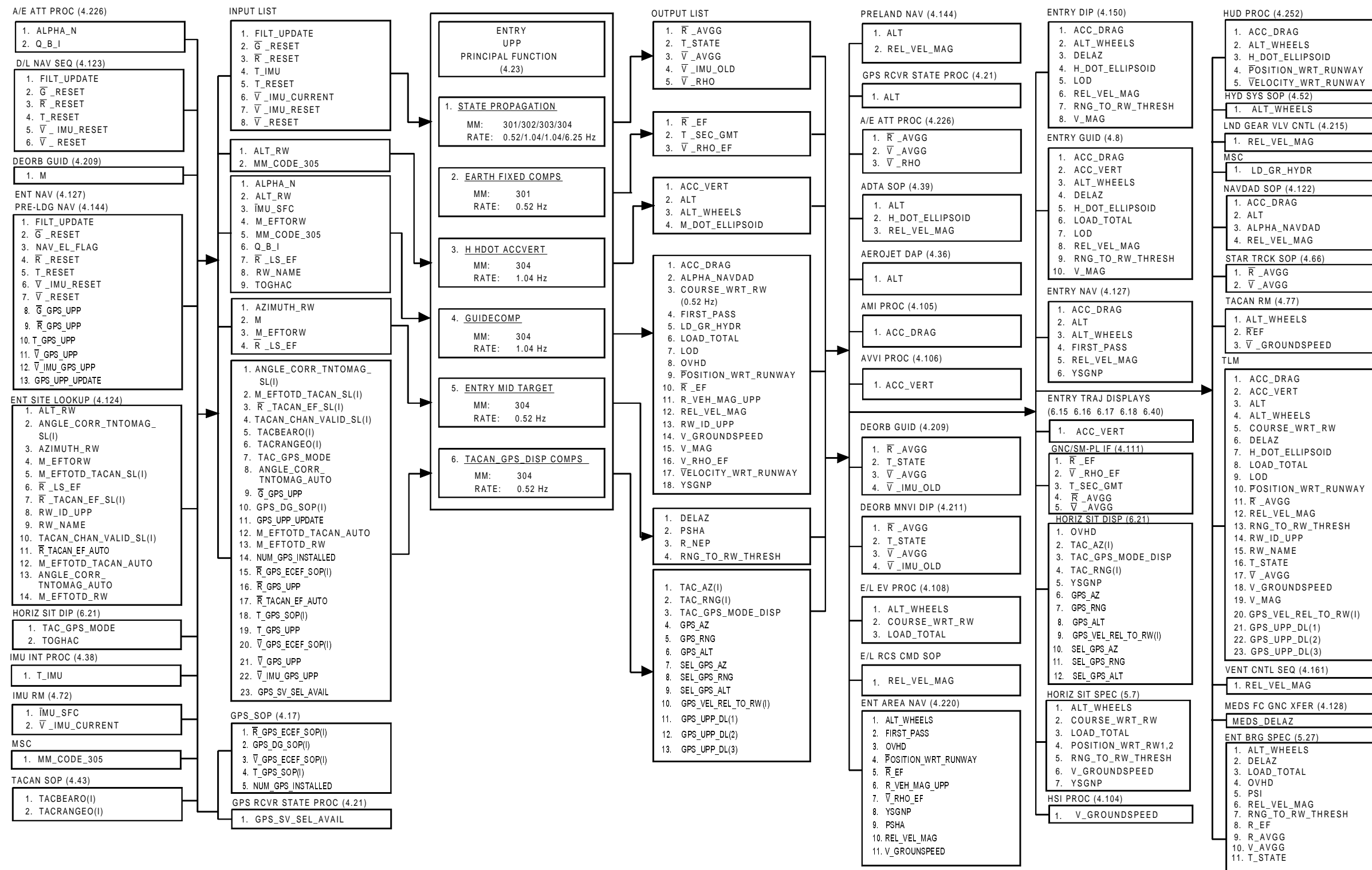


FIGURE 4.6-1. Entry User Parameter Processing Principal Function Interface Diagram

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#### 4.6.1 Entry User Parameter Processing (4.23)

This principal function will serve as the interface between navigation and users of navigation-related data during Major Modes 301 through 304. This function will maintain the vehicle state within the user parameter state propagation subfunction and shall:

1. Provide this state to users who require vehicle state parameters in mean-of-fifty (M50) coordinates and
2. Provide the software to transform this state for users who require nav-state-related parameters.

This function is controlled by the deorbit/landing user parameter sequencer and is composed of the following five subfunctions:

- A. User parameter state propagation (Section 4.6.1.1).
- B. Basic guidance-related computations (Section 4.6.1.2).
- C. Guidance and display way point computations (Section 4.6.1.3).
- D. TACAN and GPS display computations (Section 4.6.1.4).
- E. Earth-fixed coordinate system computations (Section 4.6.1.5).

The input and output lists for this principal function may be found in Tables 4.6.1.6-1 and 4.6.1.6-2, and are summarized in Table 4.6.1.

##### 4.6.1.1 User Parameter State Propagation

This subfunction shall provide state vector information to users such as guidance and displays during the entry phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.1.
- B. Interface Requirements. The input and output required are listed in Tables 4.6.1.1-1 and 4.6.1.1-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is to be found in Section 5.6, USER\_PARAM\_PROPAGATOR.

Table 4.6.1.1-1. Entry User Parameter State Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating (ON) that current nav cycle is complete	FILT_UPDATE	*	D	—	OFF/ON	—	Nav rate
Modeled acceleration at start of Shuttle state integration interval	$\bar{G}_{RESET}$	*	V	S		ft/sec <sup>2</sup>	Nav rate
Vehicle position vector after all navigation updates reserved for reset of user parameter integrator position vector $\bar{R}_{AVGG}$	$\bar{R}_{RESET}$	*	V	DP		ft	Nav rate
Time associated with currently read IMU velocity counts from the IMU selection filter (RM)	T_IMU	*	F	DP		sec	As per sequencer
Time associated with reserved reset state	T_RESET	*	F	DP		sec	Nav rate
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_CURRENT}$	*	V	DP		ft/sec	As per sequencer
Copy of $\bar{V}_{CURRENT\_FILT}$ reserved as velocity count at start of extrapolation interval when user parameter integrator is reset	$\bar{V}_{IMU\_RESET}$	*	V	DP		ft/sec	Nav rate
Vehicle velocity vector after all navigation updates reserved for reset of user parameter integrator velocity vector $\bar{V}_{AVGG}$	$\bar{V}_{RESET}$	*	V	S		ft/sec	Nav rate

\* See principal function input list (Table 4.6.1.6-1).

Table 4.6.1.1-2. Entry User Parameter State Propagation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	GPS_UPP_DISP_COMPS	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	*, Entry UPP GUIDE-COMP, Entry UPP EARTH_FIXED COMPS, GPS_UPP_DISP_COMPS	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	*, Entry UPP GUIDE-COMP, Entry UPP EARTH_FIXED COMPS, GPS_UPP_DISP_COMPS	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	*, Entry UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	*, Entry UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	DP		ft/sec	As per sequencer
Vehicle relative velocity vector in M50 coordinates	$\bar{V}_{RHO}$	*, Entry UPP GUIDE-COMP, Entry UPP EARTH_FIXED COMPS	V	S		ft/sec	As per sequencer
Flag indicating UPP state has been updated by navigation filter	UPP_UPDATE	H_HDOT_ACCVERT	D	—	OFF/ ON	—	As per sequencer

\* See principal function output list in (Table 4.6.1.6-2).

#### 4.6.1.2 Basic Guidance-Related Computations (H\_HDOT\_ACCVERT and GUIDECOMP)

These subfunctions will provide the required software to transform the user parameter state into nav-related parameters during the Entry major mode.

A. Detailed Requirements. The detailed requirements for these subfunctions are provided in Section 4.4.2. COURSE\_WRT\_RW is computed at 0.52 Hz.

B. Interface Requirements. The input and output requirements for the entry guidance parameters are listed in Tables 4.6.1.2-1 and 4.6.1.2-2.

C. Processing Requirements. The performance of these subfunctions is under the control of the deorbit/landing user parameter processing sequencer principal function.

D. Constraints. The flags LD\_GR\_HYDR and TG\_END must be initialized to OFF and the flag TEST\_LD\_GR to 0. The parameters ACC\_VERT\_OLD, DELTA\_ACC\_VERT and H\_DOT\_LAST must be initialized to zero; T\_STATE\_LAST, T\_STATE\_OLD and T\_STATE\_PREV must be initialized to zero; DELTA\_T must be initialized to a non-zero value; N\_SEQ\_RA must be initialized to one;  $\bar{V}$ \_IMU\_PREV to (0, 0, 0);  $\bar{I}$ MU\_SFC\_PREV to (1, 1, 1) and ALT and ALT\_WHEELS must be initialized to the anticipated altitude at the beginning of Major Mode 304 (approximately 600,000 feet). Execution of the subfunction H\_HDOT\_ACCVERT must precede execution of the subfunction GUIDECOMP. ALPHA\_OLD must be initialized to zero. The flag RA\_FLAG must be initialized to OFF. The parameter RW\_ID\_UPP must be initialized to zero.

E. Supplementary Information. A suggested implementation of the H\_HDOT\_ACCVERT and GUIDECOMP subfunctions are in the form of detailed flow charts in Section 5.6. The parameters A\_0 and FLATCON, although appearing here as inline code, may be derived from the earth ellipticity constant, ELLIPT and implemented as pad-loaded constants.

Table 4.6.1.2-1. Input Parameters for Entry Basic Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S		ft	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	UPP state propagation	V	S		ft/sec	As per sequencer
M50 to body quaternion	Q_B_I	*	Q	S		—	As per sequencer
Vehicle relative velocity vector in M50 coordinates	$\bar{V}_{RHO}$	UPP state propagation	V	S		ft/sec	As per sequencer
Unit vector in direction of earth's axis of rotation	$\bar{E}_{EARTH\_POLE}$	*	V	DP		—	As per sequencer
Earth equatorial radius	EARTH_RADIUS_EQUATOR	Constant	F	DP		ft	As per sequencer
Earth ellipticity constant	ELLIPT	Constant	F	DP		—	As per sequencer
The constant PI	PI	Constant	F	S		rad	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	UPP state propagation	V	DP		ft/sec	As per sequencer
Flag indicating UPP state has been updated by navigation filter	UPP_UPDATE	UPP state propagation	D	—	OFF/ON	—	As per sequencer
Current landing site selection index	RW_NAME	*	I	S	1-90		As per sequencer
IMU selection filter control vector	$\bar{I}_{MU\_SFC}$	*	V	S		—	As per sequencer
Position vector of runway in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Number of degrees per radian	DEG_PER_RAD	Constant	F	S		deg/rad	As per sequencer
Major Mode 305 flag	MM_CODE_305	*	D	—	OFF/ON	—	As per sequencer

Table 4.6.1.2-1. Input Parameters for Entry Basic Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Earth-fixed to selected RW transformation matrix	M_EFTORW	*	M	S			As per sequencer
Threshold value of relative velocity below which the flag LD_GR_HYDR is set ON	LDGR_VEL_THRSH	Constant	F	S		ft/sec	As per sequencer
NAV derived angle of attack	ALPHA_N	*	F	S		deg	As per sequencer
Initial value for spiral radius	RI	Constant	F	S		ft	As per sequencer
Initial value of HAC turn angle	PSHARS	I-Load	F	S		deg	As per sequencer
Flag denoting crew request to change approach type (OVHD/STRT)	TOGHAC	*	Bit		ON/OFF	—	As per sequencer
Overhead selection flag	OVHD	*	I	S		nd	As per sequencer

\* See principal function input list in Table 4.6.1.6-1.

Table 4.6.1.2-2. Outputs From Entry Basic Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Vehicle drag acceleration	ACC_DRAG	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Altitude of Orbiter nav base above runway altitude	ALT_WHEELS	*	F	S		ft	As per sequencer
Total load factor	LOAD_TOTAL	*	F	S		—	As per sequencer
Vehicle lift-over-drag ratio	LOD	*	F	S		—	As per sequencer
Shuttle position vector in earthfixed coordinates	$\bar{R}_{EF}$	Entry UPP guidance and display way point comps,*	V	DP		ft	As per sequencer
Magnitude of vehicle relative velocity	REL_VEL_MAG	*, ENTRY_MID_TARGET	F	S		ft/sec	As per sequencer
Vehicle inertial speed	$\bar{V}_{MAG}$	*	F	S		ft/sec	As per sequencer
Vertical component of vehicle acceleration WR earth rotating frame	ACC_VERT	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Current Orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	As per sequencer
Estimated topodetic altitude rate	H_DOT_ELLIPSOID	*	F	S		ft/sec	As per sequencer
Vehicle relative velocity vector in Earth-fixed coordinates	V_RHO_EF	Entry UPP guidance and display way point comps,*	V	S		ft/sec	As per sequencer
Vehicle velocity direction with respect to runway centerline	COURSE_WRT_RW	*	F	S	0 to 360	deg	0.52 Hz
Current landing site selection index for use by guidance	RW_ID_UPP	*	I	S	0-90	—	As per sequencer
Vehicle groundspeed WRT reference ellipsoid	V_GROUND-SPEED	*	F	S		ft/sec	As per sequencer

Table 4.6.1.2-2. Outputs From Entry Basic Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Downrange position with respect to the runway	POSITION_WRT_RUNWAY <sub>1</sub>	*	F	S		ft	As per sequencer
Crossrange position with respect to the runway	POSITION_WRT_RUNWAY <sub>2</sub>	*	F	S		ft	As per sequencer
Magnitude of the Shuttle position vector	R_VEH_MAG	ENTRY_MID_TARGET	S	S		ft	As per sequencer
Altitude position with respect to the runway	POSITION_WRT_RUNWAY <sub>3</sub>	*	F	S		ft	As per sequencer
Flag sent to MSC to initiate LND GEAR VLV CNTL	LD_GR_HYDR	*	D	—	OFF/ON	—	As per sequencer
Magnitude of the Shuttle position vector	R_VEH_MAG_UPP	*	F	DP		ft	As per sequencer
Nav derived angle of attack for use in NAVAID SOP	ALPHA_NAVDAD	*	F	S		deg	As per sequencer
Radius of HAC of selected runway	R_NEP	*, ENTRY_MID_TARGET	F	S		ft	As per sequencer
Area Nav HAC indicator initialization flag	FIRST_PASS	*	Bit		OFF/ON	—	As per sequencer
Vehicle side of selected runway centerline indicator	SIGNY	ENTRY_MID_TARGET	I		±1	—	As per sequencer
A flag denoting overhead or straight-in approach	OVHD	*	Bit		OFF/ON	—	As per sequencer
Commanded HAC side of selected runway	YSGNP	*, ENTRY_MID_TARGET	I		±1	—	As per sequencer
Turn angle of HAC of selected runway	PSHA	*, ENTRY_MID_TARGET	F	S		deg	As per sequencer
Downrange velocity with respect to the runway	VELOCITY_WRT_RUNWAY <sub>1</sub>	*	F	S		ft/sec	As per sequencer
Crossrange velocity with respect to the runway	VELOCITY_WRT_RUNWAY <sub>2</sub>	*	F	S		ft/sec	As per sequencer
Vertical velocity with respect to the runway	VELOCITY_WRT_RUNWAY <sub>3</sub>	*	F	S		ft/sec	As per sequencer



Table 4.6.1.2-2. Outputs From Entry Basic Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GPS_UPP_DISP_COMPS	M(3)	DP		-	As per sequencer
* See principal function output list in Table 4.6.1.6-2.							

### 4.6.1.3 Guidance and Displays Way Point Computations

This subsection documents the detailed requirements necessary to compute the targeting-related navigation parameters required by return-sequence graphical CRT-display pages and by guidance during the entry phase of Shuttle flight.

A. Detailed Requirements. Two subfunctions are required to perform this task. The ENTRY\_MID\_TARGET subfunction shall call the ENT\_RNG\_BEAR subfunction with input parameters corresponding to the crew selected runway:  $\bar{R}_{LS\_EF}$ , M\_EFTORW, AZIMUTH\_RW, YSGNP, R\_NEP, PSHA, SIGNY. This results in the computation of range to the selected runway threshold (RNG\_TO\_RW\_THRESH), heading error with respect to the selected heading alignment cone tangent point (DELAZ), radius of the heading alignment spiral at WP1 (R\_NEP), and the turn angle along this spiral (PSHA). The absolute value of the delta azimuth, DELAZ, will be passed to MEDS FC GNC XFER for the purpose of digital display on the MEDS composite flight instrument display.

$$MEDS\_DELAZ = ABS (DELAZ)$$

Note: The ENT\_RNG\_BEAR subfunction is also called by the Entry Bearing Specialist Function during MM 304 for each of two alternate sites with input parameters corresponding to alternate site I, I = 1, 2: R\_EF\_ALT(I), M\_EFTORW\_ALT(I), AZ\_RW\_ALT(I), YSGNP\_ALT(I), ALT\_R\_NEP(I), ALT\_PSHA(I), SIGNY\_ALT. The subfunction computes for the I<sup>th</sup> alternate site: range to the primary runway threshold (RNG\_TO\_RW\_THRESH\_ALT(I)), heading error with respect to the heading alignment cone tangent point (DELAZ\_ALT(I)), radius of the heading alignment spiral at WP1 (ALT\_R\_NEP(I)), and the turn angle along this spiral (ALT\_PSHA(I)). See Section B.5.27 of the Displays and Controls Volume 3 FSSR, STS 83-0020V3.

The ENT\_RNG\_BEAR subfunction shall accept as inputs the following parameters:  $\bar{R}_{LS\_EF}$ , M\_EFTORW, AZIMUTH\_RW, P, RADIUS\_NEP, PSHA, and SIGNY. Outputs shall be: RNG\_TO\_RW\_THRESH, DELAZ, RADIUS\_NEP, and PSHA. This subfunction will first compute the X-component of the center of the HAC. Since it is dependent on the mass of the vehicle, a test is performed on the mass. If the vehicle mass is less than a threshold value, WT\_GS1, then

$$R\_HAC\_RW_1 = X\_HAC\_LOW\_MASS$$

otherwise,

$$R\_HAC\_RW_1 = X\_HAC\_HIGH\_MASS$$

The Y-component of the center of the HAC follows from

$$R\_HAC\_RW_2 = P\ RF\phi$$

where  $RF\phi$  represents the radius of the spiral evaluated for a turn angle (PSHA) of zero degrees. Then, the position vector of the heading alignment cone center is transformed from runway coordinates to earth-fixed coordinates:

$$\bar{R}\_CC\_EF = \bar{R}\_LS\_EF + M\_EFTORW^T \bar{R}\_HAC\_RW$$

Next, the magnitude of the heading alignment cone position vector and the sine of the earth-centered angle subtended by the radius of the heading alignment cone are computed:

$$R\_CC\_MAG = |\bar{R}\_CC\_EF|$$

$$SIN\_B = RADIUS\_NEP/R\_CC\_MAG$$

The vector,  $\bar{V}\_NORM$ , normal to the great circle plane containing the Shuttle current position and heading alignment cone center, will be determined:

$$\bar{V}\_NORM = \bar{R}\_EF \times \bar{R}\_CC\_EF$$

Then, the bearing of this great circle plane with respect to true north at the Shuttle position and at the circle center is calculated:

$$BEAR\_VEH = ARCTAN2 [V\_NORM_3 R\_VEH\_MAG, \\ (V\_NORM_1 R\_EF_2 - V\_NORM_2 R\_EF_1)]$$

$$BEAR\_CC = ARCTAN2 [V\_NORM_3 R\_CC\_MAG, \\ (V\_NORM_1 R\_CC\_EF_2 - V\_NORM_2 R\_CC\_EF_1)]$$

If  $BEAR\_CC < 0$ , then  $BEAR\_CC = BEAR\_CC + 2\ PI$ . The cosine and sine of the central angle between the position of the Shuttle and the center of the heading alignment cone are determined:

$$COS\_THET\_VEH\_CC = \bar{R}\_EF \cdot \bar{R}\_CC\_EF / (R\_VEH\_MAG R\_CC\_MAG)$$

$$SIN\_THET\_VEH\_CC = (1 - COS\_THET\_VEH\_CC^2)^{1/2}$$

The cosine of the central angle between the Shuttle position and the tangent point, Way Point 1 (WP-1), is then computed and the great circle surface range from the Shuttle to WP-1 is determined:

$$COS\_THET\_VEH\_WP1 = COS\_THET\_VEH\_CC + 0.5\ SIN\_B\ SIN\_B\ COS\_THET\_VEH\_CC$$

$$DIST\_VEH\_WP1 = ARCCOS(COS\_THET\_VEH\_WP1) R\_CC\_MAG$$

Next, the sine of the bearing correction angle and the bearing from the Shuttle to WP-1 are determined:

$$SIN\_BEAR\_CORR = SIN\_B / SIN\_THET\_VEH\_CC$$

$$BEAR\_VEH\_WP1 = BEAR\_VEH - P\ ARCSIN(SIN\_BEAR\_CORR)$$

The arc length around the heading alignment cone from WP-1 to the normal entry point will be determined:

$$A2 = \text{ARCCOS}(\text{COS\_THET\_VEH\_WP1 SIN\_BEAR\_CORR})$$

$$A3 = 0.5 \text{ PI} - A2 + \text{P} (\text{AZIMUTH\_RW} - \text{BEAR\_CC})$$

If  $|A3| > \text{PI}$ , then  $A3 = A3 - 2\text{PI SIGN}(A3)$

It may be necessary to add 2 PI to A3; that is:

if  $\text{PSHA} > \text{PSHARS} + 1$ . or  $A3 < A3\_TOL$  or  $\text{P} \neq \text{SIGN Y}$

$$\text{then } A3 = A3 + 2\text{PI}$$

if  $A3 \text{ DEG\_PER\_RAD} - \text{PSHA} > 530.0 - \text{PSHARS}$ ,

$$\text{then } A3 = A3 - 2\text{PI}$$

Next, the turn angle around the HAC and the HAC radius are determined:

$$\text{PSHA} = A3 \text{ DEG\_PER\_RAD}$$

$$\text{RADIUS\_NEP} = \text{RF}\phi + (\text{R1} + \text{R2 PSHA}) \text{ PSHA}$$

$$\text{D\_ARC} = (\text{RF}\phi + (0.5 \text{ R1} + .3333333 \text{ R2 PSHA}) \text{ PSHA}) \text{ PSHA RAD\_PER\_DEG}$$

Next, the surface range from the Shuttle to the target point on the primary runway is computed via Way Point 1 and converted for output:

$$\text{RNG\_TO\_RW\_THRESH} = (\text{DIST\_VEH\_WP1} + \text{D\_ARC} - \text{R\_HAC\_RW}_1) \text{ NAUTMI\_PER\_FT}$$

Another vector,  $\bar{V}\_NORM$ , which is normal to the plane containing the Shuttle position vector and relative velocity is calculated:

$$\bar{V}\_NORM = \bar{R}\_EF \times \bar{V}\_RHO\_EF$$

Finally, the heading angle of the relative velocity vector and the azimuth error (heading minus bearing to Way Point 1) are determined:

$$\text{PSI} = \text{ARCTAN2}[\text{V\_NORM}_3 \text{ R\_VEH\_MAG}, (\text{V\_NORM}_1 \text{ R\_EF}_2 - \text{V\_NORM}_2 \text{ R\_EF}_1)]$$

$$\text{DELAZ} = \text{PSI} - \text{BEAR\_VEH\_WP1}$$

If  $|\text{DELAZ}| > \text{PI}$ ,  $\text{DELAZ} = \text{DELAZ} - 2 \text{PI SIGN}(\text{DELAZ})$

B. Interface Requirements. The input and output requirements for the guidance and displays way point computations are listed in Tables 4.6.1.3-1 and 4.6.1.3-2, respectively.

C. Processing Requirements. The performance of this subfunction and its cyclic repetition rate are under the control of the deorbit/landing user parameter processing sequencer, as described in Section 4.1.2.

D. Constraints. The parameter  $\text{R\_HAC\_RW}_3$  shall be initialized to zero.

E. Supplementary Information. A suggested implementation of the guidance and displays way point computation subfunctions may be found in Section 5.6, subfunctions ENT\_RNG\_BEAR and ENTRY\_MID\_TARGET.

Table 4.6.1.3-1. Input for Entry Guidance and Displays Way Point Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Earth-fixed to selected RW transformation matrix	M_EFTORW	*	M	S		—	As per sequencer
Feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nmi/ft	As per sequencer
Constant PI	PI	Constant	F	S		rad	As per sequencer
Shuttle position vector in earth-fixed coordinates	$\bar{R}_{EF}$	Entry UPP GUIDE-COMP	V	DP		ft	As per sequencer
Position vector of landing site in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Bearing from true north of runway coordinate system +X axis	AZIMUTH_RW	*	F	S	0, 2 $\pi$	rad	As per sequencer
Tolerance for correcting the range of values for the angle A3	A3_TOL	K-load	F	S		rad	As per sequencer
Vehicle earth relative velocity vector in earth-fixed coordinates	$\bar{V}_{RHO\_EF}$	Entry UPP GUIDE-COMP	V	S		ft/sec	As per sequencer
Magnitude of the Shuttle position vector	R_VEH_MAG	Entry UPP H_HDOT_ACCVERT	F	DP		ft	As per sequencer
Magnitude of vehicle relative velocity	REL_VEL_MAG	*	F	S		ft/sec	As per sequencer
Commanded HAC side of selected runway	YSGNP	GUIDE-COMP	I		$\pm 1$	—	As per sequencer
Radius of HAC of selected runway	R_NEP	GUIDE-COMP, ENTRY_MID_TARGET	F	S		ft	As per sequencer
Turn angle of HAC of selected runway	PSHA	GUIDE-COMP, ENTRY_MID_TARGET	F	S		deg	As per sequencer
Vehicle side of selected runway centerline	SIGNY	GUIDE-COMP	I		$\pm 1$	—	As per sequencer

Table 4.6.1.3-1. Input for Entry Guidance and Displays Way Point Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current vehicle mass	M	*	F	S		slugs	As per sequencer
Mass threshold value	WT_GS1	I-load	F	S		slugs	As per sequencer
Constant term in spiral radius equation	RF $\phi$	I-load	F	S		ft	As per sequencer
Linear term in spiral radius equation	R1	I-load	F	S		ft/deg	As per sequencer
Quadratic term in spiral radius equation	R2	I-load	F	S		ft/deg <sup>2</sup>	As per sequencer
Initial value of HAC turn angle	PSHARS	I-load	F	S		deg	As per sequencer
X-component of center of HAC for low mass vehicle	X_HAC_LOW_MASS	I-load	F	S		ft	As per sequencer
X-component of center of HAC for high mass vehicle	X_HAC_HIGH_MASS	I-load	F	S		ft	As per sequencer
Earth-fixed to primary RW transformation matrix for alternate site I**	M_EFTORW_ALT(I)	*	M	S		—	Entry Bearing Spec call rate
Position vector of primary runway for alternate site I in earth-fixed coordinates**	R_EF_ALT(I)	*	V	DP		ft	Entry Bearing Spec call rate
Bearing from true north of runway coordinate system +X axis for alternate site I**	AZ_RW_ALT(I)	*	F	S	0, 2 $\pi$	rad	Entry Bearing Spec call rate
Commanded HAC side of runway for alternate site I**	YSGNP_ALT(I)	*	I		$\pm 1$	—	Entry Bearing Spec call rate
Radius of HAC of primary runway for alternate site I**	ALT_R_NEP(I)	*	F	S		ft	Entry Bearing Spec call rate
Turn angle of HAC of primary runway for alternate site I**	ALT_PSHA(I)	*	F	S		deg	Entry Bearing Spec call rate

Table 4.6.1.3-1. Input for Entry Guidance and Displays Way Point Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Vehicle side of alternate site primary runway centerline	SIGNY_ALT	*	I		±1	—	Entry Bearing Spec call rate
* See principal function input list in Table 4.6.1.6-1.							
** I = 1, 2							

Table 4.6.1.3-2. Output for Entry Guidance and Displays Way Point Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Azimuth error (heading of relative velocity vector minus bearing to WP1)	DELAZ	*	F	S	$\pm \pi$	rad	As per sequencer
Surface range from Shuttle to runway threshold via WP1	RNG_TO_RW_THRESH	*	F	S		nmi	As per sequencer
Radius of HAC of selected runway	R_NEP	*	F			ft	As per sequencer
Turn angle of HAC of selected runway	PSHA	*	F			deg	As per sequencer
Azimuth error (heading of relative velocity vector minus bearing to WP1) for alternate site I**	DELAZ_ALT(I)	*	F	S	$\pm \pi$	rad	Entry Bearing Spec call rate
Surface range from Shuttle to runway threshold via WP1 for alternate site I**	RNG_TO_RW_THRESH_ALT(I)	*	F	S		nmi	Entry Bearing Spec call rate
Radius of HAC of primary runway for alternate site I**	ALT_R_NEP(I)	*	F	S		ft	Entry Bearing Spec call rate
Turn angle of HAC of primary runway for alternate site I**	ALT_PSHA(I)	*	F	S		deg	Entry Bearing Spec call rate
* See principal function output list in Table 4.6.1.6-2.							
** I = 1, 2							

#### 4.6.1.4 TACAN and GPS Display Computations

This section describes the requirements for the TACAN display computations and the GPS display computations which provide tabular data to the Horizontal Situation Display during the ENTRY flight phase.

##### 4.6.1.4.1 TACAN Display Computations

This subfunction provides TACAN data for the Horizontal Situation Display (HSD) during the ENTRY flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.4.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.1.4.1-1 and 4.6.1.4.1-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is given in Section 5.6, TACAN\_DISP\_COMPS.



Table 4.6.1.4.1-1. TACAN Display Computations Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating “ON” when ABS_MODE is selected for HSD display and “OFF” when DELTA_MODE is selected	TAC_GPS_MODE	*	Bit		ON/ OFF	—	As per sequencer
Switch indicating (ON) when a valid TACAN channel has been selected	TACAN_CHAN_VALID_SL <sub>I</sub>	*	Bit		ON/ OFF	—	As per sequencer
TACAN range data obtained from the SOP for each receiver, I = 1,3	TACRANGE <sub>O<sub>I</sub></sub>	*	Arr	S		ft	As per sequencer
TACAN bearing data obtained from the SOP for each receiver, I = 1,3	TACBEAR <sub>O<sub>I</sub></sub>	*	Arr	S	0, 2 $\pi$	rad	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S		deg/rad	As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nmi/ft	As per sequencer
Shuttle position vector in earth-fixed coordinates	$\bar{R}_{EF}$	GUIDE-COMP	V	DP		ft	As per sequencer
TACAN station earth-fixed position vector obtained from Site Lookup for Ith receiver	$\bar{R}_{TACAN\_EF\_SL_I}$	*	Arr	S		ft	As per sequencer
Variation of magnetic north from true north at TACAN site obtained from Site Lookup for Ith receiver	ANGLE_CORR_TNTOMAG_SL <sub>I</sub>	*	Arr	S		rad	As per sequencer
The constant PI	PI	Constant	F	S		rad	As per sequencer
Transformation matrix from earth-fixed to topodetic coordinates at the Ith TACAN site	M_EFTOTD_TACAN_SL <sub>I</sub>	*	M(3)			—	As per sequencer
Number of GPS receiver installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	-	As per sequencer

\* See principal function input list in Table 4.6.1.6-1.

Table 4.6.1.4.1-2. TACAN Display Computations Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Feedback switch indicating “ON” when ABS_MODE is selected on HSD DISP and “OFF” when DELTA_MODE is selected	TAC_GPS_MODE_DISP	*	D		ON/OFF	—	As per sequencer
TACAN azimuth for display in the ABS_MODE or delta azimuth when in DELTA_MODE	TAC_AZ <sub>I</sub>	*	Arr	S		deg	
TACAN range for display in the ABS_MODE or delta range when in the DELTA_MODE	TAC_RNG <sub>I</sub>	*	Arr	S		nmi	As per sequencer
* See principal function output list in Table 4.6.1.6–2.							

#### 4.6.1.4.2 GPS Display Computations

This subfunction provides GPS data for the Horizontal Situation Display (HSD) during the ENTRY flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.6.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.1.4.2–1 and 4.6.1.4.2–2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is given in Section 5.6, GPS\_UPP\_DISP\_COMPS.

The earth fixed position vector R\_TACAN\_EF\_AUTO, magnetic variation ANGLE\_CORR\_TNTOMAG\_AUTO and the earth-fixed to topodetic transformation matrix M\_EFTOTD\_TACAN\_AUTO, corresponding to the auto selected TACAN station, are obtained from the Entry Site Lookup Initialization subfunction. The auto selected TACAN station is that shown in Item 5 of the Horizontal Situation Display.

To insure a valid compare with the TACAN display computation data, the GPS state from each receiver,  $R\_GPS\_ECEF\_SOP_i$ , shall be extrapolated to the User Parameter State vector time tag using the receivers value of earth fixed velocity,  $V\_GPS\_ECEF\_SOP_i$ , times the extrapolation time interval. This extrapolation will occur for each receiver before the display related computations are executed.

Table 4.6.1.4.2-1. GPS Display Computation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S	--	ft	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S		deg/rad	As per sequencer
GPS data good flag	GPS_DG_SOP(1)* *	*	D	--	ON/ OFF	--	As per sequencer
Coordinate transformation matrix from 1984 World Geodetic Survey to earth fixed	M_WGS84_TO_EF	I-load	M	D			As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nmi/ft	As per sequencer
The constant PI	PI	Constant	F	S		rad	As per sequencer
Shuttle position vector in earth fixed coordinates	R_EF	GUIDE_COMP	V	DP	--	ft	As per sequencer
Time tag for current GPS receiver I data	T_GPS_SOP(I)**	*	S	DP	--	sec	As per sequencer
Switch indicating "ON" when ABS_MODE is selected for HSD display and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE	*	D	--	ON/ OFF	--	As per sequencer
Earth fixed position velocity vector of GPS receiver I	V_GPS_ECEF_SOP(1)**	*	V	SP	--	ft/sec	As per sequencer
Earth fixed position vector of I <sup>th</sup> GPS receiver	$\bar{R}_{GPS\_ECEF\_SOP_i}$ **	*	V	DP		ft	As per sequencer
Maximum of receivers for which the software is designed	GPS_SW_CAP	K-Load	INT	--	3	--	As per sequencer
Array indicating which GPS receivers are installed on the vehicle	GPS_INSTALLED <sub>i</sub> **	I-Load/ K-Load	Bit		0,1		As per sequencer
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	UPP state propagation	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer

Table 4.6.1.4.2-1. GPS Display Computation Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	UPP state propagation	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	UPP state propagation	V	DP		ft/sec	As per sequencer
Flag indicating (ON) selected GPS states are available for use	GPS_SV_SEL_AVAIL	*	D	-	ON/OFF	-	As per sequencer
Transformation matrix from earth-fixed to topodetic coordinates of the auto selected TACAN site	M_EFTOTD_TACAN_AUTO	*	M	DP	--	--	As per sequencer
Auto selected TACAN station earth-fixed position vector	$\bar{R}_{TACAN\_EF\_AUTO}$	*	V	DP	--	ft	As per sequencer
Variation of magnetic north from the true north at the auto selected TACAN site	ANGLE_CORR_TNTOMAG_AUTO	*	F	S	$0 - 2\pi$	rad	As per sequencer
Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector	$\bar{G}_{GPS\_UPP}$	*	V	S		ft/sec <sup>2</sup>	As per sequencer
I-load time staleness limit used in setting GPS UPP display computation GPS range, azimuth, altitude status indicator	GPS_UPP_TIME_STALENESS_LIM	I-load	F	S		sec	As per sequencer
Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset	GPS_UPP_UPDATE	*	D	-		ON/OFF	As per sequencer
Transformation from earth-fixed to topodetic coordinates at the runway threshold	M_EFTOTD_RW	*	M(3)	DP		-	As per sequencer

Table 4.6.1.4.2-1. GPS Display Computation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GUIDE_COMP	M(3)	DP		-	As per sequencer
Number of GPS receivers installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	-	As per sequencer
Selected GPS position vector reserved for reset of GPS UPP display computations position vector	$\bar{R}_{GPS\_UPP}$	*	V	DP		ft	As per sequencer
Position of landing site in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Time of the selected GPS state reserved for reset of GPS UPP display computations position vector	T_GPS_UPP	*	F	DP		sec	As per sequencer
Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector	$\bar{V}_{GPS\_UPP}$	*	V	S		ft/sec	As per sequencer
IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity	$\bar{V}_{IMU\_GPS\_UPP}$	*	V	DP		ft/sec	As per sequencer

\* See principal function input list in Table 4.6.1.6-1.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Table 4.6.1.4.2-2. TACAN Display Computations Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Magnetic bearing to selected TACAN station derived from I'th GPS receiver	GPS_AZ <sub>I</sub> **	*	Array	S	0, 360	deg	As per sequencer
Range to selected TACAN station derived from I'th GPS receiver	GPS_RNG <sub>I</sub> **	*	Array	S		nmi	As per sequencer
Altitude above runway derived from I'th GPS receiver	GPS_ALT <sub>I</sub> **	*	Array	S		kft	As per sequencer
Buffered GPS UPP range data for downlist	GPS_UPP_DL(1)	*	F	S		nmi	As per sequencer
Buffered GPS UPP azimuth data for downlist	GPS_UPP_DL(2)	*	F	S		deg	As per sequencer
Buffered GPS UPP altitude data for downlist	GPS_UPP_DL(3)	*	F	S		kft	As per sequencer
Velocity relative to runway derived from the I'th GPS receiver state estimate	GPS_VEL_REL_TO_RW <sub>I</sub> **	*	F	S		kft/sec	As per sequencer
Derived magnetic bearing to runway from the selected GPS state	SEL_GPS_AZ	*	F	S		deg	As per sequencer
Derived range to runway from the selected GPS state	SEL_GPS_RNG	*	F	S		nmi	As per sequencer
Derived altitude above runway from the selected GPS state	SEL_GPS_ALT	*	F	S		kft	As per sequencer
Feedback switch indicating "ON" when ABS_MODE is selected on HSD DISP and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE_DISP	*	D	--	ON/OFF	--	As per sequencer
GPS UPP data status flag	GPS_RN_AZ_H_STAT	*	D	--	ON/OFF	--	As per sequencer

\* See principal function output list in Table 4.6.1.6-1.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

#### 4.6.1.5 Earth-Fixed Coordinate System Computations (EARTH FIXED COMPS)

This subfunction will provide position and velocity vector coordinate system transformations for deorbit and entry.

A. Detailed Requirements. The following operations must be performed by the earth-fixed coordinate system computations subfunction from MM 301 until transition to MM 304.

Earth-fixed position and relative velocity of the Shuttle will be determined as follows:

A matrix to transform M50 to earth-fixed coordinates at the time of the current vehicle state vector (R\_AVGG) will be generated.

$$M\_TEMP\_TXPOS = (EARTH\_FIXED\_TO\_M50\_COORD(T\_STATE))^T$$

The earth-fixed position of the Shuttle and the Shuttle relative velocity in earth-fixed coordinates are then computed and current time is copied:

$$\bar{R}\_{EF} = M\_TEMP\_TXPOS \bar{R}\_{AVGG}$$

$$\bar{V}\_{RHO\_EF} = M\_TEMP\_TXPOS \bar{V}\_{RHO}$$

$$T\_SEC\_GMT = T\_STATE$$

B. Interface Requirements. The input and output requirements are listed in Tables 4.6.1.5-1 and 4.6.1.5-2.

C. Processing Requirements. The performance of this subfunction is under the control of the deorbit/landing user parameter processing sequencer principal function.

D. Constraints. None.

E. Supplementary Information. Reference should be made to Tables 4.6.1.5-1 and 4.6.1.5-2 for definition and source of the variables in the equations displayed.

A suggested implementation of the earth-fixed coordinate system computations subfunction is in the form of a detailed flow chart in Section 5.6, EARTH\_FIXED\_COMPS.



Table 4.6.1.5-1. Input Parameters for Earth-Fixed Coordinate System Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Vehicle relative velocity vector in M50 coordinates	$\bar{V}_{RHO}$	UPP state propagation	V	S		ft/sec	As per sequencer
Time tag for current user parameter state vectors	T_STATE	UPP state propagation	F	DP		sec	As per sequencer

Table 4.6.1.5-2. Output Parameters for Earth-Fixed Coordinate System Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Shuttle position vector in earth fixed coordinates	$\bar{R}_{EF}$	*	V	DP		ft	As per sequencer
Vehicle relative velocity vector in earth-fixed coordinates	$\bar{V}_{RHO\_EF}$	*	V	S		ft/sec	As per sequencer
Time tag associated with EF state vectors	T_SEC_GMT	*	F	DP		sec	As per sequencer

\* See principal function output list in Table 4.6.1.6-2.

#### 4.6.1.6 Entry User Parameter Processing (4.23) Principal Function Tables

The principal function input/output parameters are given in Tables 4.6.1.6-1 and .6.1.6-2. The I-load and K-load parameters are given in Tables 4.6.1.6-3 and 4.6.1.6-4. Constants are given in Table 4.6.1.6-5. The table below is a variables cross-reference table.

Entry User Parameter Processing (4.23) Principal Function Variables Cross-Reference	
FSSR Name	Source Name
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	ANGLE_CORR_TNTOMAG_S1
ANGLE_CORR_TNTOMAG_SL <sub>2</sub>	ANGLE_CORR_TNTOMAG_S2
ANGLE_CORR_TNTOMAG_SL <sub>3</sub>	ANGLE_CORR_TNTOMAG_S3
M_EFTOTD_TACAN_SL <sub>1</sub>	M_EFTOTD_TACAN_SL1
M_EFTOTD_TACAN_SL <sub>2</sub>	M_EFTOTD_TACAN_SL2
M_EFTOTD_TACAN_SL <sub>3</sub>	M_EFTOTD_TACAN_SL3
Q_B_I	Q_BOD_M50/Q_B_I
R_TACAN_EF_SL <sub>1</sub>	R_TACAN_EFSL1
R_TACAN_EF_SL <sub>2</sub>	R_TACAN_EFSL2
R_TACAN_EF_SL <sub>3</sub>	R_TACAN_EFSL3
TACAN_CHAN_VALID_SL <sub>1</sub>	TACAN_CHAN_VALID_SL1
TACAN_CHAN_VALID_SL <sub>2</sub>	TACAN_CHAN_VALID_SL2
TACAN_CHAN_VALID_SL <sub>3</sub>	TACAN_CHAN_VALID_SL3
T_STATE	T_IMUS
V_IMU_CURRENT	SEL_V_M50

N/G = Not given

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
ALT_PSHA(1)	V95H1883C	ALT SITE 1 TURN ANG HAC	ENT BRG SPEC	DEG	SPL		93167A	*
ALT_PSHA(2)	V95H1884C	ALT SITE 2 TURN ANG HAC	ENT BRG SPEC	DEG	SPL		93167A	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ALT_R_NEP(1)	V95U1885C	ALT SITE 1 HAC RADIUS	ENT BRG SPEC	FT	SPL		93167A	*
ALT_R_NEP(2)	V95U1886C	ALT SITE 2 HAC RADIUS	ENT BRG SPEC	FT	SPL		93167A	*
ANGLE_CORR_TNTOMAG_AUTO	V90H0393CA	MAGNETIC VARIATION AT AUTO SEL TAC	ENT SITE LOOKUP	RAD	SPL		92049C	
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
AZIMUTH_RW	V90H1817CA	AZIMUTH OF RW FROM TRUE NORTH	ENT SITE LOOKUP	RAD			93090E	
AZ_RW_ALT(1)	V90H3976C	ALT SITE 1 PRI RW AZIMUTH	ENT BRG SPEC	RAD	SPL		93167A	*
AZ_RW_ALT(2)	V90H3977C	ALT SITE 2 PRI RW AZIMUTH	ENT BRG SPEC	RAD	SPL		93167A	*
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
ENT_PT_SW/NEP	V93X4466X	ENTRY POINT SWITCH CMD	HORIZ SIT DISP		BD		89250B	
FILT_UPDATE	V90X0224XC	FLAG IND NAV FILTER PROC COMPLETE	PRELAND NAV					
FILT_UPDATE	V90X0224XD	FLAG IND NAV FILTER PROC COMPLETE	D/L NAV SEQ					
FILT_UPDATE	V90X0224XE	FLAG IND NAV FILTER PROC COMPLETE	ENT NAV					
GPS_DG_SOP(1)	V90X3012X	GPS 1 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(2)	V90X3013X	GPS 2 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(3)	V90X3014X	GPS 3 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_UPP_UPDATE	V90X3643XA	GPS UPP DISP RES STATE AVAIL FLAG	ENT NAV		BD		92067D	
G_GPS_UPP(1)	V90A3630CA	SELECTED GPS STATE X GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CA	SELECTED GPS STATE Y GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CA	SELECTED GPS STATE Z GRAV	ENT NAV	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CC	SEL X-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(1)	V90A0243CD	SEL X-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(1)	V90A0243CE	SEL X-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CC	SEL Y-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CD	SEL Y-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(2)	V90A0244CE	SEL Y-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(3)	V90A0245CC	SEL Z-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(3)	V90A0245CD	SEL Z-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(3)	V90A0245CE	SEL Z-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
M/CURR_ORB_MASS/MASS	V90U1961CC	CURRENT VEHICLE MASS	DEORB GUID	SLUGS			93090E	
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTORW_ALT(1)(1,1)	V90U3978C	ALT SITE 1 EF TO PRI RW MTRX 1,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(1,2)	V90U3979C	ALT SITE 1 EF TO PRI RW MTRX 1,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(1,3)	V90U3980C	ALT SITE 1 EF TO PRI RW MTRX 1,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(2,1)	V90U3981C	ALT SITE 1 EF TO PRI RW MTRX 2,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(2,2)	V90U3982C	ALT SITE 1 EF TO PRI RW MTRX 2,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(2,3)	V90U3983C	ALT SITE 1 EF TO PRI RW MTRX 2,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(3,1)	V90U3984C	ALT SITE 1 EF TO PRI RW MTRX 3,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(3,2)	V90U3985C	ALT SITE 1 EF TO PRI RW MTRX 3,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(1)(3,3)	V90U3986C	ALT SITE 1 EF TO PRI RW MTRX 3,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(1,1)	V90U3987C	ALT SITE 2 EF TO PRI RW MTRX 1,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(1,2)	V90U3988C	ALT SITE 2 EF TO PRI RW MTRX 1,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(1,3)	V90U3989C	ALT SITE 2 EF TO PRI RW MTRX 1,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(2,1)	V90U3990C	ALT SITE 2 EF TO PRI RW MTRX 2,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(2,2)	V90U3991C	ALT SITE 2 EF TO PRI RW MTRX 2,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(2,3)	V90U3992C	ALT SITE 2 EF TO PRI RW MTRX 2,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(3,1)	V90U3993C	ALT SITE 2 EF TO PRI RW MTRX 3,1	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(3,2)	V90U3994C	ALT SITE 2 EF TO PRI RW MTRX 3,2	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTORW_ALT(2)(3,3)	V90U3995C	ALT SITE 2 EF TO PRI RW MTRX 3,3	ENT BRG SPEC	ND	SPL		93167A	*
M_EFTOTD_RW(1,1)	V90U3644CA	EF TO TOPO COORD AT RW 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,2)	V90U3645CA	EF TO TOPO COORD AT RW 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,3)	V90U3646CA	EF TO TOPO COORD AT RW 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2,1)	V90U3647CA	EF TO TOPO COORD AT RW 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-2)	V90U3648CA	EF TO TOPO COORD AT RW 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-3)	V90U3649CA	EF TO TOPO COORD AT RW 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-1)	V90U3650CA	EF TO TOPO COORD AT RW 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-2)	V90U3651CA	EF TO TOPO COORD AT RW 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-3)	V90U3652CA	EF TO TOPO COORD AT RW 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,1)	V90U3566CA	EF TO TOPO COORD, AUTO SEL TAC 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,2)	V90U3567CA	EF TO TOPO COORD, AUTO SEL TAC 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,3)	V90U3568CA	EF TO TOPO COORD, AUTO SEL TAC 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,1)	V90U3569CA	EF TO TOPO COORD, AUTO SEL TAC 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,2)	V90U3570CA	EF TO TOPO COORD, AUTO SEL TAC 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,3)	V90U3571CA	EF TO TOPO COORD, AUTO SEL TAC 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,1)	V90U3572CA	EF TO TOPO COORD, AUTO SEL TAC 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,2)	V90U3573CA	EF TO TOPO COORD, AUTO SEL TAC 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,3)	V90U3574CA	EF TO TOPO COORD, AUTO SEL TAC 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP		DPL		92067D	

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NUM_GPS_INSTALLED	V90U3671C	NUMBER OF GPS RCVRS INSTALLED	GPS SOP		HXS		92067D	
Q_BOD_M50(1)/Q_B_I(1)	V90U2240CA	M50 TO BODY QUAT MEASURED ELEM 1	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(2)/Q_B_I(2)	V90U2241CA	M50 TO BODY QUAT MEASURED ELEM 2	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(3)/Q_B_I(3)	V90U2242CA	M50 TO BODY QUAT MEASURED ELEM 3	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(4)/Q_B_I(4)	V90U2243CA	M50 TO BODY QUAT MEASURED ELEM 4	A/E ATT PROC		SPL		93017G	*
RW_ID_UPP	V95X0234XA	OTT FIRST PASS FLAG	ENT SITE LOOKUP				90072	
RW_NAME	V90U1916CA	CURRENT LANDING SITE SELECTED	ENT SITE LOOKUP					
R_EF_ALT(1)(1)	V90H3970C	X-COMP OF ALT SITE 1 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_EF_ALT(1)(2)	V90H3971C	Y-COMP OF ALT SITE 1 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_EF_ALT(1)(3)	V90H3972C	Z-COMP OF ALT SITE 1 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_EF_ALT(2)(1)	V90H3973C	X-COMP OF ALT SITE 2 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_EF_ALT(2)(2)	V90H3974C	Y-COMP OF ALT SITE 2 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_EF_ALT(2)(3)	V90H3975C	Z-COMP OF ALT SITE 2 POS VECTOR	ENT BRG SPEC	FT	DPL		93167A	*
R_GPS_ECEF_SOP(1,1)	V90H3036C	GPS 1 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,2)	V90H3037C	GPS 1 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,3)	V90H3038C	GPS 1 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,1)	V90H3039C	GPS 2 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,2)	V90H3040C	GPS 2 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_GPS_ECEF_SOP(2,3)	V90H3041C	GPS 2 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,1)	V90H3042C	GPS 3 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,2)	V90H3043C	GPS 3 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,3)	V90H3044C	GPS 3 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_UPP(1)	V90H3624CA	SELECTED GPS STATE X POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CA	SELECTED GPS STATE Y POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CA	SELECTED GPS STATE Z POS	ENT NAV	FT	DPL		92067D	
R_LS_EF(1)	V90H1900CA	X-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(2)	V90H1901CA	Y-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(3)	V90H1902CA	Z-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_RESET(1)	V90H0235CC	SEL X-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(1)	V90H0235CD	SEL X-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(1)	V90H0235CE	SEL X-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(2)	V90H0236CC	SEL Y-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(2)	V90H0236CD	SEL Y-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(2)	V90H0236CE	SEL Y-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(3)	V90H0237CC	SEL Z-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(3)	V90H0237CD	SEL Z-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(3)	V90H0237CE	SEL Z-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EF_AUTO(1)	V90H3575CA	X-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(2)	V90H3576CA	Y-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(3)	V90H3577CA	Z-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SIGNY_ALT	V95J1880C	VEH SIDE ALT SITE PRI RW CTR LINE	ENT BRG SPEC	ND	HXS		93167A	*
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACBEARO(1)	V95H5122CA	TACAN NO 1 BEARING OUT	TACAN SOP	RAD				
TACBEARO(2)	V95H5222CA	TACAN NO 2 BEARING OUT	TACAN SOP	RAD				
TACBEARO(3)	V95H5322CA	TACAN NO 3 BEARING OUT	TACAN SOP	RAD				
TACRANGE0(1)	V95H5102CA	TACAN NO 1 RANGE OUT	TACAN SOP	FT				
TACRANGE0(2)	V95H5202CA	TACAN NO 2 RANGE OUT	TACAN SOP	FT				
TACRANGE0(3)	V95H5302CA	TACAN NO 3 RANGE OUT	TACAN SOP	FT				
TAC_GPS_MODE	V93X5015X	TACAN/GPS ABSOLUTE/DELTA DATA CMD	HORIZ SIT DISP		BD		91051K	
TOGHAC	V93X4477X	R/L CONE CHG CMD	HORIZ SIT DISP		BD		90302B	

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS_SOP(1)	V90W3045C	GPS 1 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(2)	V90W3046C	GPS 2 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(3)	V90W3047C	GPS 3 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_UPP	V90W3636CA	TIME OF SELECTED GPS STATE	ENT NAV	S	DPL		92067D	
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
T_IMU_SAVE_SOP(1)	V90W3048C	IMU TIME TAG FOR CURNT GPS 1 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(2)	V90W3049C	IMU TIME TAG FOR CURNT GPS 2 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(3)	V90W3050C	IMU TIME TAG FOR CURNT GPS 3 STATE	GPS SOP	S	DPL		92067D	
T_RESET	V90W0534CC	TIME OF FILTER STATE VECTOR	PRELAND NAV	S			93017G	*
T_RESET	V90W0534CD	TIME OF FILTER STATE VECTOR	D/L NAV SEQ	S			93017G	*
T_RESET	V90W0534CE	TIME OF FILTER STATE VECTOR	ENT NAV	S			93017G	*
V_GPS_ECEF_SOP(1,1)	V90L3051C	GPS 1 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,2)	V90L3052C	GPS 1 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,3)	V90L3053C	GPS 1 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,1)	V90L3054C	GPS 2 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,2)	V90L3055C	GPS 2 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,3)	V90L3056C	GPS 2 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,1)	V90L3057C	GPS 3 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,2)	V90L3058C	GPS 3 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,3)	V90L3059C	GPS 3 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_UPP(1)	V90L3627CA	SELECTED GPS STATE X VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CA	SELECTED GPS STATE Y VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CA	SELECTED GPS STATE Z VEL	ENT NAV	FT/S	SPL		92067D	
V_IMU_GPS_UPP(1)	V90L3633CA	SELECTED GPS STATE X ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CA	SELECTED GPS STATE Y ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CA	SELECTED GPS STATE Z ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_RESET(1)	V90L0247CC	SEL X-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(1)	V90L0247CD	SEL X-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(1)	V90L0247CE	SEL X-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(2)	V90L0248CC	SEL Y-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(2)	V90L0248CD	SEL Y-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(2)	V90L0248CE	SEL Y-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(3)	V90L0249CC	SEL Z-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(3)	V90L0249CD	SEL Z-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(3)	V90L0249CE	SEL Z-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_SAVE_SOP(1,1)	V95L0133C	IMU ACCUM X VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,2)	V95L0134C	IMU ACCUM Y VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,3)	V95L0135C	IMU ACCUM Z VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,1)	V95L0136C	IMU ACCUM X VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,2)	V95L0137C	IMU ACCUM Y VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,3)	V95L0138C	IMU ACCUM Z VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,1)	V95L0139C	IMU ACCUM X VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,2)	V95L0140C	IMU ACCUM Y VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,3)	V95L0141C	IMU ACCUM Z VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_RESET(1)	V90L0239CC	SEL X-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				

TABLE 4.6.1.6-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_RESET(1)	V90L0239CD	SEL X-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(1)	V90L0239CE	SEL X-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(2)	V90L0240CC	SEL Y-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(2)	V90L0240CD	SEL Y-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(2)	V90L0240CE	SEL Y-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(3)	V90L0241CC	SEL Z-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(3)	V90L0241CD	SEL Z-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(3)	V90L0241CE	SEL Z-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
YSGNP_ALT(1)	V95J1881C	ALT SITE 1 R/L CONE IND PRI RW	ENT BRG SPEC	ND	HXS		93167A	*
YSGNP_ALT(2)	V95J1882C	ALT SITE 2 R/L CONE IND PRI RW	ENT BRG SPEC	ND	HXS		93167A	*
	V93X5085XA	FLG IND AVG PRI & SEC TGT PARMS	IMU ALIGN DISP					

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ACC_DRAG	V95A0160CB	DRAG DECEL	AMI PROC DL FMT 23/1 ENT DIP ENT GUID ENT NAV HUD PROC NAVDAD SOP	FT/S2			93017G	*
ACC_VERT	V95A0170CB	VERTICAL ACCEL IN TOPODETTIC COORD	AVVI PROC ENT GUID ENTRY TRAJ1 ENTRY TRAJ2 ENTRY TRAJ3 ENTRY TRAJ4 ENTRY TRAJ5 TLM	FT/S2				
ALPHA_NAVDAD ALT	V95H0233CA V95H0175CC	AVG NAVDAD ANGLE OF ATTACK CURR ORB ALT ABOVE REF ELLIPSOID	NAVDAD SOP ADTA SOP AEROJET DAP DL FMT 23/A ENT NAV GPS RCVR STATE PROC NAVDAD SOP PRELAND NAV	DEG FT	SPL		93017G	*
ALT_PSHA(1)	V95H1883CA	ALT SITE 1 TURN ANG HAC	ENT BRG SPEC	DEG	SPL		93167A	*
ALT_PSHA(2)	V95H1884CA	ALT SITE 2 TURN ANG HAC	ENT BRG SPEC	DEG	SPL		93167A	*
ALT_R_NEP(1)	V95U1885CA	ALT SITE 1 HAC RADIUS	ENT BRG SPEC	FT	SPL		93167A	*
ALT_R_NEP(2)	V95U1886CA	ALT SITE 2 HAC RADIUS	ENT BRG SPEC	FT	SPL		93167A	*
ALT_WHEELS	V95H0165CB	ALT TO REAR WHEELS/NAV BASE(ENTRY)	DL FMT 23/1 E/L EV AN PROC ENT AREA NAV ENT BRG SPEC ENT DIP ENT GUID ENT NAV GPS SOP HORIZ SIT SPEC HUD PROC HYD SYS SOP TACAN RM	FT	DPL		93017G	*
COURSE_WRT_RW/PSD	V95H0225CA	COURSE WRT RW CENTERLINE	DL FMT 23/1 E/L EV AN PROC ENT AREA NAV	DEG			93017G	*
DELAZ	V95H0172C	HEADING ERR WRT HAC TANGENT POINT	DL FMT 23/1 ENT BRG SPEC ENT DIP ENT GUID	RAD	SPL		93017G	*

TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DELAZ_ALT(1)	V94H5517CB	ALTER SITE 1 DELTA AZIMUTH	ENT BRG SPEC	RAD	SPL		93167A	*
DELAZ_ALT(2)	V94H5518CB	ALTER SITE 2 DELTA AZIMUTH	ENT BRG SPEC	RAD	SPL		93167A	*
FIRST_PASS	V95X0184XA	AREA NAV HAC INIT FLAG	ENT AREA NAV	DEG				
GPS_ALT(2)	V94H1045CA	GPS 2 ALT TO LDG SITE THRESH	HORIZ SIT DISP	KFT	SPL		91051K	
GPS_AZ(2)	V94H1043CA	GPS 2 AZ TO SEL TAC STA	TLM HORIZ SIT DISP	DEG	SPL		91051K	
GPS_RNG(2)	V94H1044CA	GPS 2 RNG TO SEL TAC STA	TLM HORIZ SIT DISP	NM	SPL		91051K	
GPS_RN_AZ_H_STAT	V94X1046XA	GPS 2 RNG/AZ/ALT STATUS	HORIZ SIT DISP		BD		92214A	
GPS_UPP_DL(1)	V94H1162CA	SEL GPS RNG FOR DL	DL FMT 23/1	NM	SPL		93017G	*
GPS_UPP_DL(2)	V94H1163CA	SEL GPS AZ FOR DL	DL FMT 23/1	DEG	SPL		93017G	*
GPS_UPP_DL(3)	V94H1164CA	SEL GPS ALT FOR DL	DL FMT 23/1	KFT	SPL		93017G	*
GPS_VEL_REL_TO_RW(1)	V94L6042CA	GPS 1 EF RELATIVE VELOCITY	HORIZ SIT DISP	KFT/S	SPL		92067D	
GPS_VEL_REL_TO_RW(2)	V94L6043CA	GPS 2 EF RELATIVE VELOCITY	TLM HORIZ SIT DISP	KFT/S	SPL		92067D	
GPS_VEL_REL_TO_RW(3)	V94L6044CA	GPS 3 EF RELATIVE VELOCITY	TLM HORIZ SIT DISP	KFT/S	SPL		92067D	
H_DOT_ELLIPSOID/H_DOT	V95L0265CD	EST ALTITUDE RATE	ADTA SOP DL FMT 23/1 ENT DIP ENT GUID GPS SOP HUD PROC	FT/S	SPL		93017G	*
LD_GR_HYDR	V95X0238X	INIT LND GR HYDR CONDITIONING FLAG	MSC					
LOAD_TOTAL	V95U0163CA	TOTAL LOAD FACTOR	DL FMT 23/1 E/L EV AN PROC ENT GUID HORIZ SIT SPEC	FT/S2			93017G	*
LOD	V95U0180C	LIFT/DRAG	DL FMT 23/1 ENT DIP ENT GUID		SPL		93017G	*
MEDS_DELAZ	V95H0148C	MEDS HEADING ERROR	MEDS FC GNC XFER	RAD	SPL		92522D	
OVHD	V95X0154XA	OVHD/STRT IND	DL FMT 23/1 ENT AREA NAV ENT BRG SPEC HORIZ SIT DISP	EVENT	BD		93017G	*
POSN_WRT_RW(1)/X	V95H0220CB	DOWNRANGE DISTANCE WRT RW	DL FMT 23/1 ENT AREA NAV HORIZ SIT SPEC HUD PROC	FT			93017G	*
POSN_WRT_RW(2)/Y	V95H0221CB	CROSSRANGE DISTANCE WRT RW	DL FMT 23/1 ENT AREA NAV HORIZ SIT SPEC HUD PROC	FT			93017G	*

TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
POSN_WRT_RW(3)/Z	V95H0300CD	VERTICAL DISTANCE WRT RW	ENT AREA NAV HUD PROC	FT				
PSHA	V95H0181CC	TURN ANG HAC	DL FMT 23/1 ENT AREA NAV TAEM GUID	DEG	SPL		93017G	*
PSI/HEADING_VR	V94U5610C	HEADING ANGLE OF REL VELOCITY	ENT BRG SPEC	RAD	SPL		93090E	
REL_VEL_MAG/V	V95L0151CC	GND REL VEL MAGNITUDE IN M50 SYS	ABT CNTL SEQ ADTA SOP DL FMT 23/1 E/L RCS CMD SOP ENT AREA NAV ENT BRG SPEC ENT DIP ENT GUID ENT NAV GPS SOP LDG GEAR VLV CNTL MPS ENT DUMP MSC NAVDAD SOP PRELAND NAV VENT CNTL SEQ	FT/S	SPL		93017G	*
RNG_TO_RW_THRESH	V95H0176CA	RANGE TO RUNWAY THRESHOLD VIA WP1	DL FMT 23/A ENT BRG SPEC ENT DIP ENT GUID HORIZ SIT SPEC	NM			93017G	*
RNG_TO_RW_THRESH_ALT(1)	V94U6528CA	RANGE TO ALT SITE 1 PRI RW THRESH	ENT BRG SPEC	NM	SPL		93167A	*
RNG_TO_RW_THRESH_ALT(2)	V94U6529CA	RANGE TO ALT SITE 2 PRI RW THRESH	ENT BRG SPEC	NM	SPL		93167A	*
RW_ID_UPP/RW_ID	V95U0205CC	INDEX OF CURRENT RW USED FOR UPP	TLM				89250B	
RW_NAME	V90U1916CC	CURRENT LANDING SITE SELECTED	DL FMT 23/A				93017G	*
R_AVGG(1)	V95H0185CC	X-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CC	Y-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT	DPL		93017G	*

TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_AVGG(3)	V95H0187CC	Z-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT	DPL		93017G	*
R_EF(1)	V95H0155CA	ORBITER X POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
R_EF(2)	V95H0156CA	ORBITER Y POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
R_EF(3)	V95H0157CA	ORBITER Z POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
R_NEP/RTURN	V95U0183CA	HAC RADIUS	TAEM GUID	FT			89250B	
R_VEH_MAG_UPP	V95H0167CB	MAG SHUTTLE POS VECTOR	ENT AREA NAV	FT				
SEL_GPS_ALT	V94H6036CA	SEL GPS ALT TO LDG SITE THRESH	HORIZ SIT DISP	KFT	SPL		92067D	
SEL_GPS_AZ	V94H6037CA	SEL GPS AZ TO LDG SITE THRESH	HORIZ SIT DISP	DEG	SPL		92067D	
SEL_GPS_RNG	V94H6038CA	SEL GPS RNG TO LDG SITE THRESH	HORIZ SIT DISP	NM	SPL		92067D	
TAC_AZ(1)	V95H0207CA	TACAN 1 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(2)	V95H0208CA	TACAN 2 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(3)	V95H0209CA	TACAN 3 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_GPS_MODE_DISP	V95X0227XA	TACAN/GPS ABS/DELTA DATA IND	HORIZ SIT DISP				91051K	
TAC_RNG(1)	V95H0201CA	TACAN 1 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(2)	V95H0202CA	TACAN 2 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(3)	V95H0203CA	TACAN 3 RANGE	HORIZ SIT DISP	NM				
T_SEC_GMT	V95W3890CA	TIME TAG EF STATE(TOD)	GN&C/SM-PL IF	S				
T_STATE	V95W0200CE	TIME TAG ASSOC WITH CURRENT STATE	DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC	S			93017G	*
VEL_WRT_RW(1)/XDOT	V95L0255CD	DOWNRANGE VEL WRT RW	DL FMT 23/1 HUD PROC	FT/S			93017G	*
VEL_WRT_RW(2)/YDOT	V95L0256CD	CROSSRANGE VEL WRT RW	DL FMT 23/1 HUD PROC	FT/S			93017G	*
VEL_WRT_RW(3)/ZDOT	V95L0257CB	VELOCITY WRT RUNWAY (3)	DL FMT 23/1 HUD PROC	FT/S			93017G	*

TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_AVGG(1)	V95L0190CC	X-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CC	Y-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CC	Z-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DEORB GUID DEORB MNVR DIP DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF STAR TRCK SOP	FT/S	SPL		93017G	*
V_GROUNDSPEED/VH	V95L0178CB	GROUNDSPPEED	ENT AREA NAV HORIZ SIT SPEC TACAN RM TLM	FT/S			92389C	
V_IMU_OLD(1)	V95L0210CC	X-COMP OF CURRENT ACCUM IMU VEL	DEORB GUID DEORB MNVR DIP	FT/S				
V_IMU_OLD(2)	V95L0211CC	Y-COMP OF CURRENT ACCUM IMU VEL	DEORB GUID DEORB MNVR DIP	FT/S				
V_IMU_OLD(3)	V95L0212CC	Z-COMP OF CURRENT ACCUM IMU VEL	DEORB GUID DEORB MNVR DIP	FT/S				
V_MAG	V95L0150C	VEHICLE INERTIAL SPEED	ENT DIP ENT GUID	FT/S			93017G	*
V_RHO(1)	V95L0215CB	X-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO(2)	V95L0216CB	Y-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO(3)	V95L0217CB	Z-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO_EF(1)	V95L3884CA	X VELOCITY VECTOR EF(TOD)	ENT AREA NAV GN&C/SM-PL IF	FT/S				
V_RHO_EF(2)	V95L3885CA	Y VELOCITY VECTOR EF(TOD)	ENT AREA NAV GN&C/SM-PL IF	FT/S				
V_RHO_EF(3)	V95L3886CA	Z VELOCITY VECTOR EF(TOD)	ENT AREA NAV GN&C/SM-PL IF	FT/S				
YSGNP/YSGN	V95J0153CA	R/L CONE IND PRI RW	DL FMT 23/1 ENT AREA NAV HORIZ SIT DISP HORIZ SIT SPEC		SPL		93017G	*

TABLE 4.6.1.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY USER PARAMETER PROCESSING (G4.23)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V93A8201CA	DISPLAYED NORMAL ACCEL	HORIZ SIT DISP	FT/S				
	V95M2885PA	LANDING OPTIONS	DL FMT 23/1				93017G	*
	V95X0235XA	VENT DOOR SEQ INIT	MSC		BD		89599C	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.6.1.6-3. ENTRY USER PARAMETER PROCESSING (G4.23) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_INSTALLED(1)	V97U2924C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(2)	V97U2831C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(3)	V97U2925C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_UPP_TIME_STALENESS_LIM	V97U3252C	SEC	F	S	D	P	G4.20 G4.23 G4.24 G4.25	00	GPD	92292B	
M_WGS84_TO_EF(1,1)	V97U2927C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.6.1.6-3. ENTRY USER PARAMETER PROCESSING (G4.23) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(1,2)	V97U2928C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(1,3)	V97U2929C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,1)	V97U2930C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,2)	V97U2931C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,3)	V97U2932C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	



TABLE 4.6.1.6-3. ENTRY USER PARAMETER PROCESSING (G4.23) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(3,1)	V97U2933C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,2)	V97U2934C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,3)	V97U2935C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
PSHARS	V96U8647C	DEG	F	S	D	C	G4.19 G4.20 G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27	01 03	ZFU ZFU	93090E	
R1	V96U8263C	FT/DEG	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	

TABLE 4.6.1.6-3. ENTRY USER PARAMETER PROCESSING (G4.23) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
R2	V96U8264C	FT/DEG**2	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
RESELVE	V99U7680C	FT/SEC	F	S	M	C	G4.220 G4.23 G4.24 G4.25 G5.27	00	VHS	93090E	
RFO	V96U8262C	FT	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
R_GO_RAMP	V97U5438C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
START_POSITION	V99U9569C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
STOP_POSITION	V99U9570C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
WT_GS1	V97U0444C	SLUGS	F	S	M	C	G4.10 G4.220 G4.23 G4.24 G4.25 G4.9 G5.27	00	GLC	93090E	

TABLE 4.6.1.6-3. ENTRY USER PARAMETER PROCESSING (G4.23) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
X_HAC_HIGH_MASS	V96U8679C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	
X_HAC_LOW_MASS	V96U8678C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.1.6-4. ENTRY USER PARAMETER PROCESSING (G4.23) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
A3_TOL	V98U9425C	00	-3.0	E-03	RAD	F	S	C G4.127 G4.144 G4.19 G4.20 G4.205 G4.23 G5.27	93090E	
ALT_EL(1) ALT REGIONS NAV EV LAMP PROCESSING	V97U5212C	00	+1.4000000	E+05	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(2) ALT REGIONS NAV EV LAMP PROCESSING	V97U5213C	00	+1.2000000	E+04	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(3) ALT REGIONS NAV EV LAMP PROCESSING	V97U5214C	00	+5.0	E+03	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	90291B	
BIAS_RADALT RADAR ALTITUDE BIAS	V97U5253C	00	+0.0	E+00	FT	F	S	P G4.20 G4.23 G4.24 G4.25	89661A	
GPS_SW_CAP MAX NUM OF GPS LRU THAT SOFTWARE CAN HANDLE	V97U2923C	00	+3		ND	I	S	P G4.17 G4.18 G4.20 G4.21 G4.23 G4.24 G4.25	92069B	
RI	V96U8680C	00 01 03	+2.0	E+04	FT	F	S	C G4.20 G4.23 G5.27	93090E	
TIME_BIAS_RADALT PAD LOAD CORR RAD ALT TIME	V97U5546C	00	+1.50	E-02	SEC	F	D	P G4.17 G4.20 G4.23 G4.24 G4.25	92069B	

TABLE 4.6.1.6-4. ENTRY USER PARAMETER PROCESSING (G4.23) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
X_NB_CG X_STRUCT_BODY DIST NAV BASE CG	V97U5573C	00	+5.61360	E+01 FT	F		S C	G4.20 G4.23 G4.24 G4.25 G5.27	93090E	
Z_NB_CG Z_STRUCT_BODY DIS CG NAV BASE	V97U5580C	00	+4.0580	E+00 FT	F		S C	G4.20 G4.23 G4.24 G4.25 G5.27	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.1.6-5. ENTRY USER PARAMETER PROCESSING (G4.23) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S C	A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.6.1.6-5. ENTRY USER PARAMETER PROCESSING (G4.23) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RADIUS_EQUATOR EARTH EQUATORIAL RADIUS	V97U5324C	00	+2.09257414698E+07	FT	F		D C	A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.19 G4.20 G4.205 G4.210 G4.211 G4.213 G4.23 G4.236 G4.238 G4.24 G4.25 G5.26 G5.27	93090E	
ELLIPT EARTH'S ELLIPTICITY CONSTANT	V97U5332C	00	+3.352329869 E-03	ND	F		D C	V5.1.8 A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.19 G4.20 G4.205 G4.213 G4.23 G4.236 G4.237 G4.238 G4.24 G4.25 G5.26 G5.27	93090E	
LDGR_VEL_THRSH THRESHOLD OF RELATIVE VELOCITY BELOW WHICH LD_GR_HYDR IS SET	V97U6144C	00	+8.0000	E+03 FT/SEC	F		S P	V5.1.8 G4.23 G4.24	90102D	

TABLE 4.6.1.6-5. ENTRY USER PARAMETER PROCESSING (G4.23) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04	NMI/FT	F	S	C A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



#### 4.6.2 TAEM User Parameter Processing (4.24)

This principal function will serve as the interface between navigation and users of navigation-related data during the TAEM major mode. This function will maintain the vehicle state within the user parameter state propagation subfunction and shall:

1. Provide this state to users who require vehicle state parameters in mean-of-fifty (M50) coordinates and
2. Provide the software to transform this state for users who require nav-state-related parameters.

This function is controlled by the deorbit/landing user parameter sequencer and is composed of the following three subfunctions.

- a. User parameter state propagation (Section 4.6.2.1)
- b. Basic guidance-related computations (Section 4.6.2.2)
- c. TACAN and GPS display computations (Section 4.6.2.3)

The input and output parameters for this principal function are found in Tables 4.6.2.4-1 and 4.6.2.4-2, and are summarized in Table 4.6.2.

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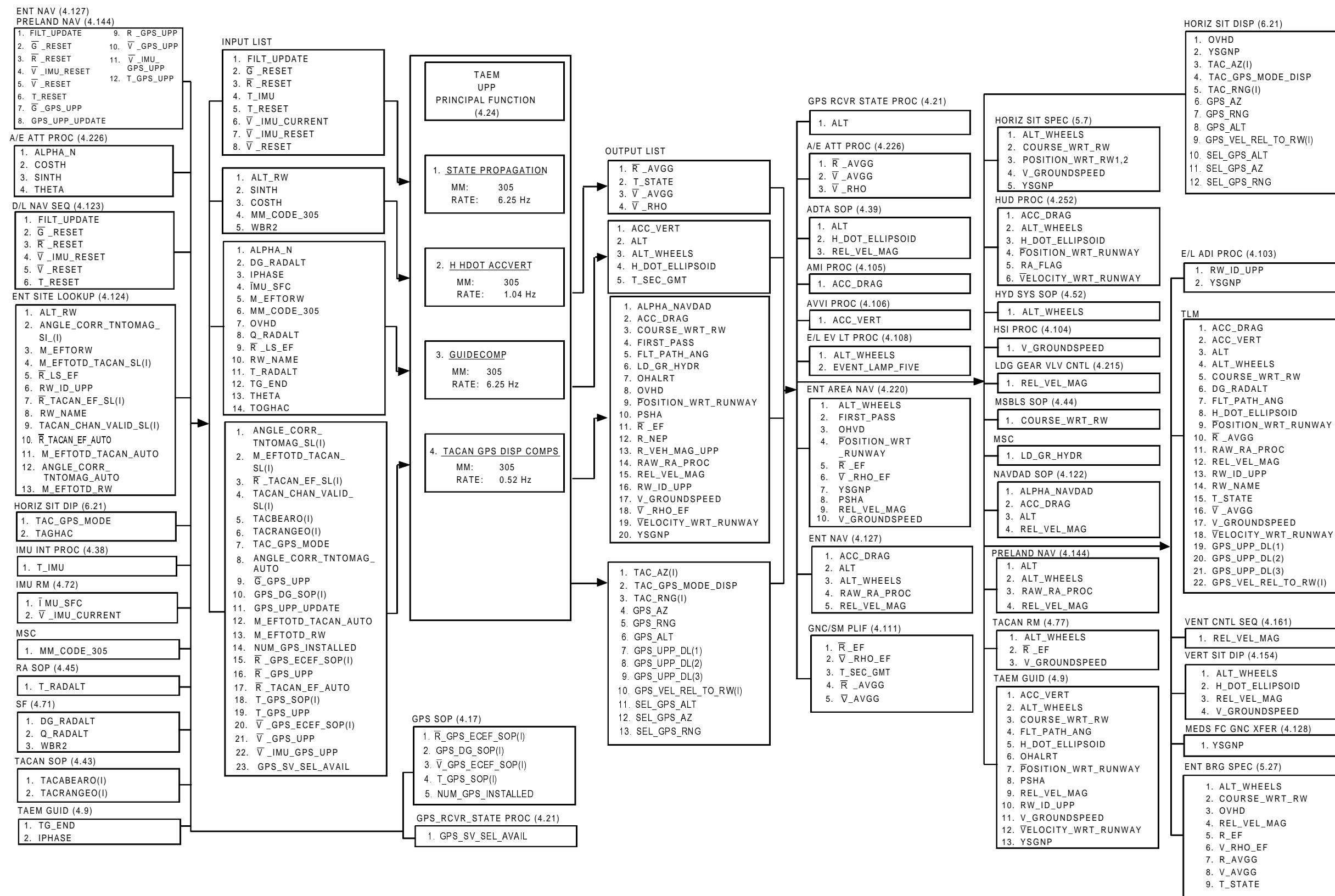


FIGURE 4.6-2. TAEM User Parameter Processing Principal Function Interface Diagram

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#### 4.6.2.1 User Parameter State Propagation

This subfunction will provide state vector information to users such as guidance and displays during the TAEM phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.1.
- B. Interface Requirements. The input and output required are listed in Tables 4.6.2.1-1 and 4.6.2.1-2.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is to be found in Section 5.6, USER\_PARAM\_PROPAGATOR.

Table 4.6.2.1-1. TAEM User Parameter State Propagation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating (ON) that the current nav cycle is complete	FILT_UPDATE	*	D	—	OFF/ON	—	Nav rate
Modeled acceleration at start of Shuttle state integration interval	$\bar{G}_{RESET}$	*	V	S		ft/sec <sup>2</sup>	Nav rate
Vehicle position vector after all navigation updates reserved for reset of user parameter integrator position vector $\bar{R}_{AVGG}$	$\bar{R}_{RESET}$	*	V	DP		ft	Nav rate
Time associated with currently read IMU velocity counts from the IMU detection filter (RM)	T_IMU	*	F	DP		sec	As per sequencer
Time associated with reserved reset state	T_RESET	*	F	DP		sec	Nav rate
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_CURRENT}$	*	V	DP		ft/sec	As per sequencer
Copy of $\bar{V}_{CURRENT\_FILT}$ reserved as velocity count at start of extrapolation interval when user parameter is reset	$\bar{V}_{IMU\_RESET}$	*	V	DP		ft/sec	Nav rate
Vehicle velocity vector after all navigation updates reserved for reset of user parameter integrator velocity vector $\bar{V}_{AVGG}$	$\bar{V}_{RESET}$	*	V	S		ft/sec	Nav rate

\* See principal function output list in Table 4.6.2.4-2.

Table 4.6.2.1-2. TAEM User Parameter State Propagation Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	GPS_UPP_DISP_COMPS	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	*, TAEM UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	*, TAEM UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	*, TAEM UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	S		ft/sec	As per sequencer
Earth-relative velocity in M50 coordinates	$\bar{V}_{RHO}$	*, TAEM UPP GUIDE-COMP	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	TAEM UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	DP		ft/sec	As per sequencer
Flag indicating UPP state has been updated by navigation filter	UPP_UPDATE	H_HDOT_ACCVERT	D	—	OFF/ON	—	As per sequencer

\* See principal function input list in Table 4.6.2.4-1.

#### 4.6.2.2 Basic Guidance-Related Computations (H\_HDOT\_ACCVERT and GUIDECOMP)

These subfunctions will provide the required software to transform the user parameter state into the related parameters required by users of navigation-derived data during the TAEM guidance phase.

- A. Detailed Requirements. It is required to calculate the parameters detailed in Section 4.4.2 during the TAEM guidance phase.
- B. Interface Requirements. The input and output requirements for the TAEM guidance parameters are listed in Tables 4.6.2.2-1 and 4.6.2.2-2.
- C. Processing Requirements. The performance and cyclic repetition rates of these subfunctions will be under the control of the deorbit/landing user parameter processing sequencer (Section 4.1.2).
- D. Constraints. The parameter RAW\_RA\_PROC must be initialized to OFF. The flag RA\_FLAG must be initialized to OFF.
- E. Supplementary Information. All assumptions and explanations applicable to this section are defined in Section 4.4.2.

Suggested implementations of the H\_HDOT\_ACCVERT and GUIDECOMP subfunctions in the form of detailed flow charts are shown in Section 5.6.



Table 4.6.2.2-1. Input Parameters for Basic TAEM Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S		ft	As per sequencer
Earth-fixed to selected RW transformation matrix	M_EFTORW	*	M	S		—	As per sequencer
The constant PI	PI	Constants	F	S		rad	As per sequencer
Cosine of Shuttle's Euler pitch angle (TD to body)	COSTH	*	F	S		—	As per sequencer
Sine of Shuttle's Euler pitch angle (TD to body)	SINTH	*	F	S		—	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Position vector of runway in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Body rate in degrees/second	$\bar{W}BR$	*	V	S		deg/sec	As per sequencer
X_STRUCT_BODY distance from navigation base to c.g.	X_NB_CG	K-load	F	S		ft	As per sequencer
Earth-relative velocity in M50 coordinates	$\bar{V}_{RHO}$	UPP state propagation	V	S		ft/sec	As per sequencer
TAEM guidance termination flag	TG_END	*	Bit		ON/OFF	—	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	UPP state propagation	V	DP		ft/sec	As per sequencer
Flag indicating UPP state has been updated by navigation filter	UPP_UPDATE	UPP state propagation	D	—	OFF/ON	—	As per sequencer
X_STRUCT_BODY distance from navigation base to rear wheels	X_NB_WH	Hard code	F	S		ft	As per sequencer
Z_STRUCT_BODY distance from c.g. to navigation base	Z_NB_CG	K-load	F	S		ft	As per sequencer
Z_STRUCT_BODY distance from rear wheels to navigation base	Z_NB_WH	Hard code	F	S		ft	As per sequencer
Current landing site selection index	RW_NAME	*	I	S	1-90	—	As per sequencer
Correction factor from radians to degrees	DEG_PER_RAD	K-load	F	S		deg/rad	As per sequencer
Altitude regions for nav event lamp processing	$\bar{ALT\_EL}$	K-load	V	S		ft	As per sequencer

Table 4.6.2.2-1. Input Parameters for Basic TAEM Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Number of sequential failures of the test criteria allowed before activating the nav event lamp	N_SEQ_MAX	K-load	I	S		—	As per sequencer
Unit vector in direction of earth's axis of rotation	EARTH_POLE	*	V	DP		—	As per sequencer
Earth equatorial radius	EARTH_RADIUS_EQUATOR	Constant	F	DP		ft	As per sequencer
Earth ellipticity constant	ELLIPT	Constant	F	DP		—	As per sequencer
IMU selection filter control vector	IMU_SFC	*	V	S	0, 1	—	As per sequencer
Number of radians per degree	RAD_PER_DEG	Constant	F	S		rad/deg	As per sequencer
Major Mode 305 flag	MM_CODE_305	*	D	—	OFF/ON	—	As per sequencer
Data-good flag for radar altimeter	DG_RADALT	*	D	S	OFF/ON	—	As per sequencer
Threshold value of relative velocity below which the flag LD_GR_HYDR is set ON	LDGR_VEL_THRSH	I-load	F	S		ft/sec	As per sequencer
Nav derived angle of attacks	ALPHA_N	*	F	S		deg	As per sequencer
Flag denoting various phases of TAEM guidance	IPHASE	*	I		0-6		As per sequencer
Flag denoting crew request to change approach type (OVHD/STRT)	TOGHAC	*	Bit		OFF/ON		As per sequencer
Body pitch attitude Euler angle	THETA	*	F	S		deg	As per sequencer
Selected radar altimeter height	Q_RADALT	*	F	S		ft	As per sequencer
Radar altimeter time tag	RA_TIME	*	F	DP		sec	As per sequencer
Overhead/straight-in indicator	OVHD	*	D		OFF/ON	—	

\* See principal function input list in Table 4.6.2.4-1.

Table 4.6.2.2-2. Output Parameters From Basic TAEM Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Vertical components of vehicle c.g. acceleration WRT earth rotating frame	ACC_VERT	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Current Orbiter altitude above reference ellipsoid	ALT	*	F	S		ft	As per sequencer
Vehicle velocity direction WRT runway centerline	COURSE_WRT_RW	*	F	S	0 to 360	deg	As per sequencer
Component of relative velocity normal to RW local ellipsoid	H_DOT_ELLIPSOID	*	F	S		ft/sec	As per sequencer
Downrange position WRT the runway	POSITION_WRT_RUNWAY <sub>1</sub>	*	F	S		ft	As per sequencer
Crossrange position WRT the runway	POSITION_WRT_RUNWAY <sub>2</sub>	*	F	S		ft	As per sequencer
Altitude position WRT the runway	POSITION_WRT_RUNWAY <sub>3</sub>	*	F	S		ft	As per sequencer
Shuttle position vector in earth-fixed coordinates	$\bar{R}_{EF}$	*	V	DP		ft	As per sequencer
Magnitude of vehicle relative velocity	REL_VEL_MAG	*	F	S		ft/sec	As per sequencer
Downrange velocity WRT the runway	VELOCITY_WRT_RUNWAY <sub>1</sub>	*	F	S		ft/sec	As per sequencer
Crossrange velocity WRT the runway	VELOCITY_WRT_RUNWAY <sub>2</sub>	*	F	S		ft/sec	As per sequencer
Vehicle relative velocity in EF coordinates	$\bar{V}_{RHO\_EF}$	*	V	S		ft/sec	As per sequencer
Vehicle c.g. groundspeed WRT runway (A/L), reference ellipsoid (TAEM)	V_GROUNDSPEED	*	F	S		ft/sec	As per sequencer
Drag acceleration	ACC_DRAG	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Flight path angle	FLT_PATH_ANG	*	F	S		deg	As per sequencer
Altitude of rear wheels above the altitude of the runway	ALT_WHEELS	*	F	S		ft	As per sequencer
Current landing site selection index for use by guidance	RW_ID_UPP	*	I	S	0-90		As per sequencer
Radar altimeter processing flag	RAW_RA_PROC	*	D	—	OFF/ON	—	As per sequencer

Table 4.6.2.2-2. Output Parameters From Basic TAEM Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Flag sent to MSC to initiate LND_GEAR_VLV_CNTL	LD_GR_HYDR	*	D	—	OFF/ON	—	As per sequencer
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GPS_UPP_DISP_COMPS	M(3)	DP		-	As per sequencer
Nav derived angle of attack for use in NAVAID SOP	ALPHA_NAVDAD	*	F	S		deg	As per sequencer
Radar altimeter crew alert, HUD	RA_FLAG	*	D		OFF/ON	—	As per sequencer
Flag denoting overhead or straight-in approach	OVHD	*	Bit		OFF/ON	—	As per sequencer
Commanded HAC side of primary runway	YSGNP	*	I		±1	—	As per sequencer
Turn angle of HAC of primary runway	PSHA	*	F	S		deg	As per sequencer
Area Nav HAC indicator initialization flag	FIRST_PASS	*	Bit		OFF/ON	—	As per sequencer
Flag denoting TAEM guidance request to downmode	OHALRT	*	Bit		OFF/ON	—	As per sequencer
Radius of HAC of selected runway	R_NEP	*	F	S		ft	As per sequencer
Magnitude of $\bar{R}_{AVGG}$	R_VEH_MAG_UPP	*	F	DP		ft	As per sequencer

\* See principal function output list in Table 4.6.2.4-2.

### 4.6.2.3 TACAN and GPS Display Computations

This section describes the requirements for the TACAN display computations and the GPS display computations which provide tabular data to the Horizontal Situation Display during the TAEM flight phase.

#### 4.6.2.3.1 TACAN Display Computations

This subfunction provides TACAN data for the Horizontal Situation Display (HSD) during the TAEM flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.4.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.2.3.1-1 and 4.6.2.3.1-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is given in Section 5.6, TACAN\_DISP\_COMPS.

Table 4.6.2.3.1-1. TACAN Display Computations Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating "ON" when ABS_MODE is selected for HSD display and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE	*	Bit		ON/OFF	—	As per sequencer
Switch indicating (ON) when a valid TACAN channel has been selected	TACAN_CHAN_VALID_SL <sub>I</sub>	*	Bit		ON/OFF	—	As per sequencer
TACAN range data obtained from the SOP for each receiver, I = 1,3	TACRANGE <sub>O<sub>I</sub></sub>	*	Arr	S		ft	As per sequencer
TACAN bearing data obtained from the SOP for each receiver, I = 1,3	TACBEAR <sub>O<sub>I</sub></sub>	*	Arr	S	0, 2 π	rad	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S		deg/rad	As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nmi/ft	As per sequencer
Shuttle position vector in earth-fixed coordinates	$\bar{R}_{EF}$	GUIDE-COMP	V	DP		ft	As per sequencer
TACAN station earth-fixed position vector obtained from Site Lookup for Ith receiver	$\bar{R}_{TACAN\_EF\_SL_I}$	*	Arr	S		ft	As per sequencer
Variation of magnetic north from true north at TACAN site obtained from Site Lookup for Ith receiver	ANGLE_CORR_TNTOMAG_SL <sub>I</sub>	*	Arr	S		rad	As per sequencer
The constant PI	PI	Constant	F	S		rad	As per sequencer
Transformation matrix from earth-fixed to topodetic coordinates at the Ith TACAN site	M_EFTOTD_TACAN_SL <sub>I</sub>	*	M(3)				As per sequencer
Number of GPS receiver installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	-	As per sequencer
* See principal function input list Table 4.6.3.4-1.							
** I = 1, 2, 3 (1 to GPS_SW_CAP)							

Table 4.6.2.3.1-2. TACAN Display Computations Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Feedback switch indicating "ON" when ABS_MODE is selected on HSD DISP and "OFF" when DELTA_MODE is selected.	TAC_GPS_MODE_DISP	*	D		ON/OFF	—	As per sequencer
TACAN azimuth for display in the ABS_MODE or delta azimuth when in DELTA_MODE	TAC_AZ <sub>i</sub>	*	Arr	S		deg	As per sequencer
TACAN range for display in the ABS_MODE or delta range when in the DELTA_MODE	TAC_RNG <sub>i</sub>	*	Arr	S		nmi	As per sequencer
* See principal function output list Table 4.6.3.4-2.							

#### 4.6.2.3.2 GPS Display Computations

This subfunction provides GPS data for the Horizontal Situation Display (HSD) during the TAEM flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.6.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.2.3.2-1 and 4.6.2.3.2-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is given in Section 5.6, GPS\_UPP\_DISP\_COMPS.

The earth fixed position vector  $R\_TACAN\_EF\_AUTO$ , magnetic variation  $ANGLE\_CORR\_TNTOMAG\_AUTO$  and the earth-fixed to topodetic transformation matrix  $M\_EFTOTD\_TACAN\_AUTO$ , corresponding to the auto selected TACAN station, are obtained from the Entry Site Lookup Initialization subfunction. The auto selected TACAN station is that shown in Item 5 of the Horizontal Situation Display.

To insure a valid compare with the TACAN display computation data, the GPS state from each receiver,  $R\_GPS\_ECEF\_SOP_i$ , shall be extrapolated to the User Parameter State vector time tag using the receivers value of earth fixed velocity,  $V\_GPS\_ECEF\_SOP_i$ , times the extrapolation time interval. This extrapolation will occur for each receiver before the display related computations are executed.



Table 4.6.2.3.2-1. GPS Display Computation Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S	--	ft	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S	--	deg/rad	As per sequencer
GPS data good flag	GPS_DG_SOP(1)**	*	D	--	ON/OFF	--	As per sequencer
Coordinate transformation matrix from 1984 World Geodetic Survey to earth fixed	M_WGS84_TO_EF	I-load	M	D	--	--	As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S	--	nmi/ft	As per sequencer
The constant PI	PI	Constant	F	S	--	rad	As per sequencer
Shuttle position vector in earth fixed coordinates	R_EF	GUIDE_COMP	V	DP	--	ft	As per sequencer
Time tag for current GPS receiver I data	T_GPS_SOP(I)***	*	S	DP	--	sec	As per sequencer
Switch indicating "ON" when ABS_MODE is selected for HSD display and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE	*	D	--	ON/OFF	--	As per sequencer
Earth fixed velocity vector of GPS receiver I	V_GPS_ECEF_SOP(1)**	*	V	SP	--	ft/sec	As per sequencer
Earth fixed position vector of I <sup>th</sup> GPS receiver	$\bar{R}_{GPS\_ECEF\_SOP_I}^{**}$	*	V	DP	—	ft	As per sequencer
Maximum number of receivers for which the software is designed	GPS_SW_CAP	K-Load	INT	—	3	—	As per sequencer
SArray indicating which GPS receivers are installed on the vehicle	GPS_INSTALLED <sub>I</sub> **	I-Load/ K-Load	Bit	—	0,1	—	As per sequencer
Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector	$\bar{G}_{GPS\_UPP}$	*	V	S		ft/sec <sup>2</sup>	As per sequencer

Table 4.6.2.3.2-1. GPS Display Computation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
I-load time staleness limit used in setting GPS UPP display computation GPS range, azimuth, altitude status indicator	GPS_UPP_TIME_STALENESS_LIM	I-load	F	S		sec	As per sequencer
Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset	GPS_UPP_UPDATE	*	D	-		ON/OFF	As per sequencer
Transformation from earth-fixed to topodetic coordinates at the runway threshold	M_EFTOTD_RW	*	M(3)	DP		-	As per sequencer
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GUIDE_COMP	M(3)	DP		-	As per sequencer
Number of GPS receivers installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	-	As per sequencer
Selected GPS position vector reserved for reset of GPS UPP display computations position vector	$\bar{R}_{GPS\_UPP}$	*	V	DP		ft	As per sequencer
Position of landing site in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Time of the selected GPS state reserved for reset of GPS UPP display computations position vector	T_GPS_UPP	*	F	DP		sec	As per sequencer
Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector	$\bar{V}_{GPS\_UPP}$	*	V	S		ft/sec	As per sequencer

Table 4.6.2.3.2-1. GPS Display Computation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
IMU accumulated sensed velocity reserved for reset of GPS UPP display computations	$\bar{V}_{IMU\_GPS\_UPP}$	*	V	DP		ft/sec	As per sequencer
IMU accumulated sensed velocity							
Transformation matrix from earth-fixed to topodetic coordinates of the auto selected TACAN site	$M_{EFTOTD\_TACAN\_AUTO}$	*	M	DP	—	—	As per sequencer
Auto selected TACAN station earth-fixed position vector	$\bar{R}_{TACAN\_EF\_AUTO}$	*	V	DP	—	ft	As per sequencer
Variation of magnetic north from true north at the auto selected TACAN site	$ANGLE\_CORR\_TNTOMAG\_AUTO$	*	F	S	0 - $2\pi$	rad	As per sequencer
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	UPP state propagation	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	UPP state propagation	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	UPP state propagation	V	DP		ft/sec	As per sequencer
Flag indicating (ON) selected GPS states are available for use	GPS_SV_SEL_AVAIL	*	D	—	ON/OFF	—	As per sequencer

\* See principal function input list in Table 4.6.2.4-1.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Table 4.6.2.3.2-2. GPS Display Computation Output Parameters

Description	Symbol	Output Dest	Type	Precision	Range	Units	Sample Rate
Magnetic bearing to selected TACAN station derived from I'th GPS receiver	GPS_AZ <sub>I</sub> **	*	Array	S	0, 360	deg	As per sequencer
Range to selected TACAN station derived from I'th GPS receiver	GPS_RNG <sub>I</sub> **	*	Array	S	--	nmi	As per sequencer
Altitude above runway derived from I'th GPS receiver	GPS_ALT <sub>I</sub> **	*	Array	S	--	kft	As per sequencer
Buffered GPS UPP range data for downlist	GPS_UPP_DL(1)	*	F	S		nmi	As per sequencer
Buffered GPS UPP azimuth data for downlist	GPS_UPP_DL(2)	*	F	S		deg	As per sequencer
Buffered GPS UPP altitude data for downlist	GPS_UPP_DL(3)	*	F	S		kft	As per sequencer
Velocity relative to runway derived from the I'th GPS receiver state estimate	GPS_VEL_REL_TO_RW <sub>I</sub> **	*	F	S		kft/sec	As per sequencer
Derived magnetic bearing to runway from the selected GPS state	SEL_GPS_AZ	*	F	S		deg	As per sequencer
Derived range to runway from the selected GPS state	SEL_GPS_RNG	*	F	S		nmi	As per sequencer
Derived altitude above runway from the selected GPS state	SEL_GPS_ALT	*	F	S		kft	As per sequencer
Feedback switch indicating "ON" when ABS_MODE is selected on HSD DISP and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE_DISP	*	D	--	ON/OFF	--	As per sequencer
GPS UPP data status flag	GPS_RN_AZ_H_STAT	*	D	--	ON/OFF	--	As per sequencer

\* See principal function output list in Table 4.6.2.4-2.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

**4.6.2.4 TAEM User Parameter Processing (4.24) Principal Function Tables**

The principal function input/output parameters are given in Tables 4.6.2.4-1 and 4.6.2.4-2. The I-load and K-load parameters are given in Tables 4.6.2.4-3 and 4.6.2.4-4. The constants and variable cross-reference parameters are given in Tables 4.6.2.4-5 and the table below.

TAEM User Parameter Processing (4.24) Principal Function Variables Cross-Reference	
FSSR Name	Source Name
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	ANGLE_CORR_TNTOMAG_S1
ANGLE_CORR_TNTOMAG_SL <sub>2</sub>	ANGLE_CORR_TNTOMAG_S2
ANGLE_CORR_TNTOMAG_SL <sub>3</sub>	ANGLE_CORR_TNTOMAG_S3
M_EFTOTD_TACAN_SL <sub>1</sub>	M_EFTOTD_TACAN_SL1
M_EFTOTD_TACAN_SL <sub>2</sub>	M_EFTOTD_TACAN_SL2
M_EFTOTD_TACAN_SL <sub>3</sub>	M_EFTOTD_TACAN_SL3
R_TACAN_EF_SL <sub>1</sub>	R_TACAN_EFSL1
R_TACAN_EF_SL <sub>2</sub>	R_TACAN_EFSL2
R_TACAN_EF_SL <sub>3</sub>	R_TACAN_EFSL3
TACAN_CHAN_VALID_SL <sub>1</sub>	TACAN_CHAN_VALID_SL1
TACAN_CHAN_VALID_SL <sub>2</sub>	TACAN_CHAN_VALID_SL2
TACAN_CHAN_VALID_SL <sub>3</sub>	TACAN_CHAN_VALID_SL3
T_STATE	T_IMUS
V_IMU_CURRENT	SEL_V_M50
WBR <sub>2</sub>	Q_ORB
N/G = Not given	

TABLE 4.6.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ANGLE_CORR_TNTOMAG_AUTO	V90H0393CA	MAGNETIC VARIATION AT AUTO SEL TAC	ENT SITE LOOKUP	RAD	SPL		92049C	
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
COSTH	V90H2215C	EULER ANGLE PITCH COSINE	A/E ATT PROC				93090E	
DG_RADALT	V90X4003X	RALT HEIGHT DATA GOOD	SF		BD		93017G	*
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FILT_UPDATE	V90X0224XC	FLAG IND NAV FILTER PROC COMPLETE	PRELAND NAV					
FILT_UPDATE	V90X0224XD	FLAG IND NAV FILTER PROC COMPLETE	D/L NAV SEQ					
FILT_UPDATE	V90X0224XE	FLAG IND NAV FILTER PROC COMPLETE	ENT NAV					
GPS_DG_SOP(1)	V90X3012X	GPS 1 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(2)	V90X3013X	GPS 2 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(3)	V90X3014X	GPS 3 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_UPP_UPDATE	V90X3643XA	GPS UPP DISP RES STATE AVAIL FLAG	ENT NAV		BD		92067D	
GPS_UPP_UPDATE	V90X3643XB	GPS UPP DISP RES STATE AVAIL FLAG	PRELAND NAV		BD		92067D	
G_GPS_UPP(1)	V90A3630CA	SELECTED GPS STATE X GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(1)	V90A3630CB	SELECTED GPS STATE X GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CA	SELECTED GPS STATE Y GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CB	SELECTED GPS STATE Y GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CA	SELECTED GPS STATE Z GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CB	SELECTED GPS STATE Z GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CC	SEL X-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(1)	V90A0243CD	SEL X-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(1)	V90A0243CE	SEL X-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CC	SEL Y-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CD	SEL Y-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(2)	V90A0244CE	SEL Y-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(3)	V90A0245CC	SEL Z-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(3)	V90A0245CD	SEL Z-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(3)	V90A0245CE	SEL Z-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
IPHASE	V90J1117CA	TAEM GUIDANCE PHASE INDICATOR	TAEM GUID	ND			93017G	*
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					

TABLE 4.6.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTOTD_RW(1,1)	V90U3644CA	EF TO TOPO COORD AT RW 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,2)	V90U3645CA	EF TO TOPO COORD AT RW 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,3)	V90U3646CA	EF TO TOPO COORD AT RW 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2,1)	V90U3647CA	EF TO TOPO COORD AT RW 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-2)	V90U3648CA	EF TO TOPO COORD AT RW 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-3)	V90U3649CA	EF TO TOPO COORD AT RW 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-1)	V90U3650CA	EF TO TOPO COORD AT RW 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-2)	V90U3651CA	EF TO TOPO COORD AT RW 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-3)	V90U3652CA	EF TO TOPO COORD AT RW 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,1)	V90U3566CA	EF TO TOPO COORD, AUTO SEL TAC 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,2)	V90U3567CA	EF TO TOPO COORD, AUTO SEL TAC 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,3)	V90U3568CA	EF TO TOPO COORD, AUTO SEL TAC 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,1)	V90U3569CA	EF TO TOPO COORD, AUTO SEL TAC 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,2)	V90U3570CA	EF TO TOPO COORD, AUTO SEL TAC 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,3)	V90U3571CA	EF TO TOPO COORD, AUTO SEL TAC 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,1)	V90U3572CA	EF TO TOPO COORD, AUTO SEL TAC 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,2)	V90U3573CA	EF TO TOPO COORD, AUTO SEL TAC 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,3)	V90U3574CA	EF TO TOPO COORD, AUTO SEL TAC 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					

TABLE 4.6.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NUM_GPS_INSTALLED	V90U3671C	NUMBER OF GPS RCVRs INSTALLED	GPS SOP		HXS		92067D	
Q_ORB/Q	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			93017G	*
Q_RADALT	V90H4002C	SELECTED RALT HEIGHT-RAW	SF	FT	SPL		93017G	*
RA_TIME	V95W7000C	RADAR ALTIMETER TIME	RA SOP	S	DPL		93017G	*
RW_ID_UPP	V95X0234XA	OTT FIRST PASS FLAG	ENT SITE LOOKUP				90072	
RW_NAME	V90U1916CA	CURRENT LANDING SITE SELECTED	ENT SITE LOOKUP					
R_GPS_ECEF_SOP(1,1)	V90H3036C	GPS 1 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,2)	V90H3037C	GPS 1 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,3)	V90H3038C	GPS 1 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,1)	V90H3039C	GPS 2 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,2)	V90H3040C	GPS 2 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,3)	V90H3041C	GPS 2 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,1)	V90H3042C	GPS 3 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,2)	V90H3043C	GPS 3 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,3)	V90H3044C	GPS 3 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_UPP(1)	V90H3624CA	SELECTED GPS STATE X POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(1)	V90H3624CB	SELECTED GPS STATE X POS	PRELAND NAV	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CA	SELECTED GPS STATE Y POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CB	SELECTED GPS STATE Y POS	PRELAND NAV	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CA	SELECTED GPS STATE Z POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CB	SELECTED GPS STATE Z POS	PRELAND NAV	FT	DPL		92067D	
R_LS_EF(1)	V90H1900CA	X-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(2)	V90H1901CA	Y-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(3)	V90H1902CA	Z-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_RESET(1)	V90H0235CC	SEL X-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(1)	V90H0235CD	SEL X-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(1)	V90H0235CE	SEL X-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(2)	V90H0236CC	SEL Y-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(2)	V90H0236CD	SEL Y-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(2)	V90H0236CE	SEL Y-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(3)	V90H0237CC	SEL Z-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(3)	V90H0237CD	SEL Z-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(3)	V90H0237CE	SEL Z-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				



TABLE 4.6.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EF_AUTO(1)	V90H3575CA	X-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(2)	V90H3576CA	Y-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(3)	V90H3577CA	Z-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SINTH	V90H2216C	EULER ANGLE PITCH SINE	A/E ATT PROC				93090E	
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACBEARO(1)	V95H5122CA	TACAN NO 1 BEARING OUT	TACAN SOP	RAD				
TACBEARO(2)	V95H5222CA	TACAN NO 2 BEARING OUT	TACAN SOP	RAD				
TACBEARO(3)	V95H5322CA	TACAN NO 3 BEARING OUT	TACAN SOP	RAD				
TACRANGE0(1)	V95H5102CA	TACAN NO 1 RANGE OUT	TACAN SOP	FT				
TACRANGE0(2)	V95H5202CA	TACAN NO 2 RANGE OUT	TACAN SOP	FT				
TACRANGE0(3)	V95H5302CA	TACAN NO 3 RANGE OUT	TACAN SOP	FT				
TAC_GPS_MODE	V93X5015X	TACAN/GPS ABSOLUTE/DELTA DATA CMD	HORIZ SIT DISP		BD		91051K	
TG_END	V90X1108XA	TAEM GUIDANCE TERMINATION FLAG	TAEM GUID				93017G	*
THETA/THETA_TOPO	V90H2217C	BODY PITCH ATTITUDE EULER ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
TOGHAC	V93X4477X	R/L CONE CHG CMD	HORIZ SIT DISP		BD		90302B	
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS_SOP(1)	V90W3045C	GPS 1 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(2)	V90W3046C	GPS 2 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(3)	V90W3047C	GPS 3 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_UPP	V90W3636CA	TIME OF SELECTED GPS STATE	ENT NAV	S	DPL		92067D	
T_GPS_UPP	V90W3636CB	TIME OF SELECTED GPS STATE	PRELAND NAV	S	DPL		92067D	
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
T_IMU_SAVE_SOP(1)	V90W3048C	IMU TIME TAG FOR CURNT GPS 1 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(2)	V90W3049C	IMU TIME TAG FOR CURNT GPS 2 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(3)	V90W3050C	IMU TIME TAG FOR CURNT GPS 3 STATE	GPS SOP	S	DPL		92067D	
T_RESET	V90W0534CC	TIME OF FILTER STATE VECTOR	PRELAND NAV	S			93017G	*
T_RESET	V90W0534CD	TIME OF FILTER STATE VECTOR	D/L NAV SEQ	S			93017G	*
T_RESET	V90W0534CE	TIME OF FILTER STATE VECTOR	ENT NAV	S			93017G	*
V_GPS_ECEF_SOP(1,1)	V90L3051C	GPS 1 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,2)	V90L3052C	GPS 1 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,3)	V90L3053C	GPS 1 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,1)	V90L3054C	GPS 2 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,2)	V90L3055C	GPS 2 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,3)	V90L3056C	GPS 2 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,1)	V90L3057C	GPS 3 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,2)	V90L3058C	GPS 3 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	

TABLE 4.6.2.4-1. INPUT FUNCTIONAL PARAMETERS FOR TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GPS_ECEF_SOP(3,3)	V90L3059C	GPS 3 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_UPP(1)	V90L3627CA	SELECTED GPS STATE X VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(1)	V90L3627CB	SELECTED GPS STATE X VEL	PRELAND NAV	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CA	SELECTED GPS STATE Y VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CB	SELECTED GPS STATE Y VEL	PRELAND NAV	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CA	SELECTED GPS STATE Z VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CB	SELECTED GPS STATE Z VEL	PRELAND NAV	FT/S	SPL		92067D	
V_IMU_GPS_UPP(1)	V90L3633CA	SELECTED GPS STATE X ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(1)	V90L3633CB	SELECTED GPS STATE X ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CA	SELECTED GPS STATE Y ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CB	SELECTED GPS STATE Y ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CA	SELECTED GPS STATE Z ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CB	SELECTED GPS STATE Z ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_RESET(1)	V90L0247CC	SEL X-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(1)	V90L0247CD	SEL X-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(1)	V90L0247CE	SEL X-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(2)	V90L0248CC	SEL Y-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(2)	V90L0248CD	SEL Y-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(2)	V90L0248CE	SEL Y-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(3)	V90L0249CC	SEL Z-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(3)	V90L0249CD	SEL Z-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(3)	V90L0249CE	SEL Z-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_SAVE_SOP(1,1)	V95L0133C	IMU ACCUM X VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,2)	V95L0134C	IMU ACCUM Y VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,3)	V95L0135C	IMU ACCUM Z VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,1)	V95L0136C	IMU ACCUM X VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,2)	V95L0137C	IMU ACCUM Y VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,3)	V95L0138C	IMU ACCUM Z VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,1)	V95L0139C	IMU ACCUM X VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,2)	V95L0140C	IMU ACCUM Y VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,3)	V95L0141C	IMU ACCUM Z VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_RESET(1)	V90L0239CC	SEL X-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(1)	V90L0239CD	SEL X-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(1)	V90L0239CE	SEL X-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(2)	V90L0240CC	SEL Y-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(2)	V90L0240CD	SEL Y-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(2)	V90L0240CE	SEL Y-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(3)	V90L0241CC	SEL Z-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(3)	V90L0241CD	SEL Z-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(3)	V90L0241CE	SEL Z-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ACC_DRAG	V95A0160CC	DRAG DECEL	AMI PROC DL FMT 23/1 ENT NAV HUD PROC NAVDAD SOP TAEM GUID	FT/S2			93017G	*
ACC_VERT	V95A0170CD	VERTICAL ACCEL IN TOPODETTIC COORD	AVVI PROC TAEM GUID TLM	FT/S2				
ALPHA_NAVDAD ALT	V95H0233CB V95H0175CD	AVG NAVDAD ANGLE OF ATTACK CURR ORB ALT ABOVE REF ELLIPSOID	NAVDAD SOP ADTA SOP DL FMT 23/A ENT NAV GPS RCVR STATE PROC NAVDAD SOP PRELAND NAV	DEG FT	SPL		93017G	*
ALT_WHEELS	V95H0165CC	ALT TO REAR WHEELS/NAV BASE(ENTRY)	DL FMT 23/1 E/L ADI PROC E/L EV AN PROC ENT AREA NAV ENT BRG SPEC ENT NAV GPS SOP HORIZ SIT SPEC HUD PROC HYD SYS SOP PRELAND NAV TACAN RM TAEM GUID VERT SIT DIP	FT	DPL		93017G	*
COURSE_WRT_RW/PSD	V95H0225CB	COURSE WRT RW CENTERLINE	DL FMT 23/1 ENT AREA NAV ENT BRG SPEC HORIZ SIT SPEC MSBLS SOP TAEM GUID TLM	DEG			93017G	*
DG_RADALT FIRST_PASS FLT_PATH_ANG/GAMMA	V95X0460XB V95X0184XB V95H0261CA	SNAPPED RALT DATA GOOD AREA NAV HAC INIT FLAG GROUND-REL FLT PATH ANGLE	ENT AREA NAV DL FMT 23/1 TAEM GUID		SPECIAL		93017G	*
GPS_ALT(2)	V94H1045CB	GPS 2 ALT TO LDG SITE THRESH	HORIZ SIT DISP TLM	KFT	SPL		91051K	
GPS_AZ(2)	V94H1043CB	GPS 2 AZ TO SEL TAC STA	HORIZ SIT DISP TLM	DEG	SPL		91051K	
GPS_RNG(2)	V94H1044CB	GPS 2 RNG TO SEL TAC STA	HORIZ SIT DISP TLM	NM	SPL		91051K	

TABLE 4.6.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_RN_AZ_H_STAT	V94X1046XB	GPS 2 RNG/AZ/ALT STATUS	HORIZ SIT DISP		BD		92214A	
GPS_UPP_DL(1)	V94H1162CB	SEL GPS RNG FOR DL	DL FMT 23/1	NM	SPL		93017G	*
GPS_UPP_DL(2)	V94H1163CB	SEL GPS AZ FOR DL	DL FMT 23/1	DEG	SPL		93017G	*
GPS_UPP_DL(3)	V94H1164CB	SEL GPS ALT FOR DL	DL FMT 23/1	KFT	SPL		93017G	*
GPS_VEL_REL_TO_RW(1)	V94L6042CB	GPS 1 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	
GPS_VEL_REL_TO_RW(2)	V94L6043CB	GPS 2 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	
GPS_VEL_REL_TO_RW(3)	V94L6044CB	GPS 3 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	
H_DOT_ELLIPSOID/H_DOT	V95L0265CB	EST ALTITUDE RATE	ADTA SOP DL FMT 23/1 GPS SOP HUD PROC TAEM GUID	FT/S	SPL		93017G	*
OVHD	V95X0154XB	OVHD/STRT IND	VERT SIT DIP DL FMT 23/1 ENT AREA NAV ENT BRG SPEC	EVENT	BD		93017G	*
POSN_WRT_RW(1)/X	V95H0220CC	DOWNRANGE DISTANCE WRT RW	HORIZ SIT DISP DL FMT 23/1 ENT AREA NAV HORIZ SIT SPEC HUD PROC TAEM GUID	FT			93017G	*
POSN_WRT_RW(2)/Y	V95H0221CC	CROSSRANGE DISTANCE WRT RW	DL FMT 23/1 E/L ADI PROC ENT AREA NAV HORIZ SIT SPEC HUD PROC TAEM GUID	FT			93017G	*
POSN_WRT_RW(3)/Z	V95H0300CB	VERTICAL DISTANCE WRT RW	ENT AREA NAV HUD PROC TLM	FT				
PSHA	V95H0181CA	TURN ANG HAC	DL FMT 23/1 ENT AREA NAV TAEM GUID	DEG	SPL		93017G	*
RAW_RA_PROC	V90X8865XB	RADAR ALTIMETER PROCESSING FLAG	DL FMT 23/1				93017G	*
RA_FLAG	V90X0450XA	RADAR ALTIMETER CREW ALERT	HUD PROC					

TABLE 4.6.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
REL_VEL_MAG/V	V95L0151CD	GND REL VEL MAGNITUDE IN M50 SYS	ADTA SOP DL FMT 23/1 ENT AREA NAV ENT BRG SPEC ENT NAV GPS SOP LDG GEAR VLV CNTL NAVDAD SOP PRELAND NAV TAEM GUID VENT CNTL SEQ VERT SIT DIP	FT/S	SPL		93017G	*
RW_ID_UPP/RW_ID	V95U0205CB	INDEX OF CURRENT RW USED FOR UPP	E/L ADI PROC TAEM GUID TLM				90996G	
RW_NAME	V90U1916CD	CURRENT LANDING SITE SELECTED	DL FMT 23/A				93017G	*
R_AVGG(1)	V95H0185CD	X-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CD	Y-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CD	Z-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A ENT BRG SPEC GN&C/SM-PL IF	FT	DPL		93017G	*
R_EF(1)	V95H0155CC	ORBITER X POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
R_EF(2)	V95H0156CC	ORBITER Y POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
R_EF(3)	V95H0157CC	ORBITER Z POSITION EF(TOD)	ENT AREA NAV ENT BRG SPEC GN&C/SM-PL IF TACAN RM	FT	DPL		93090E	
SEL_GPS_ALT	V94H6036CB	SEL GPS ALT TO LDG SITE THRESH	HORIZ SIT DISP	KFT	SPL		92067D	
SEL_GPS_AZ	V94H6037CB	SEL GPS AZ TO LDG SITE THRESH	HORIZ SIT DISP	DEG	SPL		92067D	
SEL_GPS_RNG	V94H6038CB	SEL GPS RNG TO LDG SITE THRESH	HORIZ SIT DISP	NM	SPL		92067D	
TAC_AZ(1)	V95H0207CB	TACAN 1 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(2)	V95H0208CB	TACAN 2 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(3)	V95H0209CB	TACAN 3 AZIMUTH	HORIZ SIT DISP	DEG				

TABLE 4.6.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
TAC_GPS_MODE_DISP	V95X0227XB	TACAN/GPS ABS/DELTA DATA IND	HORIZ SIT DISP				91051K	
TAC_RNG(1)	V95H0201CB	TACAN 1 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(2)	V95H0202CB	TACAN 2 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(3)	V95H0203CB	TACAN 3 RANGE	HORIZ SIT DISP	NM				
T_SEC_GMT	V95W3890CD	TIME TAG EF STATE(TOD)	GN&C/SM-PL IF	S			93023D	
T_STATE	V95W0200CA	TIME TAG ASSOC WITH CURRENT STATE	DL FMT 23/A	S			93017G	*
			E/L ADI PROC					
			ENT BRG SPEC					
			HORIZ SIT SPEC					
VEL_WRT_RW(1)/XDOT	V95L0255CA	DOWNRANGE VEL WRT RW	DL FMT 23/1	FT/S			93017G	*
			HUD PROC					
			TAEM GUID					
VEL_WRT_RW(2)/YDOT	V95L0256CB	CROSSRANGE VEL WRT RW	DL FMT 23/1	FT/S			93017G	*
			HUD PROC					
			TAEM GUID					
VEL_WRT_RW(3)/ZDOT	V95L0257CC	VELOCITY WRT RUNWAY (3)	DL FMT 23/1	FT/S			93017G	*
			HUD PROC					
V_AVGG(1)	V95L0190CD	X-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC	FT/S	SPL		93017G	*
			DL FMT 23/A					
			ENT BRG SPEC					
			GN&C/SM-PL IF					
V_AVGG(2)	V95L0191CD	Y-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC	FT/S	SPL		93017G	*
			DL FMT 23/A					
			ENT BRG SPEC					
			GN&C/SM-PL IF					
V_AVGG(3)	V95L0192CD	Z-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC	FT/S	SPL		93017G	*
			DL FMT 23/A					
			ENT BRG SPEC					
			GN&C/SM-PL IF					
V_GROUNDSPEED/VH	V95L0178CC	GROUNDSPEED	E/L ADI PROC	FT/S			92389C	
			ENT AREA NAV					
			HORIZ SIT SPEC					
			HSI PROC					
			TACAN RM					
			TAEM GUID					
			TLM					
			VERT SIT DIP					
V_RHO(1)	V95L0215CC	X-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO(2)	V95L0216CC	Y-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO(3)	V95L0217CC	Z-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO_EF(1)	V95L3884CC	X VELOCITY VECTOR EF(TOD)	ENT AREA NAV	FT/S			93090E	
			ENT BRG SPEC					
			GN&C/SM-PL IF					
V_RHO_EF(2)	V95L3885CC	Y VELOCITY VECTOR EF(TOD)	ENT AREA NAV	FT/S			93090E	
			ENT BRG SPEC					
			GN&C/SM-PL IF					

TABLE 4.6.2.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM TAEM USER PARAMETER PROCESSING (G4.24)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_RHO_EF(3)	V95L3886CC	Z VELOCITY VECTOR EF(TOD)	ENT AREA NAV ENT BRG SPEC	FT/S			93090E	
YSGNP/YSGN	V95J0153CB	R/L CONE IND PRI RW	GN&C/SM-PL IF DL FMT 23/1 E/L ADI PROC ENT AREA NAV HORIZ SIT DISP HORIZ SIT SPEC MEDS FC GNC XFER TAEM GUID		SPL		93017G	*
	V90M3122PB	CGGB_RAW_RA_PROC_MFE	DL FMT 23/1				93017G	*
	V95M2885PB	LANDING OPTIONS	DL FMT 23/1				93017G	*
	V95X0235XC	VENT DOOR SEQ INIT	MSC		BD		89599C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.6.2.4-3. TAEM USER PARAMETER PROCESSING (G4.24) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_INSTALLED(1)	V97U2924C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(2)	V97U2831C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(3)	V97U2925C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_UPP_TIME_STALENESS_LIM	V97U3252C	SEC	F	S	D	P	G4.20 G4.23 G4.24 G4.25	00	GPD	92292B	
M_WGS84_TO_EF(1,1)	V97U2927C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	



TABLE 4.6.2.4-3. TAEM USER PARAMETER PROCESSING (G4.24) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(1,2)	V97U2928C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(1,3)	V97U2929C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,1)	V97U2930C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,2)	V97U2931C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,3)	V97U2932C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.6.2.4-3. TAEM USER PARAMETER PROCESSING (G4.24) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(3,1)	V97U2933C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,2)	V97U2934C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,3)	V97U2935C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
PSHARS	V96U8647C	DEG	F	S	D	C	G4.19 G4.20 G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27	01 03	ZFU ZFU	93090E	
R1	V96U8263C	FT/DEG	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	

TABLE 4.6.2.4-3. TAEM USER PARAMETER PROCESSING (G4.24) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
R2	V96U8264C	FT/DEG**2	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
RESELVE	V99U7680C	FT/SEC	F	S	M	C	G4.220 G4.23 G4.24 G4.25 G5.27	00	VHS	93090E	
RFO	V96U8262C	FT	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
R_GO_RAMP	V97U5438C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
START_POSITION	V99U9569C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
STOP_POSITION	V99U9570C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
WT_GS1	V97U0444C	SLUGS	F	S	M	C	G4.10 G4.220 G4.23 G4.24 G4.25 G4.9 G5.27	00	GLC	93090E	

TABLE 4.6.2.4-3. TAEM USER PARAMETER PROCESSING (G4.24) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
X_HAC_HIGH_MASS	V96U8679C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	
X_HAC_LOW_MASS	V96U8678C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.6.2.4-4. TAEM USER PARAMETER PROCESSING (G4.24) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ALT_EL(1) ALT REGIONS NAV EV LAMP PROCESSING	V97U5212C	00	+1.4000000	E+05	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(2) ALT REGIONS NAV EV LAMP PROCESSING	V97U5213C	00	+1.2000000	E+04	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(3) ALT REGIONS NAV EV LAMP PROCESSING	V97U5214C	00	+5.0	E+03	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	90291B	
BIAS_RADALT RADAR ALTITUDE BIAS	V97U5253C	00	+0.0	E+00	FT	F	S	P G4.20 G4.23 G4.24 G4.25	89661A	
GPS_SW_CAP MAX NUM OF GPS LRU THAT SOFTWARE CAN HANDLE	V97U2923C	00	+3		ND	I	S	P G4.17 G4.18 G4.20 G4.21 G4.23 G4.24 G4.25	92069B	
N_SEQ_MAX NO OF FAILURES BEFORE NAV EV LAMP	V98U9435C	00	+7		ND	I	S	P G4.20 G4.24 G4.25	89661A	
TIME_BIAS_RADALT PAD LOAD CORR RAD ALT TIME	V97U5546C	00	+1.50	E-02	SEC	F	D	P G4.17 G4.20 G4.23 G4.24 G4.25	92069B	
X_NB_CG X_STRUCT_BODY DIST NAV BASE CG	V97U5573C	00	+5.61360	E+01	FT	F	S	C G4.20 G4.23 G4.24 G4.25 G5.27	93090E	

TABLE 4.6.2.4-4. TAEM USER PARAMETER PROCESSING (G4.24) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
Z_NB_CG Z_STRUCT_BODY DIS CG NAV BASE	V97U5580C	00	+4.0580	E+00 FT	F		S C	G4.20 G4.23 G4.24 G4.25 G5.27	93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.6.2.4-5. TAEM USER PARAMETER PROCESSING (G4.24) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S C	A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.6.2.4-5. TAEM USER PARAMETER PROCESSING (G4.24) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RADIUS_EQUATOR EARTH EQUATORIAL RADIUS	V97U5324C	00	+2.09257414698E+07	FT	F		D C	A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.19 G4.20 G4.205 G4.210 G4.211 G4.213 G4.23 G4.236 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	
ELLIPT EARTH'S ELLIPTICITY CONSTANT	V97U5332C	00	+3.352329869 E-03	ND	F		D C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.19 G4.20 G4.205 G4.213 G4.23 G4.236 G4.237 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	
LDGR_VEL_THRSH THRESHOLD OF RELATIVE VELOCITY BELOW WHICH LD_GR_HYDR IS SET	V97U6144C	00	+8.0000	E+03 FT/SEC	F		S P	G4.23 G4.24	90102D	



TABLE 4.6.2.4-5. TAEM USER PARAMETER PROCESSING (G4.24) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04	NMI/FT	F	S	C A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	
X_NB_WH DISTANCE FROM THE NAVIGATION BASE	V97U6219C	00	+6.2784	E+01	FT	F	S	P G4.19 G4.20 G4.24 G4.25	90374C	
Z_NB_WH DISTANCE FROM THE WHEEL TO THE NAVIGATION BASE	V97U6158C	00	+2.2405	E+01	FT	F	S	C G4.19 G4.20 G4.24 G4.25	90374C	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

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### 4.6.3 Autoland User Parameter Processing (4.25)

This principal function will serve as the interface between navigation and users of navigation-related data during the approach/landing major mode. This function will maintain the vehicle state within the user parameter state propagation subfunction and shall:

1. Provide this state to users who require vehicle state parameters in mean-of-fifty (M50) coordinates and
2. Provide the software to transform this state for users who require nav state related parameters.

This function is controlled by the deorbit/landing user parameter sequencer and is composed of the following three subfunctions:

- a. User parameter state propagation (Section 4.6.3.1)
- b. Basic guidance-related computations (Section 4.6.3.2)
- c. TACAN and GPS display computations (Section 4.6.3.3)

The input and output lists for this principal function may be found in Tables 4.6.3.4-1 and 4.6.3.4-2, and are summarized in Table 4.6.3.

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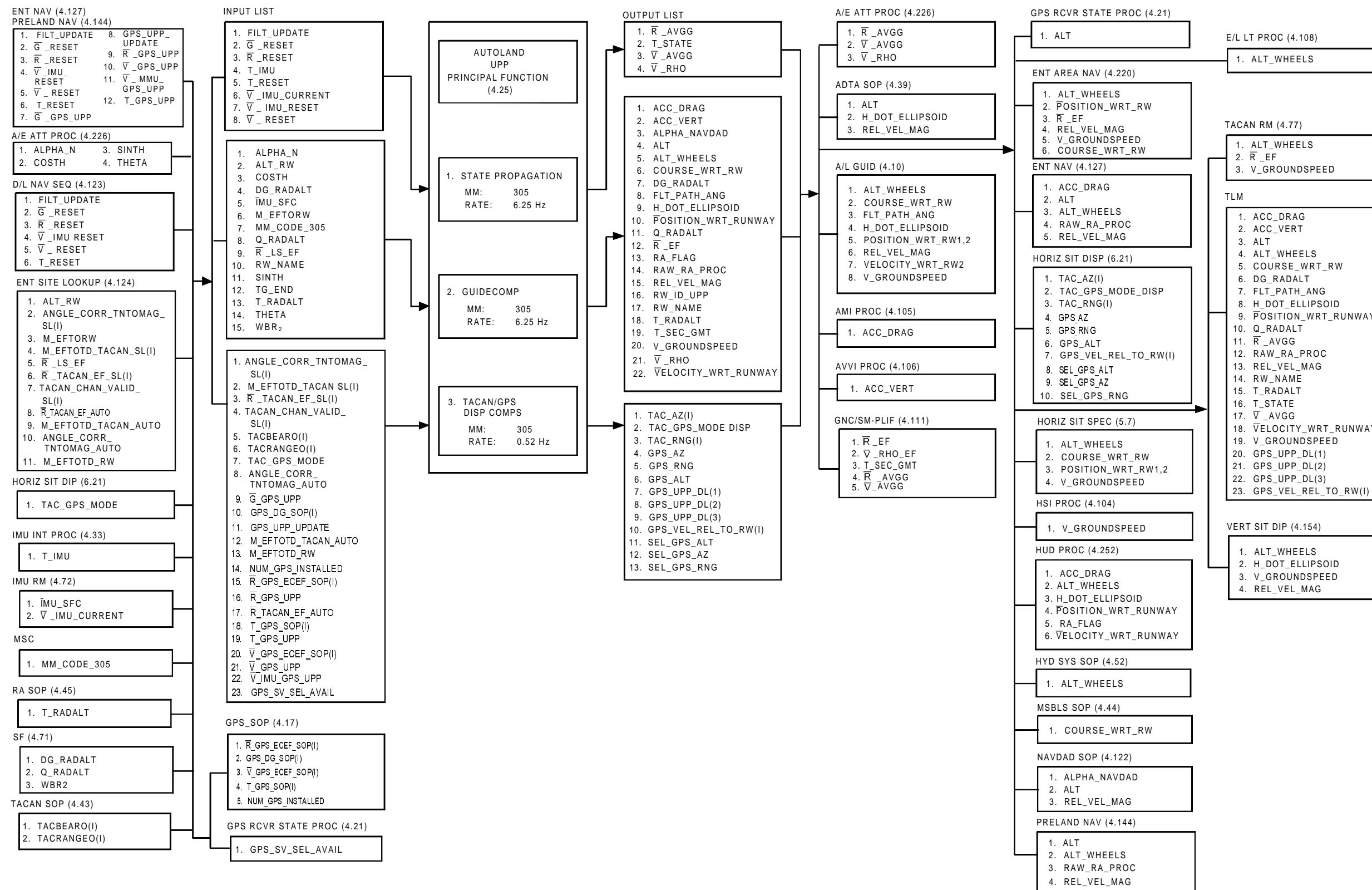


FIGURE 4.6-3. Autoland User Parameter Processing Principal Function Interface Diagram

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#### 4.6.3.1 User Parameter State Propagation

This subfunction will provide state vector information to users such as guidance and displays during the autoland phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.1.
- B. Interface Requirements. The input and output required are listed in Tables 4.6.3.1-1 and 4.6.3.1-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flowchart is to be found in Section 5.6, USER\_PARAM\_PROPAGATOR.

Table 4.6.3.1-1. Autoland User Parameter State Propagation Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating (ON) that the current nav cycle is complete	FILT_UPDATE	*	D	—	OFF/ON	—	Nav rate
Modeled acceleration at start of Shuttle state integration interval	$\bar{G}$ _RESET	*	V	S		ft/sec <sup>2</sup>	Nav rate
Vehicle position vector after all navigation updates reserved for reset of user parameter integrator position vector $\bar{R}$ _AVGG	$\bar{R}$ _RESET	*	V	DP		ft	Nav rate
Time associated with currently read IMU velocity counts from the IMU detection filter (RM)	T_IMU	*	F	DP		sec	As per sequencer
Time associated with reserved reset state	T_RESET	*	F	DP		sec	Nav rate
Current selected accumulated IMU velocity	$\bar{V}$ _IMU_CURRENT	*	V	DP		ft/sec	As per sequencer
Copy of $\bar{V}$ _CURRENT_FILT reserved as velocity count at start of extrapolation interval when user parameter integrator is reset	$\bar{V}$ _IMU_RESET	*	V	DP		ft/sec	Nav rate
Vehicle velocity vector after all navigation updates reserved for reset of user parameter integrator velocity vector $\bar{V}$ _AVGG	$\bar{V}$ _RESET	*	V	S		ft/sec	Nav rate

\* See principal function input list Table 4.6.3.4–1.



Table 4.6.3.1-2. Autoland User Parameter State Propagation Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	GPS_UPP_DISP_COMPS	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	*, AUTO-LAND UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	*, AUTO-LAND UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	*, AUTO-LAND UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	S		ft/sec	As per sequencer
Vehicle relative velocity vector in M50 coordinates	$\bar{V}_{RHO}$	*, AUTO-LAND UPP GUIDE-COMP	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	AUTO-LAND UPP GUIDE-COMP, GPS_UPP_DISP_COMPS	V	DP		ft/sec	As per sequencer
* See principal function output list in Table 4.6.3.4-2.							

#### 4.6.3.2 Basic Guidance–Related Computations (GUIDECOMP)

These subfunctions will provide the required software to transform the user parameter state into the related parameters required by users of navigation–derived data during the Autoland guidance phase.

- A. Detailed Requirements. It is required to calculate the parameters in the Guidecomp subfunction detailed in Section 4.4.2 during the Autoland guidance phase.
- B. Interface Requirements. The input and output requirements for the Autoland and rollout guidance parameters are listed in Tables 4.6.3.2–1 and 4.6.3.2–2.
- C. Processing Requirements. This subfunction will be performed at the repetition rate specified by the deorbit/landing user parameter processing sequencer (Section 4.1.2).
- D. Constraints. The parameter N\_SEQ\_RA must be initialized to a value of one. The flag RA\_FLAG must be initialized to OFF.
- E. Supplementary Information. All assumptions and explanations applicable to this section are defined in Section 4.4.2.

Suggested implementations of the GUIDECOMP subfunction in the form of detailed a detailed flowchart is shown in Section 5.6.

Table 4.6.3.2-1. Input Parameters for Basic Autoland Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Earth-fixed to selected RW transformation matrix	M_EFTORW	*	M	S		—	As per sequencer
The constant PI	PI	Constants	F	S		rad	As per sequencer
Cosine of Shuttle's pitch Euler angle (TD to body)	COSTH	*	F	S		—	As per sequencer
Sine of Shuttle's pitch Euler angle (TD to body)	SINTH	*	F	S		—	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Preset value of horizontal distance of vehicle from RW reference point below which radar altimeter measurements will be incorporated into UPP vertical position WRT runway	R_GO_RAMP	Design dependent	F	S		ft	As per sequencer
Position vector of runway in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Altitude of runway WRT reference ellipsoid	ALT_RW	*	F	S		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Body rate in degrees/second	$\bar{WBR}$	*	V	S		deg/sec	As per sequencer
X_STRUCT_BODY distance from navigation base to c.g.	X_NB_CG	K-load	F	S		ft	As per sequencer
X_STRUCT_BODY distance from navigation base to rear wheels	X_NB_WH	Constant	F	S		ft	As per sequencer
Z_STRUCT_BODY distance from c.g. to navigation base	Z_NB_CG	K-load	F	S		ft	As per sequencer

Table 4.6.3.2-1. Input Parameters for Basic Autoland Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Z_STRUCT_BODY distance from rear wheels to navigation base	Z_NB_WH	Constant	F	S		ft	As per sequencer
Pitch angle	THETA	*	F	S		deg	As per sequencer
Conversion from radians to degrees	DEG_PER_RAD	Constants	F	S		deg/rad	As per sequencer
Earth-relative velocity in M50 coordinates	$\bar{V}$ _RHO	UPP state propagation	V	S		ft/sec	As per sequencer
TAEM guidance termination flag	TG_END	*	Bit	—	OFF/ON	—	As per sequencer
Angle between body X-axis and c.g. to RA antenna vector	RADALT_ANG	Constant	F	S		rad	As per sequencer
Radar altimeter measurement	Q_RADALT	*	F	S		ft	As per sequencer
Radar altitude bias	BIAS_RADALT	Constant	F	S		ft	As per sequencer
Radar measurement time tag	RA_TIME	*	F	DP		sec	As per sequencer
Navigation base to antenna distance	RADALT_NB_DIST	Constant	F	S		ft	As per sequencer
Pad loaded bias used to correct radar altimeter time tag	TIME_BIAS_RADALT	K-load	F	DP		sec	As per sequencer
Data-good flag for radar altimeter	DG_RADALT	*	D	S	OFF/ON	—	As per sequencer
Altitude regions for nav event lamp processing	$\bar{A}$ L_T_EL	K-load	V	S		ft	As per sequencer
Number of sequential failures of the test criteria allowed before activating the nav event lamp	N_SEQ_MAX	K-load	I	S		—	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}$ _IMU_OLD	UPP state propagation	V	DP		ft/sec	As per sequencer
IMU selection filter control vector	$\bar{I}$ MU_SFC	*	V	S	0,1	—	As per sequencer
Previous value of H_DOT_ELLIPSOID	H_DOT_LAST	H_HDOT_ACCVERT	F	S		ft/sec	As per sequencer
Conversion from degrees to radians	RAD_PER_DEG	Constant	F	S		rad/deg	As per sequencer

Table 4.6.3.2-1. Input Parameters for Basic Autoland Guidance-Related Computations							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Current selected landing site selection symbol	RW_NAME	*	I	S	1-90	—	As per sequencer
Value of T_STATE at previous pass through UPP	T_STATE_LAST	H_HDOT_ACCVERT	F	DP		sec	As per sequencer
Major Mode 305 flag	MM_CODE_305	*	D	—	OFF/ON	—	As per sequencer
Nav derived angle of attack	ALPHA_N	*	F	S		deg	As per sequencer
MSBLS elevation measurement bias	BIAS_ELMLS	*	F	S		ft	As per sequencer
MLS availability	MLS_AVAIL	*	D	S	OFF/ON	—	As per sequencer
X-runway position where conversion from horizontal to sloping runway coordinates begins	START_POSITION	I-load	F	S		ft	As per sequencer
X-runway position where conversion from horizontal to sloping runway coordinates is completed	STOP_POSITION	I-load	F	S		ft	As per sequencer
* See principal function input list in Table 4.6.3.4-1.							

Table 4.6.3.2-2. Outputs from Basic Autoland Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Current Orbiter altitude above ellipsoid at runway	ALT	*	F	S		ft	As per sequencer
Altitude of rear wheels above runway altitude tangent plane	ALT_WHEELS	*	F	S		ft	As per sequencer
Vehicle velocity direction WRT runway centerline	COURSE_WRT_RW	*	F	S	0 to 360	deg	As per sequencer
Angle between navigation base relative velocity vector and ellipsoid horizontal	FLT_PATH_ANG	*	F	S		deg	As per sequencer
Downrange position WRT the runway	POSITION_WRT_RUNWAY <sub>1</sub>	*	F	S		ft	As per sequencer
Crossrange position WRT the runway	POSITION_WRT_RUNWAY <sub>2</sub>	*	F	S		ft	As per sequencer
Altitude position WRT the runway	POSITION_WRT_RUNWAY <sub>3</sub>	*	F	S		ft	As per sequencer
Magnitude of vehicle earth relative velocity	REL_VEL_MAG	*	F	S		ft/sec	As per sequencer
Crossrange velocity WRT the runway	VELOCITY_WRT_RUNWAY <sub>2</sub>	*	F	S		ft/sec	As per sequencer
Vehicle c.g. groundspeed WRT runway (A/L), reference ellipsoid (TAEM)	V_GROUNDSPEED	*	F	S		ft/sec	As per sequencer
Component of c.g. relative velocity normal to RW ellipsoid	H_DOT_ELLIPSOID	*	F	S		ft/sec	As per sequencer
Drag acceleration	ACC_DRAG	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Vertical component of vehicle c.g. acceleration WRT earth rotating frame	ACC_VERT	*	F	S		ft/sec <sup>2</sup>	As per sequencer
Shuttle position vector in earth-fixed coordinates	R_EF	*	V	DP		ft	As per sequencer
Radar altimeter processing flag	RAW_RA_PROC	*	D	—	OFF/ON	—	As per sequencer

Table 4.6.3.2-2. Outputs from Basic Autoland Guidance-Related Computations							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Vehicle relative velocity in EF coordinates	$\bar{V}_{RHO\_EF}$	*	V	S		ft/sec	As per sequencer
Downrange velocity WRT the runway	VELOCITY_WRT_RUNWAY <sub>1</sub>	*	F	S		ft/sec	As per sequencer
Current landing site selection index for use by guidance	RW_ID_UPP	*	I	S	0-90		As per sequencer
Nav derived angle of attack for use in NAVAID SOP	ALPHA_NAVDAD	*	F	S		deg	As per sequencer
Radar altimeter crew abort	RA_FLAG	*	D		OFF/ON	—	As per sequencer
Radar altimeter measurement	Q_RADALT	*	F	S		ft	As per sequencer
Radar altimeter measurement time tag (biased)	T_RADALT	*	F	DP		sec	As per sequencer
Data-good flag for radar altimeter	DG_RADALT	*	D		OFF/ON	—	As per sequencer
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GPS_UPP_DISP_COMPS	M(3)	DP		-	As per Sequencer
* See principal function output list in Table 4.6.3.4-2.							

### 4.6.3.3 TACAN and GPS Display Computations

This section describes the requirements for the TACAN display computations and the GPS display computations which provide tabular data to the Horizontal Situation Display during the APPROACH/LANDING flight phase.

#### 4.6.3.3.1 TACAN Display Computations

This subfunction will provide TACAN data for the Horizontal Situation Display (HSD) during the APPROACH/LANDING flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.4.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.3.3.1-1 and 4.6.3.3.1-2, respectively.
- C. Processing Requirements. None.
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flowchart is given in Section 5.6, TACAN\_DISP\_COMPS.



Table 4.6.3.3.1-1. TACAN Display Computations Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Switch indicating "ON" when ABS_MODE is selected for HSD display and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE	*	Bit		ON/OFF		As per sequencer
Switch indicating (ON) when a valid TACAN channel has been selected	TACAN_CHAN_VALID_SL <sub>I</sub>	*	Bit		ON/OFF		As per sequencer
TACAN range data obtained from the SOP for each receiver, I = 1, 3	TACRANGE <sub>I</sub>	*	Arr	S		ft	As per sequencer
TACAN bearing data obtained from the SOP for each receiver, I = 1, 3	TACBEAR <sub>I</sub>	*	Arr	S	0, 2 $\pi$	rad	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S		deg/rad	As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S		nmi/ft	As per sequencer
Shuttle position vector in earth-fixed coordinates	$\bar{R}_{EF}$	GUIDE-COMP	V	DP		ft	As per sequencer
TACAN station earth-fixed position vector obtained from Site Lookup for Ith receiver	$\bar{R}_{TACAN\_EF\_SL_I}$	*	Arr	S		ft	As per sequencer
Variation of magnetic north from true north at TACAN site obtained from Site Lookup for Ith receiver	ANGLE_CORR_TNTOMAG_SL <sub>I</sub>	*	Arr	S		rad	As per sequencer
The constant PI	PI	Constant	F	S		rad	As per sequencer
Transformation matrix from earth-fixed to topodetic coordinates at the Ith TACAN site	M_EFTOTD_TACAN_SL <sub>I</sub>	*	M(3)				As per sequencer
Number of GPS receivers installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	-	As per sequencer

\* See principal function input list and Table 4.6.3.4-1

Table 4.6.3.3.1-2. TACAN Display Computations Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Feedback switch indicating "ON" when ABS_MODE is selected on HSD DISP and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE_DISP	*	D		ON/OFF		As per sequencer
TACAN azimuth for display in the ABS_MODE or delta azimuth when in DELTA_MODE	TAC_AZ <sub>i</sub>	*	Arr	S		deg	As per sequencer
TACAN range for display in the ABS_MODE or delta range when in the DELTA_MODE	TAC_RNG <sub>i</sub>	*	Arr	S		nmi	As per sequencer
* See principal function output list in Table 4.6.3.4-2							

#### 4.6.3.3.2 GPS Display Computations

This subfunction provides GPS data for the Horizontal Situation Display (HSD) during the APPROACH/LANDING flight phase.

- A. Detailed Requirements. The detailed requirements for this subfunction are contained in Section 4.4.6.
- B. Interface Requirements. The inputs and outputs required are listed in Tables 4.6.3.3.2-1 and 4.6.3.3.2-2 respectively.
- C. Processing Requirements. None
- D. Constraints. None.
- E. Supplementary Information. A suggested implementation in the form of a detailed flow chart is given in Section 5.6, GPS\_UPP\_DISP\_COMPS.

The earth fixed position vector R\_TACAN\_EF\_AUTO, magnetic variation ANGLE\_CORR\_TNTOMAG\_AUTO and the earth-fixed to topodetic transformation matrix M\_EFTOTD\_TACAN\_AUTO, corresponding to the auto selected TACAN station, are obtained from the Entry Site Lookup Initialization subfunction. The auto selected TACAN station is that shown in Item 5 of the Horizontal Situation Display.

To insure a valid compare with the TACAN display computation data, the GPS state from each receiver,  $R\_GPS\_ECEF\_SOP_i$ , shall be extrapolated to the User Parameter State vector time tag using the receivers value of earth fixed velocity,  $V\_GPS\_ECEF\_SOP_i$ , times the extrapolation time interval. This extrapolation will occur for each receiver before the display related computations are executed.

Table 4.6.3.3.2-1. GPS Display Computation Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Altitude above reference ellipsoid of runway reference point	ALT_RW	*	F	S	--	ft	As per sequencer
Conversion factor from radians to degrees	DEG_PER_RAD	Constant	F	S	--	deg/ rad	As per sequencer
GPS data good flag	GPS_DG_SOP(1)**	*	D	--	ON/ OFF	--	As per sequencer
Coordinate transformation matrix from 1984 World Geodetic Survey to earth fixed	M_WGS84_TO_EF	I-load	M	D	--	--	As per sequencer
Conversion factor from feet to nautical miles	NAUTMI_PER_FT	Constant	F	S	--	nmi/ ft	As per sequencer
The constant PI	PI	Constant	F	S	--	rad	As per sequencer
Shuttle position vector in earth fixed coordinates	R_EF	GUIDE_ COMP	V	DP	--	ft	As per sequencer
Time tag for current GPS receiver I data	T_GPS_SOP(1)**	*	S	DP	--	sec	As per sequencer
Switch indicating "ON" when ABS_MODE is selected for HSD display and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE	*	D	--	ON/ OFF	--	As per sequencer
Earth fixed velocity vector of GPS receiver I	V_GPS_ECEF_SOP(1)**	*	V	SP	--	ft/ sec	As per sequencer
Earth fixed position vector of I'th GPS receiver	R_GPS_ECEF_SOP	*	V	DP	--	ft	As per sequencer
Maximum number of receivers for which the software is designed	GPS_SW_CAP	K-Load	INT	--	3	--	As per sequencer
Array indicating which GPS receivers are installed on the vehicle	GPS_INSTALLED <sub>I</sub> **	I-Load/ K-Load	Bit	--	0,1	--	As per sequencer

Table 4.6.3.3.2-1. GPS Display Computation Input Parameters							
Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector	$\bar{G}_{GPS\_UPP}$	*	V	S		ft/sec <sup>2</sup>	As per sequencer
I-load time staleness limit used in setting GPS UPP display computation GPS range, azimuth, altitude status indicator	GPS_UPP_TIME_STALENESS_LIM	I-load	F	S		sec	As per sequencer
Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset	GPS_UPP_UPDATE	*	D	--		ON/OFF	As per sequencer
Transformation from earth-fixed to topodetic coordinates at the runway threshold	M_EFTOTD_RW	*	M(3)	DP		--	As per sequencer
Transformation from M50 to earth-fixed coordinates at time of current vehicle state	M_TEMP_TXPOS	GUIDE_COMP	M(3)	DP		--	As per sequencer
Number of GPS receivers installed	NUM_GPS_INSTALLED	*	I	S	0,1,3	--	As per sequencer
Selected GPS position vector reserved for reset of GPS UPP display computations position vector	$\bar{R}_{GPS\_UPP}$	*	V	DP		ft	As per sequencer
Position of landing site in earth-fixed coordinates	$\bar{R}_{LS\_EF}$	*	V	DP		ft	As per sequencer
Time of the selected GPS state reserved for reset of GPS UPP display computations position vector	T_GPS_UPP	*	F	DP		sec	As per sequencer

Table 4.6.3.3.2-1. GPS Display Computation Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector	$\bar{V}_{GPS\_UPP}$	*	V	S		ft/sec	As per sequencer
IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity	$\bar{V}_{IMU\_GPS\_UPP}$	*	V	DP		ft/sec	As per sequencer
Gravity acceleration at start of Shuttle state integration interval	$\bar{G}_{OLD}$	UPP state propagation	V	S		ft/sec <sup>2</sup>	As per sequencer
Current Shuttle position vector	$\bar{R}_{AVGG}$	UPP state propagation	V	DP		ft	As per sequencer
Time tag for current user parameter state vector	T_STATE	UPP state propagation	F	DP		sec	As per sequencer
Current Shuttle velocity vector	$\bar{V}_{AVGG}$	UPP state propagation	V	S		ft/sec	As per sequencer
Current selected accumulated IMU velocity	$\bar{V}_{IMU\_OLD}$	UPP state propagation	V	DP		ft/sec	As per sequencer
Flag indicating (ON) selected GPS states are available for use	GPS_SV_SEL_AVAIL	*	D	--	ON/OFF	--	As per sequencer
Transformation matrix from earth-fixed to topodetic coordinates of the auto selected TACAN site	M_EFTOTD_TACAN_AUTO	*	M	DP	--	--	As per sequencer
Auto selected TACAN station earth-fixed position vector	$\bar{R}_{TACAN\_EF\_AUTO}$	*	V	DP	--	ft	As per sequencer
Variation of magnetic north from true north at the auto selected TACAN site	ANGLE_CORR_TNTOMAG_AUTO	*	F	S	0 - 2 $\pi$	rad	As per sequencer

\* See principal function input list in Table 4.6.3.4-1.

\*\* I = 1,2,3 (1 to GPS\_SW\_CAP)

Table 4.6.3.3.2-2. GPS Display Computation Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Sample Rate
Magnetic bearing to selected TACAN station derived from I'th GPS receiver	GPS_AZ <sub>I</sub> **	*	Array	S	0, 360	deg	As per sequencer
Range to selected TACAN station derived from I'th GPS receiver	GPS_RNG <sub>I</sub> **	*	Array	S	--	nmi	As per sequencer
Altitude above runway derived from I'th GPS receiver	GPS_ALT <sub>I</sub> **	S	Array	S	--	kft	As per sequencer
Buffered GPS UPP range data for downlist	GPS_UPP_DL(1)	*	F	S		nmi	As per sequencer
Buffered GPS UPP azimuth data for downlist	GPS_UPP_DL(2)	*	F	S		deg	As per sequencer
Buffered GPS UPP altitude data for downlist	GPS_UPP_DL(3)	*	F	S		kft	As per sequencer
Velocity relative to runway derived from the I'th GPS receiver state estimate	GPS_VEL_REL_TO_RW <sub>I</sub> **	*	F	S		kft/sec	As per sequencer
Derived magnetic bearing to runway from the selected GPS state	SEL_GPS_AZ	*	F	S		deg	As per sequencer
Derived range to runway from the selected GPS state	SEL_GPS_RNG	*	F	S		nmi	As per sequencer
Derived altitude above runway from the selected GPS state	SEL_GPS_ALT	*	F	S		kft	As per sequencer
Feedback switch indicating "ON" when ABS_MODE is selected on HSD DISP and "OFF" when DELTA_MODE is selected	TAC_GPS_MODE_DISP	*	D	--	ON/OFF	--	As per sequencer
GPS UPP data status flag	GPS_RN_AZ_H_STAT	*	D	--	ON/OFF	--	As per sequencer

\* See principal function output list in Table 4.6.3.4-2.

\*\* I = 1,2,3 (1 to GPS\_SW\_CAP)

**4.6.3.4 Autoland User Parameter Processing (4.25) Principal Function Tables**

The principal function input/output parameters are given in Tables 4.6.3.4-1 and 4.6.3.4-2. The I-load and K-load parameters are given in Tables 4.6.3.4-3 and 4.6.3.4-4. Constants and variable cross-reference parameters are given in Tables 4.6.3.4-5 and the table below.

Autoland User Parameter Processing (4.25) Principal Function Variables Cross-Reference	
FSSR Name	Source Name
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	ANGLE_CORR_TNTOMAG_S1
ANGLE_CORR_TNTOMAG_SL <sub>2</sub>	ANGLE_CORR_TNTOMAG_S2
ANGLE_CORR_TNTOMAG_SL <sub>3</sub>	ANGLE_CORR_TNTOMAG_S3
M_EFTOTD_TACAN_SL <sub>1</sub>	M_EFTOTD_TACAN_SL1
M_EFTOTD_TACAN_SL <sub>2</sub>	M_EFTOTD_TACAN_SL2
M_EFTOTD_TACAN_SL <sub>3</sub>	M_EFTOTD_TACAN_SL3
R_TACAN_EF_SL <sub>1</sub>	R_TACAN_EFSL1
R_TACAN_EF_SL <sub>2</sub>	R_TACAN_EFSL2
R_TACAN_EF_SL <sub>3</sub>	R_TACAN_EFSL3
TACAN_CHAN_VALID_SL <sub>1</sub>	TACAN_CHAN_VALID_SL1
TACAN_CHAN_VALID_SL <sub>2</sub>	TACAN_CHAN_VALID_SL2
TACAN_CHAN_VALID_SL <sub>3</sub>	TACAN_CHAN_VALID_SL3
TAC_MODE	N/C
T_STATE	T_IMUS
V_IMU_CURRENT	SEL_V_M50
WBR <sub>2</sub>	Q_ORB
N/G = Not given	



TABLE 4.6.3.4-1. INPUT FUNCTIONAL PARAMETERS FOR AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ANGLE_CORR_TNTOMAG_AUTO	V90H0393CA	MAGNETIC VARIATION AT AUTO SEL TAC	ENT SITE LOOKUP	RAD	SPL		92049C	
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
BIAS_ELMLS	V90H1887CA	MSBLS ELEVATION MEASUREMENT BIAS	ENT SITE LOOKUP	RAD				
COSTH	V90H2215C	EULER ANGLE PITCH COSINE	A/E ATT PROC				93090E	
DG_RADALT	V90X4003X	RALT HEIGHT DATA GOOD	SF		BD		93017G	*
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FILT_UPDATE	V90X0224XC	FLAG IND NAV FILTER PROC COMPLETE	PRELAND NAV					
FILT_UPDATE	V90X0224XD	FLAG IND NAV FILTER PROC COMPLETE	D/L NAV SEQ					
FILT_UPDATE	V90X0224XE	FLAG IND NAV FILTER PROC COMPLETE	ENT NAV					
GPS_DG_SOP(1)	V90X3012X	GPS 1 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(2)	V90X3013X	GPS 2 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_DG_SOP(3)	V90X3014X	GPS 3 DATA GOOD FLAG	GPS SOP		BD		92067D	
GPS_SV_SEL_AVAIL	V90X3081XC	GPS SEL STATE VCTR AVAIL FLAG	GPS RCVR STATE PROC		BD		92132C	
GPS_UPP_UPDATE	V90X3643XA	GPS UPP DISP RES STATE AVAIL FLAG	ENT NAV		BD		92067D	
GPS_UPP_UPDATE	V90X3643XB	GPS UPP DISP RES STATE AVAIL FLAG	PRELAND NAV		BD		92067D	
G_GPS_UPP(1)	V90A3630CA	SELECTED GPS STATE X GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(1)	V90A3630CB	SELECTED GPS STATE X GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CA	SELECTED GPS STATE Y GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(2)	V90A3631CB	SELECTED GPS STATE Y GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CA	SELECTED GPS STATE Z GRAV	ENT NAV	FT/S2	SPL		92214A	
G_GPS_UPP(3)	V90A3632CB	SELECTED GPS STATE Z GRAV	PRELAND NAV	FT/S2	SPL		92214A	
G_RESET(1)	V90A0243CC	SEL X-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(1)	V90A0243CD	SEL X-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(1)	V90A0243CE	SEL X-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CC	SEL Y-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2			92214A	
G_RESET(2)	V90A0244CD	SEL Y-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(2)	V90A0244CE	SEL Y-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
G_RESET(3)	V90A0245CC	SEL Z-COMP OF GRAV ACCEL VCTR RST	PRELAND NAV	FT/S2				
G_RESET(3)	V90A0245CD	SEL Z-COMP OF GRAV ACCEL VCTR RST	D/L NAV SEQ	FT/S2			92214A	
G_RESET(3)	V90A0245CE	SEL Z-COMP OF GRAV ACCEL VCTR RST	ENT NAV	FT/S2			92214A	
IMU_SFC	V90J2503C	IMU SELECTION FILTER COMMAND	IMU RM		BSU	S	93017G	*
MLS_AVAIL	V90X3720XA	MLS AVAILABILITY	ENT SITE LOOKUP					
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					

TABLE 4.6.3.4-1. INPUT FUNCTIONAL PARAMETERS FOR AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTOTD_RW(1,1)	V90U3644CA	EF TO TOPO COORD AT RW 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,2)	V90U3645CA	EF TO TOPO COORD AT RW 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(1,3)	V90U3646CA	EF TO TOPO COORD AT RW 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2,1)	V90U3647CA	EF TO TOPO COORD AT RW 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-2)	V90U3648CA	EF TO TOPO COORD AT RW 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(2-3)	V90U3649CA	EF TO TOPO COORD AT RW 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-1)	V90U3650CA	EF TO TOPO COORD AT RW 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-2)	V90U3651CA	EF TO TOPO COORD AT RW 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_RW(3-3)	V90U3652CA	EF TO TOPO COORD AT RW 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,1)	V90U3566CA	EF TO TOPO COORD, AUTO SEL TAC 1-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,2)	V90U3567CA	EF TO TOPO COORD, AUTO SEL TAC 1-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(1,3)	V90U3568CA	EF TO TOPO COORD, AUTO SEL TAC 1-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,1)	V90U3569CA	EF TO TOPO COORD, AUTO SEL TAC 2-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,2)	V90U3570CA	EF TO TOPO COORD, AUTO SEL TAC 2-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(2,3)	V90U3571CA	EF TO TOPO COORD, AUTO SEL TAC 2-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,1)	V90U3572CA	EF TO TOPO COORD, AUTO SEL TAC 3-1	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,2)	V90U3573CA	EF TO TOPO COORD, AUTO SEL TAC 3-2	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_AUTO(3,3)	V90U3574CA	EF TO TOPO COORD, AUTO SEL TAC 3-3	ENT SITE LOOKUP		DPL		92067D	
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					

TABLE 4.6.3.4-1. INPUT FUNCTIONAL PARAMETERS FOR AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NUM_GPS_INSTALLED	V90U3671C	NUMBER OF GPS RCVRs INSTALLED	GPS SOP		HXS		92067D	
Q_ORB/Q	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			93017G	*
Q_RADALT	V90H4002C	SELECTED RALT HEIGHT-RAW	SF	FT	SPL		93017G	*
RA_TIME	V95W7000C	RADAR ALTIMETER TIME	RA SOP	S	DPL		93017G	*
R_GPS_ECEF_SOP(1,1)	V90H3036C	GPS 1 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,2)	V90H3037C	GPS 1 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(1,3)	V90H3038C	GPS 1 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,1)	V90H3039C	GPS 2 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,2)	V90H3040C	GPS 2 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(2,3)	V90H3041C	GPS 2 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,1)	V90H3042C	GPS 3 WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,2)	V90H3043C	GPS 3 WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_SOP(3,3)	V90H3044C	GPS 3 WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_UPP(1)	V90H3624CA	SELECTED GPS STATE X POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(1)	V90H3624CB	SELECTED GPS STATE X POS	PRELAND NAV	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CA	SELECTED GPS STATE Y POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(2)	V90H3625CB	SELECTED GPS STATE Y POS	PRELAND NAV	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CA	SELECTED GPS STATE Z POS	ENT NAV	FT	DPL		92067D	
R_GPS_UPP(3)	V90H3626CB	SELECTED GPS STATE Z POS	PRELAND NAV	FT	DPL		92067D	
R_LS_EF(1)	V90H1900CA	X-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(2)	V90H1901CA	Y-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(3)	V90H1902CA	Z-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_RESET(1)	V90H0235CC	SEL X-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(1)	V90H0235CD	SEL X-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(1)	V90H0235CE	SEL X-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(2)	V90H0236CC	SEL Y-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(2)	V90H0236CD	SEL Y-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(2)	V90H0236CE	SEL Y-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_RESET(3)	V90H0237CC	SEL Z-COMP OF UPDATED POS VCTR RST	PRELAND NAV	FT	DPL			
R_RESET(3)	V90H0237CD	SEL Z-COMP OF UPDATED POS VCTR RST	D/L NAV SEQ	FT	DPL		92214A	
R_RESET(3)	V90H0237CE	SEL Z-COMP OF UPDATED POS VCTR RST	ENT NAV	FT	DPL		92281D	
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				

TABLE 4.6.3.4-1. INPUT FUNCTIONAL PARAMETERS FOR AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EF_AUTO(1)	V90H3575CA	X-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(2)	V90H3576CA	Y-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
R_TACAN_EF_AUTO(3)	V90H3577CA	Z-COMP, EF POS VCTR, AUTO SEL TAC	ENT SITE LOOKUP	FT	DPL		92067D	
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SINTH	V90H2216C	EULER ANGLE PITCH SINE	A/E ATT PROC				93090E	
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACBEARO(1)	V95H5122CA	TACAN NO 1 BEARING OUT	TACAN SOP	RAD				
TACBEARO(2)	V95H5222CA	TACAN NO 2 BEARING OUT	TACAN SOP	RAD				
TACBEARO(3)	V95H5322CA	TACAN NO 3 BEARING OUT	TACAN SOP	RAD				
TACRANGE(1)	V95H5102CA	TACAN NO 1 RANGE OUT	TACAN SOP	FT				
TACRANGE(2)	V95H5202CA	TACAN NO 2 RANGE OUT	TACAN SOP	FT				
TACRANGE(3)	V95H5302CA	TACAN NO 3 RANGE OUT	TACAN SOP	FT				
TAC_GPS_MODE	V93X5015X	TACAN/GPS ABSOLUTE/DELTA DATA CMD	HORIZ SIT DISP		BD		91051K	
TG_END	V90X1108XA	TAEM GUIDANCE TERMINATION FLAG	TAEM GUID				93017G	*
THETA/THETA_TOPO	V90H2217C	BODY PITCH ATTITUDE EULER ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS_SOP(1)	V90W3045C	GPS 1 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(2)	V90W3046C	GPS 2 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_SOP(3)	V90W3047C	GPS 3 STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_UPP	V90W3636CA	TIME OF SELECTED GPS STATE	ENT NAV	S	DPL		92067D	
T_GPS_UPP	V90W3636CB	TIME OF SELECTED GPS STATE	PRELAND NAV	S	DPL		92067D	
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
T_IMU_SAVE_SOP(1)	V90W3048C	IMU TIME TAG FOR CURNT GPS 1 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(2)	V90W3049C	IMU TIME TAG FOR CURNT GPS 2 STATE	GPS SOP	S	DPL		92067D	
T_IMU_SAVE_SOP(3)	V90W3050C	IMU TIME TAG FOR CURNT GPS 3 STATE	GPS SOP	S	DPL		92067D	
T_RESET	V90W0534CC	TIME OF FILTER STATE VECTOR	PRELAND NAV	S			93017G	*
T_RESET	V90W0534CD	TIME OF FILTER STATE VECTOR	D/L NAV SEQ	S			93017G	*
T_RESET	V90W0534CE	TIME OF FILTER STATE VECTOR	ENT NAV	S			93017G	*
V_GPS_ECEF_SOP(1,1)	V90L3051C	GPS 1 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,2)	V90L3052C	GPS 1 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(1,3)	V90L3053C	GPS 1 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,1)	V90L3054C	GPS 2 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,2)	V90L3055C	GPS 2 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(2,3)	V90L3056C	GPS 2 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,1)	V90L3057C	GPS 3 WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,2)	V90L3058C	GPS 3 WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_ECEF_SOP(3,3)	V90L3059C	GPS 3 WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92067D	
V_GPS_UPP(1)	V90L3627CA	SELECTED GPS STATE X VEL	ENT NAV	FT/S	SPL		92067D	

TABLE 4.6.3.4-1. INPUT FUNCTIONAL PARAMETERS FOR AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GPS_UPP(1)	V90L3627CB	SELECTED GPS STATE X VEL	PRELAND NAV	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CA	SELECTED GPS STATE Y VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(2)	V90L3628CB	SELECTED GPS STATE Y VEL	PRELAND NAV	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CA	SELECTED GPS STATE Z VEL	ENT NAV	FT/S	SPL		92067D	
V_GPS_UPP(3)	V90L3629CB	SELECTED GPS STATE Z VEL	PRELAND NAV	FT/S	SPL		92067D	
V_IMU_GPS_UPP(1)	V90L3633CA	SELECTED GPS STATE X ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(1)	V90L3633CB	SELECTED GPS STATE X ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CA	SELECTED GPS STATE Y ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(2)	V90L3634CB	SELECTED GPS STATE Y ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CA	SELECTED GPS STATE Z ACCUM VEL CNT	ENT NAV	FT/S	DPL		92067D	
V_IMU_GPS_UPP(3)	V90L3635CB	SELECTED GPS STATE Z ACCUM VEL CNT	PRELAND NAV	FT/S	DPL		92067D	
V_IMU_RESET(1)	V90L0247CC	SEL X-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(1)	V90L0247CD	SEL X-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(1)	V90L0247CE	SEL X-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(2)	V90L0248CC	SEL Y-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(2)	V90L0248CD	SEL Y-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(2)	V90L0248CE	SEL Y-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_RESET(3)	V90L0249CC	SEL Z-COMP OF ACCUM SENSED VEL RST	PRELAND NAV	FT/S				
V_IMU_RESET(3)	V90L0249CD	SEL Z-COMP OF ACCUM SENSED VEL RST	D/L NAV SEQ	FT/S				
V_IMU_RESET(3)	V90L0249CE	SEL Z-COMP OF ACCUM SENSED VEL RST	ENT NAV	FT/S				
V_IMU_SAVE_SOP(1,1)	V95L0133C	IMU ACCUM X VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,2)	V95L0134C	IMU ACCUM Y VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(1,3)	V95L0135C	IMU ACCUM Z VEL FOR CURRENT GPS 1	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,1)	V95L0136C	IMU ACCUM X VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,2)	V95L0137C	IMU ACCUM Y VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(2,3)	V95L0138C	IMU ACCUM Z VEL FOR CURRENT GPS 2	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,1)	V95L0139C	IMU ACCUM X VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,2)	V95L0140C	IMU ACCUM Y VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_IMU_SAVE_SOP(3,3)	V95L0141C	IMU ACCUM Z VEL FOR CURRENT GPS 3	GPS SOP	FT/S	DPL		92067D	
V_RESET(1)	V90L0239CC	SEL X-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(1)	V90L0239CD	SEL X-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(1)	V90L0239CE	SEL X-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(2)	V90L0240CC	SEL Y-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(2)	V90L0240CD	SEL Y-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(2)	V90L0240CE	SEL Y-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	
V_RESET(3)	V90L0241CC	SEL Z-COMP OF UPDATED VEL VCTR RST	PRELAND NAV	FT/S				
V_RESET(3)	V90L0241CD	SEL Z-COMP OF UPDATED VEL VCTR RST	D/L NAV SEQ	FT/S			92214A	
V_RESET(3)	V90L0241CE	SEL Z-COMP OF UPDATED VEL VCTR RST	ENT NAV	FT/S			92281D	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.3.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ACC_DRAG	V95A0160CD	DRAG DECEL	AMI PROC DL FMT 23/1 ENT NAV HUD PROC	FT/S2			93017G	*
ACC_VERT	V95A0170CC	VERTICAL ACCEL IN TOPODETTIC COORD	AVVI PROC TLM	FT/S2				
ALPHA_NAVDAD ALT	V95H0233CC V95H0175CE	AVG NAVDAD ANGLE OF ATTACK CURR ORB ALT ABOVE REF ELLIPSOID	NAVDAD SOP ADTA SOP DL FMT 23/A ENT NAV GPS RCVR STATE PROC NAVDAD SOP PRELAND NAV	DEG FT	SPL		93017G	*
ALT_WHEELS	V95H0165CD	ALT TO REAR WHEELS/NAV BASE(ENTRY)	A/L GUID DL FMT 23/1 E/L ADI PROC E/L EV AN PROC ENT AREA NAV ENT NAV GPS SOP HORIZ SIT SPEC HUD PROC HYD SYS SOP PRELAND NAV TACAN RM VERT SIT DIP	FT	DPL		93017G	*
COURSE_WRT_RW/PSD	V95H0225CC	COURSE WRT RW CENTERLINE	A/L GUID DL FMT 23/1 ENT AREA NAV HORIZ SIT SPEC MSBLS SOP	DEG			93017G	*
DG_RADALT FLT_PATH_ANG/GAMMA	V95X0460XC V95H0261CB	SNAPPED RALT DATA GOOD GROUND-REL FLT PATH ANGLE	TLM A/L GUID DL FMT 23/1	SPECIAL			93017G	*
GPS_ALT(2)	V94H1045CC	GPS 2 ALT TO LDG SITE THRESH	HORIZ SIT DISP TLM	KFT	SPL		91051K	
GPS_AZ(2)	V94H1043CC	GPS 2 AZ TO SEL TAC STA	HORIZ SIT DISP TLM	DEG	SPL		91051K	
GPS_RNG(2)	V94H1044CC	GPS 2 RNG TO SEL TAC STA	HORIZ SIT DISP TLM	NM	SPL		91051K	
GPS_RN_AZ_H_STAT	V94X1046XC	GPS 2 RNG/AZ/ALT STATUS	HORIZ SIT DISP		BD		92214A	
GPS_UPP_DL(1)	V94H1162CC	SEL GPS RNG FOR DL	DL FMT 23/1	NM	SPL		93017G	*
GPS_UPP_DL(2)	V94H1163CC	SEL GPS AZ FOR DL	DL FMT 23/1	DEG	SPL		93017G	*
GPS_UPP_DL(3)	V94H1164CC	SEL GPS ALT FOR DL	DL FMT 23/1	KFT	SPL		93017G	*
GPS_VEL_REL_TO_RW(1)	V94L6042CC	GPS 1 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	

TABLE 4.6.3.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
GPS_VEL_REL_TO_RW(2)	V94L6043CC	GPS 2 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	
GPS_VEL_REL_TO_RW(3)	V94L6044CC	GPS 3 EF RELATIVE VELOCITY	HORIZ SIT DISP TLM	KFT/S	SPL		92067D	
H_DOT_ELLIPSOID/H_DOT	V95L0265CC	EST ALTITUDE RATE	A/L GUID ADTA SOP DL FMT 23/1 GPS SOP HUD PROC VERT SIT DIP	FT/S	SPL		93017G	*
POSN_WRT_RW(1)/X	V95H0220CD	DOWNRANGE DISTANCE WRT RW	A/L GUID DL FMT 23/1 ENT AREA NAV HORIZ SIT SPEC HUD PROC	FT			93017G	*
POSN_WRT_RW(2)/Y	V95H0221CD	CROSSRANGE DISTANCE WRT RW	A/L GUID DL FMT 23/1 E/L ADI PROC ENT AREA NAV HORIZ SIT SPEC HUD PROC	FT			93017G	*
POSN_WRT_RW(3)/Z	V95H0300CC	VERTICAL DISTANCE WRT RW	ENT AREA NAV HUD PROC TLM	FT				
Q_RADALT	V95H0458CB	SNAPPED RADAR ALT MEASUREMENT	TLM					
RAW_RA_PROC	V90X8865XC	RADAR ALTIMETER PROCESSING FLAG	DL FMT 23/1				93017G	*
RA_FLAG	V90X0450XB	RADAR ALTIMETER CREW ALERT	HUD PROC					
REL_VEL_MAG/V	V95L0151CB	GND REL VEL MAGNITUDE IN M50 SYS	A/L GUID ADTA SOP DL FMT 23/1 ENT AREA NAV ENT NAV GPS SOP NAVDAD SOP PRELAND NAV VERT SIT DIP	FT/S	SPL		93017G	*
RW_NAME	V90U1916CE	CURRENT LANDING SITE SELECTED	DL FMT 23/A				93017G	*
R_AVGG(1)	V95H0185CE	X-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CE	Y-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CE	Z-COMP OF CUR SHUTTLE POS VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT	DPL		93017G	*

TABLE 4.6.3.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_EF(1)	V95H0155CD	ORBITER X POSITION EF(TOD)	ENT AREA NAV GN&C/SM-PL IF TACAN RM	FT	DPL		93023D	
R_EF(2)	V95H0156CD	ORBITER Y POSITION EF(TOD)	ENT AREA NAV GN&C/SM-PL IF TACAN RM	FT	DPL		93023D	
R_EF(3)	V95H0157CD	ORBITER Z POSITION EF(TOD)	ENT AREA NAV GN&C/SM-PL IF TACAN RM	FT	DPL		93023D	
SEL_GPS_ALT	V94H6036CC	SEL GPS ALT TO LDG SITE THRESH	HORIZ SIT DISP	KFT	SPL		92067D	
SEL_GPS_AZ	V94H6037CC	SEL GPS AZ TO LDG SITE THRESH	HORIZ SIT DISP	DEG	SPL		92067D	
SEL_GPS_RNG	V94H6038CC	SEL GPS RNG TO LDG SITE THRESH	HORIZ SIT DISP	NM	SPL		92067D	
TAC_AZ(1)	V95H0207CC	TACAN 1 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(2)	V95H0208CC	TACAN 2 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_AZ(3)	V95H0209CC	TACAN 3 AZIMUTH	HORIZ SIT DISP	DEG				
TAC_GPS_MODE_DISP	V95X0227XC	TACAN/GPS ABS/DELTA DATA IND	HORIZ SIT DISP				91051K	
TAC_RNG(1)	V95H0201CC	TACAN 1 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(2)	V95H0202CC	TACAN 2 RANGE	HORIZ SIT DISP	NM				
TAC_RNG(3)	V95H0203CC	TACAN 3 RANGE	HORIZ SIT DISP	NM				
T_RADALT	V95W0459CB	SNAPPED RADAR ALT TIME (BIASED)	TLM				92144C	
T_SEC_GMT	V95W3890CE	TIME TAG OF EF STATE(TOD)	GN&C/SM-PL IF	S			93023D	
T_STATE	V95W0200CB	TIME TAG ASSOC WITH CURRENT STATE	DL FMT 23/A E/L ADI PROC HORIZ SIT SPEC	S			93017G	*
VEL_WRT_RW(1)/XDOT	V95L0255CC	DOWNRANGE VEL WRT RW	DL FMT 23/1 HUD PROC	FT/S			93017G	*
VEL_WRT_RW(2)/YDOT	V95L0256CA	CROSSRANGE VEL WRT RW	A/L GUID DL FMT 23/1 HUD PROC	FT/S			93017G	*
VEL_WRT_RW(3)/ZDOT	V95L0257CD	VELOCITY WRT RUNWAY (3)	DL FMT 23/1 HUD PROC	FT/S			93017G	*
V_AVGG(1)	V95L0190CE	X-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CE	Y-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CE	Z-COMP OF CUR SHUTTLE VEL VCTR M50	A/E ATT PROC DL FMT 23/A GN&C/SM-PL IF	FT/S	SPL		93017G	*



TABLE 4.6.3.4-2. OUTPUT FUNCTIONAL PARAMETERS FROM AUTOLAND USER PARAMETER PROCESSING (G4.25)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GROUNDSPEED/VH	V95L0178CD	GROUNDSPPEED	A/L GUID E/L ADI PROC ENT AREA NAV HORIZ SIT SPEC HSI PROC TACAN RM TLM	FT/S			92450C	
V_RHO(1)	V95L0215CD	X-COMP OF RELATIVE VEL IN M50	VERT SIT DIP A/E ATT PROC	FT/S				
V_RHO(2)	V95L0216CD	Y-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO(3)	V95L0217CD	Z-COMP OF RELATIVE VEL IN M50	A/E ATT PROC	FT/S				
V_RHO_EF(1)	V95L3884CF	X VELOCITY VECTOR EF(TOD)	GN&C/SM-PL IF	FT/S			93023D	
V_RHO_EF(2)	V95L3885CF	Y VELOCITY VECTOR EF(TOD)	GN&C/SM-PL IF	FT/S			93023D	
V_RHO_EF(3)	V95L3886CF	Z VELOCITY VECTOR EF(TOD)	GN&C/SM-PL IF	FT/S			93023D	
	V90M3122PA	CGGB_RAW_RA_PROC_MFE	DL FMT 23/1				93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.6.3.4-3. AUTOLAND USER PARAMETER PROCESSING (G4.25) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
GPS_INSTALLED(1)	V97U2924C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(2)	V97U2831C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_INSTALLED(3)	V97U2925C	ND	D		M	X	G4.17 G4.20 G4.21 G4.23 G4.24 G4.25 G6.11 G6.21 G6.31 G6.51 V5.1.4	00	GPI	92292B	
GPS_UPP_TIME_STALENESS_LIM	V97U3252C	SEC	F	S	D	P	G4.20 G4.23 G4.24 G4.25	00	GPD	92292B	
M_WGS84_TO_EF(1,1)	V97U2927C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.6.3.4-3. AUTOLAND USER PARAMETER PROCESSING (G4.25) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(1,2)	V97U2928C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(1,3)	V97U2929C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,1)	V97U2930C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,2)	V97U2931C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,3)	V97U2932C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.6.3.4-3. AUTOLAND USER PARAMETER PROCESSING (G4.25) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(3,1)	V97U2933C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,2)	V97U2934C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,3)	V97U2935C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
PSHARS	V96U8647C	DEG	F	S	D	C	G4.19 G4.20 G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27	01 03	ZFU ZFU	93090E	
R1	V96U8263C	FT/DEG	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	

TABLE 4.6.3.4-3. AUTOLAND USER PARAMETER PROCESSING (G4.25) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
R2	V96U8264C	FT/DEG**2	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
RESELVE	V99U7680C	FT/SEC	F	S	M	C	G4.220 G4.23 G4.24 G4.25 G5.27	00	VHS	93090E	
RFO	V96U8262C	FT	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
R_GO_RAMP	V97U5438C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
START_POSITION	V99U9569C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
STOP_POSITION	V99U9570C	FT	F	S	D	P	G4.19 G4.20 G4.23 G4.24 G4.25	00	ZFV	DC0617	
WT_GS1	V97U0444C	SLUGS	F	S	M	C	G4.10 G4.220 G4.23 G4.24 G4.25 G4.9 G5.27	00	GLC	93090E	

TABLE 4.6.3.4-3. AUTOLAND USER PARAMETER PROCESSING (G4.25) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
X_HAC_HIGH_MASS	V96U8679C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	
X_HAC_LOW_MASS	V96U8678C	FT	F	S	D	C	G4.23 G4.24 G4.25 G5.27	00	XS6	93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.6.3.4-4. AUTOLAND USER PARAMETER PROCESSING (G4.25) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ALT_EL(1) ALT REGIONS NAV EV LAMP PROCESSING	V97U5212C	00	+1.4000000	E+05	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(2) ALT REGIONS NAV EV LAMP PROCESSING	V97U5213C	00	+1.2000000	E+04	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	89661A	
ALT_EL(3) ALT REGIONS NAV EV LAMP PROCESSING	V97U5214C	00	+5.0	E+03	FT	F	S	P G4.127 G4.144 G4.20 G4.205 G4.23 G4.24 G4.25	90291B	
BIAS_RADALT RADAR ALTITUDE BIAS	V97U5253C	00	+0.0	E+00	FT	F	S	P G4.20 G4.23 G4.24 G4.25	89661A	
GPS_SW_CAP MAX NUM OF GPS LRU THAT SOFTWARE CAN HANDLE	V97U2923C	00	+3		ND	I	S	P G4.17 G4.18 G4.20 G4.21 G4.23 G4.24 G4.25	92069B	
N_SEQ_MAX NO OF FAILURES BEFORE NAV EV LAMP	V98U9435C	00	+7		ND	I	S	P G4.20 G4.24 G4.25	89661A	
TIME_BIAS_RADALT PAD LOAD CORR RAD ALT TIME	V97U5546C	00	+1.50	E-02	SEC	F	D	P G4.17 G4.20 G4.23 G4.24 G4.25	92069B	
X_NB_CG X_STRUCT_BODY DIST NAV BASE CG	V97U5573C	00	+5.61360	E+01	FT	F	S	C G4.20 G4.23 G4.24 G4.25 G5.27	93090E	

TABLE 4.6.3.4-4. AUTOLAND USER PARAMETER PROCESSING (G4.25) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
Z_NB_CG Z_STRUCT_BODY DIS CG NAV BASE	V97U5580C	00	+4.0580	E+00 FT	F		S C	G4.20 G4.23 G4.24 G4.25 G5.27	93090E	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.6.3.4-5. AUTOLAND USER PARAMETER PROCESSING (G4.25) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S	C A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.6.3.4-5. AUTOLAND USER PARAMETER PROCESSING (G4.25) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
EARTH_RADIUS_EQUATOR EARTH EQUATORIAL RADIUS	V97U5324C	00	+2.09257414698E+07	FT	F		D C	A6.9 G4.126 G4.127 G4.13 G4.139 G4.144 G4.148 G4.15 G4.158 G4.19 G4.20 G4.205 G4.210 G4.211 G4.213 G4.23 G4.236 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	
ELLIPT EARTH'S ELLIPTICITY CONSTANT	V97U5332C	00	+3.352329869 E-03	ND	F		D C	A6.9 G4.126 G4.127 G4.139 G4.144 G4.148 G4.15 G4.19 G4.20 G4.205 G4.213 G4.23 G4.236 G4.237 G4.238 G4.24 G4.25 G5.26 G5.27 V5.1.8	93090E	

TABLE 4.6.3.4-5. AUTOLAND USER PARAMETER PROCESSING (G4.25) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04	NMI/FT	F	S	C A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	
RADALT_ANG ANGLE BETWEEN BODY X-AXIS AND C.G. RADAR ALT ANT VEC	V97U6217C	00	+2.005	E+00	RAD	F	S	P G4.20 G4.25	90374C	
RADALT_NB_DIST DISTANCE FROM THE NAVIGATION BASE TO THE RADAR ALT	V97U6218C	00	+1.2915	E+01	FT	F	S	P G4.20 G4.25	90374C	
X_NB_WH DISTANCE FROM THE NAVIGATION BASE	V97U6219C	00	+6.2784	E+01	FT	F	S	P G4.19 G4.20 G4.24 G4.25	90374C	
Z_NB_WH DISTANCE FROM THE WHEEL TO THE NAVIGATION BASE	V97U6158C	00	+2.2405	E+01	FT	F	S	C G4.19 G4.20 G4.24 G4.25	90374C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

#### 4.6.4 GPS Reference State Processing (4.18)

The purpose of the GPS Reference State Processing principal function is to provide a reference states to initialize the GPS receivers navigation function, to aid the receivers using propagated navigation states, for restarting receiver navigation filters, and for providing an announced reset state to the GPS receivers.

The reference state is output to the GPS SOP (4.17) for transmittal to the GPS receiver at 6.25 Hz.

All GPS related software in the GPC is required to handle phased GPS receiver installation in the vehicle in any LRU assignment order and any number of receivers actually installed from 0 to a maximum of 3.

The implementation of GPS related software in this principal function satisfies this requirement by processing data from up to three receivers and bypassing relevant calculations if a receiver is not actually installed on this vehicle. The calculations are bypassed since the GPS SOP sets the GPS receiver mode to “blank” for uninstalled receivers.

##### 4.6.4.1 GPS Reference State Processing Control

This principal function shall provide the capability to reset the GPS reference state to the navigation state continuously in OPS 1 and MM 601, or in the event of an OPS transition or announced reset of the receiver, and to propagate the reference state sent to the receiver.

A. Detailed Requirements: The following paragraphs describe the subfunctions comprising the GPS reference state processing principal function and indicate their order of execution.

1. The buffering (Snap) of external data from IMU RM and GPS SOP is accomplished by the subfunction described in Section 4.6.4.2. The current selected IMU accumulated velocity counts will be snapped from IMU RM. These IMU velocity counts will be referenced to the orbiter navbase or the orbiter center of mass, depending on the OPS sequence. Data for up to three receivers will be buffered (snapped) from the GPS SOP. The data will include the mode of each receiver, as well as flags requesting initialization and filter restart data for each receiver.
2. Resetting the GPS reference state continuously in OPS 1 and MM 601, or in the event of an OPS transition or any announced reset, using data from the navigation principal function, is accomplished by the subfunction described in Section 4.6.4.4.
3. The propagation of the GPS reference state, using the most recent selected IMU accumulated velocity counts, is accomplished by the subfunction described in Section 4.6.4.5.

B. Interface Requirements: None.

C. Processing Requirements: The GPS reference state processing principal function is scheduled by the active UPP sequencer in each OPS phase, except OPS 1 where it is scheduled by MSC at NAV\_INIT (EVENT 14). It is scheduled to execute after the IMU Redundancy Management principal function and the navigation User Parameter principal functions, and just prior to the execution of the GPS SOP. This ensures that the latest IMU counts are used in the reference state propagation and that the most current state is provided to the GPS SOP for the GPS receivers. The principal function will execute at a repetition rate of 6.25 Hertz.

D. Constraints: None.

E. Supplementary Information: A suggested implementation of the GPS reference state processing principal function in the form of a detailed flowchart (GPS\_REF\_STATE\_PROC) is shown in Section 5.6.

#### 4.6.4.2 GPS External Data Snap

This subfunction snaps data from external sources which are used by the GPS reference state processing principal function.

The request for receiver filter restart parameters,  $FILT\_RESTART\_REQUEST\_RCVD_i$ , is set to ON by the GPS SOP in response to a crew commanded receiver restart. This request flag is set to OFF by the GPS Reference State Initialization and Reanchor Subfunction when this subfunction can honor a filter restart request or when the GPS receiver is not in "INS" submode.

The request for initialization data,  $GPS\_INIT\_REQUEST_i$ , is set to ON by the GPS SOP in response to receiver initialization commanded by the crew. This request flag is set to OFF by the GPS Reference State Initialization and Reanchor Subfunction when this subfunction can honor an initialization request.

This subfunction shall perform the following:

1. Snap and store the selected IMU velocity counts and the associated time tag from the IMU RM for use by the GPS reference state propagator.
2. Snap and store the GPS mode, initialization request flag and filter restart flag for each receiver from the GPS SOP.

A. Detailed Requirements. The external data snap shall function as follows:

1. The IMU data snap task will provide the capability to obtain the selected IMU-sensed accumulated velocities expressed in M50 coordinates and their associated GMT time tag.

Data snapped from IMU RM, for all operational sequences, will be used in the reference state propagation subfunctions. Selected IMU velocity counts and their time tag will be stored as follows:

$$\text{SNAP } (\bar{V}_{\text{IMU\_M50}}, T_{\text{IMU}})$$

The snap statement implies the assignment of current variables to the variable names shown in parentheses.

2. The following data will be snapped from the GPS SOP for each receiver and stored as follows:

$$\text{SNAP } (GPS\_MODE, GPS\_INIT\_REQUEST, FILT\_RESTART\_REQUEST\_RCVD, GPS\_NAV\_SUBMODE\_RCVD)$$

The snap statement implies the assignment of current variables to the variable names shown in parentheses. The GPS SOP requests state data for a receiver filter restart through the  $FILT\_RESTART\_REQUEST\_RCVD$  flag and for initialization through the  $GPS\_INIT\_REQUEST$  flag.

B. Interface Requirements.

The input and output parameters required are listed in Tables 4.6.4.2-1 and 4.6.4.2-2.

C. Processing Requirements.

This subfunction shall execute upon entry into the GPS reference state processing principal function to provide the most current IMU data for use in propagating the reference state to be provided to the receivers.

D. Constraints. None

E. Supplementary Information. A suggested implementation in the form of a detailed flowchart (GPS\_EXTERNAL\_DATA\_SNAP) is shown in Section 5.6.

Table 4.6.4.2-1. GPS External Data Snap Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flags indicating (ON) requests for GPS filter restarts	FILT_RESTART_REQUEST_RCVD <sub>I</sub> **	*	D		ON/OFF		6.25 Hz
Flags indicating (ON) requests for GPS receiver initialization	GPS_INIT_REQUEST <sub>I</sub> **	*	D		ON/OFF		6.25 Hz
Flags indicating GPS operation mode	GPS_MODE <sub>I</sub> **	*	CHAR		INIT, NAV, TEST, Blank		6.25 Hz
Navigation submode indicator for GPS receiver I	GPS_NAV_SUBMODE_RCVD <sub>I</sub> **	*	CHAR		PVA, INS, Blank		6.25 Hz
Time tag of accumulated IMU velocity counts	T_IMU	*	F	DP		sec	6.25 Hz
Current selected IMU accumulated sensed velocity from IMU RM	$\bar{V}$ _IMU_M50	*	V	DP		ft/sec	6.25 Hz
<p>* See principal function input list in Table 4.6.4.6-1.  ** I = 1, 2, 3 (1 to GPS_SW_CAP)</p>							

Table 4.6.4.2-2. GPS External Data Snap Output Parameters

Description	Symbol	Output Destination	Type	Prec	Range	Units	Sample Rate
Flags indicating (ON) requests for GPS filter restarts	FILT_RESTART_REQUEST_RCVD <sub>I</sub> **	GPS Reference State Init	D				6.25 Hz
Flags indicating (ON) requests for GPS receiver initialization	GPS_INIT_REQUEST <sub>I</sub> **	GPS Reference State Init	D		ON/OFF		6.25 Hz
Flags indicating GPS operation mode	GPS_MODE <sub>I</sub> **	GPS Reference State Init	CHAR		INIT, NAV, TEST, Blank		6.25 Hz
Navigation Submode Indicator for GPS receiver I	GPS_NAV_SUBMODE_RCVD <sub>I</sub> **	GPS Ref State Init and Reanchor	CHAR		PVA, INS, Blank		6.25Hz
Time tag of accumulated IMU velocity counts	T_IMU	GPS Reference State Propagator	F	DP		sec	6.25 Hz
Current selected IMU accumulated sensed velocity from IMU RM	$\bar{V}$ _IMU_M50	GPS Reference State Propagator	V	DP		ft/sec	6.25 Hz

\* See principal function output list in Table 4.6.4.6-2.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

#### 4.6.4.3 Deleted

#### 4.6.4.4 GPS Reference State Initialization and Reanchor

The GPS reference state initialization and reanchor subfunction shall set the appropriate flags to command the GPS receiver to perform an initialization, filter restart, or an announced reset. The subfunction will initialize the GPS reference state to the navigation filter state on first pass of a new OPS, every pass when Ascent Navigation is executing, that is during OPS 1 and MM 601, and whenever an announced reset is commanded. An announced reset of the GPS reference state is commanded periodically by the GPS Receiver State Processing principal function at an I-load determined rate.

This subfunction shall (1) prevent the reanchoring of the single GPS reference state while any one of the GPS receivers is still processing a previous command and (2) provide bounded propagation of the GPS reference state. GPS reference state propagation will be bounded through the reanchoring of the reference state to the navigation filter state. To ensure that the reference state is reanchored in a timely manner, once an announced reset is commanded, in-progress commands will complete, but any new commands on all receivers will pend until the announced reset can reanchor the reference state.

A. Detailed Requirements.

**4.6.4.4.1 Reference State Initialization and Reanchor**

The GPS reference state initialization and reanchor subfunction shall function as follows:

- 1.0 If the initialization state is valid (indicated by GPS\_REF\_INIT\_VALID = ON) then continue to step 2.0; otherwise, turn the announced reset flag, the previous value flag of GPS\_REF\_INIT\_VALID, and aiding data valid flags OFF and exit this subfunction.

```
IF_GPS_REF_INIT_VALID = ON THEN
    Continue to Step 2

OTHERWISE
    GPS_ANNCD_RESET = OFF
    GPS_REF_INIT_VALID_PREV = OFF
    AIDING_DATA_VALID(1) = OFF
    AIDING_DATA_VALID(2) = OFF
    AIDING_DATA_VALID(3) = OFF
    EXIT Reference State Initialization and Reanchor Subfunction
```

- 2.0 To determine if the GPS Reference State needs to be reanchored to the navigation filter state, check the following conditions:

- 1) Indication that there was not a valid state available to the reference state previously (indicated by GPS\_REF\_INIT\_VALID\_PREV = OFF);
- 2) An announced reset command has been received from the GPS Receiver State Processing (indicated by GPS\_ANNCD\_RESET = ON), and there are not any initialization or reset commands still in progress for any of the receivers (indicated by IN\_PROGRESS\_CNT(1), IN\_PROGRESS\_CNT(2), IN\_PROGRESS\_CNT(3) being equal to zero);
- 3) The major mode indicates Ascent Navigation is running (as indicated by MM\_CODE < 200 or MM\_CODE = 601).

If at least one of these conditions is satisfied, the reference state variables are set to the stored initialization state and associated parameters:

```
IF GPS_REF_INIT_VALID_PREV = OFF or
   (GPS_ANNCD_RESET = ON and IN_PROGRESS_CNT(1) = 0 and
    IN_PROGRESS_CNT(2) = 0 and IN_PROGRESS_CNT(3) = 0) or
   MM_CODE < 200 or
   MM_CODE = 601 THEN
     $\bar{R}_{REF} = \bar{R}_{GPS\_INIT}$ 
     $\bar{V}_{REF} = \bar{V}_{GPS\_INIT}$ 
     $\bar{G}_{GPS} = \bar{G}_{GPS\_INIT}$ 
     $\bar{T}_{REF} = \bar{T}_{GPS\_INIT}$ 
     $\bar{V}_{IMU\_GPS} = \bar{V}_{IMU\_GPS\_INIT}$ 
     $T_{IMU\_PREV} = T_{GPS\_INIT}$ 
    GPS_REF_INIT_VALID_PREV = ON
    Continue to step 2.1
```



Otherwise continue with step 3.0

- 2.1 If the reanchoring of the GPS Reference state was due to an announced reset, set the GPS announced reset reanchor flag ON and set the announced reset command from GPS Receiver State Processing to OFF.

```
IF GPS_ANNCD_RESET = ON THEN
  GPS_ANNCD_RESET_REF = ON
  GPS_ANNCD_RESET = OFF
```

- 3.0 The operations in Step 3 are then performed for up to three receivers.

```
DO FOR I = 1 TO GPS_SW_CAP
```

- 3.1 The operational mode of the I'th GPS receiver is tested. If the mode is not 'blank', the flag controlling aiding data validity for that receiver is set to 'ON':

```
IF GPS_MODEI ≠ 'blank' THEN
  AIDING_DATA_VALIDI = ON
  Continue to Step 3.2
```

Otherwise

Return to Step 3.0

- 3.2 To ensure that a consistent set of state data is sent to the receiver during a restart, initialization, or an announced reset, a check of the following conditions are made for the I'th receiver: a restart is not in progress, indicated by GPS\_FILT\_RESTART<sub>I</sub> = OFF; a receiver initialization is not in progress, indicated by INIT\_STATE\_SET<sub>I</sub> = OFF; and an announced reset is not in progress, indicated by GPS\_ANNCD\_RESET\_SET<sub>I</sub> = OFF. If all three of these conditions are satisfied, then Steps 3.2.1 through 3.2.4 are executed. Otherwise Step 3.2.5 is executed.

- 3.2.1 Reset the GPS command in-progress counter to zero, IN\_PROGESS\_CNT<sub>I</sub> = 0

- 3.2.2 If a commanded announced reset is unable to be processed by GPS Reference State Initialization and Reanchor due to a command being in progress on one of the GPS receivers, all new reset and initialization commands will pend. GPS Reference State determines whether an announced reset is being held out by checking the GPS\_ANNCD\_RESET flag. If this flag is OFF, an announced reset is not being held out and step 3.2.3 is executed next. If this flag is ON, an announced reset is being held out and processing returns to Step 3.0.

```
IF GPS_ANNCD_RESET = OFF then
  continue to Step 3.2.3
```

OTHERWISE

Return to Step 3.0

- 3.2.3 If the initialization data request from the GPS SOP for the I'th receiver is set to ON, GPS\_INIT\_REQUEST<sub>I</sub> = ON, the parameter indicating to the GPS SOP that initialization data has been made available, INIT\_STATE\_SET<sub>I</sub>, is set to ON, and the flag from the GPS SOP which initiated the initialization data request, GPS\_INIT\_REQUEST\_SOP<sub>I</sub>, is set to OFF. Since the receiver initialization process reinitializes the receiver navigation covariance and state estimates, there

is no need to perform a Filter Restart if one occurs during the reinitialization process. Therefore the flag indicating a Filter Restart is requested, `FILT_RESTART_REQUESTI` is also set to OFF. To prevent the GPS Reference State from being reanchored by a request on another receiver while the Initialization is being processed, the in progress counter, `IN_PROGRESS_CNTI`, will be set to 1.

```
IF GPS_INIT_REQUESTI = ON THEN
  INIT_STATE_SETI = ON
  GPS_INIT_REQUEST_SOPI = OFF
  FILT_RESTART_REQUESTI = OFF
  IN_PROGRESS_CNTI = 1
  Return to Step 3.0
```

Otherwise Step 3.2.4 is executed.

3.2.4 If the I'th receiver is not in the INS NAV submode, indicated by `GPS_NAV_SUBMODE_RCVDI ≠ 'INS'`, then the parameter indicating a filter restart request is set to OFF. Any existing filter restart command will pend until the next time that the receiver enters the INS NAV submode, at which time the filter restart will commence.

```
IF GPS_NAV_SUBMODE_RCVDI ≠ 'INS' THEN
  FILT_RESTART_REQUESTI = OFF
  Return to Step 3.0
```

Otherwise, if the I'th receiver is in the INS NAV submode, indicated by `GPS_NAV_SUBMODE_RCVDI = 'INS'`, then the steps in Section 4.6.4.4.2 are executed. The steps in Sections 4.6.4.4.2 are performed to set the appropriate data request acknowledgments for the GPS SOP and to turn off, where appropriate, the flags from the GPS SOP which initiated the data request. The steps are executed in the order which reflects the priority of commands for the receiver when the receiver is in the INS NAV submode: a commanded filter restart during the OPS; and an announced reset of the reference state being provided to the receiver. Once Section 4.6.4.4.2 is complete return to Step 3.0.

3.2.5 However, if a receiver is in the middle of a filter restart, initialization, or an announced reset, a check on the corresponding GPS command in progress counter, `IN_PROGRESS_CNTI`, is made. If a receiver takes longer than the allowable limit to complete one of these three processes (indicated by `IN_PROGRESS_CNTI > IN_PROGRESS_LIM`), set the GPS Command Reset flag, `GPS_CMD_RESETI`, to ON. Otherwise, increment the GPS command in-progress counter by one.

```
IF IN_PROGRESS_CNTI > IN_PROGRESS_LIM THEN
  GPS_CMD_RESETI = ON
ELSE
  IN_PROGRESS_CNTI = IN_PROGRESS_CNTI + 1
```

4.0 Reset the GPS announced reset reanchor flag (`GPS_ANNCD_RESET_REF`) to OFF, so that all receivers in INS NAV submode will be commanded to perform announced resets on the same GPS reference state processing cycle.

#### 4.6.4.4.2 Filter Restarts and Announced Resets

This section contains the necessary steps to (1) set the appropriate flags for the GPS SOP if a Filter Restart was requested and (2) set the appropriate flags for the GPS SOP if an announced reset of the reference state is to be executed. These steps are executed in the required order to complete the priority of commands for the receiver when the receiver is in the INS NAV submode: a commanded filter restart during the OPS; and an announced reset of the reference state being provided to the receiver.

- 1.0 If the filter restart request flag,  $FILT\_RESTART\_REQUEST\_RCVD_I$ , is set to ON, the GPS filter restart flag,  $GPS\_FILT\_RESTART_I$ , is set to ON, indicating that a filter restart is commanded, and the filter restart request flag,  $FILT\_RESTART\_REQUEST_I$ , is set to OFF. To prevent the GPS Reference State from being reanchored while the filter restart is being processed, the in progress counter,  $IN\_PROGRESS\_CNT_I$ , will be set to 1.

```
IF  $FILT\_RESTART\_REQUEST\_RCVD_I = ON$ 
     $GPS\_FILT\_RESTART_I = ON$ 
     $FILT\_RESTART\_REQUEST_I = OFF$ 
     $IN\_PROGRESS\_CNT_I = 1$ 
Otherwise Execute Step 2
```

- 2.0 If an announced reset, which will reanchor the reference state, for the I'th receiver is to be executed (indicated by  $GPS\_ANNCD\_RESET\_REF = ON$ ), the flag indicating an announced reset is commanded and the requisite data is available,  $GPS\_ANNCD\_RESET\_SET_I$ , is set to ON. Furthermore, the flag indicating an announced reset for the GPC-to-GPS time adjustment computation ( $GPS\_ANNCD\_RESET\_TIME\_ADJ$ ) is set to ON. To prevent the GPS Reference State from being reanchored while the announced reset is being processed, the in progress counter,  $IN\_PROGRESS\_CNT_I$ , will be set to 1.

```
IF  $GPS\_ANNCD\_RESET\_REF = ON$  THEN
     $GPS\_ANNCD\_RESET\_SET_I = ON$ 
     $GPS\_ANNCD\_RESET\_TIME\_ADJ = ON$ 
     $IN\_PROGRESS\_CNT_I = 1$ 
```

#### B. Interface Requirements.

The input and output parameters required are listed in Tables 4.6.4.4-1 and 4.6.4.4-2.

#### C. Processing Requirements. This subfunction shall execute after the GPS external data snap subfunction and before GPS reference state propagation subfunction.

$GPS\_REF\_INIT\_VALID$  shall be initialized to ON, and shall be protected and carried across all GN&C OPS transition.

The following single element and array variables, where  $I = 1$  to 3, shall be initialized to OFF at each OPS transition except for OPS 1 to 6, OPS 6 to 9, OPS 3 to 9, and OPS 2 to 0 to 2:

```
AIDING_DATA_VALIDI
GPS_FILT_RESTARTI
INIT_STATE_SETI
GPS_ANNCD_RESET_SETI
```

GPS\_ANNCD\_RESET\_REF  
GPS\_REF\_INIT\_VALID\_PREV  
GPS\_ANNCD\_RESET\_TIME\_ADJ

D. Constraints. None.

E. Supplementary Information. A suggested implementation in the form of a detailed flow chart (GPS\_REF\_STATE\_INIT\_REANCHOR) may be found in Section 5.6.

The logic check in Step 3.2 of Section 4.6.4.4.1 enables a consistent set of state data to be sent to the receiver while it is completing one of the following three operations: a receiver initialization; a filter restart; or an announced reset. If the receiver takes more than one cycle of the reference state processing principal function to complete its response to one of these conditions a situation could arise whereby the reference states sent to the receiver can change suddenly without the receiver being notified of the change. This situation can arise if a new initialization state is made available by the navigation principal function during the receiver restart or initialization process. The logic check in Step 3.2 ensures that the reference state being sent to the receiver does not change while the receiver completes its restart, initialization, or announced reset process.

#### 4.6.4.4.3 Deleted

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) the request for a GPS filter restart	FILT_RESTART_REQUEST_RCVD <sub>1</sub> **	GPS external data snap	D	--	ON/OFF	--	6.25 Hz
Flag indicating (ON) the request for a GPS receiver initialization	GPS_INIT_REQUEST <sub>1</sub> **	GPS external data snap	D	--	ON/OFF	--	6.25 Hz
Flags indicating GPS receiver mode	GPS_MODE <sub>1</sub> **	GPS reference state processing external data snap	CHAR	--	INIT, NAV, TEST, Blank	--	6.25 Hz
GPS command in progress count limit	IN_PROGRESS_LIM	K-load	I	--		--	6.25 Hz
Flag indicating request for GPS announced resets and GPS reference state to be reanchored with navigation state	GPS_ANNCD_RESET	*	D	--	ON/OFF	--	6.25 Hz

Table 4.6.4.4-1. GPS Reference State Initialization and Reanchor Subfunction Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) to GPS Reference State Processing principal function that a valid reference state exists for the GPS receivers	GPS_REF_INIT_VALID	*	D	--	ON/OFF	--	6.25Hz
Maximum number of GPS receivers for which GPS specific flight software is designed	GPS_SW_CAP	K-load	I	--	3	--	Filter rate
Major mode indicator	MM_CODE	*	I	S		--	6.25
GPS position vector for initialization/reanchor	$\bar{R}_{GPS\_INIT}$	*	V	DP		ft	6.25 Hz
GPS state time tag for initialization/reanchor	T_GPS_INIT	*	F	DP		sec	6.25 Hz
GPS velocity vector for initialization/reanchor	$\bar{V}_{GPS\_INIT}$	*	V	S		ft/sec	6.25 Hz
IMU velocity count for GPS initialization/reanchor	$\bar{V}_{IMU\_GPS\_INIT}$	*	V	DP		ft/sec	6.25 Hz
Flag indicating (ON) valid aiding reference states	AIDING_DATA_VALID <sub>I</sub> **	*	D		ON/OFF		6.25 Hz
Gravity acceleration vector for propagation of reference state for GPS initialization/reanchor	$\bar{G}_{GPS\_INIT}$	*	V	S		ft/sec** 2	6.25 Hz
Flag indicating (ON) GPS announced reset of receiver I is commanded	GPS_ANNCD_RESET_SET <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
Flag indicating (ON) GPS filter restart of receiver I is commanded	GPS_FILT_RESTART <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
Navigation submode of GPS receiver I	GPS_NAV_SUBMODE_RCVD <sub>I</sub> **	*	Char	--	PVA/ INS/ 'b'		6.25 Hz
Flag indicating (ON) initialization of receiver I is commanded	INIT_STATE_SET <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz

\* See principal function input list in Table 4.6.4.6-1.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Description	Symbol	Output Destination	Type	Prec	Range	Units	Sample Rate
Flag indicating (ON) valid aiding reference states	AIDING_DATA_VALID <sub>I</sub> **	*, GPS Reference State Prop	D	---	ON/OFF	--	6.25 Hz
Flag indicating (ON) initialization of receiver I is commanded	INIT_STATE_SET <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
Flag indicating (ON) GPS filter restart of receiver I is commanded	GPS_FILT_RESTART <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
Flag indicating (ON) GPS announced reset of receiver I is commanded	GPS_ANNCD_RESET_SET <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
Flag indicating an announced reset for the GPC-to-GPS time adjustment computation	GPS_ANNCD_RESET_TIME_ADJ	*	D	-	ON/OFF	-	6.25 Hz
Flag indicating (ON) a GPS command reset is required due to a GPS command time-out	GPS_CMD_RESET <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz
GPS reference state position vectors	$\bar{R}_{REF}$	GPS reference state prop	V	DP		ft	6.25 Hz
Reserved time tags for last new accumulated IMU velocity counts	T_IMU_PREV <sub>I</sub> **	GPS reference state prop	F	DP		sec	6.25 Hz
Time tags of GPS reference states	T_REF	GPS reference state prop	F	DP		sec	6.25 Hz
Selected accumulated IMU velocity counts	$\bar{V}_{IMU\_GPS}$	GPS reference state prop	V	DP		ft/sec	6.25 Hz
GPS reference state velocity vectors	$\bar{V}_{REF}$	GPS reference state prop	V	DP		ft/sec	6.25 Hz
Gravity vector for GPS reference state propagation	$\bar{G}_{GPS}$	GPS reference state prop	V	DP		ft/sec <sup>2</sup>	6.25 Hz
Flag indicating (ON) the request for a GPS receiver initialization	GPS_INIT_REQUEST_SOP <sub>I</sub> **	*	D	--	ON/OFF	--	6.25 Hz

\* See principal function output list in Table 4.6.4.6-2.  
\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

#### 4.6.4.5 GPS Reference State Propagation

The GPS reference state propagation subfunction propagates the reference state at 6.25 Hz. If the IMU data is not available at 6.25 Hz, then the previous average acceleration is used to integrate the states to the current clock time.

##### A. Detailed Requirements.

The AIDING\_DATA\_VALID flags for the GPS receivers are checked to determine if the receiver reference state is to be propagated. If any of the flags is ON, indicated by AIDING\_DATA\_VALID<sub>1</sub> = ON or AIDING\_DATA\_VALID<sub>2</sub> = ON or AIDING\_DATA\_VALID<sub>3</sub> = ON, then the reference state propagation will take place as follows (Steps 1.0 through 5.0):

- 1.0 The current clocktime, T\_CURRENT, is stored in the intermediate variable T\_CURRENT\_GPS\_REF for propagating the GPS receiver reference states to current time.

$$T\_CURRENT\_GPS\_REF = T\_CURRENT$$

- 2.0 The current IMU time is compared to the previous GPS reference state time. If the times are not equal, then the acceleration over the time interval is computed as follows:

$$\begin{aligned} \text{IF } T\_IMU \neq T\_IMU\_PREV \text{ THEN} \\ \overline{DV\_GPS} &= \overline{V\_IMU\_M50} - \overline{V\_IMU\_GPS} \\ \overline{ACC\_IMU} &= \overline{DV\_GPS} / (T\_IMU - T\_IMU\_PREV) \end{aligned}$$

Note that if the current and previous IMU times are equal, the acceleration computed on the previous cycle is used for the current time interval.

If the magnitude of the computed acceleration is less than the given I-load acceleration threshold, the acceleration vector is set to zero and the values of the parameters for using drag and vent accelerations in the state propagation are set to the appropriate GPS drag and vent I-load values, otherwise they are set to 0.

$$\text{IF } |\overline{ACC\_IMU}| < ACC\_THRESH\_GPS\_REF \text{ THEN}$$

$$\begin{aligned} \overline{ACC\_IMU} &= 0 \\ I\_DRAG &= I\_DRAG\_GPS\_REF \\ I\_VENT &= I\_VENT\_GPS\_REF \end{aligned}$$

ELSE

$$\begin{aligned} I\_DRAG &= 0 \\ I\_VENT &= 0 \end{aligned}$$

Note that the drag and vent acceleration flags which are input to the ACCEL\_GPS function will be used for propagation only if the ACCEL function in the current OPS supports that capability.

The IMU velocity counts and associated time tag assigned to the receiver are updated for use on the next cycle:

$$\begin{aligned} \overline{V\_IMU\_GPS} &= \overline{V\_IMU\_M50} \\ T\_IMU\_PREV &= T\_IMU \end{aligned}$$

- 3.0 The propagation time interval is computed by differencing the current time and the reference state time tag. The reference state time tag is then updated to current time:

$$\begin{aligned} DT\_IMU &= T\_CURRENT\_GPS\_REF - T\_REF \\ T\_REF &= T\_CURRENT\_GPS\_REF \end{aligned}$$

4.0 The velocity change over the propagation interval is computed:

$$\overline{DV\_PROP} = \overline{ACC\_IMU} DT\_IMU$$

5.0 The reference state is propagated to the current time using I-loaded gravity model parameters and an average-G algorithm as follows:

$$\begin{aligned} \overline{R\_REF} &= \overline{R\_REF} + DT\_IMU (\overline{V\_REF} + 0.5 (DV\_PROP + DT\_IMU \overline{G\_GPS})) \\ \overline{G\_GPS\_NEW} &= ACCEL\_GPS (GM\_DEG\_GPS\_AID, GM\_ORD\_GPS\_AID, \\ &\quad I\_DRAG, I\_VENT, \overline{R\_REF}, \overline{V\_REF}, T\_REF) \\ \overline{V\_REF} &= \overline{V\_REF} + \overline{DV\_PROP} + 0.5 DT\_IMU (\overline{G\_GPS} + \overline{G\_GPS\_NEW}) \\ \overline{G\_GPS} &= \overline{G\_GPS\_NEW} \end{aligned}$$

B. Interface Requirements.

The input and output parameters required are listed in Tables 4.6.4.5-1 and 4.6.4.5-2.

C. Processing Requirements.

This subfunction shall execute after the GPS reference state initialization and reanchor subfunction.

D. Constraints. None.

E. Supplementary Information.

A suggested implementation in the form of a detailed flow chart (GPS\_REF\_STATE\_PROP) may be found in Section 5.6.

ACCEL\_GPS may be found in Section 4.2.1.4 in the Entry Navigation FSSR, STS 83-0004.

Table 4.6.4.5-1. GPS_REF_STATE_PROP Procedure Input Parameters							
Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Sensed acceleration from selected IMU velocity counts	$\overline{ACC\_IMU}^{**}$	*	V	DP		ft/sec <sup>2</sup>	6.25 Hz
Reference acceleration for GPS state propagation	ACC_THRESH_GPS_REF	I-Load	F	SP		ft/sec <sup>2</sup>	6.25 Hz
Drag flag for acceleration model	I_DRAG_GPS_REF	I-Load	D		ON/OFF		6.25 Hz
Vent flag for acceleration model	I_VENT_GPS_REF	I-Load	D		ON/OFF		6.25 Hz
Order of gravity model used in propagating GPS reference states	GM_ORD_GPS_AID	K-Load	I			--	6.25 Hz
Degree of gravity model used in propagating GPS reference states	GM_DEG_GPS_AID	K-Load	I			--	6.25 Hz



Table 4.6.4.5-1. GPS\_REF\_STATE\_PROP Procedure Input Parameters

Description	Symbol	Input Source	Type	Prec	Range	Units	Sample Rate
Gravity vector for GPS reference state propagation	$\bar{G}_{GPS}^{**}$	GPS reference state init and reanchor, GPS reference state external data snap	V	DP		ft/sec <sup>2</sup>	6.25 Hz
Maximum number of GPS receivers for which the GPS software is designed	GPS_SW_CAP	K-Load	I	S	3	--	6.25 Hz
GPS reference state position vector	$\bar{R}_{REF}^{**}$	GPS reference state init and reanchor	V	DP		ft	6.25 Hz
Current MTU clock GMT time	T_CURRENT	*	F	DP		sec	6.25 Hz
Time tag of accumulated IMU velocity counts	T_IMU	GPS external data snap	F	DP		sec	6.25 Hz
Time of accumulated sensed velocity from the previous GPS reference state processing cycle	T_IMU_PREV <sup>**</sup>	GPS reference state init and reanchor	F	DP		sec	6.25 Hz
Time tag of GPS reference state	T_REF <sup>**</sup>	GPS reference state init and reanchor	F	DP		sec	6.25 Hz
GPS reference state velocity vector	$\bar{V}_{REF}^{**}$	GPS reference state init and reanchor	V	DP		ft/sec	6.25 Hz
Selected IMU accumulated sensed velocity from last cycle of GPS reference state processing	$\bar{V}_{IMU\_GPS}^{**}$	GPS reference state init and reanchor	V	DP		ft/sec	6.25 Hz
Current selected IMU accumulated sensed velocity from IMU RM	$\bar{V}_{IMU\_M50}$	GPS external data snap	V	DP		ft/sec	6.25 Hz
Flag indicating (ON) valid aiding reference states	AIDING_DATA_VALID <sub>1</sub> <sup>**</sup>	GPS reference state init and reanchor	D	--	ON/OFF	--	6.25 Hz

\* See principal function output list in Table 4.6.4.6-2.

\*\* I = 1, 2, 3 (1 to GPS\_SW\_CAP)

Description	Symbol	Output Destination	Type	Prec	Range	Units	Sample Rate
GPS reference state position vector	$\bar{R}_{REF}$	*	V	DP		ft	6.25 Hz
GPS reference state velocity vector	$\bar{V}_{REF}$	*	V	DP		ft/sec	6.25 Hz
Time tag for GPS reference state	T_REF	*	F	DP		sec	6.25 Hz

\* See principal function output list in Table 4.6.4.6-2.

#### 4.6.4.6 GPS Reference State Processing (4.18) Principal Function Tables

This section contains the input/output, I-Load, and variable cross-reference tables for the GPS reference state vector processing principal function, which are presented in Tables 4.6.4.6-1 and 4.6.4.6-2.

FSSR Name	Source Name
FILT_RESTART_REQUEST_RCVD	FILT_RESTART_REQUEST
GPS_INIT_REQUEST	GPS_INIT_REQUEST_SOP
GPS_MODE	GPS_MODE_CURRENT
GPS_NAV_SUBMODE_RCVD	GPS_NAV_SUBMODE
T_CURRENT	CLOCK/CLOCKTIME
T_IMU	TIME_V
V_IMU_M50 (1)	SEL_VEL_GPS_M50(1)
V_IMU_M50 (2)	SEL_VEL_GPS_M50(2)
V_IMU_M50 (3)	SEL_VEL_GPS_M50(3)

TABLE 4.6.4.6-1. INPUT FUNCTIONAL PARAMETERS FOR GPS REFERENCE STATE PROCESSING (G4.18)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ACC_IMU(1)	V90A3830C	GPS X COMP SENSED ACCEL	ASC NAV SEQ	FT/S2	DPL		92369B	
ACC_IMU(2)	V90A3831C	GPS Y COMP SENSED ACCEL	ASC NAV SEQ	FT/S2	DPL		92369B	
ACC_IMU(3)	V90A3832C	GPS Z COMP SENSED ACCEL	ASC NAV SEQ	FT/S2	DPL		92369B	
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER(GMT)	FCOS	S			93160B	*
EARTH_POLE(1)	V90U0190C	X-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(2)	V90U0191C	Y-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
EARTH_POLE(3)	V90U0192C	Z-COMP UNIT VCTR ALONG EARTH AXIS	RNP MAT COMP	ND	DPL		93090E	
FILT_RESTART_REQUEST(1)	V90X3006X	GPS 1 FILTER RESTART REQUEST FLAG	GPS SOP		BD		91051K	
FILT_RESTART_REQUEST(2)	V90X3007X	GPS 2 FILTER RESTART REQUEST FLAG	GPS SOP		BD		91051K	
FILT_RESTART_REQUEST(3)	V90X3008X	GPS 3 FILTER RESTART REQUEST FLAG	GPS SOP		BD		91051K	
GPS_ANNCD_RESET	V90X3075X	GPS ANNCD RESET FLAG	GPS RCVR STATE PROC		BD		92369B	
GPS_ANNCD_RESET_SET(1)	V90X3290XB	GPS 1 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_ANNCD_RESET_SET(2)	V90X3291XB	GPS 2 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_ANNCD_RESET_SET(3)	V90X3292XB	GPS 3 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_FILT_RESTART(1)	V90X3269XA	GPS 1 FILTER RESTART FLAG	GPS SOP		BD		92049C	
GPS_FILT_RESTART(2)	V90X3270XA	GPS 2 FILTER RESTART FLAG	GPS SOP		BD		92049C	
GPS_FILT_RESTART(3)	V90X3271XA	GPS 3 FILTER RESTART FLAG	GPS SOP		BD		92049C	
GPS_INIT_REQUEST_SOP(1)	V90X3018XB	GPS 1 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
GPS_INIT_REQUEST_SOP(2)	V90X3019XB	GPS 2 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
GPS_INIT_REQUEST_SOP(3)	V90X3020XB	GPS 3 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
GPS_MODE_CURRENT(1)	V90U3021C	GPS 1 CURRENT OPERATING MODE	GPS SOP		VAR		92132C	
GPS_MODE_CURRENT(2)	V90U3022C	GPS 2 CURRENT OPERATING MODE	GPS SOP		VAR		92132C	
GPS_MODE_CURRENT(3)	V90U3023C	GPS 3 CURRENT OPERATING MODE	GPS SOP		VAR		92132C	
GPS_NAV_SUBMODE(1)	V90U2616C	GPS 1 NAV SUBMODE INDICATOR	GPS SOP		VAR		91051K	
GPS_NAV_SUBMODE(2)	V90U2617C	GPS 2 NAV SUBMODE INDICATOR	GPS SOP		VAR		91051K	
GPS_NAV_SUBMODE(3)	V90U2618C	GPS 3 NAV SUBMODE INDICATOR	GPS SOP		VAR		91051K	
GPS_REF_INIT_VALID	V90X3642XA	GPS INIT REF STATE VALID FLAG	D/L NAV SEQ		BD		92067D	
GPS_REF_INIT_VALID	V90X3642XB	GPS INIT REF STATE VALID FLAG	ENT NAV		BD		92067D	
GPS_REF_INIT_VALID	V90X3642XC	GPS INIT REF STATE VALID FLAG	ORB/RND NAV		BD		92067D	
GPS_REF_INIT_VALID	V90X3642XD	GPS INIT REF STATE VALID FLAG	ORB/RND NAV SEQ		BD		92067D	
G_GPS_INIT(1)	V90A2619CA	X GRAV ACC FOR GPS REF STATE INIT	D/L NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CB	X GRAV ACC FOR GPS REF STATE INIT	ENT NAV	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CC	X GRAV ACC FOR GPS REF STATE INIT	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CD	X GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CE	X GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CF	X GRAV ACC FOR GPS REF STATE INIT	ASC NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CG	X GRAV ACC FOR GPS REF STATE INIT	RTLS NAV	FT/S2	SPL		92214A	
G_GPS_INIT(1)	V90A2619CH	X GRAV ACC FOR GPS REF STATE INIT	ASC NAV	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CA	Y GRAV ACC FOR GPS REF STATE INIT	D/L NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CB	Y GRAV ACC FOR GPS REF STATE INIT	ENT NAV	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CC	Y GRAV ACC FOR GPS REF STATE INIT	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CD	Y GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CE	Y GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CF	Y GRAV ACC FOR GPS REF STATE INIT	ASC NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CG	Y GRAV ACC FOR GPS REF STATE INIT	RTLS NAV	FT/S2	SPL		92214A	
G_GPS_INIT(2)	V90A2620CH	Y GRAV ACC FOR GPS REF STATE INIT	ASC NAV	FT/S2	SPL		92214A	

TABLE 4.6.4.6-1. INPUT FUNCTIONAL PARAMETERS FOR GPS REFERENCE STATE PROCESSING (G4.18)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
G_GPS_INIT(3)	V90A2621CA	Z GRAV ACC FOR GPS REF STATE INIT	D/L NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CB	Z GRAV ACC FOR GPS REF STATE INIT	ENT NAV	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CC	Z GRAV ACC FOR GPS REF STATE INIT	PRELAND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CD	Z GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CE	Z GRAV ACC FOR GPS REF STATE INIT	ORB/RND NAV	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CF	Z GRAV ACC FOR GPS REF STATE INIT	ASC NAV SEQ	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CG	Z GRAV ACC FOR GPS REF STATE INIT	RTLS NAV	FT/S2	SPL		92214A	
G_GPS_INIT(3)	V90A2621CH	Z GRAV ACC FOR GPS REF STATE INIT	ASC NAV	FT/S2	SPL		92214A	
INIT_STATE_SET(1)	V90X3278XB	GPS 1 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
INIT_STATE_SET(2)	V90X3279XB	GPS 2 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
INIT_STATE_SET(3)	V90X3280XB	GPS 3 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
MM_CODE	V90Q8001C	MAJOR MODE CODE	UI		HXS		93017G	*
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
R_GPS_INIT(1)	V90H3476CA	GPS INIT POS VECTOR X-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CB	GPS INIT POS VECTOR X-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CC	GPS INIT POS VECTOR X-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CD	GPS INIT POS VECTOR X-COMP	D/L NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CE	GPS INIT POS VECTOR X-COMP	ORB/RND NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(1)	V90H3476CF	GPS INIT POS VECTOR X-COMP	ASC NAV SEQ	FT	DPL		92067D	
R_GPS_INIT(1)	V90H3476CG	GPS INIT POS VECTOR X-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_INIT(1)	V90H3476CH	GPS INIT POS VECTOR X-COMP	ASC NAV	FT	DPL		92067D	
R_GPS_INIT(2)	V90H3477CA	GPS INIT POS VECTOR Y-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CB	GPS INIT POS VECTOR Y-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CC	GPS INIT POS VECTOR Y-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CD	GPS INIT POS VECTOR Y-COMP	D/L NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CE	GPS INIT POS VECTOR Y-COMP	ORB/RND NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(2)	V90H3477CF	GPS INIT POS VECTOR Y-COMP	ASC NAV SEQ	FT	DPL		92067D	
R_GPS_INIT(2)	V90H3477CG	GPS INIT POS VECTOR Y-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_INIT(2)	V90H3477CH	GPS INIT POS VECTOR Y-COMP	ASC NAV	FT	DPL		92067D	
R_GPS_INIT(3)	V90H3478CA	GPS INIT POS VECTOR Z-COMP	ENT NAV	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CB	GPS INIT POS VECTOR Z-COMP	PRELAND NAV	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CC	GPS INIT POS VECTOR Z-COMP	ORB/RND NAV	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CD	GPS INIT POS VECTOR Z-COMP	D/L NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CE	GPS INIT POS VECTOR Z-COMP	ORB/RND NAV SEQ	FT	DPL		91051K	
R_GPS_INIT(3)	V90H3478CF	GPS INIT POS VECTOR Z-COMP	ASC NAV SEQ	FT	DPL		92067D	
R_GPS_INIT(3)	V90H3478CG	GPS INIT POS VECTOR Z-COMP	RTLS NAV	FT	DPL		92067D	
R_GPS_INIT(3)	V90H3478CH	GPS INIT POS VECTOR Z-COMP	ASC NAV	FT	DPL		92067D	
SEL_VEL_GPS_M50(1)	V90L2631C	SEL TOTAL M50 X VEL FOR GPS	IMU RM	FT/S	DPL		92369B	

TABLE 4.6.4.6-1. INPUT FUNCTIONAL PARAMETERS FOR GPS REFERENCE STATE PROCESSING (G4.18)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
SEL_VEL_GPS_M50(2)	V90L2632C	SEL TOTAL M50 Y VEL FOR GPS	IMU RM	FT/S	DPL		92369B	
SEL_VEL_GPS_M50(3)	V90L2633C	SEL TOTAL M50 Z VEL FOR GPS	IMU RM	FT/S	DPL		92369B	
TIME_V	V90W2553CA	TIME OF SEL TOTAL M50 VEL	IMU RM	S			91051K	
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_GPS_INIT	V90W3482CA	GPS INIT STATE TIME TAG	ENT NAV	S	DPL		91051K	
T_GPS_INIT	V90W3482CB	GPS INIT STATE TIME TAG	PRELAND NAV	S	DPL		91051K	
T_GPS_INIT	V90W3482CC	GPS INIT STATE TIME TAG	ORB/RND NAV	S	DPL		91051K	
T_GPS_INIT	V90W3482CD	GPS INIT STATE TIME TAG	D/L NAV SEQ	S	DPL		92214A	
T_GPS_INIT	V90W3482CE	GPS INIT STATE TIME TAG	ORB/RND NAV SEQ	S	DPL		92214A	
T_GPS_INIT	V90W3482CF	GPS INIT STATE TIME TAG	ASC NAV SEQ	S	DPL		92067D	
T_GPS_INIT	V90W3482CG	GPS INIT STATE TIME TAG	RTLS NAV	S	DPL		92067D	
T_GPS_INIT	V90W3482CH	GPS INIT STATE TIME TAG	ASC NAV	S	DPL		92067D	
V_GPS_INIT(1)	V90L3495CA	GPS INIT VEL VECTOR X-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CB	GPS INIT VEL VECTOR X-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CC	GPS INIT VEL VECTOR X-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CD	GPS INIT VEL VECTOR X-COMP	D/L NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CE	GPS INIT VEL VECTOR X-COMP	ORB/RND NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(1)	V90L3495CF	GPS INIT VEL VECTOR X-COMP	ASC NAV SEQ	FT/S	SPL		92067D	
V_GPS_INIT(1)	V90L3495CG	GPS INIT VEL VECTOR X-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_INIT(1)	V90L3495CH	GPS INIT VEL VECTOR X-COMP	ASC NAV	FT/S	SPL		92067D	
V_GPS_INIT(2)	V90L3496CA	GPS INIT VEL VECTOR Y-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CB	GPS INIT VEL VECTOR Y-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CC	GPS INIT VEL VECTOR Y-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CD	GPS INIT VEL VECTOR Y-COMP	D/L NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CE	GPS INIT VEL VECTOR Y-COMP	ORB/RND NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(2)	V90L3496CF	GPS INIT VEL VECTOR Y-COMP	ASC NAV SEQ	FT/S	SPL		92067D	
V_GPS_INIT(2)	V90L3496CG	GPS INIT VEL VECTOR Y-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_INIT(2)	V90L3496CH	GPS INIT VEL VECTOR Y-COMP	ASC NAV	FT/S	SPL		92067D	
V_GPS_INIT(3)	V90L3497CA	GPS INIT VEL VECTOR Z-COMP	ENT NAV	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CB	GPS INIT VEL VECTOR Z-COMP	PRELAND NAV	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CC	GPS INIT VEL VECTOR Z-COMP	ORB/RND NAV	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CD	GPS INIT VEL VECTOR Z-COMP	D/L NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CE	GPS INIT VEL VECTOR Z-COMP	ORB/RND NAV SEQ	FT/S	SPL		91051K	
V_GPS_INIT(3)	V90L3497CF	GPS INIT VEL VECTOR Z-COMP	ASC NAV SEQ	FT/S	SPL		92067D	
V_GPS_INIT(3)	V90L3497CG	GPS INIT VEL VECTOR Z-COMP	RTLS NAV	FT/S	SPL		92067D	
V_GPS_INIT(3)	V90L3497CH	GPS INIT VEL VECTOR Z-COMP	ASC NAV	FT/S	SPL		92067D	
V_IMU_GPS_INIT(1)	V90L3506CA	IMU ACCUM X VEL FOR GPS INIT	ENT NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CB	IMU ACCUM X VEL FOR GPS INIT	PRELAND NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CC	IMU ACCUM X VEL FOR GPS INIT	ORB/RND NAV	FT/S	SPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CD	IMU ACCUM X VEL FOR GPS INIT	D/L NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CE	IMU ACCUM X VEL FOR GPS INIT	ORB/RND NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CF	IMU ACCUM X VEL FOR GPS INIT	ASC NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CG	IMU ACCUM X VEL FOR GPS INIT	RTLS NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(1)	V90L3506CH	IMU ACCUM X VEL FOR GPS INIT	ASC NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CA	IMU ACCUM Y VEL FOR GPS INIT	ENT NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CB	IMU ACCUM Y VEL FOR GPS INIT	PRELAND NAV	FT/S	DPL		92369B	

TABLE 4.6.4.6-1. INPUT FUNCTIONAL PARAMETERS FOR GPS REFERENCE STATE PROCESSING (G4.18)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_IMU_GPS_INIT(2)	V90L3507CC	IMU ACCUM Y VEL FOR GPS INIT	ORB/RND NAV	FT/S	SPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CD	IMU ACCUM Y VEL FOR GPS INIT	D/L NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CE	IMU ACCUM Y VEL FOR GPS INIT	ORB/RND NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CF	IMU ACCUM Y VEL FOR GPS INIT	ASC NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CG	IMU ACCUM Y VEL FOR GPS INIT	RTLS NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(2)	V90L3507CH	IMU ACCUM Y VEL FOR GPS INIT	ASC NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CA	IMU ACCUM Z VEL FOR GPS INIT	ENT NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CB	IMU ACCUM Z VEL FOR GPS INIT	PRELAND NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CC	IMU ACCUM Z VEL FOR GPS INIT	ORB/RND NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CD	IMU ACCUM Z VEL FOR GPS INIT	D/L NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CE	IMU ACCUM Z VEL FOR GPS INIT	ORB/RND NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CF	IMU ACCUM Z VEL FOR GPS INIT	ASC NAV SEQ	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CG	IMU ACCUM Z VEL FOR GPS INIT	RTLS NAV	FT/S	DPL		92369B	
V_IMU_GPS_INIT(3)	V90L3508CH	IMU ACCUM Z VEL FOR GPS INIT	ASC NAV	FT/S	DPL		92369B	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.6.4.6-2. OUTPUT FUNCTIONAL PARAMETERS FROM GPS REFERENCE STATE PROCESSING (G4.18)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
AIDING_DATA_VALID(1)	V90X3266X	GPS 1 AIDING REF STATE VALID	GPS SOP		BD		91051K	
AIDING_DATA_VALID(2)	V90X3267X	GPS 2 AIDING REF STATE VALID	GPS SOP		BD		91051K	
AIDING_DATA_VALID(3)	V90X3268X	GPS 3 AIDING REF STATE VALID	GPS SOP		BD		91051K	
GPS_ANNCD_RESET_SET(1)	V90X3290XA	GPS 1 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_ANNCD_RESET_SET(2)	V90X3291XA	GPS 2 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_ANNCD_RESET_SET(3)	V90X3292XA	GPS 3 REF STATE ANNCD RESET	GPS SOP		BD		92067D	
GPS_ANNCD_RESET_TIME_ADJ	V90X0437X	GPS ANNCD RESET FOR TIME ADJ	GPS SOP		BD		92817C	
GPS_CMD_RESET(1)	V90X0444X	GPS 1 COMMAND RESET FLAG	GPS SOP		BD		92289A	
GPS_CMD_RESET(2)	V90X0445X	GPS 2 COMMAND RESET FLAG	GPS SOP		BD		92289A	
GPS_CMD_RESET(3)	V90X0446X	GPS 3 COMMAND RESET FLAG	GPS SOP		BD		92289A	
GPS_FILT_RESTART(1)	V90X3269XB	GPS1 FILTER RESTART FLAG	GPS SOP		BD		92049C	
			GPS STATUS DISP					
GPS_FILT_RESTART(2)	V90X3270XB	GPS2 FILTER RESTART FLAG	GPS SOP		BD		92049C	
			GPS STATUS DISP					
GPS_FILT_RESTART(3)	V90X3271XB	GPS3 FILTER RESTART FLAG	GPS SOP		BD		92049C	
			GPS STATUS DISP					
GPS_INIT_REQUEST_SOP(1)	V90X3018XA	GPS 1 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
GPS_INIT_REQUEST_SOP(2)	V90X3019XA	GPS 2 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
GPS_INIT_REQUEST_SOP(3)	V90X3020XA	GPS 3 REQUEST INITIAL STATE	GPS SOP		BD		92067D	
INIT_STATE_SET(1)	V90X3278XA	GPS 1 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
INIT_STATE_SET(2)	V90X3279XA	GPS 2 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
INIT_STATE_SET(3)	V90X3280XA	GPS 3 REFERENCE STATE INITIALIZED	GPS SOP		BD		92067D	
R_REF(1)	V90H3281C	X-COMP OF GPS REF STATE POS VEC	GPS SOP	FT	DPL		92369B	
R_REF(2)	V90H3282C	Y-COMP OF GPS REF STATE POS VEC	GPS SOP	FT	DPL		92369B	
R_REF(3)	V90H3283C	Z-COMP OF GPS REF STATE POS VEC	GPS SOP	FT	DPL		92369B	
T_CURRENT_GPS_REF	V90W3581C	TIME TAG FOR GPS REFERENCE STATES	GPS SOP	S	DPL		92035D	
V_REF(1)	V90L3308C	X-COMP OF GPS REF STATE VEL VEC	GPS SOP	FT/S	DPL		92369B	
V_REF(2)	V90L3309C	Y-COMP OF GPS REF STATE VEL VEC	GPS SOP	FT/S	DPL		92369B	
V_REF(3)	V90L3310C	Z-COMP OF GPS REF STATE VEL VEC	GPS SOP	FT/S	DPL		92369B	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.6.4.6-3. GPS REFERENCE STATE PROCESSING (G4.18) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ACC_THRESH_GPS_REF	V97U3560C	FT/SEC**2	F	S	D	P	G4.18	08 03 02 01	GP2 GP3 GP2 GP3	92214A	
I_DRAG_GPS_REF	V97U3649C	ND	D		D	P	G4.18	00	GP2	92214A	
I_VENT_GPS_REF	V97U3650C	ND	D		D	P	G4.18	00	GP2	92214A	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**



TABLE 4.6.4.6-4. GPS REFERENCE STATE PROCESSING (G4.18) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
GM_DEG_GPS_AID DEGREE OF MODELED GRAVITY ACCELERATION	V97U3574C	00	2	ND	I	S	C	G4.18	93000A	
GM_ORD_GPS_AID ORDER OF MODELED GRAVITY ACCELERATION	V97U3575C	00	0	ND	I	S	C	G4.18	93000A	
GPS_SW_CAP MAX NUM OF GPS LRU THAT SOFTWARE CAN HANDLE	V97U2923C	00	+3	ND	I	S	P	G4.17 G4.18 G4.20 G4.21 G4.23 G4.24 G4.25	92069B	
IN_PROGRESS_LIM GPS COMMAND IN PROGRESS COUNT LIMIT	V97U6071C	00	+100	ND	I	S	C	G4.18	92370C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.4.6-5. GPS REFERENCE STATE PROCESSING (G4.18) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
ATFL_OV CONTROLS USE OF CURRENT ORB ATTITUDE IN DRAG COMPUTE	V97U6102C	00	+0	ND	I		S C	G4.126 G4.148 G4.18 G4.21 G4.22	91051K	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

#### 4.7 ENTRY AREA NAVIGATION PRINCIPAL FUNCTION (4.220)

The area navigation principal function supports the horizontal situation indicators (HSI), which are dedicated display devices located in the Shuttle cockpit that provide visual outputs of certain navigation and guidance parameters for the crew. A separate HSI, together with its associated moding and selector switches, will be provided for both the commander and the pilot; the commander's panel and a larger view of an HSI are shown in Figures 4.7-1 and 4.7-2 (for reference only). The parameters to be displayed – fundamental directions, distances, and nominal course and glide path deviations to defined way points – have been chosen to permit the crew to adequately monitor and assess the automatic mode of GN&C on the basis of sources of data and computational software independent of that being employed in the automatic mode. Additionally, the choice of parameters provides the minimum necessary G&N information from this independent display to allow the crew to control the vehicle manually by using the HSI as a flight director. Any of three sets of display parameters will be provided for (entry, TAEM, or autoland) and selected for either HSI by its associated three-position mode switch together with certain auto switching logic. Other selector switches will provide for selection of data types used in navigationally related computations (e.g., TACAN/ BARO when TACAN receivers are installed or GPS when no TACAN receivers are installed, MSBLS, or NAV STATE) and for selection of a specific string in the case of redundant navigation sensors.\* The three-position switches are shown in Figure 4.7-1 for the commander's HSI. The source selection will be independent of whatever source is currently being used in the automatic navigation; the string selection will precede and be independent of the redundancy management function (except in the case of the barometric altitude); and finally, the commander's and pilot's HSI switches will function appropriately for their HSI and cause computations and displays independent of each other. The display mode will be determined based upon either manual or automatic switching logic. If the three position mode switch is set to the entry position, then the display mode is automatically switched from entry to TAEM, based upon major mode, and from TAEM to autoland, based upon altitude above the runway. For the TAEM or approach switch settings, the display mode selection is manual and the TAEM or autoland display computations, respectively, will be performed.

\* The barometric altitude used with the TACAN data will come from the redundancy management selection filter and, therefore will be unaffected by string selection.

The intent of the requirements for the HSI displays is to provide information derived primarily from raw navigation sensor data (for its navigation parameters) and to transform that derived navigation state into guidance related target parameters. The source selection, however, will permit use of the current navigation state vector. Generally, the targeting to waypoints is consistent with the current guidance targeting parameters. Overhead Targeting (OTT) has been implemented as an option (along with straight-in), with compatibility between crew displays and controls, guidance moding, user parameter processing, and the area navigation processing. In most instances, the same trajectory characteristics are supported, that is, overhead versus straight-in ground tracks, left and right heading alignment cones (HAC), and altitude versus range profiles. Exceptions are by design and are due to either unique functional requirements or trades and balances between compatibility and independence. Source and receive selections for area Nav may produce somewhat different outputs compared to the guidance and user parameter processing, which use only the navigation state vector. Computations based upon present positions determined from independent and different sources is a requirement, and differences are anticipated. Certain status flags will be displayed on the HSI to indicate cues regarding validity of selected source/string data: these include an ON/OFF flag, range flags, a bearing flag, course deviation flag, and glide slope deviation flag. The status setting of the flags will provide some means of rapid, real-time diagnosis of problems by the crew and will normally permit a crewman to select a good input source to

drive the HSI. (That, incidentally, may permit isolation of bad sources, which he may inhibit for the automatic GN&C processing.)

Through the interpretation of the displayed parameters on the HSI, the crew will be provided an independent monitor of certain GN&C parameters critical to a safe arrival near the touchdown zone and through rollout. The HSI, together with other dedicated displays, will provide the primary backup to guidance and navigation as well as a flight director function for horizontal and vertical guidance for a similar safe arrival by manual control up to a region in which transition from the steep glide slope to a shallow glide is required. Thereafter, the glide slope deviation is not computed because its use as an altitude director in a manual landing is questionable (radar altimeter altitude being preferable). The horizontal flight direction will be validly applicable throughout rollout.

The UPP sequencer principal functions will schedule the area navigation principal function to be performed during the appropriate phases of Shuttle flight at a repetition rate commensurate with the HSI processing principal function.

Interface parameters between this principal function and other GN&C principal functions are shown in Table 4.7.1-1.

A. Detailed Requirements. In order for the area navigation to initialize with the same trajectory characteristics as the user parameter processing, guidance, and displays (that is, overhead versus straight-in and turns around the same, either left or right, HAC at the selected runway), it is required that the ENTRY UPP principal function execute before the first pass through area Nav processing and compute these necessary selection indicators. Area navigation processing tests a "first pass" indicator (FIRST\_PASS), which will be set to ON by ENTRY UPP after its execution in Major Mode 304. It will also be set to ON by ENTRY UPP or TAEM UPP after any area or runway redesignation where new selection indicators are computed. Whenever Area Nav finds the "first pass" indicator set (ON), it performs three actions. (1) It copies (saves) the overhead/straight-in indicator and the left/right HAC indicator for subsequent cycles. (2) It resets the left/right Area Nav HAC turn angle to the reset value (PSHARS). (3) It resets the "first pass" indicator to OFF.

Provision for change in the overhead/straight-in indicator is provided elsewhere in the Area Nav (then left/right turn indicator is computed by A.N.), but only in this "first pass" is the left/right indicator accepted as input command. After the left/right HAC indicator is determined, it specifies a "selected HAC" for subsequent Area Nav computations.

HSI computations will be based upon inputs from the tactical air navigation (TACAN) system with the air data system (ADS) or the Global Positioning System (GPS), the microwave scanning beam landing system (MSBLS), or the navigated state from a general-purpose computer (GPC). The HSI, with its associated switches, will be located at each side of the cockpit. Since each may be operated independently, computations will be executed independently for the left and right HSI. Cockpit switches will permit crew selection of data sources and will provide for either automatic or manual control over the display modes. A cockpit switch setting will determine which of three data sources is to be used for the computation of the HSI parameters. These data sources are (1) TACAN (range and azimuth), together with ADS (barometric altitude), or GPS receiver data, depending on the number of GPS receivers installed on the vehicle; (2) MSBLS (range, azimuth, and elevation); and (3) navigation solution of Shuttle's position and attitude.

Since the TACAN, GPS and MSBLS NAVAID sources are multiredundant, another cockpit switch will be used to select which of three subsources is to be used (i.e., there will be three TACAN's, three GPS receivers, or three MSBLS transceivers to choose from). However, only one source for the navigated state

will be used. When the source selection switch is set to the NAV position, the receiver selection switch will have no function, since the single source driving the HSI will be the user parameter state vector. Regardless of which data source is selected, the HSI parameter computation module will first transform the data to the coordinate system of the primary runway.

A third cockpit switch, together with major mode flags and altitude above the runway, will determine the display mode (ENTRY, TAEM, or A/L). The parameters computed for display will vary with the display mode selected. The actual display mode, HSI\_MODE\_LEFT/RIGHT, will be saved for use by the MEDS (1 = Entry, 2 = TAEM, 3 = Landing). The parameters computed and the logic for determining the display mode are described in more detail below.

The HSI display and area navigation computation function will compute and output seven dynamic parameters for display on the HSI: primary bearing (PRI\_BEAR), primary range (PRI\_RANGE), secondary bearing (SEC\_BEAR), secondary range (SEC\_RANGE), course deviation (CDI), glide slope deviation (GSI), and the heading angle (HEADING). The definitions of these parameters vary according to the display mode as indicated briefly in Table 4.7-1. Their geometry is shown in Figures 4.7-3 and 4.7-4.

In the ENTRY display mode, these parameters are defined as follows:

**PRI\_BEAR** Spherical angle in degrees (measured positive eastward) between magnetic north and the great circle direction to Way Point 1\* (WP-1) for the selected HAC at the selected landing runway

\* Way Point 1 is defined as the tangential target point on the HAC.

**PRI\_RANGE** Great circle surface distance in nautical miles from the Shuttle to Way Point 2\*\* (WP-2) on the selected landing runway via the selected HAC WP-1. This distance includes the distance from the Shuttle to WP-1, the arc length around the normal entry HAC from WP-1 to the normal entry point (NEP), and the distance from the NEP to WP-2.

\*\* Way Point 2 (WP-2) is defined as the intersection with the runway centerline of the shallow glide slope. The runway X-component of WP-2 is a premission-determined value that nominally is expected to be on the order of 1,000 feet.

**SEC\_BEAR** Same as PRI\_BEAR

**SEC\_RANGE** Same as PRI\_RANGE

**GSI** Not computed for entry mode. Validity indicator set OFF (invalid)

**CDI** Not computed. Set to a valid zero.

**HEADING** Heading of the earth-relative velocity vector with respect to magnetic north

In the TAEM display mode, these parameters are defined as follows:

**PRI\_BEAR** Angle in degrees (measured positive eastward) between the direction to magnetic north and the direction to WP-1 on the selected HAC as viewed from the Shuttle. After intercepting the HAC, this will be the angle of the tangent at the Shuttle location.

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- PRI\_RANGE** Horizontal distance from the Shuttle to WP-2 via WP-1 on the selected HAC (see Figure 4.7-3). This distance includes the distance from the Shuttle to WP-1, the arc length around the selected HAC from WP-1 to the EP and the distance from the EP to WP-2.
- SEC\_BEAR** Bearing to center of selected HAC at the selected landing runway
- SEC\_RANGE** Horizontal distance to center of selected HAC at the selected runway
- CDI** The deviation in degrees (measured positive to the pilot's left on approach to the runway) of the Shuttle from the extended runway centerline. (The apex of this angle is located on the runway centerline directly opposite the MSBLS AZ/DME antenna.) The CDI display full scale is 10 degrees.
- GSI** The vertical deviation in feet of the Shuttle from the guidance reference altitude (positive when Shuttle is above glide path). The GSI display full scale deflection is 5,000 feet.
- HEADING** Heading of the body X-axis with respect to magnetic north

In the A/L display mode, the parameters are defined as follows:

- PRI\_BEAR** Angle in degrees (measured positive eastward) between the direction to magnetic north and the direction to WP-2 as viewed from the Shuttle
- PRI\_RANGE** Horizontal distance from the Shuttle directly to WP-2
- SEC\_BEAR** Same as PRI\_BEAR
- SEC\_RANGE** Same as PRI\_RANGE
- CDI** Same as CDI in TAEM mode switch setting, with the exception that full scale is 2.5 degrees
- GSI** Vertical deviation in feet of the Shuttle from the linear segment reference altitude (positive when Shuttle is above glide path). Not computed for altitudes less than a prescribed value. The GSI display full scale deflection is 1,000 feet.
- HEADING** Same as HEADING in TAEM mode switch setting

Note: Scale factors in the HSI Processing principal function provide conversion factors so that the least significant range digit corresponds to one nautical mile for entry; therefore, AREA NAV provides a decimal point shift for TAEM and A/L range values (by multiplying by TEN) so that the display's least significant digit indicates tenths of a nmi.

In addition to the seven dynamic parameters described above, the HSI display and area navigation computation function will compute OFF-ON values for four display validity indicator flags that are capable of being displayed on the HSI. These four flags are the bearing flag (BRG\_FLAG), the course deviation flag (CDI\_FLAG), the glide slope flag (GSI\_FLAG), and the heading flag (HDG\_FLAG).

The meaning of the flags on the display varies according to flag grouping and the setting of the source switch as described in detail below.

The BRG and GSI flags presented as OFF: If the source switch is set to TAC/GPS and TACAN receivers are installed on the vehicle, either the TACAN range or azimuth data (or both) have been labeled invalid by the TACAN SOP. If the source switch is set to MSBLS, either the MSBLS range or azimuth data (or both) have been labeled invalid by the MSBLS SOP.

Only the GSI flag presented as OFF: If the source switch is set to TAC/GPS and TACAN receivers are installed on the vehicle, the barometric altitude data have been labeled invalid by the air data RM and a constant average altitude, or one derived from the navigation state, is being substituted for barometric altitude to drive the HSI. If the source switch is set to MSBLS, the MSBLS elevation data have been labeled invalid by the MSBLS SOP and a constant elevation angle is being substituted. Additionally, the GSI flag is OFF in the entry display mode and in the A/L display mode below a certain design dependent altitude.

The BRG, CDI, and GSI flags presented as OFF: If TACAN receivers are installed on the vehicle, this indicates to the crew that the station location of the beacon to which the selected TACAN receiver is tuned could not be found in the TACAN site table. If three GPS receivers are installed on the vehicle (no TACAN receivers are installed), the BRG, CDI, and GSI flags presented as OFF indicates that the GPS data from the selected receiver has been labeled invalid by the data staleness check in the GPS to Runway function. The data staleness check declares the data invalid if the difference between the GPS state time tag and current time is greater than an I-load value.

The HDG flag: This flag shall always indicate valid data (ON).

The detailed requirements for the HSI display and area navigation computation function may be described by breaking the function into the following nine subfunctions:

HSI\_SEQUENCER  
NAV\_STATE\_TO\_RW  
TAC\_BARO\_TO\_RW  
TAC\_BARO\_TO\_TOPODETTIC  
GPS\_TO\_RW  
MSBLS\_TO\_RW  
ENTRY\_HSI\_COMP  
TAEM\_HSI\_COMP  
LAND\_HSI\_COMP  
RANGE\_BEAR\_TO\_HAC\_ENTRY

The HSI\_SEQUENCER subfunction performs a “first pass” test in order to initialize and save certain parameter values for subsequent processing. This is to insure that area Nav computations initially and following any area or runway redesignation are based upon the same overhead/straight-in command and the same left/right HAC as the guidance and displays. The parameters to be saved are equated to the values provided by the previously executed ENTRY or TAEM UPP. That is, if FIRST\_PASS = ON, then:

P = YSGNP  
OVHD\_LAST = OVHD  
ARC\_LEFT = PSHARS  
ARC\_RIGHT = PSHARS

This “first pass” code is not to be repeated unless a new area in runway is selected; hence,

FIRST\_PASS = OFF

The remainder of the sequencing subfunction (HSI\_SEQUENCER) will cycle through twice to perform the HSI computation function for both the left HSI and the right HSI. If the cycle is for the left HSI, the source, mode, and receiver switch settings for the left HSI will be obtained from the GN&C switch processor principal function and renamed for subsequent processing:

SOURCE = SOURCE\_LEFT  
MODE = MODE\_LEFT  
RCVR = RCVR\_LEFT

If the cycle is for the right HSI:

SOURCE = SOURCE\_RIGHT  
MODE = MODE\_RIGHT  
RCVR = RCVR\_RIGHT

The data validity flags shall then be initialized to ON:

BRG\_FLAG = ON  
GSI\_FLAG = ON  
CDI\_FLAG = ON

Next, the source, mode, and receiver indicators will be tested to control subsequent calculations. If the source indicated is navigation, the NAV\_STATE\_TO\_RW subfunction will be performed to reduce navigation state data to the runway coordinate system. If the source indicated is not navigation, the receiver indicator will be tested to determine from which redundant receiver source data will be taken; in addition, the integer, N, will be set to the desired receiver number (1, 2, or 3) for data indexing purposes. If the source indicated is TAC/GPS and TACAN receivers are installed on the vehicle, all required TACAN data for the appropriate receiver will be obtained from the TACAN SOP and barometric data will be obtained from the redundancy management selection filter. All these data, along with their corresponding commfault/lock-on or data-good indicators, will be used in subsequent processing. The parameters to be used are as follows:

TAC\_CHAN\_VALID\_SL(N)



TACBEARO(N)  
TACRANGEO(N)  
TBRG\_CMLK(N)  
TRNG\_CMLK(N)  
HPC  
ALT\_DG

These data will be utilized in the TAC\_BARO\_TO\_RW subfunction, where they will be transformed to the runway coordinate system.

If the source indicated is TAC/GPS and no TACAN receivers are installed on the vehicle, the required GPS data for the appropriate receiver will be obtained from the GPS SOP and used in subsequent processing.

The following parameters will be utilized:

$\bar{R}_{GPS\_ECEF\_NEW_N}$   
 $T_{GPS\_NEW_N}$

where N is the desired receiver number.

If the source indicated is neither navigation nor TAC/GPS, all appropriate MSBLS data and commfault/lock-on indicators for the appropriate receiver will be obtained from the MSBLS SOP and used in subsequent processing. Then the MSBLS\_TO\_RW subfunction will be performed to reduce these data to the runway coordinate system.

The following parameters will be utilized:

MSBAZIMO(N)  
MSBELEVO(N)  
MSBRANGEO(N)  
MRNG\_CMLK(N)  
MAZM\_CMLK(N)  
MELV\_CMLK(N)

At this point, the selected data will have been reduced to the selected runway coordinate system, and mode-dependent processing will begin.

If the runway approach (overhead/straight-in) is changed, the HAC turn angle needs to be set to the reset value (PSHARS). That is, if  $OVHD \neq OVHD\_LAST$ , then:

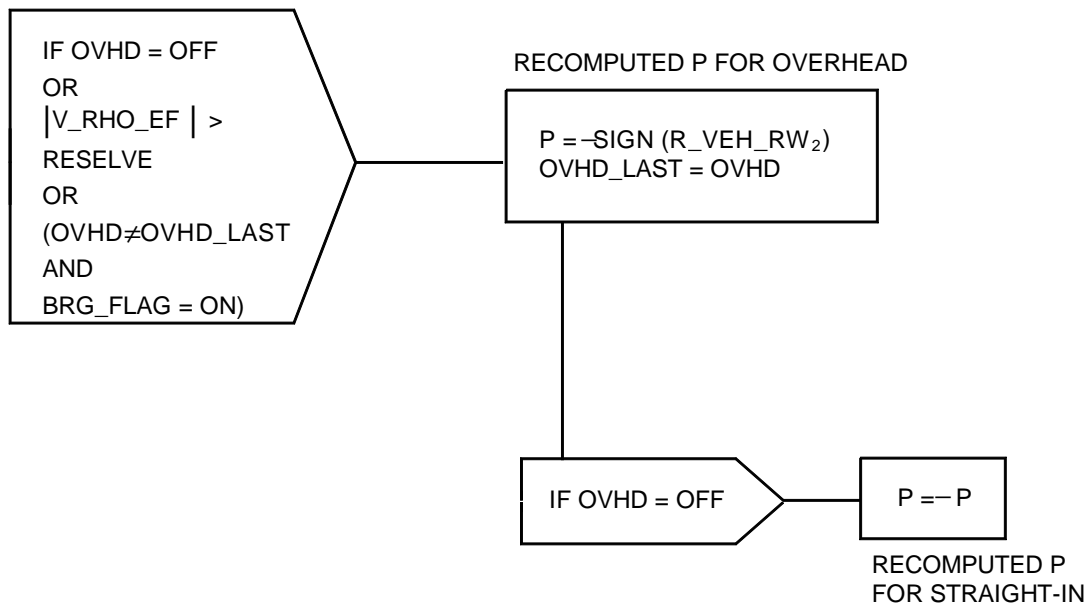
$ARC\_LEFT = PSHARS$

ARC\_RIGHT = PSHARS

In response to a change in the overhead/straight-in command, (OVHD), it may or may not be required to recompute the left/right heading alignment indicator for the selected runway (the parameter P, where +1 signifies the right turn HAC and -1 signifies the left turn HAC). For the straight-in (OVHD = OFF), P and OVHD\_LAST must be computed for each left cycle and each right cycle because the value of P depends upon present position derived from source and receiver switch positions for that side's display. For Earth relative velocities greater than the overhead correction termination velocity ( $|V\_RHO\_EF| > RESELVE$ ), P must also be recomputed for each left cycle and each right cycle to be compatible with the vehicle's Y runway position ( $R\_VEH\_RW_2$ ).

If OVHD is ON but was not ON in the previous cycle ( $OVHD \neq OVHD\_LAST$ ), this condition indicates a command to transition from straight-in back to overhead, in which case it is necessary to compute the HAC indicator (i.e., P corresponding to the HAC on the opposite side of the runway centerline from the current source and receiver derived present position). However, this one-time computation will not be done until valid input data are available (indicated by  $BRG\_FLAG = ON$ ). The HAC indicator (P) is continually computed for each left and right cycle so long as the Earth relative velocity is greater than the overhead correction termination velocity ( $|V\_RHO\_EF| > RESELVE$ ). At and below this velocity, the computation of P is not repeated for the overhead approach unless a subsequent transition from straight-in to overhead occurs and valid data are available.

(Note that P is established by the first pass logic as the overhead (OVHD = ON) HAC location and continues to be computed for each left cycle and each right cycle until the overhead correction termination velocity (RESELVE) is reached.) A transition to OVHD = OFF causes P to be recomputed every left side and right side cycle. Then a further transition back to OVHD = ON after RESELVE causes a one-cycle recomputation of P on the first valid input data cycle, and this single cycle recomputation establishes the value of P as long as this OVHD indicator is ON. Suggested logic (tests) and equations follow.



It will next be determined whether computations are to be performed for the entry display mode, the TAEM display mode or the autoland display mode. The "ENTRY" position on the mode switch provides automatic transitions of the display modes (ENTRY, TAEM, APPROACH/LAND). If the mode switch

setting is entry and if the major mode is ENTRY (MM\_CODE\_304 = ON) during OPS-3 or GLIDE RTLS 1 (MM\_CODE\_602 = ON) during OPS-6, then the ENTRY\_HSI\_COMP subfunction will be performed to generate display output parameters peculiar to the entry display mode. If the display mode indicated is not entry, the angular deviation of the vehicle from the extended runway centerline (CDI) will be computed, and the heading of the body X-axis with respect to magnetic north will be obtained from attitude processing and converted for output.

$$\text{CDI} = \text{ARCTAN2}(-R\_VEH\_RW_2, 16300 - R\_VEH\_RW_1) \text{ DEG\_PER\_RAD} \quad \text{F7}$$

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

$$\text{HEADING} = \text{PSI\_HSIMV} \text{ DEG\_PER\_RAD}$$

Next, during OPS-3, two tests are made to determine certain constants which are dependent on vehicle mass and wind conditions, which are provided by crew interface. Depending on the mass of the vehicle, there are two distinct values for the final approach steep glide path angle. If the vehicle mass, M, is less than a threshold value, M\_GSI, then the glide slope index IGS will be set equal to one, corresponding to the nominal case; that is, if

$$M < M\_GSI$$

then

$$\text{IGS} = 1$$

If the mass of the vehicle is greater than or equal to M\_GSI, then the glide slope index IGS will be set equal to two, corresponding to the high mass case; that is, if

$$M \geq M\_GSI$$

then

$$\text{IGS} = 2$$

During OPS-6, only one glide path is available. Therefore, set IGS = 1, without reference to vehicle mass.

The glide slope index is used to differentiate the constants employed in polynomial expressions relating the reference altitude and range for these two steep final approach glide path angles, as well as the cubic-fit higher altitude profile. (These coefficients are the same as those used by the onboard guidance for reference altitude.)

Next, certain constants are calculated which are used later to compute range-to-go and the reference altitude:

$$\text{DELX\_NEP} = -\text{HCO}(\text{IGS})/\text{C1}(\text{IGS},1)$$

$$\text{DELX\_MEP} = -\text{HMEP}(\text{IGS})/\text{C1}(\text{IGS},1)$$

$$\text{DELX\_REF} = -\text{C0}(\text{IGS},1)/\text{C1}(\text{IGS},1)$$

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Since the masses used in the comparison test do not change after AREA NAV begins operating, these calculations need be performed only once. In order to handle this, a flag (MASS\_FLAG) is introduced which should be initialized to ON as a first pass flag; after this one time execution, it should be turned to the OFF position:

$$\text{MASS\_FLAG} = \text{OFF}$$

A value of ALT\_LAND, which is employed in the automatic switching logic, is initialized at this point to correspond to the desired altitude at the NEP; that is,

$$\text{ALT\_LAND} = \text{HCO(IGS)}$$

Depending on the wind conditions, as defined by crew interface (keyboard entries on HSD), there are two distinct values for X\_GSI (X\_GSI is the distance from the glide slope intercept point on the extended runway centerline to the runway threshold). If the winds are normal, denoted by HI\_WINDS = OFF, then the value for this parameter is set equal to its nominal value:

$$\text{X\_GSI} = \text{X\_GSI\_NOMINAL}$$

If the winds are determined to be high head winds, denoted by HI\_WINDS = ON, then the value for this parameter is set equal to its HI\_WIND value:

$$\text{X\_GSI} = \text{X\_GSI\_HI\_WIND}$$

The LAND\_HSI\_COMP subfunction will be performed to generate output parameters peculiar to the approach and landing display mode if any one or more of the following three conditions are true:

1. The mode switch setting indicates LANDING.
2. The mode switch setting indicates ENTRY (auto-switching) and the altitude (H) is less than the altitude at the entry point (ALT\_LAND).
3. The mode switch setting is ENTRY (auto-switching) and the altitude (H) is less than 6,000 feet above the entry point (ALT\_LAND) and the absolute value of course deviation (CDI) is less than 0.044 radian.

If none of the conditions are true, additional parameters must be computed to support the TAEM display mode.

Depending on the vehicle's energy, there are two sets of distinct HAC's which the crew may select via crew interface (HSD): the nominal HAC indicated by the term NEP and low energy HAC indicated by the term MEP. If guidance determines that the vehicle has low energy, it will send a signal to the crew informing them to switch from the NEP to the MEP on the HSD (item entry). This switch will be received by AREA NAV as the NEP flag, which determines whether the nominal (NEP = ON) or the minimum energy (NEP = OFF) HAC shall be used. That is:

If NEP = ON, then

$$\text{X\_EP} = \text{X\_GSI} + \text{DELX\_NEP}$$

Since the value of ALT\_LAND depends on the selected HAC, the value associated with the nominal HAC is computed at this point:

$$\text{ALT\_LAND} = \text{HCO(IGS)}$$

If NEP = OFF, then

$$\text{X\_EP} = \text{X\_GSI} + \text{DELX\_MEP}$$

The value of ALT\_LAND associated with the low energy HAC is computed at this point:

$$\text{ALT\_LAND} = \text{HMEP(IGS)}$$

Next, the TAEM\_HSI\_COMP subfunction will be performed to generate display outputs peculiar to the TAEM display mode, and the CDI and GSI data will be scaled for desired display range.

$$\text{CDI} = 0.25 \text{ CDI}$$

$$\text{GSI} = 0.2 \text{ GSI}$$

Finally, all outputs generated will be renamed according to the HSI (left or right) they were destined for, including the HAC indicator for the HSI which will be set for the left HSI:

If left:

PRIBEAR_LEFT = PRI_BEAR	GSI_FLAG_LEFT = GSI_FLAG
PRIRANGE_LEFT = PRI_RANGE	BRG_FLAG_LEFT = BRG_FLAG
CDI_LEFT = CDI	CDI_FLAG_LEFT = CDI_FLAG
GSI_LEFT = GSI	SECBEAR_LEFT = SEC_BEAR
HEADING_LEFT = HEADING	SECRANGE_LEFT = SEC_RANGE
HDG_FLAG_LEFT = ON	LHSI_P = P
HSI_MODE_LEFT = HSI_MODE_INDICATOR	

If right:

PRIBEAR_RIGHT = PRI_BEAR	GSI_FLAG_RIGHT = GSI_FLAG
PRIRANGE_RIGHT = PRI_RANGE	BRG_FLAG_RIGHT = BRG_FLAG
CDI_RIGHT = CDI	CDI_FLAG_RIGHT = CDI_FLAG
GSI_RIGHT = GSI	SECBEAR_RIGHT = SEC_BEAR
HEADING_RIGHT = HEADING	SECRANGE_RIGHT = SEC_RANGE
HDG_FLAG_RIGHT = ON	
HSI_MODE_RIGHT = HSI_MODE_INDICATOR	

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After left and right HSI processing is completed, the HSI\_SEQUENCER will set a flag for MEDS to indicate Area Nav has been performed and its outputs can be used:

$$\text{MEDS\_AREA\_NAV\_FIRST\_PASS} = \text{ON}$$

The NAV\_STATE\_TO\_RW subfunction will establish the Shuttle position vector both in earth-fixed coordinates and in coordinates of the primary runway whenever the data source is navigation. Both vectors will be obtained from user parameter processing principal functions and renamed for HSI processing:

$$\bar{\mathbf{R}}_{\text{VEH\_EF}} = \bar{\mathbf{R}}_{\text{EF}}$$

$$\bar{\mathbf{R}}_{\text{VEH\_RW}} = \bar{\mathbf{POSITION\_WRT\_RUNWAY}}$$

Next, the course with respect to the runway centerline (PSD\_HSI), relative velocity magnitude (V\_HSI), and the vehicle groundspeed (VH\_HSI) are established:

$$\text{PSD\_HSI} = \text{COURSE\_WRT\_RW RAD\_PER\_DEG}$$

$$\text{V\_HSI} = \text{REL\_VEL\_MAG}$$

$$\text{VH\_HSI} = \text{V\_GROUNDSPEED}$$

The altitude of the Shuttle referenced to the runway altitude will be obtained from the appropriate UPP principal function and renamed for HSI processing:

$$\text{H} = \text{ALT\_WHEELS}$$

The TAC\_BARO\_TO\_RW subfunction, together with the TAC\_BARO\_TO\_TOPODETTIC subfunction, will transform TACAN data for the selected receiver into a vehicle position vector expressed in primary runway coordinates. To perform the required transformations, certain site-dependent parameters will be required that relate the TACAN data to the location of the TACAN beacon to which the selected (Nth) receiver is tuned. This site-dependent data will be obtained from the TACAN site look-up subfunction according to receiver number and will include the following parameters:

$$\text{ALT\_TACAN\_SL(N)}, \text{RD\_TAC\_SL(N)}, \text{ANGLE\_CORR\_TNTOMAG\_SL(N)},$$

$$\bar{\mathbf{R}}_{\text{TACAN\_EF\_SL(N)}}, \text{DH\_TACAN\_SL(N)}, \text{TACAN\_CHAN\_VALID\_SL(N)},$$

$$\text{M\_EFTOTD\_TACAN\_SL(N)}$$

The TAC\_BARO\_TO\_RW subfunction will first determine if either the TACAN bearing or TACAN range commfault/lock-on indicator, TBRG\_CMLK(N) or TRNG\_CMLK(N), indicates invalid data. If so, both the HSI BRG and GSI flags will be set OFF accordingly:

$$\text{BRG\_FLAG} = \text{OFF}$$

$$\text{GSI\_FLAG} = \text{OFF}$$

and no further computations within this subfunction shall be performed.

Otherwise, the channel validity indicator, TACAN\_CHAN\_VALID\_SL(N) will be tested by the HSI software; if it indicates that the beacon's location is not available, the HSI BRG, GSI, and CDI flags will

be set to OFF. Thus, the crew will be notified of the situation, and all subsequent calculations utilizing beacon locations will be bypassed.

If the beacon's location is available, the TAC\_BARO\_TO\_TOPODETIC subfunction will be performed to reduce the data to a topodetic coordinate system located at the TACAN beacon. The TAC\_BARO\_TO\_TOPODETIC subfunction will compute the Shuttle position vector with respect to the TACAN site,  $\bar{R}_{VEH\_TD\_TAC}$ , and will also establish the condition of the flag, GSI\_FLAG, that indicates the validity of the barometric altitude data.

Finally, the position of the Shuttle will be established in both earth-fixed and runway coordinates:

$$\bar{R}_{VEH\_EF} = M\_EFTOTD\_TACAN\_SL(N)^T \bar{R}_{VEH\_TD\_TAC} + \bar{R}_{TACAN\_EF\_SL(N)}$$

$$\bar{R}_{VEH\_RW} = M\_EFTORW (\bar{R}_{VEH\_EF} - \bar{R}_{LS\_EF})$$

The TAC\_BARO\_TO\_TOPODETIC subfunction will convert TACAN range and azimuth for the selected (Nth) receiver, together with altitude data, to a vehicle position vector expressed in a topodetic system located at the TACAN beacon.

Barometric altitude data will be used for this purpose unless it is indicated to be invalid, in which case its value will be replaced with a corresponding, premission-determined, average value whenever the display mode is ENTRY. If the display mode is TAEM or approach/landing, an estimate of barometric altitude will be made on the basis of navigation-derived altitude above the runway. Also, the GSI\_FLAG will be turned to OFF:

If ALT\_DG = OFF, then GSI\_FLAG = OFF;

and if in ENTRY mode:

If MM\_CODE\_602 = ON or MM\_CODE\_304 = ON, then H\_BARO = 85000

Otherwise

$$H\_BARO = ALT\_WHEELS + ALT\_RW - DELH\_MSL\_ELLIPSOID\_RW$$

Whenever the barometric altitude data are indicated to be valid, barometric altitude, HPC, will be renamed for processing:

$$H\_BARO = HPC$$

Finally, all data will be reduced to the topodetic coordinate system as follows:

$$R\_TAC = RD\_TAC\_SL(N) + ALT\_TACAN\_SL(N) - DH\_TACAN\_SL(N)$$

$$R\_VEH = RD\_TAC\_SL(N) + H\_BARO$$

$$A = TACBEARO(N) + ANGLE\_CORR\_TNTOMAG\_SL(N) + PI$$

$$COSB = \frac{R\_TAC^2 + TACRANGE(N)^2 - R\_VEH^2}{2 R\_TACRANGE(N)} \quad F3$$

F3 This equation shall be protected against division by zero (Section 3.5).

If  $\text{COSB} < -1$ , then  $\text{COSB} = -1$

$$D = \text{TACRANGE}(N) (1 - \text{COSB}^2)^{1/2}$$

$$R\_VEH\_TD\_TAC_1 = D \text{COS}(A) \quad \text{F9}$$

$$R\_VEH\_TD\_TAC_2 = D \text{SIN}(A) \quad \text{F9}$$

$$R\_VEH\_TD\_TAC_3 = \text{TACRANGE}(N) \text{COSB}$$

F9 This equation shall be protected against return value of sine or cosine with magnitude greater than unity (Section 3.5).

Whatever the source for  $H\_BARO$ , this value of the altitude will be transformed into an altitude referenced to the runway altitude and renamed for HSI processing:

$$H = H\_BARO - \text{ALT\_RW} + \text{DELH\_MSL\_ELLIPSOID\_RW}$$

The  $\text{GPS\_TO\_RW}$  subfunction will first determine if the latency of the state from the selected receiver compared to current time exceeds a pre-mission determined I-load value. If so, the HSI bearing (BRG), glide slope (GSI), and course deviation (CDI) flags will be set to OFF and no further computations within this subfunction will be performed.

```
IF (CLOCKTIME - T_GPS_NEWN) > GPS_HSI_TIME_STALENESS_LIM
THEN
    BRG_FLAG = OFF
    GSI_FLAG = OFF
    CDI_FLAG = OFF
```

If the GPS data latency is less than or equal to the I-load value, however, the following calculations are performed.

The GPS state, which is coordinatized in the WGS84 coordinate system, will be transformed to earth fixed coordinates.

$$\bar{R}\_VEH\_EF = M\_WGS84\_TO\_EF \bar{R}\_GPS\_ECEF\_NEW\_N$$

$$\bar{V}\_VEH\_EF = M\_WGS84\_TO\_EF \bar{V}\_GPS\_ECEF\_NEW\_N$$

The earth fixed position and velocity vectors are transformed to the runway coordinate system according to the following equations:

$$\bar{R}\_VEH\_RW = M\_EFTORW (\bar{R}\_VEH\_EF - \bar{R}\_LS\_EF)$$

$$\bar{V}\_VEH\_RW = M\_EFTORW \bar{V}\_VEH\_EF$$

Next, the course with respect to the runway centerline ( $\text{PSD\_HSI}$ ), relative velocity magnitude ( $\text{V\_HSI}$ ), and the vehicle groundspeed ( $\text{VH\_HSI}$ ) are calculated:

$$\text{PSD\_HSI} = \text{ARCTAN2} (V\_VEH\_RW_2, V\_VEH\_RW_1)$$

$$V\_HSI = \text{ABVAL} (\bar{V}\_VEH\_RW)$$



$$VH\_HSI = (V\_VEH\_RW_1^2 + V\_VEH\_RW_2^2)^{1/2}$$

The altitude of the vehicle above the runway is then computed using the earth fixed to geodetic routine.

CALL: EF\_TO\_GEODETTIC  
INLIST: R\_VEH\_EF  
OUTLIST: DUMMY\_LAT, DUMMY\_LON, GPS\_ALT\_ABOVE\_REF\_ELLIP

$$H = GPS\_ALT\_ABOVE\_REF\_ELLIP - ALT\_RW$$

The MSBLS\_TO\_RW subfunction will first determine if either the MLS range or MLS azimuth comm-fault/lock-on indicator for the selected receiver (MRNG\_CMLK(N) or MAZM\_CMLK(N)) indicates invalid data. If so, both the HSI bearing (BRG) and glide slope (GSI) flags will be set accordingly to OFF:

$$BRG\_FLAG = OFF$$

$$GSI\_FLAG = OFF$$

and no further computations within this subfunction will be performed.

Otherwise, the MSBLS elevation commfault/lock-on indicator, MELV\_CMLK(N), will be tested. If invalid data are indicated, the elevation angle will be set to one of two assumed values and the HSI GSI flag will be set OFF (GSI\_FLAG = OFF) to indicate to the crew that invalid MSBLS elevation is being replaced with an assumed value—a change resulting in degraded performance of the HSI. The choice between the two assumed values for MSBLS elevation will depend upon the altitude relative to a predetermined reference value H\_GSI\_SHALLOW; that is,

if  $H > H\_GSI\_SHALLOW$ , then  $EL\_MSBLS = 0.33281$

otherwise  $EL\_MSBLS = 0.0$

Whenever the MSBLS elevation data are indicated to be valid, the elevation angle for the selected receiver, MSBELEVO(N), will be renamed for subsequent processing:

$$EL\_MSBLS = MSBELEVO(N)$$

Finally, the MSBLS data will be reduced to the runway coordinate system according to the following equations:

$$TAZ = TAN(MSBAZIMO(N))$$

$$TEL = TAN(EL\_MSBLS)$$

$$TEL2 = TEL^2$$

$$A = 1 + TEL2 + TAZ^2$$

$$B = 2 (X\_EL\_RW - X\_DMEAZ\_RW) TEL2$$

$$C = (X\_EL\_RW - X\_DMEAZ\_RW)^2 TEL2 - MSBRANGE(N)^2$$

$$X\_VEH\_DMEAZ = \frac{B - (B^2 - 4AC)^{1/2}}{2A}$$

F4

$$R\_VEH\_RW_1 = X\_DMEAZ\_RW + X\_VEH\_DMEAZ$$

$$R\_VEH\_RW_2 = (X\_DMEAZ\_RW - R\_VEH\_RW_1) TAZ + Y\_DMEAZ\_RW$$

$$R\_VEH\_RW_3 = (R\_VEH\_RW_1 - X\_EL\_RW) TEL$$

F4 This equation shall be protected against square roots of a negative number (Section 3.5).

The negative of the third component of the position vector  $\bar{R}\_VEH\_RW$  will be renamed for HSI processing:

$$H = -R\_VEH\_RW_3$$

The ENTRY\_HSI\_COMP subfunction will compute the heading of the relative velocity vector with respect to magnetic north is then to be determined by utilizing the vehicle position vector and relative velocity in earth-fixed coordinates obtained from appropriate user parameter processing principal functions.

First, a vector,  $\bar{V}\_NORM$ , which is normal to the plane containing the position vector and the relative velocity is determined:

$$\bar{V}\_NORM = \bar{R}\_EF \times \bar{V}\_RHO\_EF$$

Then, the heading follows from

$$PSI = ARCTAN2(V\_NORM_3 R\_VEH\_MAG\_UPP, (V\_NORM_1 R\_EF_2 - V\_NORM_2 R\_EF_1))$$

$$HEADING = (PSI - ANGLE\_CORR\_TNTOMAG\_RW) DEG\_PER\_RAD$$

If HEADING < 0, then

$$HEADING = HEADING + 360$$

Then the magnitude of the position vector from the selected source is calculated:

$$R\_VEH\_MAG = |\bar{R}\_VEH\_EF|$$

The RANGE\_BEAR\_TO\_HAC\_ENTRY subfunction will be performed with input parameters determined by the value of P. If P is positive, then the input parameters are

$$\bar{R}\_CC\_R\_PRI$$

$$R\_CC\_RMAG\_PRI$$

If P is negative, then the input parameters are

$$\bar{R}\_CC\_L\_PRI$$

$$R\_CC\_LMAG\_PRI$$

Regardless of the value of P, the following quantities are also required by this subfunction:

OVHD  
P  
 $\bar{R}_{VEH\_EF}$   
R\_VEH\_MAG  
AZIMUTH\_RW  
ANGLE\_CORR\_TNTOMAG\_RW

This action results in the calculation of the primary range (PRI\_RANGE) and primary bearing (PRI\_BEAR).

The secondary range (SEC\_RANGE) and the secondary bearing (SEC\_BEAR) are subsequently set equal to their corresponding primary values:

SEC\_RANGE = PRI\_RANGE  
SEC\_BEAR = PRI\_BEAR

CDI and GSI are set to zero and the HSI glide slope valid flag is set to OFF.

CDI = 0  
GSI = 0  
GSI\_FLAG = OFF

Finally, the HSI\_MODE\_INDICATOR is set to the Entry value:

HSI\_MODE\_INDICATOR = 1

The RANGE\_BEAR\_TO\_HAC\_ENTRY subfunction will accept as inputs the overhead/straight-in indicator (OVHD), the left/right HAC indicator (P), the position vector of the center of the HAC in EF coordinates, the magnitude of this vector, a parameter which is indicative of the position of the Shuttle with respect to the runway centerline, the position vector of the Shuttle in EF coordinates, the magnitude of this vector, the azimuth of the runway, and the true north to magnetic north correction angle. It will then compute a range and bearing for the entry mode display.

The vector,  $\bar{V}_{NORM}$ , normal to the great circle plane containing the Shuttle and HAC center will be determined:

$\bar{V}_{NORM} = \bar{R}_{VEH\_EF} \times \bar{R}_{CC\_EF}$

The bearing of this great circle plane with respect to true north at the Shuttle position and at the circle center will be computed:

$$\text{BEAR\_VEH} = \text{ARCTAN2}(\text{V\_NORM}_3 \text{R\_VEH\_MAG}, (\text{V\_NORM}_1 \text{R\_VEH\_EF}_2 - \text{V\_NORM}_2 \text{R\_VEH\_EF}_1)) \quad \text{F7}$$

$$\text{BEAR\_CC} = \text{ARCTAN2}(\text{V\_NORM}_3 \text{R\_CC\_MAG}, (\text{V\_NORM}_1 \text{R\_CC\_EF}_2 - \text{V\_NORM}_2 \text{R\_CC\_EF}_1)) \quad \text{F7}$$

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

If  $\text{BEAR\_CC} < 0$ , then  $\text{BEAR\_CC} = \text{BEAR\_CC} + 2 \text{PI}$ . The sine of the central angle between the position of the Shuttle and the center of the HAC will then be calculated:

$$\text{SIN\_THET\_VEH\_CC} = |\sqrt{\text{V\_NORM}}| / (\text{R\_VEH\_MAG} \text{R\_CC\_MAG})$$

Then, the great circle surface range from the Shuttle to WP-1 will be approximated by:

$$\text{DIST\_VEH\_WP1} = \text{ARCSIN}(\text{SIN\_THET\_VEH\_CC}) \text{R\_CC\_MAG} \quad \text{F5}$$

F5 This equation shall be protected against arc sine of arguments with magnitudes greater than unity (Section 3.5).

Next, the angle defined by the intersection of the two great circle planes (one passing through the Shuttle position and the HAC center, and the other through the Shuttle position and WP-1) is given by

$$\text{A2} = \text{RADIUS\_EP} / \text{DIST\_VEH\_WP1}$$

and the bearing from the Shuttle to WP-1 follows from

$$\text{BEAR\_VEH\_WP1} = \text{BEAR\_VEH} - \text{P A2}$$

The arc length around the selected HAC from WP-1 to the entry point will be determined next:

$$\text{A3} = \text{A2} + \text{P} (\text{AZIMUTH\_RW} - \text{BEAR\_CC})$$

If  $\text{A3} < -0.003$ , then  $\text{A3} = \text{A3} + 2 \text{PI}$ .

If  $\text{OVHD} = \text{ON}$  and  $\text{A3} < \pi / 2$ , then  $2\pi$  is added to  $\text{A3}$  for an additional full turn around the HAC.

Then  $\text{D\_ARC} = \text{A3} \text{RADIUS\_EP}$

Finally, the display computations will be performed:

$$\text{RANGE} = (\text{DIST\_VEH\_WP1} + \text{D\_ARC} - \text{X\_NEP} + \text{X\_WP2}) \text{NAUTMI\_PER\_FT}$$

$$\text{BEARING} = (\text{BEAR\_VEH\_WP1} - \text{ANGLE\_CORR\_TNTOMAG\_RW}) \text{DEG\_PER\_RAD}$$

If  $\text{BEARING} < 0$ , then  $\text{BEARING} = \text{BEARING} + 360$ .

The  $\text{LAND\_HSI\_COMP}$  subfunction will first compute the bearing to WP-2 according to the following:

$$\text{D} = \text{X\_WP2} - \text{R\_VEH\_RW}_1$$

$$\text{PRI\_BEAR} = (\text{ARCTAN2}(-\text{R\_VEH\_RW}_2, \text{D}) + \text{AZIMUTH\_RW} - \text{ANGLE\_CORR\_TNTOMAG\_RW}) \text{ DEG PER RAD} \quad \text{F7}$$

F7 This equation shall be protected against arc tangents with both arguments equal to zero (Section 3.5).

If  $\text{PRI\_BEAR} < 0$ , then  $\text{PRI\_BEAR} = \text{PRI\_BEAR} + 360$ . Otherwise, if  $\text{PRI\_BEAR} > 360$ , then  $\text{PRI\_BEAR} = \text{PRI\_BEAR} - 360$ . Next, primary range will be computed:

$$\text{DIST\_WP2} = (\text{R\_VEH\_RW}_2^2 + \text{D}^2)^{1/2}$$

$$\text{PRI\_RANGE} = (\text{DIST\_WP2 NAUTMI\_PER\_FT}) 10$$

Secondary range and bearing are then set equal to primary range and bearing:

$$\text{SEC\_RANGE} = \text{PRI\_RANGE}$$

$$\text{SEC\_BEAR} = \text{PRI\_BEAR}$$

The multiply by 10 shifts the range decimal point to provide one-tenth NMI resolution on the display.

In order to compute the glide slope deviation for Shuttle altitudes greater than a premission-determined value, that is,  $H > H\_GSI\_SHALLOW$ , the reference altitude HREF must be calculated. The reference altitude is related to the distance (R) from the vehicle ground position to a reference point

$$R = \text{DIST\_WP2} + X\_GSI + \text{DELX\_REF} - X\_WP2$$

by the following linear relation

$$\text{HREF} = C0(\text{IGS},1) + C1(\text{IGS},1) R$$

where C0, C1 are premission constants corresponding to guidance altitude coefficients and depend on the glide slope index. The glide slope deviation follows from

$$\text{GSI} = H - \text{HREF}$$

where H is the actual vehicle altitude above the runway threshold and HREF is the desired vehicle altitude. When the Shuttle altitude is less than the premission value,  $H\_GSI\_SHALLOW$ , the glide slope deviation is not computed and the HSI glide slope flag is set to OFF:

$$\text{GSI FLAG} = \text{OFF}$$

Finally, the HSI\_MODE\_INDICATOR is set to the Landing value:

$$\text{HSI\_MODE\_INDICATOR} = 3$$

The TAEM\_HSI\_COMP subfunction will accept as inputs the runway X-component,  $X\_EP$ , of a HAC associated with the crew-selected entry point (EP). This function will compute primary and secondary range, primary and secondary bearing, and glide slope deviation for the TAEM mode display. The primary bearing is the direction to WP-1 on the selected HAC; the primary range is the distance to WP-2 via the WP-1; the glide slope deviation is the altitude error as compared to the reference altitude which is based on the guidance defined coefficients (a function of distance to go via the selected path). The secondary range

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and bearing are computed with respect to the center of the selected HAC. The ranges are scaled to represent range in tenths of nautical miles. The detailed requirements for this subfunction are as follows.

For the first pass of the TAEM\_HSI\_COMP subfunction, the HAC turn angle and the radius of the spiral at WP-1 are initialized to the values calculated in guidance:

If FIRST\_PASS\_TAEM = ON  
ARC\_LEFT = PSHA  
ARC\_RIGHT = PSHA  
RTURN\_HSI\_LEFT = RTURN  
RTURN\_HSI\_RIGHT = RTURN  
FIRST\_PASS\_TAEM = OFF

A coordinate system will then be established whose origin is located at the Shuttle. Also, the X-, Y-position of the center of the selected HAC will be expressed in these Shuttle-centered coordinates. The distance and bearing to the center of the HAC is computed by:

$$\text{SIGN}_Y\text{\_HSI} = \text{SIGN}(\text{R\_VEH\_RW}_2)$$

If the source indicated is navigation (SOURCE = NAV), then  $R_0 = \text{RF}$ , otherwise  $R_0 = \text{RF}_0$ .

$$\text{Y\_CC} = \text{P } R_0 - \text{R\_VEH\_RW}_2$$

$$\text{X\_CC} = \text{X\_EP} - \text{R\_VEH\_RW}_1$$

$$\text{R\_CC} = (\text{X\_CC}^2 + \text{Y\_CC}^2)^{1/2}$$

$$\text{PHI} = \text{ARCTAN2}(\text{Y\_CC}, \text{X\_CC})$$

If  $\text{PHI} < 0$ , then  $\text{PHI} = \text{PHI} + 2\text{PI}$  ( $\text{PI} = \pi$ ).

The spiral radius at WP-1, RTURN\_HSI, is set to the value of the previous cycle of the appropriate side:

If LEFT\_SIDE = ON then,

$$\text{RTURN\_HSI} = \text{RTURN\_HSI\_LEFT}$$

Otherwise

$$\text{RTURN\_HSI} = \text{RTURN\_HSI\_RIGHT}$$

Next, two cases will be distinguished: (1) the Shuttle is on or inside the HAC and (2) the Shuttle is outside the HAC. In each of these cases, the distance from the Shuttle to WP-1 will be calculated, together with the bearing relative to the runway and the turn angle remaining around the HAC onto the runway centerline.

If  $\text{R\_CC} \leq \text{RTURN\_HSI}$ , then Case 1; otherwise, Case 2.

Case 1:

$$\text{DIST\_VEH\_WP1} = 0$$

$$\text{BEAR\_RW} = \text{PHI} - \text{P} \cdot 0.5 \text{ PI}$$

In case 2, the nominal case, the angle THETA will be computed, which corrects the bearing from the center of the HAC to the tangent point WP-1.

Case 2:

$$\text{THETA} = \text{ARCSIN}(\text{RTURN\_HSI}/\text{R\_CC})$$

$$\text{DIST\_VEH\_WPI} = (\text{R\_CC}^2 - \text{RTURN\_HSI}^2)^{1/2}$$

$$\text{BEAR\_RW} = \text{PHI} - \text{P} \cdot \text{THETA}$$

Next, for either Case 1 or 2, BEAR\_RW is tested and corrected for large angles or if found to be negative.

$$\text{If } \text{ABS}(\text{BEAR\_RW}) > \text{PI}, \text{ then } \text{BEAR\_RW} = \text{BEAR\_RW} - \text{SIGN}(\text{BEAR\_RW}) \cdot 2 \text{ PI}$$

$$\text{A3} = -\text{P} \cdot \text{BEAR\_RW} \cdot \text{DEG\_PER\_RAD}$$

$$\text{If } \text{BEAR\_RW} < 0., \text{ then } \text{BEAR\_RW} = \text{BEAR\_RW} + 2 \text{ PI}$$

For the TAEM\_HSI\_COMP subfunction, the HAC turn angle, ARC, must be computed for each left cycle and each right cycle to test for changes in HAC selection. In order to correctly calculate the HAC turn angle, ARC, under all possible situations, a test is included which monitors the HAC turn angle to check for an overhead/straight-in toggling condition or runway change.

$$\text{If } \text{LEFT\_SIDE} = \text{ON} \text{ then } \text{ARC} = \text{ARC\_LEFT}, \text{ otherwise } \text{ARC} = \text{ARC\_RIGHT}$$

$$\text{If } ((\text{ARC} > \text{PSHARS} + 1. \text{ or } \text{A3} < -1. \text{ or } \text{P} \neq \text{SIGN}_Y\text{\_HSI}) \text{ AND } \text{ARC} > 90.), \text{ then } \text{A3} = \text{A3} + 360$$

$$\text{If } \text{LEFT\_SIDE} = \text{ON} \text{ then } \text{ARC\_LEFT} = \text{A3}, \text{ otherwise } \text{ARC\_RIGHT} = \text{A3}$$

$$\text{ARC} = \text{A3}$$

Next, the spiral radius at WP-1 and the distance around the HAC will be determined.

$$\text{RTURN\_HSI} = \text{R0} + (\text{R1} + \text{R2} \cdot \text{ARC}) \cdot \text{ARC}$$

$$\text{D\_ARC} = (\text{R0} \cdot \text{ARC} + 0.5 \cdot \text{R1} \cdot \text{ARC}^2 + 0.333333 \cdot \text{R2} \cdot \text{ARC}^3) \cdot \text{RAD\_PER\_DEG}$$

If LEFT\_SIDE = ON

$$\text{RTURN\_HSI\_LEFT} = \text{RTURN\_HSI}$$

Otherwise,

$$\text{RTURN\_HSI\_RIGHT} = \text{RTURN\_HSI}$$

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If the source indicated is navigation (SOURCE=NAV) or GPS (SOURCE=TAC/GPS and NUM\_GPS\_INSTALLED = 3), and IPHASE < 2, the acquisition turn radius and arc length are then computed in equation set 1 and a new distance from the Shuttle to WP-1 is calculated in equation set 2:

$$1.0 \text{ DPSAC} = \text{BEAR\_RW} - \text{PSD\_HSI}$$

$$1.1 \text{ If } \text{ABS}(\text{DPSAC}) > \text{PI}, \text{ then } \text{DPSAC} = \text{DPSAC} - \text{SIGN}(\text{DPSAC}) \text{ 2 PI}$$

$$1.2 \text{ PHAVG} = \text{PHAVGC} - \text{PHAVGS MACH}$$

$$1.3 \text{ PHAVG} = \text{MIDVAL}(\text{PHAVG}, \text{PHAVGLL}, \text{PHAVGUL})$$

$$1.4 \text{ RTAC} = \text{VH\_HSI V\_HSI} / (\text{G0 TAN}(\text{PHAVG RAD\_PER\_DEG}))$$

$$1.5 \text{ ARCAC} = \text{RTAC ABS}(\text{DPSAC})$$

$$2.0 \text{ A} = \text{RTAC} (1. - \text{COS}(\text{DPSAC}))$$

$$2.1 \text{ B} = \text{DIST\_VEH\_WP1} - \text{RTAC ABS}(\text{SIN}(\text{DPSAC}))$$

$$2.2 \text{ RC} = \text{SQRT}(\text{A}^2 + \text{B}^2)$$

$$2.3 \text{ DIST\_VEH\_WP1} = \text{ARCAC} + \text{RC}$$

Then, the display computations will be performed:

$$\text{RANGE\_FT} = \text{DIST\_VEH\_WP1} + \text{D\_ARC} - \text{X\_EP} + \text{X\_WP2}$$

$$\text{PRI\_RANGE} = (\text{RANGE\_FT NAUTMI\_PER\_FT}) \text{ 10.}$$

$$\text{PRI\_BEAR} = (\text{BEAR\_RW} + (\text{AZIMUTH\_RW} - \text{ANGLE\_CORR\_TNTOMAG\_RW})) \\ \text{DEG\_PER\_RAD}$$

$$\text{SEC\_BEAR} = (\text{PHI} + (\text{AZIMUTH\_RW} - \text{ANGLE\_CORR\_TNTOMAG\_RW})) \\ \text{DEG\_PER\_RAD}$$

$$\text{SEC\_RANGE} = \text{10. R\_CC NAUTMI\_PER\_FT}$$

If either of the bearings exceed 360 degrees, they shall be reduced by 360 degrees:

$$\text{If } \text{PRI\_BEAR} > 360, \text{ PRI\_BEAR} = \text{PRI\_BEAR} - 360.$$

$$\text{If } \text{SEC\_BEAR} > 360, \text{ SEC\_BEAR} = \text{SEC\_BEAR} - 360.$$

In order to compute the glide slope deviation, the reference altitude, HREF, is first calculated. This altitude is related to the ground distance (R) from the vehicle position to the reference along the selected path:

$$\text{R} = \text{RANGE\_FT} + \text{X\_GSI} + \text{DELX\_REF} - \text{X\_WP2}$$

Two different polynomial expressions are employed depending on the relative distance (DR) from a predetermined distance (CUBRC) from the MEP

$$\text{DR} = \text{R} - \text{CUBRC (IGS)}$$



If  $DR < 0$ , then the expression for HREF is given by a cubic in R

$$HREF = CO(IGS,1) + CI(IGS,1) R + C2(IGS,1) R^2 + C3(IGS,1) R^3$$

where C0, C1, C2, C3 are premission constants and depend on the glide slope index. If  $DR \geq 0$ , then the expression for HREF is given by a cubic in DR

$$HREF = CO(IGS,2) + CI(IGS,2) DR + C2(IGS,2) DR^2 + C3(IGS,2) DR^3$$

where C0, C1, C2, C3 are premission constants and depend on the glide slope index. Subsequently, the glide slope deviation is calculated:

$$GSI = H - HREF$$

Finally, the HSI\_MODE\_INDICATOR is set to the TAEM value:

$$HSI\_MODE\_INDICATOR = 2$$

B. Interface Requirements. The input and output variables are listed in Tables 4.7.1-1 and 4.7.1-2. For OPS-3, the vehicle mass is obtained from the DEORB Guidance principal function (4.209), while for OPS-6 it is not required. Targeting parameters, which may be mission dependent or design dependent, are defined by the appropriate guidance principal function.

Interfacing between the submodules of the HSI computation function may consist of call/assign lists, name-scoping rules of HAL-structured programming, or other available techniques.

C. Processing Requirements. The left side (commander's) HSI and its associated switches will be independent of those on the right side (pilot's); thus, the HSI computations must be performed for each display. Crew interface inputs via spec functions, however, effect both displays.

FIRST\_PASS\_TAEM shall be initialized to ON.

It is required that all floating-point computations be in precision to provide adequate computational speed.

D. Constraints. Computation rates will be dependent on requirements for the dedicated instrument drive rates and must be compatible with the independence of the right and left HSI requirements. There will be provision in this function to inhibit the processing of data if the sensor range or azimuth commfault/lock-on flags indicate bad data. The HSI flags will provide an indication to the crew that the data may not be valid. These flags may be used as a cue to the crew that another receiver or source might be advisable.

Navigation state, TACAN measurements or GPS state data, and MLS sensor measurements must be in appropriate sequence to ensure HSI input data availability when the GPC operation (navigation filter, etc.) is using other sources (e.g., provide TACAN for HSI while Nav state is using MLS data).

Prior to activating area navigation, ENTRY Site Lookup (Section 4.5.2) is required to have been performed for the selected runway as well as for all TACAN ground stations currently tuned by the TACAN receivers.

It is also required that ENTRY UPP must have executed prior to the first pass through area Nav because the overhead/straight-in indicator and the initial left/right HAC indicator for the selected runway are required inputs to be used, as well as saved, for subsequent cycles.

E. Supplementary Information. A suggested implementation of the area navigation computation function may be found in Section 5.4 in the detailed flow charts.

The course deviation (CDI) and glide slope deviation (GSI) outputs from area navigation are utilized to drive “fly to” indicators on the HSI. Thus, a positive course deviation output will correspond to a “fly right” indication to the crew and a positive glide slope deviation output will correspond to a “fly down” indication to the crew.

Table 4.7-1. HSI Display Parameter/Mode Switch Matrix

Display Mode	Primary Bearing	Primary Range	Secondary Bearing	Secondary Range	Course Deviation (CDI)	Glide slope Deviation (GSI)	Compass Card (Heading)
ENTRY (HSI_MODE_LEFT/RIGHT = 1)	Spherical bearing to WP-1 for NEP at selected landing runway	Spherical surface range to WP-2 on selected runway via WP-1 for NEP (LSB = 1 nmi)	Spherical bearing to WP-1 for NEP at selected landing runway	Spherical surface range to WP-2 on selected runway via WP-1 for NEP (LSB = 1 nmi)	A valid software zero	Not computed, GSI_FLAG set invalid	Magnetic heading of vehicle relative velocity vector
TAEM (HSI_MODE_LEFT/RIGHT = 2)	Bearing to WP-1 on selected HAC for selected runway	Horizontal distance to WP-2 on selected runway via WP-1 for EP selected (LSB = 1/10 nmi)	Bearing to center of selected HAC for selected runway	Horizontal distance to center of selected HAC for selected runway (LSB = 1/10 nmi)	Deviation from extended runway centerline (Full scale = ±10 deg)	Deviation from TAEM reference altitude (Full scale = ±5,000 ft)	Magnetic heading of body X-axis
A/L (HSI_MODE_LEFT/RIGHT = 3)	Bearing to WP-2 at selected runway	Horizontal distance to WP-2 on selected runway (LSB = 1/10 nmi)	Bearing to WP-2 at selected runway (same as primary bearing)	Horizontal distance to WP-2 on selected runway (same as selected miles) (LSB = 1/10 nmi)	Deviation from extended runway centerline (Full scale = ± 2.5 deg)	Deviation from steep glide path; not computed for (altitude less than prescribed value) (Full scale = ± 1,000 ft)	Magnetic heading of body X-axis

CDR CONTROLS

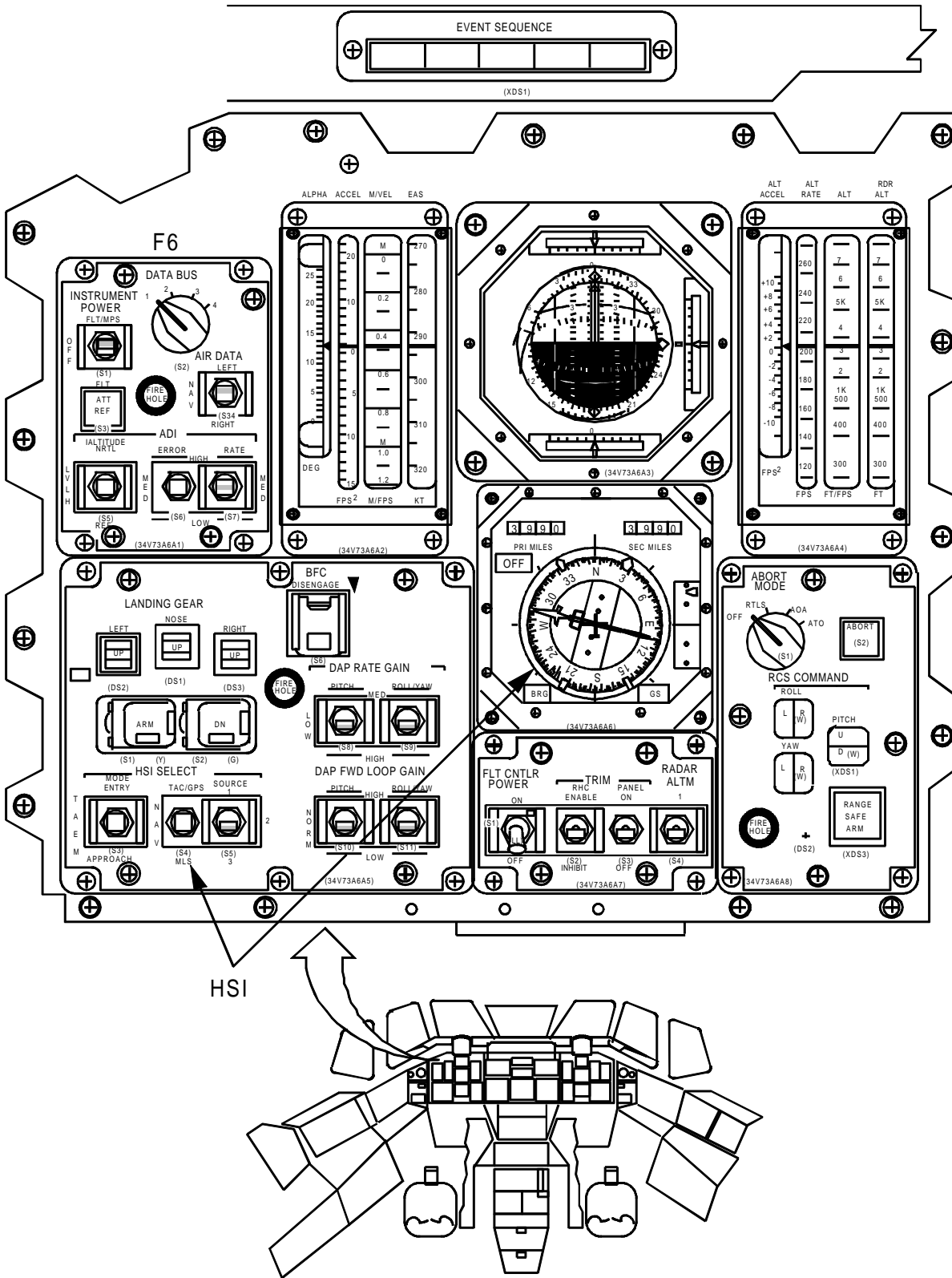


FIGURE 4.7-1. Left-Hand Forward Flight Station

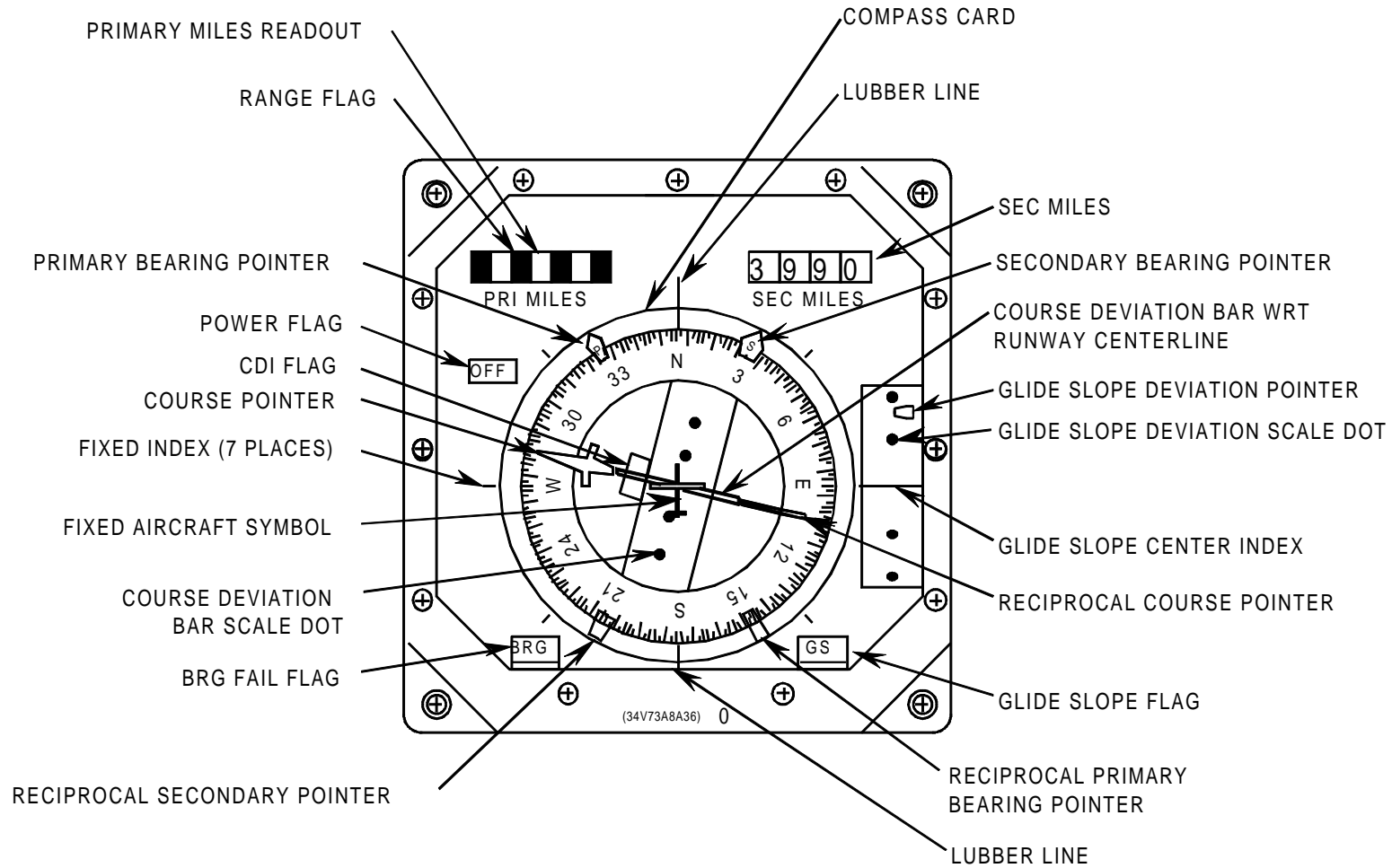


FIGURE 4.7-2. HSI Display

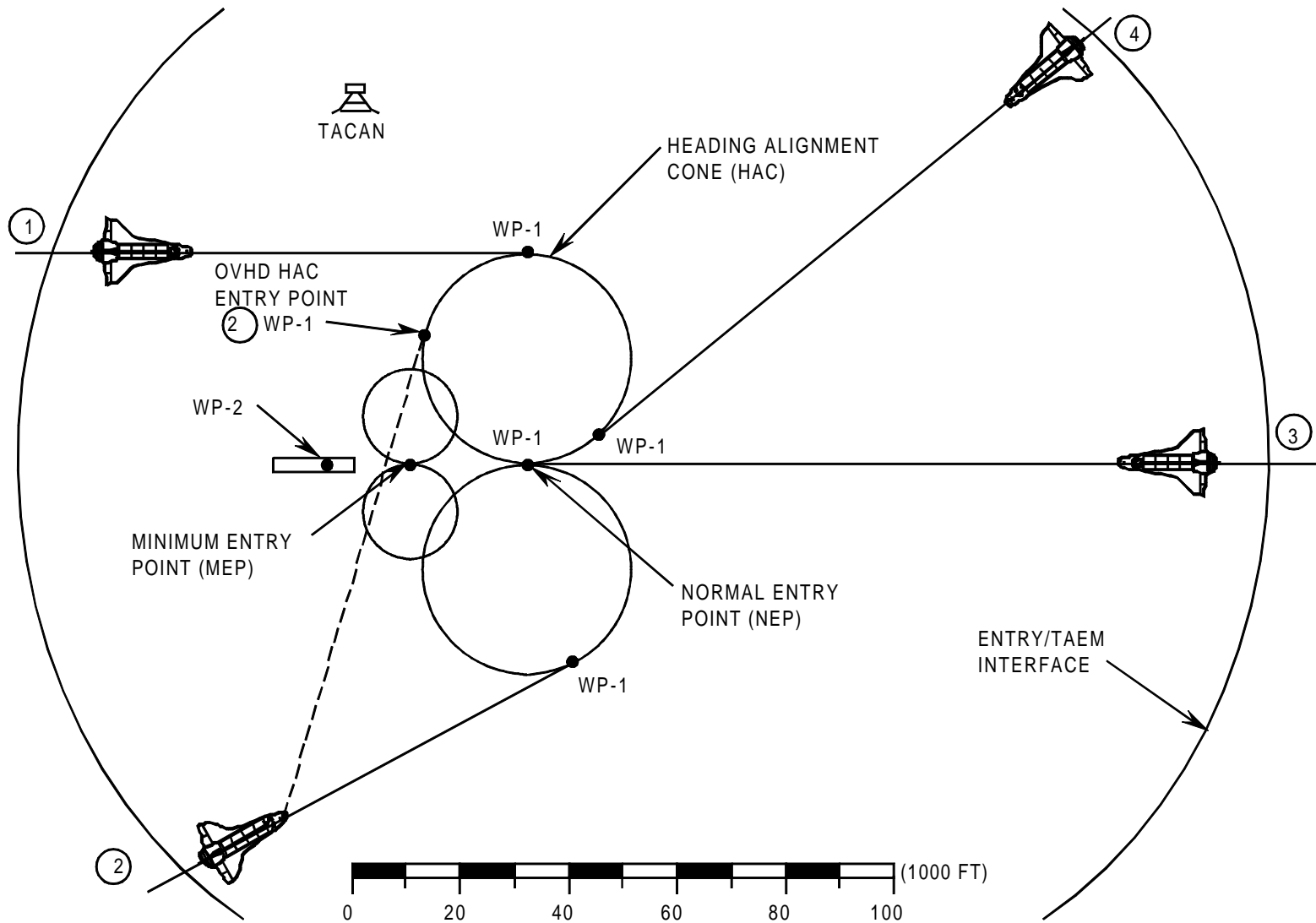


FIGURE 4.7-3. Flight Path Geometry - Horizontal Plane

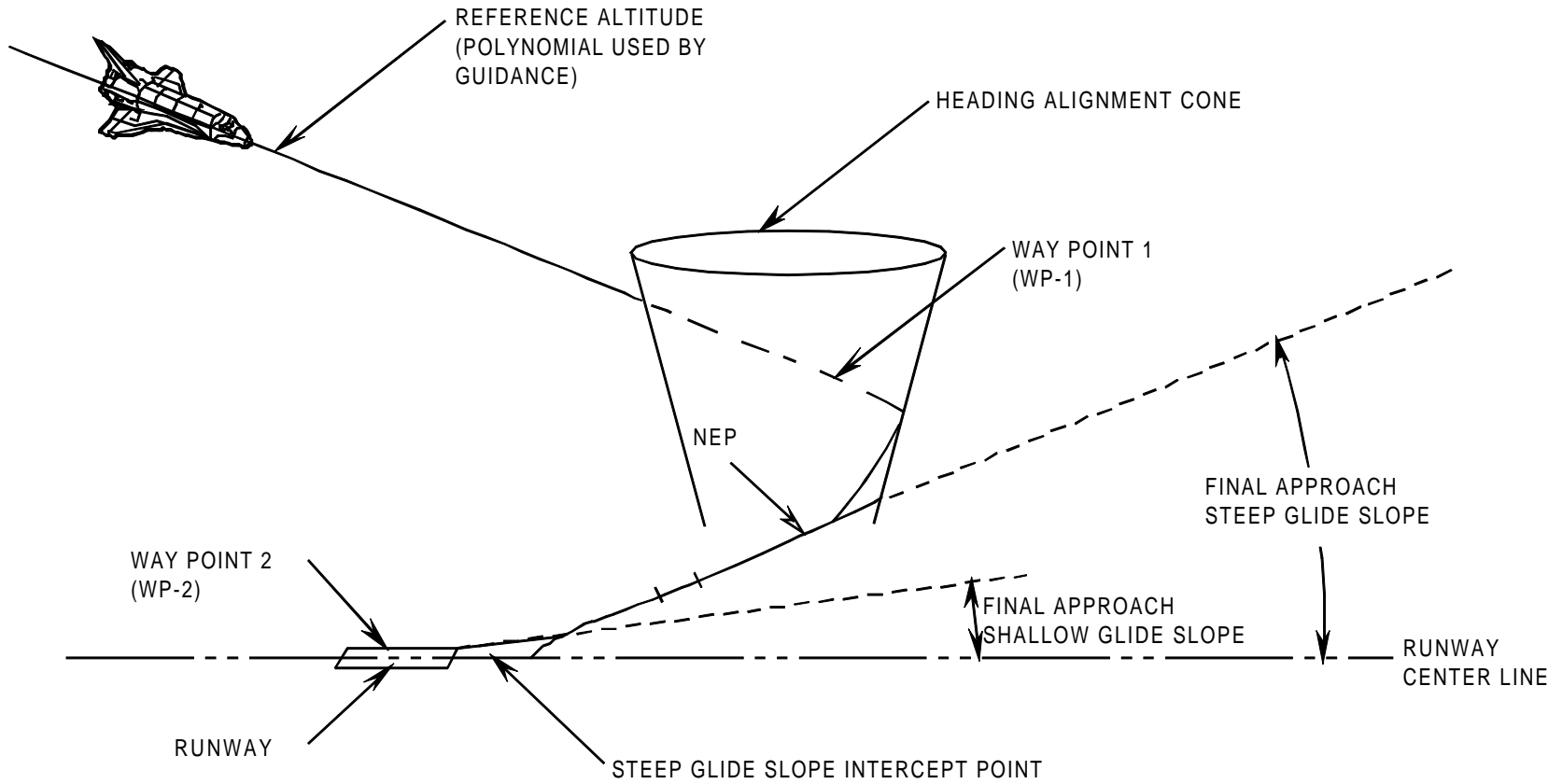


FIGURE 4.7-4. Flight Path Geometry - Vertical Plane

#### 4.7.1 Entry Area Navigation (4.220) Principal Function Tables

The principal function input/output parameters are given in Tables 4.7.1-1 and 4.7.1-2. The I-load and K-load parameters are given in Tables 4.7.1-3 and 4.7.1-4. Constants and variable cross-references are given in Tables 4.7.1-5 and the table below.

Entry Area Navigation (4.220) Principal Function Variable Cross-Reference	
FSSR Name	Source Name
MM_CODE_602	MM_CODE_602/MM_602
MM_CODE_304	MM_CODE_304/MM_304
MODE_LEFT	N/G
MODE_RIGHT	N/G
MASS_FLAG	N/G
HI_WINDS	N/G
NEP	N/G
C0 (I, 1)	HALI
C0 (I, 2)	PBHC
C1 (I, 1)	TGGS
C1 (I, 2)	PBGC
C2 (I, 1)	CUBIC_C3
C2 (I, 2)	0.0
C3 (I, 1)	CUBIC_C4
C3 (I, 2)	0.0
CUBRC	PBRC
HCO	HFTC
X_WP2	X_AIM_PT
M_GSI	WT_GSI
X_GSI_HI_WIND	XA(2)
X_GSI_NOMINAL	XA(1)
N/G = Not given	

TABLE 4.7.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALT_DG	V95X3111X	PRESSURE ALTITUDE DATA GOOD FLAG	ADTA SOP		BD		93017G	*
ALT_RW	V90H1818CA	ALTITUDE OF RW WRT REF ELLIPSOID	ENT SITE LOOKUP	FT			93155B	
ALT_TACAN_SL(1)	V90H1846CA	ALTITUDE OF TACAN 1 STATION	ENT SITE LOOKUP	FT				
ALT_TACAN_SL(2)	V90H1847CA	ALTITUDE OF TACAN 2 STATION	ENT SITE LOOKUP	FT				
ALT_TACAN_SL(3)	V90H1848CA	ALTITUDE OF TACAN 3 STATION	ENT SITE LOOKUP	FT				
ALT_WHEELS	V95H0165CB	ALT TO REAR WHEELS/NAV BASE(ENTRY)	ENT UPP	FT	DPL		93017G	*
ALT_WHEELS	V95H0165CC	ALT TO REAR WHEELS/NAV BASE(ENTRY)	TAEM UPP	FT	DPL		93017G	*
ALT_WHEELS	V95H0165CD	ALT TO REAR WHEELS/NAV BASE(ENTRY)	A/L UPP	FT	DPL		93017G	*
ANGLE_CORR_TNTOMAG_RW	V90H1820CA	MAGNETIC VARIATION OF RW	ENT SITE LOOKUP	RAD			92297B	
ANGLE_CORR_TNTOMAG_S1	V90H1843CA	MAGNETIC VARIATION AT TACAN 1 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S2	V90H1844CA	MAGNETIC VARIATION AT TACAN 2 SITE	ENT SITE LOOKUP	RAD				
ANGLE_CORR_TNTOMAG_S3	V90H1845CA	MAGNETIC VARIATION AT TACAN 3 SITE	ENT SITE LOOKUP	RAD				
AZIMUTH_RW	V90H1817CA	AZIMUTH OF RW FROM TRUE NORTH	ENT SITE LOOKUP	RAD			93090E	
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER(GMT)	FCOS	S			93160B	*
COURSE_WRT_RW/PSD	V95H0225CA	COURSE WRT RW CENTERLINE	ENT UPP	DEG			93017G	*
COURSE_WRT_RW/PSD	V95H0225CB	COURSE WRT RW CENTERLINE	TAEM UPP	DEG			93017G	*
COURSE_WRT_RW/PSD	V95H0225CC	COURSE WRT RW CENTERLINE	A/L UPP	DEG			93017G	*
DELH_MSL_ELLIPSOID_RW	V90H1819CA	ALT OF MSL ABOVE REF ELLIP AT RW	ENT SITE LOOKUP	FT				
DH_TACAN_SL(1)	V90H1849CA	ALT OF MSL ABV REF ELLIP AT TAC 1	ENT SITE LOOKUP	FT				
DH_TACAN_SL(2)	V90H1850CA	ALT OF MSL ABV REF ELLIP AT TAC 2	ENT SITE LOOKUP	FT				
DH_TACAN_SL(3)	V90H1851CA	ALT OF MSL ABV REF ELLIP AT TAC 3	ENT SITE LOOKUP	FT				
ENT_PT_SW/NEP	V93X4466X	ENTRY POINT SWITCH CMD	HORIZ SIT DISP		BD		89250B	
FIRST_PASS	V95X0184XA	AREA NAV HAC INIT FLAG	ENT UPP	DEG				
FIRST_PASS	V95X0184XB	AREA NAV HAC INIT FLAG	TAEM UPP					
GI_CHANGE	V93X4476X	HEAD WIND HI/LO CMD	HORIZ SIT DISP		BD		93017G	*
HERROR	V90H1115CA	ALTITUDE ERROR	TAEM GUID	FT			90960E	
HPC	V95H3001C	ADS CORRECTED PRESSURE ALTITUDE	ADTA SOP	FT	SPL		93017G	*
IPHASE	V90J1117CA	TAEM GUIDANCE PHASE INDICATOR	TAEM GUID	ND			93017G	*
M/CURR_ORB_MASS/MASS	V90U1961CC	CURRENT VEHICLE MASS	DEORB GUID	SLUGS			93090E	
M/MACH	V95L3029C	GN&C MACH NUMBER	ADTA SOP		SPL		93017G	*
MAZM_CMLK(1)	V95X6058X	MSBLS 1 AZ COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MAZM_CMLK(2)	V95X6064X	MSBLS 2 AZ COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MAZM_CMLK(3)	V95X6069X	MSBLS 3 AZ COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MELV_CMLK(1)	V95X6057X	MSBLS 1 EL COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MELV_CMLK(2)	V95X6063X	MSBLS 2 EL COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MELV_CMLK(3)	V95X6068X	MSBLS 3 EL COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MM_CODE_304/MM_304	V90X8161X	MAJOR MODE 304 FLAG	MSC				92355B	
MM_CODE_602/MM_602	V90X8174X	MAJOR MODE 602 FLAG	MSC				92355B	
MRNG_CMLK(1)	V95X6056X	MSBLS 1 RANGE COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MRNG_CMLK(2)	V95X6062X	MSBLS 2 RANGE COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MRNG_CMLK(3)	V95X6067X	MSBLS 3 RANGE COMFAULT/LOCKON FLAG	MSBLS SOP				92297B	
MSBAZIMO(1)	V95H6122C	MSBLS 1 AZIMUTH OUT	MSBLS SOP	RAD			90278D	
MSBAZIMO(2)	V95H6222C	MSBLS 2 AZIMUTH OUT	MSBLS SOP	RAD			90278D	
MSBAZIMO(3)	V95H6322C	MSBLS 3 AZIMUTH OUT	MSBLS SOP	RAD			90278D	
MSBELEVO(1)	V95H6142C	MSBLS 1 ELEVATION OUT	MSBLS SOP	RAD			90278D	
MSBELEVO(2)	V95H6242C	MSBLS 2 ELEVATION OUT	MSBLS SOP	RAD			90278D	



TABLE 4.7.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
MSBELEVO(3)	V95H6342C	MSBLS 3 ELEVATION OUT	MSBLS SOP	RAD			90278D	
MSBRANGE0(1)	V95H6102C	MSBLS 1 RANGE OUT	MSBLS SOP	FT			90278D	
MSBRANGE0(2)	V95H6202C	MSBLS 2 RANGE OUT	MSBLS SOP	FT			90278D	
MSBRANGE0(3)	V95H6302C	MSBLS 3 RANGE OUT	MSBLS SOP	FT			90278D	
M_EFTORW(1-1)	V90U1805CA	EF TO PRIME RW XFORM MTRX ELE 1-1	ENT SITE LOOKUP					
M_EFTORW(1-2)	V90U1806CA	EF TO PRIME RW XFORM MTRX ELE 1-2	ENT SITE LOOKUP					
M_EFTORW(1-3)	V90U1807CA	EF TO PRIME RW XFORM MTRX ELE 1-3	ENT SITE LOOKUP					
M_EFTORW(2-1)	V90U1808CA	EF TO PRIME RW XFORM MTRX ELE 2-1	ENT SITE LOOKUP					
M_EFTORW(2-2)	V90U1809CA	EF TO PRIME RW XFORM MTRX ELE 2-2	ENT SITE LOOKUP					
M_EFTORW(2-3)	V90U1810CA	EF TO PRIME RW XFORM MTRX ELE 2-3	ENT SITE LOOKUP					
M_EFTORW(3-1)	V90U1811CA	EF TO PRIME RW XFORM MTRX ELE 3-1	ENT SITE LOOKUP					
M_EFTORW(3-2)	V90U1812CA	EF TO PRIME RW XFORM MTRX ELE 3-2	ENT SITE LOOKUP					
M_EFTORW(3-3)	V90U1813CA	EF TO PRIME RW XFORM MTRX ELE 3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-1)	V90U1775CA	EF TO TOPO COORD AT TA SITE 1/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-2)	V90U1776CA	EF TO TOPO COORD AT TA SITE 1/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(1-3)	V90U1777CA	EF TO TOPO COORD AT TA SITE 1/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-1)	V90U1778CA	EF TO TOPO COORD AT TA SITE 1/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-2)	V90U1779CA	EF TO TOPO COORD AT TA SITE 1/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(2-3)	V90U1780CA	EF TO TOPO COORD AT TA SITE 1/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-1)	V90U1781CA	EF TO TOPO COORD AT TA SITE 1/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-2)	V90U1782CA	EF TO TOPO COORD AT TA SITE 1/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL1(3-3)	V90U1783CA	EF TO TOPO COORD AT TA SITE 1/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-1)	V90U1784CA	EF TO TOPO COORD AT TA SITE 2/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-2)	V90U1785CA	EF TO TOPO COORD AT TA SITE 2/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(1-3)	V90U1786CA	EF TO TOPO COORD AT TA SITE 2/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-1)	V90U1787CA	EF TO TOPO COORD AT TA SITE 2/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-2)	V90U1788CA	EF TO TOPO COORD AT TA SITE 2/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(2-3)	V90U1789CA	EF TO TOPO COORD AT TA SITE 2/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-1)	V90U1790CA	EF TO TOPO COORD AT TA SITE 2/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-2)	V90U1791CA	EF TO TOPO COORD AT TA SITE 2/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL2(3-3)	V90U1792CA	EF TO TOPO COORD AT TA SITE 2/3-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-1)	V90U1793CA	EF TO TOPO COORD AT TA SITE 3/1-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-2)	V90U1794CA	EF TO TOPO COORD AT TA SITE 3/1-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(1-3)	V90U1795CA	EF TO TOPO COORD AT TA SITE 3/1-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-1)	V90U1796CA	EF TO TOPO COORD AT TA SITE 3/2-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-2)	V90U1797CA	EF TO TOPO COORD AT TA SITE 3/2-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(2-3)	V90U1798CA	EF TO TOPO COORD AT TA SITE 3/2-3	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-1)	V90U1799CA	EF TO TOPO COORD AT TA SITE 3/3-1	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-2)	V90U1800CA	EF TO TOPO COORD AT TA SITE 3/3-2	ENT SITE LOOKUP					
M_EFTOTD_TACAN_SL3(3-3)	V90U1801CA	EF TO TOPO COORD AT TA SITE 3/3-3	ENT SITE LOOKUP					
NUM_GPS_INSTALLED	V90U3671C	NUMBER OF GPS RCVRs INSTALLED	GPS SOP		HXS		92067D	
OVHD	V95X0154XA	OVHD/STRT IND	ENT UPP	EVENT	BD		93017G	*
OVHD	V95X0154XB	OVHD/STRT IND	TAEM UPP	EVENT	BD		93017G	*
POSN_WRT_RW(1)/X	V95H0220CB	DOWNRANGE DISTANCE WRT RW	ENT UPP	FT			93017G	*
POSN_WRT_RW(1)/X	V95H0220CC	DOWNRANGE DISTANCE WRT RW	TAEM UPP	FT			93017G	*
POSN_WRT_RW(1)/X	V95H0220CD	DOWNRANGE DISTANCE WRT RW	A/L UPP	FT			93017G	*

TABLE 4.7.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
POSN_WRT_RW(2)/Y	V95H0221CB	CROSSRANGE DISTANCE WRT RW	ENT UPP	FT			93017G	*
POSN_WRT_RW(2)/Y	V95H0221CC	CROSSRANGE DISTANCE WRT RW	TAEM UPP	FT			93017G	*
POSN_WRT_RW(2)/Y	V95H0221CD	CROSSRANGE DISTANCE WRT RW	A/L UPP	FT			93017G	*
POSN_WRT_RW(3)/Z	V95H0300CB	VERTICAL DISTANCE WRT RW	TAEM UPP	FT				
POSN_WRT_RW(3)/Z	V95H0300CC	VERTICAL DISTANCE WRT RW	A/L UPP	FT				
POSN_WRT_RW(3)/Z	V95H0300CD	VERTICAL DISTANCE WRT RW	ENT UPP	FT				
PSC	V90H1234CA	HDG CORR-HAC CNTR TO HAC TAN	TAEM GUID	DEG				
PSHA	V95H0181CA	TURN ANG HAC	TAEM UPP	DEG	SPL		93017G	*
PSHA	V95H0181CC	TURN ANG HAC	ENT UPP	DEG	SPL		93017G	*
PSI_HSIMV	V90H2212C	HEADING RELATIVE TO MAG NORTH	A/E ATT PROC	RAD			93090E	
PST	V90H1235CA	HEADING TO HAC TANGENCY	TAEM GUID	DEG				
RCIR	V90H1236CA	DISTANCE TO HAC CENTER	TAEM GUID	FT				
RCVR_LEFT	V96J2105C	LH HSI RECEIVER SELECT	GN&C SW RM					
RCVR_RIGHT	V96J2205C	RH HSI RECEIVER SELECT	GN&C SW RM					
RD_TAC_SL(1)	V90H1861CA	GEODETIC RADIUS AT TACAN SITE 1	ENT SITE LOOKUP	FT				
RD_TAC_SL(2)	V90H1862CA	GEODETIC RADIUS AT TACAN SITE 2	ENT SITE LOOKUP	FT				
RD_TAC_SL(3)	V90H1863CA	GEODETIC RADIUS AT TACAN SITE 3	ENT SITE LOOKUP	FT				
REL_VEL_MAG/V	V95L0151CB	GND REL VEL MAGNITUDE IN M50 SYS	A/L UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CC	GND REL VEL MAGNITUDE IN M50 SYS	ENT UPP	FT/S	SPL		93017G	*
REL_VEL_MAG/V	V95L0151CD	GND REL VEL MAGNITUDE IN M50 SYS	TAEM UPP	FT/S	SPL		93017G	*
RF	V90H1158CA	FINAL TURN RADIUS OF SPIRAL	TAEM GUID	FT			92389C	
RPRED	V90H1103CB	RANGE TO RUNWAY THRESHOLD VIA WP1	TAEM GUID	FT			93017G	*
RTURN	V90H1159CA	SPIRAL TURN RADIUS	TAEM GUID	FT			92389C	
R_CC_LMAG_PRI	V90H1931CA	MAG OF POS VCT HAC LFT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_L_PRI(1)	V90H1925CA	X-COMP POS VCT HAC LFT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_L_PRI(2)	V90H1926CA	Y-COMP POS VCT HAC LFT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_L_PRI(3)	V90H1927CA	Z-COMP POS VCT HAC LFT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_RMAG_PRI	V90H1932CA	MAG OF POS VCT HAC RHT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_R_PRI(1)	V90H1928CA	X-COMP POS VCT HAC RHT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_R_PRI(2)	V90H1929CA	Y-COMP POS VCT HAC RHT SIDE RW	ENT SITE LOOKUP	FT				
R_CC_R_PRI(3)	V90H1930CA	Z-COMP POS VCT HAC RHT SIDE RW	ENT SITE LOOKUP	FT			89625A	
R_EF(1)	V95H0155CA	ORBITER X POSITION EF(TOD)	ENT UPP	FT	DPL		93090E	
R_EF(1)	V95H0155CC	ORBITER X POSITION EF(TOD)	TAEM UPP	FT	DPL		93090E	
R_EF(1)	V95H0155CD	ORBITER X POSITION EF(TOD)	A/L UPP	FT	DPL		93023D	
R_EF(2)	V95H0156CA	ORBITER Y POSITION EF(TOD)	ENT UPP	FT	DPL		93090E	
R_EF(2)	V95H0156CC	ORBITER Y POSITION EF(TOD)	TAEM UPP	FT	DPL		93090E	
R_EF(2)	V95H0156CD	ORBITER Y POSITION EF(TOD)	A/L UPP	FT	DPL		93023D	
R_EF(3)	V95H0157CA	ORBITER Z POSITION EF(TOD)	ENT UPP	FT	DPL		93090E	
R_EF(3)	V95H0157CC	ORBITER Z POSITION EF(TOD)	TAEM UPP	FT	DPL		93090E	
R_EF(3)	V95H0157CD	ORBITER Z POSITION EF(TOD)	A/L UPP	FT	DPL		93023D	
R_GPS_ECEF_NEW(1,1)	V90H1346C	GPS 1 NEW WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(1,2)	V90H1347C	GPS 1 NEW WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(1,3)	V90H1348C	GPS 1 NEW WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(2,1)	V90H1349C	GPS 2 NEW WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(2,2)	V90H1350C	GPS 2 NEW WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(2,3)	V90H1351C	GPS 2 NEW WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	

TABLE 4.7.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
R_GPS_ECEF_NEW(3,1)	V90H1352C	GPS 3 NEW WGS84 POS VECTOR X-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(3,2)	V90H1353C	GPS 3 NEW WGS84 POS VECTOR Y-COMP	GPS SOP	FT	DPL		92067D	
R_GPS_ECEF_NEW(3,3)	V90H1354C	GPS 3 NEW WGS84 POS VECTOR Z-COMP	GPS SOP	FT	DPL		92067D	
R_LS_EF(1)	V90H1900CA	X-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(2)	V90H1901CA	Y-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_LS_EF(3)	V90H1902CA	Z-COMP LDG SITE POS VCT-EF COORD	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(1)	V90H1834CA	X-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(2)	V90H1835CA	Y-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL1(3)	V90H1836CA	Z-COMP EF POS VECTOR OF TACAN 1	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(1)	V90H1837CA	X-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(2)	V90H1838CA	Y-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL2(3)	V90H1839CA	Z-COMP EF POS VECTOR OF TACAN 2	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(1)	V90H1840CA	X-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(2)	V90H1841CA	Y-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_TACAN_EFSL3(3)	V90H1842CA	Z-COMP EF POS VECTOR OF TACAN 3	ENT SITE LOOKUP	FT				
R_VEH_MAG_UPP	V95H0167CB	MAG SHUTTLE POS VECTOR	ENT UPP	FT				
SOURCE_LEFT	V96X2111X	LH HSI SOURCE SELECT	GN&C SW RM					
SOURCE_RIGHT	V96X2211X	RH HSI SOURCE SELECT	GN&C SW RM					
TACAN_CHAN_VALID_SL1	V90X1858XA	TACAN CHANNEL VALIDITY FLAG(TAC 1)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL2	V90X1859XA	TACAN CHANNEL VALIDITY FLAG(TAC 2)	ENT SITE LOOKUP					
TACAN_CHAN_VALID_SL3	V90X1860XA	TACAN CHANNEL VALIDITY FLAG(TAC 3)	ENT SITE LOOKUP					
TACBEARO(1)	V95H5122CA	TACAN NO 1 BEARING OUT	TACAN SOP	RAD				
TACBEARO(2)	V95H5222CA	TACAN NO 2 BEARING OUT	TACAN SOP	RAD				
TACBEARO(3)	V95H5322CA	TACAN NO 3 BEARING OUT	TACAN SOP	RAD				
TACRANGE0(1)	V95H5102CA	TACAN NO 1 RANGE OUT	TACAN SOP	FT				
TACRANGE0(2)	V95H5202CA	TACAN NO 2 RANGE OUT	TACAN SOP	FT				
TACRANGE0(3)	V95H5302CA	TACAN NO 3 RANGE OUT	TACAN SOP	FT				
TBRG_CMLK(1)	V95X5141XA	TACAN 1 BEAR COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
TBRG_CMLK(2)	V95X5241XA	TACAN 2 BEAR COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
TBRG_CMLK(3)	V95X5341XA	TACAN 3 BEAR COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
TRNG_CMLK(1)	V95X5140XA	TACAN 1 RANGE COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
TRNG_CMLK(2)	V95X5240XA	TACAN 2 RANGE COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
TRNG_CMLK(3)	V95X5340XA	TACAN 3 RANGE COMFAULT/LOCKON FLAG	TACAN SOP				93017G	*
T_GPS_NEW(1)	V90W1355C	GPS 1 NEW STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_NEW(2)	V90W1356C	GPS 2 NEW STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
T_GPS_NEW(3)	V90W1357C	GPS 3 NEW STATE TIME TAG(GMT)	GPS SOP	S	DPL		92067D	
V_GPS_ECEF_NEW(1,1)	V90L1521C	GPS 1 NEW WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(1,2)	V90L1522C	GPS 1 NEW WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(1,3)	V90L1523C	GPS 1 NEW WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(2,1)	V90L1524C	GPS 2 NEW WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(2,2)	V90L1525C	GPS 2 NEW WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(2,3)	V90L1526C	GPS 2 NEW WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(3,1)	V90L1527C	GPS 3 NEW WGS84 VEL VECTOR X-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(3,2)	V90L1528C	GPS 3 NEW WGS84 VEL VECTOR Y-COMP	GPS SOP	FT/S	SPL		92389C	
V_GPS_ECEF_NEW(3,3)	V90L1529C	GPS 3 NEW WGS84 VEL VECTOR Z-COMP	GPS SOP	FT/S	SPL		92389C	
V_GROUNDSPEED/VH	V95L0178CB	GROUNDSPPEED	ENT UPP	FT/S			92389C	

TABLE 4.7.1-1. INPUT FUNCTIONAL PARAMETERS FOR ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_GROUNDSPEED/VH	V95L0178CC	GROUNDSPPEED	TAEM UPP	FT/S			92389C	
V_GROUNDSPEED/VH	V95L0178CD	GROUNDSPPEED	A/L UPP	FT/S			92450C	
V_RHO_EF(1)	V95L3884CA	X VELOCITY VECTOR EF(TOD)	ENT UPP	FT/S				
V_RHO_EF(1)	V95L3884CC	X VELOCITY VECTOR EF(TOD)	TAEM UPP	FT/S			93090E	
V_RHO_EF(2)	V95L3885CA	Y VELOCITY VECTOR EF(TOD)	ENT UPP	FT/S				
V_RHO_EF(2)	V95L3885CC	Y VELOCITY VECTOR EF(TOD)	TAEM UPP	FT/S			93090E	
V_RHO_EF(3)	V95L3886CA	Z VELOCITY VECTOR EF(TOD)	ENT UPP	FT/S				
V_RHO_EF(3)	V95L3886CC	Z VELOCITY VECTOR EF(TOD)	TAEM UPP	FT/S			93090E	
X_DMEAZ_RW	V90H1815CA	X-COMP RNG/AZ ANTENNA IN RW COORD	ENT SITE LOOKUP	FT			89137C	
X_EL_RW	V90H1910CA	X-COMP OF ELEV ANTENNA IN RW COORD	ENT SITE LOOKUP	FT			89137C	
YSGNP/YSGN	V95J0153CA	R/L CONE IND PRI RW	ENT UPP		SPL		93017G	*
YSGNP/YSGN	V95J0153CB	R/L CONE IND PRI RW	TAEM UPP		SPL		93017G	*
Y_DMEAZ_RW	V90H1816CA	Y-COMP RNG/AZ ANTENNA IN RW COORD	ENT SITE LOOKUP	FT			89137C	
	V96X2101X	LH HSI MODE SELECT	GN&C SW RM					
	V96X2201X	RH HSI MODE SELECT	GN&C SW RM					

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.7.1-2. OUTPUT FUNCTIONAL PARAMETERS FROM ENTRY AREA NAVIGATION PROCESSING (G4.220)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
BRG_FLAG_LEFT	V90X0970XA	LH BEARING DATA - VALID FLAG	HSI PROC					
BRG_FLAG_RIGHT	V90X0971XA	RH BEARING DATA - VALID FLAG	HSI PROC					
CDI_FLAG_LEFT	V90X0966XA	LH COURSE DEVIATION - VALID FLAG	HSI PROC					
CDI_FLAG_RIGHT	V90X0967XA	RH COURSE DEVIATION - VALID FLAG	HSI PROC					
CDI_LEFT	V90H0958CA	LH COURSE DEVIATION	HSI PROC	DEG				
CDI_RIGHT	V90H0959CA	RH COURSE DEVIATION	HSI PROC	DEG				
GSI_FLAG_LEFT	V90X0972XA	LH GLIDESLOPE DEV DATA VALID FLAG	HSI PROC					
GSI_FLAG_RIGHT	V90X0973XA	RH GLIDESLOPE DEV DATA VALID FLAG	HSI PROC					
GSI_LEFT	V90H0960CA	LH GLIDESLOPE DEVIATION	HSI PROC	FT				
GSI_RIGHT	V90H0961CA	RH GLIDESLOPE DEVIATION	HSI PROC	FT				
HDG_FLAG_LEFT	V90X0968XA	LH HEADING DATA - VALID FLAG	HSI PROC					
HDG_FLAG_RIGHT	V90X0969XA	RH HEADING DATA - VALID FLAG	HSI PROC					
HEADING_LEFT	V90H0878CA	LH MAG HEADING OF REL VEL VECTOR	HSI PROC	DEG				
HEADING_RIGHT	V90H0953CA	RH MAG HEADING OF REL VEL VECTOR	HSI PROC	DEG				
HSI_MODE_LEFT	V85J0627CB	LH HSI MODE	MEDS FC GNC XFER				92355B	
HSI_MODE_RIGHT	V85J0628CB	RH HSI MODE	MEDS FC GNC XFER				92355B	
L_HSI_P	V90J0981CA	L HSI L/R HAC INDICATOR-PRI	HORIZ SIT DISP					
MEDS_AREA_NAV_FIRST_PASS	V85X0651XB	AREA NAV COMPLETE INDICATOR	MEDS FC GNC XFER				92355B	
PRIBEAR_LEFT	V90H0954CA	LH PRIMARY BEARING	HSI PROC	DEG				
PRIBEAR_RIGHT	V90H0955CA	RH PRIMARY BEARING	HSI PROC	DEG				
PRIRANGE_LEFT	V90H0956CA	LH PRIMARY RANGE	HSI PROC	NM				
PRIRANGE_RIGHT	V90H0957CA	RH PRIMARY RANGE	HSI PROC	NM				
SECBEAR_LEFT	V90H0964CA	LH SECONDARY BEARING	HSI PROC	DEG				
SECBEAR_RIGHT	V90H0965CA	RH SECONDARY BEARING	HSI PROC	DEG				
SECRANGE_LEFT	V90H0962CA	LH SECONDARY RANGE	HSI PROC	NM				
SECRANGE_RIGHT	V90H0963CA	RH SECONDARY RANGE	HSI PROC	NM				

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec  
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.7.1-3. ENTRY AREA NAVIGATION PROCESSING (G4.220) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CUBIC_C3(1)	V97U0103C	FT**-1	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
CUBIC_C3(2)	V97U0104C	FT**-1	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
CUBIC_C4(1)	V97U0105C	FT**-2	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
CUBIC_C4(2)	V97U0106C	FT**-2	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
GPS_HSI_TIME_STALENESS_LIM	V97U3253C	SEC	F	S	D	P	G4.220 G4.237	00	GPD	92292B	
HALI(1)	V97U0287C	FT	F	S	D	C	G4.220 G4.9	00	ZFU	89979F	
HALI(2)	V97U0288C	FT	F	S	D	C	G4.220 G4.9	00	ZFU	89979F	
HFTC(1)	V97U0291C	FT	F	S	D	C	G4.204 G4.220 G4.237 G4.9	01 03	ZFU ZFU	89979F	
HFTC(2)	V97U0292C	FT	F	S	D	C	G4.220 G4.9	00	ZFU	89979F	
HMEP(1)	V96U8636C	FT	F	S	D	C	G4.204 G4.220 G4.237 G4.9	01 03	ZFU ZFU	89979F	
HMEP(2)	V96U8637C	FT	F	S	D	C	G4.220 G4.9	00	ZFU	89979F	
M_WGS84_TO_EF(1,1)	V97U2927C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(1,2)	V97U2928C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.7.1-3. ENTRY AREA NAVIGATION PROCESSING (G4.220) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(1,3)	V97U2929C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,1)	V97U2930C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,2)	V97U2931C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(2,3)	V97U2932C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,1)	V97U2933C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	

TABLE 4.7.1-3. ENTRY AREA NAVIGATION PROCESSING (G4.220) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
M_WGS84_TO_EF(3,2)	V97U2934C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
M_WGS84_TO_EF(3,3)	V97U2935C	ND	F	D	M	P	G4.17 G4.20 G4.21 G4.220 G4.23 G4.237 G4.24 G4.25 V5.1.8	00	WGS	92067D	
PBGC(1)	V97U0327C	ND	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PBGC(2)	V97U0328C	ND	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PBHC(1)	V97U0329C	FT	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PBHC(2)	V97U0330C	FT	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PBRC(1)	V97U0331C	FT	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PBRC(2)	V97U0332C	FT	F	S	M	C	G4.220 G4.9	00	GT3	DC2431A	
PHAVGC	V97U0335C	DEG	F	S	D	X	G4.204 G4.220 G4.237 G4.9 G5.27	00	ZSU	93090E	
PHAVGLL	V97U0336C	DEG	F	S	D	C	G4.204 G4.220 G4.237 G4.9 G5.27	01 03	ZFU ZFU	93090E	
PHAVGS	V97U0337C	DEG	F	S	D	C	G4.204 G4.220 G4.237 G4.9 G5.27	01 03	ZFU ZFU	93090E	



TABLE 4.7.1-3. ENTRY AREA NAVIGATION PROCESSING (G4.220) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
PHAVGUL	V97U0338C	DEG	F	S	D	C	G4.204 G4.220 G4.237 G4.9 G5.27	01 03	ZFU ZFU	93090E	
PSHARS	V96U8647C	DEG	F	S	D	C	G4.19 G4.20 G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27	01 03	ZFU ZFU	93090E	
R1	V96U8263C	FT/DEG	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
R2	V96U8264C	FT/DEG**2	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
RADIUS_EP	V99U6873C	FT	F	S	D	X	G4.220 G4.237	00	ZFV	DC0617	
RESELVE	V99U7680C	FT/SEC	F	S	M	C	G4.220 G4.23 G4.24 G4.25 G5.27	00	VHS	93090E	

TABLE 4.7.1-3. ENTRY AREA NAVIGATION PROCESSING (G4.220) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RFO	V96U8262C	FT	F	S	D	X	G4.204 G4.220 G4.23 G4.237 G4.24 G4.25 G4.9 G5.27 G5.7	00	ZSU	93090E	
TGGS(1)	V97U0414C	ND	F	S	M	C	G4.220 G4.9	00	XS3	DC0599	
TGGS(2)	V97U0415C	ND	F	S	M	C	G4.220 G4.9	00	XS3	DC0599	
WT_GS1	V97U0444C	SLUGS	F	S	M	C	G4.10 G4.220 G4.23 G4.24 G4.25 G4.9 G5.27	00	GLC	93090E	
XA(1)	V97U0456C	FT	F	S	M	X	G4.204 G4.220 G4.237 G4.9	00	XS3	DC0599	
XA(2)	V97U0457C	FT	F	S	M	X	G4.204 G4.220 G4.237 G4.9	00	XS3	DC0599	
X_AIM_PT	V97U0445C	FT	F	S	M	C	G4.10 G4.154 G4.220 G4.234 G4.237 G4.252 G5.27 G5.7	01 03	GL1 GL3	93090E	
X_EP	V98U9427C	FT	F	S	D	C	G4.220 G4.237	01 03	XS8 XS8	DC2748	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.7.1-4. ENTRY AREA NAVIGATION PROCESSING (G4.220) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
H_GSI_SHALLOW	V97U9022C	00	+1.5000	E+03 FT	F	S	C	G4.220 G4.237	59960	

**NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.**

TABLE 4.7.1-5. ENTRY AREA NAVIGATION PROCESSING (G4.220) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S C	A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	

TABLE 4.7.1-5. ENTRY AREA NAVIGATION PROCESSING (G4.220) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
GO EARTH GRAV ACCEL CONSTANT	V90A7622C	00	+3.2174049	E+01 FT/SEC**2	F		S P	A6.9 G4.10 G4.105 G4.126 G4.204 G4.208 G4.22 G4.220 G4.227 G4.234 G4.237 G4.36 G4.8 G4.9 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	
NAUTMI_PER_FT FEET TO NAUTICAL MILES CONVERSION FACTOR	V97U5423C	00	+1.6457884	E-04 NMI/FT	F		S C	A6.9 G4.127 G4.144 G4.158 G4.19 G4.20 G4.205 G4.21 G4.210 G4.211 G4.220 G4.23 G4.237 G4.24 G4.25 G4.8 G5.27	93090E	

TABLE 4.7.1-5. ENTRY AREA NAVIGATION PROCESSING (G4.220) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
PI RATIO OF CIRCUMFERENCE TO DIAMETER	V98U8725C	00	+3.14159265358E+00	ND	F	D	C	A6.9 G4.126 G4.127 G4.13 G4.144 G4.15 G4.158 G4.16 G4.19 G4.2 G4.20 G4.205 G4.209 G4.210 G4.213 G4.220 G4.236 G4.237 G4.3 G4.4 G4.5 G4.97 G5.10 G5.24 G5.26 G5.27	93090E	

TABLE 4.7.1-5. ENTRY AREA NAVIGATION PROCESSING (G4.220) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

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## 4.8 SPECIALIST FUNCTIONS NAVIGATION SUPPORT FORMULATIONS

This section describes noncyclic navigation processing and data transfer required for the navigation system to respond to crew controls and data entered at the display keyboard, via a specialist function, and to provide the software support associated with the specialist function. Output from these formulations is not uniquely generated for the navigation system. Specialist functions navigation support formulations consist of the formulations required for keyboard entry of a delta state update and keyboard entry of a delta time tag update.

### 4.8.1 Keyboard Delta State Update

The capability for keyboard entry of a delta state update shall be provided via the horizontal situation display (HSD) specialist function.

- A. Detailed Requirements. The HSD keyboard support software shall interpret the keyboard entries and set the appropriate elements of the delta vectors needed by the cyclic navigation functions to the input values. This software shall also set a flag, DO\_DELTA\_UPDATE, indicating to the navigation that a command to perform the delta state update has been entered via the keyboard. The navigation function will return this flag to the "OFF" position to preclude multiple updates.
- B. Interface Requirements. Input and output parameters for this subfunction are shown in Tables 4.8.1-1 and 4.8.1-2, respectively.
- C. Processing Requirements. The keyboard delta state update data and execution command shall be provided only via keyboard entry.
- D. Constraints. It is the responsibility of the crew to input the data (delta vectors) before commanding that a delta state update be performed. No method for testing the values of input data for errors is provided.
- E. Supplemental Information. An example implementation of these requirements is shown in Section 5.5, ENTRY\_KEYBOARD\_PROCESSOR.

Table 4.8.1-1. Keyboard Delta State Update Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Keyboard entry for each component of DR_RW	DR_RW	Kybd	F	S		ft	As needed
Keyboard entry for each component of DV_RW	DV_RW	Kybd	F	S		ft/sec	As needed
Keyboard entry to initiate delta state update processing	DO_DELTA_UPDATE	Kybd	D	—	ON/OFF	—	As needed

Table 4.8.1-2. Keyboard Delta State Update Output Parameters							
Description	Symbol	Output Destination	Type	Precision	Range	Units	Comp Rate
Position delta vector for delta state update	$\overline{DR\_RW}$	Entry NAV, preland NAV	V	S		ft	As needed
Velocity delta vector for delta state update	$\overline{DV\_RW}$	Entry NAV, preland NAV	V	S		ft/sec	As needed
Command to perform delta state update	DO_DELTA_UPDATE	Entry NAV, preland NAV	D	—	OFF/ON	—	As needed

#### 4.8.2 Keyboard Delta Time Tag Update

The capability shall be provided to accomplish a downrange position correction via a keyboard entry of a state vector time tag adjustment.

A. Detailed Requirements. The crew will receive, via voice communications, a value for delta time tag adjustment. This value will then be entered, via keyboard, onto the HSD, followed by entry of a command to perform the update.

Upon receipt of the command to perform a delta time tag adjustment, keyboard processing software shall establish input data needed by the state vector prediction task (see Section 4.3.1.4.3) and initiate execution of this subfunction.

The necessary equations are:

$$\overline{R\_GND} = \overline{R\_FILT}$$

$$\overline{V\_GND} = \overline{V\_FILT}$$

$$T\_GND = T\_CURRENT\_FILT + DELTA\_T$$

DO\_DELTA\_T\_UPDATE = ON

```
IF |DELTA_T| ≤ 1.0E-08 THEN
    ZERO_DELTA_T_UPDATE = ON
ENDIF
```

CALL: STATE\_VECTOR\_PREDICTION\_TASK

where DELTA\_T is defined through a keyboard entry. The sense of the state update made is that a positive value of DELTA\_T is used to correct the onboard navigated state when the navigated state is in error by being too far downtrack compared to the solution obtained from ground tracking data. A negative value of DELTA\_T is used when the onboard state lags behind the downtrack position as obtained from ground tracking data.

If DELTA\_T is zero, the navigated state will be unchanged, but the covariance matrix will be reset as though a state vector update had occurred. Use of the DO\_DELTA\_T\_UPDATE flag allows the spec

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function to zero the displayed DELTA\_T value after the update has been processed and navigation has reset the flag to OFF.

Provision has been made to reset the QA2 (GPS minus navigation) difference thresholds when a non-zero DELTA\_T is input. The flag ZERO\_DELTA\_T\_UPDATE is set ON to tell navigation that a zero DELTA\_T input was made and to not reset the QA2 difference thresholds.

- B. Interface Requirements. Input and output parameters for this function are shown in Tables 4.8.2-1 and 4.8.2-2, respectively.
- C. Processing Requirements. No provision is made to automatically resolve conflicts between the use of the state vector prediction task for a delta time tag update as compared to using this subfunction for a whole vector update via command uplink. Any potential conflicts must be resolved via crew ground procedures and coordination.
- D. Constraints. It is necessary to prevent the possibility of using an incompletely updated filter state vector if the filter is interrupted by keyboard activity in the middle of a processing cycle.
- E. Supplemental Information. An example implementation of these requirements is illustrated in Section 5.5, ENTRY\_KEYBOARD\_PROCESSOR.

Table 4.8.2-1. Keyboard Delta Time Tag Update Input Parameters

Description	Symbol	Input Source	Type	Precision	Range	Units	Sample Rate
Amount by which the state vector time tag is to be adjusted	DELTA_T	Kybd Entry	F	S	±99.9	sec	As needed
Current filter position vector	$\bar{R}_{FILT}$	Entry NAV	V	DP		ft	As needed
Current filter velocity vector	$\bar{V}_{FILT}$	Entry NAV	V	SP		ft/sec	As needed
Time tag of current filter position and velocity vectors	T_CURRENT_FILT	Entry NAV	F	DP		sec	As needed

Table 4.8.2-2. Keyboard Delta Time Tag Update Output Parameters

Description	Symbol	Output Destination	Type	Precision	Range	Units	Rate
Initial position vector used by the state vector prediction task	$\bar{R}_{GND}$	Entry NAV	V	DP		ft	As needed
Initial velocity vector used by the state vector prediction task	$\bar{V}_{GND}$	Entry NAV	V	SP		ft/sec	As needed
Time tag of the initial vectors used by the state vector prediction task	T_GND	Entry NAV	F	DP		sec	As needed
Flag indicating (ON) that a time tag update is to be performed	DO_DELTA_ T_UPDATE	5.7	D	—	OFF/ON	—	As needed
Flag indicating (ON) that a zero delta time update has occurred	ZERO_DELTA_ T_UPDATE	Entry NAV	D	—	ON/OFF	—	As needed

## 4.9 DOWNLIST REQUIREMENTS

Downlist requirements for the Entry through Landing (OPS-3) operations computer load are discussed in the Computer Program Development Specification, Volume I, Book 4 (SS-P-0002-140), Downlist/Uplink Software Requirements.

## 4.10 UPLINK REQUIREMENTS

This section is included to discuss the navigation-related uplink capabilities, data, and any special processing requirements needed to enable proper action by the appropriate navigation function. This discussion is not intended to supplant the requirements imposed by the DOWNLIST/UPLINK CPDS (SS-P-0002-140) but rather to clarify the action necessary to provide the proper interfaces between the navigation function and other on-board software which interprets and decodes the uplinked data for applications processing. The term “special processing requirement” is used to identify computation, flag settings, or other actions to be performed by on-board software external to the navigation functions to provide or establish values for inputs needed by the navigation function.

This discussion is limited to the formatted uplink capabilities defined in the DOWNLIST/UPLINK CPDS.

The formatted uplink capabilities are:

1. Delta State Vector Update
2. Orbiter State Vector Update
3. Deorbit Landing Site Parameters Load
4. Deorbit TACAN Parameters Load
5. MSBLS Parameters Load
6. RNP Matrix Time Parameters Load

### 4.10.1 Delta State Vector Update

The delta state vector update will be performed by the navigation function as described in Sections 4.2.6, 4.3.1.4.2, and 4.3.2.4.2. The proper performance of the update by the navigation function is possible only if the delta vectors  $\overline{DR\_RW\_UP}$  and  $\overline{DV\_RW\_UP}$  (see principal function input list for a description) are set to the data uplinked and the flag  $DO\_DELTA\_UPDATE\_UP$  is set to the ON position. The flag itself is not part of the uplinked information and must be set by the uplink processing software which decodes the uplinked command word. The flag setting is a special processing requirement and must follow the setting of  $\overline{DR\_RW\_UP}$  and  $\overline{DV\_RW\_UP}$  to the uplinked values.

Upon sensing  $DO\_DELTA\_UPDATE\_UP$  to be in the ON position, the navigation function will perform the update to the navigation state vector, and turn  $DO\_DELTA\_UPDATE\_UP$  to the OFF position to automatically inhibit multiple processing of the same uplinked data. An example illustration of these requirements is shown in Section 5.2 (ENTRY UPLINK PROCESSOR) for  $OP\_CODE = 0100000$ .

#### 4.10.2 Orbiter State Vector Update

The orbiter state vector update will be performed by the navigation function as described in Section 4.3.1.4.3. The proper performance of the update by the navigation function is possible only if the update vector  $\bar{R}_{GND}$  and  $\bar{V}_{GND}$  and the associated time tag  $T_{GND}$  (see the principal function input list for a description) are set to the data uplinked and the OP\_CODE is set to the proper value. The OP\_CODE setting must follow the setting of  $\bar{R}_{GND}$ ,  $\bar{V}_{GND}$ , and  $T_{GND}$  to the uplinked values.

Upon sensing OP\_CODE to have the value 0001001, the navigation function will perform the update to the navigation state vectors and set OP\_CODE to a value of 0000000 to automatically inhibit multiple processing of the same uplinked data.

#### 4.10.3 Entry Site Lookup Data Uplink

There are three command uplink loads in OPS-3 which affect data used by the Entry site lookup principal function:

1. Deorbit Landing Site Parameters Load (Ref. CPDS-140, Table 6.3.23-1 and CPDS-510, Paragraph 3.9.15)
2. Deorbit TACAN Parameters Load (Ref. CPDS-140, Table 6.3.28-1 and CPDS-510, Paragraph 3.9.18)
3. MSBLS Parameters Load (Ref. CPDS-140, Table 6.3.44-1 and CPDS-510 paragraph 3.9.25)

##### 4.10.3.1 Deorbit Landing Site Parameters Load (OP\_CODE = 0010101)

The deorbit landing site parameters load provides the capability to uplink parameters related to the table of data for the 90 runways maintained in OPS-3. The following list of parameters may be uplinked:

Deorbit Landing Site Parameters Load		
M/S ID No.	Nomenclature	Type
V96J1207C	LDG SITE TABLE SLOT ID (1-90)	INT
V96J1208C	RUNWAY NAME ID	ASCII
V96J1209C	RUNWAY NAME ID FILL	ASCII
V96H1210C	RUNWAY GEODETIC LATTITUDE	SP
V96H1211C	RUNWAY GEODETIC LONGITUDE	SP
V96H1212C	RUNWAY TRUE AZIMUTH	SP
V96H1213C	RUNWAY MAGNETIC VARIATION	SP
V96H1214C	RUNWAY ALT ABOVE REF. ELLIPSOID	SP
V96H0102C	RUNWAY GEODETIC SEPARATION	SP
V90H3760C	RUNWAY LENGTH	INT
V96J0103C	RUNWAY MSBLS INDEX	INT



There are three special processing requirements associated with uplink into the runway site table. The first special processing requirement is that MSBLS site data are not included as part of the runway uplink data, except the pointer RW\_MSBLS\_INDEX, which indicates the one MSBLS associated with the uplinked runway out of a possible fifteen choices. The second special processing requirement is that all angular parameters must be stored (replace other parameter) in radians regardless of the uplink units. The third special processing requirement is that if a different runway at another landing area is uplinked to replace an existing runway, the alternate site indexes associated with the replaced landing area must be set to zero. If a new runway is uplinked to replace a currently selected runway, the crew should make a runway selection to this runway by means of the appropriate HSD item entry in order to ensure use of the new runway coordinates. This procedure will retain the overhead/straight-in status. Similarly, if a new runway is uplinked to the primary runway of an alternate site of the currently selected runway, the crew should take one of the following actions to ensure use of the new alternate site data:

1. Change the selected landing site and then reselect the previous site via Item 41 on the HSD or Entry Bearing Display.
2. Change the alternate site and then reselect the affected alternate site via Item 1 or 2 as appropriate on the Entry Bearing Display.

The logical order of responding to an uplink is that the OP\_CODE be tested to determine if it has a value of 0010101. If true, then all necessary data handling and computations shall be performed. The final necessary action is to set OP\_CODE to a value of 0000000 to inhibit multiple processing of an uplinked data set.

Notes:

(1) Deorbit Landing Site Uplink processing zeroes the alternate site indexes for the landing area when the site part of the uplinked runway name (the first three characters) differs from either the site part of the runway name being replaced or the site part of the runway name for the other runway at the landing area. Both runway names at the landing area are checked to account for a “split site”, where the runways may not physically be at the same landing area.

(2) Deorbit Landing Site Uplink processing does not zero alternate site indexes for other landing areas which reference the landing area of the uplinked runway. Such action was not deemed to be of sufficient operational significance. The primary operational reason to uplink a runway into the landing site table is to select that runway. In this case, use of the affected landing area as an alternate site is not of interest.

An example implementation of the necessary logic, data handling, computations, and invoking of the initialization subfunction is shown in Section 5.5, DEORBIT\_LANDING\_SITE\_UPLINK.

**4.10.3.2 Deorbit TACAN Site Parameters Load (OP\_CODE = 0011111)**

The deorbit TACAN parameters load provides the capability to uplink data related to the table of TACAN data for up to 90 sites in OPS-3. For each site, the following parameters may be uplinked:

Deorbit Tacan Parameters		
M/S ID No.	Nomenclature	Type
V96J0095C	TACAN TABLE SLOT (1-90)	INT

Deorbit Tacan Parameters		
M/S ID No.	Nomenclature	Type
V96H0096C	TACAN MAGNETIC VARIATION	SP
V96H0097C	TACAN GEODETIC SEPARATION	SP
V96H0098C	TACAN ALT ABOVE REF. ELLIPSOID	SP
V96H0099C	TACAN GEODETIC LONGITUDE	SP
V96H0100C	TACAN GEODETIC LATITUDE	SP
V96J0101C	TACAN CHANNEL/MODE	INT

There are two special processing requirements associated with a TACAN parameters uplink. The first requirement is that all the angular parameters must be stored in radians regardless of the uplink units. All subsequent manipulations and use of these data assume that the table data are in units of radians. The second special processing requirement is that if a new TACAN is uplinked to replace a currently selected TACAN, the crew should make two TACAN change requests by means of the appropriate item entry in order to ensure use of the new TACAN data.

The logical order of responding to an uplink is that the OP\_CODE be tested to determine if it has the value 0011111. If true, then all necessary data handling and computations shall be performed. The final necessary action is to set OP\_CODE to a value of 0000000 to inhibit multiple processing of an uplinked data set.

An example implementation of the necessary logic, data handling, computations, and invoking of the initialization subfunction is shown in Section 5.5, DEORBIT\_TACAN\_SITE\_UPLINK.

#### 4.10.3.3 MSBLS Parameters Load (OP\_CODE = 0100010)

The MSBLS parameters load provides the capability to uplink parameters related to the table of data for the fifteen MSBLS sites in OPS 3. The following list of parameters may be uplinked:

MSBLS Parameters Load		
M/S ID No.	Nomenclature	Type
V96J0080C	MSBLS TABLE SLOT ID (1-15)	INT
V96H0081C	MSBLS AZ/RNG STATION GEODETIC LAT	SP
V96H0082C	MSBLS AZ/RNG STATION GEODETIC LON	SP
V96H0083C	MSBLS AZ/RNG STATION GEODETIC ALT	SP
V96H0084C	MSBLS AZ/RNG STATION ANT BORESIGHT	SP
V96H0085C	MSBLS ELEV STATION GEODETIC LAT	SP
V96H0086C	MSBLS ELEV STATION GEODETIC LON	SP
V96H0087C	MSBLS ELEV STATION GEODETIC ALT	SP
V96H0088C	MSBLS ELEV STATION ANT BORESIGHT	SP
V96H0089C	MSBLS RANGE BIAS	SP

MSBLS Parameters Load		
M/S ID No.	Nomenclature	Type
V96H0090C	MSBLS AZIMUTH ANGLE BIAS	SP
V96H0091C	MSBLS ELEVATION ANGLE BIAS	SP
V96H0092C	MSBLS AZ/RNG STATION X-RW COORD	SP
V96H0093C	MSBLS ELEV STATION X-RW COORD	SP
V96H0094C	MSBLS AZ/RNG STATION Y-RW COORD	SP

There are three special processing requirements associated with uplink into the MSBLS site table. First, all angular parameters must be stored (replace other parameters) in radians, regardless of the uplink units. All subsequent manipulations and use of angular data assumes that the table data is in units of radians. Second, all distance parameters must be stored in feet regardless of uplink units. Again, all subsequent manipulations and use of distance data assumes that the table data is in units of feet. The third requirement is that if a new MSBLS site data is uplinked into the currently selected landing site area and runway, the crew must reselect the landing site area and/or runway associated with the new MSBLS site using the item entries provided on the HSD.

The logical order of responding to an uplink is that the OP\_CODE be tested to determine if it has a value of 0100010. If true, then all necessary data handling and computations shall be performed. The final necessary action is to set OP\_CODE to a value of 0000000 to inhibit multiple processing of an uplinked data set.

An example implementation of the necessary logic, data handling, computations, and invoking of the initialization subfunction is shown in Section 5.5, MSBLS\_SITE\_UPLINK.

#### 4.10.4 RNP Matrix Time Parameters Uplink (OP\_CODE = 0111011)

The flight software shall provide the capability to update the RNP Matrix time parameters via uplink in OPS 9, MM201, and MM301. When an RNP Matrix Time Parameters uplink is received, the RNP Matrix I-Loads LAUNCH\_YEAR and RNP\_DAY shall be replaced by their uplinked values, the uplink OP\_CODE shall be reset, and the RNP\_TIME\_UL flag shall be set ON so that Entry Navigation will call the RNP MAT COMP function to compute new values for the RNP matrix data.

A. Detailed Requirements. Check to see if the RNP Matrix Time Parameters have been uplinked (indicated by the uplink OP\_CODE being set to 0111011). If so, the following actions shall be taken. The I-Load parameters LAUNCH\_YEAR and RNP\_DAY shall be set equal to their uplinked values. The uplink OP\_CODE shall be set to 0000000 to prevent repeated processing of the uplink. Finally, the RNP\_TIME\_UL flag shall be set ON, indicating that the RNP MAT COMP function must be called by Entry Navigation to re-compute the RNP matrix data (M\_M50TOEF\_AT\_EPOCH, T\_EPOCH, and EARTH\_POLE) based on the uplinked values for LAUNCH\_YEAR and RNP\_DAY.

```
IF OP_CODE = 0111011 THEN
    LAUNCH_YEAR = LAUNCH_YEAR_UL
    RNP_DAY = RNP_DAY_UL
    OP_CODE = 0000000
    RNP_TIME_UL = ON
```

B. Interface Requirements. The following parameters may be uplinked:

RNP Matrix Time Parameters Load			
M/S ID No.	FSSR Name	Nomenclature	Type
V97U5383C	LAUNCH_YEAR	LAUNCH YEAR FOR RNP MATRIX CALC	INT
V97U5384C	RNP_DAY	DAY OF YEAR FOR RNP MATRIX CALC	INT

The following table contains the input/output data for the RNP Matrix Time Parameters uplink:

RNP Matrix Time Parameters Uplink Input/Output		
Variable Name	Input Source	Output Destination
OP_CODE	GROUND UPLINK PROCESSOR	
LAUNCH_YEAR_UL	GROUND UPLINK PROCESSOR	
RNP_DAY_UL	GROUND UPLINK PROCESSOR	
OP_CODE		GROUND UPLINK PROCESSOR
LAUNCH_YEAR		RNP MAT COMP (G4.16)
RNP_DAY		RNP MAT COMP (G4.16)
RNP_TIME_UL		ENTRY NAV

C. Processing Requirements. The flag RNP\_TIME\_UL is initially set OFF.

D. Constraints. The RNP Matrix Time Parameters uplink processing is only supported in OPS 9, MM201 and MM301.

E. Supplementary Information. A suggested implementation of these requirements is illustrated as a flow chart (RNP\_MATRIX\_TIME\_UPLINK\_PROCESSING) in Section 5.5.

## 5.0 SUPPLEMENTAL MATERIAL

The material in this section is provided for information. It is divided by major function as follows:

1. Sections 5.1 and 5.2 Basic Entry Through Landing Navigation
2. Section 5.3 Coordinate Systems
3. Section 5.4 Area Navigation
4. Section 5.5 Specialist Functions
5. Section 5.6 User Parameter Processing

### 5.1 NAVIGATION VARIABLE NAMES AND DESCRIPTIONS

Provided in Table 5.1–1 is a list of the total navigation variables for entry through landing, excluding user parameter processing and specialist functions. Listed below are definitions that will aid in interpreting Table 5.1–1. Note that this variable list is directly correlated to the flow charts in Section 5.2. Table 5.1–1 is sorted in alphabetical order in this baseline FSSR.

#### DEFINITIONS

##### Code used for variable data type

S:	scalar
V(n):	vector (dimension)
M(n):	square matrix (dimension)
INT:	integer
BIT:	bit
CHAR:	character
STR:	structure
ARR(n):	array (dimension)
BIN:	binary

Coordinate frame code and definition

Body: (structural)	x: parallel to the longitudinal axis (positive aft)
	y: completes right-hand system
	z: perpendicular to the x-axis, positive upward
EF:	Earth-fixed coordinate system
M50:	Mean of 50 reference coordinate system
RW: (runway coordinates)	x: down runway centerline in direction of landing
	y: completes right-hand system
	z: down, normal to ellipsoid
SCAN: (MLS scanner coordinates)	x: scanner boresight axis
	y: completes right-hand system
	z: up, normal to ellipsoid
TD: (topodetic coordinates)	x: north
	y: east
	z: down, normal to ellipsoid
UVW	Quasi-inertial, right-handed Cartesian coordinate system

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
A	ARR(5.2)	0	—	Array for temporary storage of Legendre polynomials in Pine's formulation
ACC_DRAG	S	0	—	Vehicle c.g. drag acceleration
ACC_DRAG_MIN	S	K-load	—	Minimum acceleration magnitude required for processing drag data
ACC_PROP_MIN	S	K-load	—	Acceleration magnitude above which vent and drag models are not employed
ACC_SENSED	S	0	—	Magnitude of sensed acceleration used to determine whether to incorporate IMU data
$\bar{A}$ CCCEL	V	0	M50	Modeled acceleration vector
ALPHA	S	0	—	Angle of attack for computing drag coefficient, in radians
ALPHAIN	S	0	—	Angle of attack in degrees from attitude snap
ALPHAR	S	0	—	Angle of attack used to compute drag altitude pseudomeasurement
ALT	S	600,000	—	Current orbiter altitude above reference ellipsoid
ALT_BARO_CUTOFF	S	*	—	Baro processing cutoff altitude
ALT_BARO_CUTOFF_HIGH	S	I-load	—	Baro processing cutoff altitude if MSBLS data processed at low vehicle altitudes
ALT_EL	ARR(3)	K-load	—	Altitude regions for nav event lamp processing
ALT_RW	S	0	—	Altitude above reference ellipsoid of runway reference point
ALT_WHEELS	S	600,000	—	Altitude of orbiter above runway altitude
ALT_ZONE_CHANGE	S	K-load	—	Altitude where model for atmospheric density is changed
ANGLE_CORR_TNTMAG_SL	S	—	—	Variation of magnetic north from true north at TACAN site obtained from site lookup
ANGLE_CORR_TNTOMAG	S	0	—	Copy of ANGLE_CORR_TNTOMAG_SL for navigation processing
ATM_INDEX	INT	0	—	Atmospheric model selection index
AUXILIARY	S	0	—	Intermediate variable in the Pine's formulation
$\bar{B}$	V(6)	0	—	Measurement first partials with respect to filter state
BARO_AIF	CHAR	Inhibit	—	Auto-inhibit-force switch for barometric sensor selection
BARO_DATA_GOOD	BIT	Off	—	Copy of current data-good discrete reserved for measurement processing
BARO_EDIT_OVERRIDE	BIT	Off	—	Switch used to force incorporation of barometric data regardless of residual edit test

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
BARO_MARK_NUM	INT	0	—	Counter indicating the number of times that barometric measurement was selected for filter processing
BARO_STAT	BIT	Off	—	Flag indicating stat-flag setting for barometric measurements
$\bar{B}$ ASE_DEN	V(12)	I-load	—	Vector of base densities for each layer to model drag
BETA	S	0	—	Sideslip angle in radians
BETA_IN	S	0	—	Sideslip angle in degrees from attitude snap
BIAS_AZMLS	S	0	—	MLS azimuth measurement bias
BIAS_BARO	S	K-load	—	Barometric altimeter measurement bias
BIAS_DRAG	S	0	—	Drag measurement bias
$\bar{B}$ IAS_DRAG_LAYER	V(12)	I-load	—	Vector of deterministic drag biases for each layer
BIAS_ELMLS	S	0	—	MLS elevation measurement bias
BIAS_RMLS	S	0	—	MLS range measurement bias
BT_E_B	S	0	—	Variable used to store the calculation of $B \cdot \text{TRANSPOSE} \cdot E \cdot B$
$\bar{C}$	V(9)	Constant	—	Tesseral harmonic coefficients
C_DRAG	S	0	—	Drag coefficient
C_DRAG_ONE	S	I-load	—	Polynomial term for computing drag coefficient as function of angle of attack
C_DRAG_TWO	S	I-load	—	Polynomial term for computing drag coefficient as function of angle of attack
C_DRAG_ZERO	S	I-load	—	Polynomial term for computing drag coefficient as function of angle of attack
CD	S	—	—	Shuttle's drag coefficient
CDA	S	I-load	—	Constant used to model drag coefficient (additional corrective term)
CDF	S	I-load	—	Constant used to model drag coefficient (frontal area)
CDN	S	I-load	—	Constant used to model drag coefficient (top area correction)
CDS	S	I-load	—	Constant used to model drag coefficient (side area correction)
COLUMN	INT	1	—	Indexing integer
$\bar{C}$ OR	V(7)	0	—	General term for correlation coefficients
$\bar{C}$ ORR_COEFF_AOA	V(7)	I-load	UVW	Correlation coefficients to initialize covariance matrix for AOA
$\bar{C}$ ORR_COEFF_INIT	V(7)	K-load	UVW	Correlation coefficients to initialize covariance matrix for normal end of mission and TAL
$\bar{C}$ ORR_COEFF_UPDATE	V(7)	K-load	UVW	Correlation coefficients to initialize covariance matrix for delta state update



Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{C}$ ORR_COEFF_UPDATE_M50	V(7)	K-load	UVW	Correlation coefficients to initialize covariance matrix for whole vector update
COV_POS_SIG	S	0	—	Square root of the trace of the position elements (E(1,1), E(2,2), E(3,3)) of the navigation Kalman filter covariance matrix for downlist
COV_VEL_SIG	S	0	—	Square root of the trace of the velocity elements (E(4,4), E(5,5), E(6,6)) of the navigation Kalman filter covariance matrix for downlist
$\bar{D}$	V	0	M50	Drag acceleration vector
DEL_TIME_STEP	S	I-Load	—	Maximum step size for precise predictor for OPS-3 initialization
DELCD	S	0	—	Additive CD factor which accounts for effects of angle of attack and altitude variations
DELH_MSL_ELLIPSOID_RW	S	—	—	Altitude of mean sea level above reference ellipsoid at runway
DELQ	S	0	—	General term for measurement residual
DELQ_ONE	S	0	—	General variable for residual during three-state configuration of State 1
DELQ_THREE	S	0	—	General variable for residual during three-state configuration for State 3
DELQ_TWO	S	0	—	General variable for residual during three-state configuration for State 2
$\bar{D}$ ENSE	V(6)	K-load	—	Density model constants
$\bar{D}$ ENSITY_LIMIT	V(12)	I-load	—	Altitudes at which to change density model parameters
DEORBIT_BURN	BIT	Off	—	Flag indicating (ON) that nav phase deorbit maneuver is being executed
DIFCD1	S	K-load	—	Constant used in expression for computing DIFF_CD
DIFCD2	S	K-load	—	Constant used in expression for computing DIFF_CD
DIFCD3	S	K-load	—	Constant used in expression for computing DIFF_CD
DIFCD4	S	K-load	—	Constant used in expression for computing DIFF_CD
DIFF_CD	S	0	—	Difference between the coefficients of drag at 600,000 feet and 300,000 feet as a function of angle of attack
$\bar{D}$ ISP_DELQ	V(7)	0	—	Display measurement residual for Ith sensor measurement
$\bar{D}$ ISP_EDIT	V(7)	Blank	—	Display edit history indicator for Ith sensor measurement

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\overline{\text{DISP\_SIG}}$	V(7)	0	—	Display residual ratio for Ith sensor measurement
DNM	S	0	—	Variable used in Pine's formulation
DNSA	S	0	—	Variable used in density calculations
DNSB	S	0	—	Variable used in density calculations
DNSC	S	0	—	Variable used in density calculations
DO_BARO_NAV	BIT	Off	—	Flag indicating (ON) that barometric altimeter data are to be processed
DO_DELTA_T_UPDATE	BIT	Off	—	Flag indicating (ON) that a time tag update is to be performed
DO_DELTA_UPDATE	BIT	Off	—	Flag indicating (ON) that a delta state update is to be performed (keyboard entry)
DO_DELTA_UPDATE_UP	BIT	Off	—	Flag indicating (ON) that a delta state update is to be performed from uplinked data
DO_DRAG_NAV	BIT	Off	—	Flag indicating (ON) that drag altitude data are to be processed
DO_MLS_NAV	BIT	Off	—	Flag indicating (ON) that MLS data are to be processed
DO_TACAN_NAV	BIT	Off	—	Flag indicating (ON) that TACAN data are to be processed
DQ	S	0	—	General term for measurement residual
$\overline{\text{DR\_RW}}$	V	0	RW	Ground-computed position deviations to update on-board state vector via keyboard entry
$\overline{\text{DR\_RW\_UP}}$	V	0	RW	Ground-computed position deviations to update on-board state vector via command uplink
DRAG_AIF	CHAR	Auto	—	Drag auto/inhibit/force flag
DRAG_CONST	S	I-load*	—	Drag constant equal to the vehicle reference area divided by twice the vehicle mass
DRAG_EDIT_OVERRIDE	BIT	Off	—	Switch used to force incorporation of drag altitude measurement regardless of residual edit test
DRAG_MARK_NUM	INT	0	—	Counter indicating the number of times that drag measurement was selected for filter processing
DRAG_STAT	BIT	Off	—	Flag indicating (ON) that drag data are processed for statistical display only
DT_DEORB_PF_NAV	S	Constant	—	Sequencing time interval for entry navigation during deorbit burn
DT_DEORB_PREP_NAV	S	Constant	—	Sequencing time interval for entry navigation during coasting flight prior to deorbit burn

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
DT_ENTRY_NAV	S	Constant	—	Sequencing time interval for entry navigation after completion of deorbit burn
DT_FILT	S	Constant	—	Interval over which to propagate the state vector(s) and covariance matrix
DT_INTERP	S	Constant	—	State vector interpolation time interval
DT_LAND	S	Constant	—	Sequencing time interval for preland external navigation sensor processing function
DT_MAX	S	0	—	Max allowable time step size for entry precise predictor
$\bar{D}V$	V	0	M50	General vector of difference between present and previous accumulated sensed velocities
$\bar{D}V_{FILT}$	V	0	M50	Difference between accumulated sensed IMU readings on present cycle and previous cycle
$\bar{D}V_{FILT\_ONE}$	V	0	M50	Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU-1 during three-state configuration
$\bar{D}V_{FILT\_THREE}$	V	0	M50	Difference between present and previous accumulated sensed velocities for IMU-3 during three-state configuration
$\bar{D}V_{FILT\_TWO}$	V	0	M50	Difference between accumulated sensed IMU readings on present cycle and previous cycle for IMU-2 during three-state configuration
$\bar{D}V_{RW}$	V	0	RW	Ground-computed relative velocity deviations to update on-board state vector via keyboard entry
$\bar{D}V_{RW\_UP}$	V	0	RW	Ground-computed relative velocity deviations to update on-board state vector via command uplink
E	M(6)	0	M50	Filter covariance matrix
E_TEMP	M(6)	0	—	Temporary matrix for covariance matrix initialization
EARTH_MU	S	Constant	—	Gravitational constant of earth
$\bar{E}ARTH\_POLE$	V	0,0,1	M50	Unit vector in direction of earth's axis of rotation
EARTH_RADIUS_EQUATOR	S	Constant	—	Earth equatorial radius
EARTH_RADIUS_GRAV	S	Constant	—	Earth radius used for gravity oblateness calculations
EARTH_RATE	S	Constant	—	Earth rotational rate
$\bar{E}B\_COPY$	V(6)	0	M50	Variable used to reserve the product of the covariance matrix and the partials vector B

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
EDIT_ARRAY	ARR	0	—	Array of last 4 edit flags for display processing
EDIT_FLAG	BIT	Off	—	General variable for edit flags
ELEM 1	S	0	—	Variable used by mid-select to select middle element
ELEM 2	S	0	—	Variable used by mid-select to select middle element
ELEM 3	S	0	—	Variable used by mid-select to select middle element
ELLIPT	S	Constant	—	Earth ellipticity constant
EPS_TAG	S	Constant	—	Criterion for difference between measurement time and state time, above which the filter state will be extrapolated for residual calculations
EVENT_E_14A	BIT	Off	—	MSC event - OMS cutoff confirmation
EVENT_E1	INT	—	—	Flag indicating (ON) a transition from OPS-3 to OPS-2
EXP_SHAPE_FACTOR	S	I-load	—	Exponential shaping factor for drag coefficient model
F1	S	0	—	Auxiliary variable in Pine's formulation
F2	S	0	—	Auxiliary variable in Pine's formulation
F3	S	0	—	Auxiliary variable in Pine's formulation
F4	S	0	—	Auxiliary variable in Pine's formulation
FIFTY	M(3)	0	—	General transformation matrix from EF to M50 coordinates
FILT_UPDATE	BIT	Off	—	Switch indicating (ON) that current measurement processing is complete for UPP propagator reset
$\bar{G}$	V	0	M50	Gravity acceleration
$\bar{G}_{FINAL}$	V	0	M50	Current gravity vector
$\bar{G}_{OLD}$	V	0	M50	Gravity acceleration at start of Shuttle state integration interval
$\bar{G}_{ONE}$	V	0	M50	Past acceleration vector due to gravity
$\bar{G}_{ONE\_OLD}$	V	0	M50	Gravity acceleration vector at beginning of integration interval associated with IMU-1
$\bar{G}_{RESET}$	V	0	M50	Vehicle gravity acceleration vector reserved for reset of user parameter gravity acceleration vector
$\bar{G}_{THREE\_OLD}$	V	0	M50	Gravity acceleration vector at beginning of integration interval associated with IMU-3
$\bar{G}_{TWO}$	V	0	M50	Current acceleration vector due to gravity
$\bar{G}_{TWO\_OLD}$	V	0	M50	Gravity acceleration vector at beginning of integration interval associated with IMU-2

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
GM_DEG	S	0	—	Integer indicating degree of modeled acceleration
GM_ORD	S	0	—	Integer indicating order of modeled acceleration
GM_PRED	S	0	—	Integer indicating degree of modeled acceleration in OPS_3_INITIALIZE (code)
GMD	S	0	—	General term indicating degree of modeled acceleration
GMO	S	0	—	General term indicating order of modeled acceleration
GMO_PRED	S	0	—	Integer indicating order of modeled acceleration in OPS_3_INITIALIZE (code)
GRAV_GRAD_NEW	M(3)	0	M50	Gravity gradient at end of transition matrix integration interval
GRAV_GRAD_OLD	M(3)	0	M50	Gravity gradient at start of transition matrix integration interval
H_DRAG_LOW	S	K-load	—	Altitude below which the drag data are not processed
H_INHIB	BIT	Off	—	Flag indicating (ON) that altitude data has been deselected based on an automatic selection constraint
H_S	S	0	—	Atmospheric scale height for density calculation
I	INT	1	—	Integer-subscript or iteration counter
$\bar{I}_V$ _RHO	V	0	M50	Unit vector of $\bar{V}$ _RHO
$\bar{I}_Z$	V	0	M50	Unit vector along TACAN, MLS azimuth, or elevation scanner coordinate Z-axis
ID_MATRIX_3x3	M(3)	Constant	—	Identity matrix (3x3)
$\bar{I}$ MU_SFC	V	0	—	IMU selection filter control vector
IMU_STATUS	S	0	—	Integer indicating combined status of 3 IMU's
IMU_BYPASS(J)	BIT	Off	—	IMU bypass indicator corresponding to the J <sup>th</sup> IMU for the current nav cycle
IMU_BYPASS_PREV(J)	BIT	Off	—	IMU bypass indicator corresponding to the J <sup>th</sup> IMU for the previous nav cycle
IMU_BYPASS_REMOVED(J)	BIT	Off	—	Flag indicating (ON) that the J <sup>th</sup> IMU bypass flag has been removed
IMU_REANCHOR(J)	BIT	Off	—	Flag indicating (ON) that the navigation state associated with the J <sup>th</sup> IMU is to be set equal to the selected navigation state
$\bar{I}$ MU_SFC_PREV	V	0	—	IMU selection filter command vector for the previous nav cycle
IN_CONE_FLAG	BIT	Off	—	Flag indicating (ON) that vehicle is in selected TACAN station's cone of confusion

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
INITIATE_PWR_FLIGHT_NAV_EVENT	BIT	Off	—	Flag indicating (ON) that the deorbit burn begins in TBD seconds
I_Z_CROSS_RELR	V	0	—	Temporary vector used in Angle-Partials
J	INT	1	—	Integer-subscript or iteration counter
K	INT	1	—	Integer-used in Pine's formulation
K_EDIT_BARO	INT	K-load	—	Scale factor on filter mean square residual used in residual edit test for baro measurement
K_EDIT_DRAG	INT	K-load	—	Scale factor on filter mean square residual used in residual edit test for drag measurement
K_EDIT_MLSAZ	INT	400	—	Scale factor on filter mean square residual used in residual edit test for MSBLS azimuth measurement
K_EDIT_MLSAZ_MAX	INT	K-load	—	Maximum value of K_EDIT_MLSAZ
K_EDIT_MLSAZ_MIN	INT	K-load	—	Minimum value of K_EDIT_MLSAZ
K_EDIT_MLSEL	INT	400	—	Scale factor on filter mean square residual used in residual edit test for MSBLS elevation measurement
K_EDIT_MLSEL_MAX	INT	K-load	—	Maximum value of K_EDIT_MLSEL
K_EDIT_MLSEL_MIN	INT	K-load	—	Minimum value of K_EDIT_MLSEL
K_EDIT_MLSR	INT	400	—	Scale factor on filter mean square residual used in residual edit test for MSBLS range measurement
K_EDIT_MLSR_MAX	INT	K-load	—	Maximum value of K_EDIT_MLSR
K_EDIT_MLSR_MIN	INT	K-load	—	Minimum value of K_EDIT_MLSR
K_EDIT_TACBR	INT	K-load	—	Scale factor on filter mean square residual used in residual edit test for TACAN bearing measurement
K_EDIT_TACR	INT	K-load	—	Scale factor on filter mean square residual used in residual edit test for TACAN range measurement
K_MAX	S	I-load	—	Maximum number of edits allowed a measurement before display of edit warning
K_RES_EDIT	S	0	—	Scale factor on filter mean square residual used in residual edit test
K_UND_WGT	S	I-load	—	Scale factor used in measurement under weighting equation
KN1	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes less than 400,000 feet
KN2	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes less than 400,000 feet

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
KN3	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes less than 400,000 feet
KN4	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes between 400,000 and 600,000 feet
KN5	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes between 400,000 and 600,000 feet
KN6	S	Constant	—	Constant used in expression for computing logarithm of Knudsen number for altitudes between 400,000 and 600,000 feet
L	INT	1	—	Integer used in Pine's formulation
LAYER	INT	0	—	Atmospheric layer label
LOG_10_KN	S	0	—	Logarithm of Knudsen number
M	M(3)	0	—	General transformation matrix
M_EFTOM50	M(3)	0	—	Earth-fixed-to-M50 coordinate transformation matrix
M_EFTORAD_EL	M(3)	0	—	Transformation matrix from earth-fixed to MSBLS elevation radar coordinates
M_EFTORAD_R_AZ	M(3)	0	—	Transformation matrix from earth-fixed to AZ/range MSBLS radar coordinate frame
M_EFTORW	M(3)	0	—	Earth-fixed to prime RW transformation matrix
M_EFTOTD_TACAN	M(3)	0	—	Copy of M_EFTOTD_TACAN_SL from site lookup
M_EFTOTD_TACAN_SL	M(3)	0	—	Transformation matrix from earth-fixed to topodetic coordinates at TACAN site obtained from site lookup
M_M50_TO_SCANNER	M(3)	0	—	Transformation matrix from M50 to MSBLS scanner coordinates
M_M50TOTD	M(3)	0	—	Transformation matrix from M50 to topodetic coordinates
M_SBODYM50	M(3)	0	—	Structural body-to-M50 coordinate transformation
M_TEMP	M(3)	0	—	Transformation matrix
MACH_JUMP	BIT	Off	—	Flag indicating (ON) that the Shuttle is in the MACH jump region
MANUAL_EDIT_OVERRIDE	BIT	Off	—	Flag indicating (ON) that the filter's residual edit test is to be overridden
MAX_TIME_TOL	S	K-load	—	Maximum delta time for which state vector prediction is done by STATE_VECTOR_PRED_TASK
MID_ELEM	S	0	—	Element selected by MID SELECT

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
MLS_AIF	CHAR	AUTO	—	Auto-inhibit-force command for MSBLS sensor selection
MLS_AIF_RCVD	CHAR	AUTO	—	Flag indicating which MLS_AIF command is in effect
MLS_AUTO_PROC_IND	BIT	OFF	—	Flag indicating (ON) that MLS data are being processed through MLS Auto command
MLS_AVAIL	BIT	Off	—	Flag output by site lookup subfunction indicating the availability of MSBLS data
MLS_COV_INIT	BIT	Off	—	Switch to initialize portions of the covariance matrix to zero when MSBLS first acquired
MLS_DROPOUT_DT_LIM	S	I-Load	—	Time limit for continuous dropout of MLS data prior to allowing switch over to GPS nav
MLS_EDIT_MUL_COUNT	INT	0	—	Counter indicating number of cycles that MSBLS meas. have been processed since the most recent selection
MLS_EDIT_OVERRIDE	BIT	OFF	—	Flag used (ON) to override MLS residual edit test
MLS_FORCE_PROC_IND	BIT	OFF	—	Flag indicating (ON) that MLS data are being processed through MLS FORCE command
MLS_MARK_NUM	INT	0	—	Counter indicating the number of times that MSBLS measurement was selected for filter processing
MLS_R_AZ_GOOD	BIT	Off	—	Switch which indicates when a good set of MSBLS range and azimuth data has been received
MLS_STAT	BIT	OFF	—	Flag indicating (ON) that MLS data are to be processed for statistical display only
MLSANT_ANG	S	K-load	—	Angle between navigation base-to-MSBLS antenna vector and positive vehicle X-body axis
MLSANT_NB_DIST	S	K-load	—	Distance from navigation base to MSBLS antenna
MLSAZ_DATA_GOOD	BIT	Off	—	Copy of current data-good discrete reserved for measurement processing
MLSEL_DATA_GOOD	BIT	Off	—	Copy of current data-good discrete reserved for measurement processing
MLSRANGE_DATA_GOOD	BIT	Off	—	Copy of current data-good discrete reserved for measurement processing
MM_CODE	INT	0	—	Major mode number (set by MSC for use by navigation)
MS_DELQ	S	0	—	Filter estimated mean squared measurement residual



Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
MS_POS_UND_WGT	S	I-load	—	Value of filter mean squared position error below which no measurement underweighting is used
MSBLS_EL_ANGLE_CUTOFF	S	I-load	—	Angle below which MSBLS elevation data not used to update state vector
MSBLS_EL_INHIBIT	D	Off	—	Flag indicating (ON) that MSBLS elevation data updates to the state vector have been terminated
N	INT	1	—	General indexing integer
N_SEQ_ALT	INT	0	—	Sequential counter, Nav altitude
N_SEQ_MAX	INT	K-load	—	Number of sequential failures of the Nav event lamp test criteria allowed before activating the Nav event lamp
N_SEQ_MLS	INT	0	—	Sequential counter, Nav MSBLS
N_SEQ_TAC	INT	1	—	Sequential counter, Nav TACAN
N1	INT	1	—	General indexing integer
NAUTMI_PER_FT	S	Constant	—	Number of nautical miles per foot
NAV_ALT_FLAG	BIT	Off	—	Nav edit altitude crew alert
NAV_EDIT_IND	BIT	Off	—	Nav edit flag
NAV_MLS_FLAG	BIT	Off	—	Nav edit MSBLS crew alert
NAV_TAC_FLAG	BIT	Off	—	Nav edit TACAN crew alert
NAV_THREE_STATE	BIT	Off	—	Flag indicating whether the mode of operation is single-state or three-state
NOISE	S	0	—	State process noise added to velocity diagonals of filter covariance matrix
NOISE_R	S	0	—	State process noise added to position diagonals of filter covariance matrix
NOISE_RV	S	0	—	State process noise added to off diagonals of position-velocity sub-matrix of filter covariance matrix
Ω	V(6)	0	—	Kalman filter gain vector
ONE_BRG_LOCK	BIT	Off	—	TACAN RM one LRU bearing lock-on requirement flag
ONE_RANGE_LOCK	BIT	Off	—	TACAN RM one LRU range lock-on requirement flag
OPS_3_INITIALIZE_COMPLETE	BIT	Off	—	Flag to enable scheduling of the user parameter state propagation principal function
OPS_3_RECONFIGURE	BIT	Off	—	Flag indicating (ON) that OPS-3 initialization is complete
OPS_TRANS_REQUEST	BIT	Off	—	Flag indicating OPS transition request
OTREQ	BIT	Off	—	OPS transition request flag passed to and returned from the precise predictor

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
PHI	M(6)	0	—	Transition matrix for covariance propagation
PI	S	Constant	—	The constant PI
PITCH_M	S	0	—	Copy of pitch angle reserved for MLS elevation processing
PRELAND_TRANSITION	BIT	Off	—	Flag indicating (ON) that transition to preland navigation principal function is complete
PROCESSING_MLS	BIT	OFF	—	Flag indicating (ON) that MLS data are being processed
Q	S	0	—	Measurement estimate
Q_AZMLS	S	0	—	MSBLS azimuth sensor measurement
Q_BARO	S	0	—	Barometric altimeter sensor measurement
Q_DRAG	S	0	—	Pseudodrag altitude generated sensor measurement
Q_ELMLS	S	0	—	MSBLS elevation sensor measurement
Q_M50_BODY	STR:S,V	0	M50	M50 body frame attitude quaternion
Q_ONE	S	0	—	Estimated for state one baro altimeter measurement
Q_RANGE	S	0	—	MSBLS range sensor measurement
Q_TAC_BRG	S	0	—	TACAN bearing sensor measurement
Q_TAC_R	S	0	—	TACAN range sensor measurement
Q_THREE	S	0	—	Estimated for state three baro altimeter measurement
Q_TWO	S	0	—	Estimated for state two baro altimeter measurement
$\bar{R}$	V	0	M50	General Shuttle position vector
R_AZ_COUNT	INT	0	—	Running count of number of consecutive MLS azimuth and range measurements failing data-good test
R_AZ_COUNT_MAX	S	K-load	—	Prescribed number of consecutive MLS range/azimuth measurement data-good 'fails' to force inhibit of MLS processing and allow TACAN processing
$\bar{R}_{AZMLS}$	V	0	—	Position vector of MLS azimuth scanner in M50 coordinates
$\bar{R}_{AZMLS\_EF}$	V	0	EF	Earth-fixed MLS azimuth scanner position vector
$\bar{R}_{COV\_LAST}$	V	0	M50	Updated vehicle position vector associated with current covariance matrix
$\bar{R}_{EF}$	V	0	EF	General position vector in earth-fixed coordinates
$\bar{R}_{ELMLS}$	V	0	M50	Position vector of MLS elevation scanner in M50 coordinates

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{R}_{ELMLS\_EF}$	V	0	EF	Earth-fixed MLS elevation scanner position vector
$\bar{R}_{FILT}$	V	0	M50	Filter current Shuttle position vector in M50 coordinates
$\bar{R}_{FILT\_INIT}$	V	OPS 2	M50	Shuttle position vector for OPS-3 initialization
$\bar{R}_{FILT\_ONE}$	V	0	M50	Current Shuttle position vector for three-state configuration, State 1
$\bar{R}_{FILT\_THREE}$	V	0	M50	Current Shuttle position vector for three-state configuration, State 3
$\bar{R}_{FILT\_TWO}$	V	0	M50	Current Shuttle position vector for three-state configuration, State 2
$\bar{R}_{FINAL}$	V	0	M50	Position vector propagation to current time
$\bar{R}_{GND}$	V	0	M50	Uplinked position vector for the whole vector update
$\bar{R}_{INIT}$	V	0	M50	Shuttle initial position vector input to predictor
R_INV	S	0	—	Inverse of the magnitude of the position vector
$\bar{R}_{MS\_ONE}$	V	0	M50	Vector used to represent a state for selection by VECTOR_SELECTION
$\bar{R}_{MS\_THREE}$	V	0	M50	Vector used to represent a state for selection by VECTOR_SELECTION
$\bar{R}_{MS\_TWO}$	V	0	M50	Vector used to represent a state for selection by VECTOR_SELECTION
$\bar{R}_{RESET}$	V	0	M50	Vehicle position vector after all navigation updates reserved for reset of guidance integrator position vector
$\bar{R}_{RESID}$	V	0	M50	Vehicle position vector used in measurement residual calculation after interpolation to time of measurement
$\bar{R}_{RESID\_ONE}$	V	—	M50	Interpolated position vector associated with the first state vector during three-state TACAN processing
$\bar{R}_{RESID\_TACAN}$	V	—	M50	General term denoting interpolated position vector during TACAN processing
$\bar{R}_{RESID\_THREE}$	V	—	M50	Interpolated position vector associated with the third state vector during three-state TACAN processing
$\bar{R}_{RESID\_TWO}$	V	—	M50	Interpolated position vector associated with the second state vector during three-state TACAN processing
R_RHO	S	0	—	Magnitude of general position vector R
$\bar{R}_{RMLS\_EF}$	V	0	EF	Earth-fixed position vector of MLS range scanner

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{R}$ _SCANNER	V	0	M50	General M50 position vector used in range residual calculations
$\bar{R}$ _SENSOR	V	0	M50	General sensor ground station position vector
$\bar{R}$ _TACAN_EF	V	—	EF	Copy of R_TACAN_EF_SL for TACAN station used by navigation filter
$\bar{R}$ _TACAN_EF_SL	V	—	EF	TACAN station earth-fixed position vector obtained from site lookup
$\bar{R}$ _TO_NAV	V	—	M50	Position vector output by STATE_VECTOR_PRED_TASK
RAD_PER_DEG	S	Constant	—	Conversion constant-radians per degree
REF_AREA	S	K-load	—	Orbiter reference area
$\bar{R}$ _REL_R	V	0	M50	Sensor from ground station to vehicle
RESID_TEST	S	0	—	General residual test variable
RHO	S	0	—	General range variable also, atmospheric density
RHO_ZERO	S	—	—	Copy of BASE_DEN for the selected layer
RNG	S	—	—	Range from the TACAN station to the vehicle
RNG_VAR_BEARING_STEP	S	K-load	—	Range criterion used to select TACAN bearing variance
RNG_VAR_RNG_STEP	S	K-load	—	Range criterion used to select TACAN range variance
RNP_TIME_UL	BIT	OFF	—	Flag indicating (ON) that RNP Matrix time parameters have been uplinked
RO_N	S	0	—	Variable used in Pine's formulation
RO_ZERO	S	0	—	Variable used in Pine's formulation
RV_MAG	S	0	—	Orbiter relative velocity magnitude
RV_MAX	S	I-load	—	Maximum relative velocity magnitude for baro processing
S	ARR (9)	Constant	—	Tesseral harmonic coefficients
S_AOA	BIT	Off	—	AOA abort flag
S2B	S	0	—	Sine of double the sideslip angle
SA	S	0	—	Sine of alpha
SB	S	0	—	Sine of beta
$\bar{S}$ SCALE_HT	V(12)	I-load	—	Array of scale heights for each layer to model drag
SEA_LEVEL_DENSITY	S	K-load	—	Sea level atmospheric density
SEL_LRU_ID	INT	0	—	Integer indicating which TACAN LRU (1, 2, or 3) is selected by RM for use by navigation filter for TACAN data processing
$\bar{S}$ ENSOR_DELQ	V(7)	0	—	Vector of measurement residual for display purposes

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{S}$ ENSOR_EDIT	V(7)	Off	—	Edit indicator for measurement types
$\bar{S}$ ENSOR_RESID_TEST	V(7)	0	—	Vector of residual edit test values for measurements to use for display
$\bar{S}$ IG	V(6)	0	—	General term for square root of diagonal elements of covariance matrix
SIG_DIAG_AOA	V(6)	I-load	UVW	Square root of diagonal elements for AOA covariance matrix initialization
$\bar{S}$ IG_DIAG_UPDATE	V(6)	K-load	UVW	Square root of diagonal elements for delta update covariance initialization
$\bar{S}$ IG_DIAG_UPDATE_M50	V(6)	K-load	UVW	Square root of diagonal elements for whole vector update covariance initialization
$\bar{S}$ IG_DIAG_UVW_INIT	V(6)	K-load	UVW	Square root of diagonal elements for covariance matrix initialization for normal end of mission and TAL
STAT_FLAG	BIT	Off	—	Switch indicating (ON) that only filter statistics are to be generated for display with no incorporation of measurement into the filter state
STATE_VECTOR_UPDATE	BIT	Off	—	Flag indicating (ON) that STATE_VECTOR PRED_TASK has completed execution
$\bar{S}$ UM	V(6)	0	—	Accumulated sum of post-residual edits
SV_TIME_TAG_DIFF	S	Constant	—	Accuracy with which an uplinked state vector is matched to current filter time
T	S	0	—	Time tag for Shuttle state vector
T_BARO	S	0	—	Time tag associated with barometric altimeter measurement
T_CURRENT_FILT	S	0	—	MTU or clock time when IMU was read
T_EF_AZMLS	S	0	—	Time at which MSBLS azimuth was read (adjusted)
T_EF_ELMLS	S	0	—	Time tag of current MSBLS elevation measurement
T_EF_RMLS	S	0	—	Time at which MSBLS range measurement was read
T_FILT_INIT	S	OPS 2/3	—	Time of current filter state vector and covariance matrix for OPS-3/ OPS-2 initialization
T_FINAL	S	0	—	End time of state vector prediction
T_GND	S	0	—	Time of uplinked state vector
T_INIT	S	0	—	Time tag of vector input to predictor
T_LAST_FILT	S	0	—	Time of the filter state vector
T_LAST_MLS_PROC	S	0	—	Time of last MLS measurement processing
T_RESET	S	0	—	Time associated with reserved reset state
T_SENSORS	S	0	—	General time tag of sensor data

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
T_TACAN	S	—	—	Time at which TACAN was read
T_TO_NAV	S	—	—	Time tag of output vector from STATE_VECTOR_PRED_TASK
TAC_BRG_DATA_GOOD	BIT	Off	—	Current data-good discrete for TACAN bearing measurement processing
TAC_CHAN_VALID	BIT	Off	—	Copy of TACAN_CHAN_VALID_SL for TACAN station used by navigation filter
TAC_CHAN_VALID_SL	BIT	Off	—	TACAN channel validity flag obtained from site lookup
TAC_RNG_DATA_GOOD	BIT	Off	—	Current data-good discrete for TACAN range measurement processing
TACAN_AIF	CHAR	Inhibit	—	AUTO-INHIBIT-FORCE switch for TACAN sensor selection
TACAN_BRG_CONVERG_TEST	S	K-load	—	Expected bearing variance criterion to turn on TACAN RM bearing one-lock flag
TACAN_EDIT_OVERRIDE	BIT	Off	—	Switch used to override TACAN residual edit test
$\bar{T}$ TACAN_ID	V	—	—	ID's of TACAN stations currently associated with the three LRU's
TACAN_ID_LAST	INT	0	—	ID of previously selected TACAN station
TACAN_MARK_NUM	INT	0	—	Counter indicating the number of times that TACAN measurement was selected for filter processing
TACAN_RNG_CONVERG_TEST	S	K-load	—	Expected range variance criterion to turn on TACAN RM range one-lock flag
TACAN_STAT	BIT	Off	—	Flag indicating TACAN data processed only for statistical display
THETA	S	0	—	Pitch angle from A/E ATT PROC
TIME_BIAS_BARO	S	K-load	—	Pad-loaded bias used to correct barometric time tag
TIME_BIAS_MLS	S	K-load	—	Pad-loaded bias used to correct MSBLS time tag
TIME_BIAS_TACAN	S	K-load	—	Pad-loaded bias used to correct TACAN time tag
$\bar{U}$ R	V	0	M50	Unit vector of $\bar{R}$ position vector
USE_IMU_DATA	BIT	Off	—	Flag indicating whether IMU data are to be used for propagation
$\bar{V}$	V	—	M50	General Shuttle velocity vector in M50 coordinates
$\bar{V}$ _CURRENT	V	0	M50	General variable for current IMU accumulated velocity
$\bar{V}$ _CURRENT_FILT	V	0	M50	Snap of IMU raw velocity counts reserved for measurement processing
$\bar{V}$ _CURRENT_FILT_ONE	V	0	M50	Current accumulated IMU-1 velocity counts reserved for measurement processing

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{V}$ _CURRENT_FILT_THREE	V	0	M50	Current accumulated IMU-3 velocity counts reserved for measurement processing
$\bar{V}$ _CURRENT_FILT_TWO	V	0	M50	Current accumulated IMU-2 velocity counts reserved for measurement processing
$\bar{V}$ _FILT	V	0	M50	Shuttle current velocity vector
$\bar{V}$ _FILT_INIT	V	OPS 2/OPS-3	M50	Shuttle velocity vector for OPS-2/OPS 3 initialization
$\bar{V}$ _FILT_ONE	V	0	M50	Shuttle velocity vector, State 1
$\bar{V}$ _FILT_THREE	V	0	M50	Shuttle velocity vector, State 3
$\bar{V}$ _FILT_TWO	V	0	M50	Shuttle velocity vector, State 2
$\bar{V}$ _FINAL	V	0	M50	Shuttle velocity vector predicted to T_FINAL
$\bar{V}$ _GND	V	0	M50	Uplinked velocity vector for whole vector update
$\bar{V}$ _IMU_RESET	V	0	M50	Copy of V_LAST_FILT reserved as velocity count at start of extrapolation interval when guidance integrator is reset
$\bar{V}$ _INIT	V	0	M50	Initial velocity vector input to predictor
$\bar{V}$ _LAST	V	0	M50	General variable for previous IMU accumulated velocity
$\bar{V}$ _LAST_FILT	V	0	M50	Previously read selected accumulated IMU velocity
$\bar{V}$ _LAST_FILT_ONE	V	0	M50	Previously read accumulated IMU-1 velocity
$\bar{V}$ _LAST_FILT_THREE	V	0	M50	Previously read accumulated IMU-3 velocity
$\bar{V}$ _LAST_FILT_TWO	V	0	M50	Previously read accumulated IMU-2 velocity
$\bar{V}$ _R	V	0	M50	Vehicle relative velocity vector
$\bar{V}$ _RESET	V	0	M50	Vehicle velocity vector after all navigation updates reserved for reset of guidance integrator velocity vector
$\bar{V}$ _RHO	V	0	M50	Vehicle relative velocity vector
$\bar{V}$ _RHO_BODY	V	0	Body	Vehicle relative velocity vector in body coordinates
$\bar{V}$ _TO_NAV	V	—	M50	Velocity vector output from STATE_VECTOR_PRED_TASK
VAR	S	0	—	General sensor variance
VAR_ACC_QUANT	S	K-load	—	Accelerometer quantization error variance
VAR_ACC_QUANT_COAST	S	K-load	—	Accelerometer quantization error variance during unpowered flight
VAR_ACC_QUANT_IMU	S	K-load	—	Accelerometer quantization variance during powered flight
VAR_AZMLS	S	K-load	—	MSBLS azimuth measurement instrument variance
VAR_DRAG	S	K-load	—	Drag altitude measurement error variance
VAR_ELMLS	S	K-load	—	MSBLS elevation instrument variance

Table 5.1-1. Navigation Variables for Entry Through Landing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
VAR_H1	S	0	—	Barometric altimeter instrument variance constant
VAR_H2	S	0	—	Barometric altimeter instrument variance constant
VAR_RMLS	S	K-load	—	MSBLS range measurement instrument variance
VAR_TAC_BRG_HIGH	S	K-load	—	TACAN bearing instrument variance at high range
VAR_TAC_BRG_LOW	S	K-load	—	TACAN bearing instrument variance at low range
VAR_TAC_R_HIGH	S	K-load	—	TACAN range instrument variance at high range
VAR_TAC_R_LOW	S	K-load	—	TACAN range instrument variance at low range
VAR_UNMOD_ACC_DT_COAST	S	K-load	—	Variance of unmodeled acceleration times scale time during unpowered flight
VAR_UNMOD_ACC_DT	S	0	—	Variance of unmodeled acceleration times scale time
VAR_UNMOD_ACC_DT_IMU	S	K-load	—	Variance of unmodeled acceleration times scale time during powered flight
VEH_MASS	S	0	—	Current vehicle mass
ZERO_DELTA_T_UPDATE	D	OFF	—	Flag indicating a zero delta time update was input using the Horizontal Situation Display
ZETA_IMAG	V(5)	0	—	Complex vector to account for effect of the Tesseral harmonics (imaginary portion)
ZETA_REAL	V(5)	0	—	Complex vector to account for effect of the Tesseral harmonics (real portion)
ZONAL	ARR(4)	Constant	—	Zonal harmonic coefficients
* ALT_BARO_CUTOFF is initialized with I-load name ALT_BARO_CUTOFF_LOW.				
* The DRAG_CONST is recomputed every time a major mass change occurs as described in Section 4.1.1.				



### 5.1A GPS Related Variables Names and Description

Provided in Table 5.1A-1 is a list of GPS related variables required for entry through landing navigation, user parameter processing, the GPS Receiver State Processing Principal Function, and the GPS Reference State Processing Principal Function.

The definitions that will aid in the interpreting of the tables are the same as those for Table 5.1-1, the entry through landing navigation variables. These variable lists are directly correlated with the flowcharts in Section 5.2.

The variables will be initialized at each OPS transition as defined in the tables, except for Major Function Base parameters which are indicated by an asterisk, \*.

Table 5.1A-1. GPS Related Variables				
Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{A}CC\_IMU(I)$	V	0	M50	Sensed acceleration from IMU assigned to GPS receiver I
ACC_THRESH_GPS_REF	S	I-load	–	Reference acceleration for GPS state propagation
$\bar{A}CCEL\_GPS$	V	0	M50	Acceleration vector over integration interval
$\bar{A}CC\_GPS\_UPP$	V	0	M50	Acceleration vector in M50 coordinates corresponding to the time interval between the current and previous IMU accumulated sensed velocity
$\bar{A}CC\_GPS\_UPP\_EF$	V	0	EF	Acceleration vector in M50 coordinates corresponding to the time interval between the current and previous IMU accumulated sensed velocity rotated to earth fixed coordinates
AIDING_DATA_VALID(I)	BIT	Off	–	Flag indicating (ON) the availability of valid aiding data for the I'th GPS receiver
ALT_SF	S	I-load	–	GPS selected state altitude downlist scale factor
ALT_WHEELS_NAV	S	600,000	–	Altitude of vehicle above the runway computed in UPP and snapped by navigation
ANG_SF	S	I-load	–	GPS selected state latitude and longitude downlist scale factor
ANGLE_CORR_TNTOMAG_AUTO	S	0	–	Variation of magnetic north from true north at the auto selected TACAN site
ATFL_OV	I	0	–	Attitude use flag from Orb/Rnd Nav
BL_METER	BIT	Off	–	Flag indicating (ON) metering of baseline navigation state
CLOCK/CLOCKTIME	S	0	–	GPC Clock Time (GMT)

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
COMPUTE_NAV_VALUES	Bit	Off	–	Flag controlling the computation of navigation derived range and bearing
$\bar{C}$ ORR_COEFF_GPS	V(7)	0	UVW	Correlation coefficients to initialize covariance matrix after resetting the baseline navigation state(s) to the selected GPS state
$\bar{C}$ ORR_COEFF_GPS_NOM	V(7)	I-load	–	Vector (7) of nominal values of the covariance matrix correlation coefficients to be used for reinitializing the navigation Kalman filter covariance at a GPS reset of the navigation filter state
CREW_DES_RCVR_RCVD(I)	BIT	Off, *	–	Navigation copy of crew deselect receiver command for the I'th GPS receiver. Setting of ON removes the state from the receiver as a candidate for GPS state vector selection
CREW_DESELECT_RCVR(I)	BIT	Off, *	–	Crew command (ON) to deselect the state from the I'th GPS receiver as a candidate for GPS state vector selection.
CREW_IMU_TO_GPS_ASSIGN(I)	I	0	–	Crew IMU assignment for the I'th GPS receiver
CREW_METERING_OVERRIDE	BIT	Off	–	Crew command (ON) to override software metering of the user parameter reset state
CREW_QA_OVERRIDE_RCVD(I)	BIT	Off	–	Crew command (ON) snapped by navigation to enable the GPS state from the I'th GPS receiver to be a candidate for selection independent of the results of its passing or failing the quality assessment checks, if no dilemma condition exists for that receiver
CREW_QA_OVRD_STATUS_IND(I)	BIT	Off	–	Indicator (ON) sent to display notifying crew that the quality assessment override command for the I'th GPS receiver was not in effect on this cycle because that receiver was either deselected by the crew or the navigation GPS data good flag for that receiver was OFF
DEG	I	–	–	Parameter specifying degree of gravity model to be used by ACCEL_GPS
DEG_PER_RAD	S	Const	–	Conversion factor from radians to degrees
$\bar{D}$ ELR	V	0	M50	Vector difference between GPS position estimate and Nav filter position
$\bar{D}$ ELR_GPS_QA2_UVW	V	0	UVW	Difference between GPS position and nav filter position in UVW coords

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\overline{\text{DELR\_GPS\_QA2\_UVW}}(\text{I})$	V	0	UVW	Difference between I'th GPS receiver position and nav filter position in UVW coordinates
$\overline{\text{DELR\_GPS\_QA2\_UVW\_SEL}}$	V	0	UVW	Position vector residuals of selected GPS state
$\text{DELR\_GPS\_SEL}$	S	0	-	Magnitude of the vector difference between the selected GPS position estimate and the nav filter position
$\text{DELR\_GPS\_SEL\_DL}$	I	0	-	Magnitude of the vector difference between the selected GPS position estimate and the nav filter position scaled for downlist
$\overline{\text{DELR\_GPS\_UVW}}$	V	-	UVW	GPS to filter position residuals in UVW
$\text{DELR\_MAG}$	S	0	-	Magnitude of vector difference between the procedure input GPS position estimate and the nav filter position
$\text{DELR\_MAG}(\text{I})$	S	0	-	Magnitude of vector difference between the position estimate from the I'th GPS receiver and the nav filter position
$\text{DELR\_RATIO}(\text{I})$	S	-	-	QA2 GPS-to-filter position vector residual ratio for the I'th GPS receiver
$\text{DELR\_RATIO\_GPS\_SEL}$	S	0	-	QA2 GPS-to-filter position vector residual ratio for selected GPS state
$\text{DELR\_RATIO\_GPS\_SEL\_DL}$	I	0	-	QA2 GPS-to-filter position vector residual ratio for selected GPS state scaled for downlist
$\text{DELR\_RATIO\_GPS\_SEL\_ST}$	CHAR	“↓”	-	QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state
$\text{DELR\_RATIO\_MAX}$	S	-	-	Maximum value of GPS position vector residual ratios
$\text{DELR\_RATIO\_MAX\_ST}$	CHAR	“X”	-	QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the GPS State input to the procedure
$\text{DELR\_RATIO\_QA2\_DISPLAY}(\text{I})$	S	0	-	QA2 GPS-to-filter position residual ratio for the I'th GPS receiver for display
$\text{DELR\_RATIO\_QA2\_DL}(\text{I})$	I	0	-	Scaled QA2 GPS-to-filter position residual ratio for the I'th GPS receiver for downlist
$\text{DELR\_RATIO\_QA2\_MAX}(\text{I})$	S	0	-	Maximum component-wise QA2 GPS-to-filter position residual ratio for the I'th GPS receiver
$\text{DELR\_RATIO\_QA2\_MAX\_ST}(\text{I})$	CHAR	↓	-	QA2 GPS-to-filter position vector residual ratio status indicator (down arrow for ratio greater than 1) for the I'th GPS receiver

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
DELR_RATIO_QA3_DISPLAY(I)	S	0	–	GPS QA3 position magnitude residual ratio for the I <sup>th</sup> receiver
DELR_RATIO_QA3_DL(I)	I	0	–	Scaled GPS QA3 position magnitude residual ratio for the I <sup>th</sup> GPS receiver for downlist
DELR_RATIO_QA4_1_2	S	0	–	QA4 pairwise compare position ratio between GPS receivers 1 and 2
DELR_RATIO_QA4_1_2_DL	I	0	–	Scaled QA4 pairwise compare position ratio between GPS receivers 1 and 2 for downlist
DELR_RATIO_QA4_1_3	S	0	–	QA4 pairwise compare position ratio between GPS receivers 1 and 3
DELR_RATIO_QA4_1_3_DL	I	0	–	Scaled QA4 pairwise compare position ratio between GPS receivers 1 and 3 for downlist
DELR_RATIO_QA4_2_3	S	0	–	QA4 pairwise compare position ratio between GPS receivers 2 and 3
DELR_RATIO_QA4_2_3_DL	I	0	–	Scaled QA4 pairwise compare position ratio between GPS receivers 2 and 3 for downlist
DELR_RATIO_SEL	S	0	–	Position vector residual ratios of selected GPS state
DELR_SV_SEL	S	0	–	GPS-to-filter residual for the selected GPS state
DELR_UVW_POS_SF	S	I-load	–	QA2 UVW position residuals downlist scale factor
DELTA_RATIO_IND	CHAR	–	–	Indicates whether position (P) or velocity (V) residual ratio is largest
DELTA_RATIO_MAX	S	–	–	Largest of position and velocity residual ratios
DELTA_RATIO_QA2_IND(I)	BIT	Off	–	Maximum GPS QA2 residual ratio indicator (position or velocity) for the I <sup>th</sup> GPS receiver
DELTA_RATIO_QA2_MAX(I)	S	0	–	Maximum component-wise GPS QA2 residual ratio (position or velocity) for the I <sup>th</sup> receiver
DELTA_RATIO_SV_SEL	S	0	–	Maximum GPS-to-filter residual ratio (position or velocity) for the selected GPS state
DELTA_RATIO_SV_SEL_STAT	CHAR	“P”	–	GPS-to-filter residual ratio status for the selected GPS state
DELTA_RATIO_SV_SEL_IND	BIT	Off	–	GPS-to-filter residual ratio indicator (“P” ON or “V” OFF) for the selected GPS state
$\overline{\text{DELV}}$	V	0	M50	Vector difference between GPS velocity estimate and Nav filter velocity

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{D}$ ELV_GPS_QA2_UVW	V	0	UVW	Difference between GPS velocity and nav filter velocity in UVW coords
$\bar{D}$ ELV_GPS_QA2_UVW(I)	V	0	UVW	Difference between the I'th GPS receiver velocity vector and NAV filter velocity vector in UVW coordinates
$\bar{D}$ ELV_GPS_QA2_UVW_SEL	V	-	UVW	Velocity vector residuals of selected GPS state
DELV_GPS_SEL	S	0	-	Magnitude of the vector difference between the selected GPS velocity estimate and the NAV filter velocity
DELV_GPS_SEL_DL	I	0	-	Magnitude of the vector difference between the selected GPS velocity estimate and the nav filter velocity scaled for downlist
$\bar{D}$ ELV_GPS_UVW	V	-	UVW	GPS to filter position residuals
DELV_MAG	S	0	-	Magnitude of the vector difference between the procedure input GPS velocity estimate and the NAV filter velocity
DELV_MAG(I)	S	0	-	Magnitude of the vector difference between the GPS velocity estimate from the I'th GPS receiver and the NAV filter velocity
DELV_RATIO(I)	S	-	-	QA2 GPS-to-filter velocity vector residual ratio for the I'th GPS receiver
DELV_RATIO_GPS_SEL	S	0	-	QA2 GPS-to-filter velocity vector ratio for selected GPS state
DELV_RATIO_GPS_SEL_DL	I	0	-	QA2 GPS-to-filter velocity vector residual ratio for selected GPS state scaled for downlist
DELV_RATIO_GPS_SEL_ST	CHAR	“ $\Downarrow$ ”	-	QA2 GPS-to-filter velocity vector residual ratio status indicator (down arrow for ratio greater than 1) for the selected GPS state
DELV_RATIO_MAX	S	-	-	Maximum value of GPS velocity vector residual ratios
DELV_RATIO_MAX_ST	CHAR	“ $\Downarrow$ ”	-	QA2 GPS-to-filter velocity vector ratio status indicator (down arrow for ratio greater than 1) for the GPS state input to the procedure
DELV_RATIO_QA2_DISPLAY(I)	S	0	-	QA2 GPS-to-filter velocity residual ratio for the I'th GPS receiver for display
DELV_RATIO_QA2_DL(I)	I	0	V	Scaled QA2 GPS-to-filter velocity residual ratio for the I'th GPS receiver for downlist
DELV_RATIO_QA2_MAX(I)	S	0	-	Maximum component-wise QA2 GPS-to-filter velocity residual ratio for the I'th GPS receiver

Table 5.1A-1. GPS Related Variables				
Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
DELV_RATIO_QA2_MAX_ST(I)	CHAR	∅	–	QA2 GPS-to-filter velocity vector residual ratio status indicator (down arrow for ratio greater than 1) for the I'th GPS receiver
DELV_RATIO_QA3_DISPLAY(I)	S	0	–	GPS QA3 velocity magnitude residual ratio for the I'th receiver
DELV_RATIO_QA3_DL(I)	I	0	–	Scaled GPS QA3 velocity magnitude residual ratio for the I'th GPS receiver for downlist
DELV_RATIO_QA4_1_2	S	0	–	QA4 pairwise compare velocity ratio between GPS receivers 1 and 2
DELV_RATIO_QA4_1_2_DL	I	0	–	Scaled QA4 pairwise compare velocity ratio between GPS receivers 1 and 2 for downlist
DELV_RATIO_QA4_1_3	S	0	–	QA4 pairwise compare velocity ratio between GPS receivers 1 and 3
DELV_RATIO_QA4_1_3_DL	I	0	–	Scaled QA4 pairwise compare velocity ratio between GPS receivers 1 and 3 for downlist
DELV_RATIO_QA4_2_3	S	0	–	QA4 pairwise compare velocity ratio between GPS receivers 2 and 3
DELV_RATIO_QA4_2_3_DL	I	0	–	Scaled QA4 pairwise compare velocity ratio between GPS receivers 2 and 3 for downlist
DELV_RATIO_SEL	S	0	–	Velocity vector residual ratios of selected GPS state
DELV_UVW_VEL_SF	S	I-load	–	QA2 UVW velocity residuals downlist scale factor
DIFF(1)	S	0	–	Mid value select magnitude of the difference between GPS receiver 2 and GPS receiver 3 position vectors
DIFF(2)	S	0	–	Mid value select magnitude of the difference between GPS receiver 1 and GPS receiver 3 position vectors
DIFF(3)	S	0	–	Mid value select magnitude of the difference between GPS receiver 1 and GPS receiver 2 position vectors
DRAGI	BIT	–	–	Flag indicating whether drag acceleration should be used by ONORBIT
DT	S	0	–	Delta between current state and reset state time tags
DT_ANNCD_RESET	S	I-load	–	Time interval between successive reference state reset cycles
DT_GPS_OFF	S	0	–	Time interval for which no GPS state has been a candidate for selection

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
DT_GPS_OFF_MIN	S	0	–	Minutes portion of the time since the last GPS state vector selection by the GPS state vector function
DT_GPS_UPP	S	0	–	Time interval for propagating the most recent GPS receiver states from the GPS SOP to the current time
DT_IMU	S	0	–	Difference between current and reference state time tags
DT_QA2	F	0	–	Time interval over which the QA2 tolerance limits are scaled
DT_QA2_DL	I	0	–	QA2 DT for downlist
DT_QA2_SF	S	I-load	–	Downlist scale factor for DT_QA2
DT_UDC	S	0	–	Time interval for propagating the selected GPS state in GPS UPP DISP COMPS to current time
$\bar{D}$ UMMY_GRAV	V	–	M50	Gravity acceleration vector returned from procedure which is not used in subsequent code
DUMMY_LAT	S	–	–	Unused latitude output from EF_TO_GEODETTIC routine
DUMMY_LON	S	–	–	Unused longitude output from EF_TO_GEODETTIC routine
$\bar{D}$ V	V	0	M50	Delta velocity
$\bar{D}$ V_GPS	V	0	M50	Delta velocity used in reference state processing
$\bar{D}$ V_PROP	V	0	M50	Delta velocity for use in propagating reference states to the desired time
FAIL_FOM_GAX_MSG_CNT(I)	I	1	–	Counter used to count the number of consecutive cycles that the I'th GPS receiver has failed the FOM check
FILT_RESTART_REQUEST(I)	BIT	Off	–	Flag set by GPS SOP indicating (ON) request for filter restart of the I'th GPS receiver
FILT_RESTART_REQUEST_RCVD(I)	BIT	Off	–	Flag snapped from GPS SOP indicating (ON) request for restart state for the I'th GPS receiver
FOM(I)	I	0	–	Figure of merit for the I'th GPS receiver
FOM_COV_SF_TABLE	F(2,9)	I-load	–	Table which is used to scale the I-load nav filter GPS reset position and velocity covariance values to reflect accuracy of the selected GPS state
FOM_NAV(I)	I	0	–	Figure of merit for the I'th GPS receiver used in GPS receiver state processing
FOM_SOP	I	0	–	Figure of merit for a given GPS receiver

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{G}_{AVE}$	V	0	M50	Average gravity vector from current and previous cycles
$\bar{G}_{FINAL}$	V	0	M50	Predicted Shuttle gravity vector
$\bar{G}_{GPS}$	V	0	M50	Gravity vector used in reference state propagation
$\bar{G}_{GPS\_INIT}$	V	0	M50	Gravity acceleration vector set by navigation for GPS receiver initialization/reanchor
$\bar{G}_{GPS\_SEL}$	V	0	M50	Gravity acceleration vector corresponding to the selected GPS state
$\bar{G}_{GPS\_UDC}$	V	0	M50	Gravity acceleration vector used in propagating the selected GPS state in GPS UPP DISP COMPS to current time
$\bar{G}_{GPS\_UPP}$	V	0	M50	Gravity acceleration vector for selected GPS state reserved for reset of GPS UPP DISP COMPS gravity acceleration vector
$\bar{G}_{OLD}$	V	0	M50	Vehicle gravity acceleration vector at start of integration interval
$\bar{G}_{SEL}$	V	0	M50	Intermediate gravity vector used in the user parameter reset function to set the user parameter reset state
$\bar{G}_{TEMP}$	V	0	M50	Temporary gravity acceleration vector
$\bar{G}_{TWO(I)}$	V	0	M50	Gravity acceleration vector for the I'th receiver at the current navigation cycle time
$\bar{G}_{TWO\_PREV(I)}$	V	0	M50	Gravity acceleration vector corresponding to the I'th GPS receiver state from the previous navigation cycle
GAX_OFF_ALERT_RMNDR_FLAG	BIT	Off	–	Flag (ON) used in the logic to reissue the GAX OFF ALERT message after an I-load period of time has elapsed, if the GAX OFF ALERT condition still exists at that time
GM_DEG_GPS	S	0	–	Degree of modeled gravity acceleration
GM_DEG_GPS_AID	I	K-load	–	Integer indicating degree of modeled gravity acceleration
GM_DEG_GPS_UPP	I	–	–	Parameter specifying degree of gravity model to be used by ACCEL_GPS for UPP update
GM_ORD_GPS	S	0	–	Order of modeled gravity acceleration
GM_ORD_GPS_AID	I	K-load	–	Integer indicating order of modeled gravity acceleration
GM_ORD_GPS_UPP	I	–	–	Parameter specifying order of gravity model to be used by ACCEL_GPS for UPP update



Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_AIF_EXEC	CHAR	Blank	–	Flag indicating if GPS AUTO/INHIBIT/FORCE executed
GPS_AIF_RCVD	I	1(INH)	–	Flag indicating which GPS AUTO/INHIBIT/FORCE is in effect
GPS_ALERT_DT	S	I-load	–	Time interval allowed without having usable GPS state vectors and a warning sent to the crew
GPS_ALT(I)	S	0	–	Altitude above runway in k feet derived from the I'th GPS receiver state estimate
GPS_ALT_ABOVE_REF_ELLIP	S	0	–	Altitude of a GPS state above reference ellipsoid
GPS_ALT_FOR_HIGH_RATE_NAV	F	I-Load	–	Altitude at which automatic GPS updates to navigation switch from low to high rate
GPS_ANNCD_RESET	BIT	Off	–	Flag indicating (ON) request for GPS announced resets and GPS reference state to be reanchored with navigation state
GPS_ANNCD_RESET_REF	BIT	Off	–	Flag indicating (ON) that the GPS Reference State was reanchored due to an announced reset being scheduled by GPS Receiver State Processing
GPS_ANNCD_RESET_SET(I)	BIT	Off	–	Flag indicating (ON) announced reset is commanded for the I'th GPS receiver
GPS_AZ(I)	S	0	–	Derived magnetic bearing to AUTO selected TACAN station from I'th GPS receiver state
GPS_BYPASS(I)	BIT	–	–	Flag indicating (ON) GPS receiver I is to be bypassed
GPS_CMD_RESET(I)	BIT	Off	–	Flag indicating (ON) a GPS command reset is required due to a GPS command time-out for the I'th receiver
GPS_COLLECTION_WORD	BIT(16)	Off	–	Data word containing downlist data
GPS_COLLECTION_WORD_TWO	BIT(16)	Off	–	Data word 2 containing downlist data
GPS_COLLECTION_WORD_THREE	BIT(16)	Off	–	Data collection word three containing downlist data
GPS_COLLECTION_WORD_FOUR	BIT(16)	Off	–	Data collection word four containing downlist data
GPS_COLLECTION_WORD_FIVE	BIT(16)	Off	–	Data collection word five containing downlist data
GPS_CYCLE_TIME	F	40.0	–	Minimum time between automatic GPS updates to navigation
GPS_DG(I)	BIT	Off	–	Flag indicating (ON) data good (power on with no communications fault, valid navigation data and receiver in NAV mode) for the I'th GPS receiver

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_DG_SF(I)	BIT	Off	–	Data good for GPS state selection indicating (ON) valid GPS state from I'th receiver (power on with no communications fault, valid navigation data, receiver in NAV mode and state data less than I-load specified staleness time limit)
GPS_DG_SF_PREV(I)	BIT	Off	–	Data good for GPS state selection indicating (ON) valid GPS state from I'th receiver (power on with no communications fault, valid navigation data, receiver in NAV mode and state data less than I-load specified staleness time limit) from previous navigation cycle
GPS_DG_SOP(I)	BIT	Off	–	GPS data good flag indicating power on with no communications fault, valid data and receiver in NAV mode for the I'th receiver
GPS_DILEMMA_ANNUN_GAX	BIT	Off	–	Flag to issue GPS message annunciation indicating a dilemma condition exists for one of the GPS receivers
GPS_DISP_DILEMMA(I)	BIT	Off	–	Flag indicating (ON) that a dilemma indicator (?) should be displayed next to the GPS receiver
GPS_FAIL_FOM_DISP(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed the Figure of Merit quality assessment check
GPS_FAIL_FOM(I)	BIT	Off	–	Flag indicating (ON) that I'th GPS receiver has failed the Figure of Merit quality assessment check
GPS_FAIL_FOM_GAX(I)	BIT	Off	–	Flag indicating (ON) that I'th GPS receiver has failed the Figure of Merit quality assessment check for an I-load number of consecutive cycles.
GPS_FAIL_FOM_GAX_MSG_CNT_MIN	I	I-load	–	Minimum number of consecutive cycles that a GPS receiver must fail the figure of merit (FOM) quality assessment check before setting the GPS fail FOM GAX flag for that receiver
GPS_FAIL_FOM_SOP	BIT	Off	–	FOM failure status of GPS receiver
GPS_FAIL_QA(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed any one of the four quality assessment checks on the current cycle

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_FAIL_QA_GAX(I)	BIT	Off	–	Flag to issue the GAX GPS quality assessment failure message for the I'th GPS receiver indicating that the receiver state has failed one or more of the three quality assessment checks
GPS_FAIL_QA2(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed the second quality assessment check (any position or velocity component difference of the GPS state minus the navigation filter state exceeds an I-load derived tolerance) on the current cycle
GPS_FAIL_QA2_R(I)	BIT	Off	–	Flag indicating (ON) that quality assessment 2 was failed in position for the I'th GPS receiver
GPS_FAIL_QA2_V(I)	BIT	Off	–	Flag indicating (ON) that quality assessment 2 was failed in velocity for the I'th GPS receiver
GPS_FAIL_QA3(I)	BIT	Off	–	Flag indicating (ON) that I'th GPS receiver has failed the third quality assessment check (the magnitude of either the position or velocity vector difference of the current GPS state minus its previous state propagated to current time exceeds an I-load derived tolerance) on the current cycle
GPS_FAIL_QA3_GAX(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed the third quality assessment check for more than an I-load number of consecutive cycles
GPS_FAIL_QA3_R(I)	BIT	Off	–	Flag indicating (ON) that quality assessment 3 was failed in position for the I'th GPS receiver
GPS_FAIL_QA3_V(I)	BIT	Off	–	Flag indication (ON) that quality assessment 3 was failed in velocity for the I'th GPS receiver
GPS_FAIL_QA4(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed the fourth quality assessment check (either the pairwise compare position or velocity vector magnitude difference between eligible receivers exceeds an I-load tolerance) on the current cycle
GPS_FAIL_QA4_GAX(I)	BIT	Off	–	Flag indicating (ON) that the I'th GPS receiver has failed the fourth quality assessment check for more than an I-load number of consecutive cycles

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_FAIL_QA4_R_1_2	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in position
GPS_FAIL_QA4_R_1_3	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in position
GPS_FAIL_QA4_R_2_3	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in position
GPS_FAIL_QA4_V_1_2	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 2 was failed in velocity
GPS_FAIL_QA4_V_1_3	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 1 and 3 was failed in velocity
GPS_FAIL_QA4_V_2_3	BIT	Off	–	Flag indicating (ON) that the quality assessment 4 pairwise compare between receivers 2 and 3 was failed in velocity
GPS_FILT_RESTART(I)	BIT	Off	–	Flag indicating (ON) that filter restart of the I'th GPS receiver is commanded
GPS_GAX_OFF_ALERT_RMNDR_DT	S	I-load	–	I-load period of time after the issuance of a GAX OFF ALERT message at which the GAX OFF ALERT message will be reissued if the GAX OFF ALERT condition still exists at that time
GPS_HSI_TIME_STALENESS_LIM	S	I-load	–	I-load time staleness limit used in setting HSI bearing data validity flag for a GPS receiver
GPS_IMU_VEL_THRESH	F	I-load	–	Minimum delta velocity magnitude needed to use IMU data for propagating current GPS state
GPS_INIT_REQUEST(I)	BIT	Off	–	Flag snapped from GPS SOP indicating (ON) request for initialization of the I'th GPS receiver
GPS_INIT_REQUEST_SOP(I)	BIT	Off	–	Flag set by GPS SOP indicating (ON) request for initialization of the I'th GPS receiver
GPS_INSTALLED(I)	BIT	I-load	–	BIT (ON) indicating that the I'th GPS receiver is installed on the vehicle
GPS_LOCKOUT	I	I-load	–	Parameter defining permissible GPS incorporation (A/I/F) for different memory configurations
GPS_MIN_ALT_MSG	S	I-load	–	I-loaded altitude below which GPS GAX messages will not be issued
GPS_MODE_CURRENT(I)	CHAR	blank	–	GPS I'th receiver operating mode flag from the GPS SOP

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_MODE(I)	CHAR	blank	–	Current operating mode of I'th GPS receiver
GPS_NAV_EDIT_ALT_GAX	BIT	I-load	–	Flag indicating (ON) that GAX GPS NAV edit message is to be issued due to vehicle going below I-load altitude with either no GPS state selected or GPS off alert condition existing
GPS_NAV_EDIT_GAX	BIT	Off	–	Flag indicating (ON) that GPS GAX NAV edit message is to be issued due to GPS ratio condition
GPS_NAV_SUBMODE(I)	CHAR	“ $\emptyset$ ”	–	Navigation submode indicator for I'th GPS receiver
GPS_NAV_SUBMODE_RCVD(I)	CHAR	blank	–	Current NAV submode indicator for I'th GPS receiver
GPS_OFF_ALERT	BIT	Off	–	Flag indicating the maximum delta time with unusable GPS state vectors has been exceeded
GPS_OFF_ALERT_GAX	BIT	Off	–	GPS GAX off alert indicator
$\overline{\text{GPS\_QA2\_RTOL\_MAX\_UVW}}$	V	I-load	UVW	Maximum I-load values of UVW position tolerances used in computation of QA2 position tolerance
GPS_QA2_RTOL_UVW	V	0	–	Used for calculating GPS to nav filter position residual ratios
$\overline{\text{GPS\_QA2\_RTOL\_UVW\_A}}$	V	I-load	UVW	I-load used in computation of QA2 position tolerance
$\overline{\text{GPS\_QA2\_RTOL\_UVW\_B}}$	V	I-load	UVW	I-load used in computation of QA2 position tolerance
$\overline{\text{GPS\_QA2\_RTOL\_UVW\_C}}$	V	I-load	UVW	I-load used in computation of QA2 position tolerance
GPS_QA2_RTOL_UVW_DL	I	0	–	QA2 RTOL UVW for downlist
$\overline{\text{GPS\_QA2\_RTOL\_UVW\_DL}}$	V	0	UVW	Scaled GPS_QA2_RTOL_UVW vector for downlist
$\overline{\text{GPS\_QA2\_VTOL\_MAX\_UVW}}$	V	I-load	UVW	Maximum I-load values of UVW velocity tolerances used in computation of QA2 velocity tolerance
$\overline{\text{GPS\_QA2\_VTOL\_UVW}}$	V	0	–	Used for calculating GPS to nav filter velocity residual ratios
$\overline{\text{GPS\_QA2\_VTOL\_UVW\_A}}$	V	I-load	UVW	I-load used in computation of QA2 velocity tolerance
$\overline{\text{GPS\_QA2\_VTOL\_UVW\_B}}$	V	I-load	UVW	I-load used in computation of QA2 velocity tolerance
$\overline{\text{GPS\_QA2\_VTOL\_UVW\_C}}$	V	I-load	UVW	I-load used in computation of QA2 velocity tolerance
GPS_QA2_VTOL_UVW_DL	I	–	–	QA2 VTOL UVW for downlist

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_QA2_VTOL_UVW_DL	V	0	UVW	Scaled GPS_QA2_VTOL_UVW vector for downlist
GPS_QA3_GAX_MSG_CNT_MIN	I	I-load	–	Minimum number of consecutive cycles that a GPS receiver must fail the third quality assessment (QA3) check before setting the GPS fail QA3 GAX flag for that receiver
GPS_QA3_RTOL	S	I-load	–	Position tolerance used in checking for a QA3 failure
GPS_QA3_VTOL	S	I-load	–	Velocity tolerance used in checking for a QA3 failure
GPS_QA4_DILEMMA(I)	BIT	Off	–	Flag indicating (ON) that a dilemma condition for the I'th GPS receiver exists on the current cycle as a result of the fourth quality assessment check
GPS_QA4_DILEMMA_GAX(I)	BIT	Off	–	Flag indicating (ON) that a dilemma condition exists for the I'th GPS receiver as a result of the fourth quality assessment check for an I-load number of consecutive cycles
GPS_QA4_DILEMMA_GAX_MSG_CNT_MIN	I	I-load	–	Minimum number of consecutive cycles that a dilemma condition must exist for a GPS receiver, as a result of the fourth quality assessment (QA4) check, before setting the GPS fail dilemma GAX flag for that receiver
GPS_QA4_GAX_MSG_CNT_MIN	I	I-load	–	Minimum number of consecutive cycles that a GPS receiver must fail the fourth quality assessment (QA4) check before setting the GPS fail QA4 GAX flag for that receiver
GPS_QA4_RTOL	S	I-load	–	Position tolerance used in checking for pairwise compare QA4 position failure
GPS_QA4_VTOL	S	I-load	–	Position tolerance used in checking for pairwise compare QA4 velocity failure
GPS_RATIO_FLAG	BIT	Off	–	Flag indicating (ON) that the selected GPS residual ratio exceeded its allowed limit
GPS_REF_INIT_VALID	BIT	On,*	–	Flag indicating (ON) that a valid orbiter state exists for setting receiver reference state in GPS reference state processing
GPS_REF_INIT_VALID_PREV	BIT	Off	–	Flag indicating (ON) that a valid orbiter state exists for setting receiver reference state, from previous GPS reference state processing cycle
GPS_RN_AZ_H_STAT	BIT	0	–	GPS UPP data status flag

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_RNG(I)	S	0	–	Derived range to AUTO selected TACAN station from the I <sup>th</sup> GPS receiver state estimate
GPS_SEL_AGE_MAX	S	I-load	–	Maximum allowable time since last update of selected GPS state with GPS receiver data
GPS_SEL_ALT	S	0	–	Altitude of selected GPS state above Fischer ellipsoid
GPS_SEL_ALT_DISP	S	0	–	Altitude of selected GPS state above Fischer ellipsoid for display to the crew
GPS_SEL_ALT_DL	I	0	–	Altitude of selected GPS state above Fischer ellipsoid buffered for downlist
$\overline{\text{GPS\_SEL\_DELR\_UVW}}$	V	0	UVW	Difference between selected GPS receiver position and NAV filter position in UVW coordinates for display
$\overline{\text{GPS\_SEL\_DELR\_UVW\_DL}}$	V	0	UVW	Scaled difference between selected GPS receiver position and NAV filter position in UVW coordinates for display
$\overline{\text{GPS\_SEL\_DELV\_UVW}}$	V	0	–	Difference between selected GPS receiver velocity and NAV filter velocity in UVW coordinates for display
$\overline{\text{GPS\_SEL\_DELV\_UVW\_DL}}$	V	0	UVW	Scaled difference between selected GPS receiver velocity and NAV filter velocity in UVW coordinates for display
GPS_SEL_LAT	S	0	–	Latitude of selected GPS state
GPS_SEL_LAT_DISP	S	0	–	Latitude of selected GPS state for display to the crew
GPS_SEL_LAT_DL	I	0	–	Latitude of selected GPS state buffered for downlist
GPS_SEL_LAT_IND	CHAR	N	–	Latitude indicator of selected GPS state (N or S)
GPS_SEL_LON	S	0	–	Longitude of selected GPS state
GPS_SEL_LON_DISP	S	0	–	Longitude of selected GPS state for display to the crew
GPS_SEL_LON_DL	I	0	–	Longitude of selected GPS state buffered for downlist
GPS_SEL_LON_IND	CHAR	E	–	Longitude indicator of selected GPS state (E or W)
GPS_SV_SEL_ALT_LIM_FP	BIT	On	–	First pass indicator for the GPS state vector selection altitude check
GPS_SV_SEL_ALT_LIMIT	S	I-load	–	I-load altitude below which the GAX GPS NAV edit message will be issued. If the vehicle altitude goes below this altitude with either no GPS state selected or GPS off alert condition existing

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
GPS_SV_SEL_AVAIL	BIT	Off	–	Flag indicating (ON) that a selected GPS state vector is available for use in resetting the baseline navigation state and/or for guidance
GPS_SW_CAP	I	K-load	–	Maximum number of GPS receivers for which software is designed
GPS_TO_GC_AIF	I	1(INH)	–	GPS AUTO/INHIBIT/FORCE flag from SOP
GPS_TO_NAV_AI	BIT	ON(INH)	–	GPS data to NAV AUTO/INHIBIT flag
GPS_TO_NAV_AIF	I	1(INH)	–	GPS AUTO/INHIBIT/FORCE command for GPS incorporation into navigation, formed from GPS_TO_NAV_AI and GPS_TO_NAV_FORCE commands
GPS_TO_NAV_FORCE	BIT	Off	–	Force command for GPS forced incorporation into navigation
GPS_TO_NAV_FORCE_RCVD	BIT	Off	–	A local copy of the force command for GPS forced incorporation into navigation
GPS_TO_NAV_RCVD	BIT	ON(INH)	–	A local copy of the AUTO/INHIBIT command for GPS incorporation into navigation
GPS_UPDATE_ALT_FLOOR	F	I-Load	–	Altitude below which automatic GPS updates to navigation are not allowed
GPS_UPP_DL(1)	S	0	–	Buffered GPS UPP range data for downlist
GPS_UPP_DL(2)	S	0	–	Buffered GPS UPP azimuth data for downlist
GPS_UPP_DL(3)	S	0	–	Buffered GPS UPP altitude data for downlist
GPS_UPP_TIME_STALENESS_LIM	S	I-load	–	I-load time staleness limit used in setting GPS UPP display computation GPS range, azimuth, altitude status indicator
GPS_UPP_UPDATE	BIT	Off	–	Flag indicating that current GPS receiver state processing is complete for GPS UPP display computation state parameter reset
GPS_VEL_REL_TO_RW(I)	S	0	–	Velocity relative to runway derived from the I <sup>th</sup> GPS receiver state estimate
I_DRAG	BIT	–	–	Flag indicating whether drag acceleration should be used by ACCEL for GPS State propagation
I_DRAG_GPS_REF	D	I-load	–	Drag flag for acceleration model
I_VENT	BIT	–	–	Flag indicating whether vent acceleration should be used by ACCEL for GPS State propagation
I_VENT_GPS_REF	D	I-load	–	Vent flag for acceleration model



Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
IDRAG_GPS	BIT	Off	–	Flag indicating whether drag acceleration should be used by ACCEL for GPS state propagation
IDRAG_UPP	BIT	Off	–	Flag indicating whether drag acceleration should be used by ACCEL for UPP update
IN_PROGRESS_CNT(I)	I	0	–	GPS command in progress counter for the I'th receiver
IN_PROGRESS_LIM	I	K-load	–	GPS command in progress count limit
INIT_STATE_SET(I)	BIT	Off	–	Flag indicating (ON) that initialization of the I'th GPS receiver is commanded
IVENT_GPS	BIT	Off	–	Flag indicating whether vent acceleration should be used by ACCEL for GPS state propagation
IVENT_UPP	BIT	Off	–	Flag indicating whether vent acceleration should be used by ACCEL for UPP update
J	I	–	–	Index variable
K	I	–	–	Index variable
M_EFTOTD_TACAN_AUTO	M(3)	Identity Matrix	–	Matrix transformation from earth fixed to topodetic coordinate frame
M_M50_TO_EF	M(3)	Identity Matrix	–	Transformation matrix from M50 to earth fixed coordinates
M_M50_TO_UVW	M(3)	0	–	Transformation from M50 coords to UVW coords
M_WGS_TO_M50	M	Identity Matrix	–	Matrix transformation between WGS84 and M50 coordinate frame
M_WGS84_TO_EF	M	I-load	–	Matrix transformation between WGS84 and shuttle earth fixed coordinate frame
MCU	S	0	UVW	Metering constraint value (ft) in U direction used for computing position metering gain
MCUD	S	0	UVW	Metering constraint value (ft/sec) in U direction used for computing velocity metering gain
MCV	S	0	UVW	Metering constraint value (ft) in V direction used for computing position metering gain
MCVD	S	0	UVW	Metering constraint value (ft/sec) in V direction used for computing velocity metering gain
MCW	S	0	UVW	Metering constraint value (ft) in W direction used for computing position metering gain
MCWD	S	0	UVW	Metering constraint value (ft/sec) in W direction used for computing velocity metering gain

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
METER_FLAG	BIT	Off	–	Flag indicating (ON) that the user parameter reset state is being metered
METER_SF	S	1	–	Metering gain (the maximum of either the position or velocity metering gains) applied to scale the M50 position and velocity changes to the user parameter reset state on the current cycle so that the metering constraints are not violated
METER_SF_DL	I	0	-	Metering gain applied to scale the user parameter reset state on the current cycle scaled for downlist
MID_R	V	0	M50	Mid value selected GPS position when three GPS states are candidates for selection
MID_V	V	0	M50	Mid value selected GPS velocity when three GPS states are candidates for selection
MM_CODE	I	0	–	Snapped major mode designation
MVS_RCVR_SEL	I	0	–	ID of selected GPS receiver
N_RATIOS_ABOVE_LIMIT	I	1	–	Counter used to count the number of consecutive cycles that the maximum QA2 residual ratio (either position or velocity) for the selected GPS state is greater than 1.0
N_RATIOS_ABOVE_LIMIT_MIN	I	I-load	–	Minimum number of consecutive cycles that the maximum QA2 residual ratio (either position or velocity) for the selected GPS state is greater than 1.0 before setting the GPS nav edit GAX flag
NAUTMI_PER_FT	F	Const	–	Conversion factor from feet to nautical miles
NAV_AZ	S	0	–	Navigation derived bearing to selected TACAN station
NAV_MM_CODE	I	0	–	Snapped major mode code
NAV_RESET	BIT	Off	–	Flag indicating (ON) that the navigation states have been reset with the selected GPS state
NAV_RNG	S	0	–	Navigation derived range to selected TACAN station
NOOP_GPS_GAX_MSGS	BIT	Off	–	Flag to inhibit GPS GAX messages
NUM_GPS_FOR_QA4	I	0	–	Integer indicating number of GPS receivers eligible for the fourth quality assessment check (QA4) on the current cycle
NUM_GPS_INSTALLED	I	0	–	Integer (0, 1 or 3) indicating the number of GPS receivers installed on the vehicle

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
NUM_GPS_SEL	I	0	–	Number of GPS receivers that are considered usable in the process of generating a selected GPS state
ORD	I	–	–	Parameter specifying order of gravity model to be used by ACCEL_GPS
PI	F	Const	–	The constant PI
POS_METER_SF	S	I	–	Position metering scale factor to be applied to the change in the user parameter reset state on the current cycle so that the metering constraints are not violated in UVW coordinates
QA_OVERRIDE(I)	BIT	Off	–	Crew command (ON) to enable the GPS state from the I'th GPS receiver to be a candidate for selection independent of the results of its passing or failing the quality assessment checks, if no dilemma condition exists for that receiver
QA2_DELV_RATIO_SF	F	I-load	–	QA2 velocity residual ratio downlist scale factor
QA2_DELR_RATIO_SF	F	I-load	–	QA2 position residual ratio downlist scale factor
QA2_RTOL_SF	S	I-load	–	QA2 RTOL downlist position scale factor
QA2_VTOL_SF	S	I-load	–	QA2 VTOL downlist velocity scale factor
QA3_BLANKING(I)	BIT	ON	–	Flag indicating (ON) quality assessment 3 data is to be blanked for the I'th GPS receiver
QA3_DELR_RATIO_SF	S	I-load	–	QA3 position residual ratio downlist scale factor
QA3_DELV_RATIO_SF	S	I-load	–	QA3 velocity residual ratio downlist scale factor
QA3_FAIL_GAX_MSG_CNT(I)	I	1	–	Counter used to count the number of consecutive cycles that the I'th GPS receiver has failed the third quality assessment check
QA4_DELR_RATIO_SF	S	I-load	–	Scale factor for scaling QA4 pairwise compare position ratios between GPS receivers
QA4_DELV_RATIO_SF	S	I-load	–	Scale factor for scaling QA4 pairwise compare velocity ratios between GPS receivers
QA4_DILEMMA_GAX_MSG_CNT(I)	I	1	–	Counter used to count the number of consecutive cycles that a dilemma condition has existed, as a result of the fourth quality assessment check, for the I'th GPS receiver

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
QA4_FAIL_GAX_MSG_CNT(I)	I	1	–	Counter used to count the number of consecutive cycles that the I <sup>th</sup> GPS receiver has failed the fourth quality assessment check
$\bar{R}_{DIFF}$	V	0	M50	Vector position difference in M50 coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{R}_{DIFF\_METERED}$	V	0	M50	Metered (scaled) vector position difference in M50 coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{R}_{DIFF\_UVW}$	V	0	UVW	Vector position difference in UVW coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{R}_{EF}$	V	0	Earth Fixed	Shuttle position vector in earth fixed coordinates
$\bar{R}_{GPS(I)}$	V	0	M50	Estimate of Shuttle position vector from the I <sup>th</sup> GPS receiver
$\bar{R}_{GPS\_ECEF}$	V	0	EF	GPS receiver estimate of Shuttle vector in earth-fixed coordinates
$\bar{R}_{GPS\_ECEF\_NEW(I)}$	V	0	WGS84	Most current estimate of Shuttle position vector in WGS84 coordinates from the I <sup>th</sup> GPS receiver, not necessarily bracketed by IMU selected accumulated sensed velocity
$\bar{R}_{GPS\_ECEF\_SOP}$	V	0	WGS84	Position vector of GPS data sent to GPS Receiver State Proc
$\bar{R}_{GPS\_ECEF\_SOP(I)}$	V	0	WGS84	Estimate of Shuttle position vector in WGS84 coordinates from the I <sup>th</sup> GPS receiver, bracketed by IMU selected accumulated sensed velocity
$\bar{R}_{GPS\_INIT}$	V	0	M50	Estimates of shuttle position for GPS reference state initialization/reanchor
$\bar{R}_{GPS\_PREV(I)}$	V	0	M50	Estimate of Shuttle position vector from the I <sup>th</sup> GPS receiver from previous navigation cycle
$\bar{R}_{GPS\_SEL}$	V	0	M50	Selected GPS position vector

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{R}_{GPS\_SEL\_DL}$	V	0	M50	Selected GPS position vector scaled for downlist
$\bar{R}_{GPS\_UDC}$	V	0	M50	Position vector of the selected GPS state in GPS UPP DISP COMPS
$\bar{R}_{GPS\_UPP}$	V	0	M50	Selected GPS position vector reserved for reset of GPS UPP display computations position vector
$\bar{R}_{OUT}$	V	-	M50	Position vector output from the GPS Super G integrator
$\bar{R}_{REF}$	V	0	M50	Estimates of shuttle position to be used in initializing GPS reference position
$\bar{R}_{REF\_INIT}$	V	0	M50	Estimates of shuttle position to be used in initializing GPS reference positions
$\bar{R}_{RESET\_PREV\_PROP}$	V	0	M50	User parameter reset position from previous cycle propagated to current cycle time in M50 coordinates
$\bar{R}_{RESET\_PREV\_PROP\_EF}$	V	0	EF	User parameter reset state from previous cycle propagated to current cycle time in earth fixed coordinates defined by vehicle position and earth relative velocity
$\bar{R}_{SEL}$	V	0	M50	Intermediate position vector used in user parameter reset function to set the user parameter reset state
$\bar{R}_{TACAN\_EF\_AUTO}$	V	0	EF	Auto selected TACAN station position vector
$\bar{R}_{TEMP}$	V	0	M50	Temporary M50 vehicle position vector
$\bar{R}_{VECT(I)}$	V	0	M50	I'th GPS receiver position vector used in mid value selection when three receiver states are candidates for selection
$\bar{R}_{VEH\_EF}$	V	0	EF	Copy of GPS receiver estimate of Shuttle position vector in earth-fixed coordinates
$\bar{R}_{VEH\_RW}$	V	0	RW	GPS receiver estimate of Shuttle position vector relative to runway in runway coordinates
$\bar{R}_{WRT\_STA\_EF}$	V	0	EF	GPS derived position of the vehicle relative to the selected TACAN station
$\bar{R}_{WRT\_STA\_TD}$	V	0	TD	GPS receiver estimate of Shuttle position vector relative to the AUTO selected TACAN station
$\bar{R}_{WRT\_STA\_TD(1)}$	S	0	TD	X-component of the GPS derived position of the vehicle relative to the AUTO selected TACAN station
$\bar{R}_{WRT\_STA\_TD(2)}$	S	0	TD	Y-component of the GPS derived position of the vehicle relative to the AUTO selected TACAN station

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
SCALEF	S	0	–	Scale factor used in GPS nav state propagator
SEL_CMD(I)	BIT	Off	–	Flag indicating (ON) that state from I'th GPS receiver is a candidate for GPS state vector selection
SEL_GPS_ALT	S	0	–	Vehicle altitude above the runway computed from the selected GPS state
SEL_GPS_AZ	S	0	–	Vehicle azimuth with respect to the runway threshold computed from the selected GPS state
SEL_GPS_RNG	S	0	–	Vehicle slant range with respect to the runway threshold computed from the selected GPS state
SEL_IND(I)	I	0	–	Integer value of SEL_CMD for the I'th GPS receiver used in computing selected GPS state and associated FOM when less than three receiver states are candidates for selection on the current navigation cycle
SEL_SITE_ID	CHAR	Blank	–	Runway name for the selected landing site
SF_POS	S	I-load	–	Shuttle reference position vector conversion scale factor for GPS and downlist formatting
SEL_RCVR(I)	BIT	Off	–	Flag indicating (ON) that state from the I'th GPS receiver has been selected on current navigation cycle to determine selected GPS state
SF_VEL	S	I-load	–	Shuttle reference velocity vector conversion scale factor for GPS and downlist formatting
$\bar{\text{SIG\_DIAG\_GPS}}$	V(6)	I-load	UVW	Square root of diagonal elements for GPS update covariance matrix
$\bar{\text{SIG\_DIAG\_GPS\_NOM}}$	V(6)	I-load	–	I-load values of the diagonal elements used in computing the GPS update covariance matrix
STATE_FOR_UPP_PREV	CHAR	Baseline	–	Character (baseline or GPS) indicating which state (baseline navigation or selected GPS state) was used on the last cycle to reset the user parameter propagator state
T	S	–	–	Time associated with state vector supplied to routine to compute acceleration vector
T_ANNCD_RESET	S	0	–	Time stamp of most recent GPS reference state reanchor/announced reset request
T_CURRENT	S	0	–	Current clock time

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
T_CURRENT_GPS_REF	S	0	–	Current clock time for GPS reference state propagation
T_GPS(I)	S	0	–	Time tag of I'th GPS receiver estimate of Shuttle state vector
T_GPS_CYCLE	S	I-load	–	I-load time between auto GPS updates (resetting) of the nav filter state in Entry navigation
T_GPS_CYCLE_FOR_HIGH_RATE_NAV	S	I-load	–	I-load time between auto GPS updates (resetting) of the nav filter state in Preland navigation
T_GPS_INIT	S	0	–	Time tags of the estimates of the shuttle state vector for GPS reference initialization/reanchor
T_GPS_LAST_UPDATE	S	*	–	Time of last GPS update (reset) of the Nav filter state
T_GPS_NEW(I)	S	0	–	Time of most current Shuttle state estimate in WGS84 coordinates from the I'th GPS receiver, not necessarily bracketed by IMU selected accumulated sensed velocity
T_GPS_OFF	S	0	–	Time stamp of most recent GPS state vector selection
T_GPS_PREV(I)	S	0	–	Time tag of the I'th GPS receiver state estimate from the previous cycle
T_GPS_SEL	S	0	–	Time tag for selected GPS state
T_GPS_SEL_DL	S	0	–	Time, associated with selected GPS state vector, buffered for downlist
T_GPS_SOP(I)	S	0	–	Time tag of the Shuttle state estimate from the I'th GPS receiver, bracketed by IMU selected accumulated sensed velocity
T_GPS_UDC	S	0	–	Time tag of the position vector of the selected GPS state in GPS UPP DISP COMPS
T_GPS_UPP	S	0	–	Time of the selected GPS state reserved for reset of GPS UPP display computations position vector
T_IMU	S	0	–	Time tag for IMU data
T_IMU_GPS_UPP	S	0	–	Time of IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity
T_IMU_GPS_UPP_PREV	S	0	–	Time of previous IMU accumulated sensed velocity used in GPS UPP display computations

Table 5.1A-1. GPS Related Variables				
Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
T_IMU_PREV	S	0	–	Time of accumulated sensed velocity from the previous GPS reference state processing cycle
T_IMU_SAVE_SOP(I)	S	0	–	Time tag of IMU data closest to the GPS receiver state time tag and earlier than the receiver state time tag for the I'th receiver from the GPS SOP
T_LAST	S	–	–	Time of the state vector supplied to the GPS Super G integrator
T_LAST_GPS(I)	S	0	–	Time tag of the IMU data closest to GPS receiver state time tag and earlier than the receiver state time tag for the I'th receiver, from the GPS SOP, snapped by NAV
T_REF_INIT	S	0	–	State time tag for GPS initialization reference state
T_REF(I)	S	0	–	Time of estimate of Shuttle position to be used in initializing GPS reference position for the I'th GPS receiver
T_SEL	S	0	–	Time of the intermediate state used in user parameter reset state
TAC_GPS_MODE	BIT	Off	–	Switch indicating “ON” when ABS_MODE is selected for HSD display and “OFF” when DELTA_MODE is selected
TAC_GPS_MODE_DISP	BIT	Off	–	Feedback switch indicating “ON” when ABS_MODE is selected for HSD display and “OFF” when DELTA_MODE is selected
TEMP	S	0	–	Temporary working variable
TIME_OFF_ALERT_ISSUED	S	0	–	Time at which the GPS OFF ALERT GAX message was issued
TIME_V	S	0	–	Time tag of accumulated IMU velocity counts
UA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of U direction position metering constraint below U direction position breakpoint altitude
UA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of U direction position metering constraint above U direction position breakpoint altitude



Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
UB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of U direction position metering constraint below U direction position breakpoint altitude
UB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of U direction position metering constraint above U direction position breakpoint altitude
UBKPOINT	S	I-load	UVW (EF vrel)	U direction position breakpoint altitude used in computation of U direction position metering constraint
UDA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of U direction velocity metering constraint below U direction velocity breakpoint altitude
UDA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of U direction velocity metering constraint above U direction velocity breakpoint altitude
UDB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of U direction velocity metering constraint below U direction velocity breakpoint altitude
UDB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of U direction velocity metering constraint above U direction velocity breakpoint altitude
UDBKPOINT	S	I-load	UVW (EF vrel)	U direction velocity breakpoint altitude used in computation of U direction velocity metering constraint
UDMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of U direction velocity metering constraint
UDMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of U direction velocity metering constraint
UMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of U direction position metering constraint
UMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of U direction position metering constraint

Table 5.1A-1. GPS Related Variables				
Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
UPDATE_LIMIT_U	S	1	UVW	Ratio of the absolute value of the U direction position change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft) in that direction
UPDATE_LIMIT_UDOT	S	1	UVW	Ratio of the absolute value of the U direction velocity change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft/sec) in that direction
UPDATE_LIMIT_V	S	1	UVW	Ratio of the absolute value of the V direction position change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft) in that direction
UPDATE_LIMIT_VDOT	S	1	UVW	Ratio of the absolute value of the V direction velocity change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft/sec) in that direction
UPDATE_LIMIT_W	S	1	UVW	Ratio of the absolute value of the W direction position change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft) in that direction
UPDATE_LIMIT_WDOT	S	1	UVW	Ratio of the absolute value of the W direction velocity change in the user parameter reset state (difference between the current reset state minus the previous reset state propagated to current time) to the metering constraint value (ft/sec) in that direction
UVW_TO_M50	M	Identity Matrix	–	Matrix transformation between UVW and M50 coordinate frames

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{V}_{DIFF}$	V	0	M50	Vector velocity difference in M50 coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{V}_{DIFF\_METERED}$	V	0	M50	Metered (scaled) vector velocity difference in M50 coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{V}_{DIFF\_UVW}$	V	0	UVW (EF vrel)	Vector velocity difference in UVW coordinates between the user parameter state from the previous cycle propagated to the current cycle and the current intermediate user parameter state (either baseline navigation or selected GPS state from crew command)
$\bar{V}_{FILT\_TEMP}$	V	0	-	Velocity vector used to determine the M50 to UVW transformation
$\bar{V}_{GPS\_ECEF}$	V	0	EF	GPS receiver estimate of Shuttle velocity vector in earth-fixed coordinates
$\bar{V}_{GPS\_ECEF\_NEW(I)}$	V	0	WGS84	Most current estimate of Shuttle velocity vector in WGS84 coordinates from the I <sup>th</sup> GPS receiver, not necessarily bracketed by IMU selected accumulated sensed velocity
$\bar{V}_{GPS\_ECEF\_SOP(I)}$	V	0	WGS84	Estimate of Shuttle velocity vector in WGS84 coordinates from GPS receiver I, bracketed by IMU selected accumulated sensed velocity
$\bar{V}_{GPS(I)}$	V	0	M50	Estimate of shuttle velocity vector from the I <sup>th</sup> GPS receiver
$\bar{V}_{GPS\_INIT}$	V	0	M50	Estimates of shuttle velocity for GPS reference state initialization/reanchor
$\bar{V}_{GPS\_PREV(I)}$	V	0	M50	Estimate of Shuttle velocity vector from the I <sup>th</sup> GPS receiver from the previous navigation cycle
$\bar{V}_{GPS\_SEL}$	V	0	M50	Selected GPS Velocity vector
$\bar{V}_{GPS\_SEL\_DL}$	V	0	M50	Selected GPS Velocity vector scaled for downlist
$\bar{V}_{GPS\_UDC}$	V	0	M50	Velocity vector of the selected GPS state in GPS UPP DISP COMPS

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{V}$ _GPS_UPP	V	0	M50	Selected GPS velocity vector reserved for reset of GPS UPP display computations position vector
$\bar{V}$ _IMU_GPS_IN	V	0	M50	Selected IMU velocity counts for the GPS reference state processor
$\bar{V}$ _IMU_GPS	V	0	M50	Selected IMU accumulated sensed velocity from last cycle of GPS reference state processing
$\bar{V}$ _IMU_GPS_INIT	V	0	M50	Initial selected IMU accumulated sensed velocity (IMU velocity counts) for GPS receiver initialization
$\bar{V}$ _IMU_GPS_UDC	V	0	M50	Selected IMU accumulated sensed velocity for selected GPS state in GPS UPP DISP COMPS
$\bar{V}$ _IMU_GPS_UPP	V	0	M50	IMU accumulated sensed velocity reserved for reset of GPS UPP display computations IMU accumulated sensed velocity
$\bar{V}$ _IMU_GPS_UPP_PREV	V	0	M50	Previously selected IMU accumulated sensed velocity used in extrapolating GPS receiver states to current time in GPS UPP DISP COMPS
$\bar{V}$ _IMU_M50	V	0	M50	Current selected IMU accumulated sensed velocity
$\bar{V}$ _IMU_SAVE_SOP(I)	V	0	M50	IMU counts closest to the GPS receiver state time tag and earlier than the receiver state time tag for the I'th receiver from the GPS SOP
$\bar{V}$ _LAST_GPS(I)	V	0	M50	IMU counts closest to the GPS receiver state time tag and earlier than the receiver state time tag for the I'th receiver, from the GPS SOP, snapped by NAV
$\bar{V}$ _LAST_GPS_SEL	V	0	M50	Selected GPS velocity vector from previous nav cycle
V_METER_MAX	S	I-load	UVW (EF vrel)	Maximum value of V direction position metering constraint
$\bar{V}$ _OUT	V	-	M50	Velocity vector output from the GPS Super G integrator
$\bar{V}$ _REF_INIT	V	0	M50	Estimates of shuttle velocity for initializing GPS reference velocities
$\bar{V}$ _REF	V	0	M50	Estimate of Shuttle velocity to be used in initializing GPS reference position
$\bar{V}$ _RESET_PREV_PROP	V	0	M50	User parameter reset velocity from previous cycle propagated to current cycle time in M50 coordinates

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
$\bar{V}_{SEL}$	V	0	M50	Intermediate velocity vector used in user parameter reset function to set the user parameter reset state
$\bar{V}_{TEMP}$	V	0	M50	Temporary M50 vehicle velocity vector
$\bar{V}_{VECT(I)}$	V	0	M50	I'th GPS receiver velocity vector used in mid value selection when three receiver states are candidates for selection
VA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of V direction position metering constraint below V direction position breakpoint altitude
VA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of V direction position metering constraint above V direction position breakpoint altitude
VB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of V direction position metering constraint below V direction position breakpoint altitude
VB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of V direction position metering constraint above V direction position breakpoint altitude
VBKPOINT	S	I-load	UVW (EF vrel)	V direction position breakpoint altitude used in computation of V direction position metering constraint
VDA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of V direction velocity metering constraint below V direction velocity breakpoint altitude
VDA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of V direction velocity metering constraint above V direction velocity breakpoint altitude
VDB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of V direction velocity metering constraint below V direction velocity breakpoint altitude
VDB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of V direction velocity metering constraint above V direction velocity breakpoint altitude

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
VDBKPOINT	S	I-load	UVW (EF vrel)	V direction position breakpoint altitude used in computation of V direction position metering constraint
VDMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of V direction velocity metering constraint
VDMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of V direction velocity metering constraint
VEL_METER_SF	S	1	-	Velocity metering scale factor to be applied to the change in the user parameter reset state on the current cycle so that the metering constrains are not violated in the UVW coordinates
VENTI	BIT	-	-	Flag indicating whether vent acceleration should be used by ACCEL
VENTI	D	-	-	Flag indicating whether vent acceleration should be used by ACCEL
VMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of V direction position metering constraint
VMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of V direction position metering constraint
WA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of W direction position metering constraint below W direction position breakpoint altitude
WA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of W direction position metering constraint above W direction position breakpoint altitude
WB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of W direction position metering constraint below W direction position breakpoint altitude
WB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of W direction position metering constraint above W direction position breakpoint altitude
WBKPOINT	S	I-load	UVW (EF vrel)	W direction position breakpoint altitude used in computation of W direction position metering constraint

Table 5.1A-1. GPS Related Variables

Variable Name	Data Type	Initial Value †	Coord Frame	Variable Description
WDA(1)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of W direction velocity metering constraint below W direction velocity breakpoint altitude
WDA(2)	S	I-load	UVW (EF vrel)	Slope of metering constraint versus altitude used in linear computation of W direction velocity metering constraint above W direction velocity breakpoint altitude
WDB(1)	S	I-load	UVW (EF vrel)	Constant used in linear computation of W direction velocity metering constraint below W direction velocity breakpoint altitude
WDB(2)	S	I-load	UVW (EF vrel)	Constant used in linear computation of W direction velocity metering constraint above W direction velocity breakpoint altitude
WDBKPOINT	S	I-load	UVW (EF vrel)	W direction position breakpoint altitude used in computation of W direction position metering constraint
WDMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of W direction velocity metering constraint
WDMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of W direction velocity metering constraint
WMETER_MAX	S	I-load	UVW (EF vrel)	Maximum value of W direction velocity metering constraint
WMETER_MIN	S	I-load	UVW (EF vrel)	Minimum value of W direction velocity metering constraint

† Initial Value at OPS Transition unless indicated otherwise

\* Major Function Base parameter

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## **5.2 NAVIGATION SEQUENCER PRINCIPAL FUNCTION AND NAVIGATION PRINCIPAL FUNCTIONS FLOW CHARTS**

The material provided in this section consists of suggested flow charts for the navigation sequencer principal function and basic navigation principal function (Figures 5.2-1 through 5.2-43). Excluded are area navigation and user parameter processor. Note that these flow charts directly correlate to the variable list in Section 5.1.

DEORBIT/LANDING\_NAV\_SEQUENCER

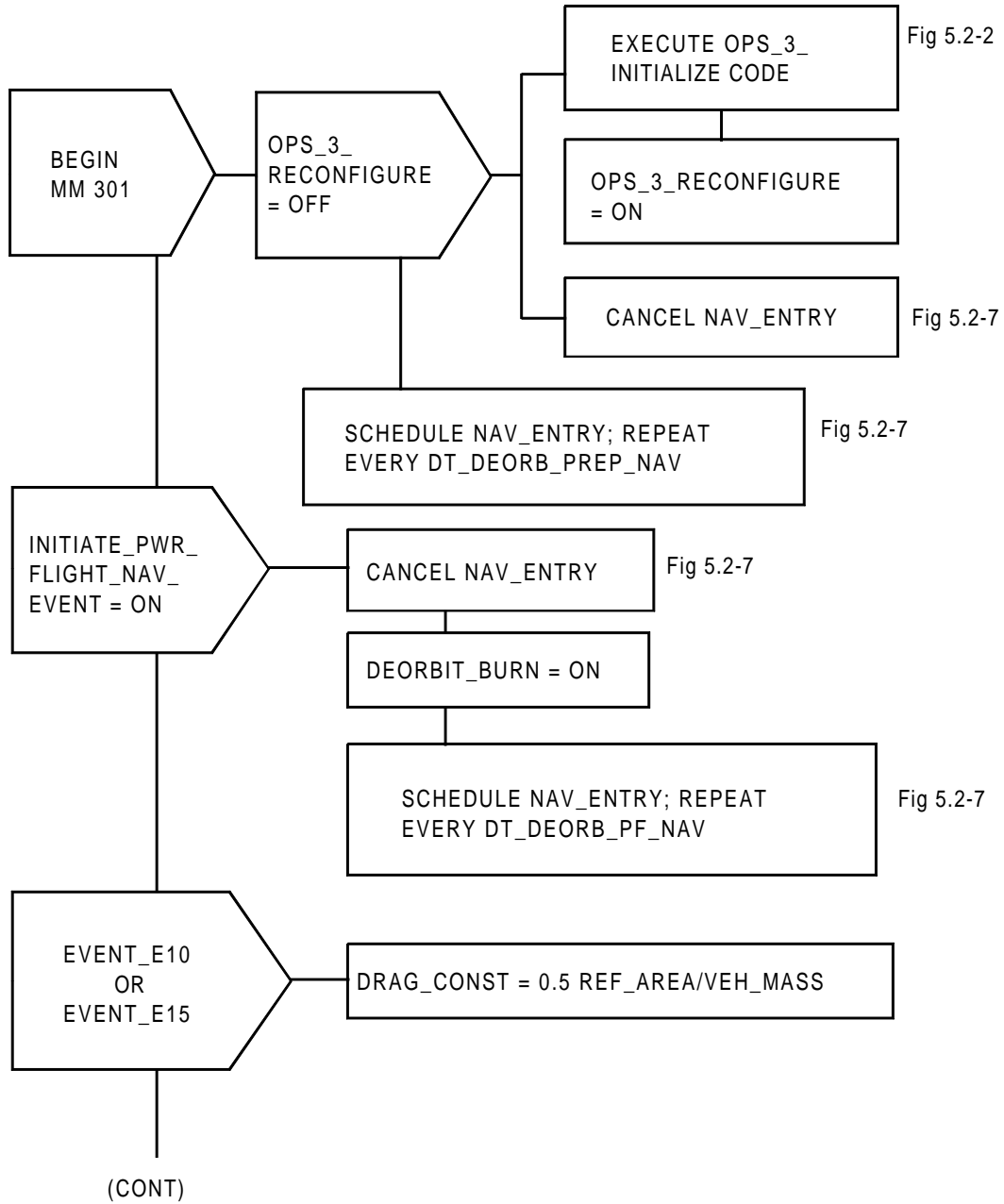


FIGURE 5.2-1.(1) DEORBIT/LANDING\_NAV\_SEQUENCER (Sheet 1 of 2)

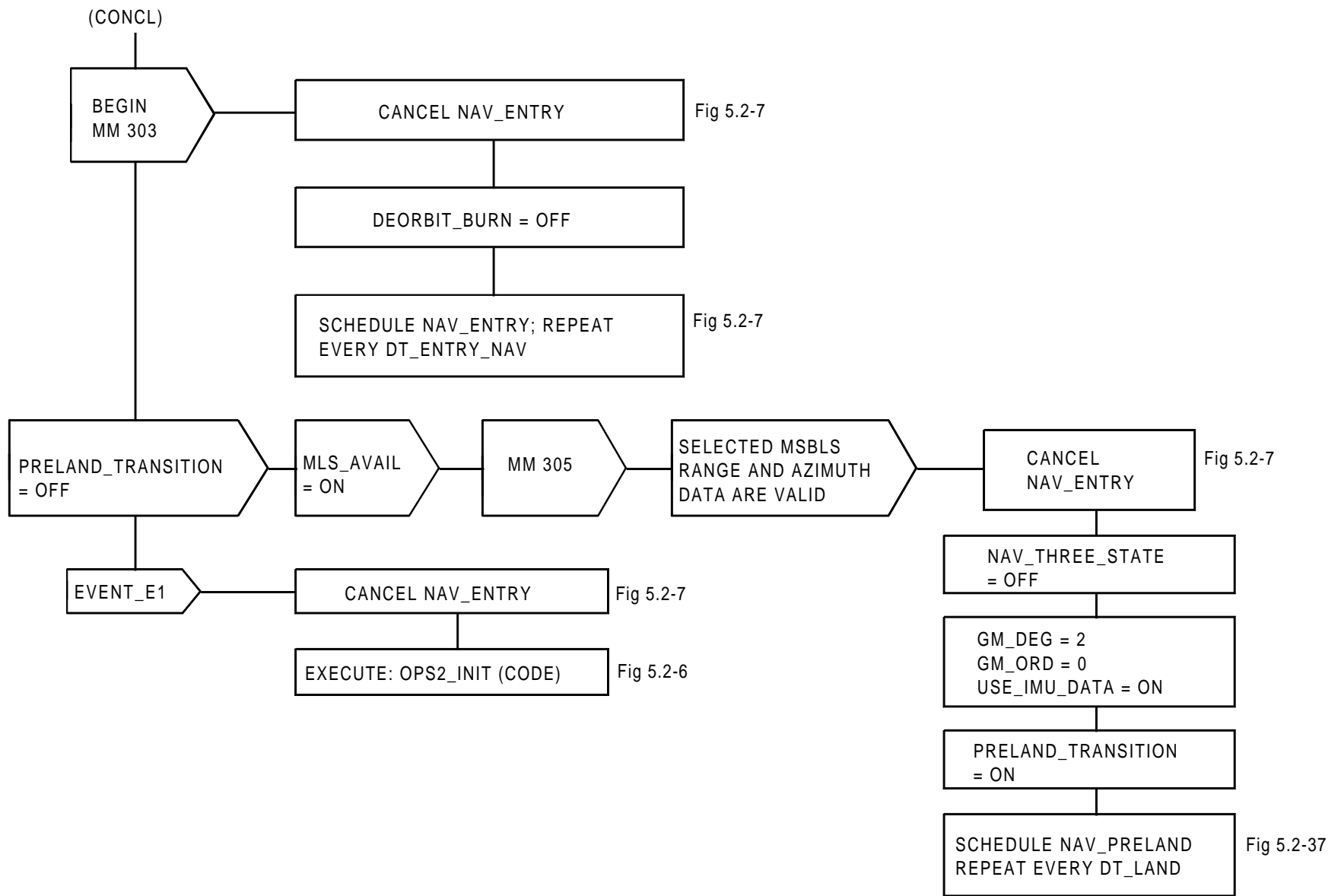


FIGURE 5.2-1.(2) DEORBIT/LANDING\_NAV\_SEQUENCER (Sheet 2 of 2)

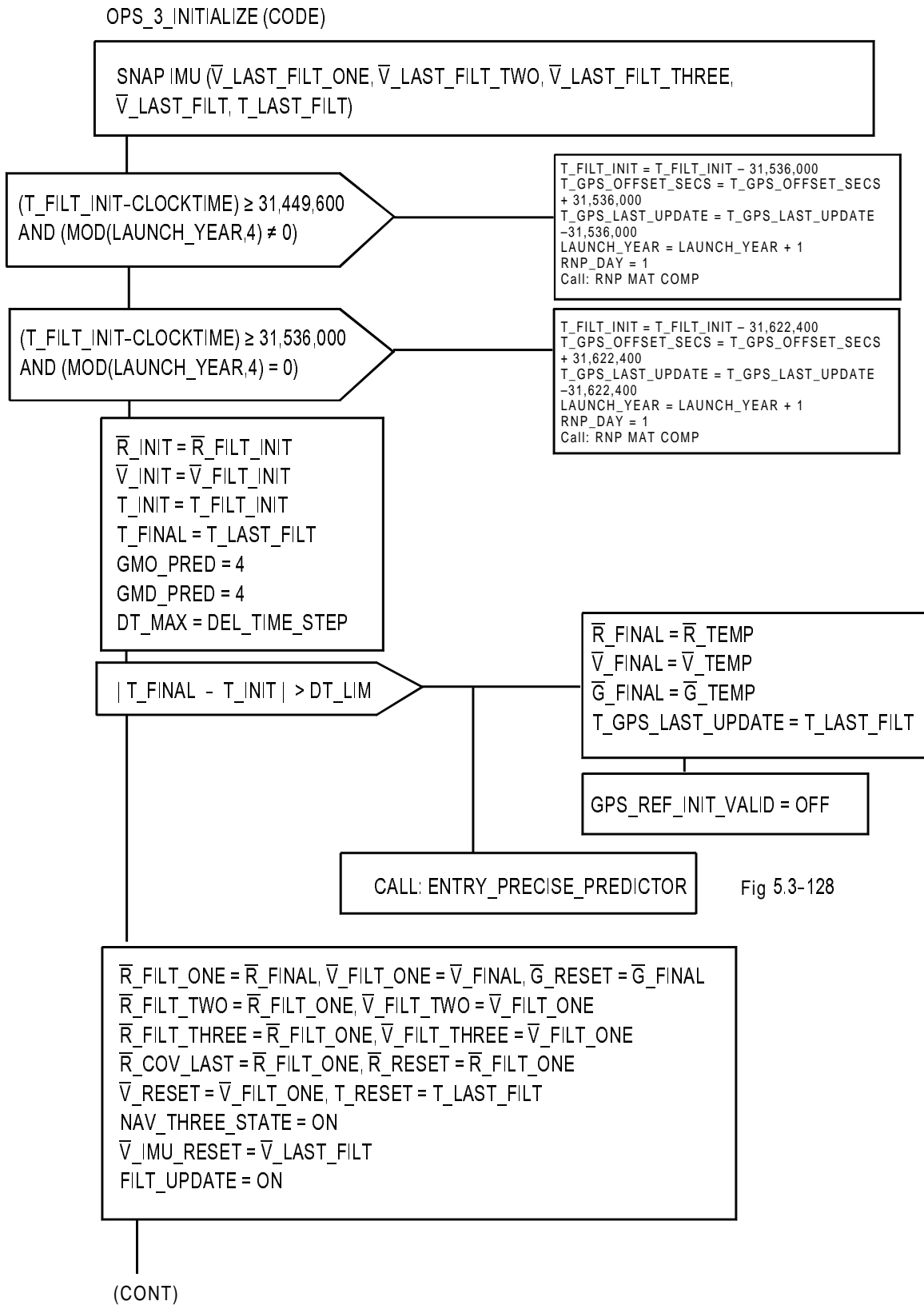


Fig 5.3-128

FIGURE 5.2-2.(1) OPS\_3\_INITIALIZE (CODE) (Sheet 1 of 2)

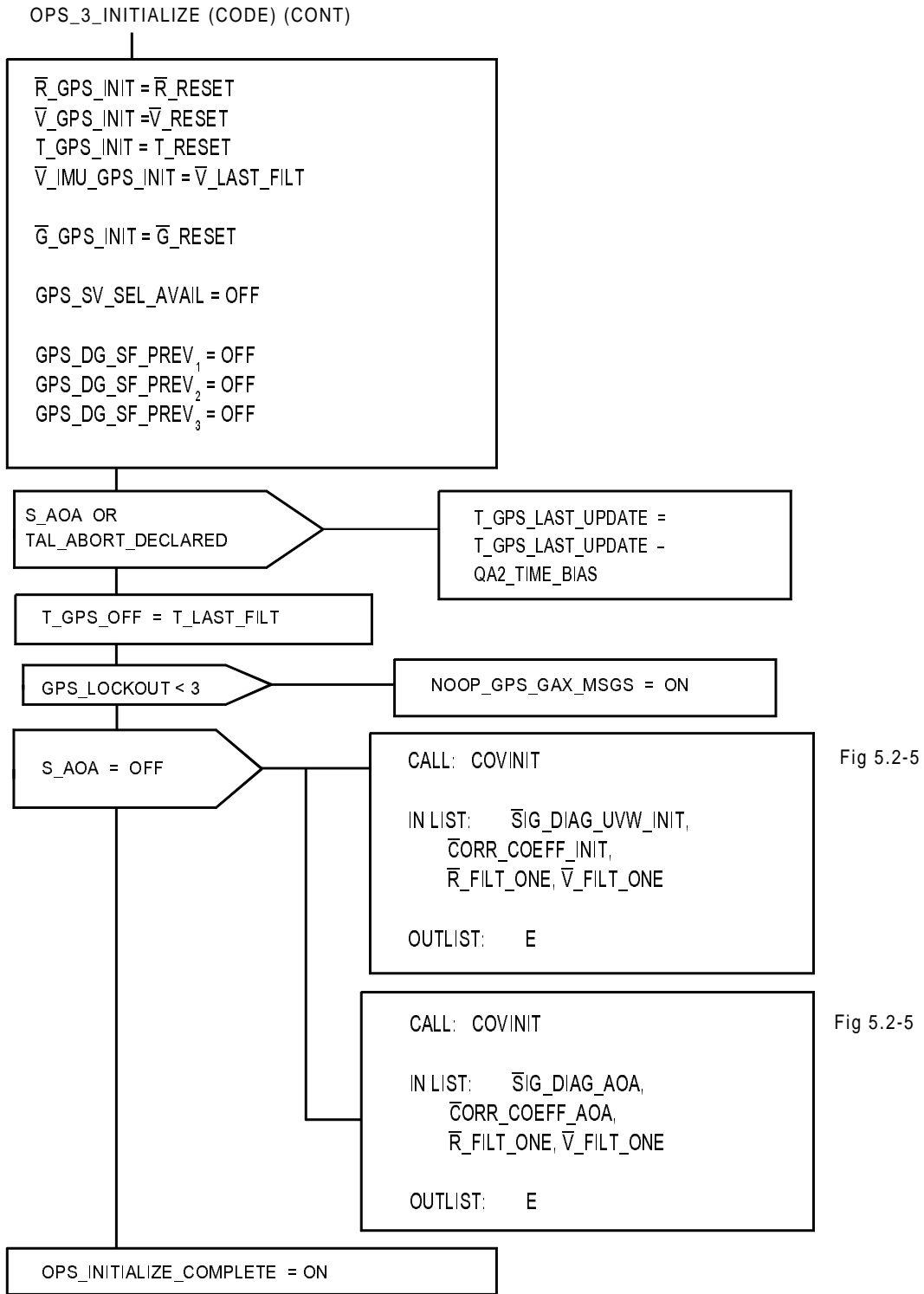


FIGURE 5.2-2.(2) OPS\_3\_INITIALIZE (Code) (Sheet 2 of 2)

VECTOR\_SELECTION

IN LIST:  $\bar{R}_{MS\_ONE}$ ,  $\bar{R}_{MS\_TWO}$ ,  $\bar{R}_{MS\_THREE}$

OUT LIST:  $\bar{R}$

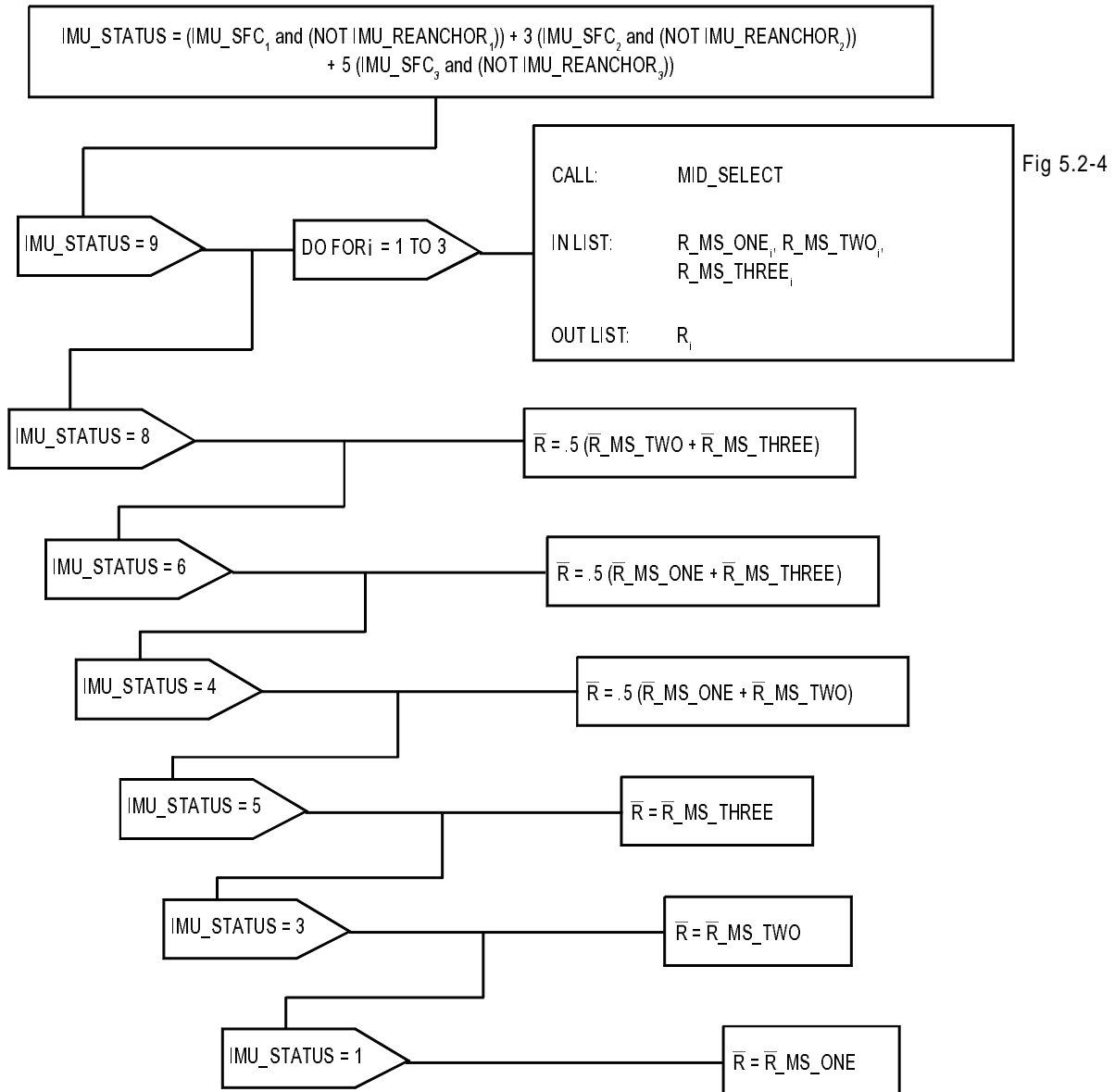


FIGURE 5.2-3. VECTOR\_SELECTION

MID\_SELECT

IN LIST : ELEM1, ELEM2, ELEM3

OUT LIST : MID\_ELEM

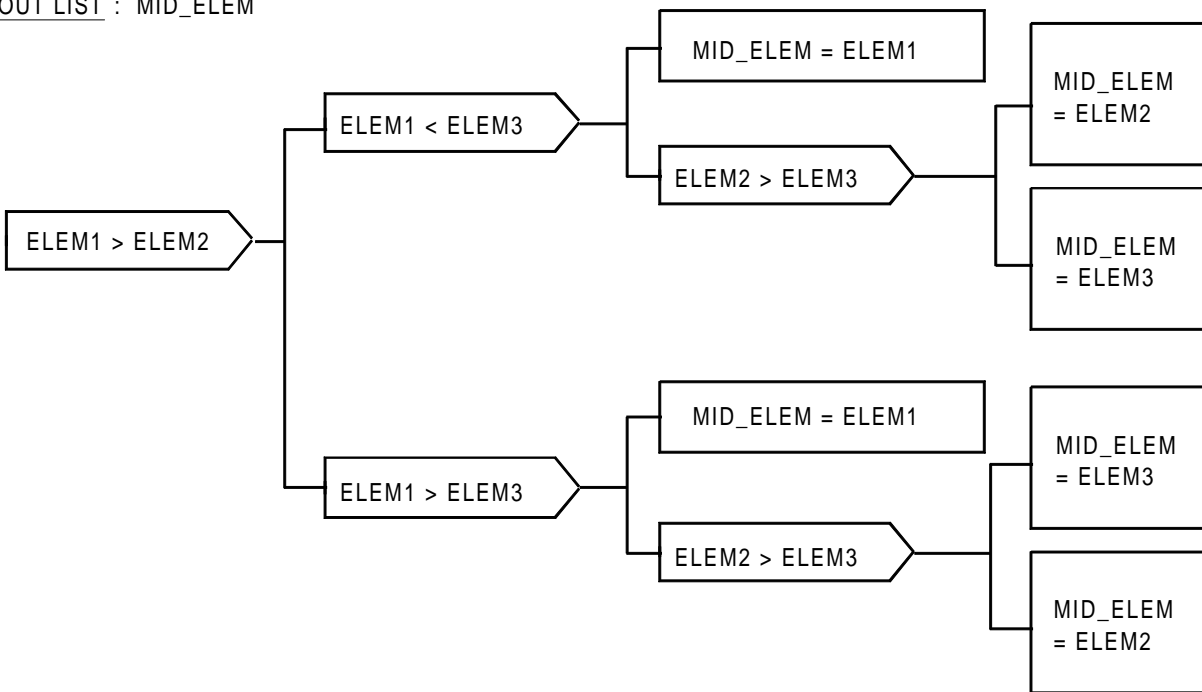


FIGURE 5.2-4. MID\_SELECT

COVINIT

IN LIST: SIG, COR, R, V

OUT LIST: E\_TEMP

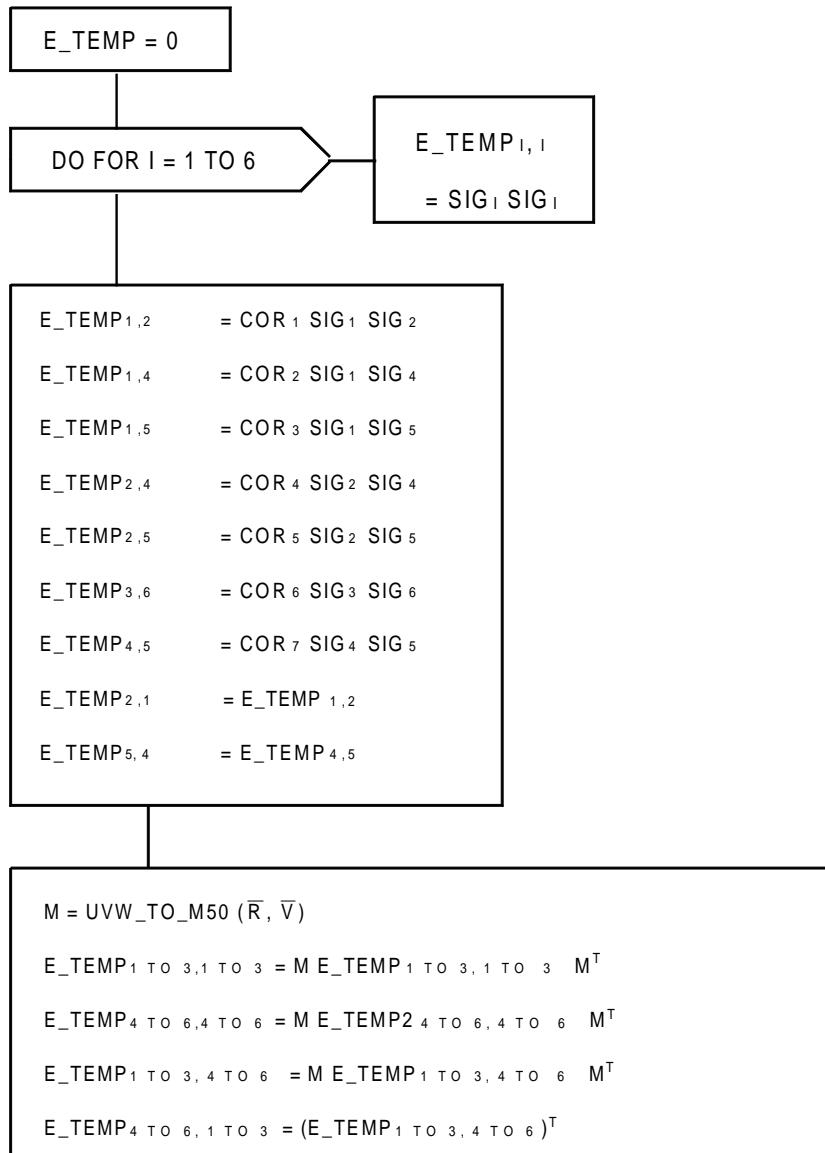


Fig 5.3-20

FIGURE 5.2-5. COVINIT



OPS2\_INIT (CODE)

$\bar{R}$ \_FILT\_INIT =  $\bar{R}$ \_FILT  
 $\bar{V}$ \_FILT\_INIT =  $\bar{V}$ \_FILT  
T\_FILT\_INIT = T\_LAST\_FILT

CALL: COV\_INIT\_UVW\_INVERSE  
IN LIST: E, R\_FILT\_INIT, V\_FILT\_INIT  
OUT LIST:  $\bar{S}$ IG\_DIAG\_UVW\_INIT,  
CORR\_COEF\_INIT

Fig 5.2-6A

FIGURE 5.2-6. OPS2\_INIT (CODE)

COV\_INIT\_UVW\_INVERSE  
 IN LIST: E\_TEMP, R, V  
 OUT LIST: SIG, COR

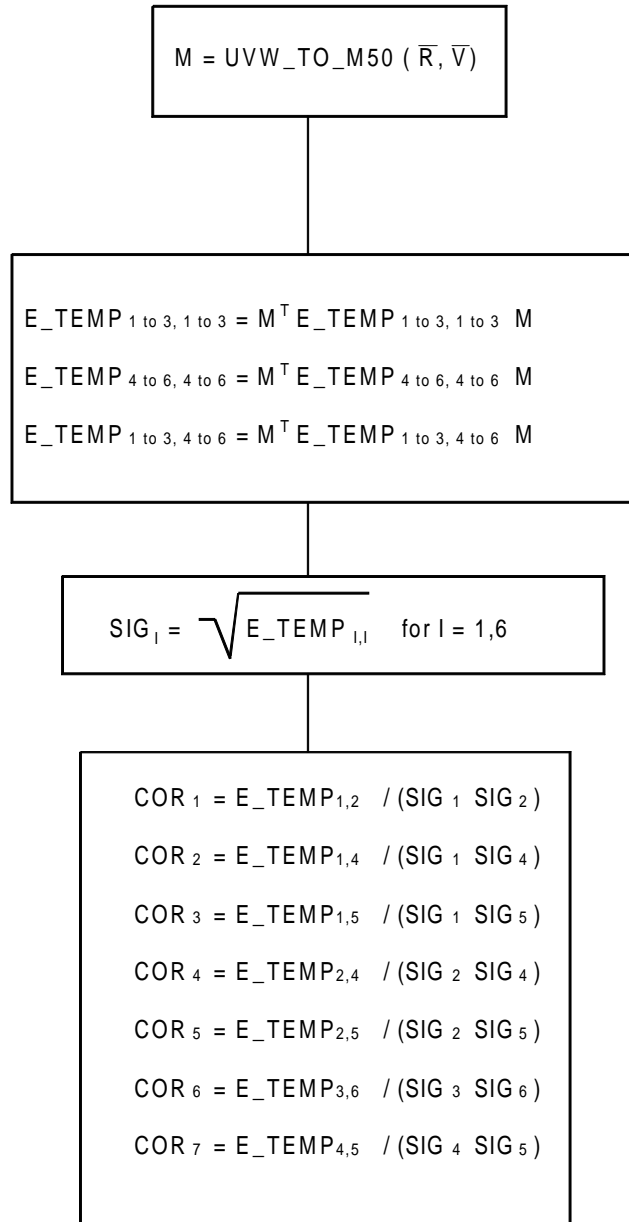


FIGURE 5.2-6A. COV\_INIT\_UVW\_INVERSE

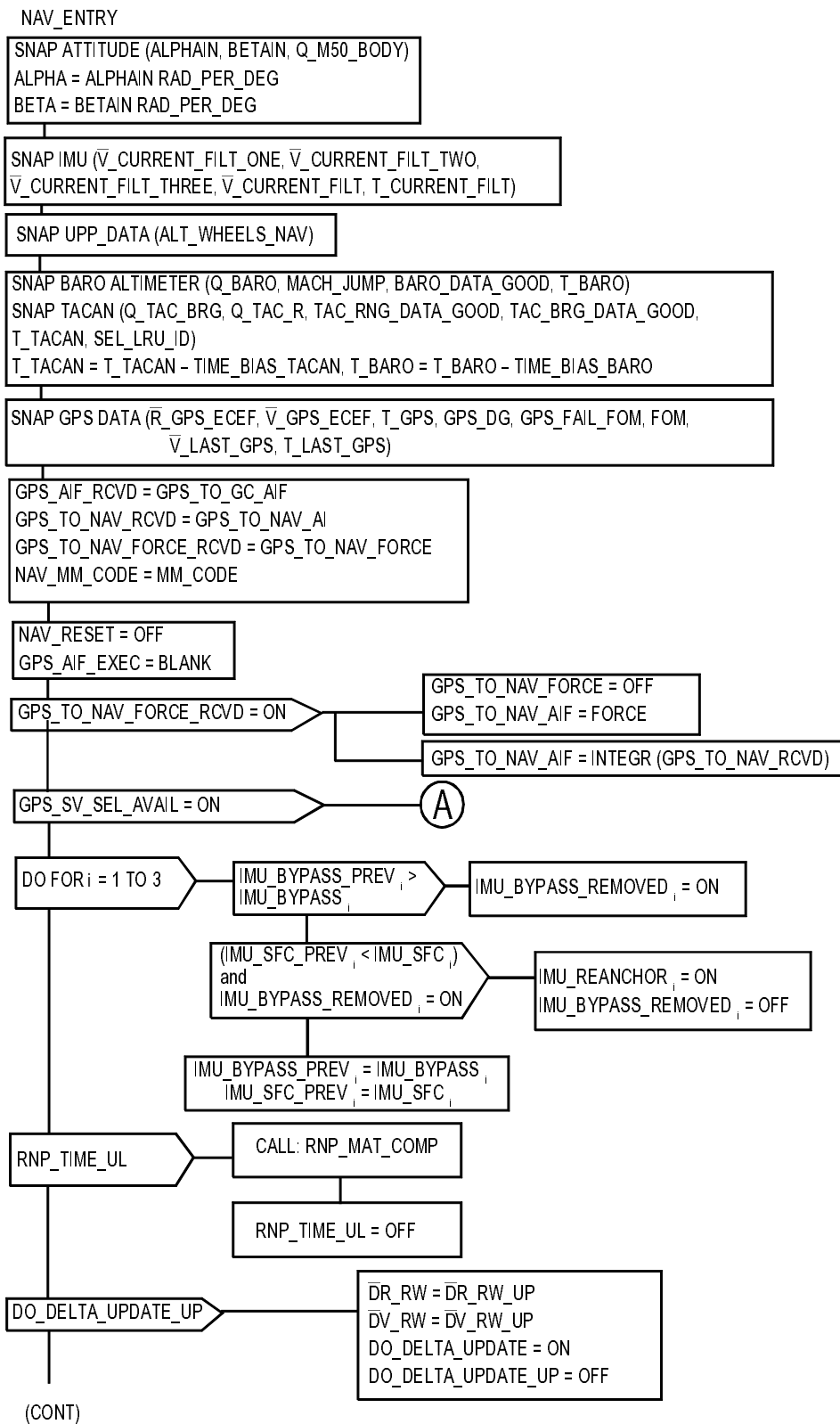


FIGURE 5.2-7.(1) NAV\_ENTRY (Sheet 1 of 4)

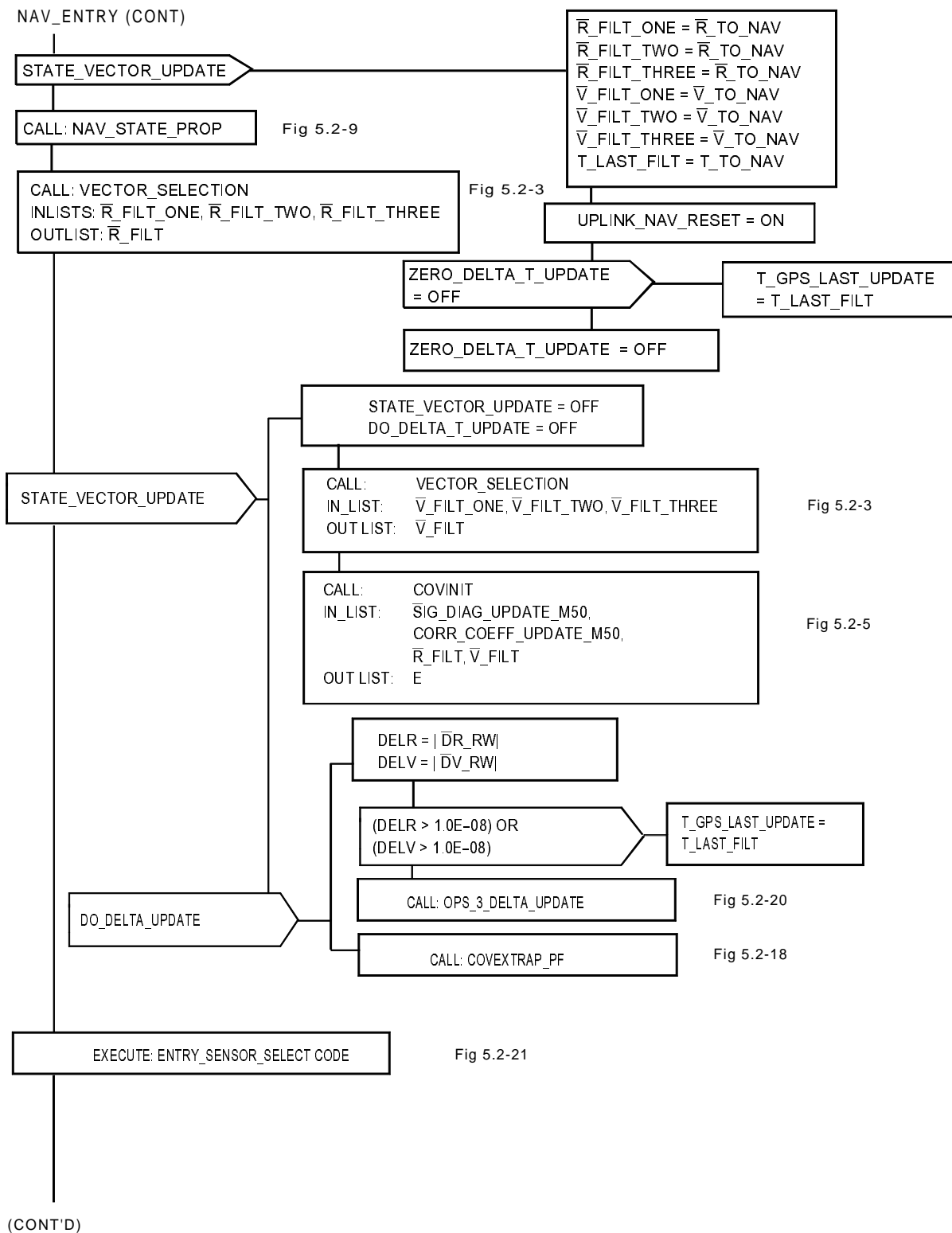


FIGURE 5.2-7.(2) NAV\_ENTRY (Sheet 2 of 4)

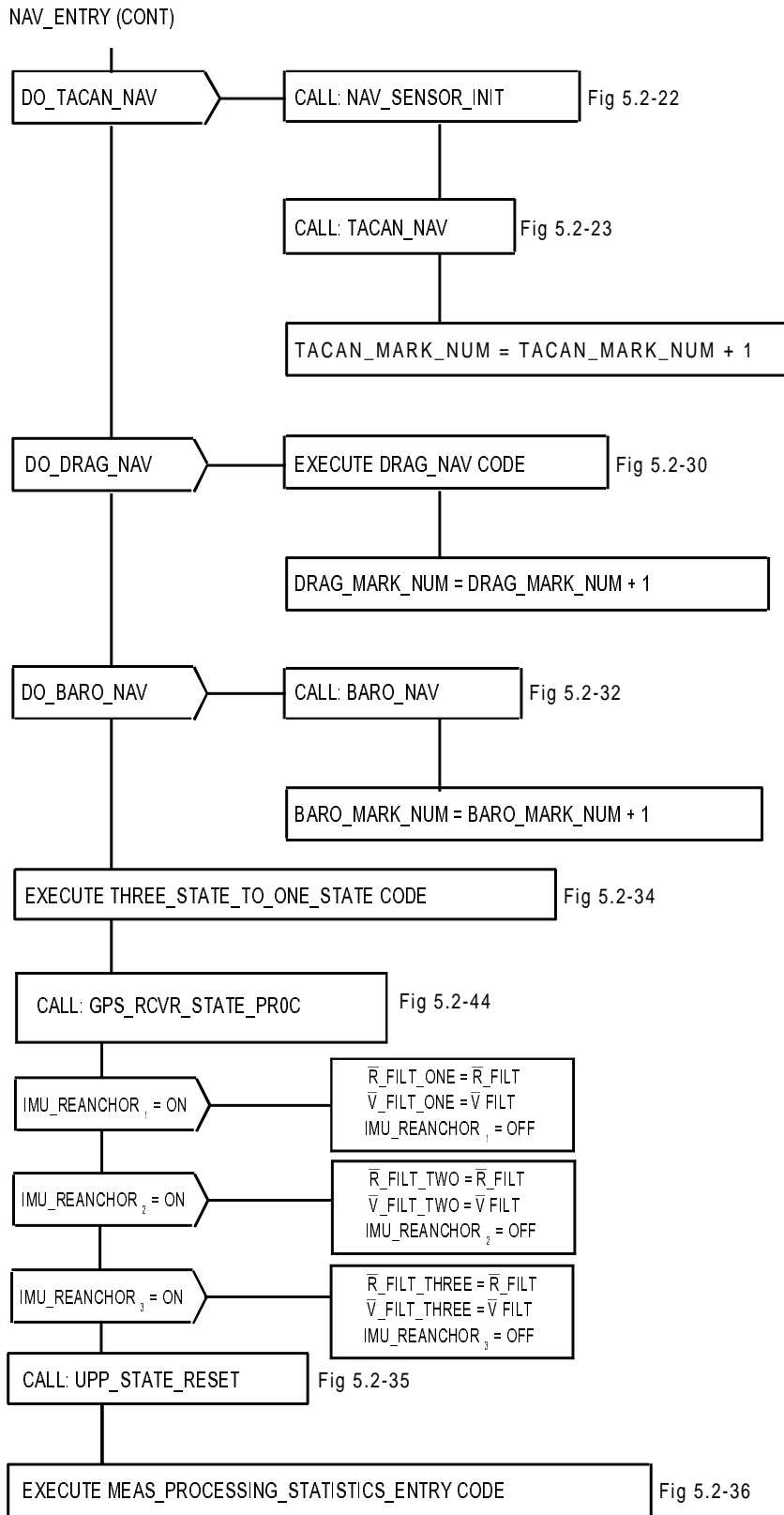


FIGURE 5.2-7.(3) NAV\_ENTRY (Sheet 3 of 4)

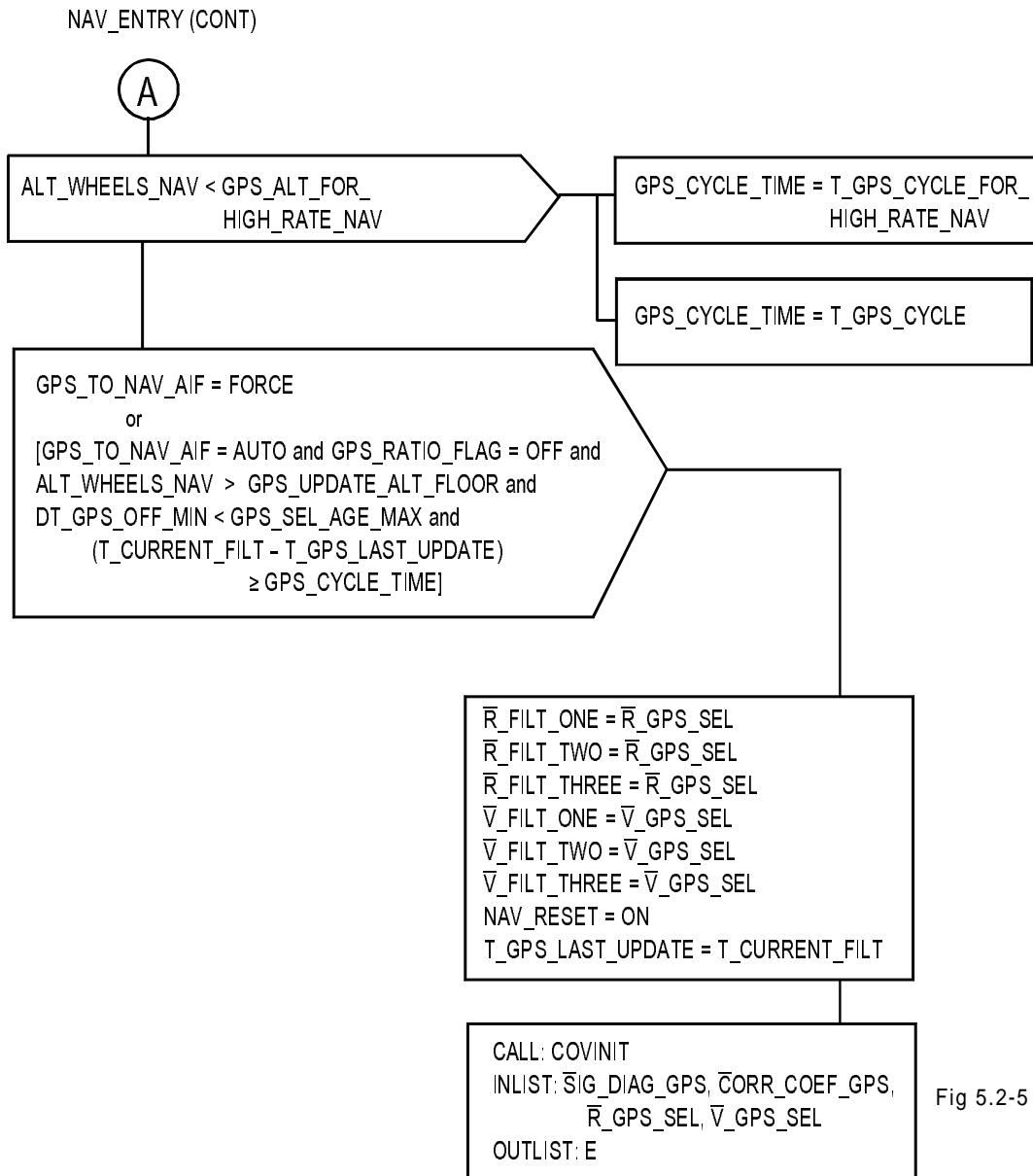


Fig 5.2-5

FIGURE 5.2-7.(4) NAV\_ENTRY (Sheet 4 of 4)

STATE\_VECTOR\_PRED\_TASK

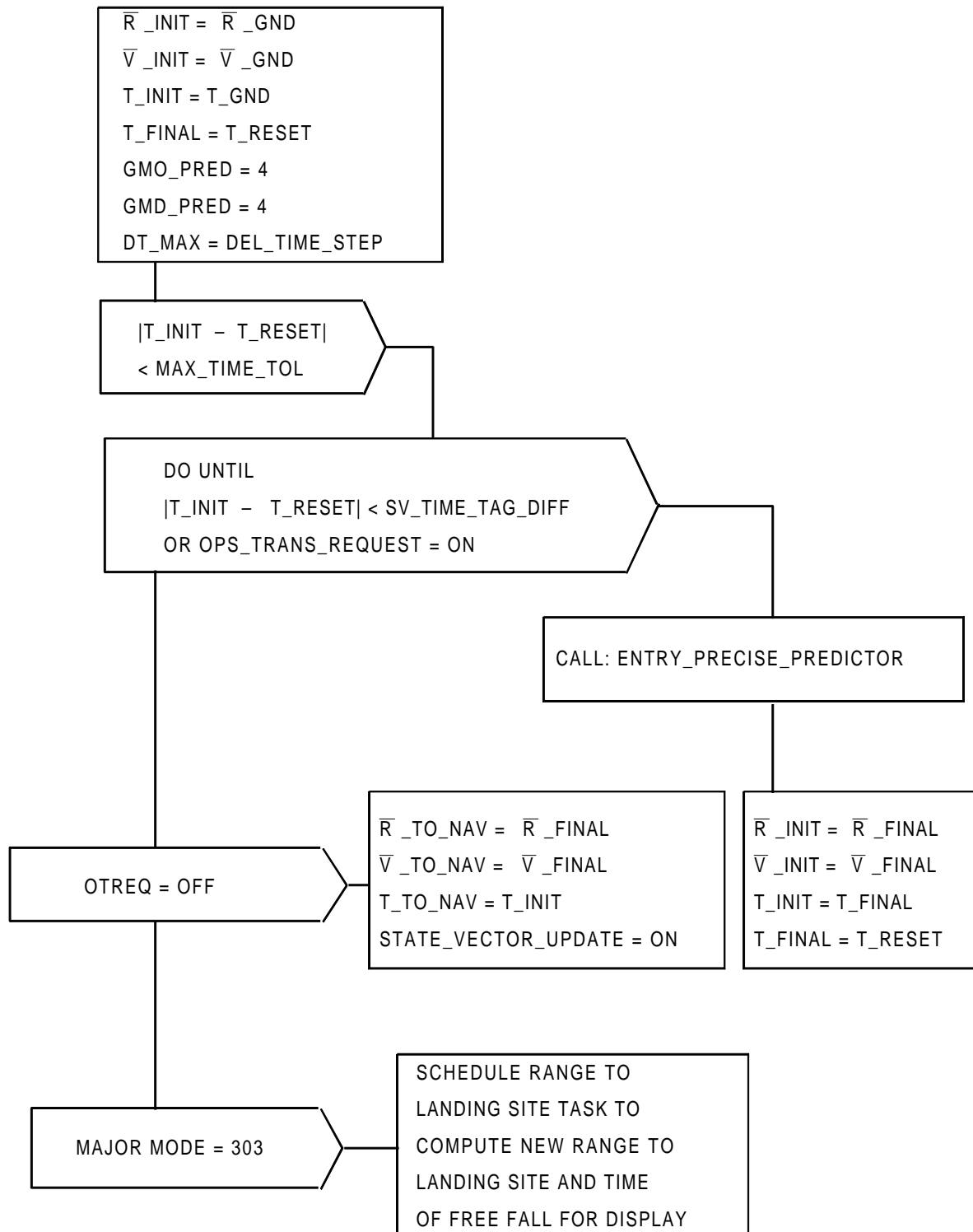


Fig 5.3-26

FIGURE 5.2-8. STATE\_VECTOR\_PRED\_TASK

NAV\_STATE\_PROP

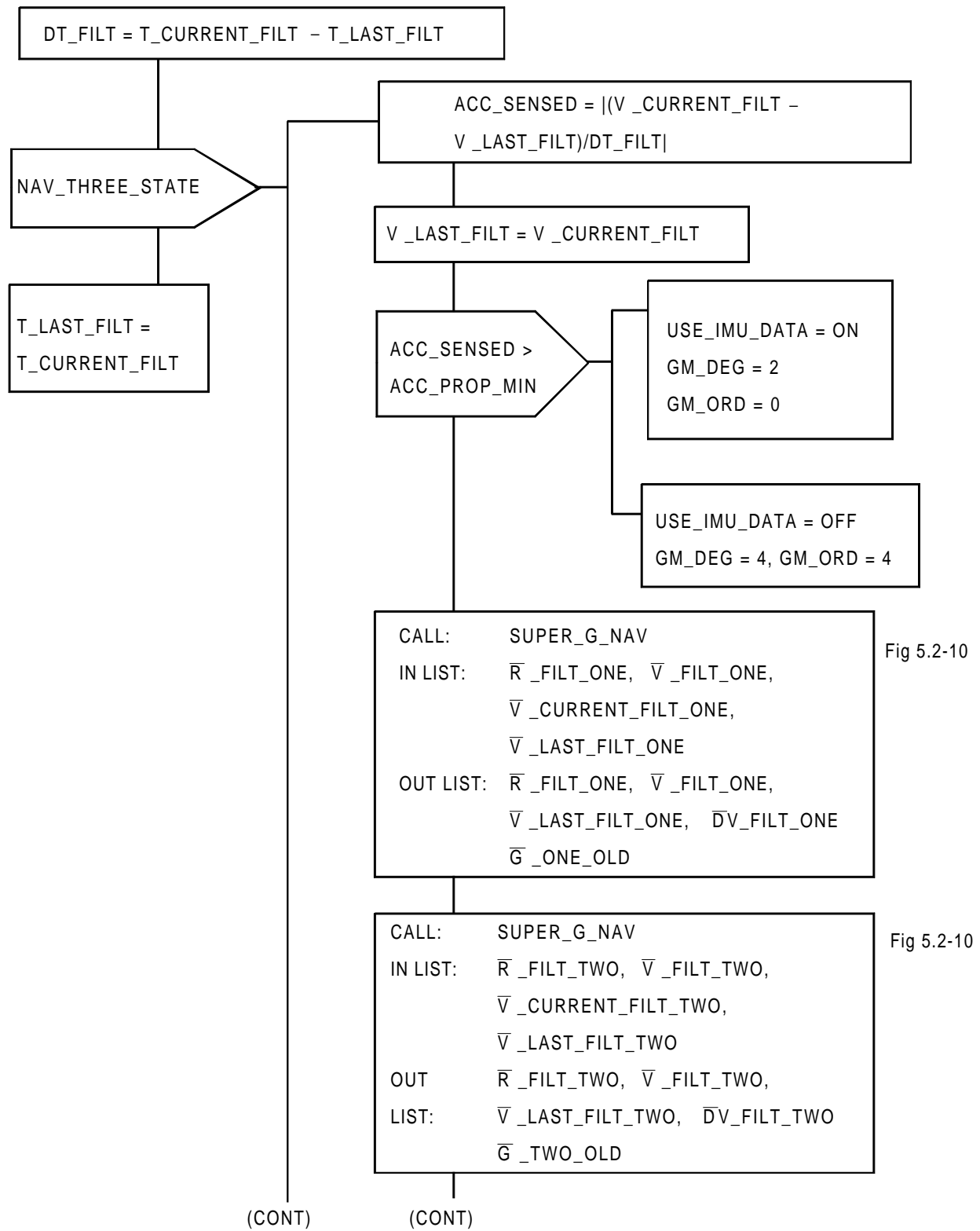


FIGURE 5.2-9.(1) NAV\_STATE\_PROP (Sheet 1 of 2)



NAV\_STATE\_PROP (CONT)

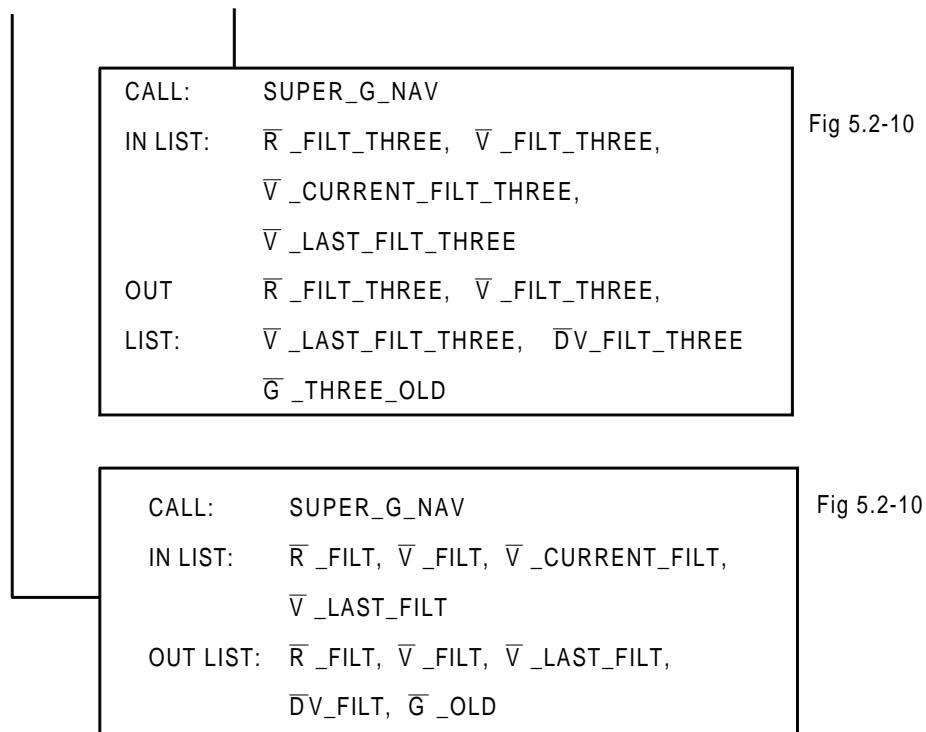


FIGURE 5.2-9.(2) NAV\_STATE\_PROP (Sheet 2 of 2)

SUPER\_G\_NAV

IN LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{V}_{\_CURRENT}$ ,  $\bar{V}_{\_LAST}$

OUT LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{V}_{\_LAST}$ ,  $\bar{D}V$ ,  $\bar{G}_{\_TWO}$

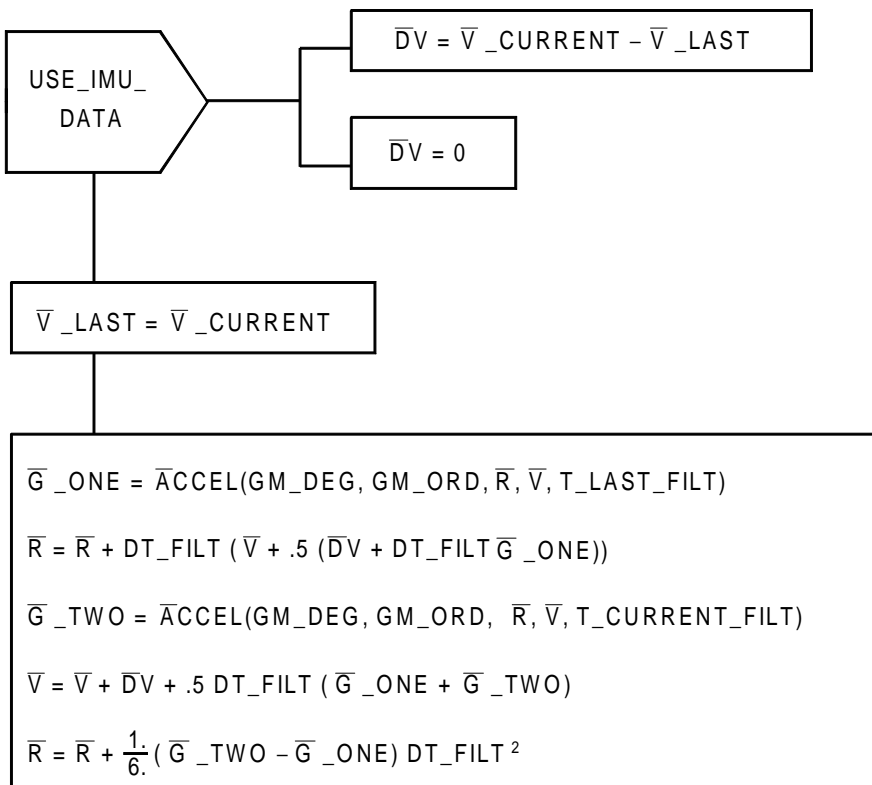


Fig 5.2-11

Fig 5.2-11

FIGURE 5.2-10. SUPER\_G\_NAV

ACCEL (FUNCTION)

IN LIST: GMD, GMO,  $\bar{R}$ ,  $\bar{V}$ , T

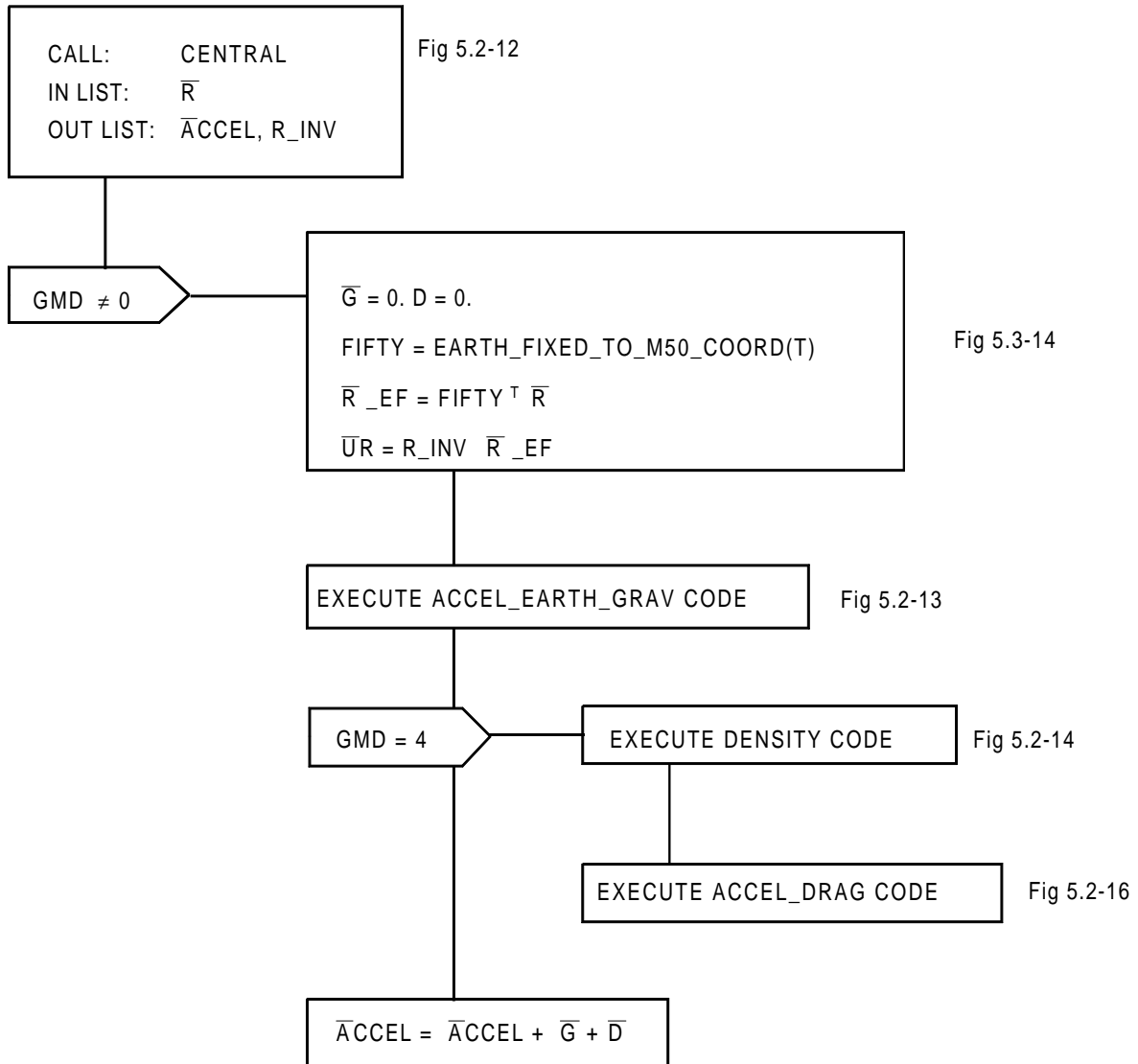


FIGURE 5.2-11. ACCEL (FUNCTION)

CENTRAL  
IN LIST:  $\bar{R}$   
OUT LIST:  $\bar{ACCEL}$ ,  $R\_INV$

$$R\_INV = 1./[\bar{R}]$$
$$\bar{ACCEL} = -EARTH\_MU R\_INV^3 \bar{R}$$

FIGURE 5.2-12. CENTRAL

ACCEL\_EARTH\_GRAV CODE

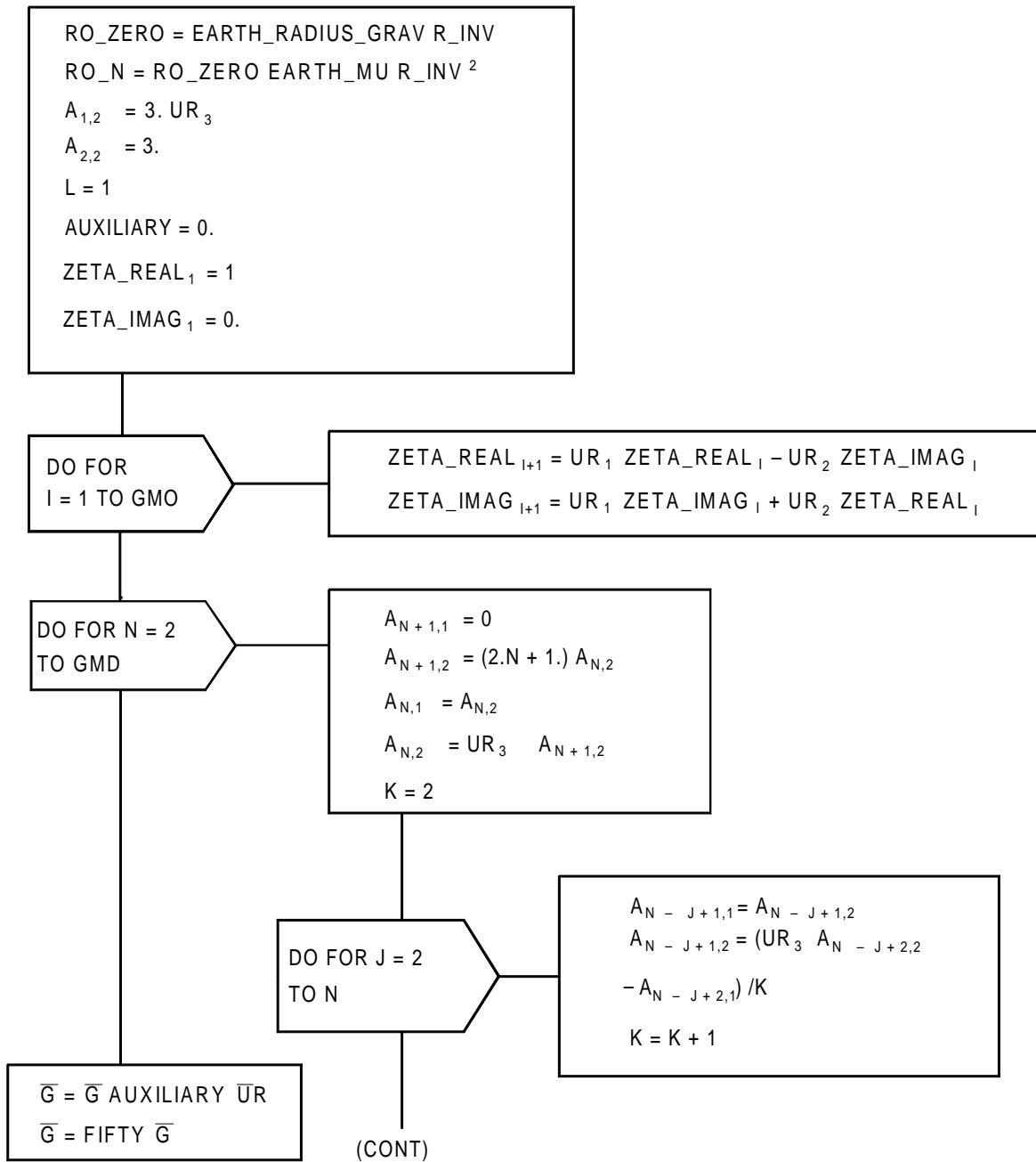


FIGURE 5.2-13.(1) ACCEL\_EARTH\_GRAV CODE (Sheet 1 of 2)

ACCEL\_EARTH\_GRAV CODE

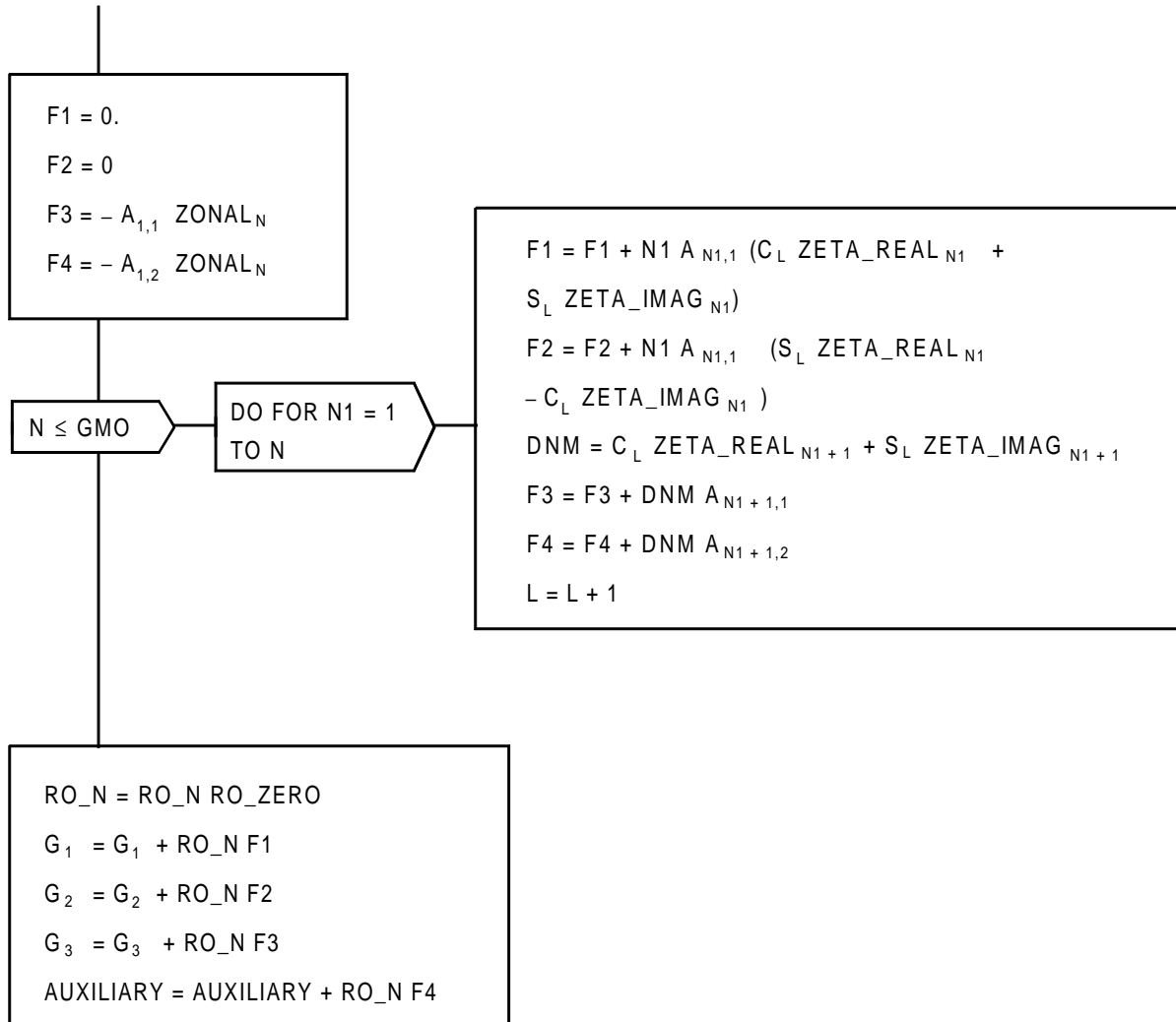


FIGURE 5.2-13.(2) ACCEL\_EARTH\_GRAV CODE (Sheet 2 of 2)

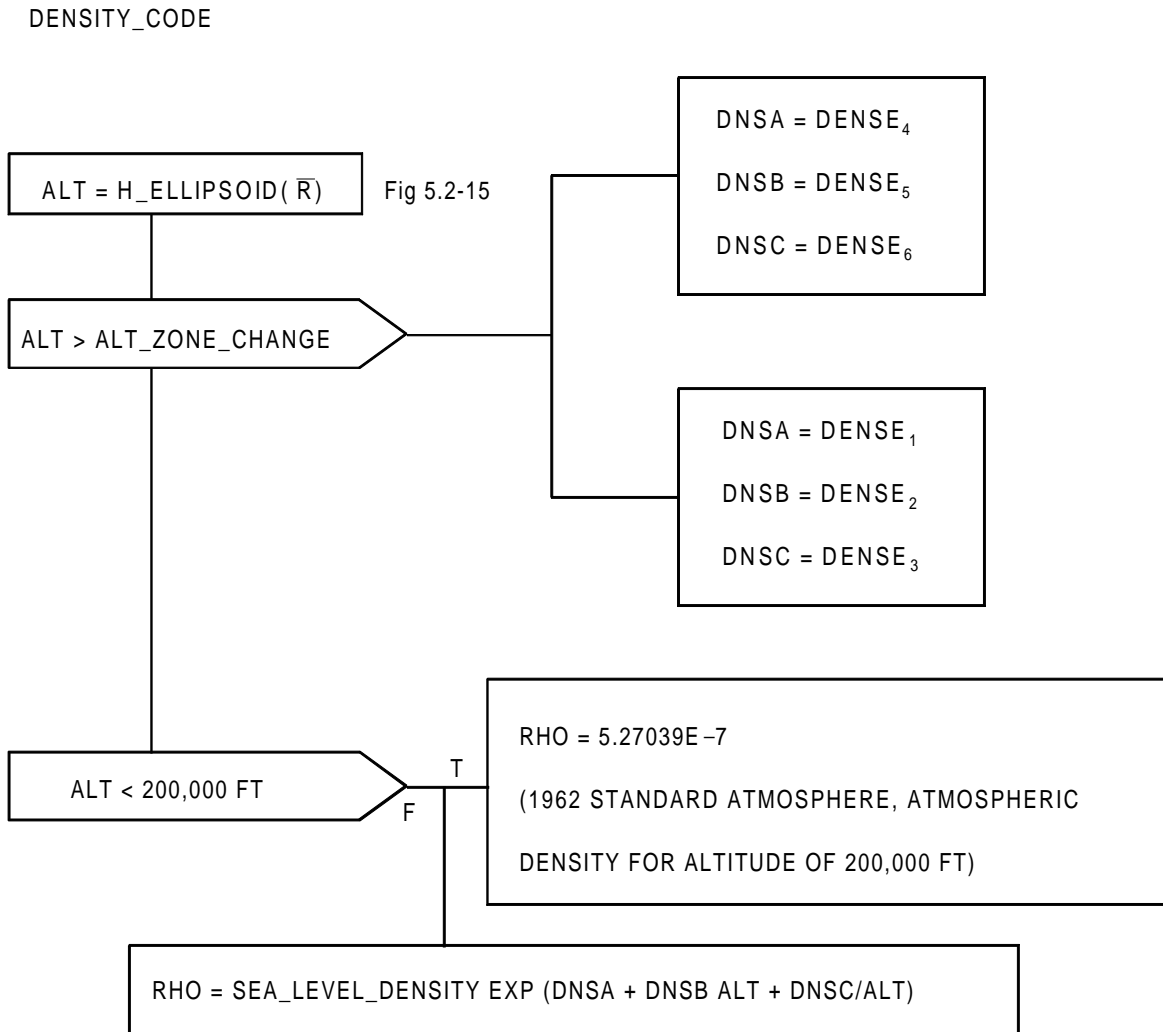


FIGURE 5.2-14. DENSITY\_CODE

H\_ELLIPSOID (FUNCTION)

$$H\_ELLIPSOID(\bar{R}) = |\bar{R}| - \frac{(1 - ELLIPT) \text{EARTH\_RADIUS\_EQUATOR}}{\sqrt{1 + [(1 - ELLIPT)^2 - 1] [1 - (\bar{UNIT}(\bar{R}) \cdot \bar{EARTH\_POLE}^2)]}}$$

FIGURE 5.2-15. H\_ELLIPSOID (FUNCTION)



ACCEL\_DRAG CODE

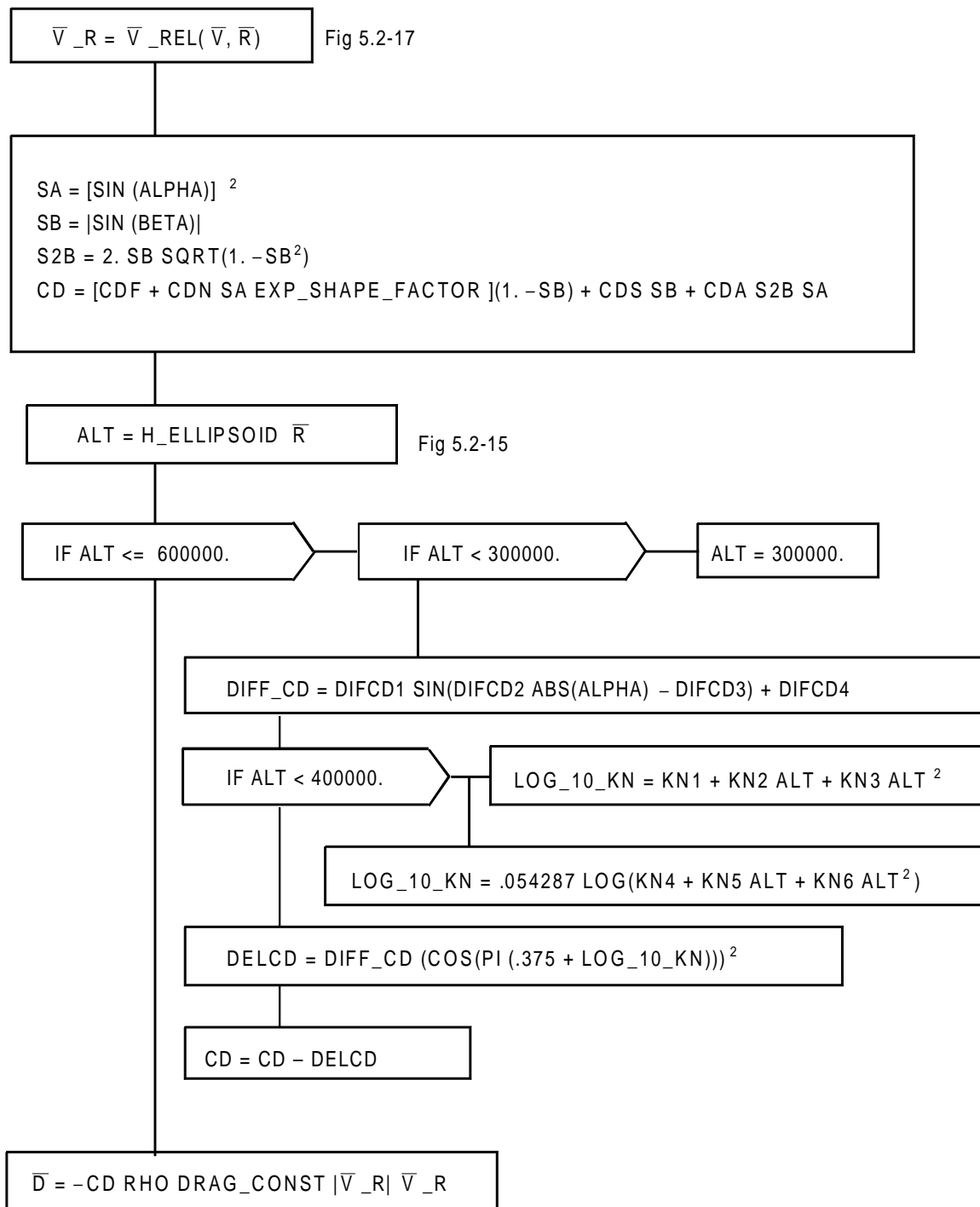


FIGURE 5.2-16. ACCEL\_DRAG CODE

$\bar{V}$ \_REL (FUNCTION)

$$\bar{V}_{REL}(\bar{V}, \bar{R}) = \bar{V} - \text{EARTH\_RATE} (\bar{EARTH\_POLE} \times \bar{R})$$

FIGURE 5.2-17.  $\bar{V}$ \_REL (FUNCTION)

COVEXTRAP\_PF

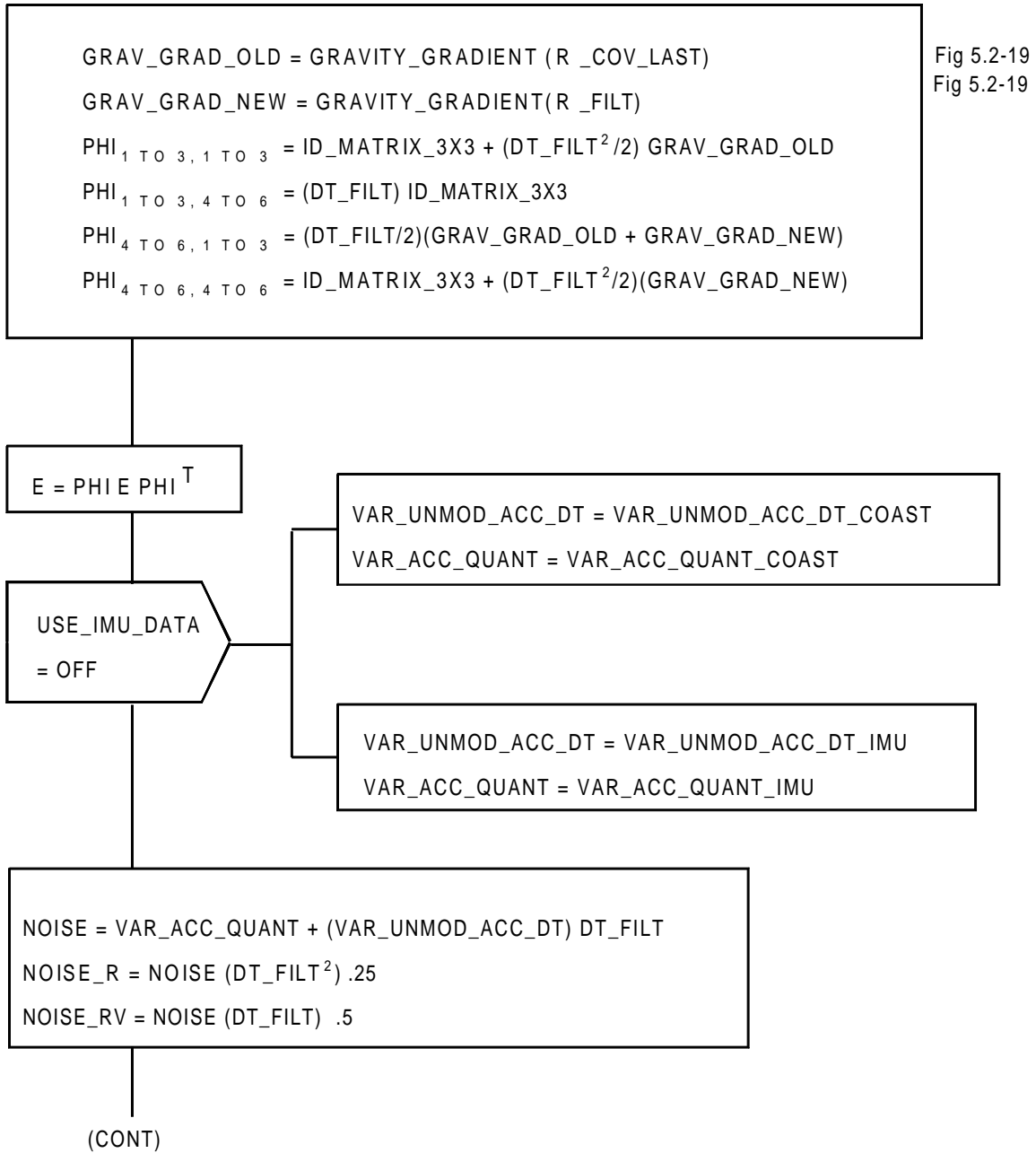


FIGURE 5.2-18.(1) COVEXTRAP\_PF (Sheet 1 of 2)

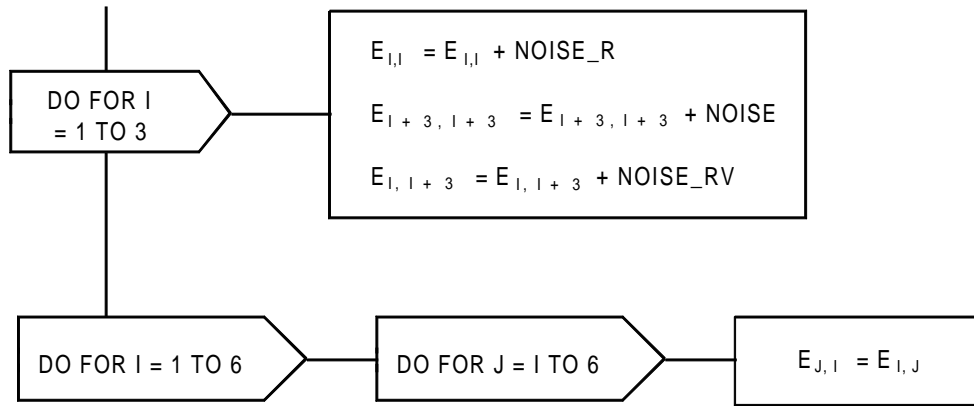


FIGURE 5.2-18.(2) COVEXTRAP\_PF (Sheet 2 of 2)

GRAVITY\_GRADIENT (FUNCTION)

$$\text{GRAVITY\_GRADIENT}(\bar{R}) = (\text{EARTH\_MU}/|\bar{R}|^5) (3 \bar{R} \bar{R}^T - |\bar{R}|^2 \text{ID\_MATRIX\_3X3})$$

FIGURE 5.2-19. GRAVITY\_GRADIENT (FUNCTION)

OPS\_3\_DELTA\_UPDATE

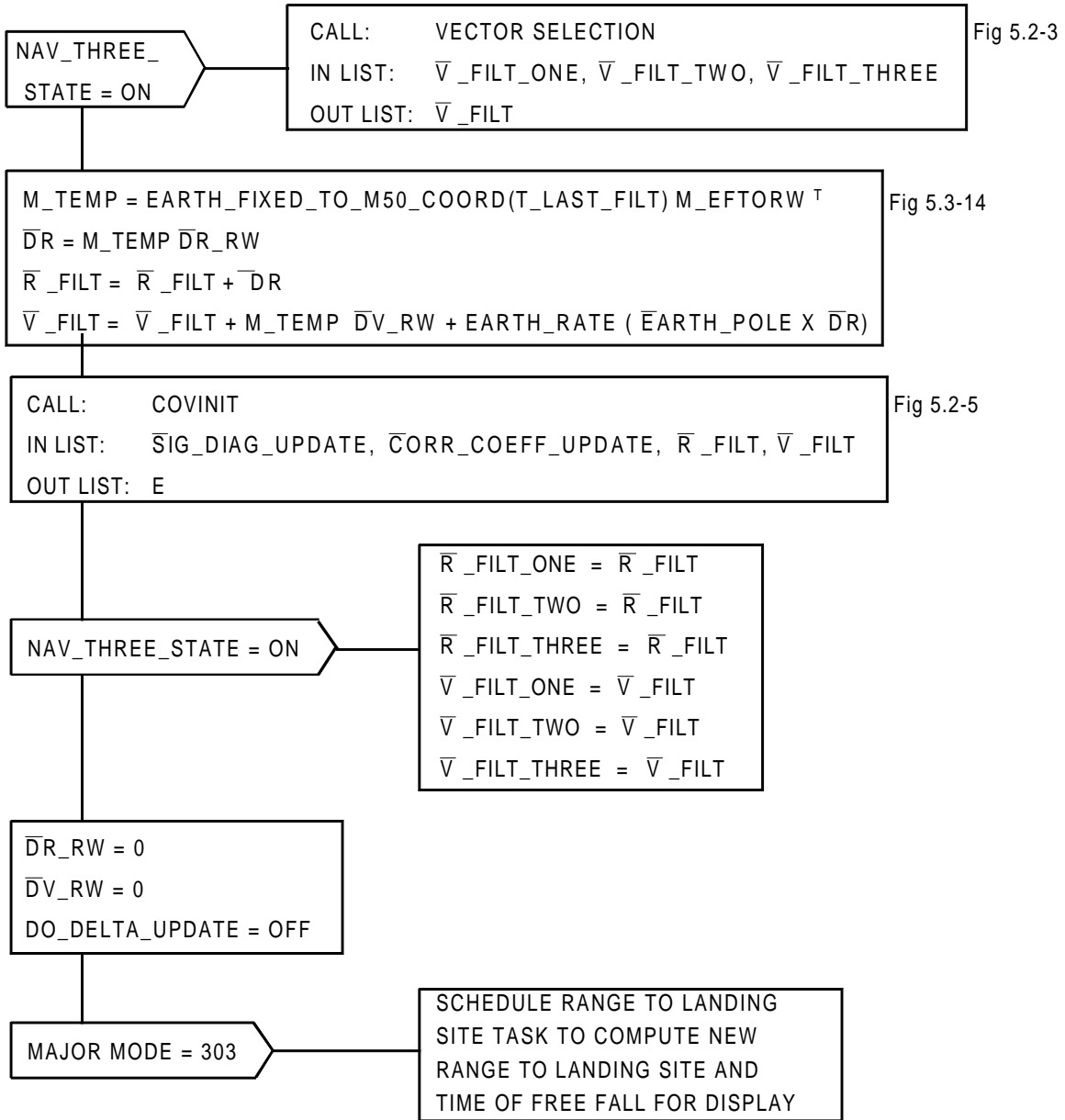
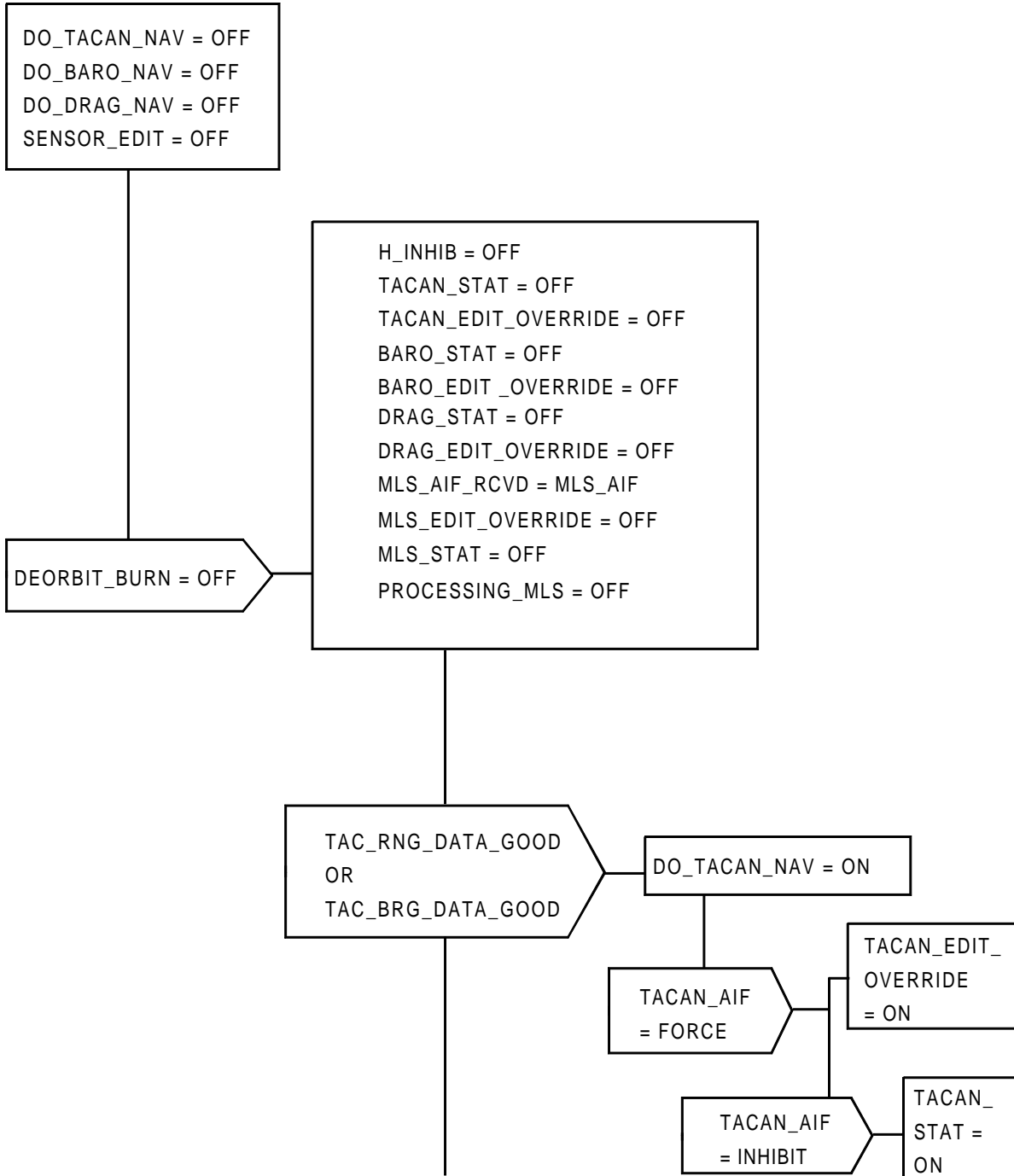


FIGURE 5.2-20. OPS\_3\_DELTA\_UPDATE

ENTRY\_SENSOR\_SELECT CODE



(CONT)

FIGURE 5.2-21.(1) ENTRY\_SENSOR\_SELECT CODE (Sheet 1 of 3)

ENTRY\_SENSOR\_SELECT CODE (CONT)

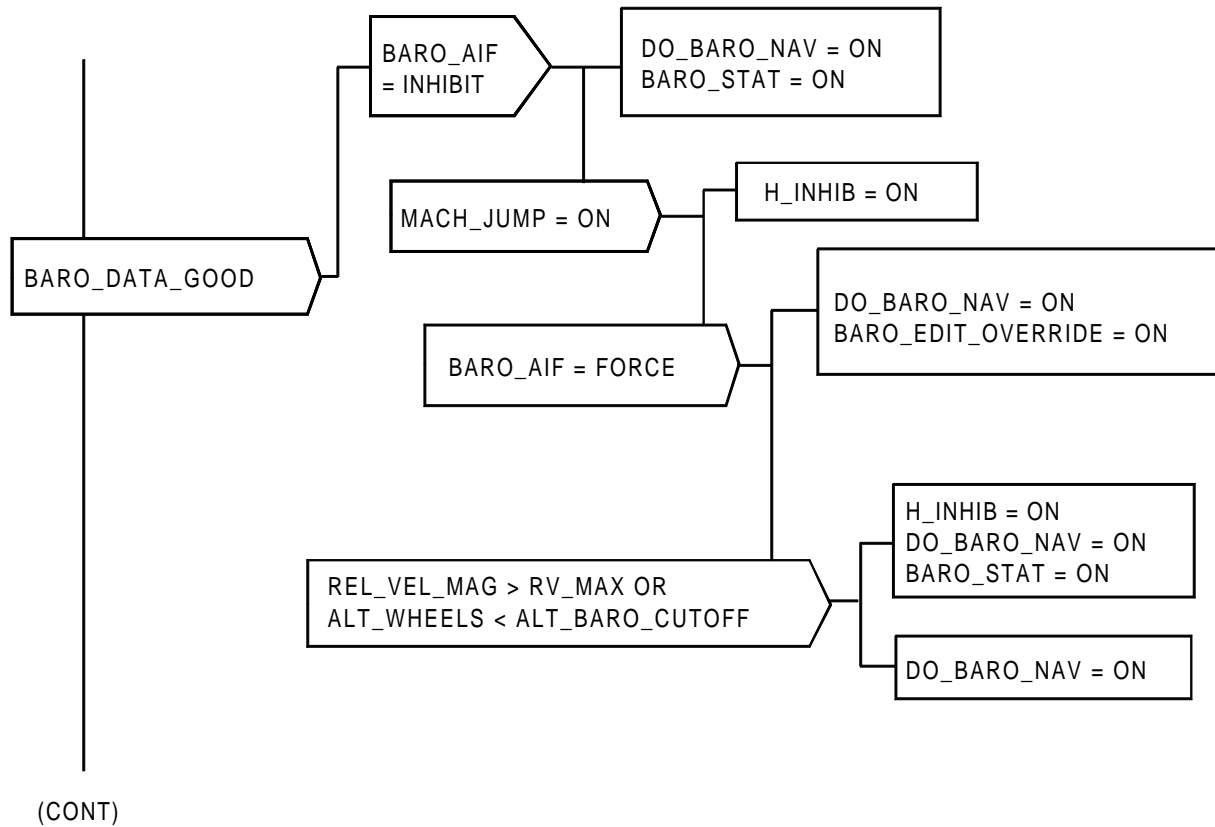


FIGURE 5.2-21.(2) ENTRY\_SENSOR\_SELECT CODE (Sheet 2 of 3)



ENTRY\_SENSOR\_SELECT CODE (CONCLUDED)

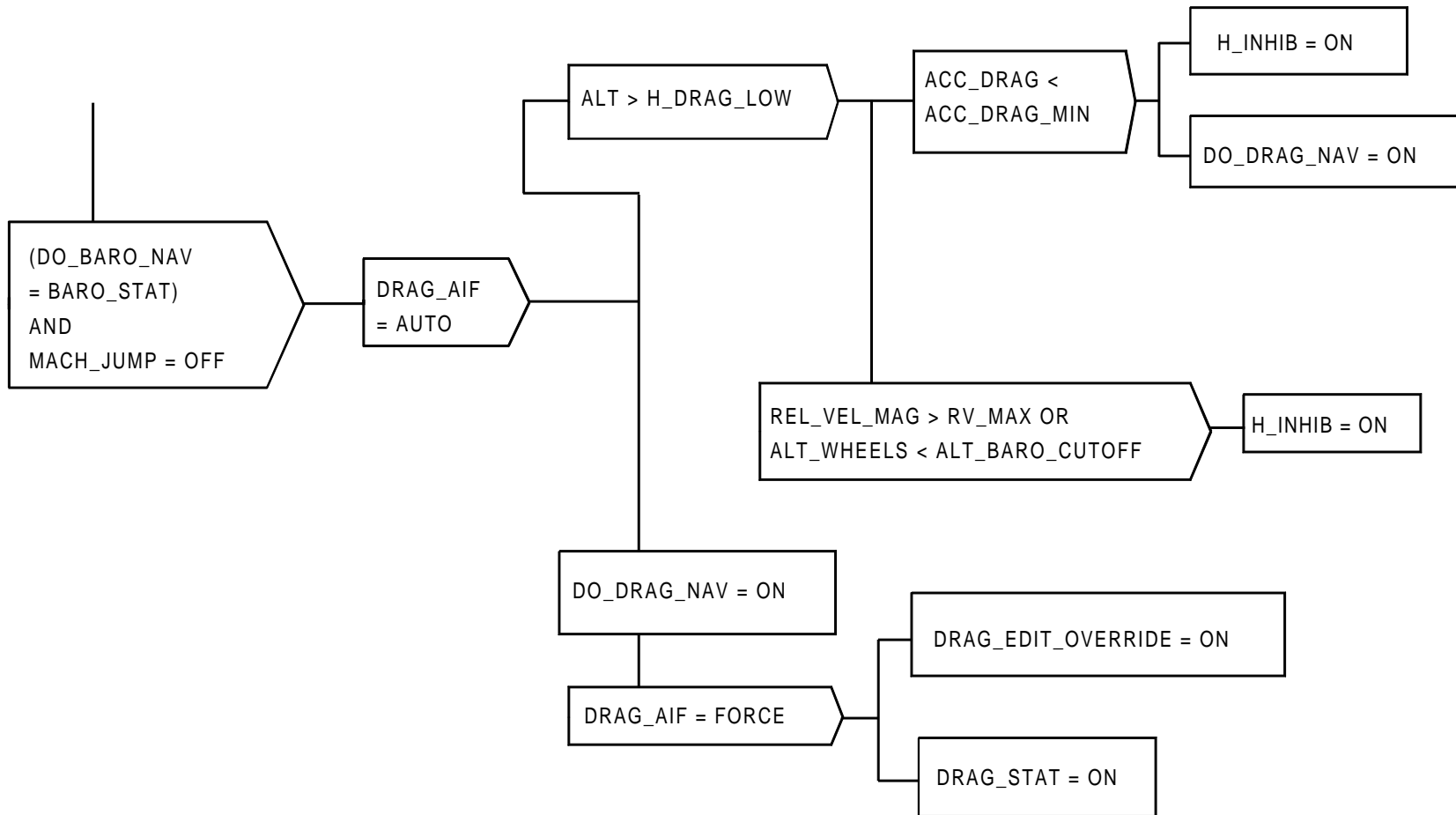


FIGURE 5.2-21.(3) ENTRY\_SENSOR\_SELECT CODE (Sheet 3 of 3)

NAV\_SENSOR\_INIT

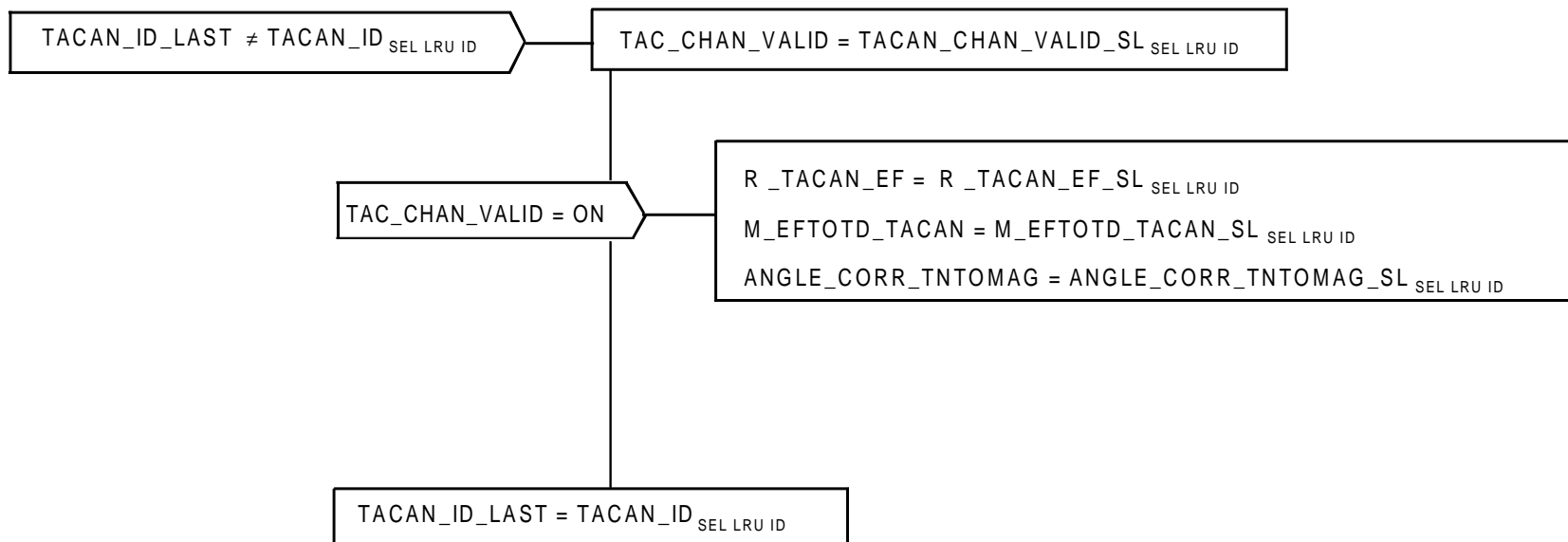


FIGURE 5.2-22. NAV\_SENSOR\_INIT

TACAN\_NAV

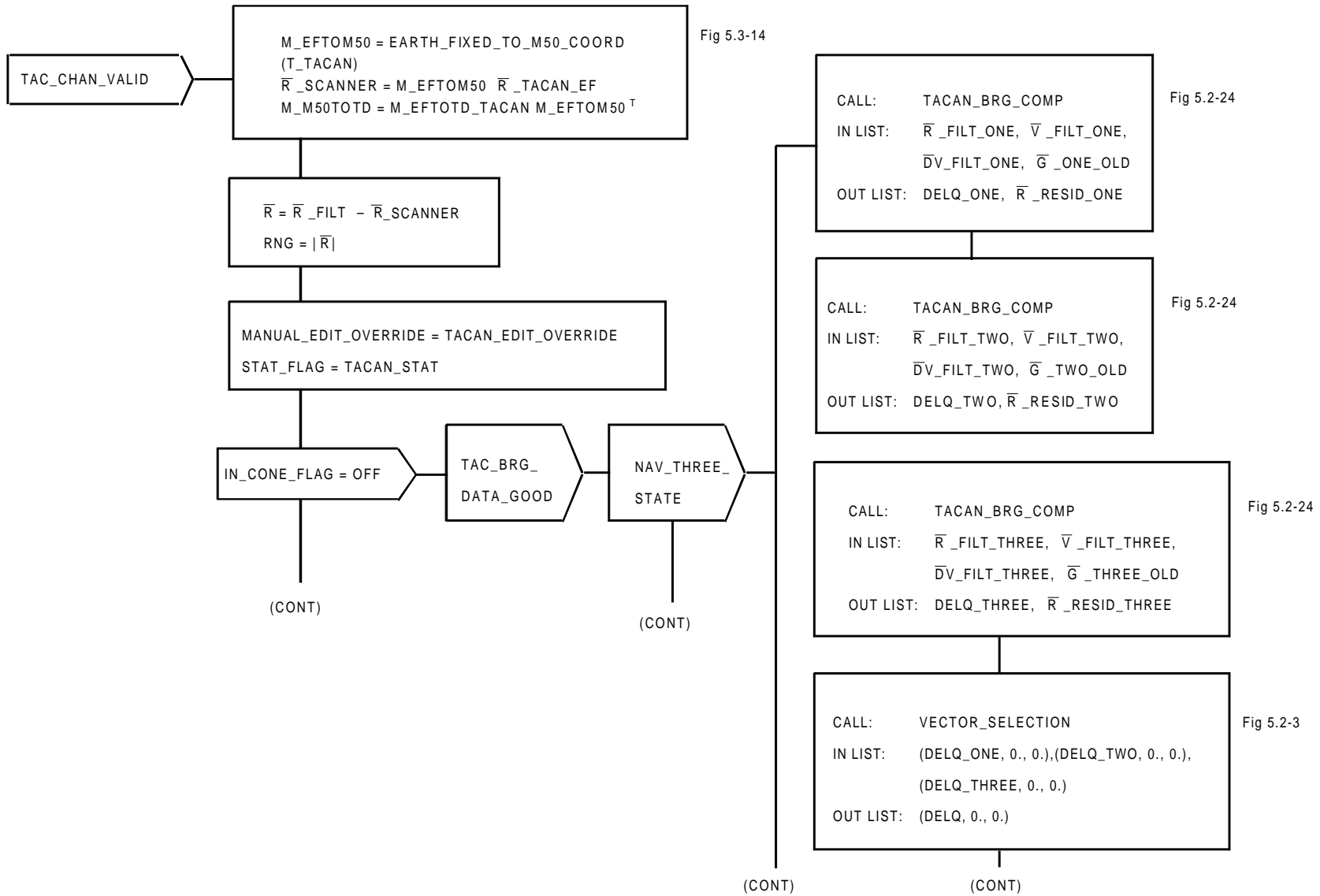


FIGURE 5.2-23.(1) TACAN\_NAV (Sheet 1 of 4)

TACAN\_NAV (CONTINUED)

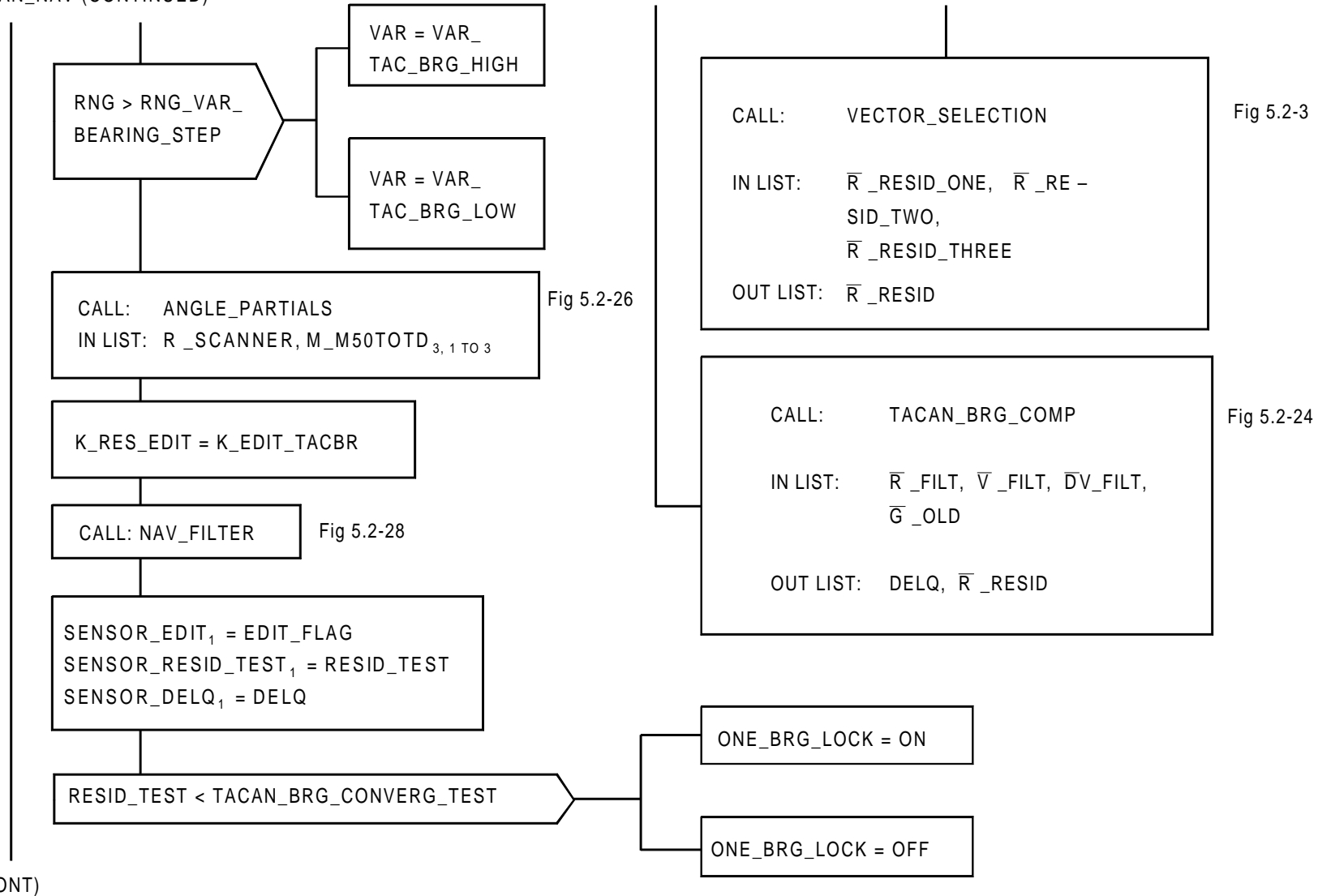


FIGURE 5.2-23.(2) TACAN\_NAV (Sheet 2 of 4)

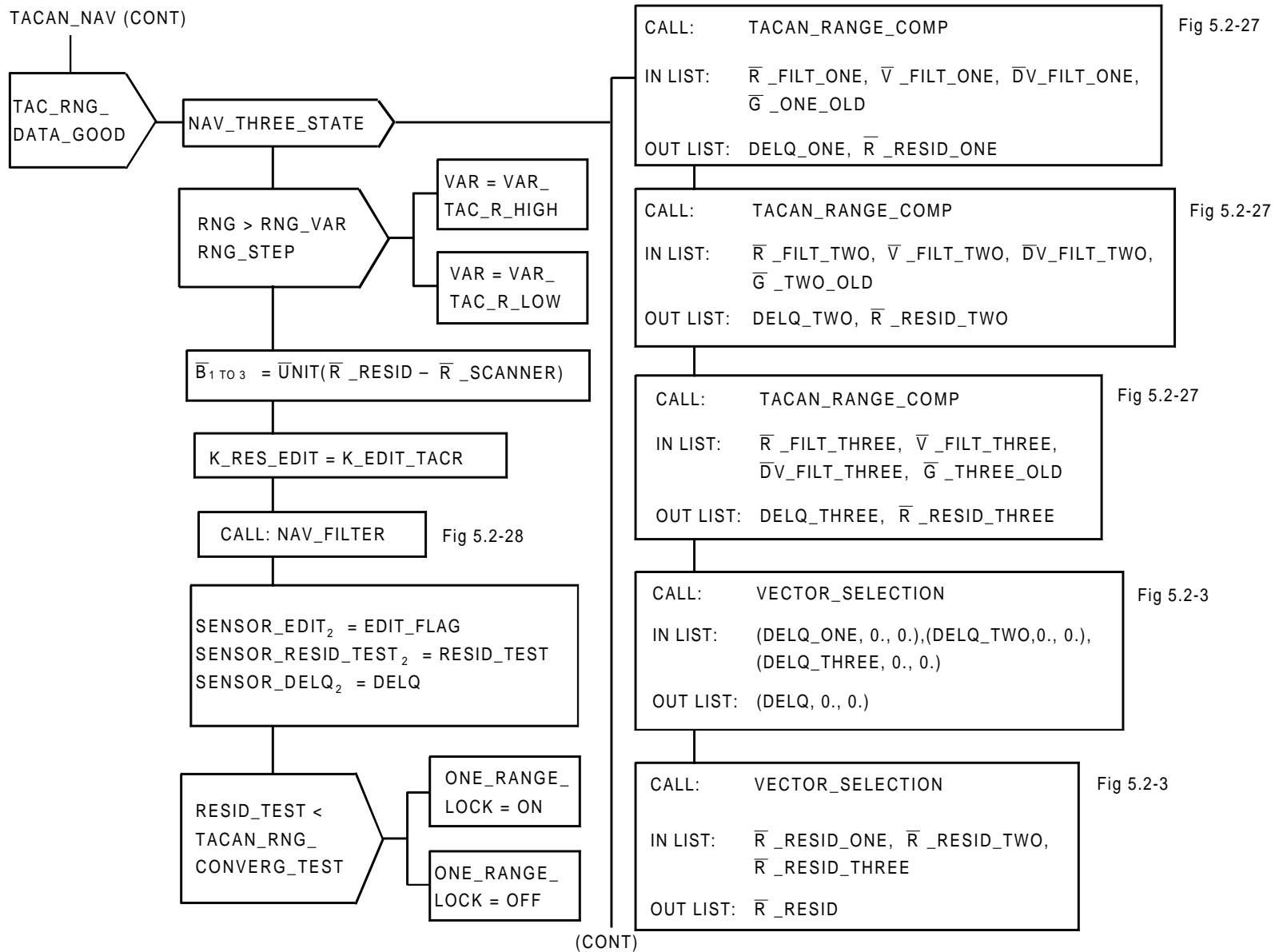


FIGURE 5.2-23.(3) TACAN\_NAV (Sheet 3 of 4)

TACAN\_NAV (CONCLUDED)

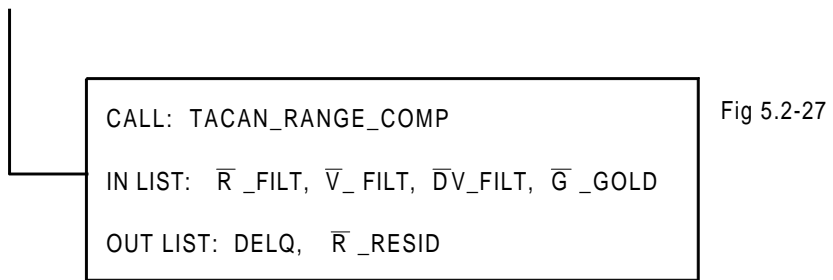


FIGURE 5.2-23.(4) TACAN\_NAV (Sheet 4 of 4)

TACAN\_BRG\_COMP

IN LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{D}\bar{V}$ ,  $\bar{G}$

OUT LIST: DQ,  $\bar{R}$ \_RESID\_TACAN

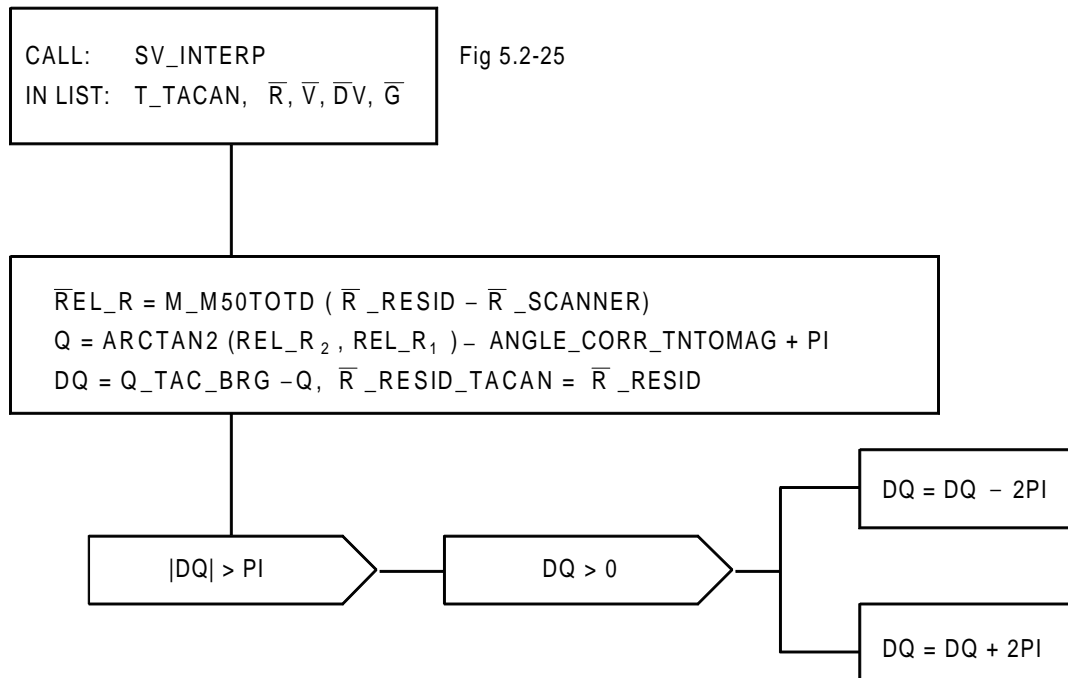


FIGURE 5.2-24. TACAN\_BRG\_COMP

SV\_INTERP

IN LIST: T\_SENSORS,  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{D}V$ ,  $\bar{G}$

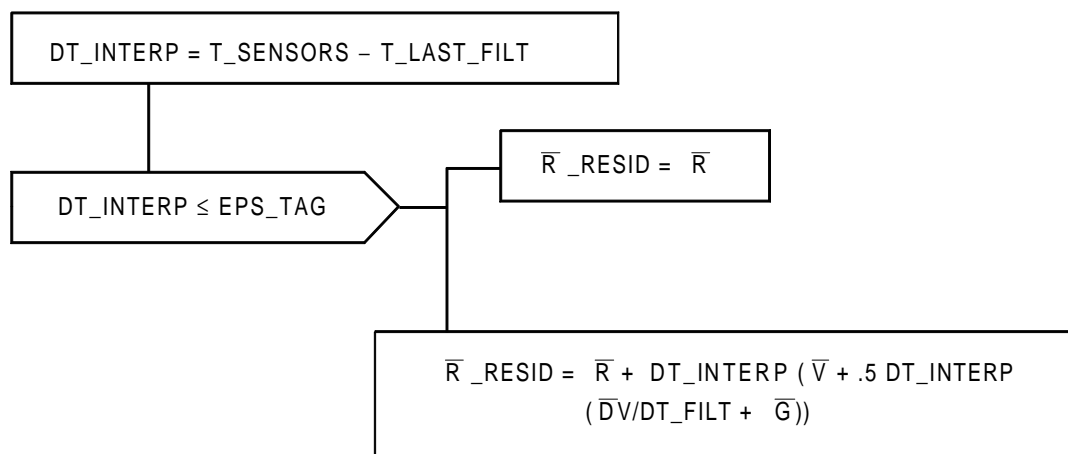


FIGURE 5.2-25. SV\_INTERP



ANGLE\_PARTIALS

IN LIST:  $\bar{R}$ \_SENSOR,  $\bar{I}$ \_Z

$$\bar{R}EL\_R = \bar{R}\_RESID - \bar{R}\_SENSOR$$

$$\bar{I}Z\_CROSS\_REL\_R = \bar{I}\_Z \times \bar{R}EL\_R$$

$$B_{1TO3} = \bar{I}Z\_CROSS\_REL\_R / |\bar{I}Z\_CROSS\_REL\_R|^2$$

FIGURE 5.2-26. ANGLE\_PARTIALS

TACAN\_RANGE\_COMP

IN LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{D}V$ ,  $\bar{G}$

OUT LIST:  $DQ$ ,  $\bar{R}$ \_RESID\_TACAN

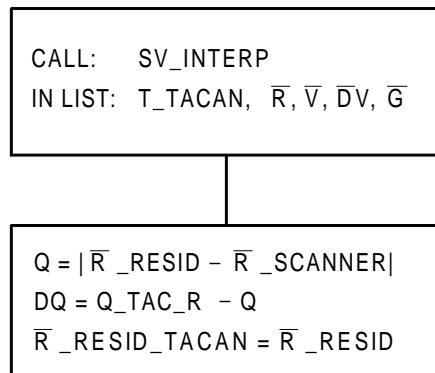


Fig 5.2-25

FIGURE 5.2-27. TACAN\_RANGE\_COMP

NAV\_FILTER

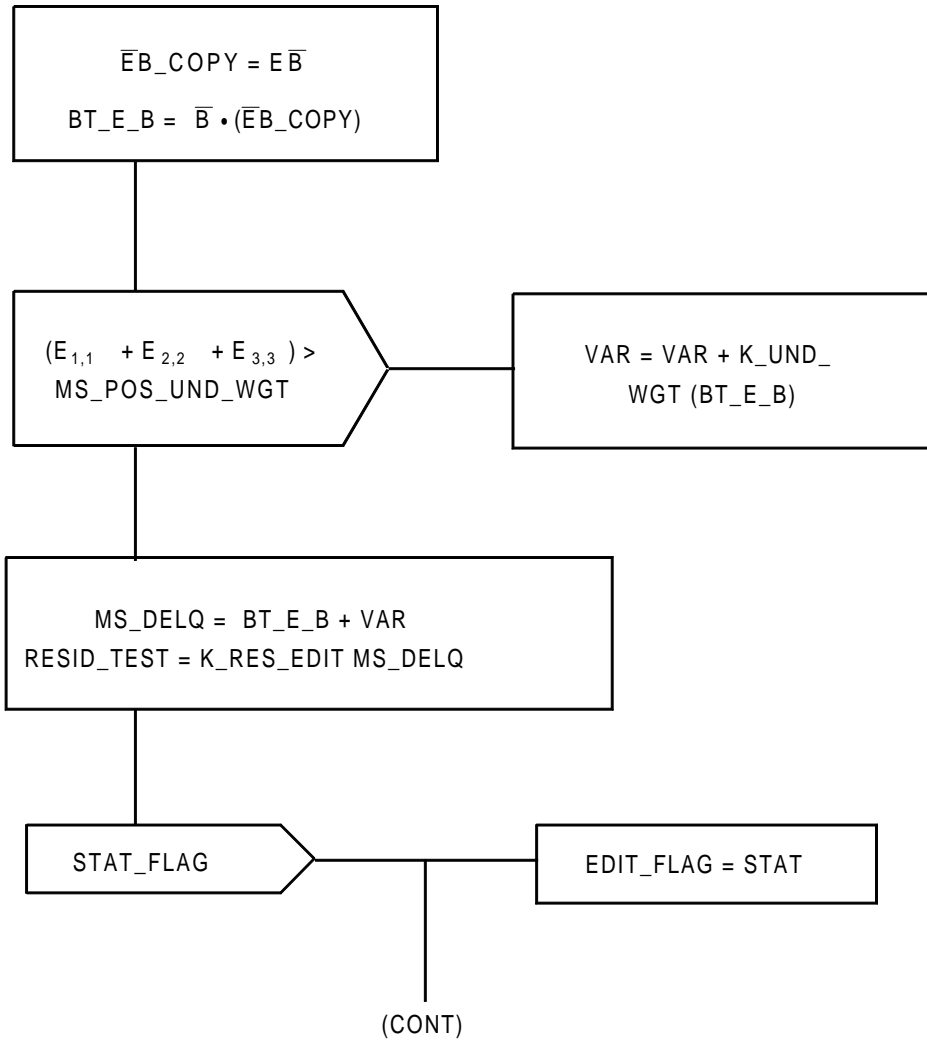


FIGURE 5.2-28.(1) NAV\_FILTER (Sheet 1 of 2)

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NAV\_FILTER (CONCLUDED)

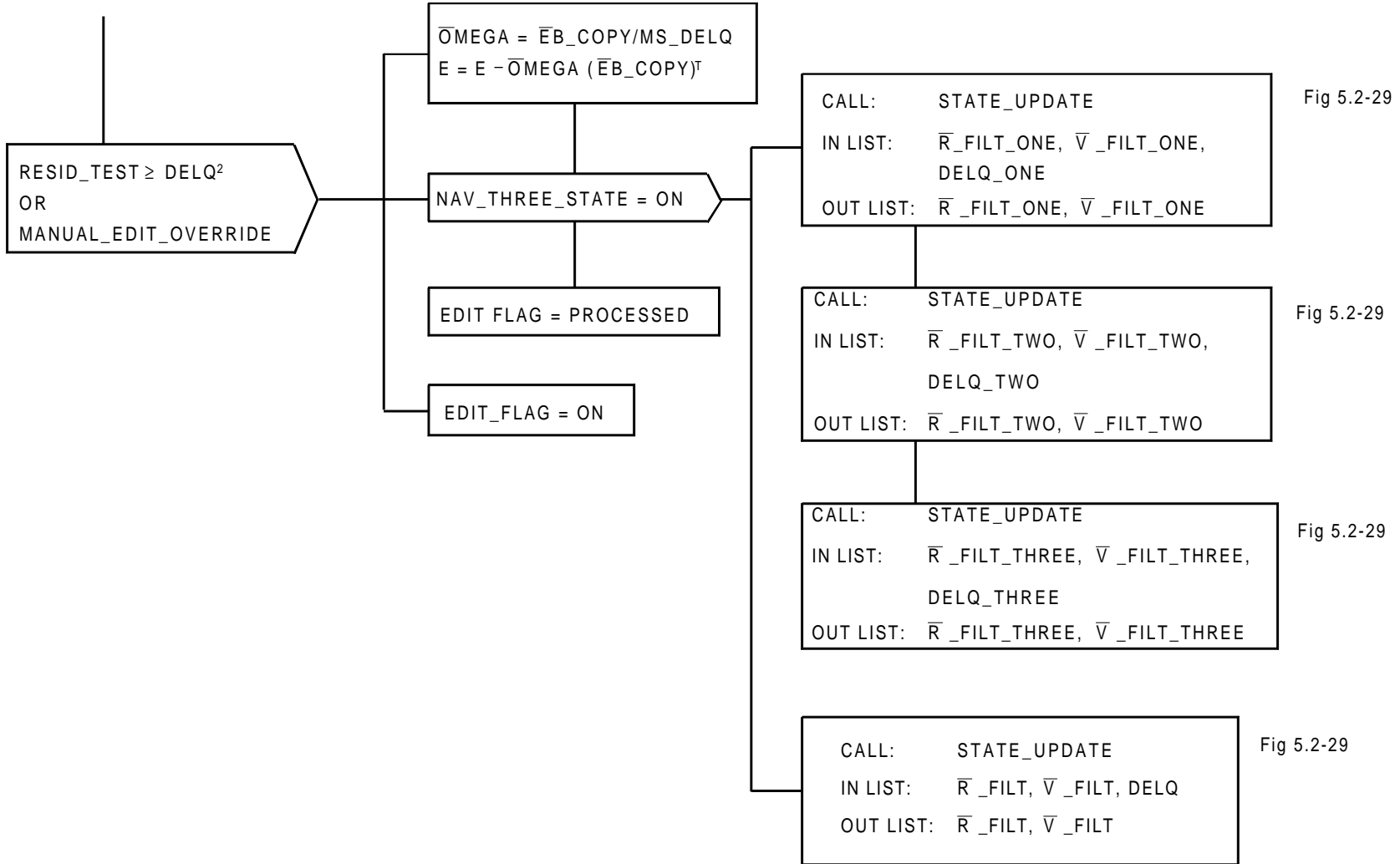


FIGURE 5.2-28.(2) NAV\_FILTER (Sheet 2 of 2)

STATE\_UPDATE

IN LIST:  $\bar{R}$ ,  $\bar{V}$ , DQ

OUT LIST:  $\bar{R}$ ,  $\bar{V}$

$$\bar{R} = \bar{R} + \text{OMEGA}_{1 \text{ TO } 3} \text{ DQ}$$

$$\bar{V} = \bar{V} + \text{OMEGA}_{4 \text{ TO } 6} \text{ DQ}$$

FIGURE 5.2-29. STATE\_UPDATE

DRAG\_NAV CODE

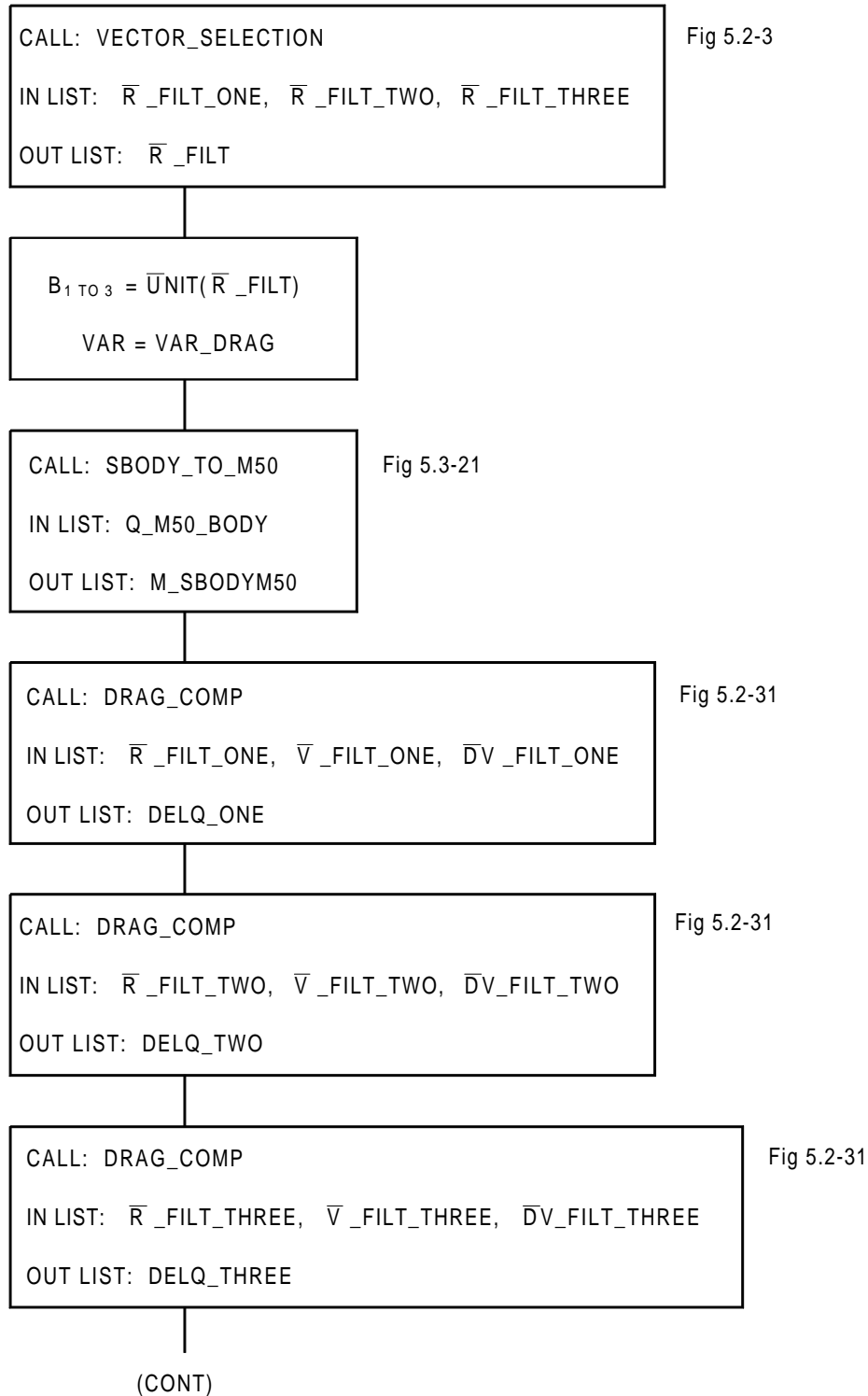


FIGURE 5.2-30.(1) DRAG\_NAV CODE (Sheet 1 of 2)

DRAG\_NAV CODE (CONCLUDED)

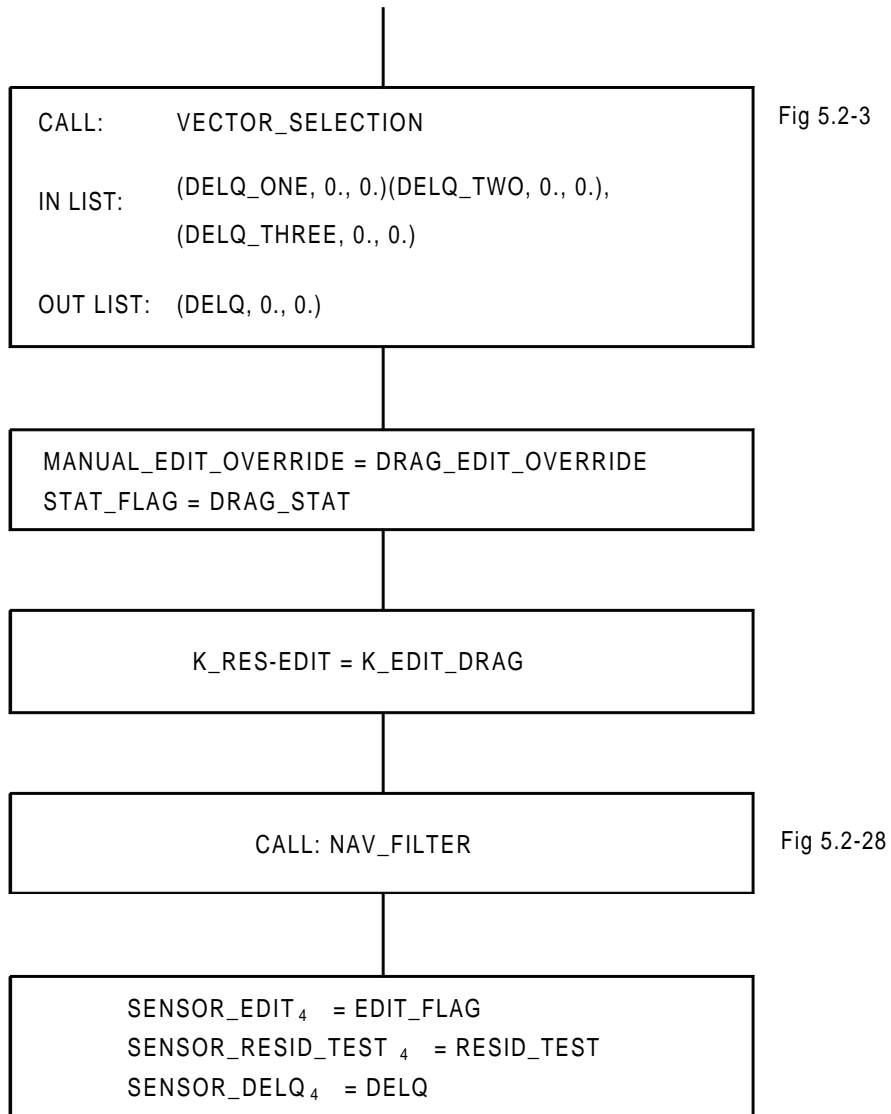


FIGURE 5.2-30.(2) DRAG\_NAV CODE (Sheet 2 of 2)



DRAG\_COMP  
IN LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{D}\bar{V}$   
OUT LIST: DQ

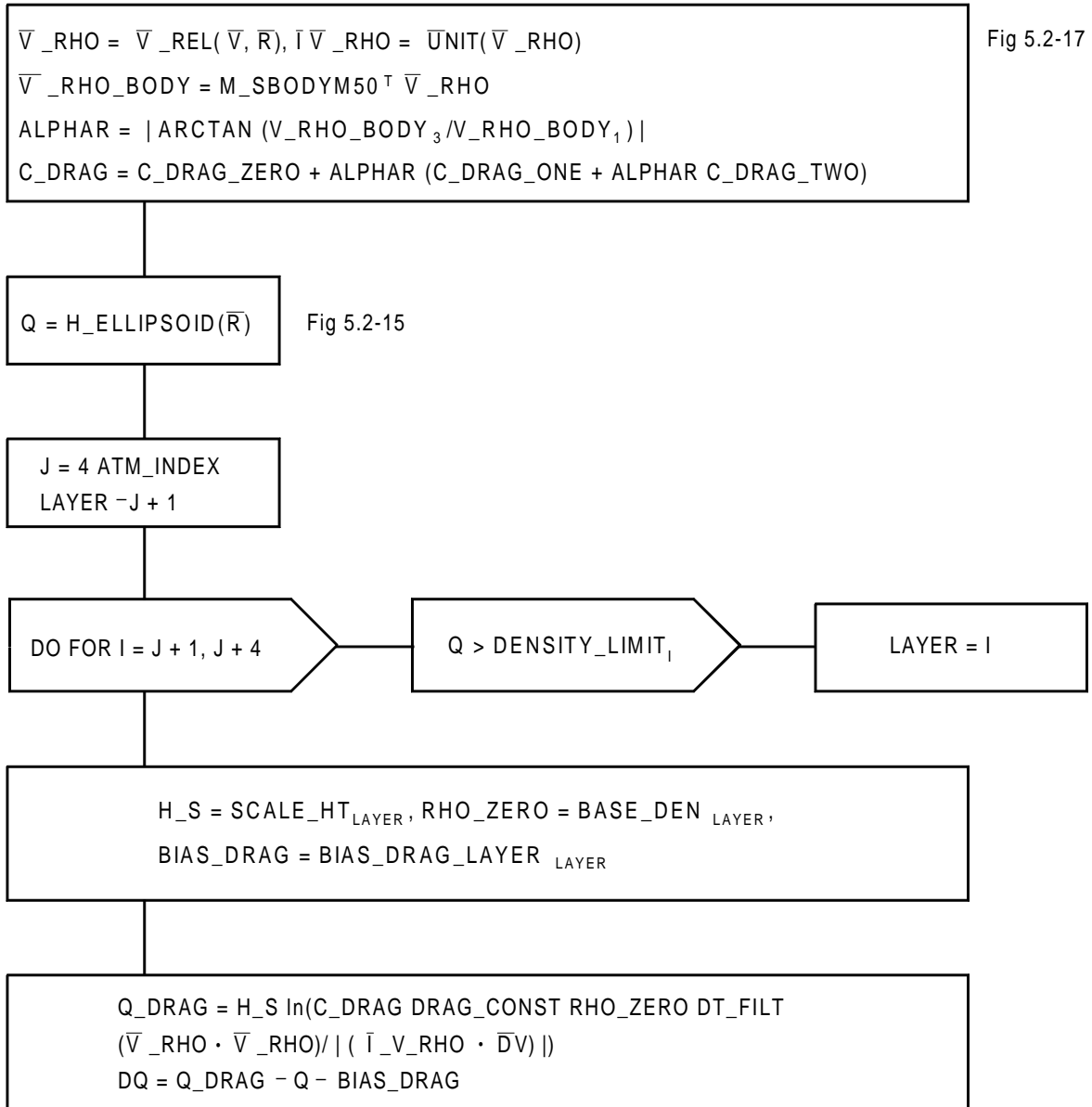
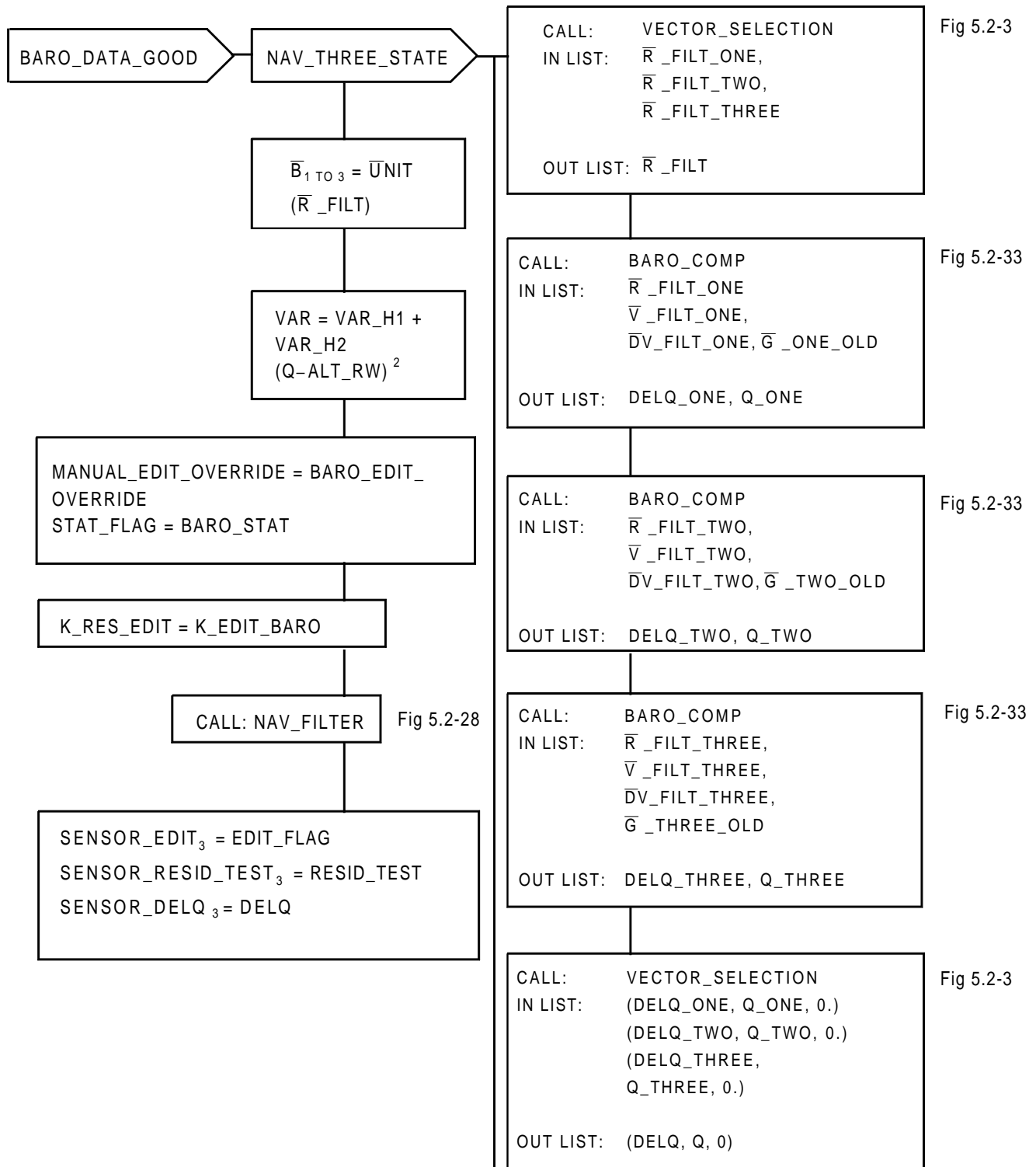


FIGURE 5.2-31. DRAG\_COMP

BARO\_NAV



(CONT)

FIGURE 5.2-32.(1) BARO\_NAV (Sheet 1 of 2)

BARO\_NAV (CONCLUDED)

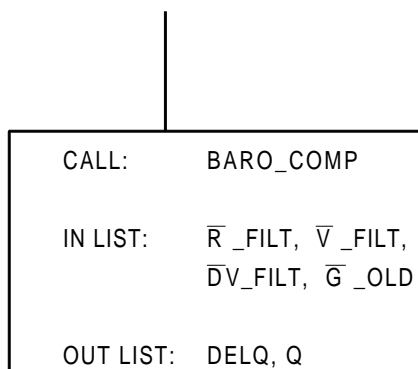


Fig 5.2-33

FIGURE 5.2-32.(2) BARO\_NAV (Sheet 2 of 2)

BARO\_COMP

IN LIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{DV}$ ,  $\bar{G}$

OUT LIST: DQ, Q

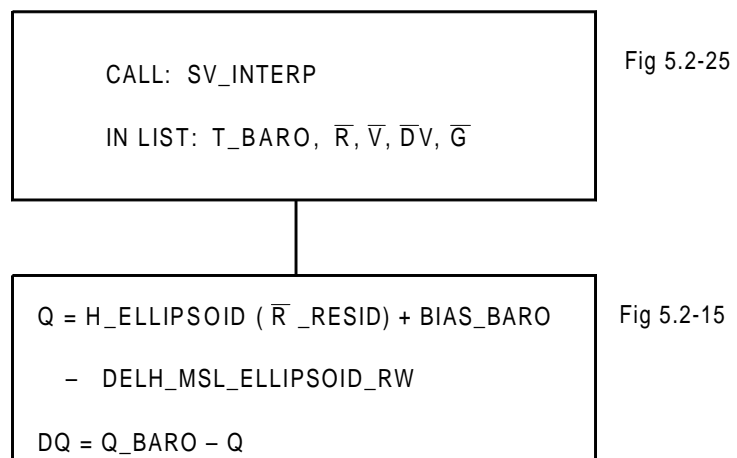


FIGURE 5.2-33. BARO\_COMP

THREE\_STATE\_TO\_ONE\_STATE CODE

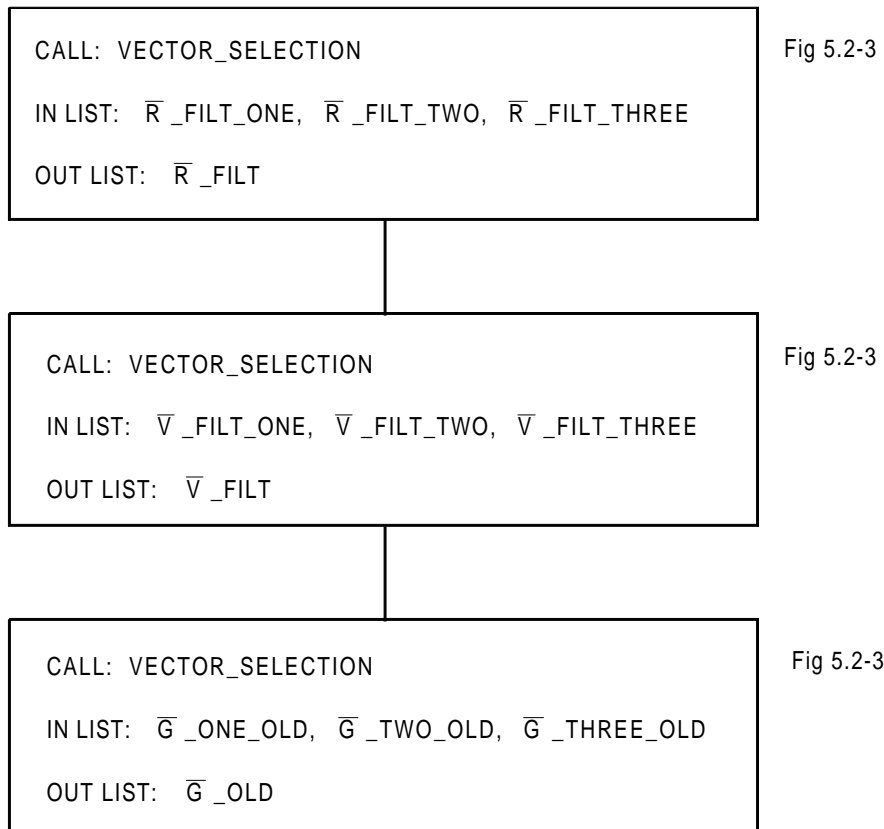


FIGURE 5.2-34. THREE\_STATE\_TO\_ONE\_STATE CODE

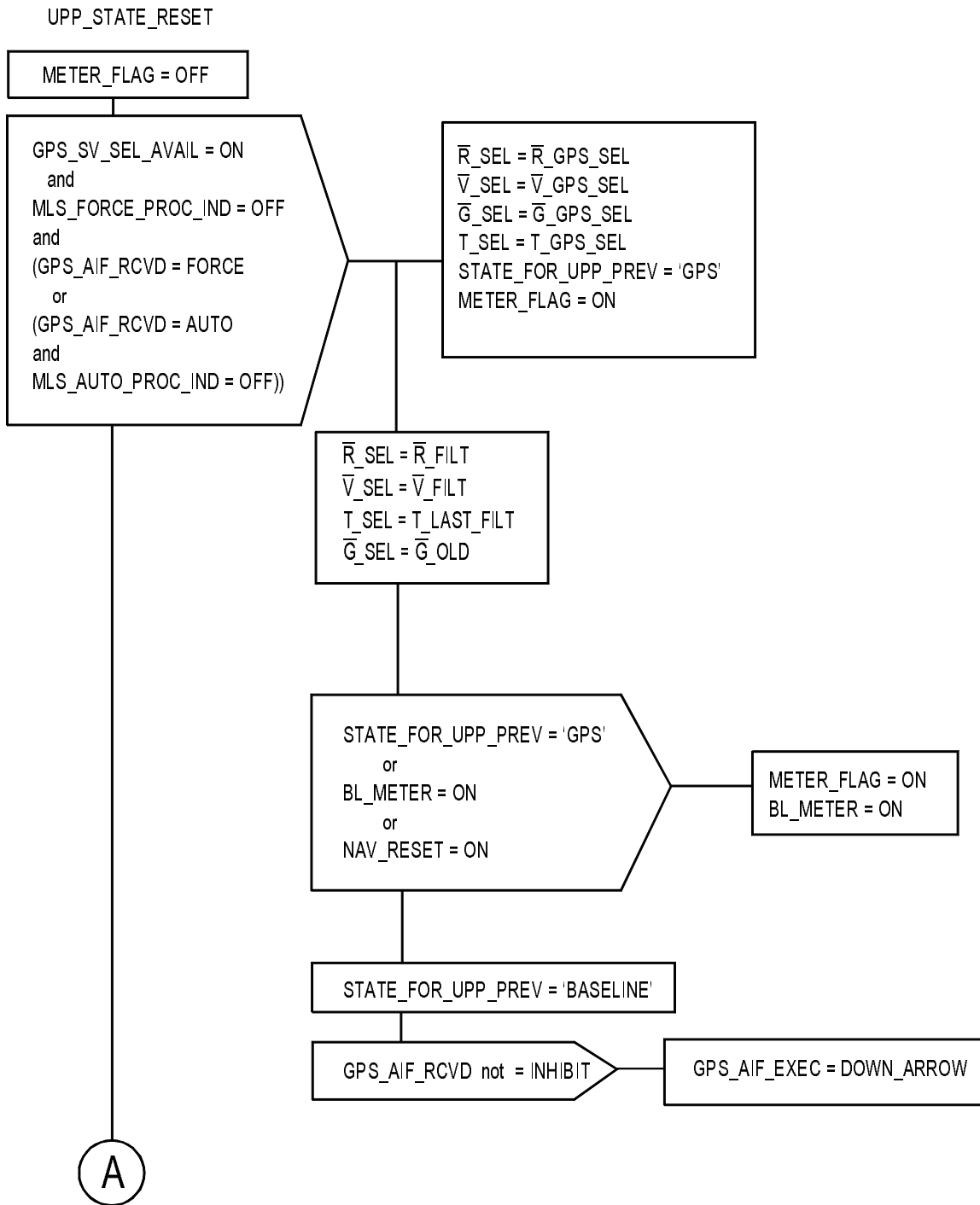


FIGURE 5.2-35.(1) UPP\_STATE\_RESET (Sheet 1 of 2)

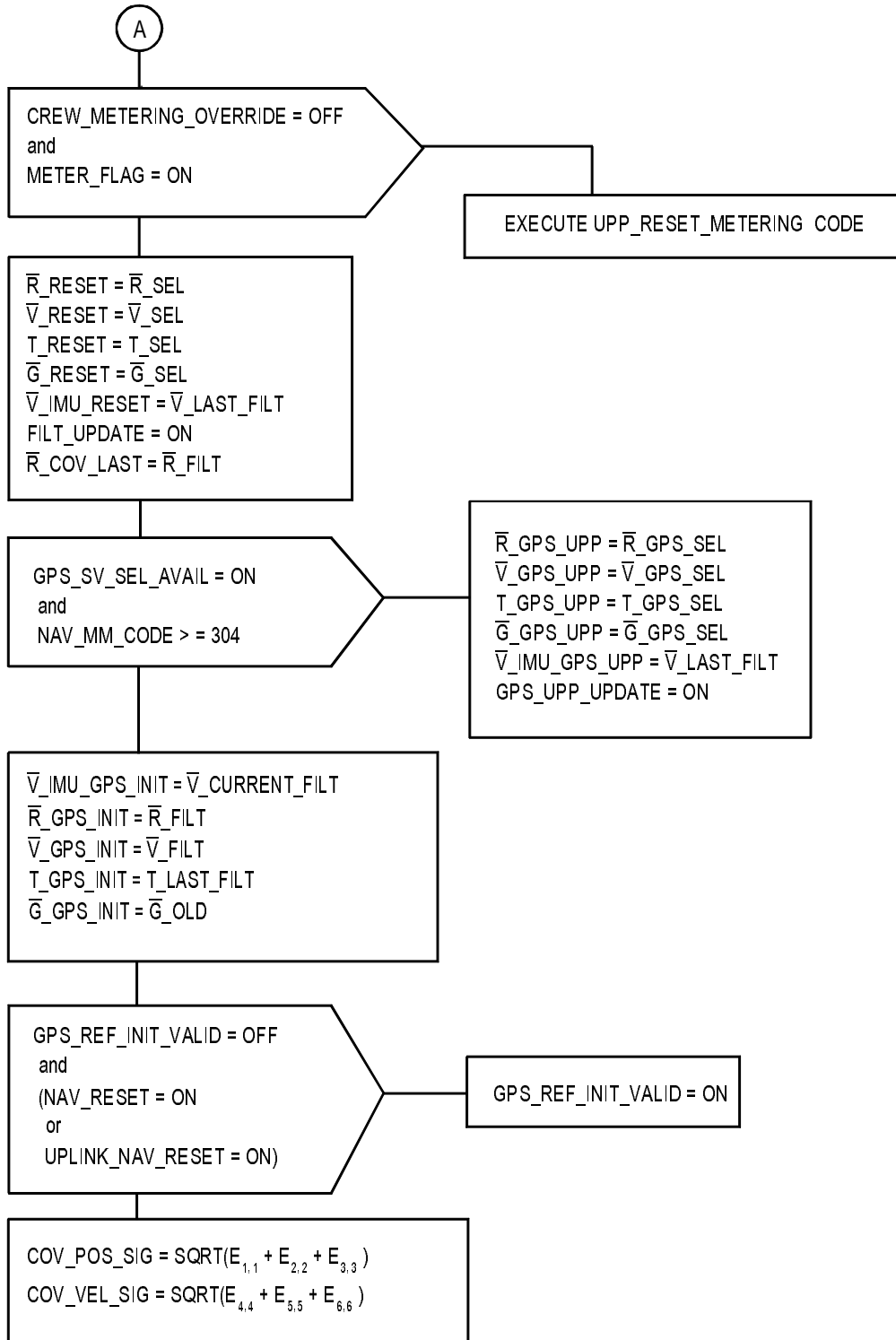


FIGURE 5.2-35.(2) UPP\_STATE\_RESET (Sheet 2 of 2)

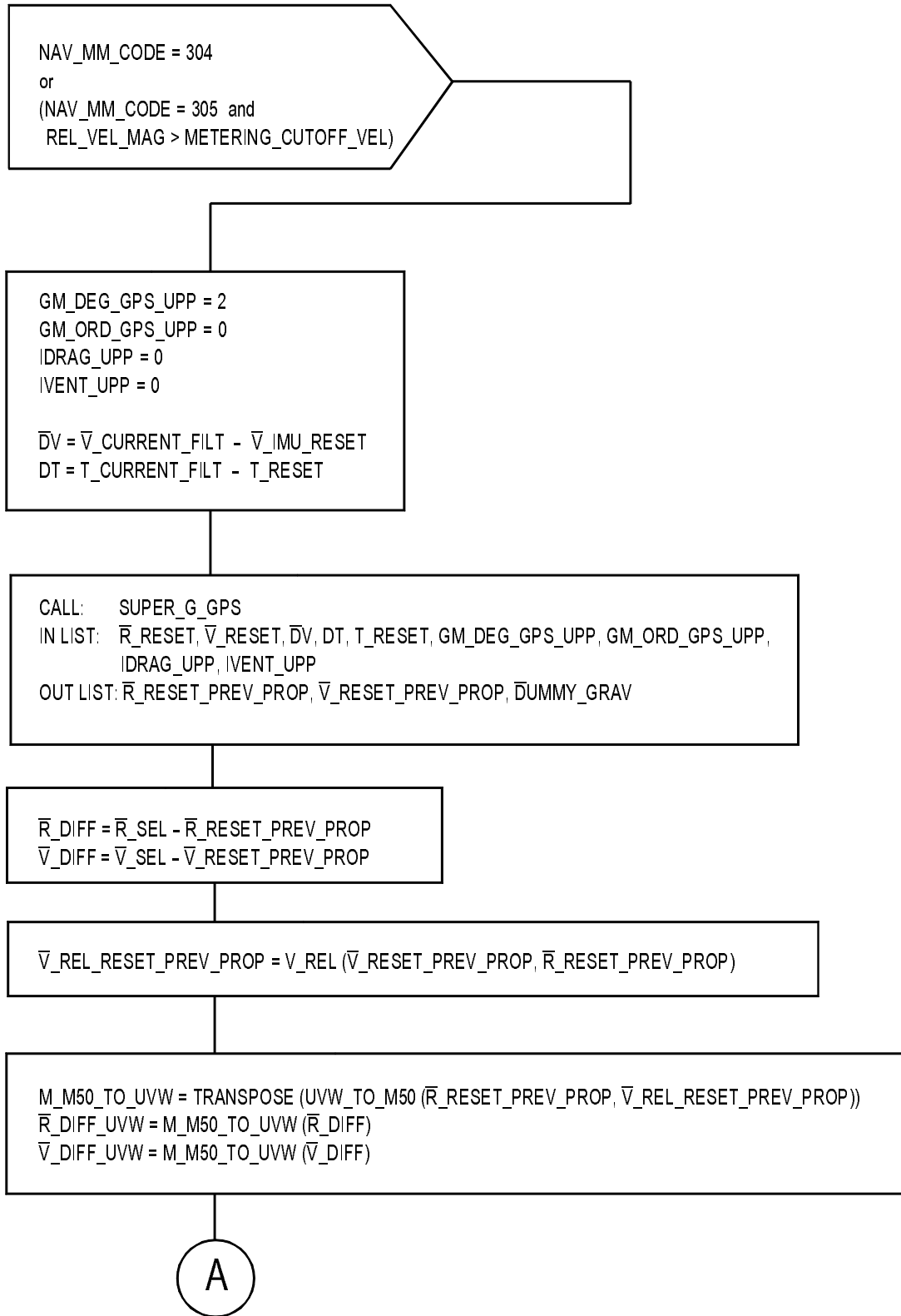


FIGURE 5.2-35A.(1) UPP\_RESET\_METERING CODE (Sheet 1 of 2)



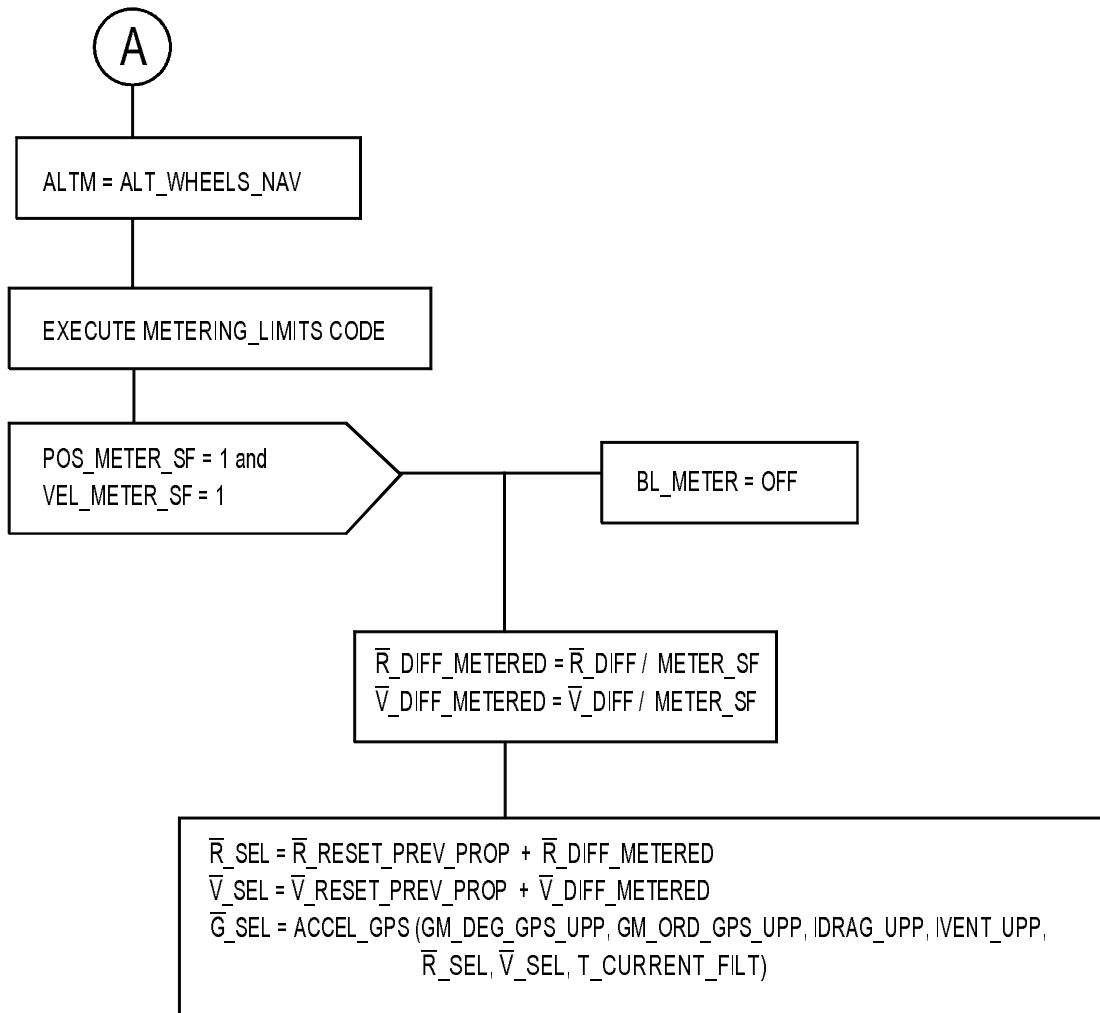


FIGURE 5.2-35A.(2) UPP\_RESET\_METERING CODE (Sheet 2 of 2)

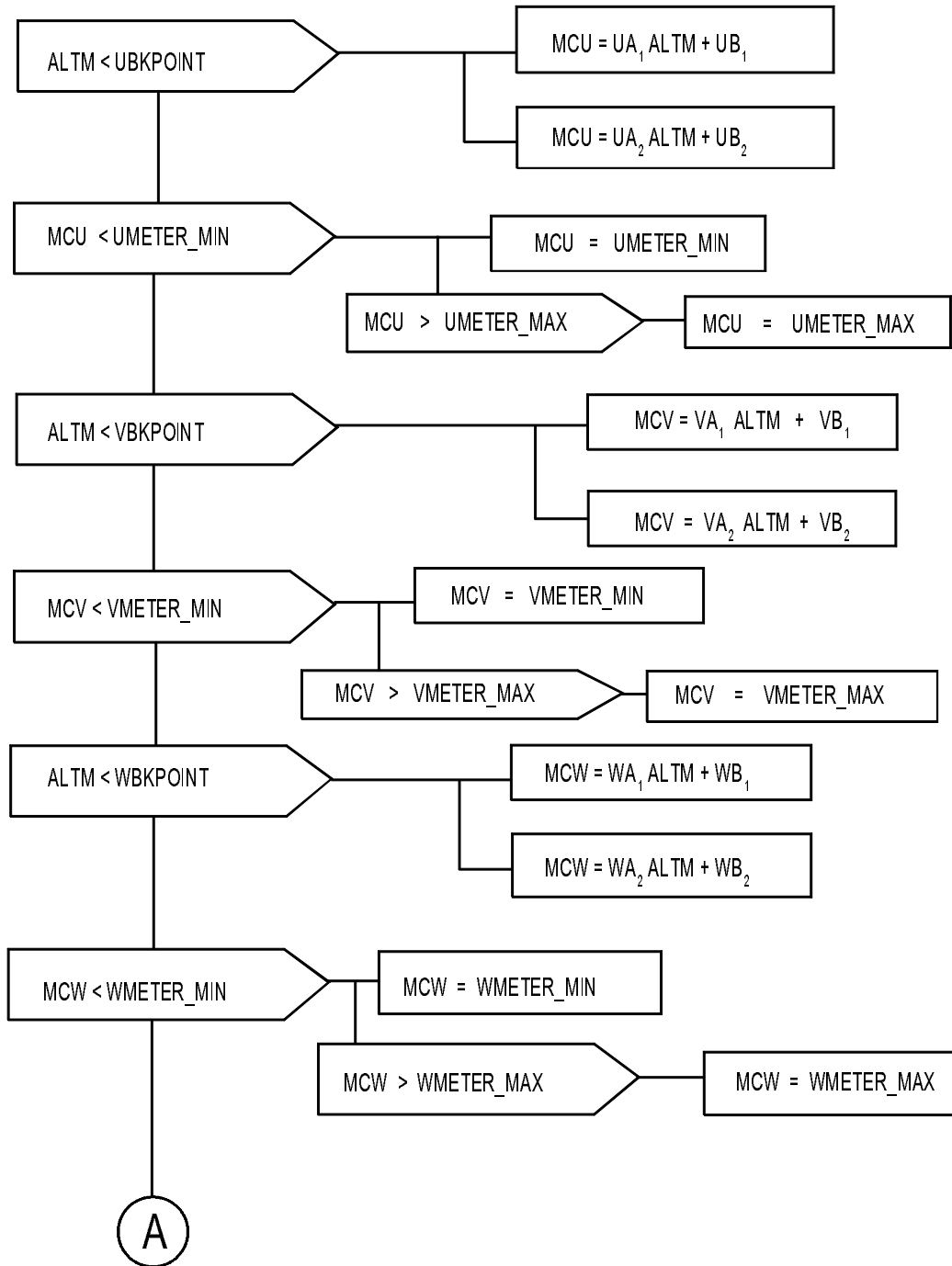


FIGURE 5.2-35B.(1) METERING\_LIMITS CODE (Sheet 1 of 3)

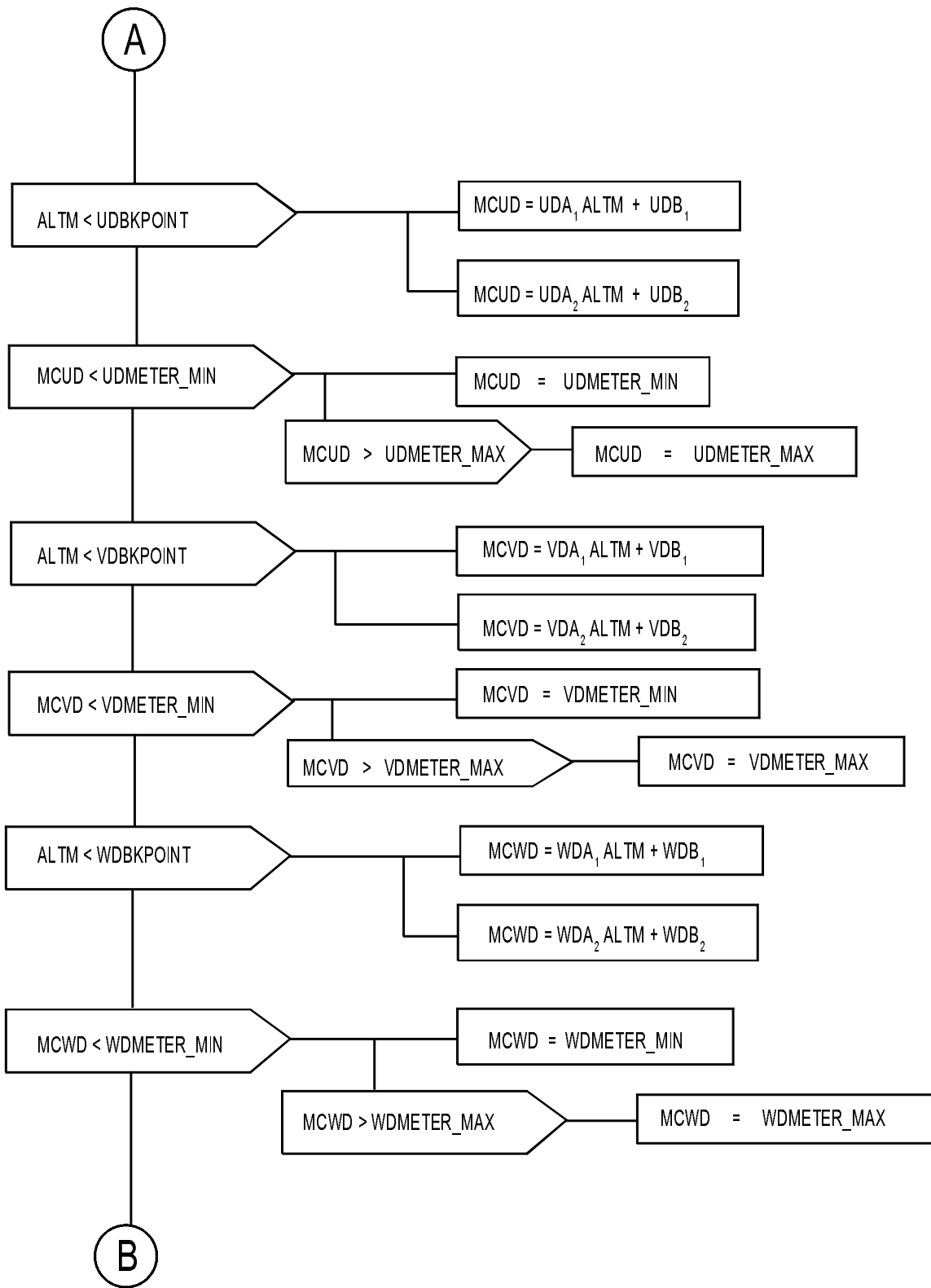


FIGURE 5.2-35B.(2) METERING\_LIMITS CODE (Sheet 2 of 3)

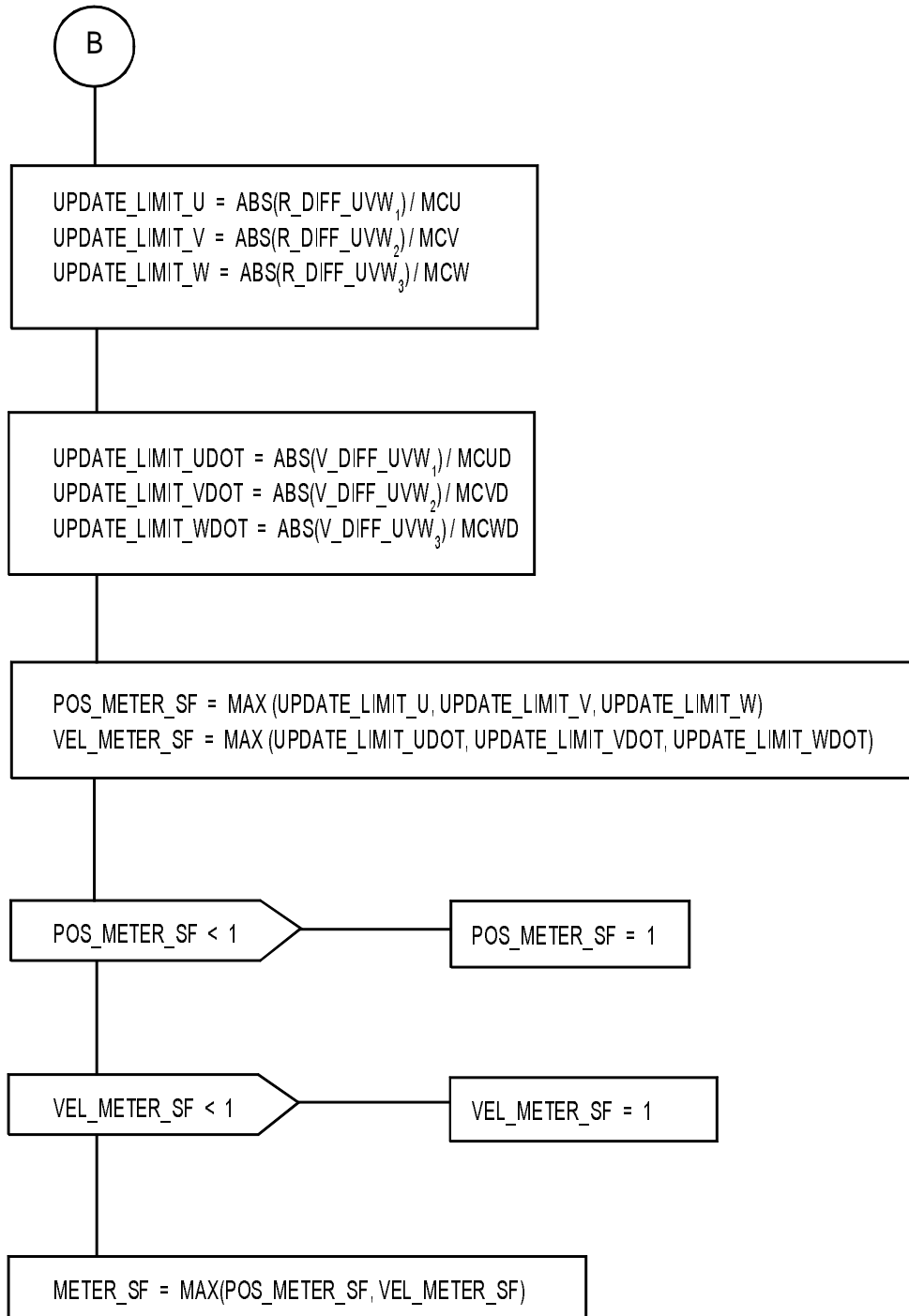


FIGURE 5.2-35B.(3) METERING\_LIMITS CODE (Sheet 3 of 3)

MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE

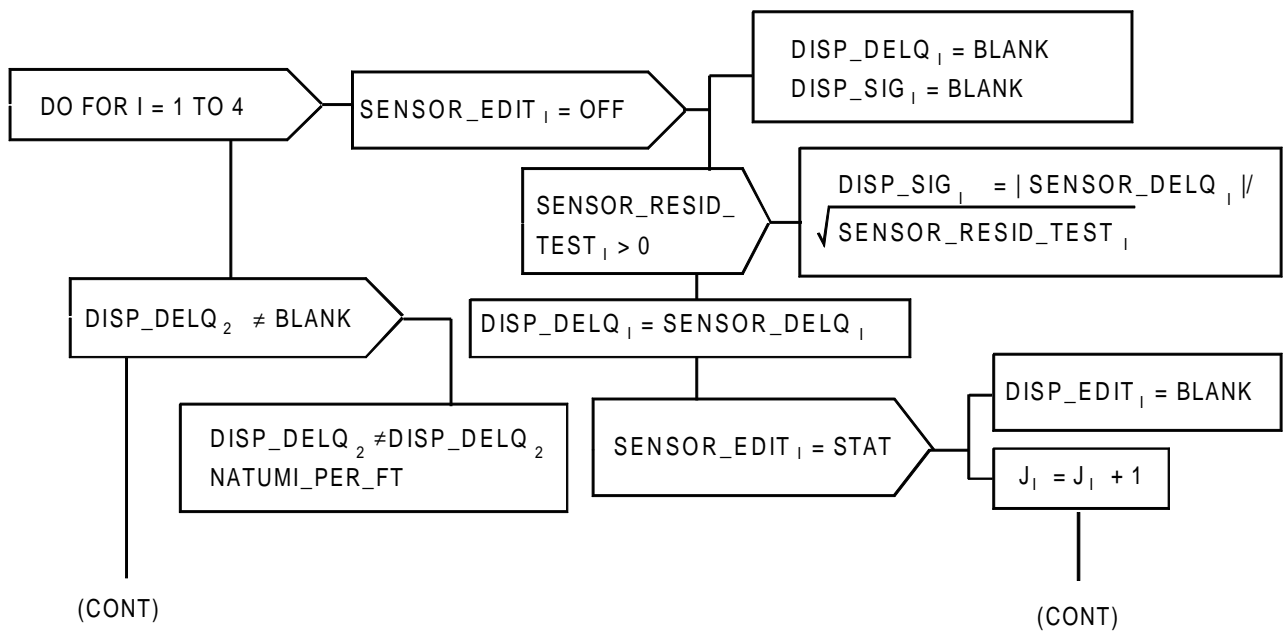
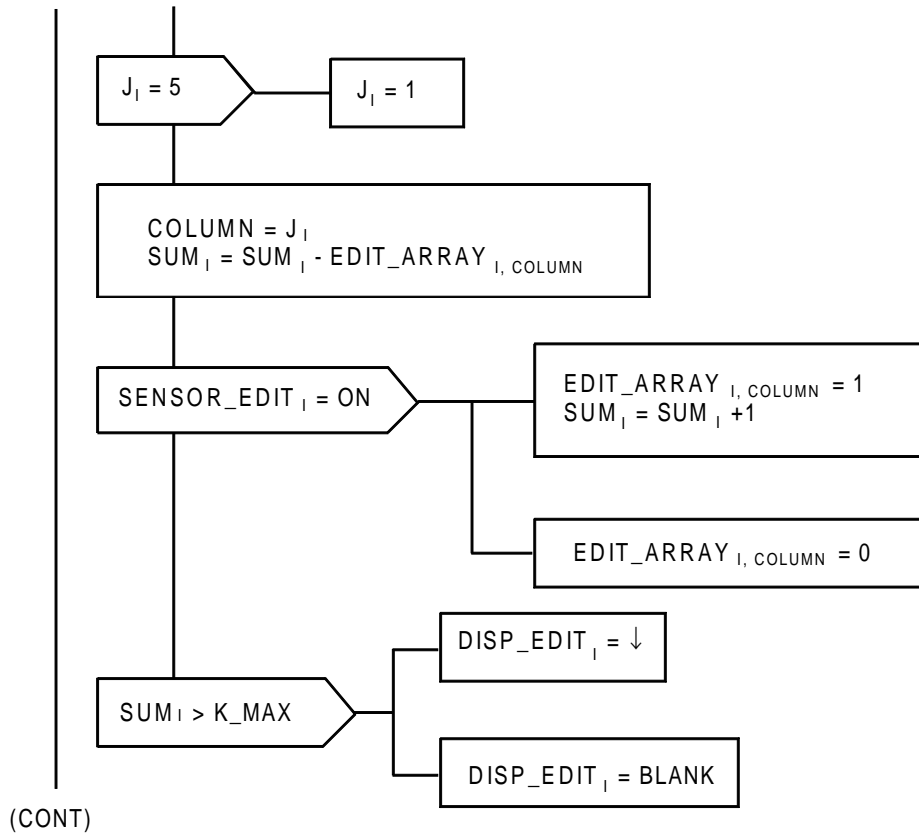


FIGURE 5.2-36.(1) MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE (Sheet 1 of 3)

MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE (CONTINUED)



NOTE: THE CORRESPONDENCE BETWEEN THE INDEX I AND THE MEASUREMENT TYPE IS AS FOLLOWS: 1-TACAN BEARING, 2-TACAN RANGE, 3-BARO ALTITUDE, AND 4-DRAG ALTITUDE

FOR FURTHER INFORMATION SEE NOTE ON FLOW CHART FOR MEAS\_PROCESSING\_STATISTICS\_PRELAND

FIGURE 5.2-36.(2) MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE (Sheet 2 of 3)

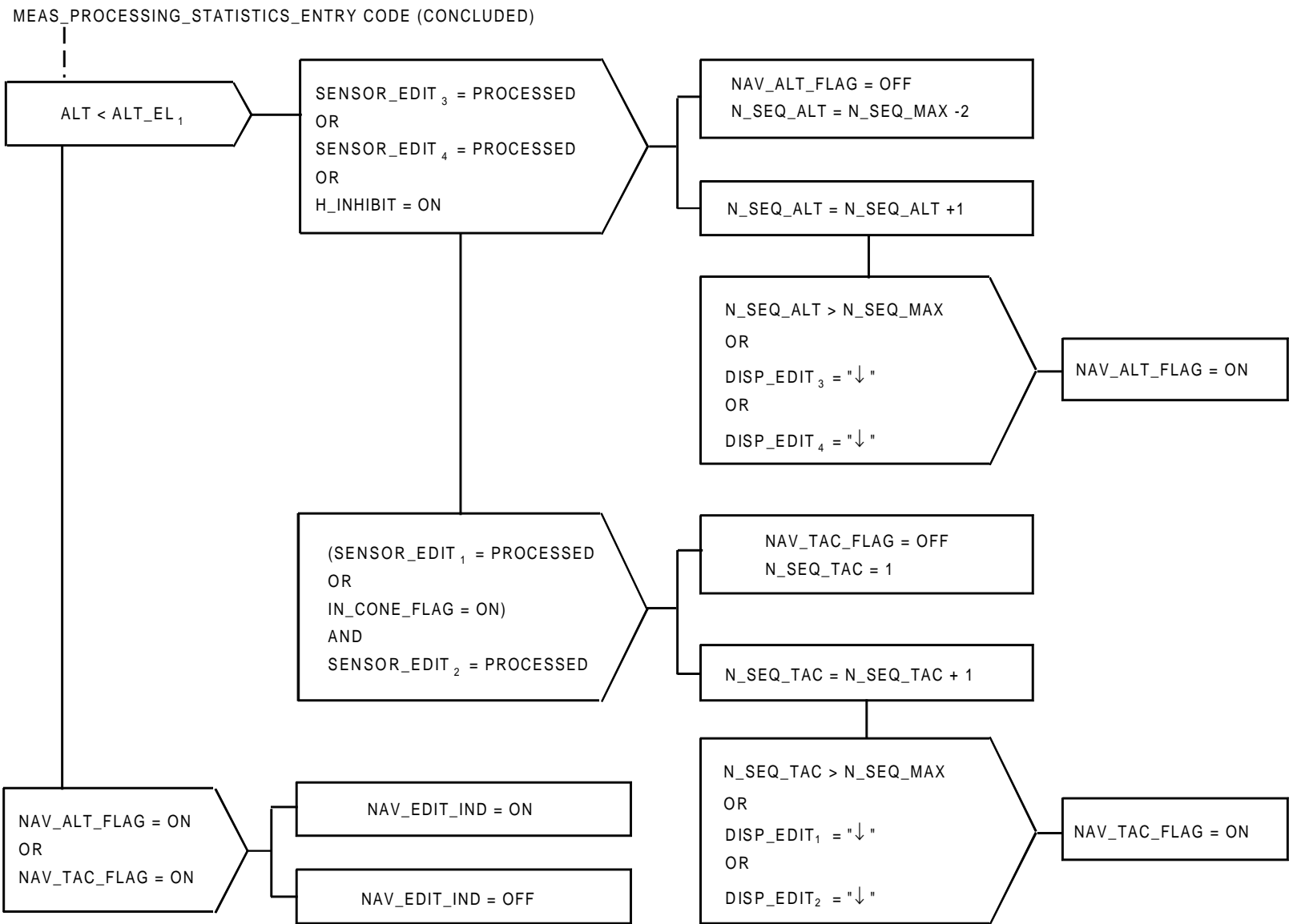


FIGURE 5.2-36.(3) MEAS\_PROCESSING\_STATISTICS\_ENTRY CODE (Sheet 3 of 3)

STS 83-0004-34  
December 14, 2007

NAV\_PRELAND

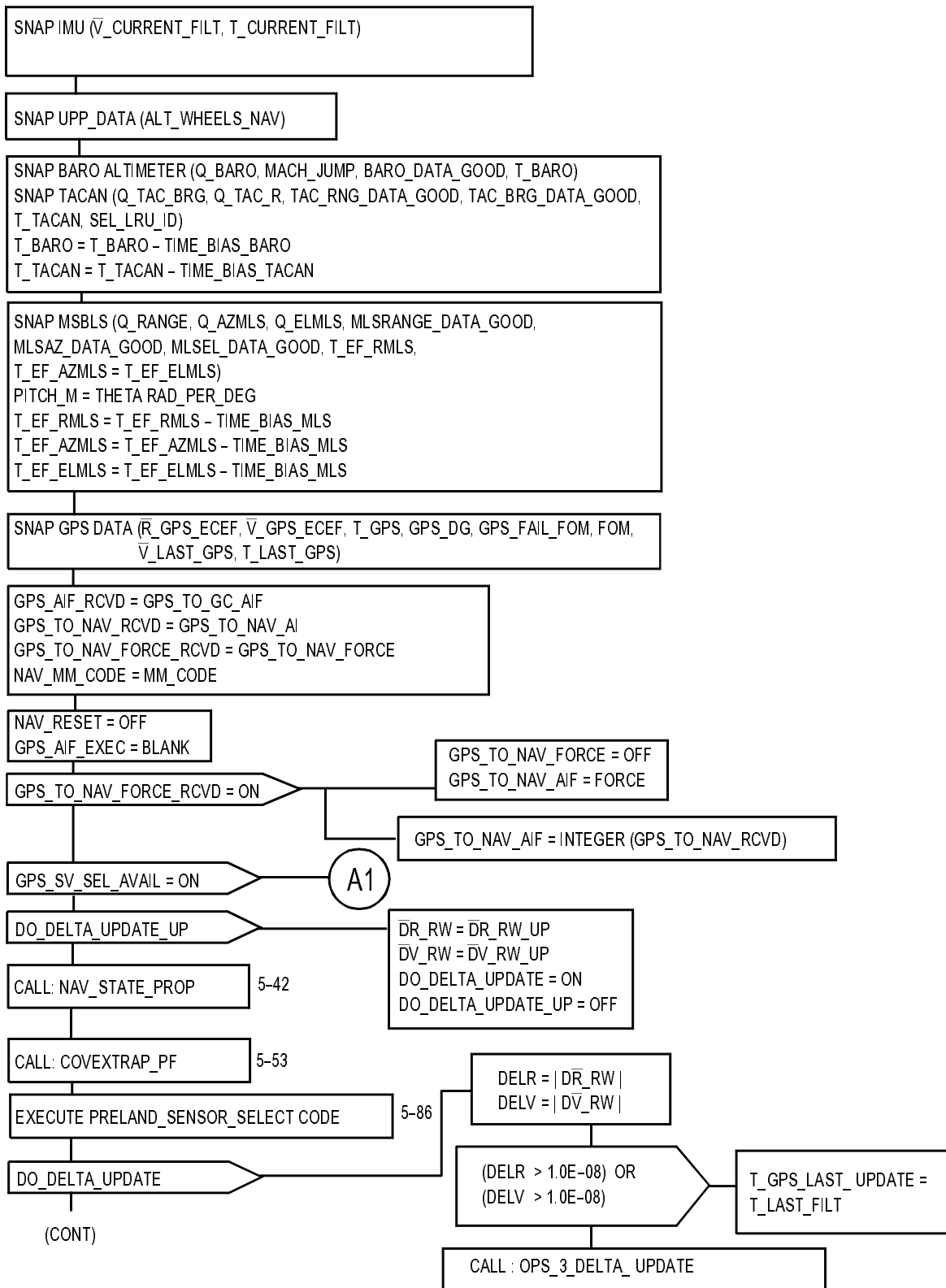


FIGURE 5.2-37.(1) NAV\_PRELAND (Sheet 1 of 4)



NAV\_PRELAND (CONCLUDED)

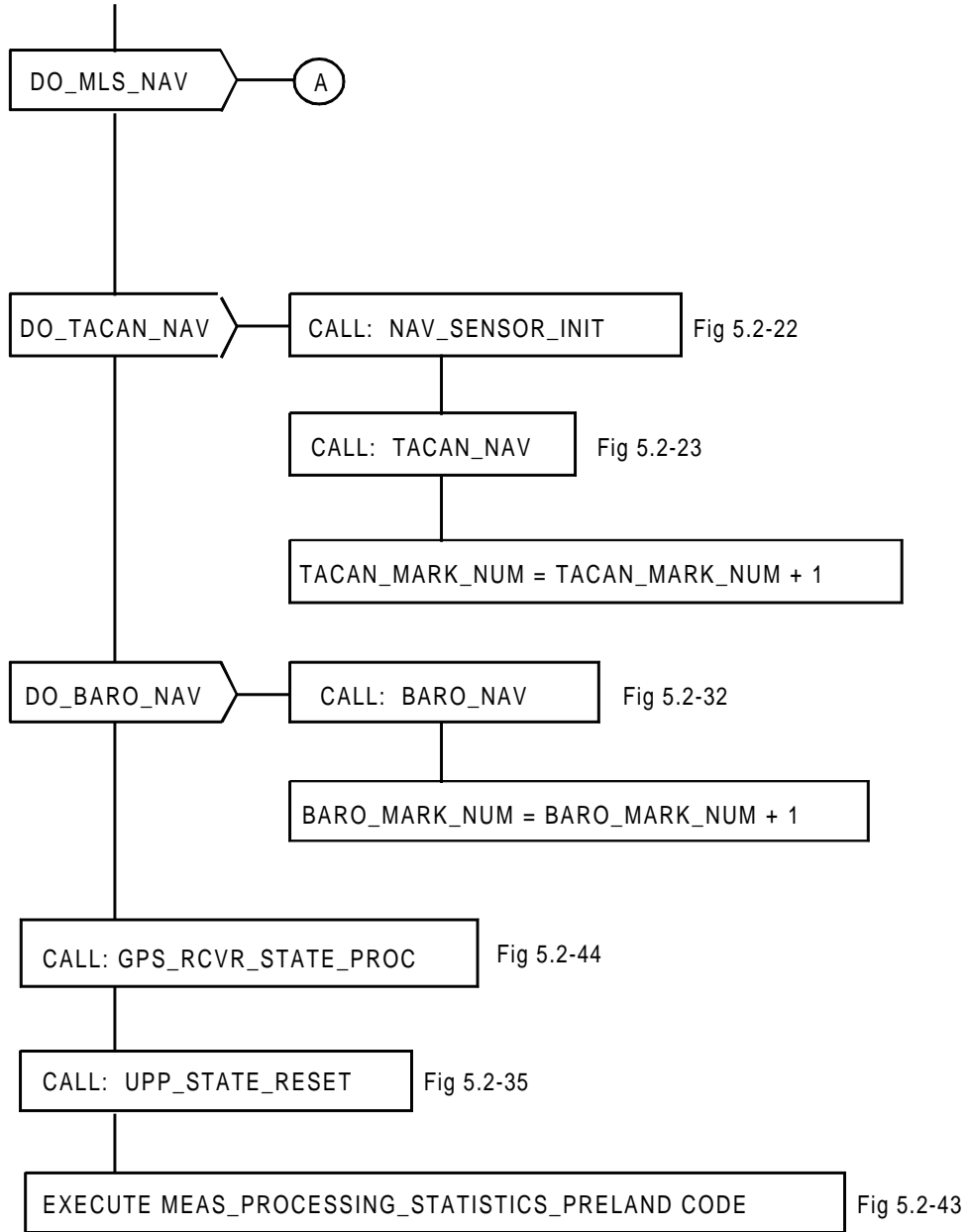


FIGURE 5.2-37.(2) NAV\_PRELAND (Sheet 2 of 4)

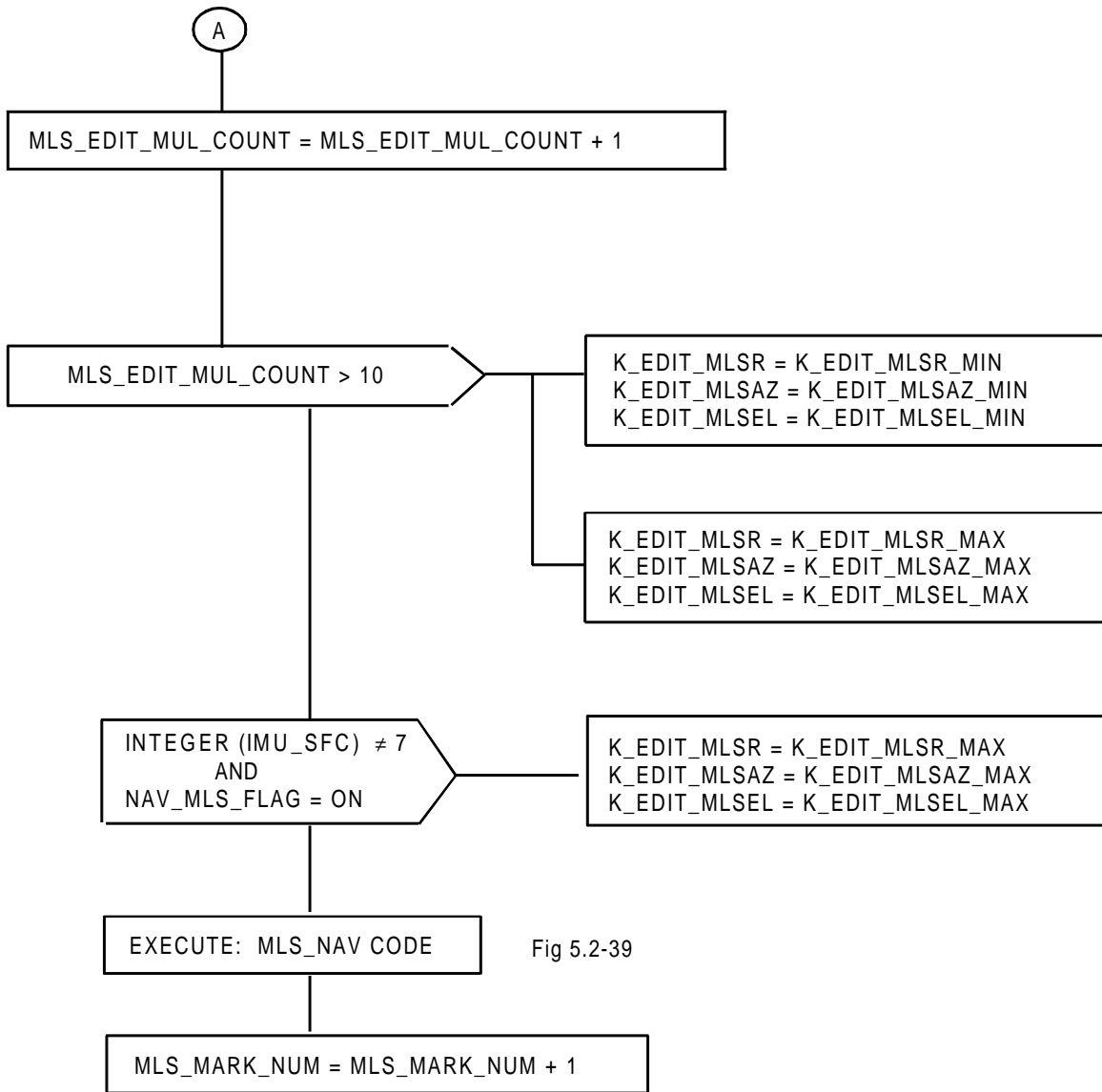


Fig 5.2-39

FIGURE 5.2-37.(3) NAV\_PRELAND (Sheet 3 of 4)

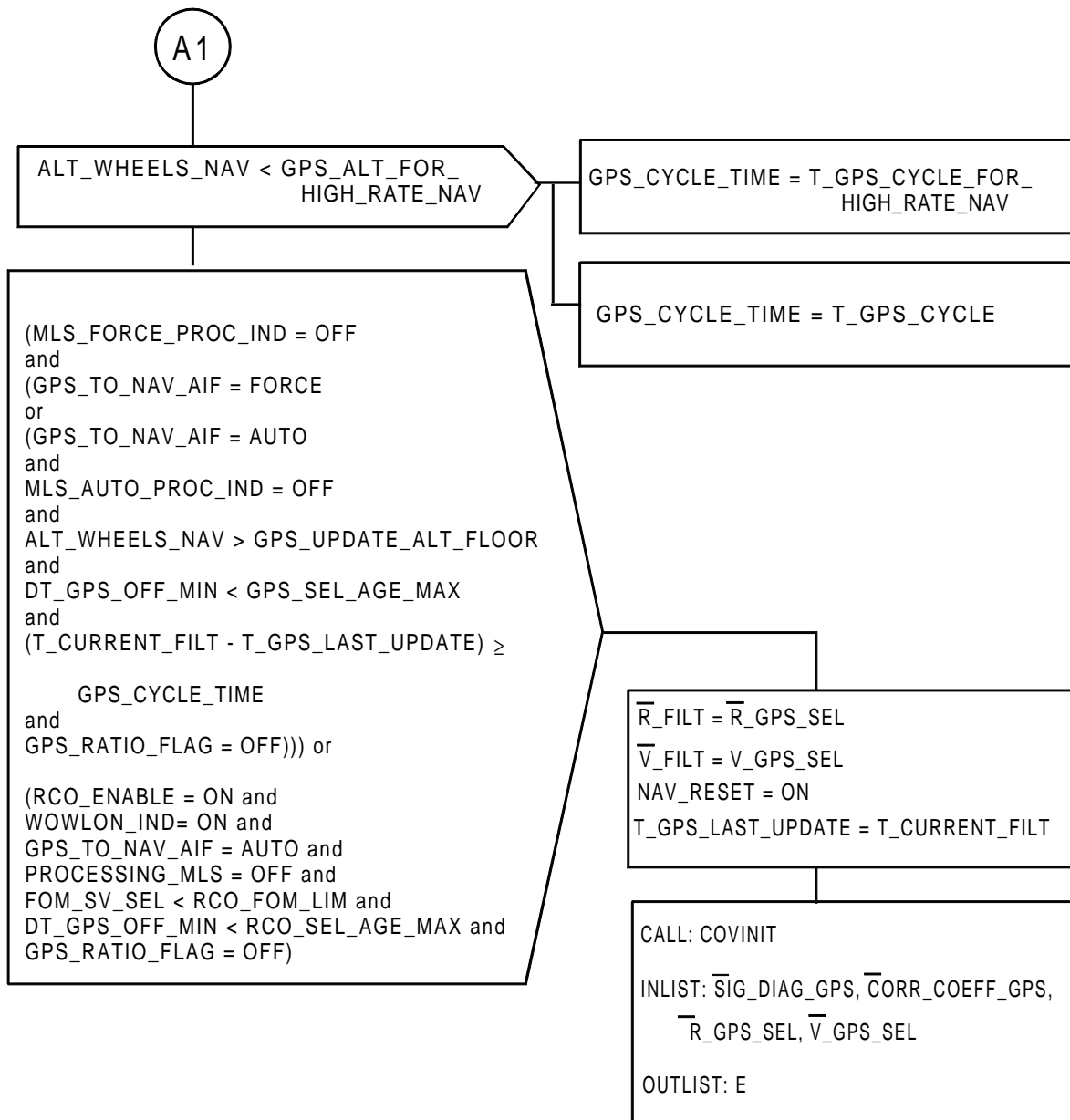


FIGURE 5.2-37.(4) NAV\_PRELAND (Sheet 4 of 4)

PRELAND\_SENSOR\_SELECT CODE

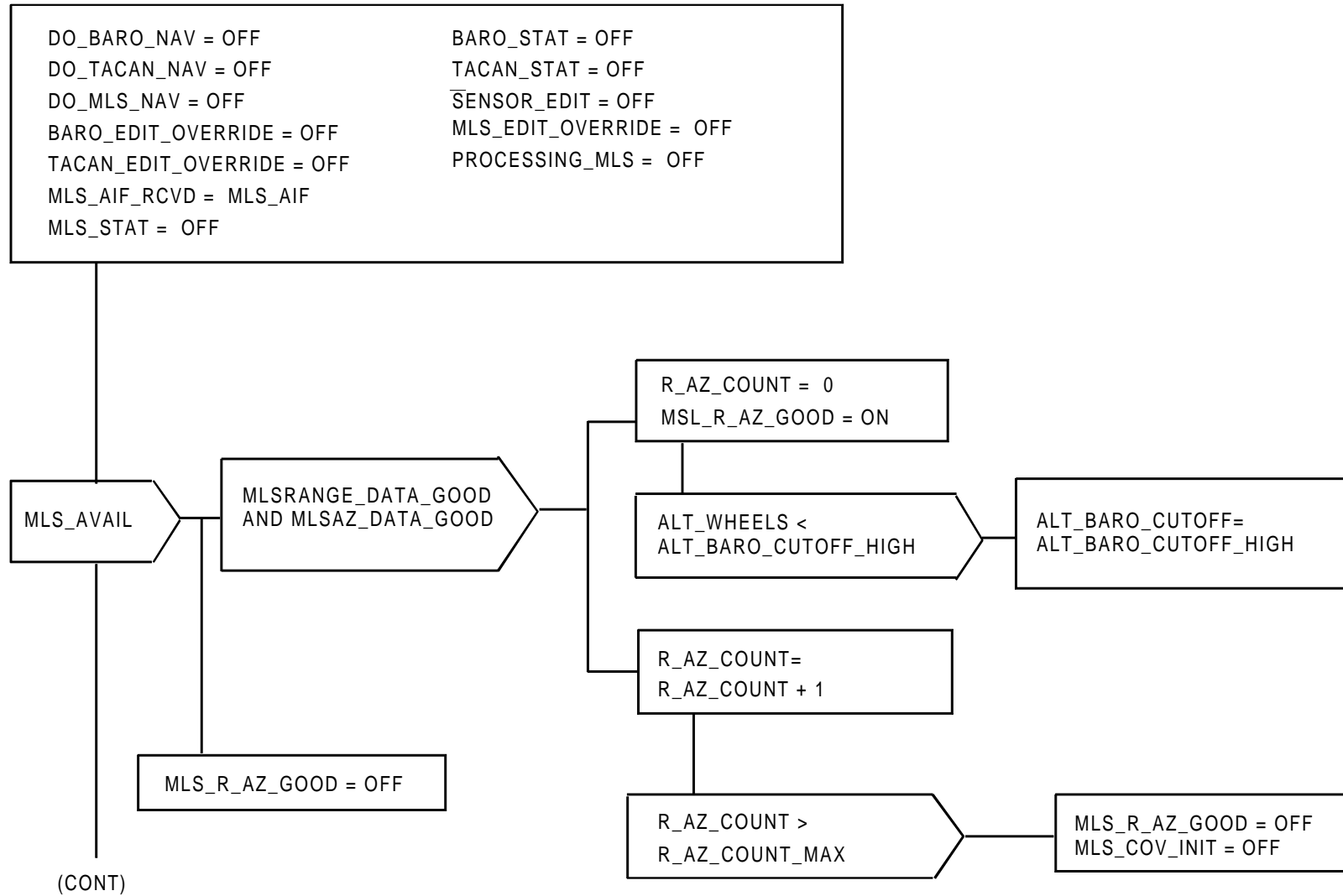


FIGURE 5.2-38.(1) PRELAND\_SENSOR\_SELECT CODE (Sheet 1 of 4)

PRELAND\_SENSOR\_SELECT CODE (CONCLUDED)

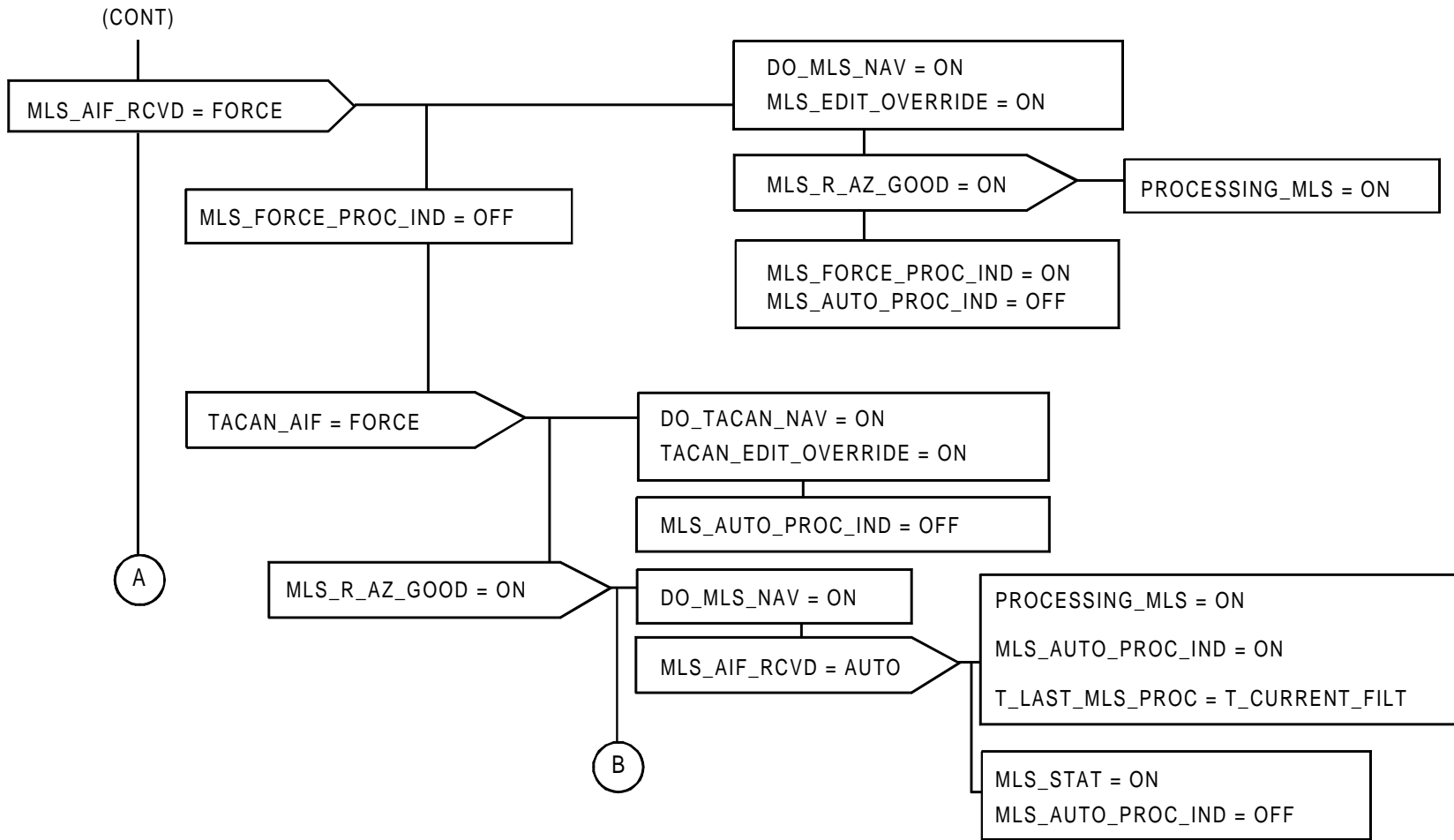


FIGURE 5.2-38.(2) PRELAND\_SENSOR\_SELECT CODE (Sheet 2 of 4)

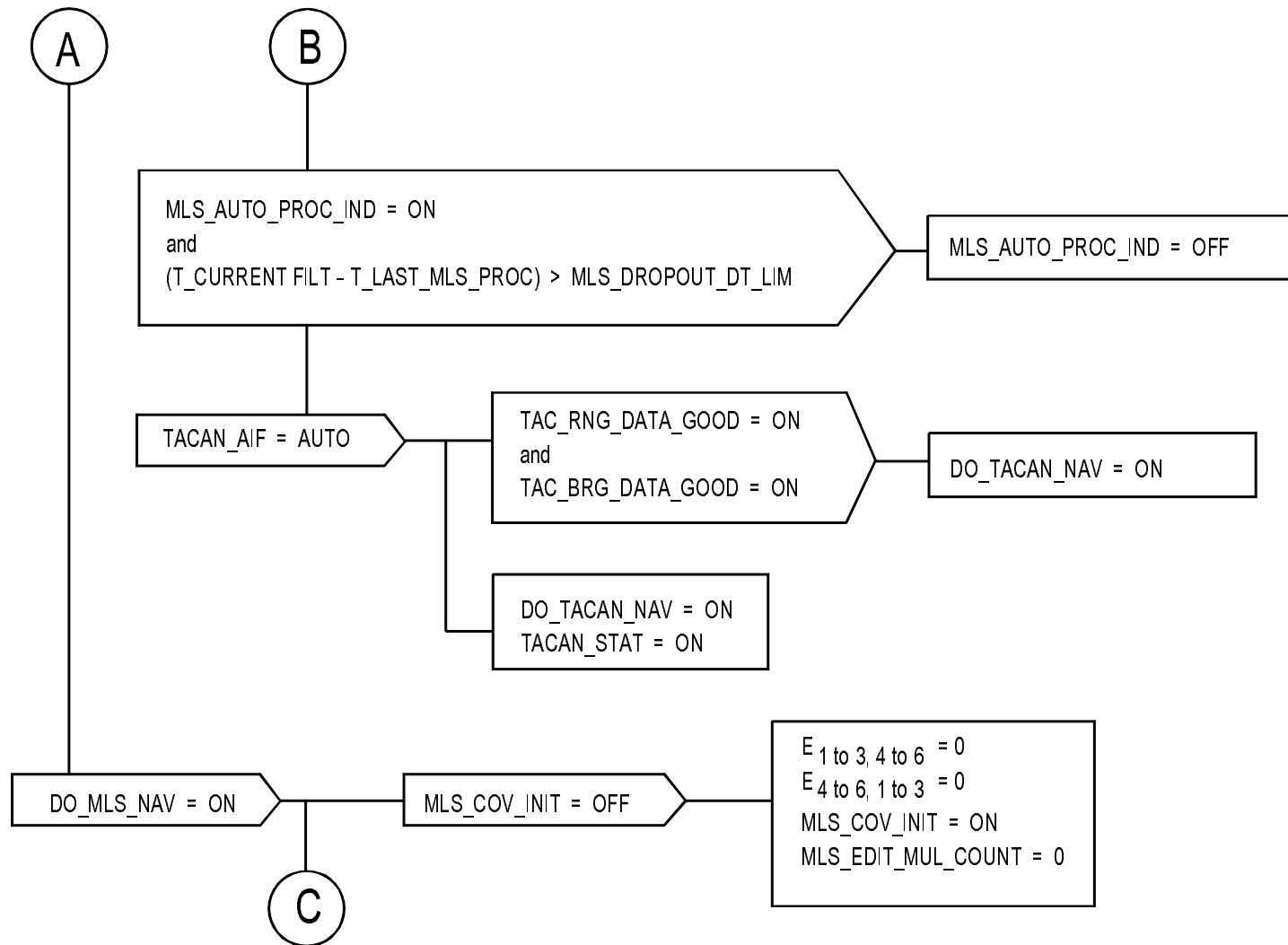


FIGURE 5.2-38.(3) PRELAND\_SENSOR\_SELECT CODE (Sheet 3 of 4)

PRELAND\_SENSOR\_SELECT CODE (CONCLUDED)

(CONT)

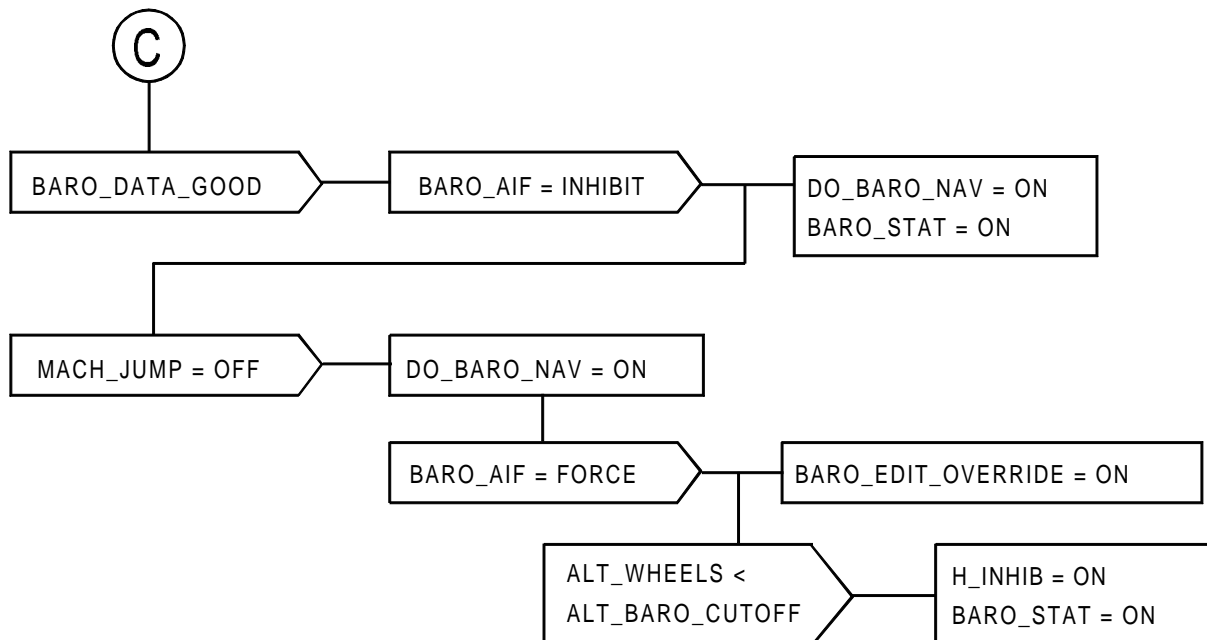


FIGURE 5.2-38.(4) PRELAND\_SENSOR\_SELECT CODE (Sheet 4 of 4)

MLS\_NAV CODE

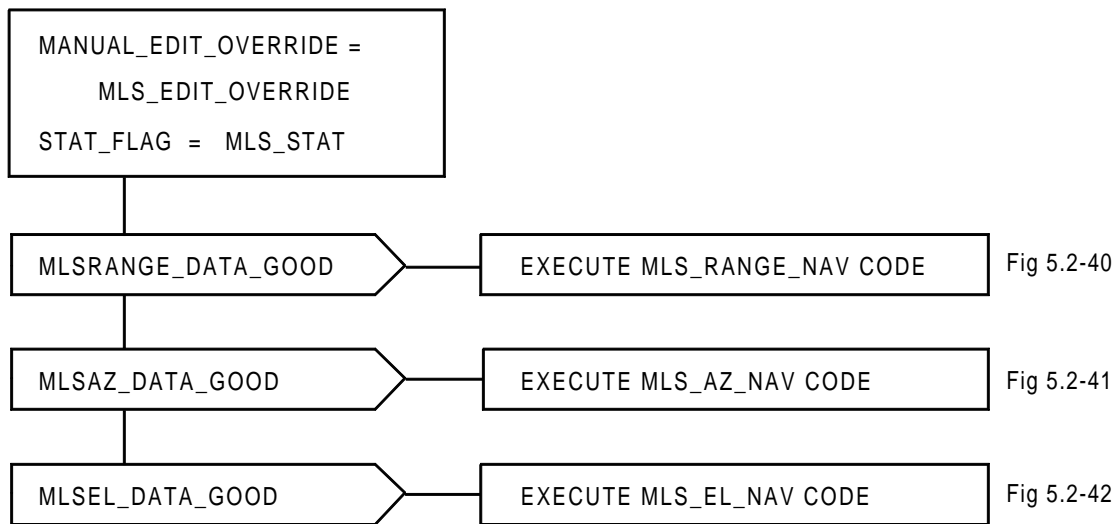


FIGURE 5.2-39. MLS\_NAV CODE



MLS\_RANGE\_NAV CODE

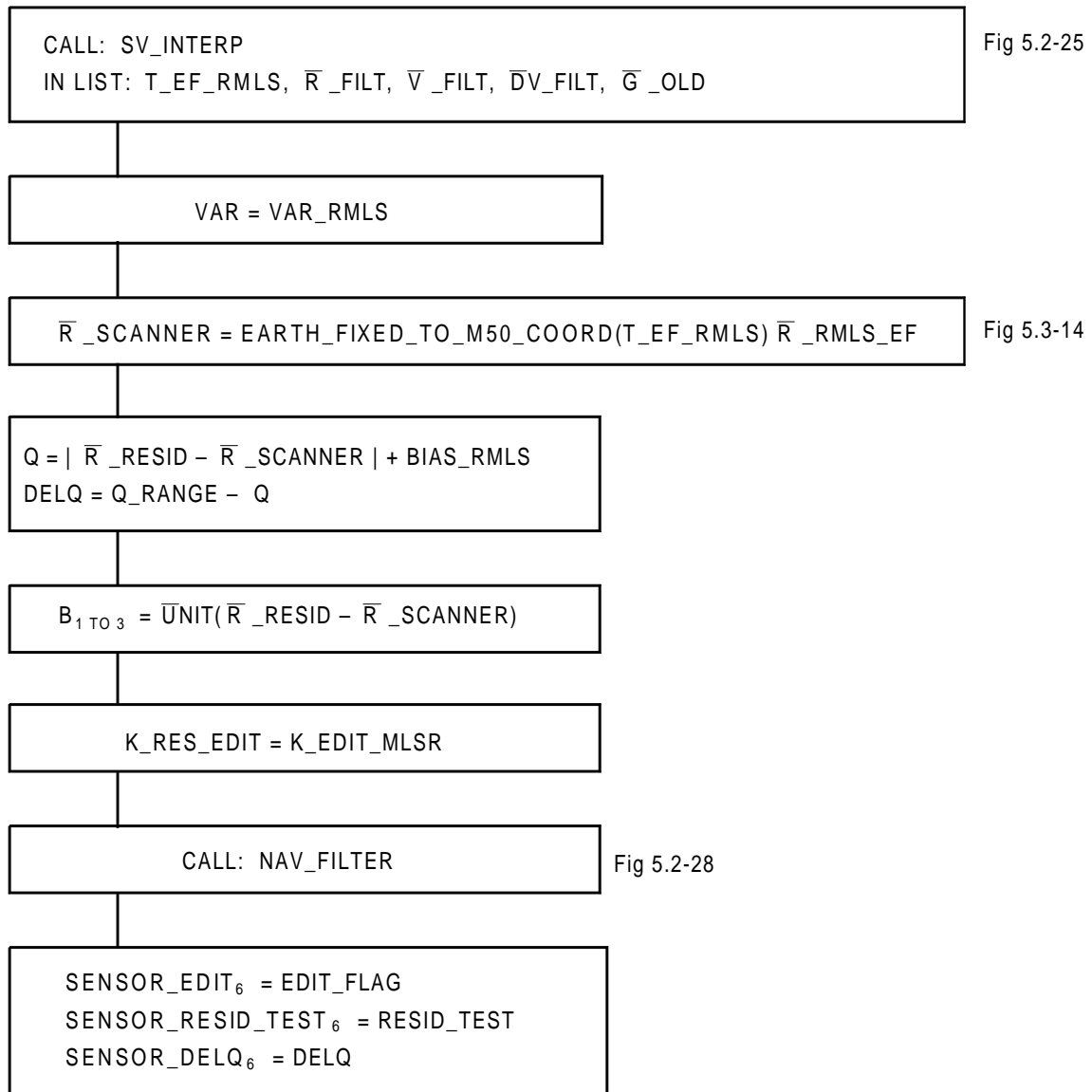


FIGURE 5.2-40. MLS\_RANGE\_NAV CODE

MLS\_AZ\_NAV CODE

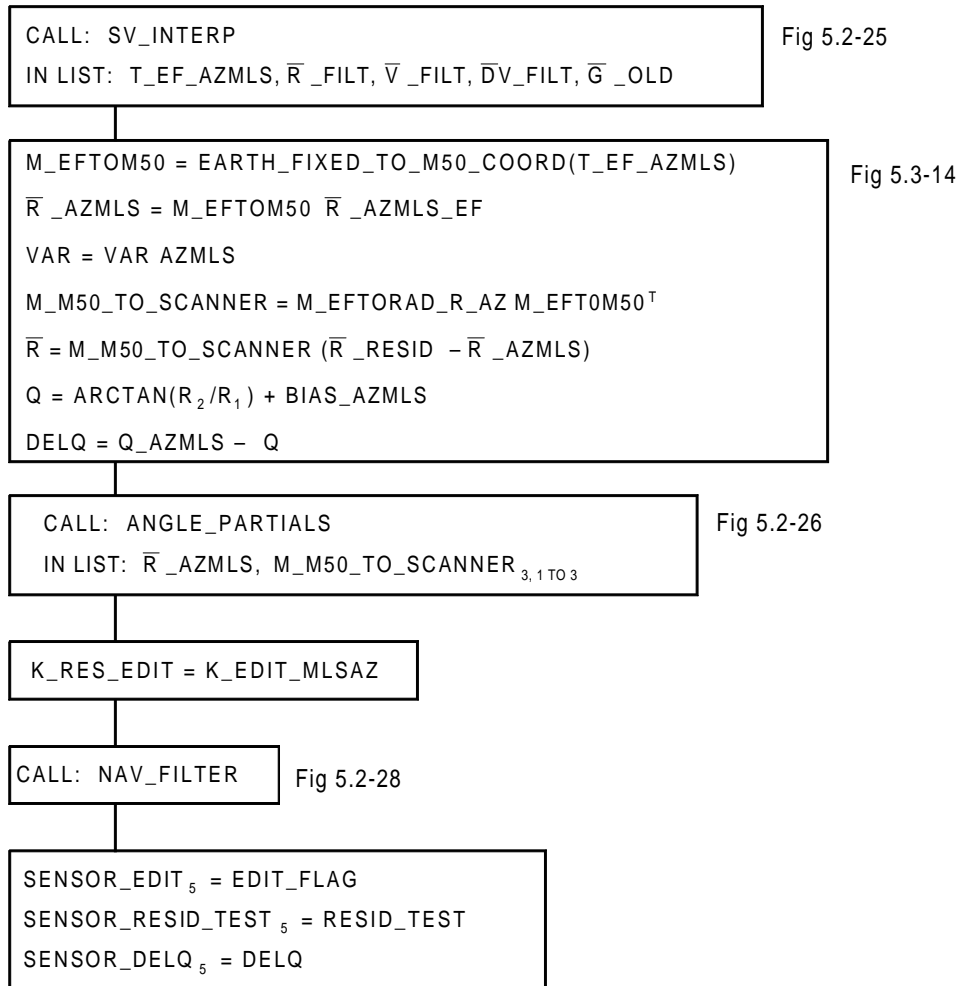


FIGURE 5.2-41. MLS\_AZ\_NAV CODE

MLS\_EL\_NAV CODE

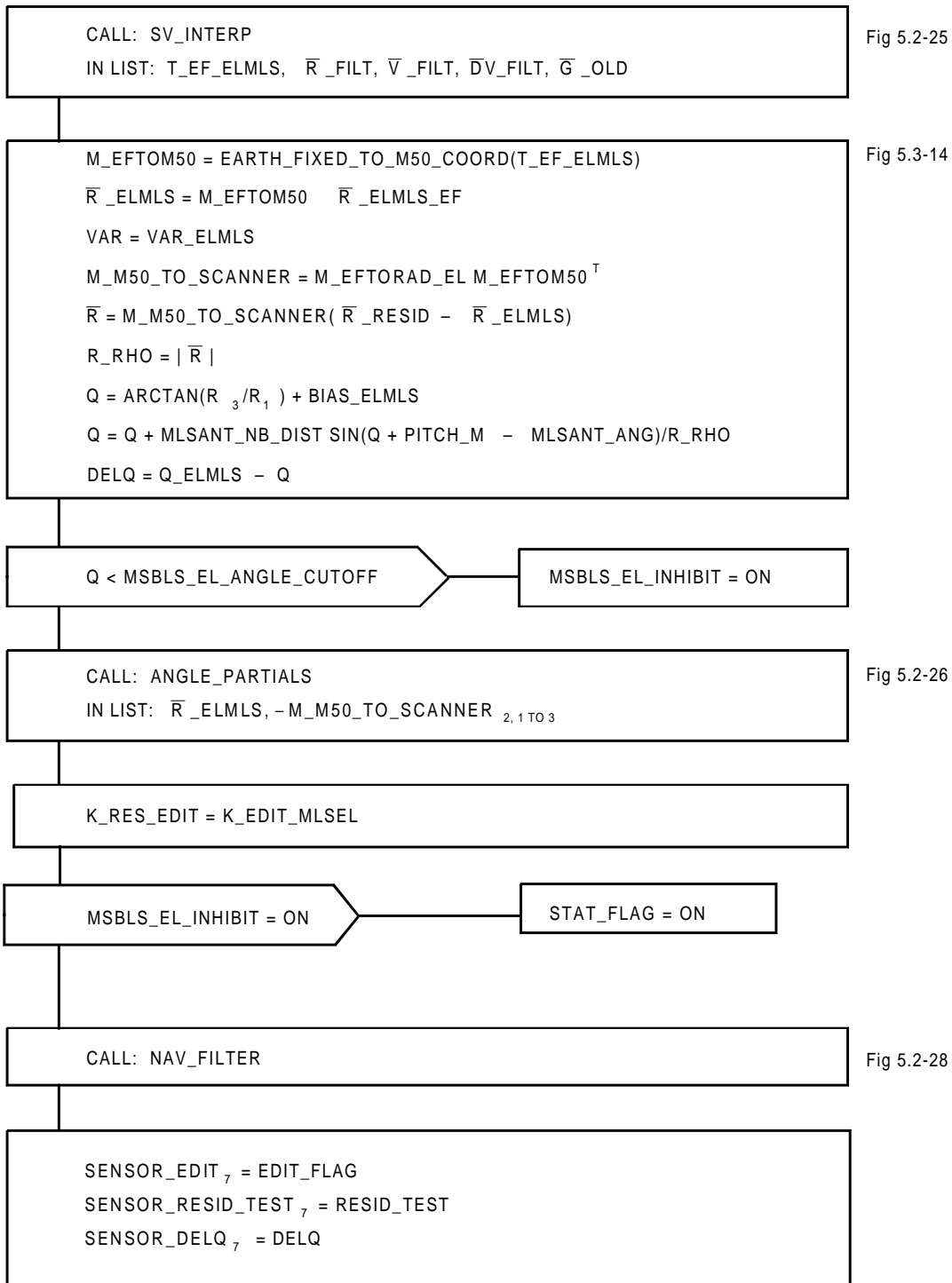


FIGURE 5.2-42. MLS\_EL\_NAV CODE

MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE

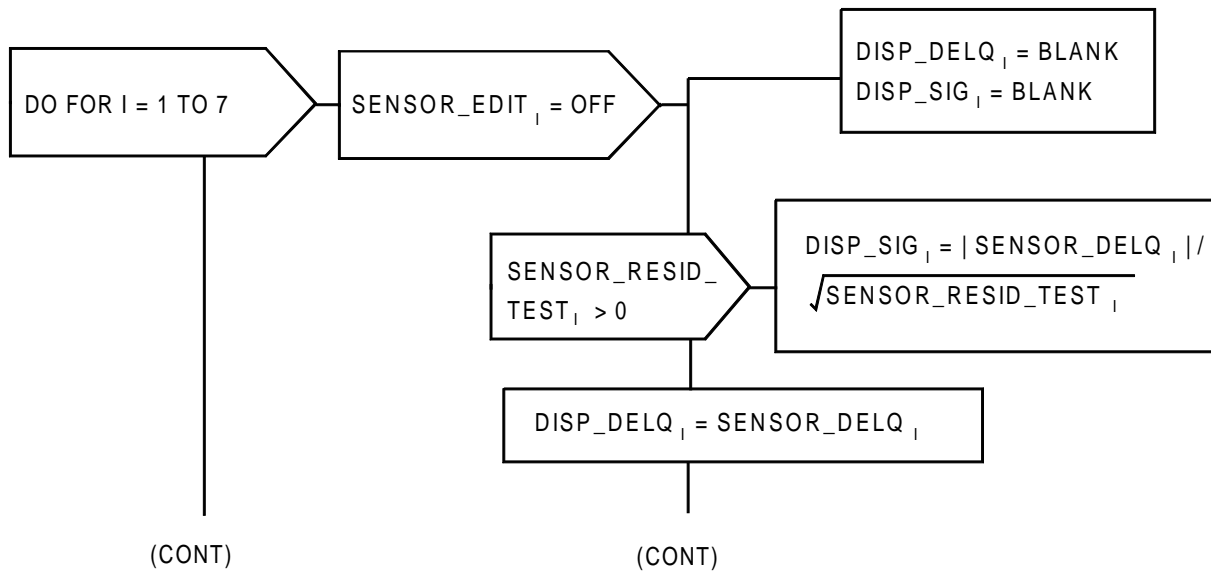
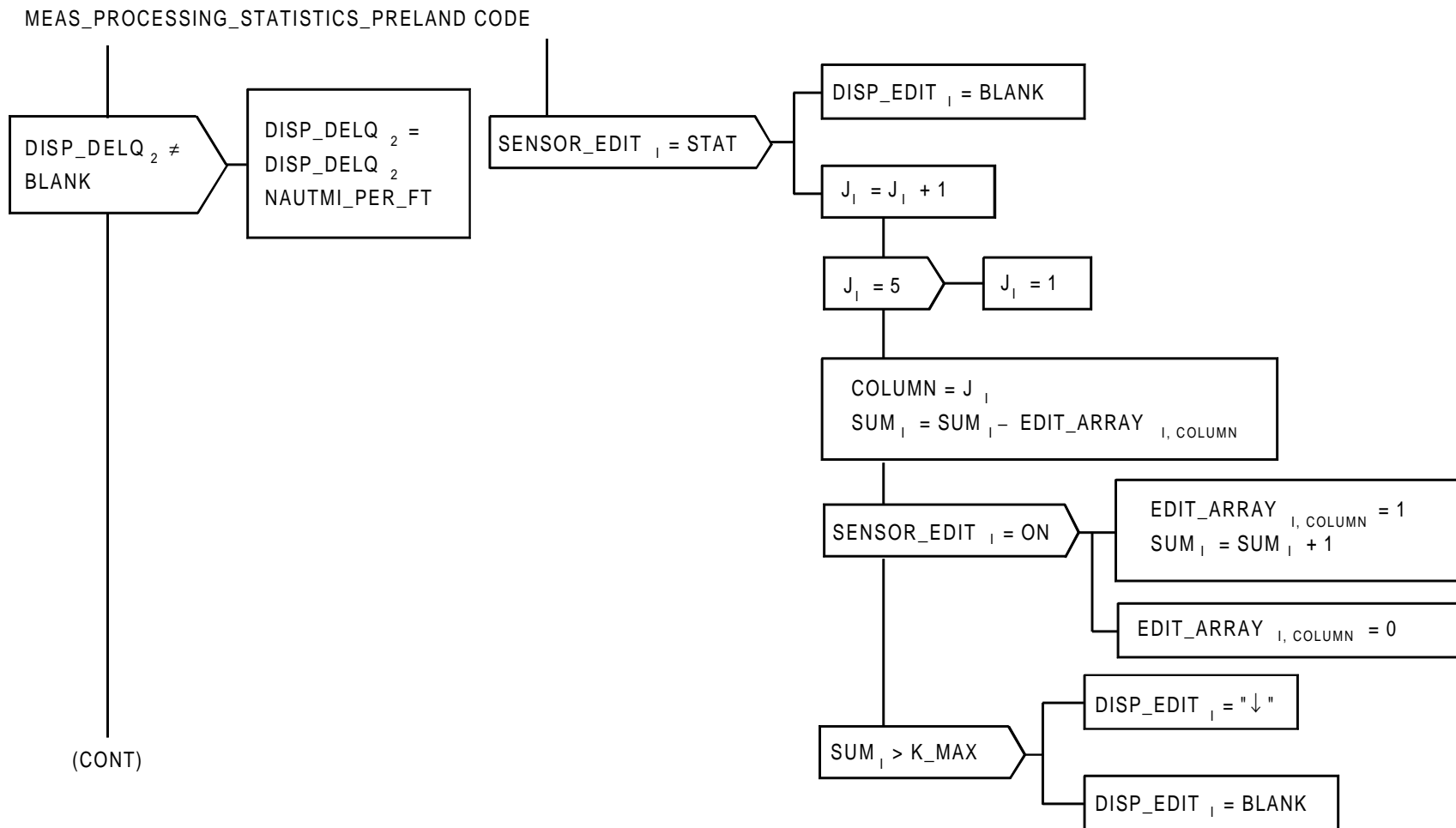


FIGURE 5.2-43.(1) MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE (Sheet 1 of 3)



NOTE: THE VECTORS  $\bar{D}ISP\_EDIT$ ,  $\bar{D}ISP\_DELQ$ , AND  $\bar{D}ISP\_SIG$  ARE OUTPUT TO COMPOOL FOR SUBSEQUENT USE BY DISPLAYS.

THE CORRESPONDENCE BETWEEN THE INDEX I AND THE MEASUREMENT TYPE IS AS FOLLOWS:  
 1-TACAN BEARING, 2 TACAN RANGE, 3 BARO ALTITUDE, 4 DRAG ALTITUDE, 5 HLS-AZIMUTH,  
 6-MLS RANGE, AND 7 MLS ELEVATION.

FIGURE 5.2-43.(2) MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE (Sheet 2 of 3)

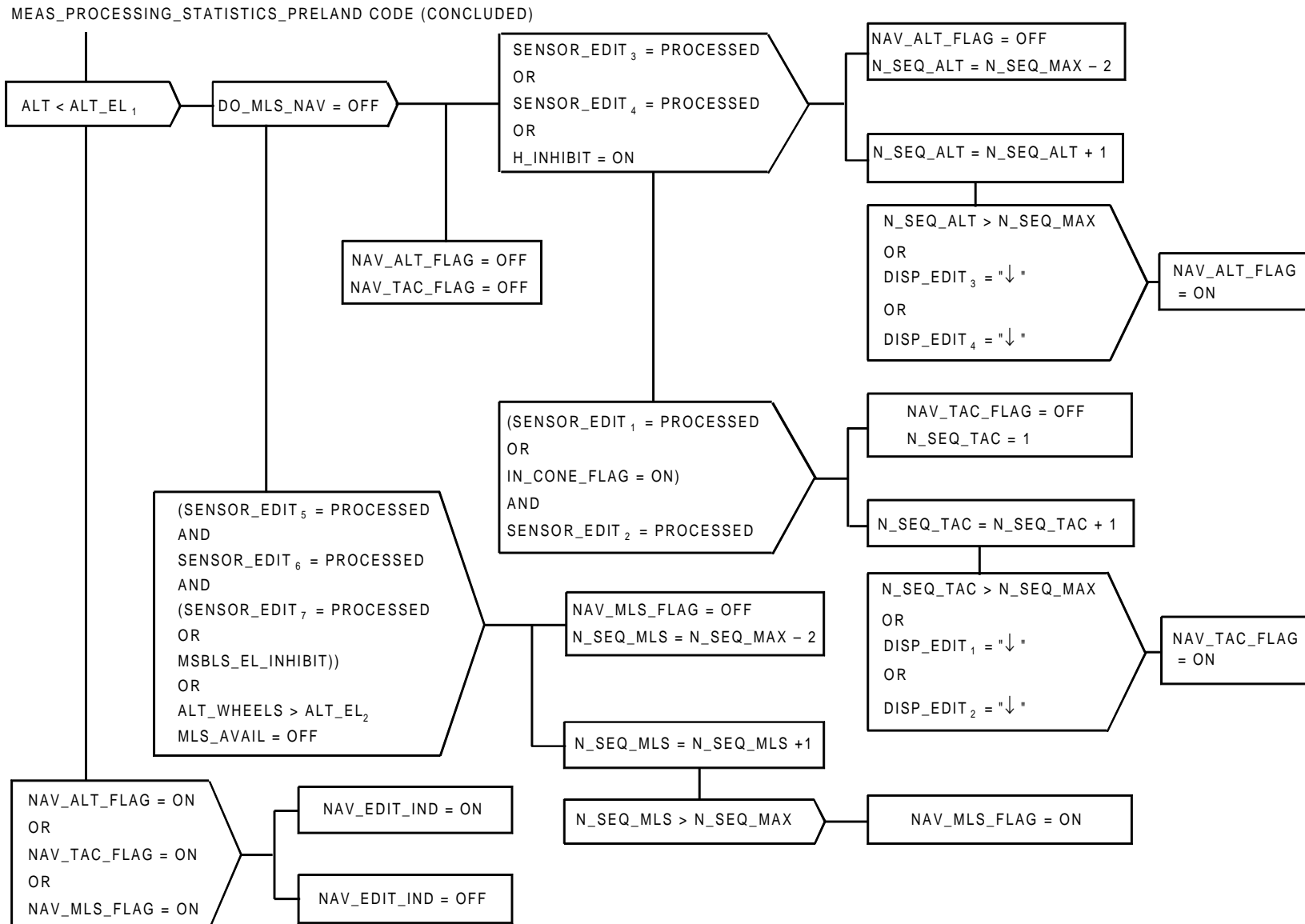


FIGURE 5.2-43.(3) MEAS\_PROCESSING\_STATISTICS\_PRELAND CODE (Sheet 3 of 3)

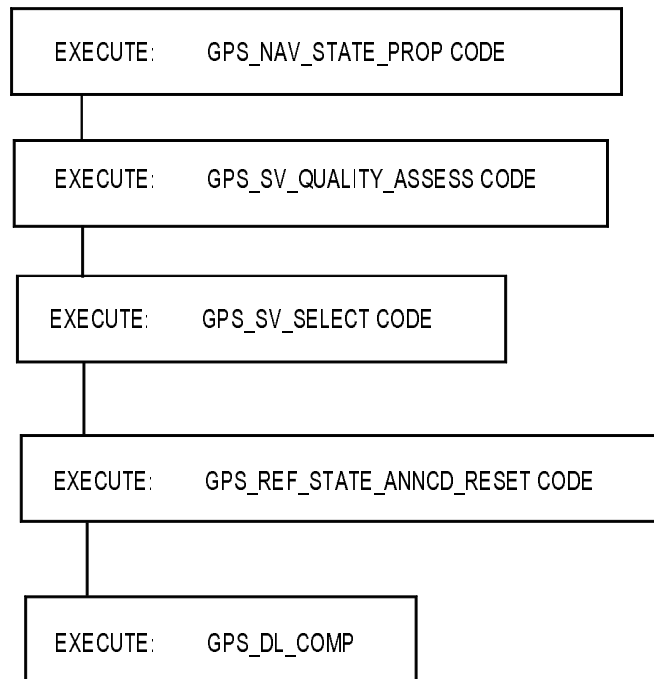


FIGURE 5.2-44. GPS\_RCVR\_STATE\_PROC

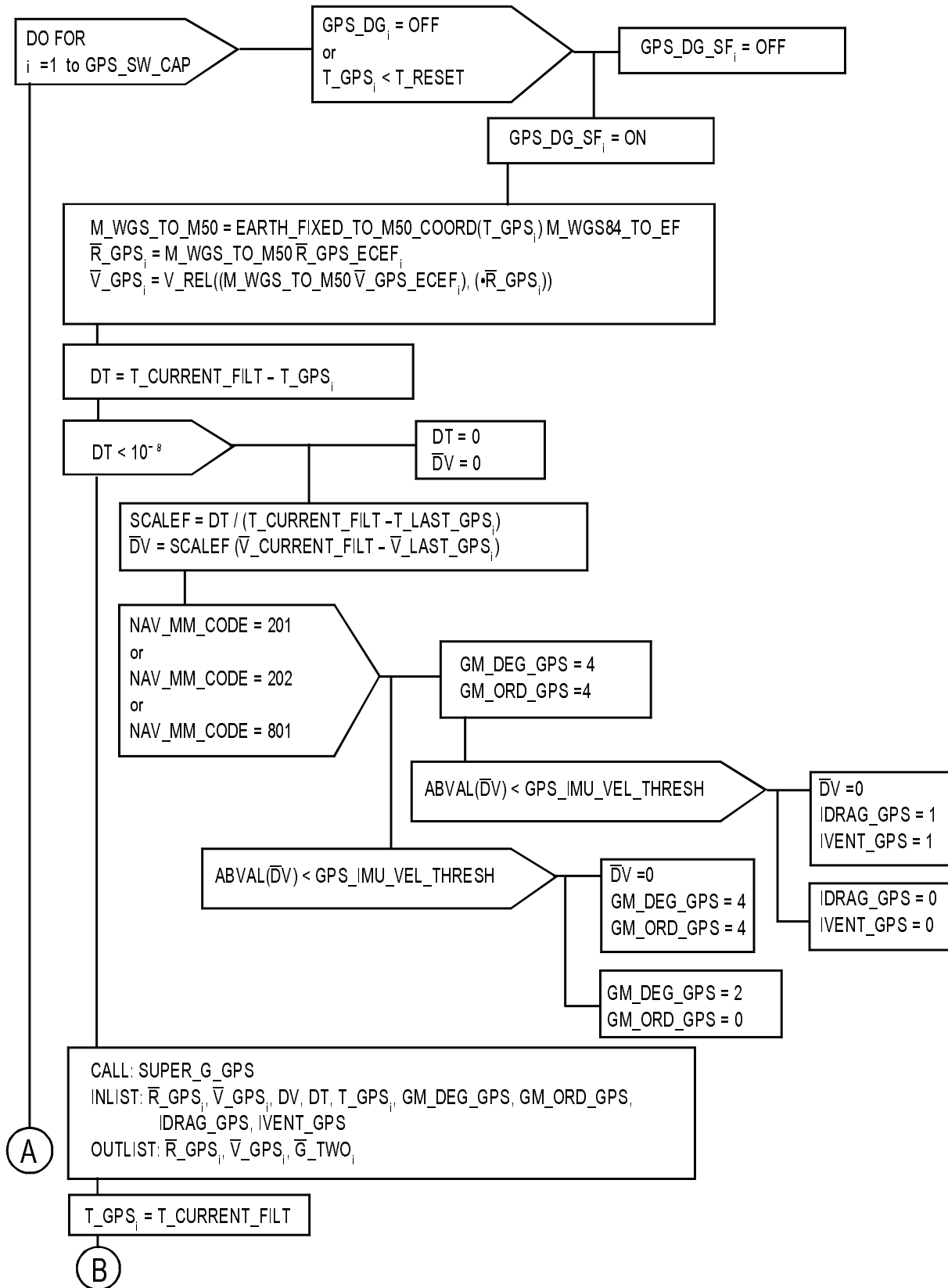


FIGURE 5.2-46.(1) GPS\_NAV\_STATE\_PROP (Sheet 1 of 3)



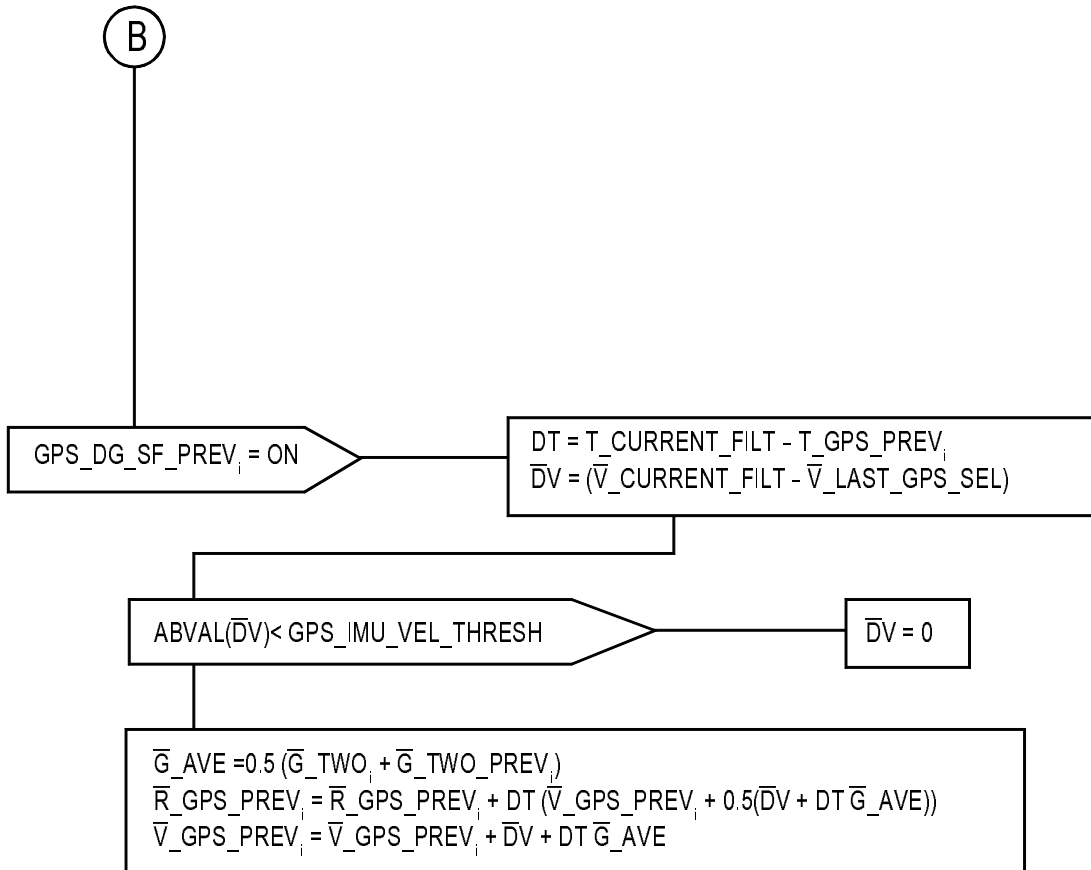


FIGURE 5.2-46.(2) GPS\_NAV\_STATE\_PROP (Sheet 2 of 3)

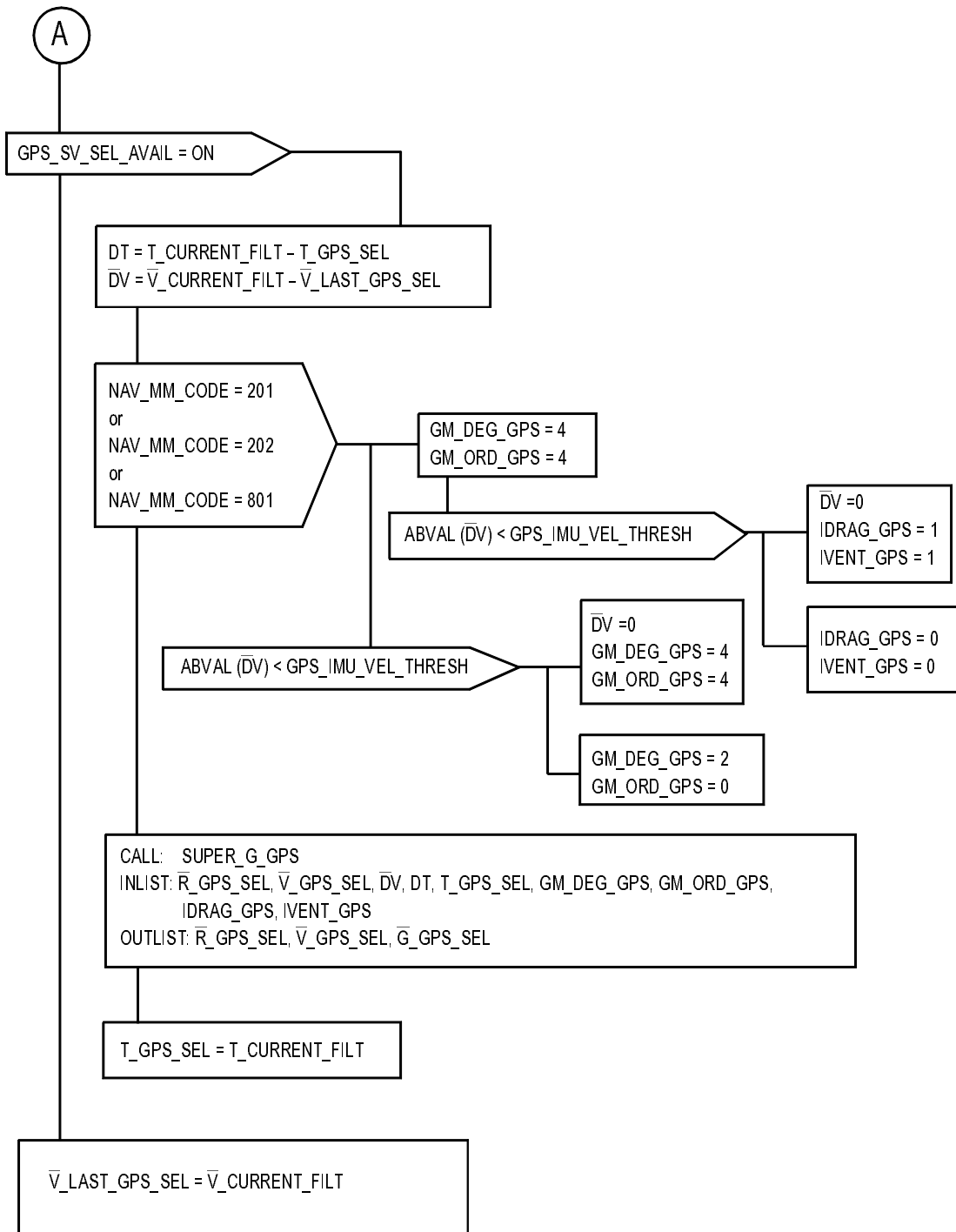


FIGURE 5.2-46.(3) GPS\_NAV\_STATE\_PROP (Sheet 3 of 3)

SUPER\_G\_GPS  
INLIST:  $\bar{R}$ ,  $\bar{V}$ ,  $\bar{D}V$ , DT, T\_LAST, DEG, ORD, I\_DRAG, I\_VENT  
OUTLIST:  $\bar{R}_{OUT}$ ,  $\bar{V}_{OUT}$ ,  $\bar{G}_{TWO}$

$$\begin{aligned}T_{FINAL} &= T_{LAST} + DT \\ \bar{G}_{ONE} &= ACCEL\_GPS (DEG, ORD, I\_DRAG, I\_VENT, \bar{R}, \bar{V}, T_{LAST}) \\ \bar{R}_{OUT} &= \bar{R} + DT (\bar{V} + 0.5 (\bar{D}V + DT \bar{G}_{ONE})) \\ \bar{G}_{TWO} &= ACCEL\_GPS (DEG, ORD, I\_DRAG, I\_VENT, \bar{R}_{OUT}, \bar{V}, T_{FINAL}) \\ \bar{V}_{OUT} &= \bar{V} + \bar{D}V + 0.5 DT (\bar{G}_{ONE} + \bar{G}_{TWO}) \\ \bar{R}_{OUT} &= \bar{R}_{OUT} + (1./6.) (\bar{G}_{TWO} - \bar{G}_{ONE}) DT^2\end{aligned}$$

FIGURE 5.2-47. SUPER\_G\_GPS

ACCEL\_GPS (DEG, ORD, DRAGI, VENTI,  $\bar{R}$ ,  $\bar{V}$ , T) :

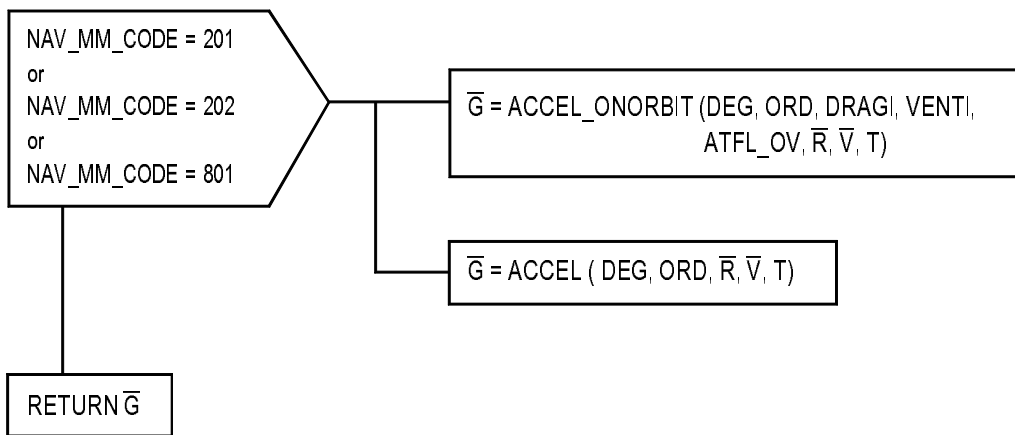


FIGURE 5.2-47A. ACCEL\_GPS

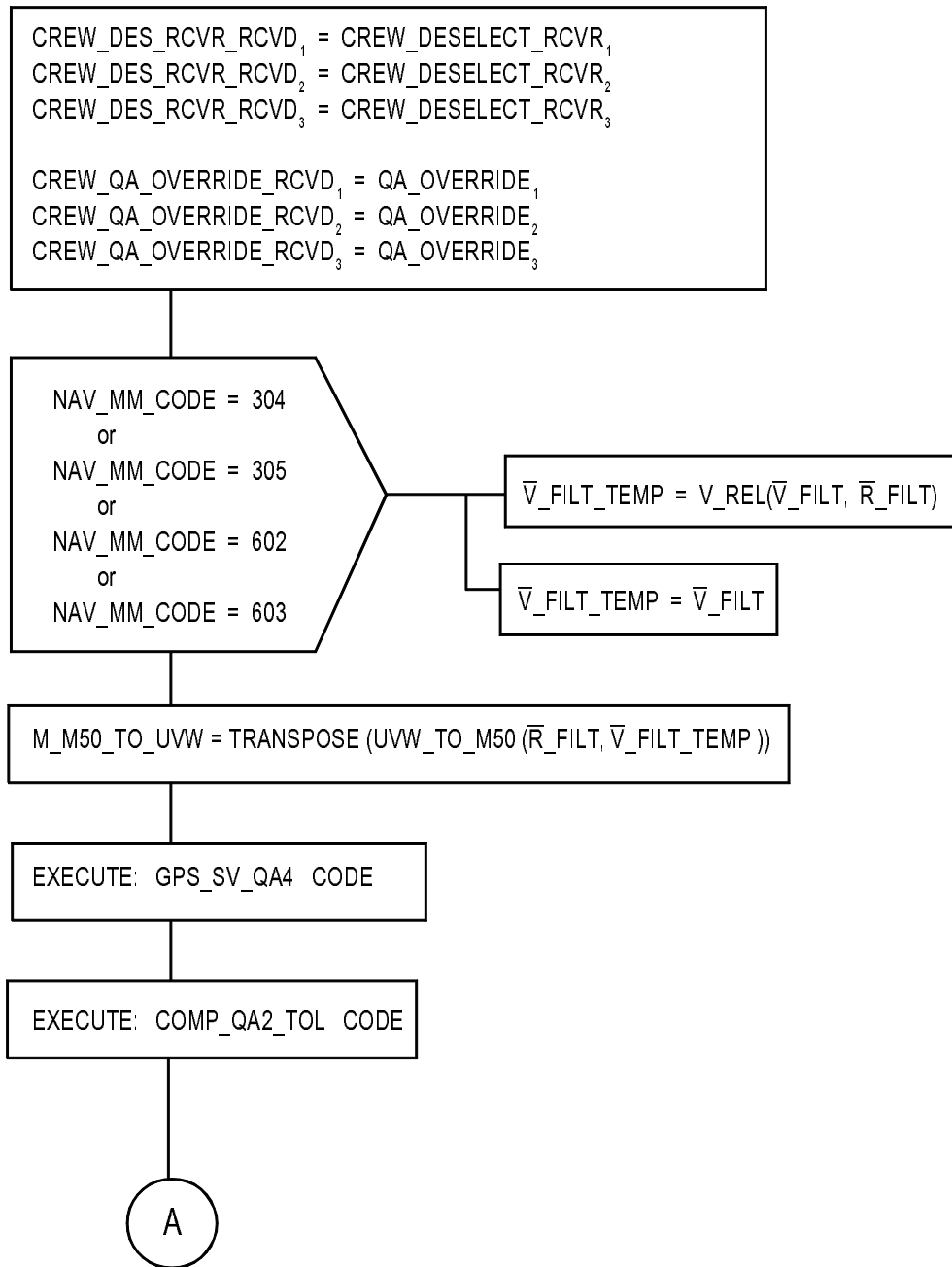


FIGURE 5.2-48.(1) GPS\_SV\_QUALITY\_ASSESS (Sheet 1 of 2)

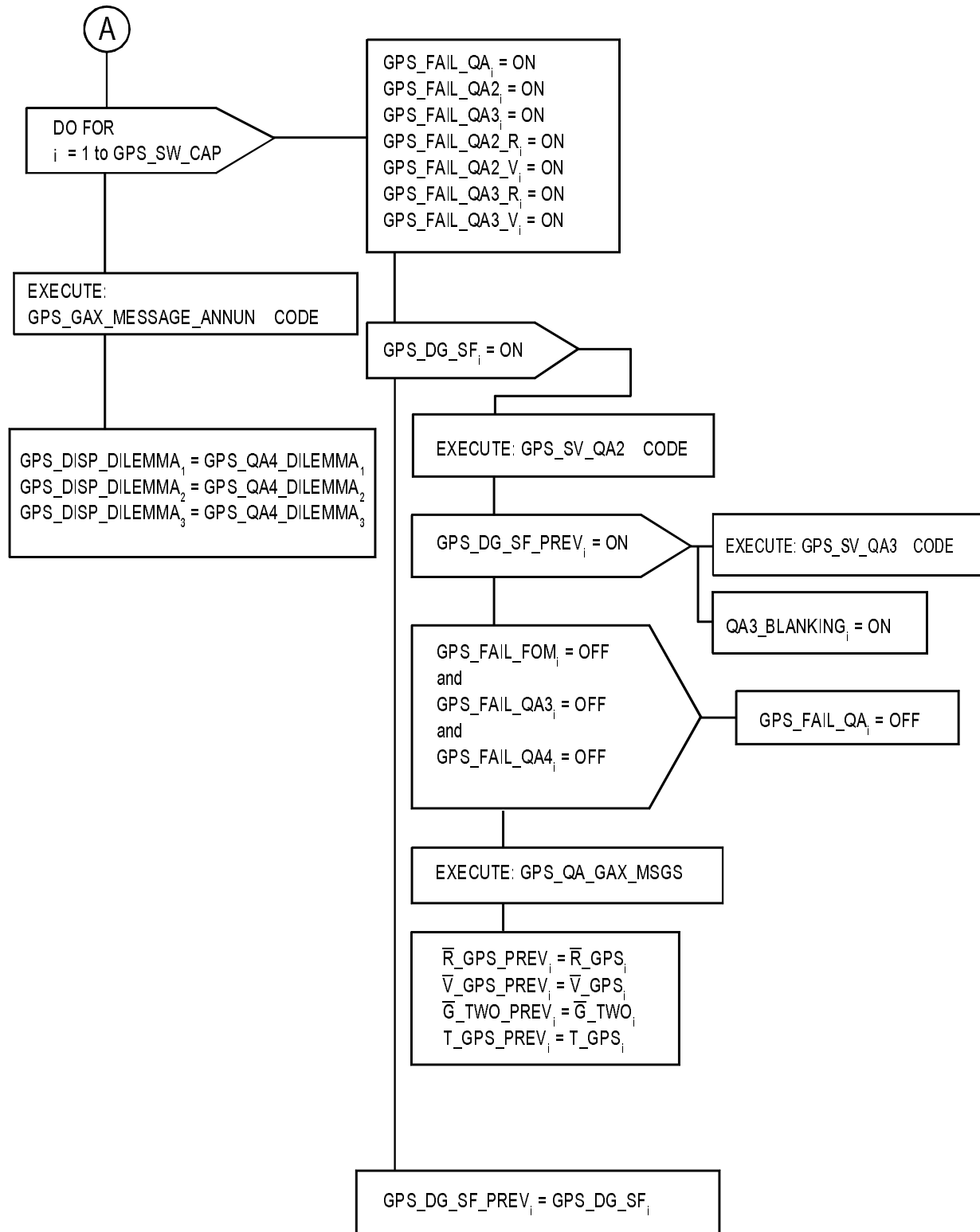


FIGURE 5.2-48.(2) GPS\_SV\_QUALITY\_ASSESS (Sheet 2 of 2)

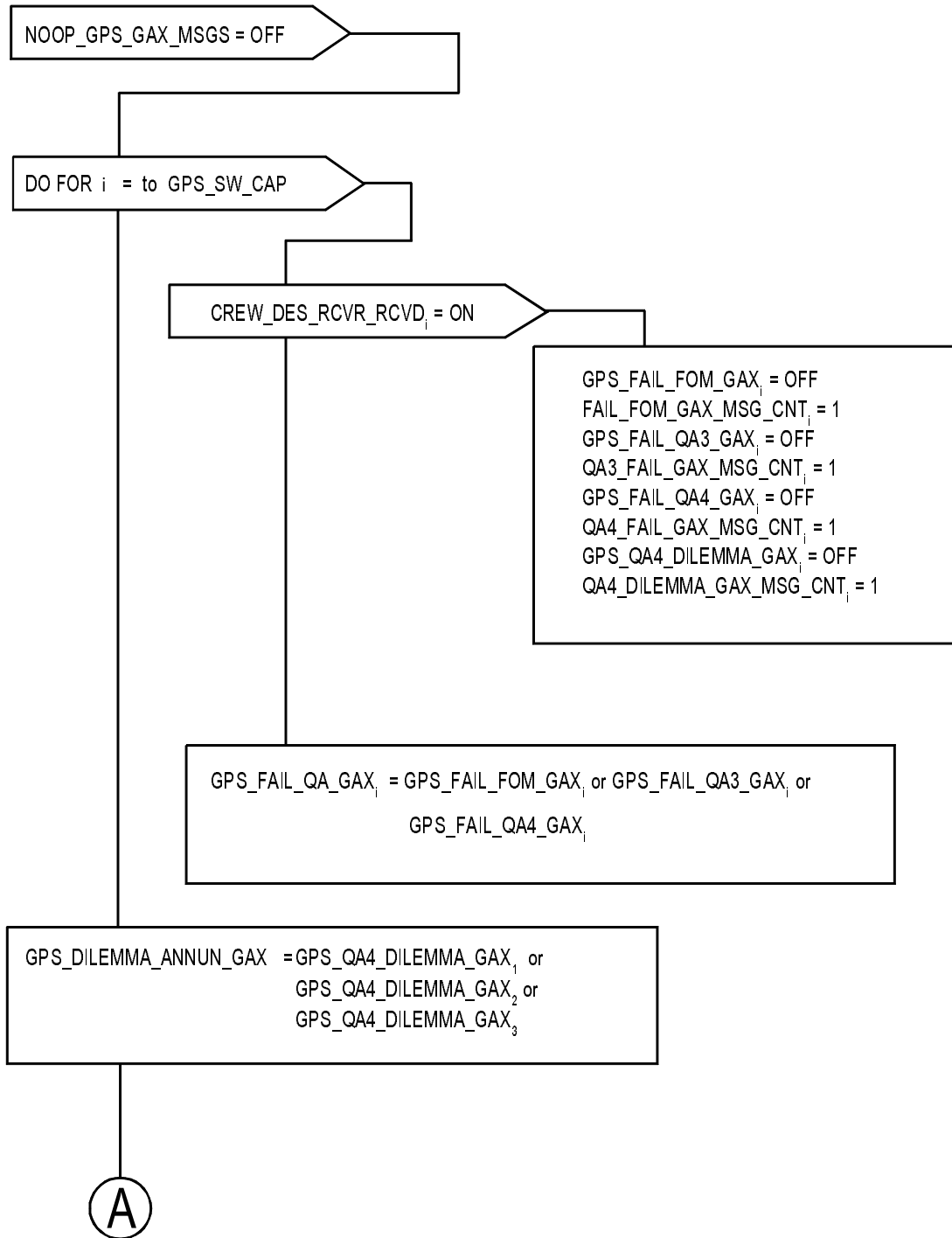


FIGURE 5.2-48-1.(1) GPS\_GAX\_MESSAGES\_ANNUN CODE (Sheet 1 of 2)

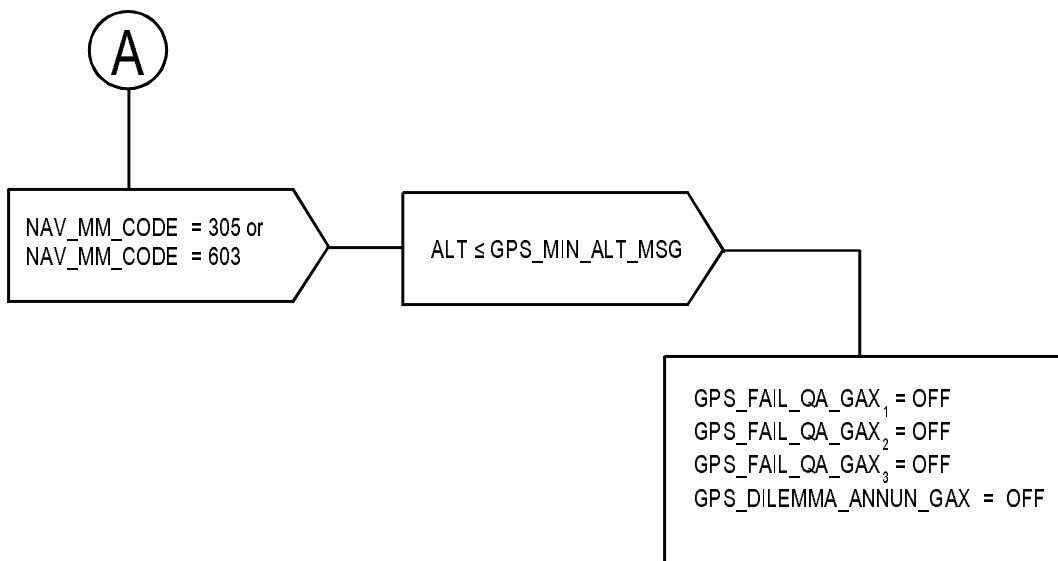


FIGURE 5.2-48-1.(2) GPS\_GAX\_MESSAGES\_ANNUN CODE (Sheet 2 of 2)



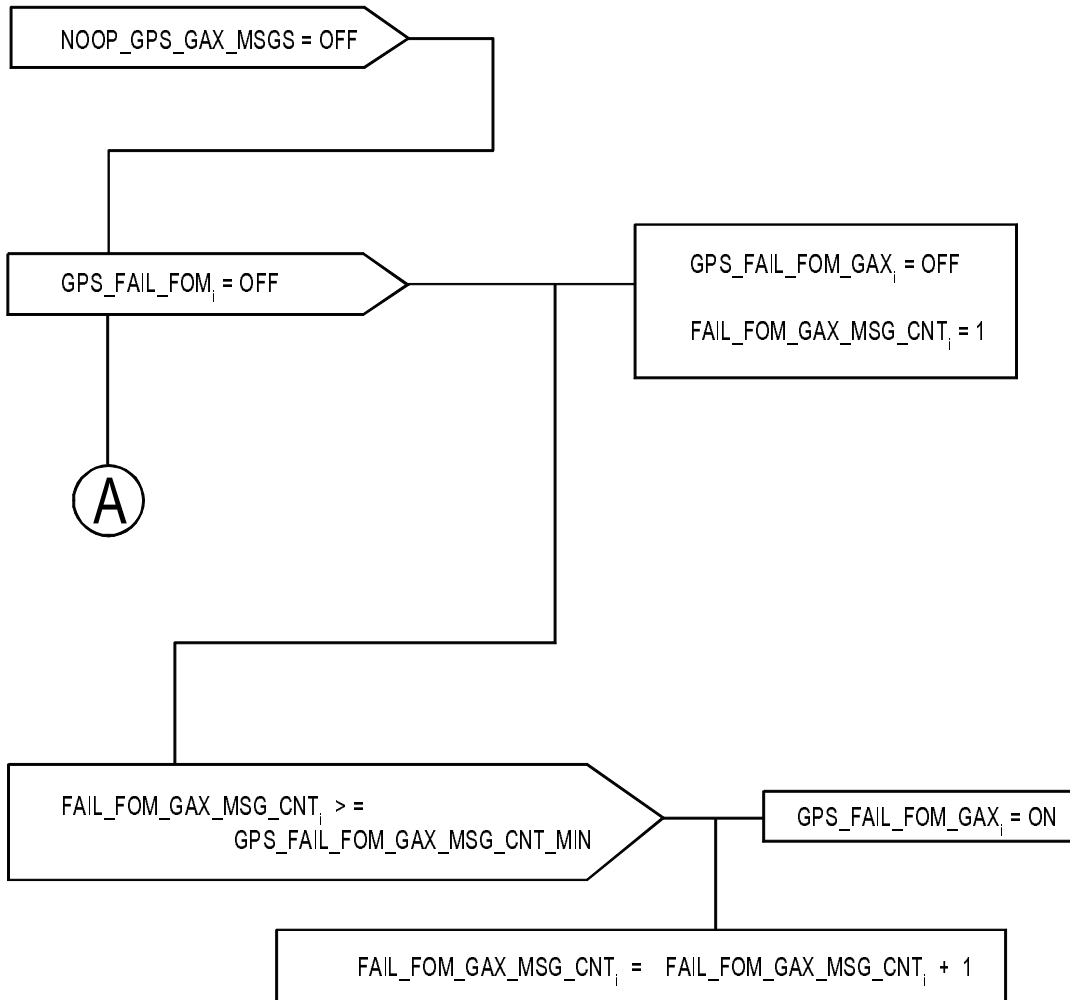


FIGURE 5.2-48A.(1) GPS\_QA\_GAX\_MSGS (Sheet 1 of 4)

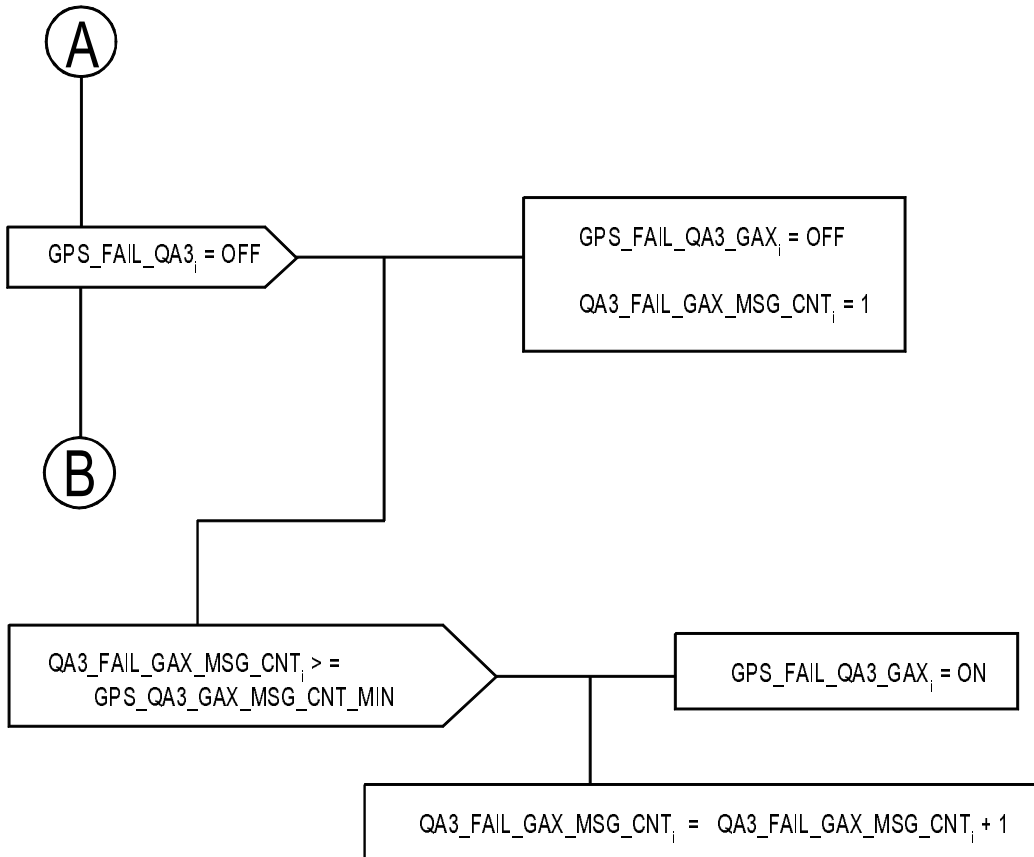


FIGURE 5.2-48A.(2) GPS\_QA\_GAX\_MSGS (Sheet 2 of 4)

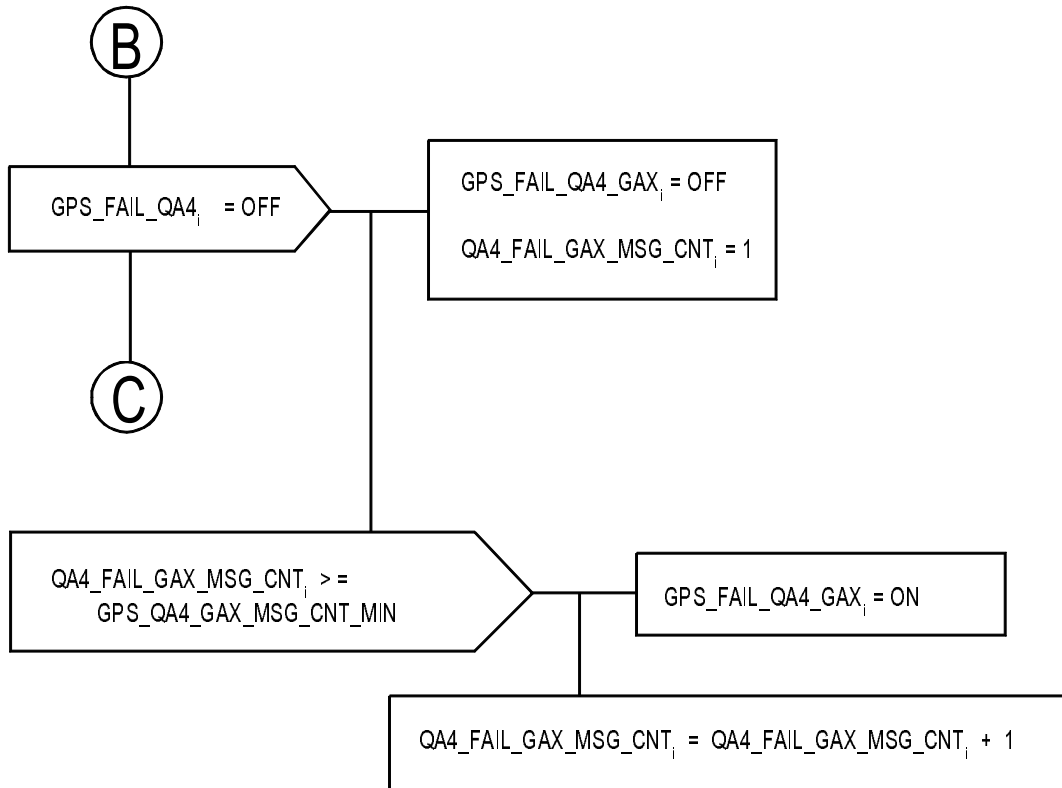


FIGURE 5.2-48A.(3) GPS\_QA\_GAX\_MSGS (Sheet 3 of 4)

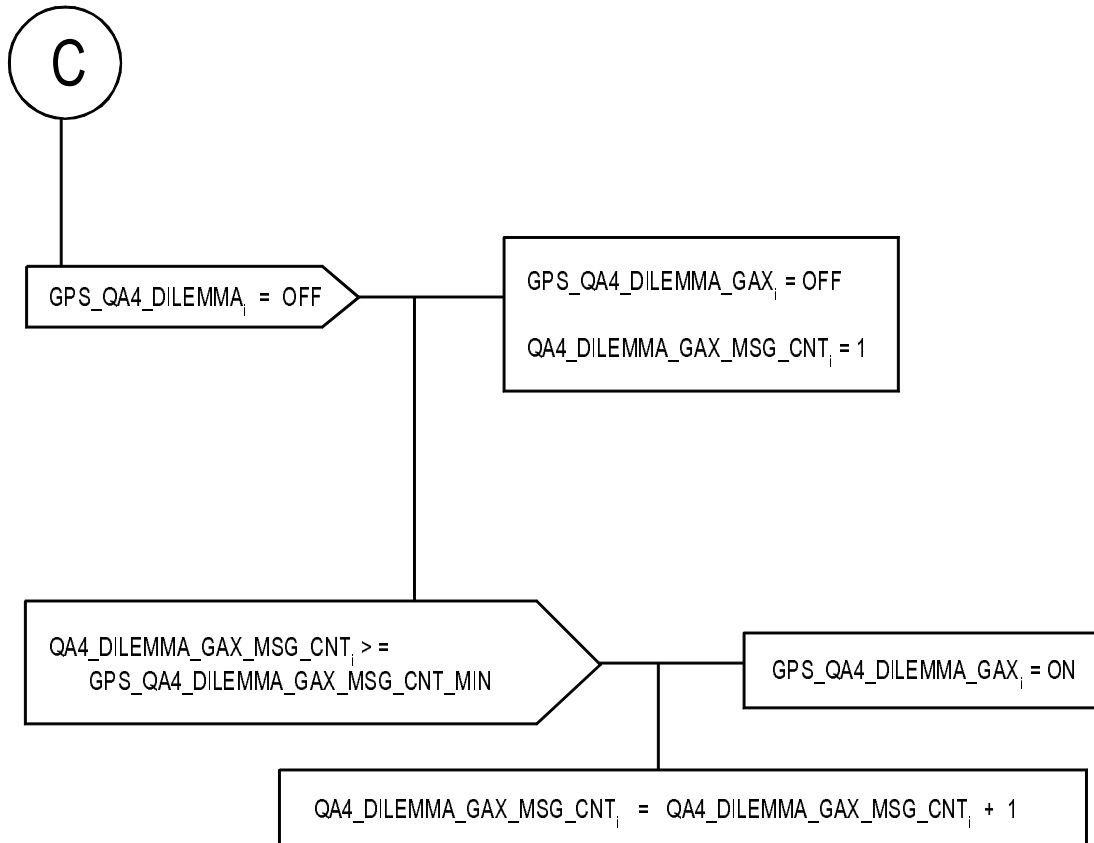


FIGURE 5.2-48A.(4) GPS\_QA\_GAX\_MSGS (Sheet 4 of 4)

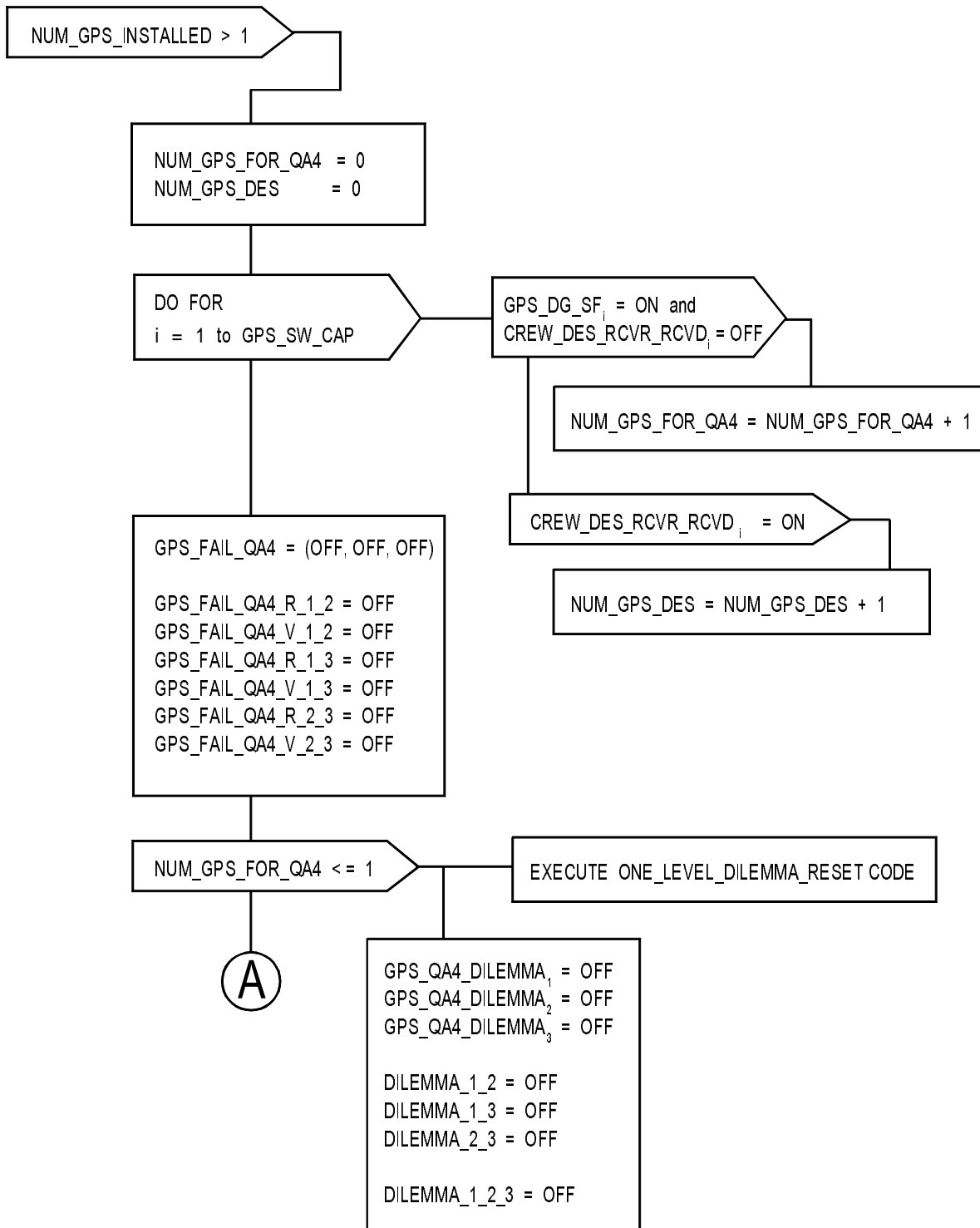


FIGURE 5.2-49.(1) GPS\_SV\_QA4 (Sheet 1 of 5)

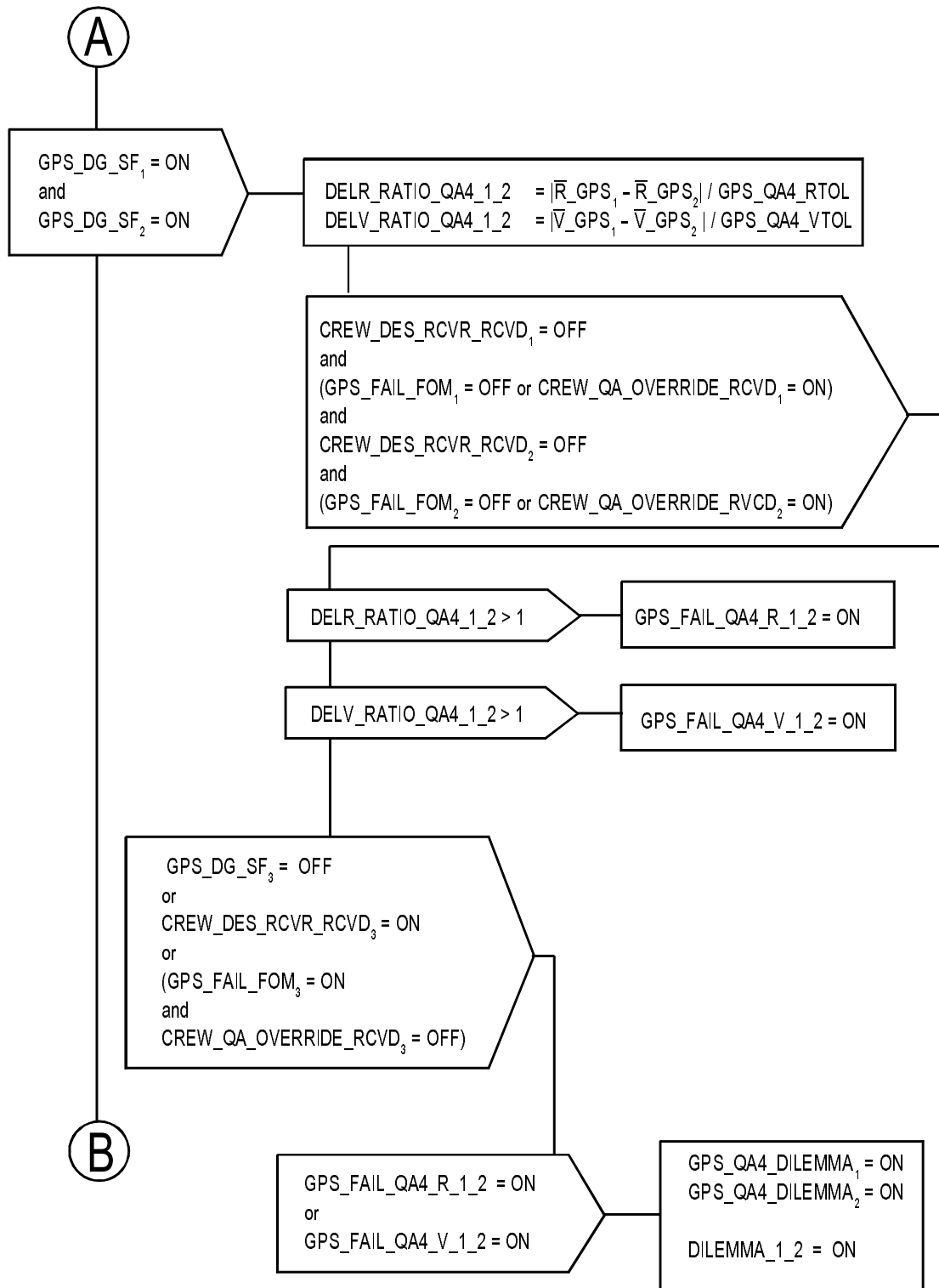


FIGURE 5.2-49.(2) GPS\_SV\_QA4 (Sheet 2 of 5)

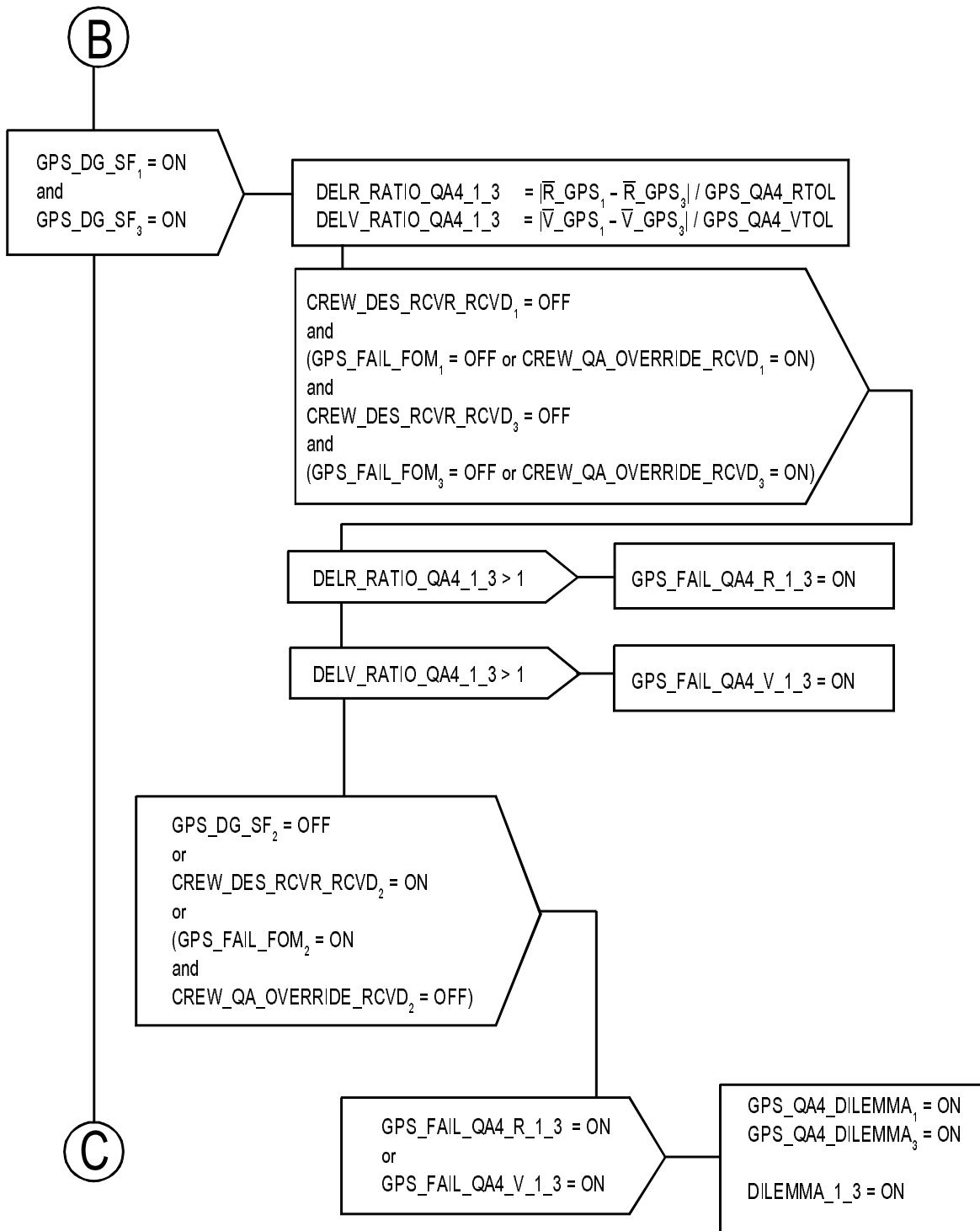


FIGURE 5.2-49.(3) GPS\_SV\_QA4 (Sheet 3 of 5)

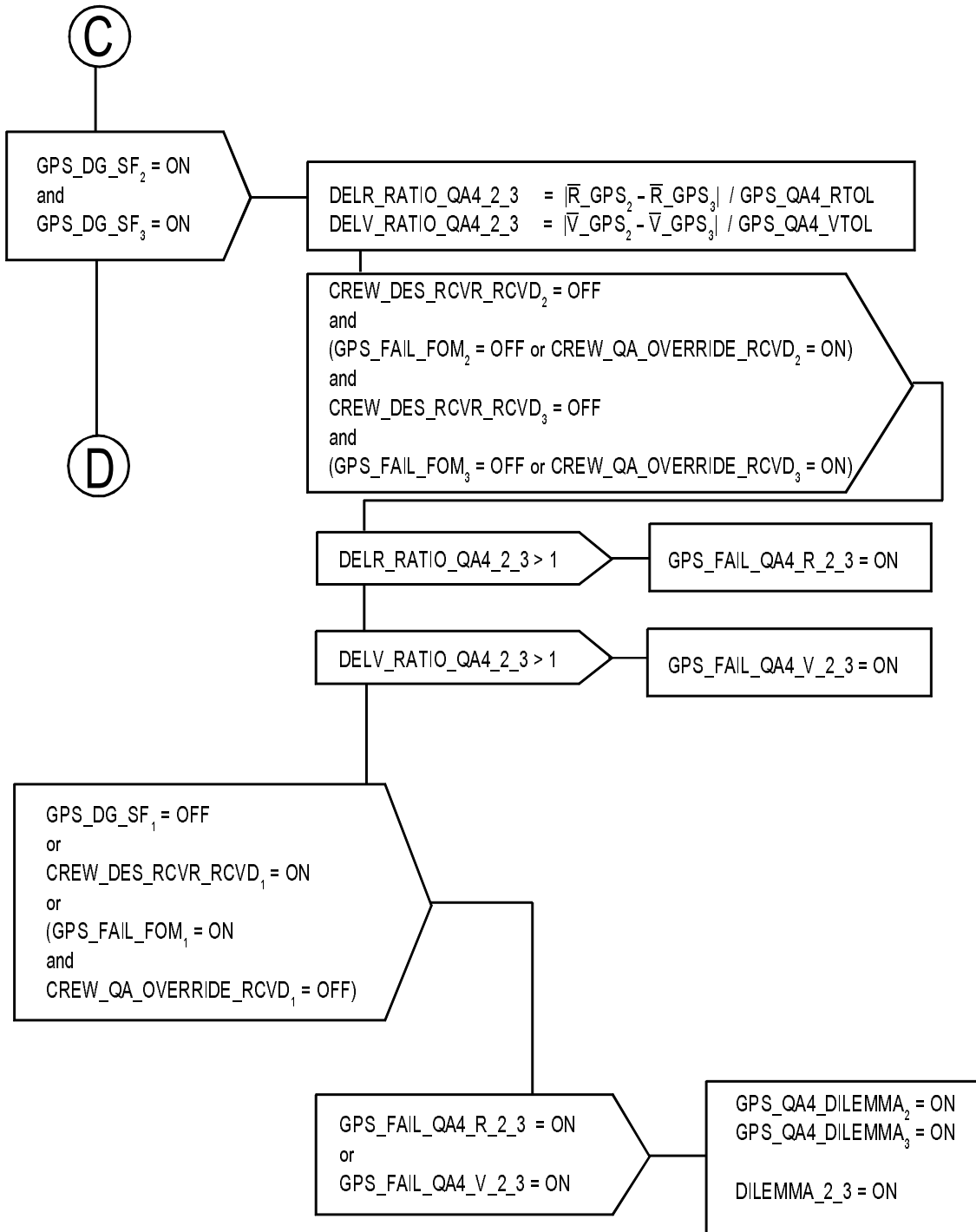


FIGURE 5.2-49.(4) GPS\_SV\_QA4 (Sheet 4 of 5)



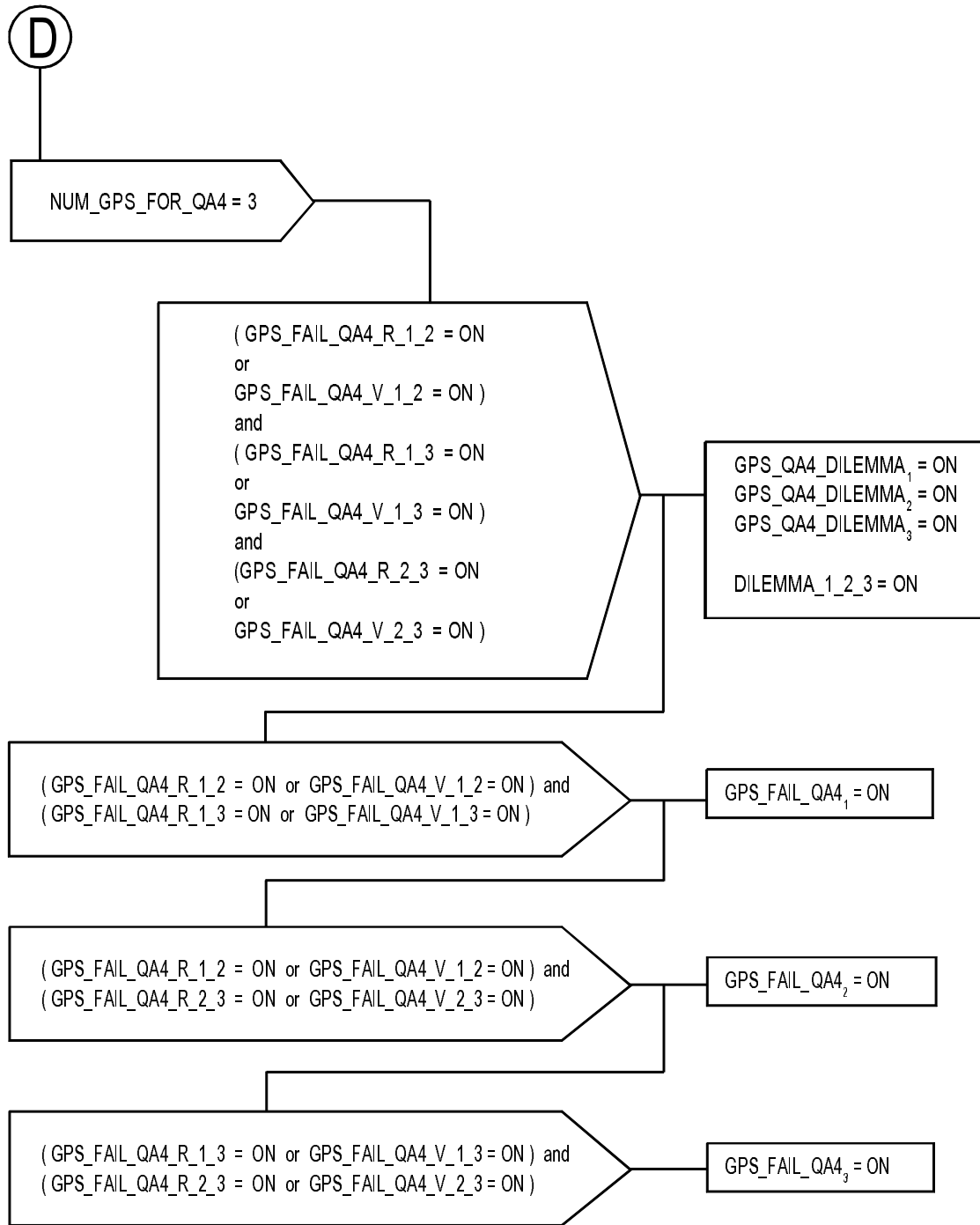


FIGURE 5.2-49.(5) GPS\_SV\_QA4 (Sheet 5 of 5)

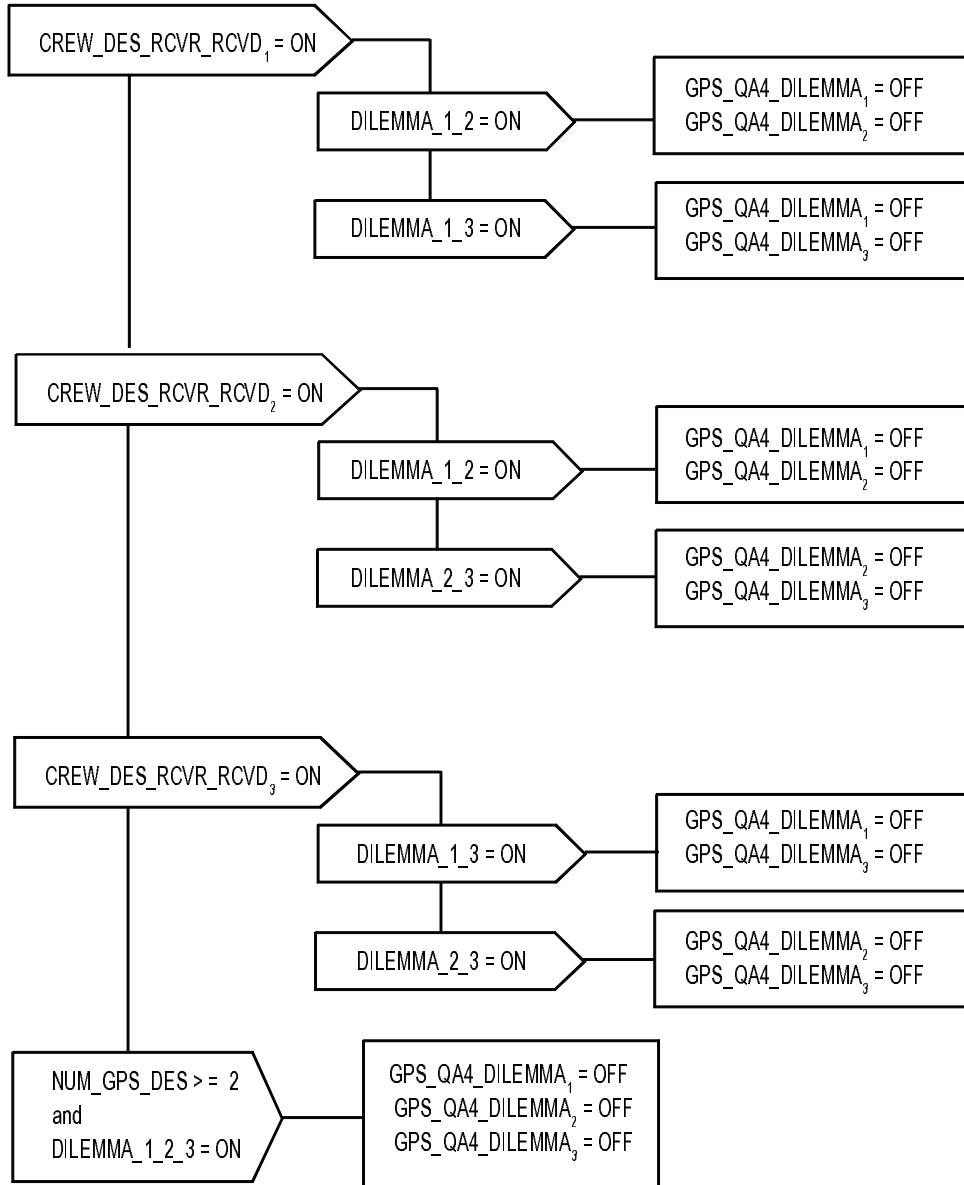


FIGURE 5.2-49A. ONE\_LEVEL\_DILEMMA\_RESET

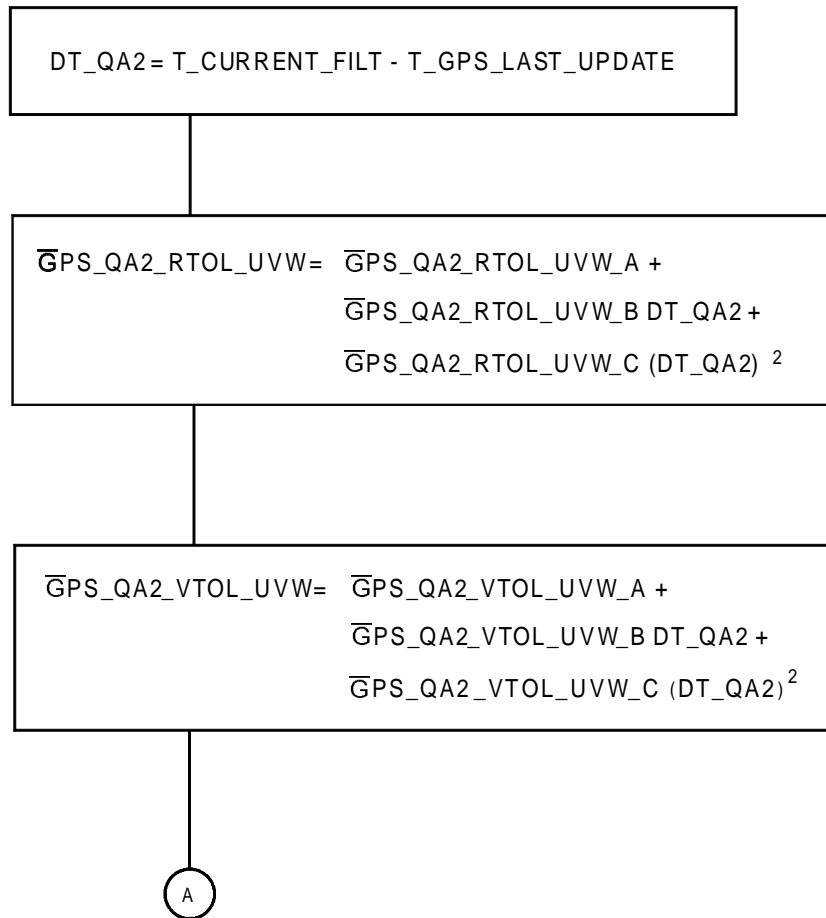


FIGURE 5.2-50.(1) COMP\_QA2\_TOL (Sheet 1 of 2)

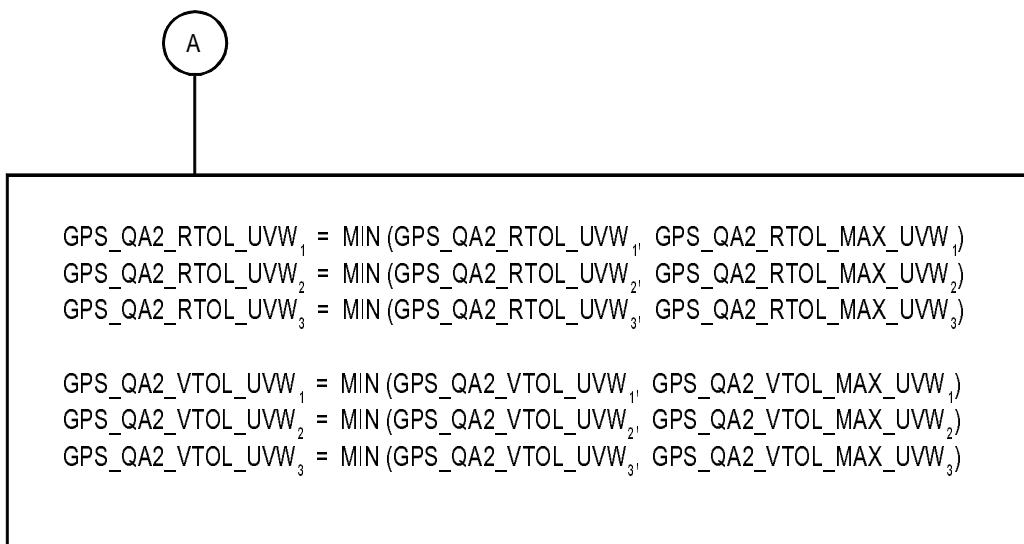


FIGURE 5.2-50.(2) COMP\_QA2\_TOL (Sheet 2 of 2)

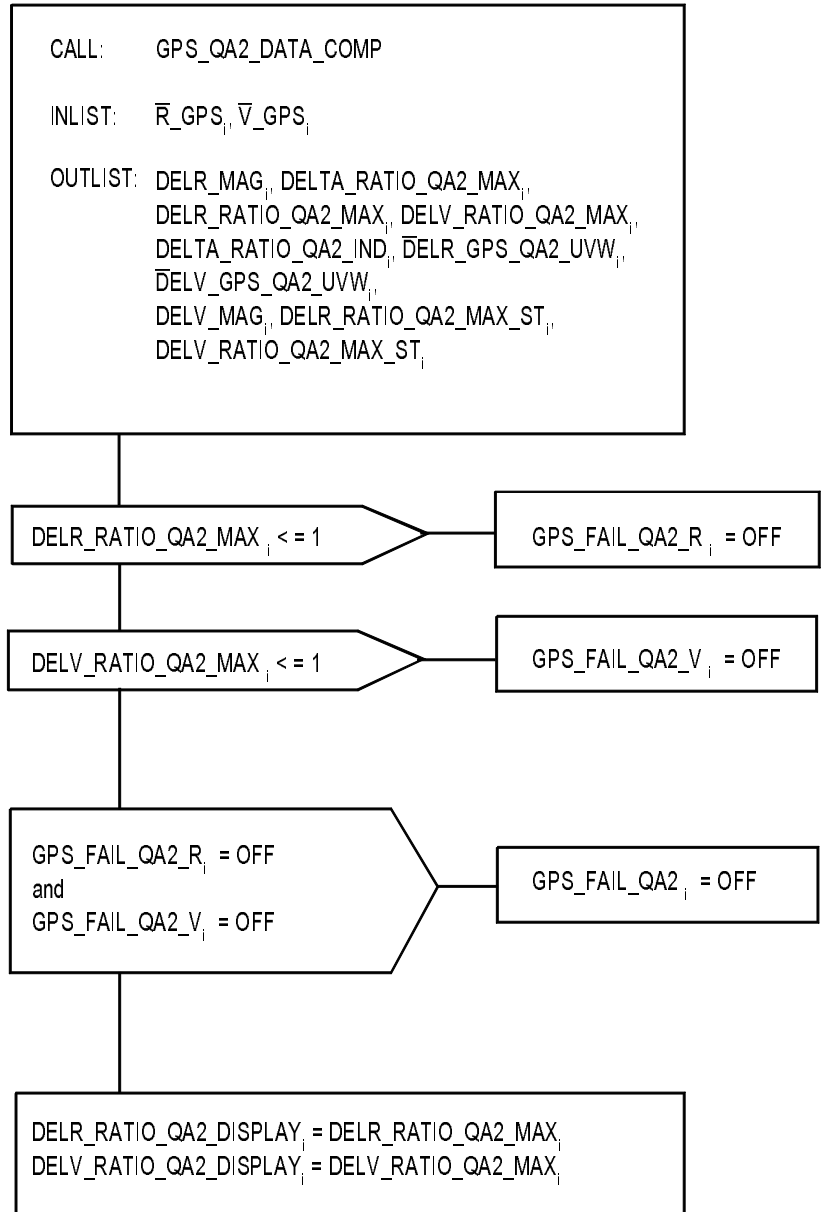


FIGURE 5.2-51. GPS\_SV\_QA2

GPS\_QA2\_DATA\_COMP  
 INLIST:  $\bar{R}_{GPS}$ ,  $\bar{V}_{GPS}$   
 OUTLIST: DELR\_MAG, DELTA\_RATIO\_MAX,  
 DELR\_RATIO\_MAX, DELV\_RATIO\_MAX,  
 DELTA\_RATIO\_IND,  $\bar{DEL}_R_{GPS\_UVW}$ ,  $\bar{DEL}_V_{GPS\_UVW}$ ,  
 DELV\_MAG, DELR\_RATIO\_MAX\_ST, DELV\_RATIO\_MAX\_ST

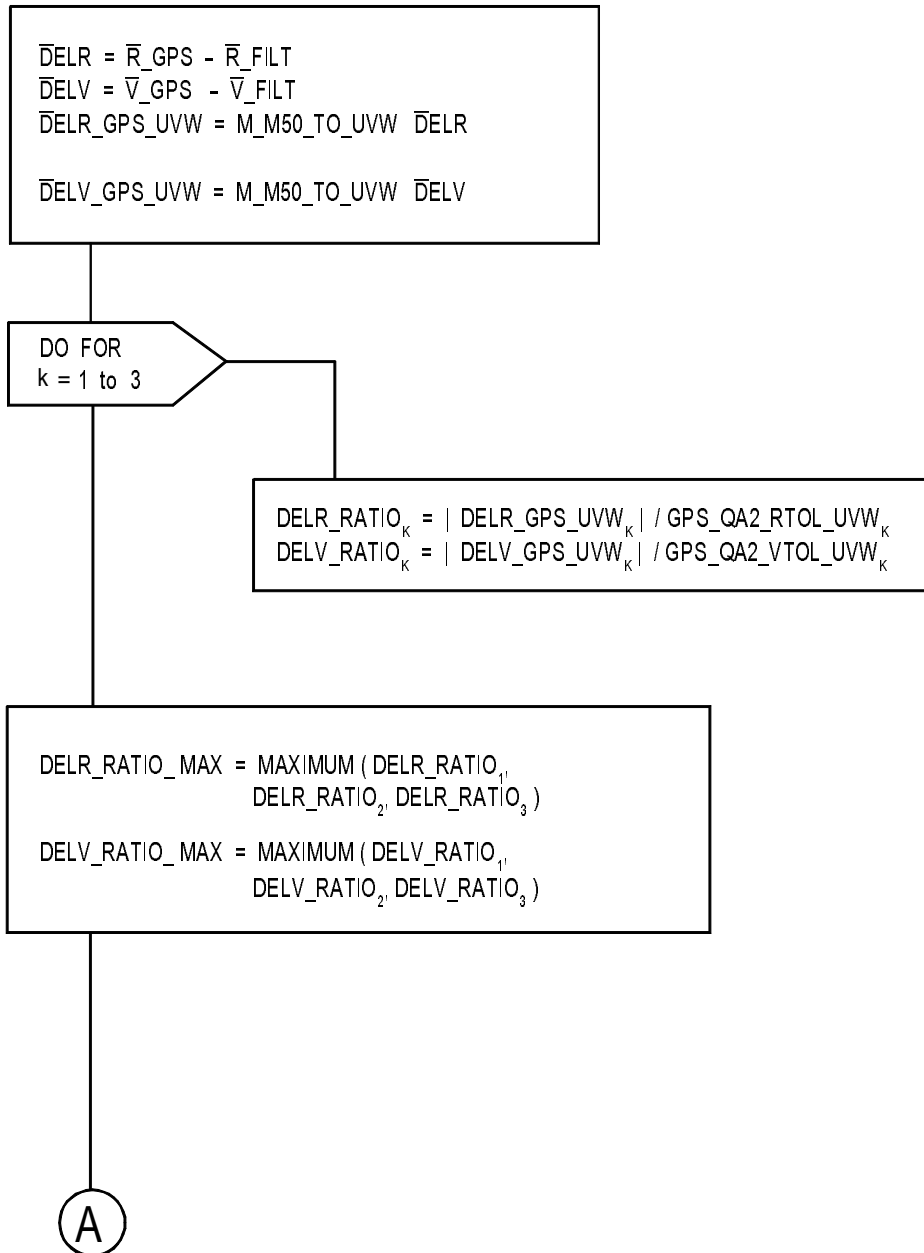


FIGURE 5.2-52.(1) GPS\_QA2\_DATA\_COMP (Sheet 1 of 2)

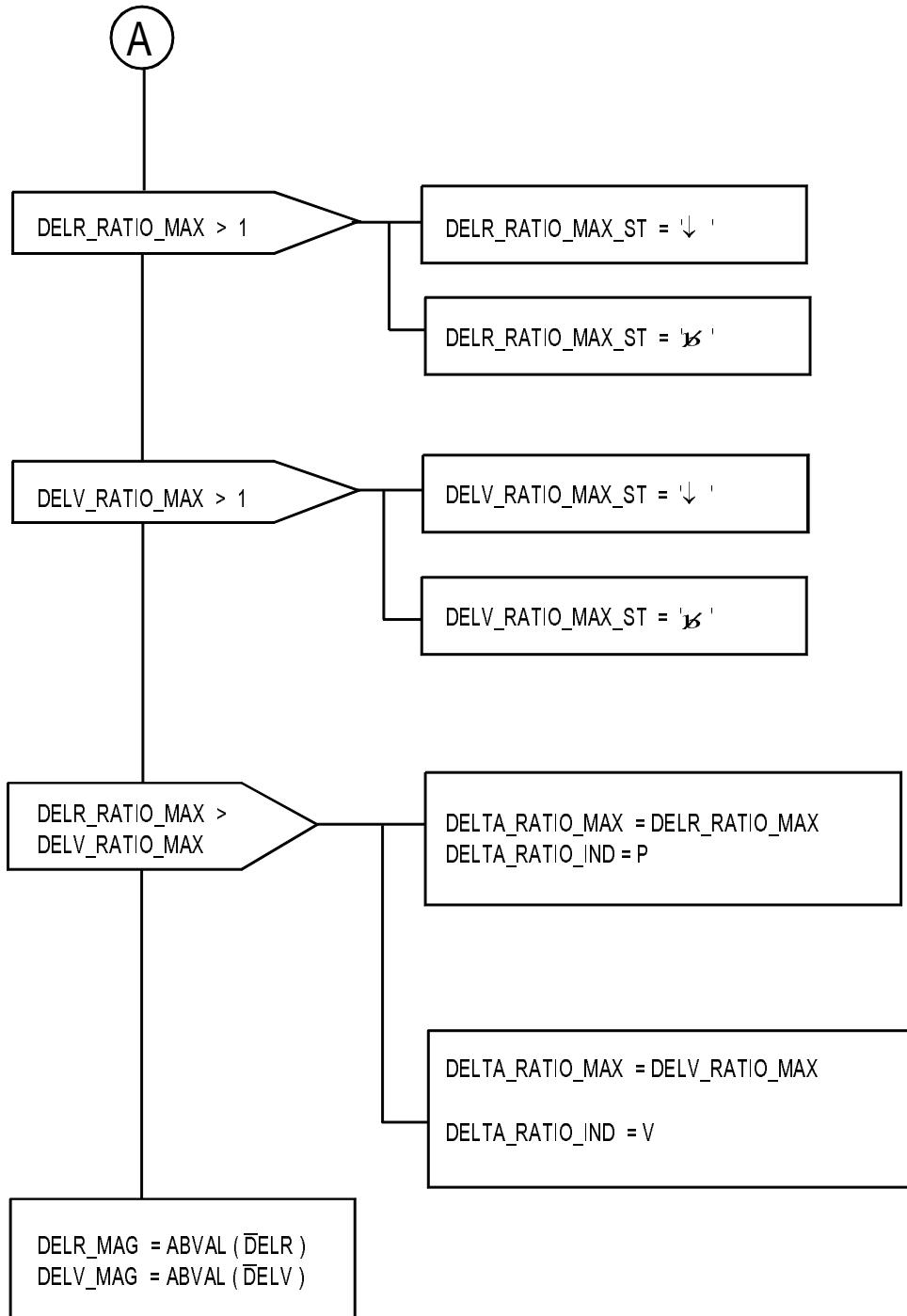


FIGURE 5.2-52.(2) GPS\_QA2\_DATA\_COMP (Sheet 2 of 2)

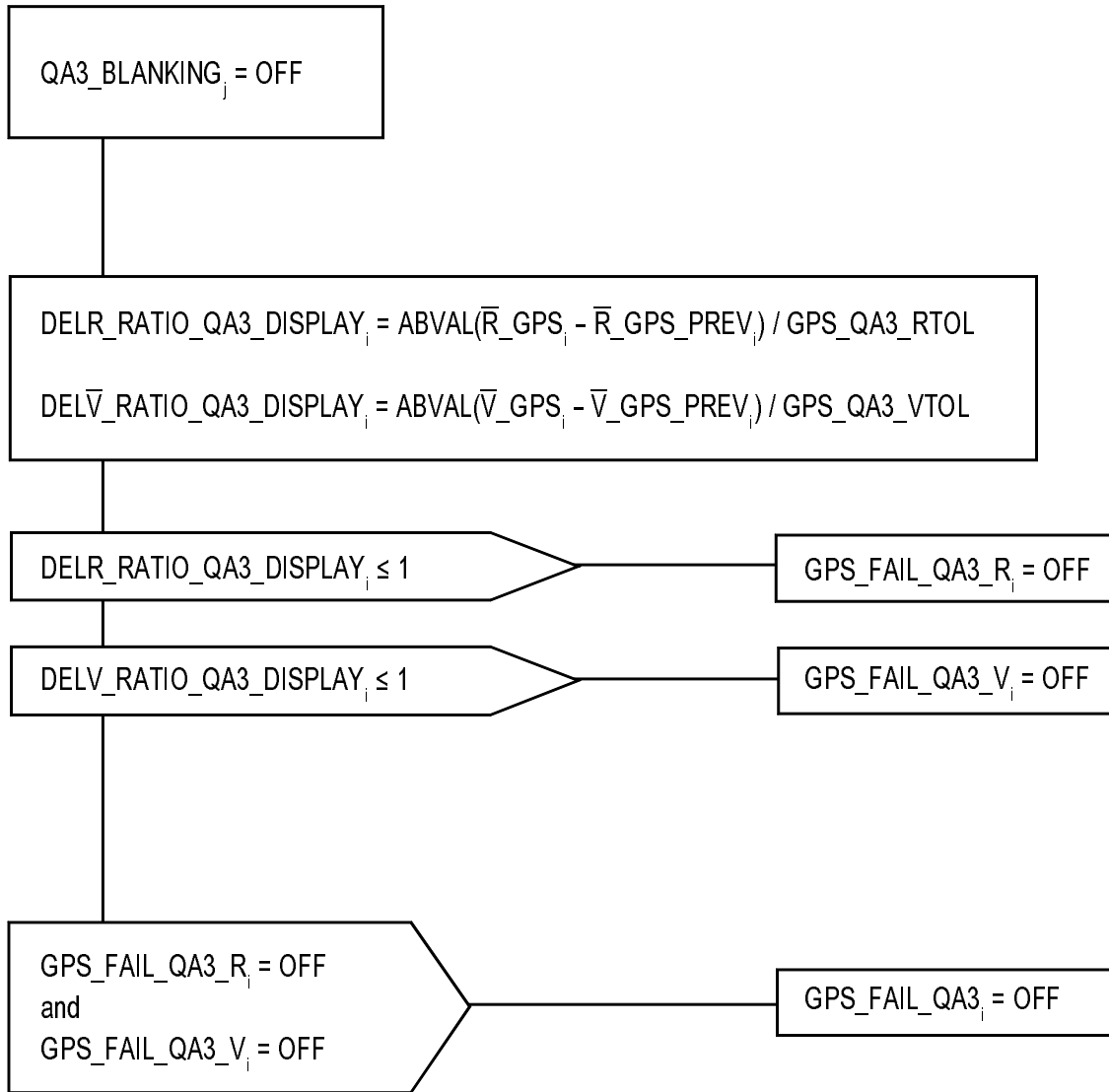


FIGURE 5.2-53. GPS\_SV\_QA3



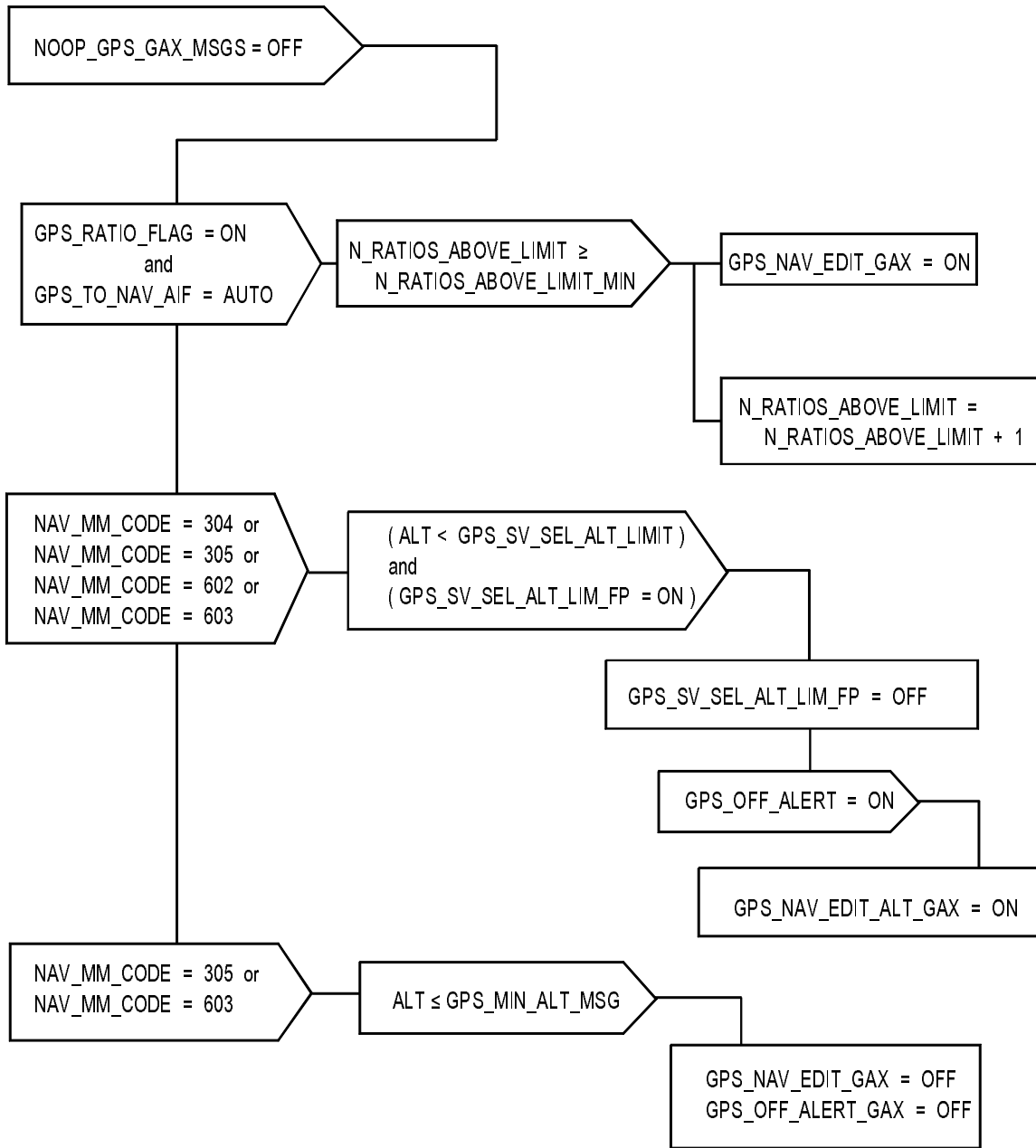


FIGURE 5.2-53A. GPS\_NAV\_EDIT\_MSG CODE

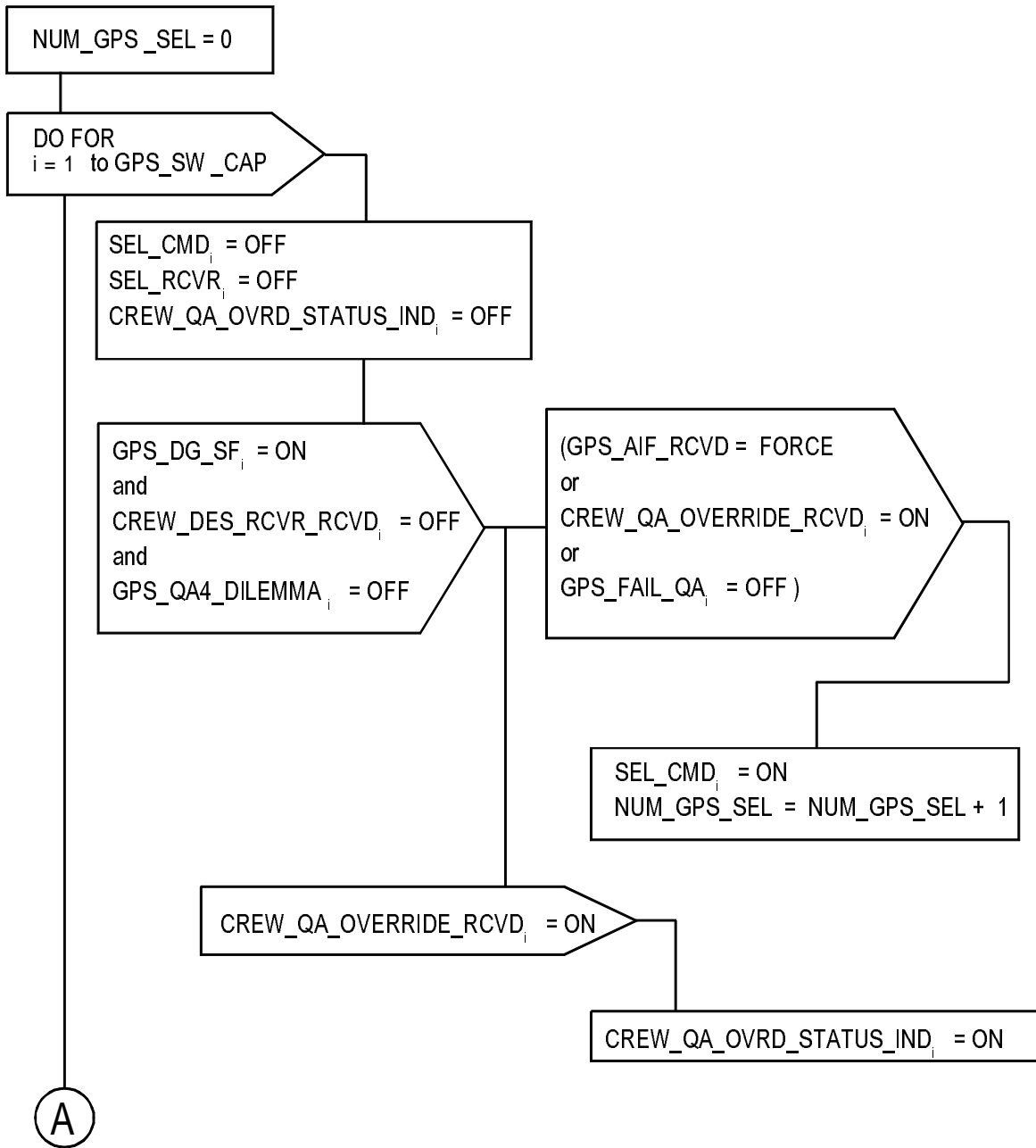


FIGURE 5.2-54.(1) GPS\_SV\_SELECT (Sheet 1 of 8)

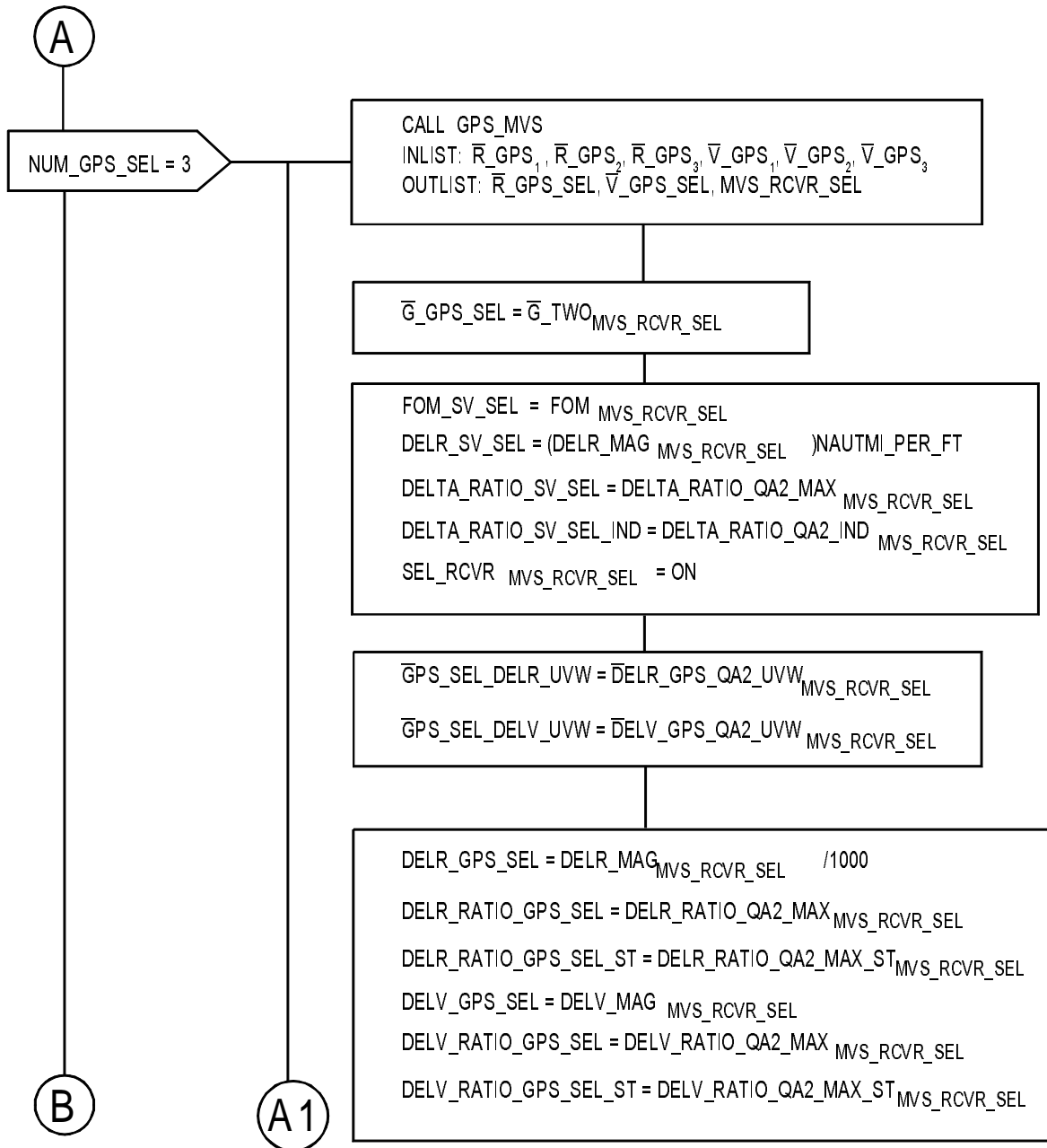


FIGURE 5.2-54.(2) GPS\_SV\_SELECT (Sheet 2 of 8)

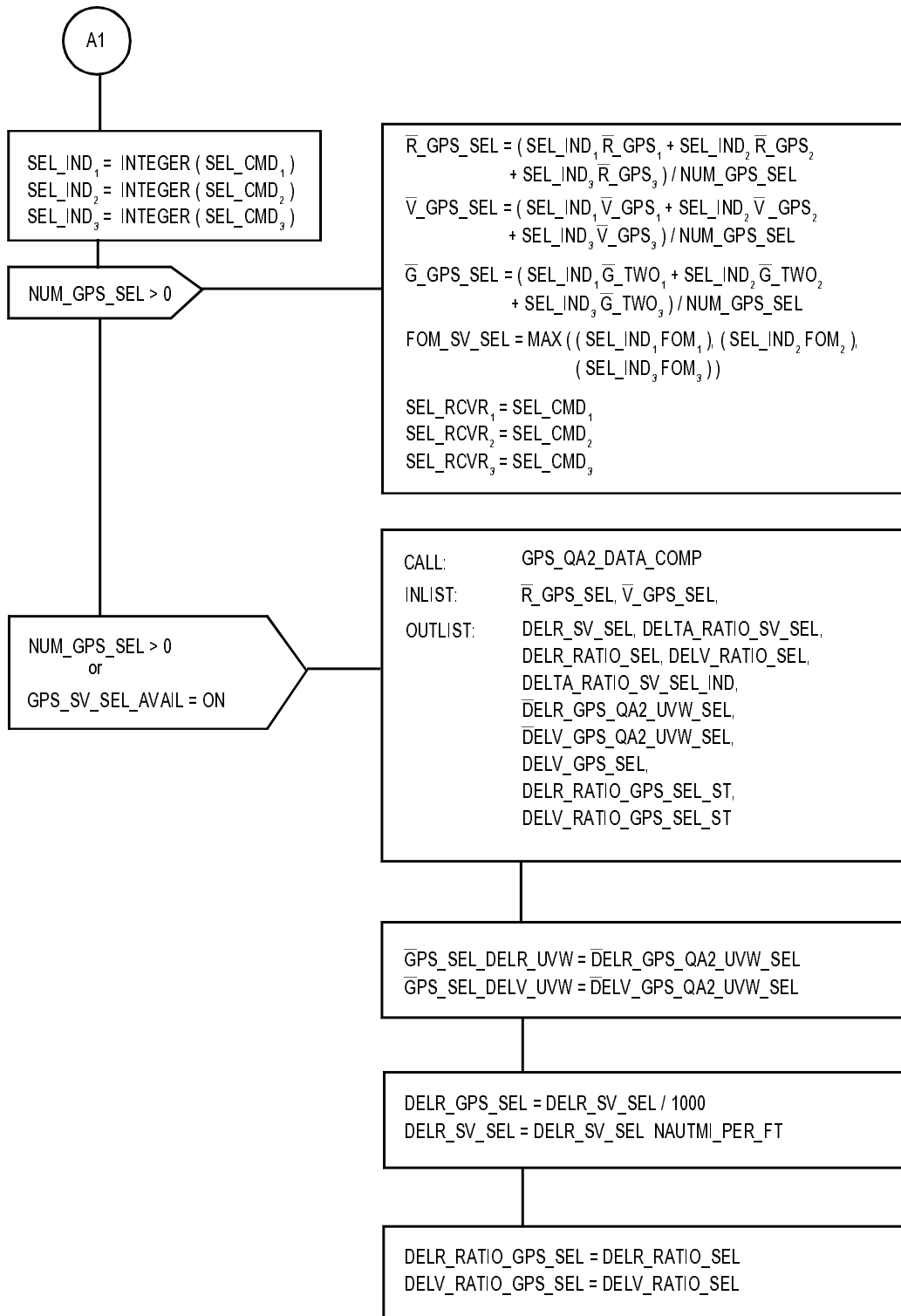


FIGURE 5.2-54.(3) GPS\_SV\_SELECT (Sheet 3 of 8)

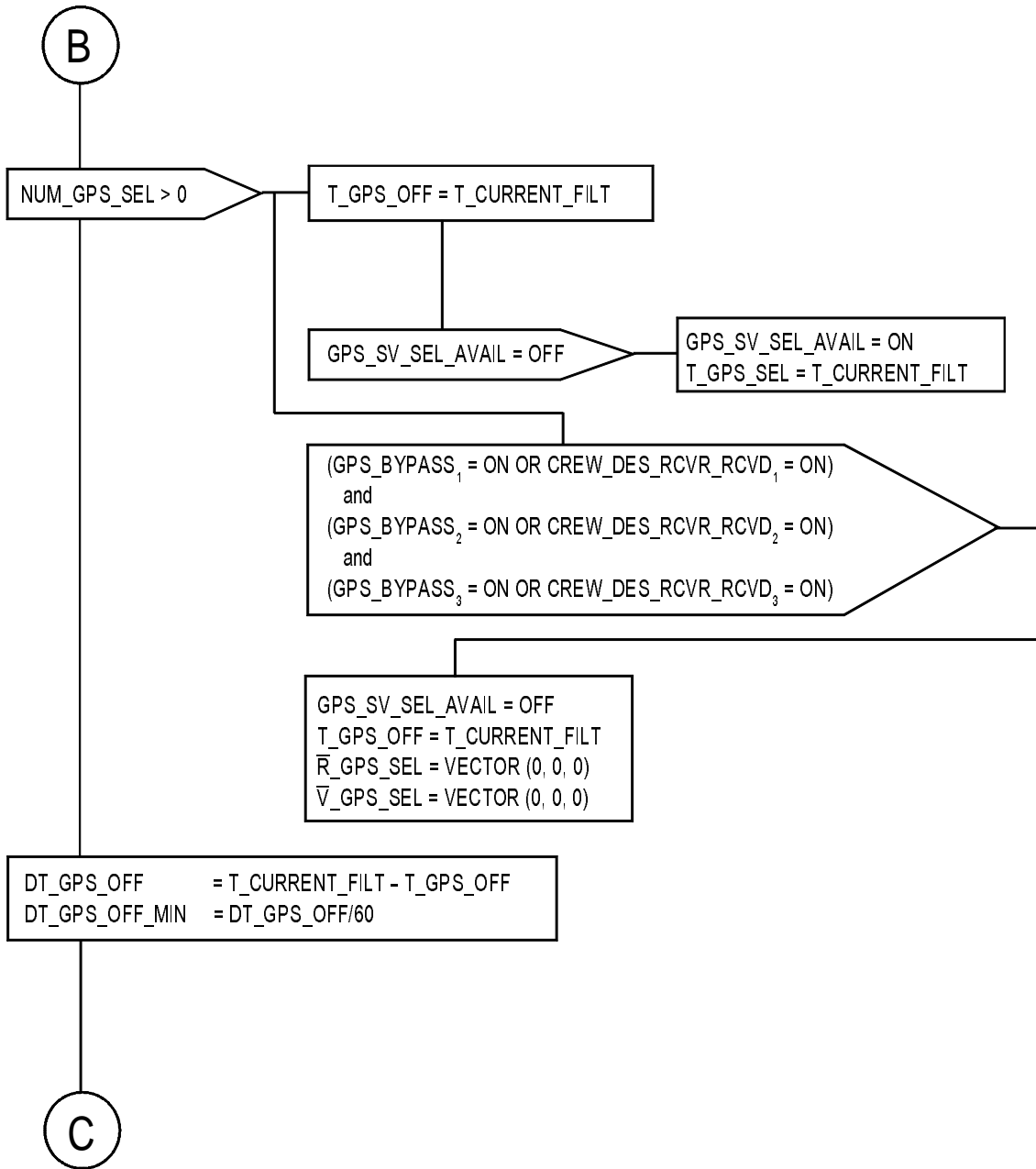


FIGURE 5.2-54.(4) GPS\_SV\_SELECT (Sheet 4 of 8)

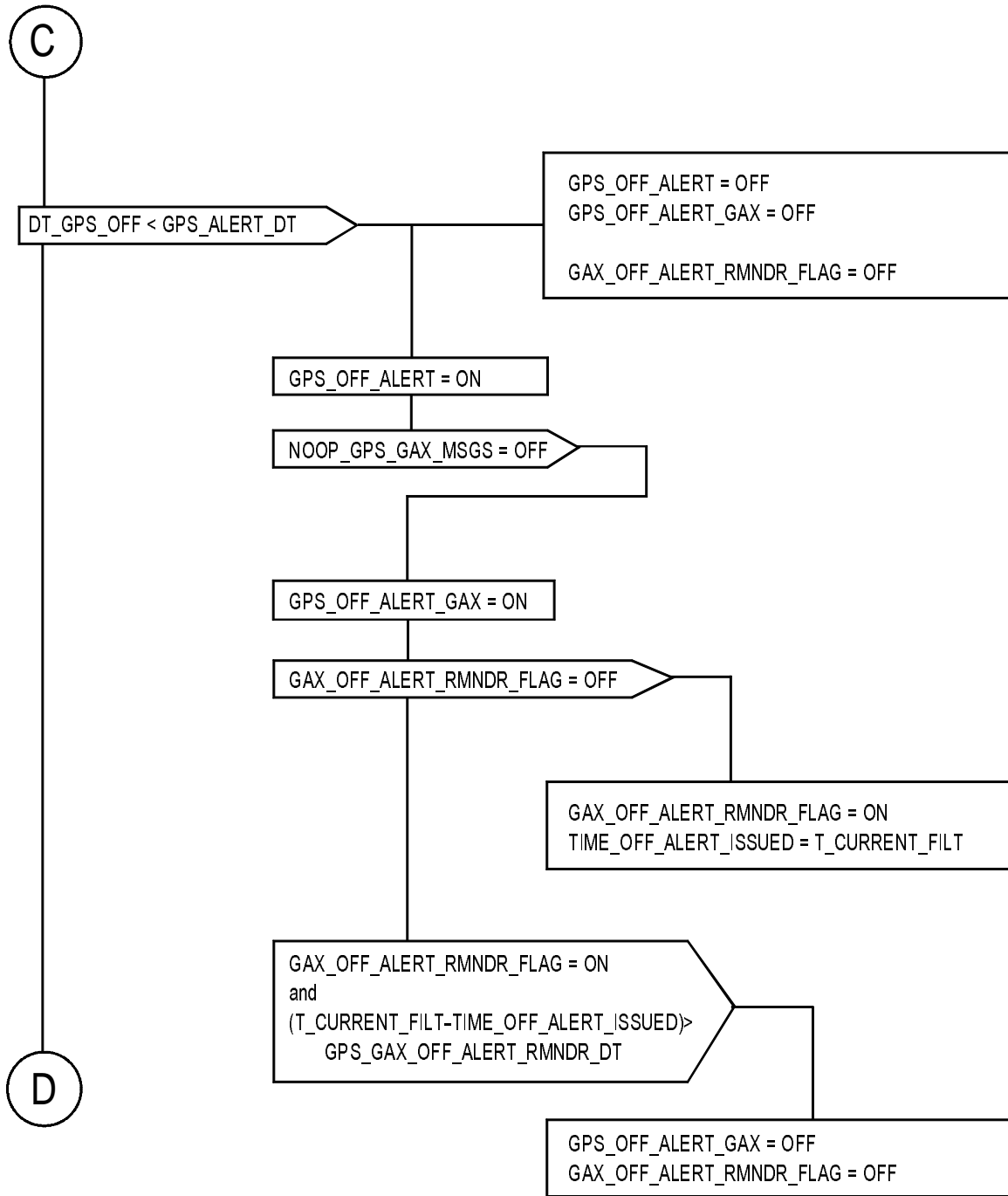


FIGURE 5.2-54.(5) GPS\_SV\_SELECT (Sheet 5 of 8)

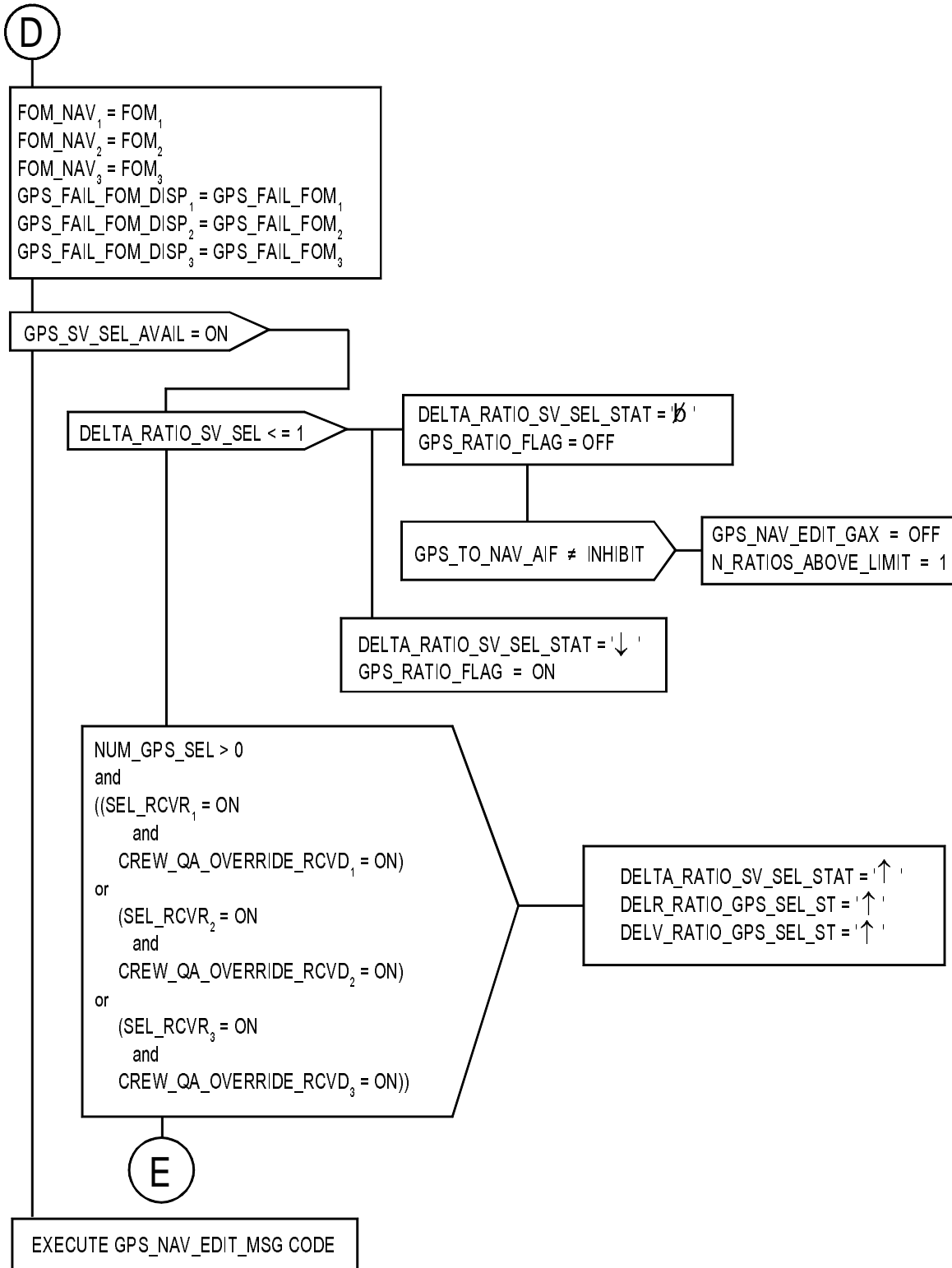


FIGURE 5.2-54.(6) GPS\_SV\_SELECT (Sheet 6 of 8)

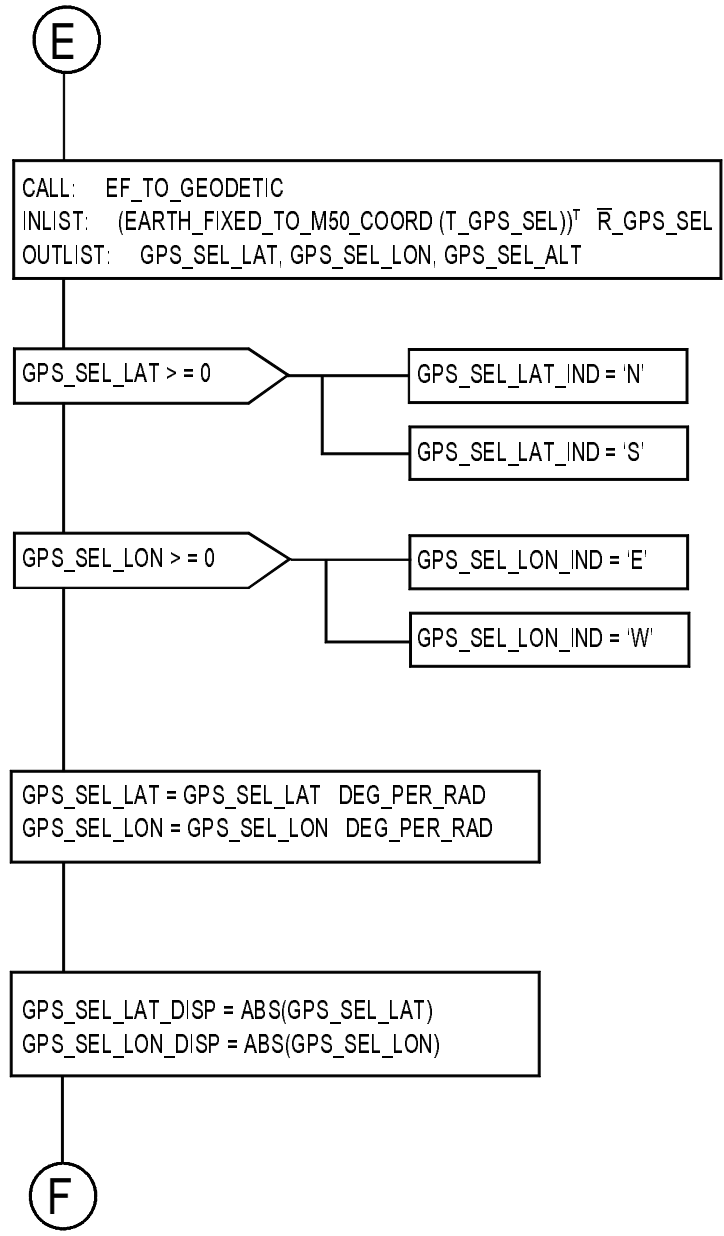


FIGURE 5.2-54.(7) GPS\_SV\_SELECT (Sheet 7 of 8)



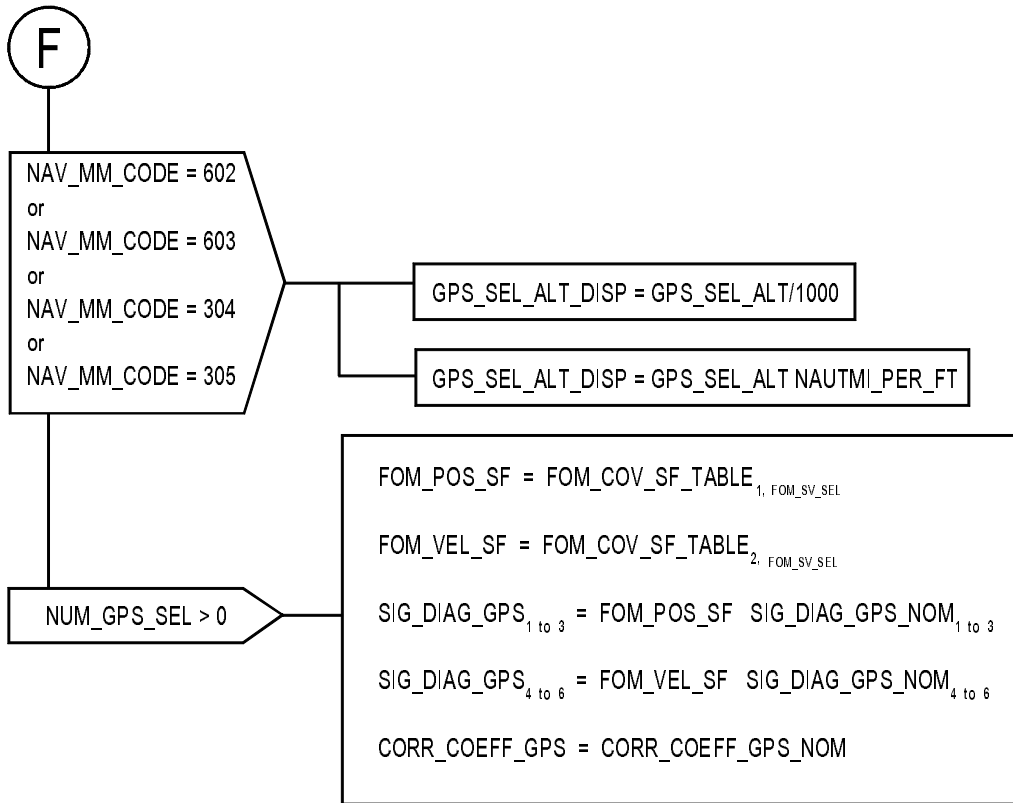


FIGURE 5.2-54.(8) GPS\_SV\_SELECT (Sheet 8 of 8)

GPS\_MVS:

INLIST:  $\bar{R}_{VECT}_1, \bar{R}_{VECT}_2, \bar{R}_{VECT}_3, \bar{V}_{VECT}_1, \bar{V}_{VECT}_2, \bar{V}_{VECT}_3$

OUTLIST:  $\bar{MID}_R, \bar{MID}_V, MID\_ELEM$

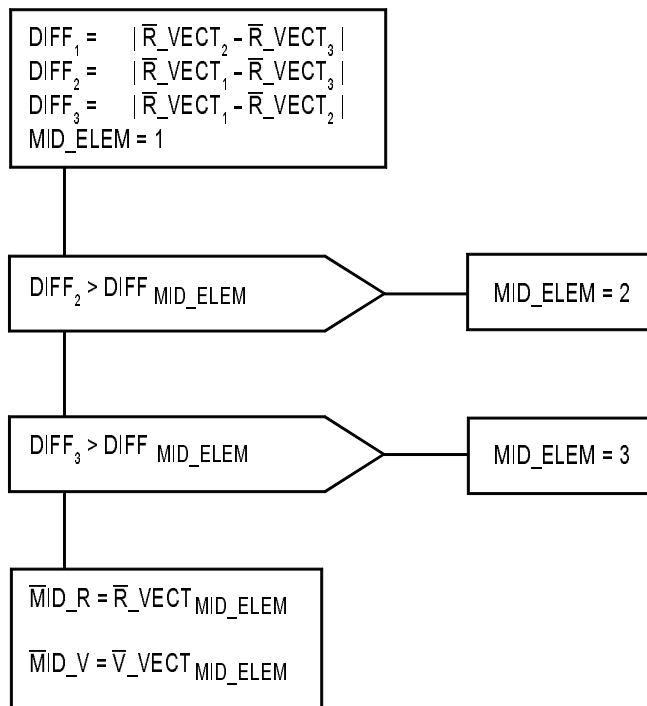


FIGURE 5.2-55. GPS\_MVS

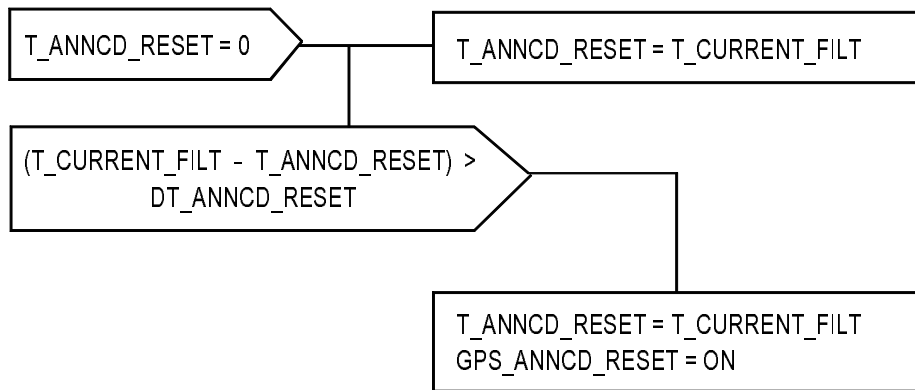


FIGURE 5.2-56. GPS\_REF\_STATE\_ANNCD\_RESET

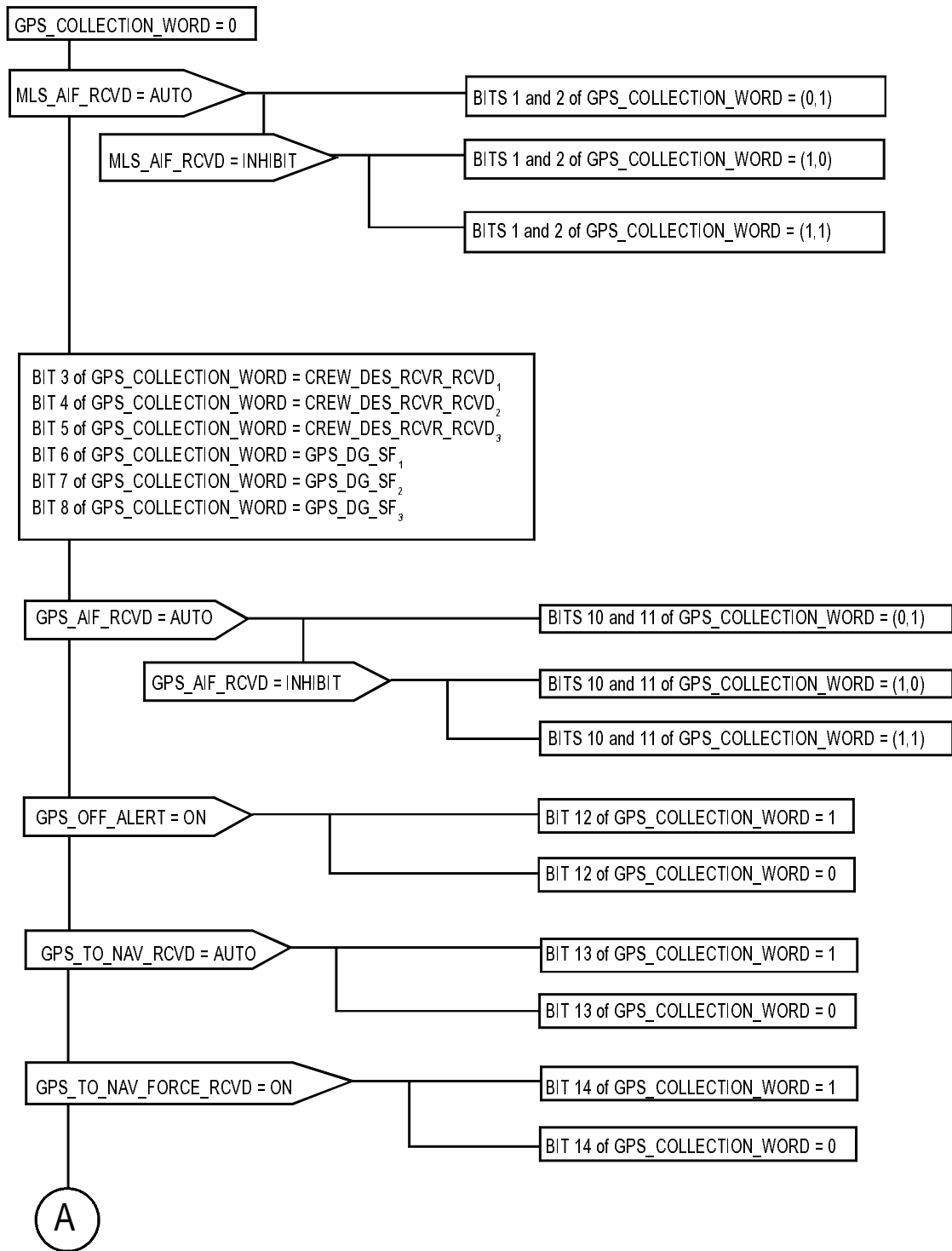


FIGURE 5.2-57.(1) GPS\_DL\_COMP (Sheet 1 of 9)

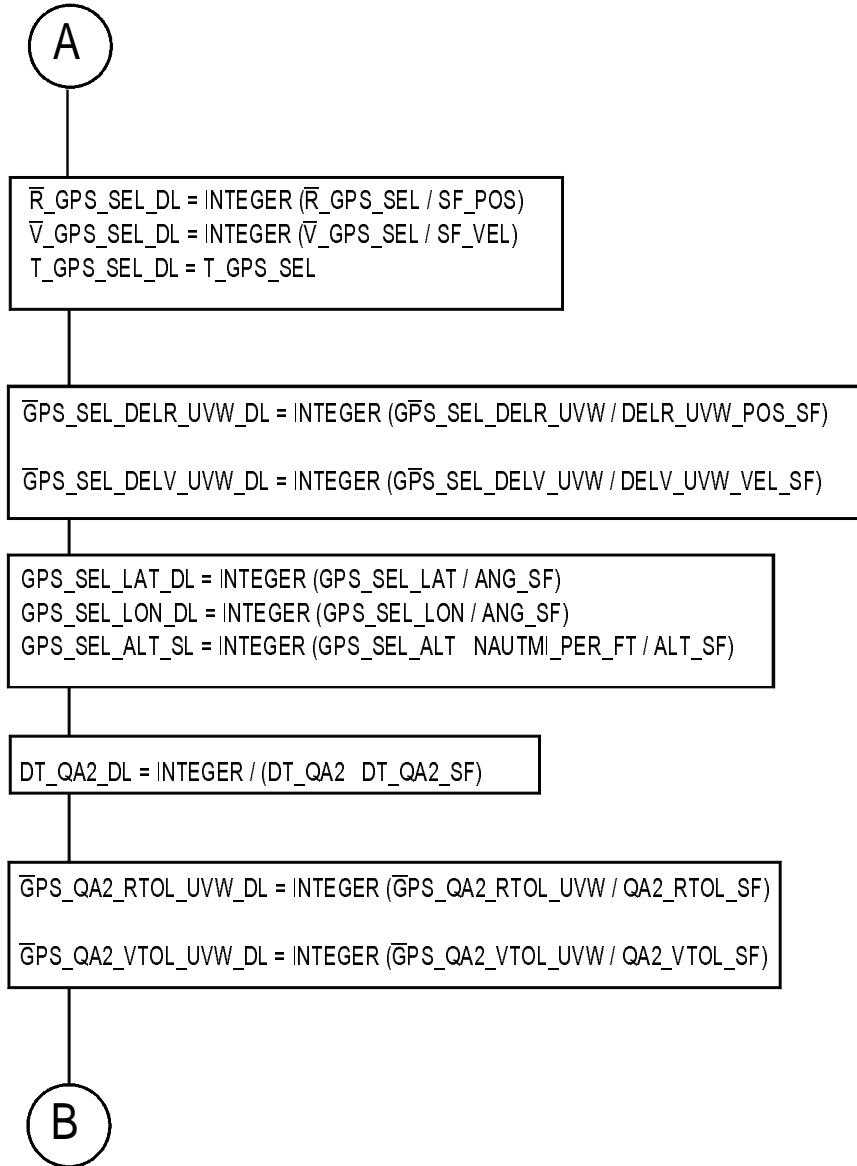


FIGURE 5.2-57.(2) GPS\_DL\_COMP (Sheet 2 of 9)

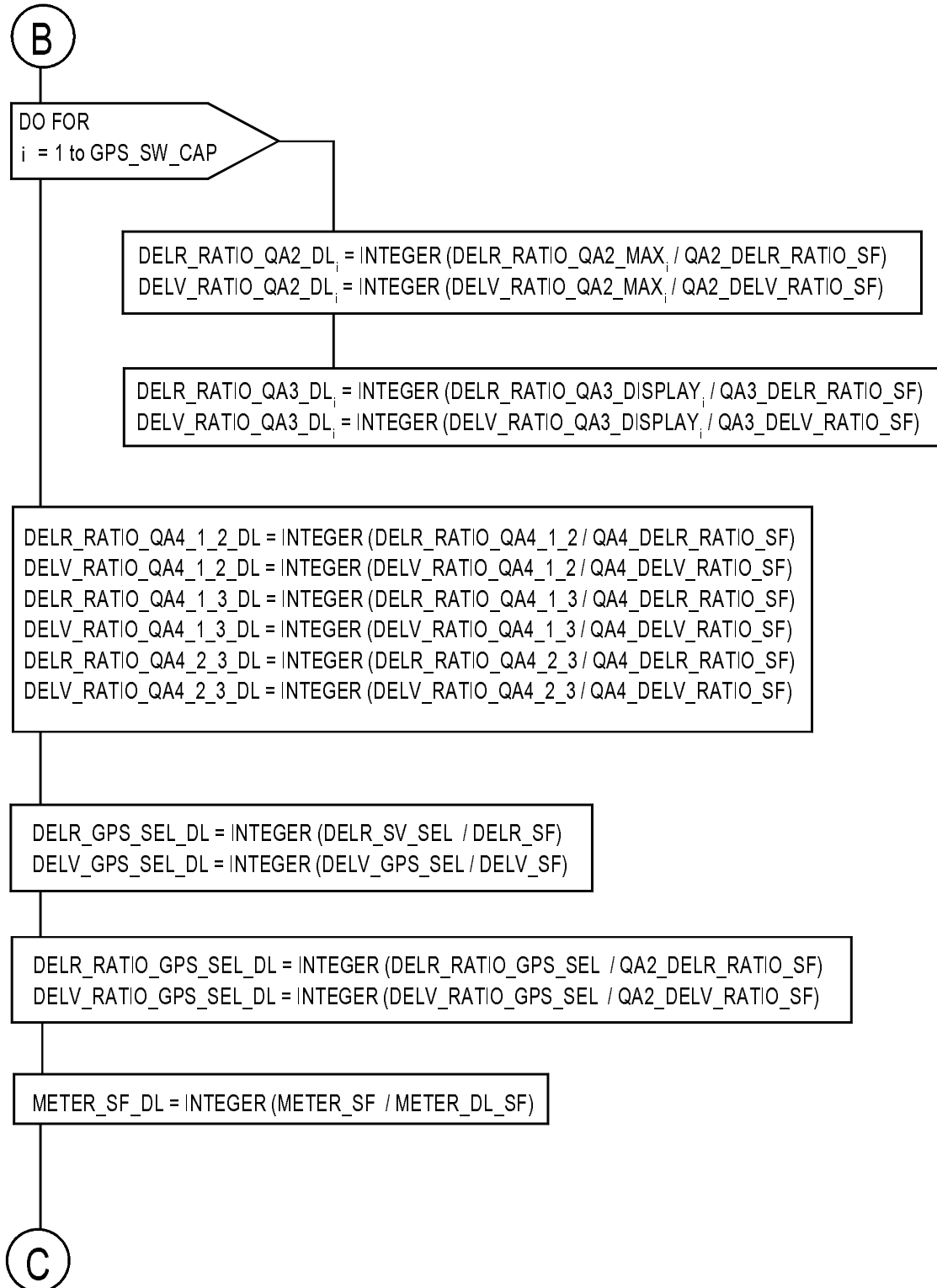


FIGURE 5.2-57.(3) GPS\_DL\_COMP (Sheet 3 of 9)

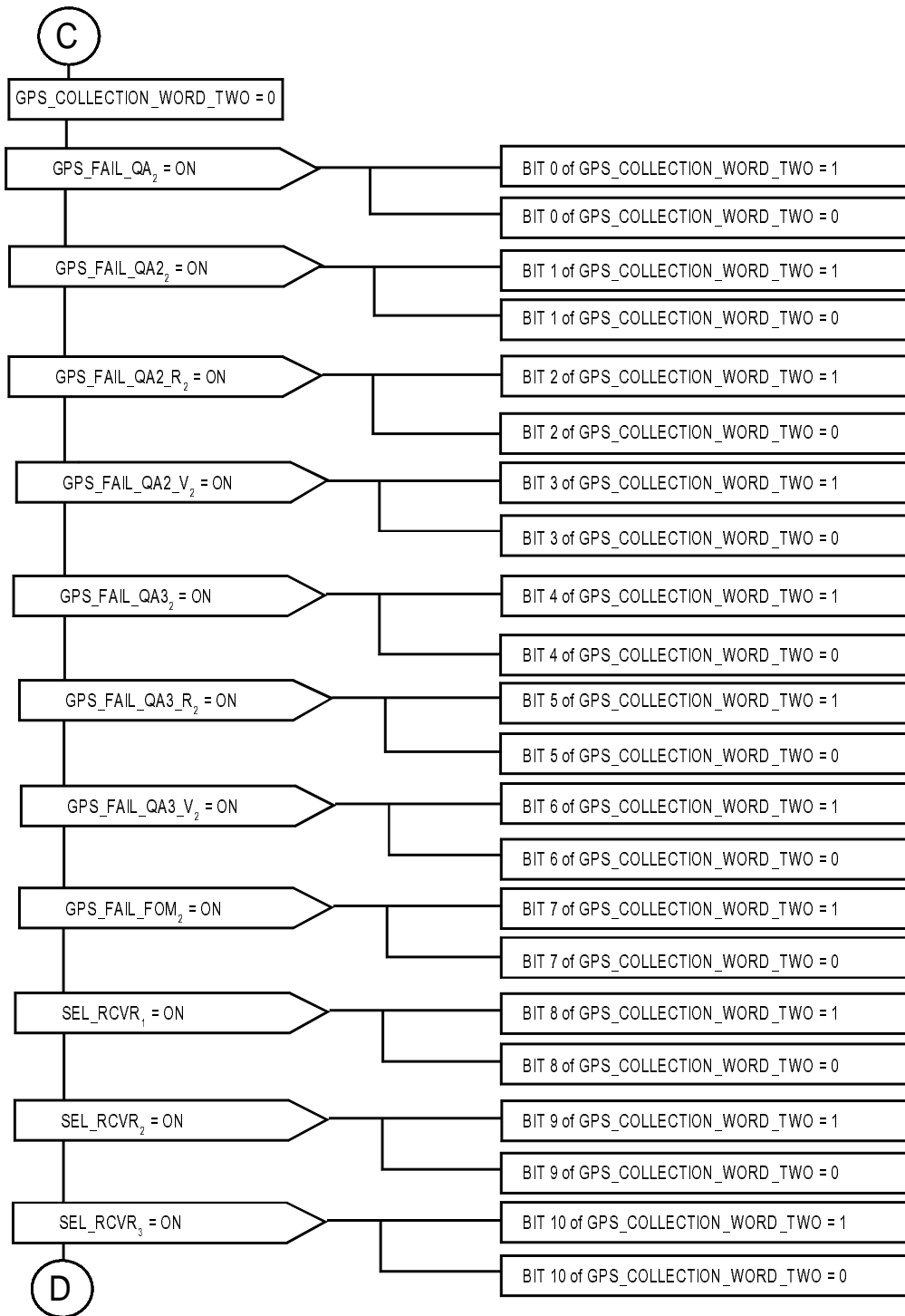


FIGURE 5.2-57.(4) GPS\_DL\_COMP (Sheet 4 of 9)

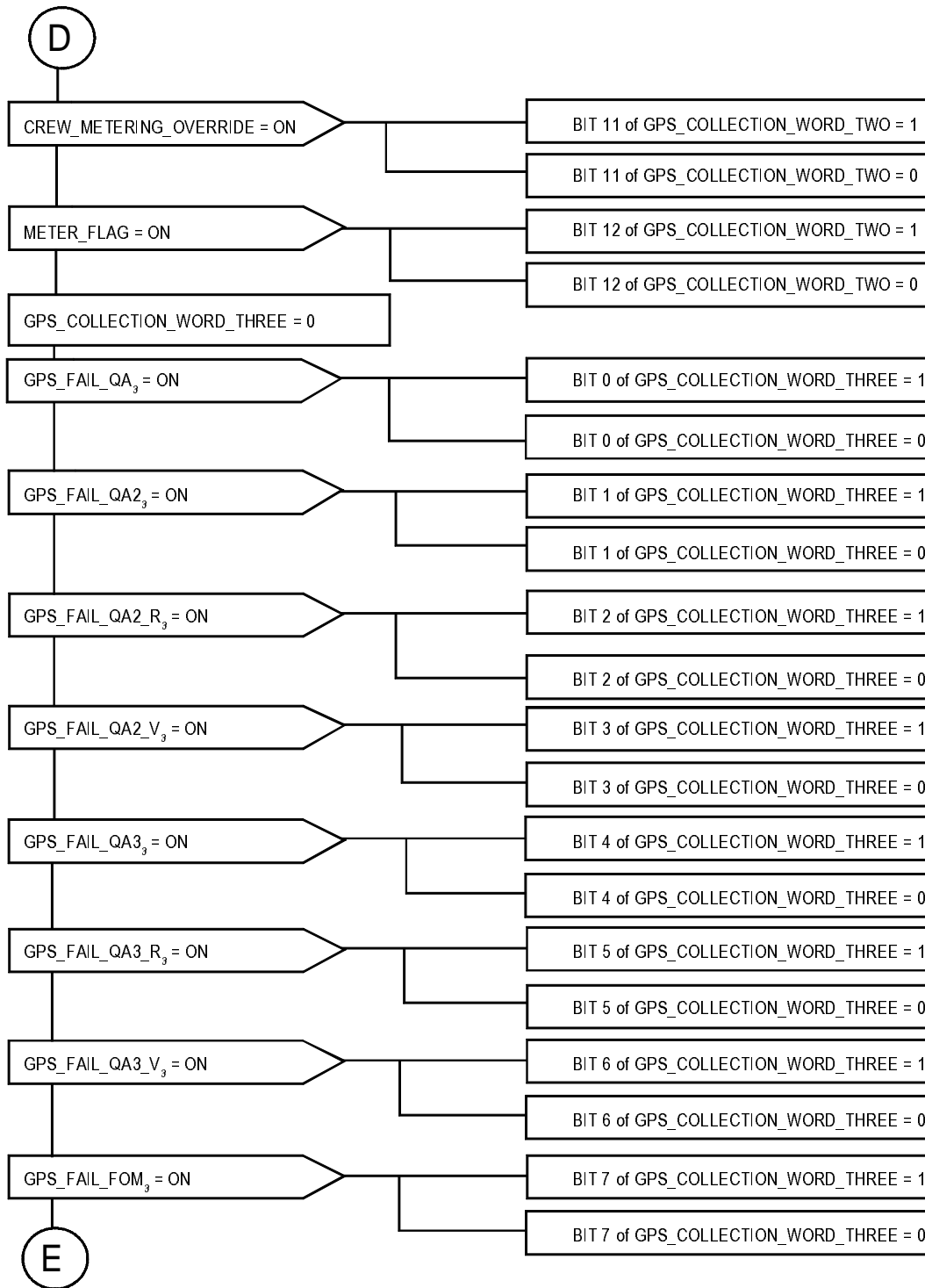


FIGURE 5.2-57.(5) GPS\_DL\_COMP (Sheet 5 of 9)



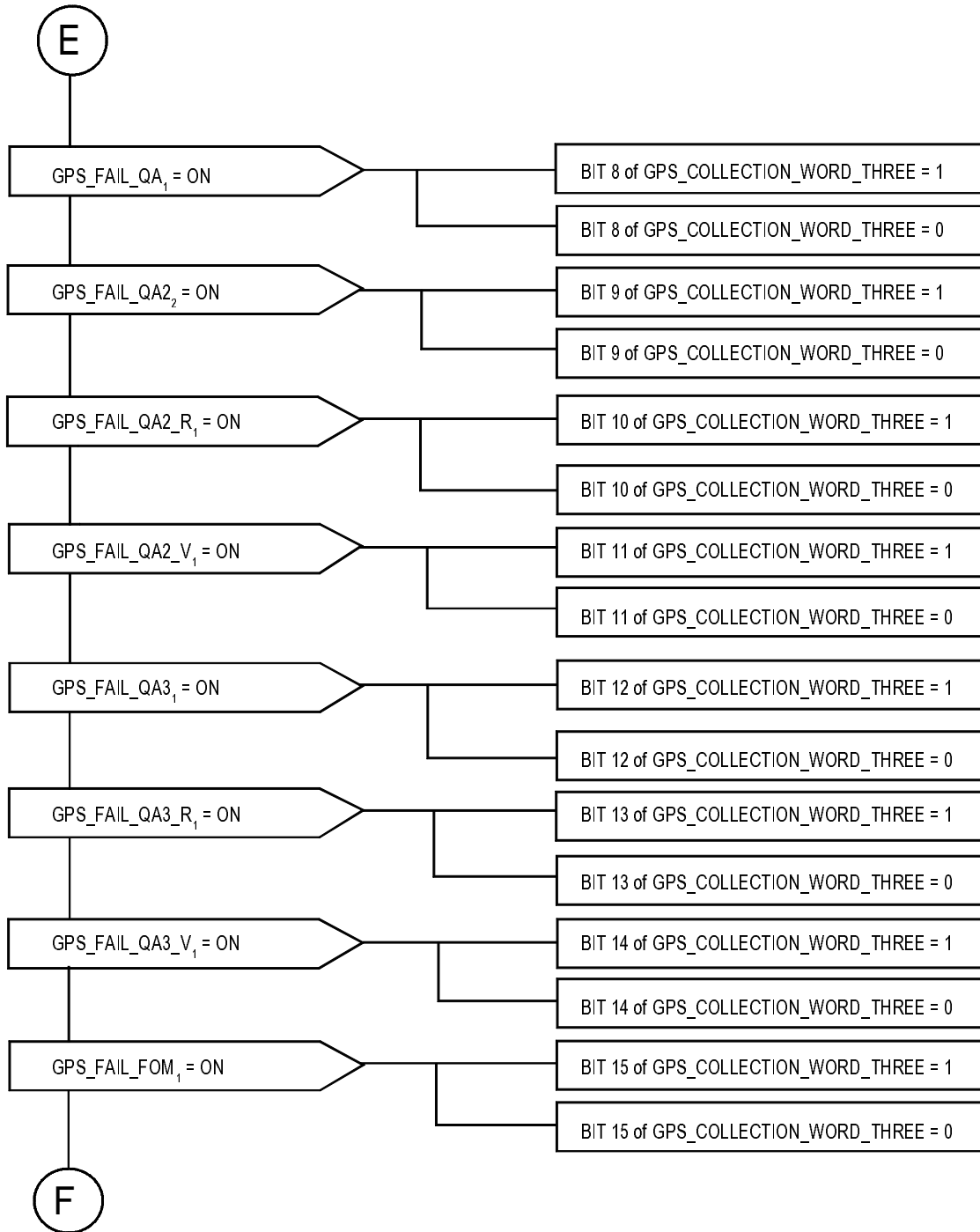


FIGURE 5.2-57.(6) GPS\_DL\_COMP (Sheet 6 of 9)

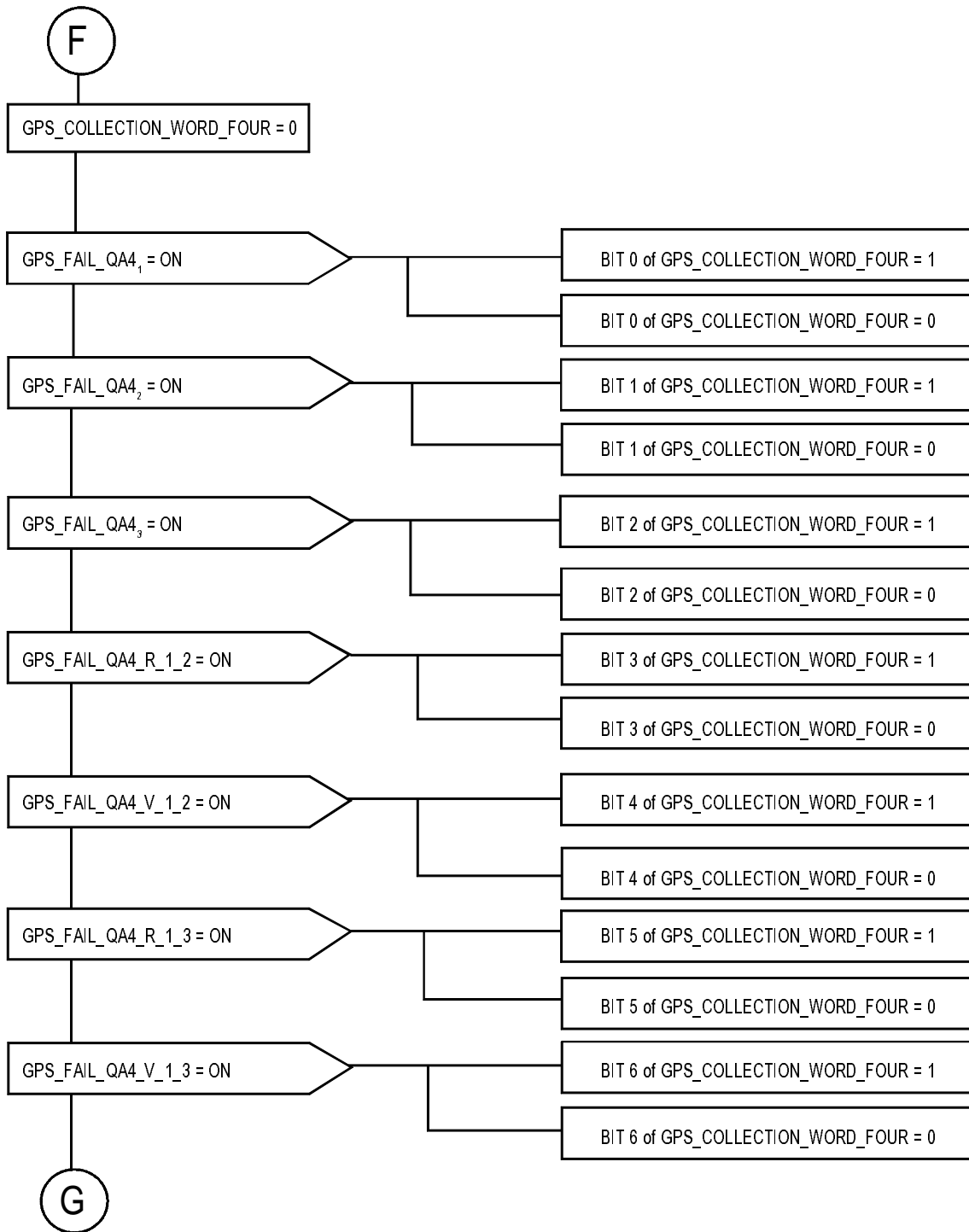


FIGURE 5.2-57.(7) GPS\_DL\_COMP (Sheet 7 of 9)

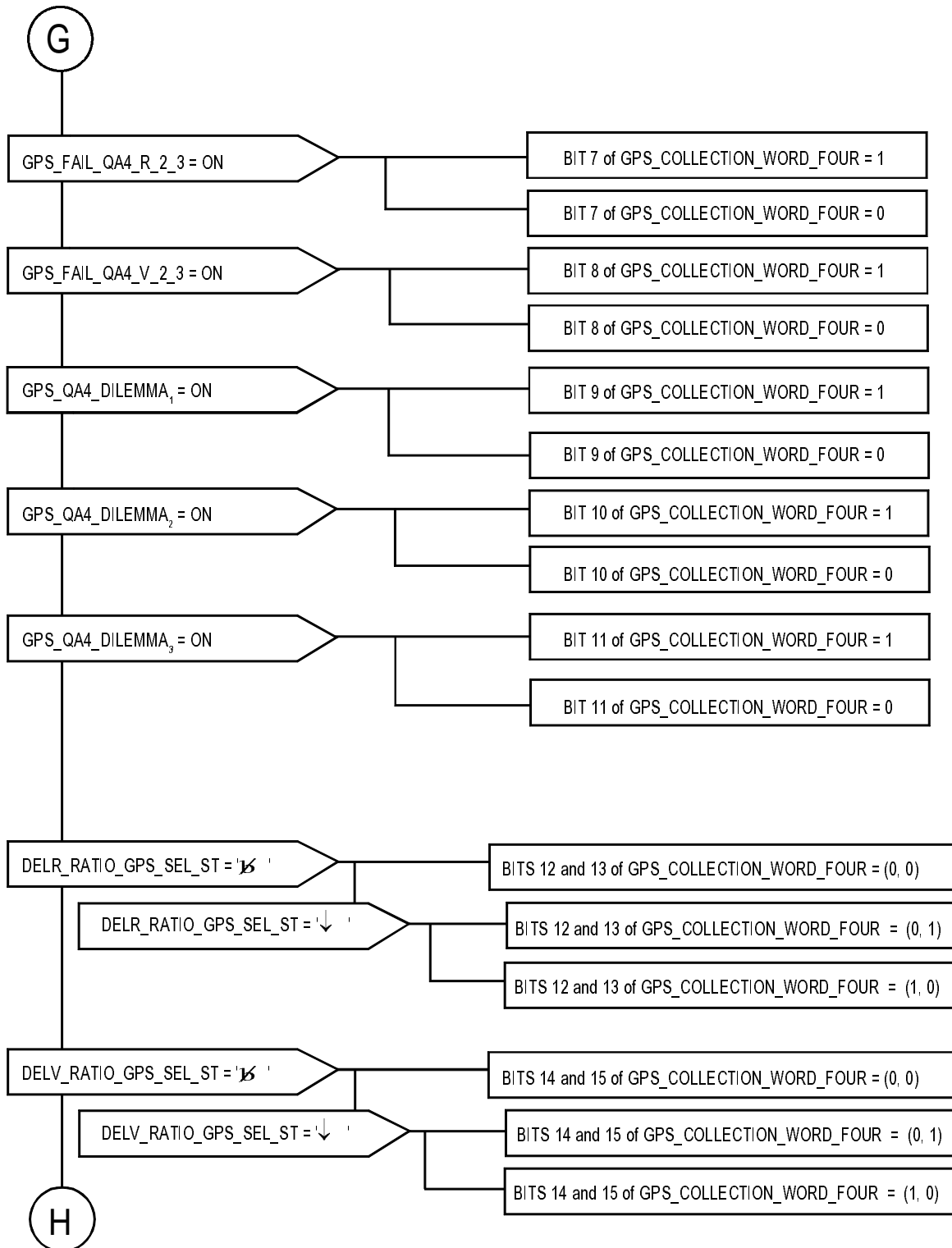


FIGURE 5.2-57.(8) GPS\_DL\_COMP (Sheet 8 of 9)

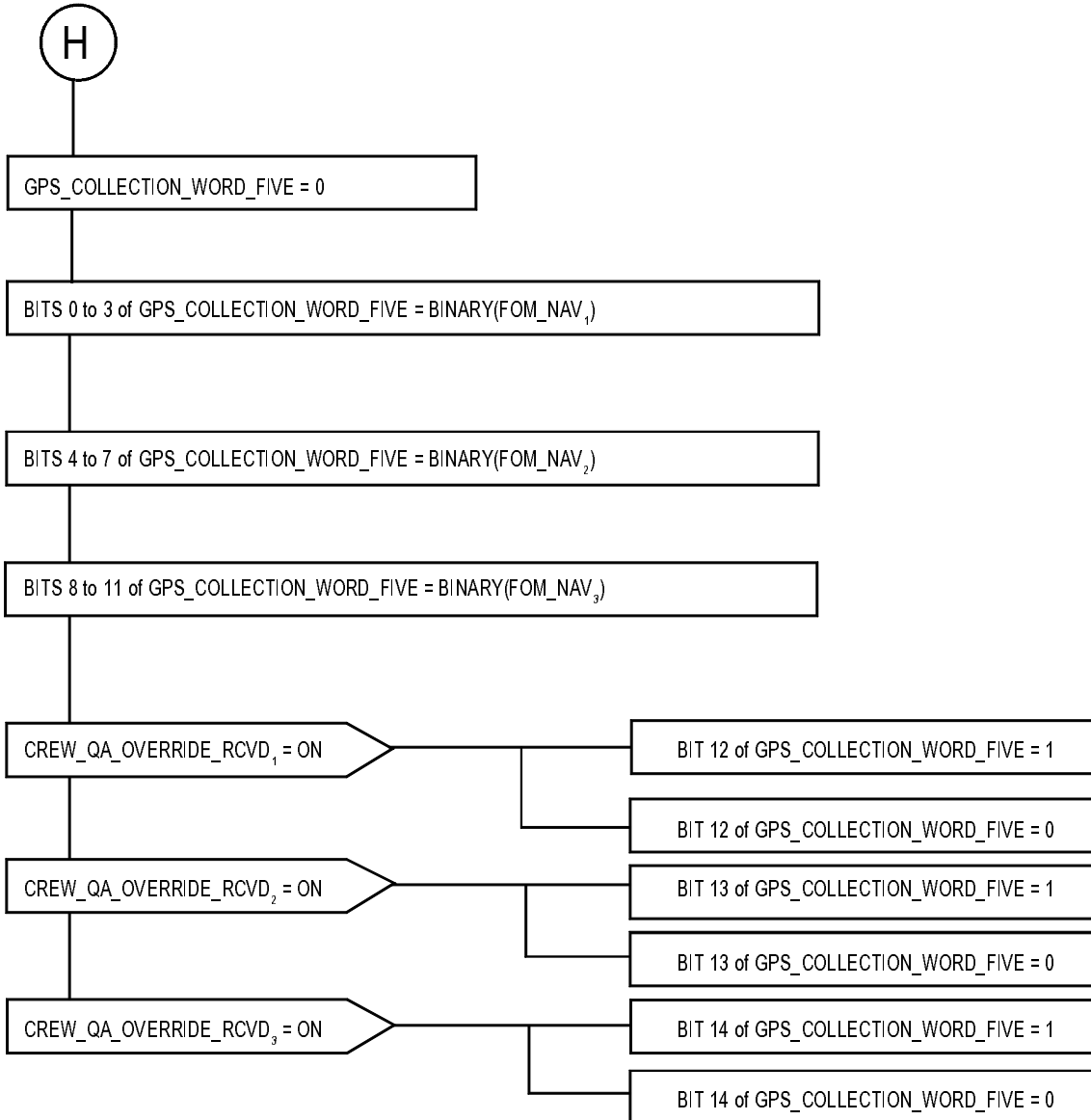
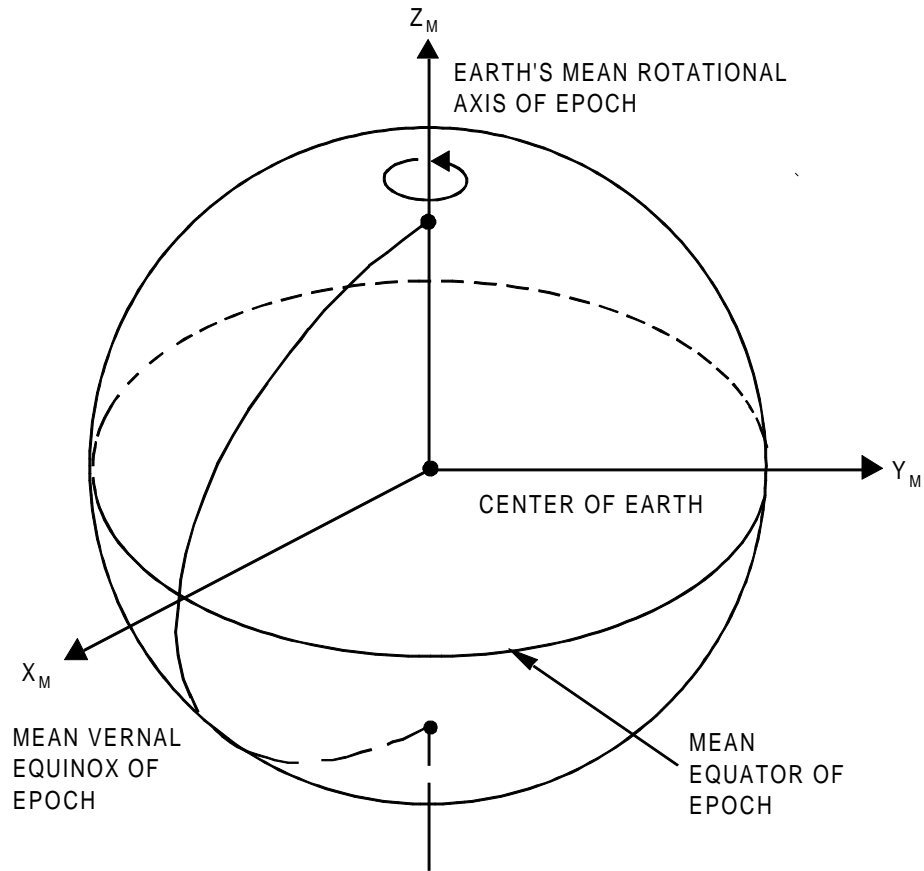


FIGURE 5.2-57.(9) GPS\_DL\_COMP (Sheet 9 of 9)

### **5.3 GENERAL REQUIREMENTS PRINCIPAL FUNCTIONS AND COORDINATE TRANSFORMATIONS FLOW CHARTS, VARIABLE NAMES, AND DESCRIPTIONS**

The supplemental material provided in this section includes definitions and explanations of the various coordinate systems (Figure 5.3-1 through Figure 5.3-13) used in the navigation requirements, and the transformation and general operations functional flow charts (Figure 5.3-14 through Figure 5.3-26). The variable list for the flow charts is provided in Table 5.3-1.



NAME: ARIES MEAN-OF-1950, CARTESIAN, COORDINATE SYSTEM

ORIGIN: THE CENTER OF THE EARTH

ORIENTATION: THE EPOCH IS THE BEGINNING OF BESSELIAN YEAR 1950 OR JULIAN EPHEMERIS DATE 2433282.423357

THE  $X_M - Y_M$  PLANE IS THE MEAN EARTH'S EQUATOR OF EPOCH.

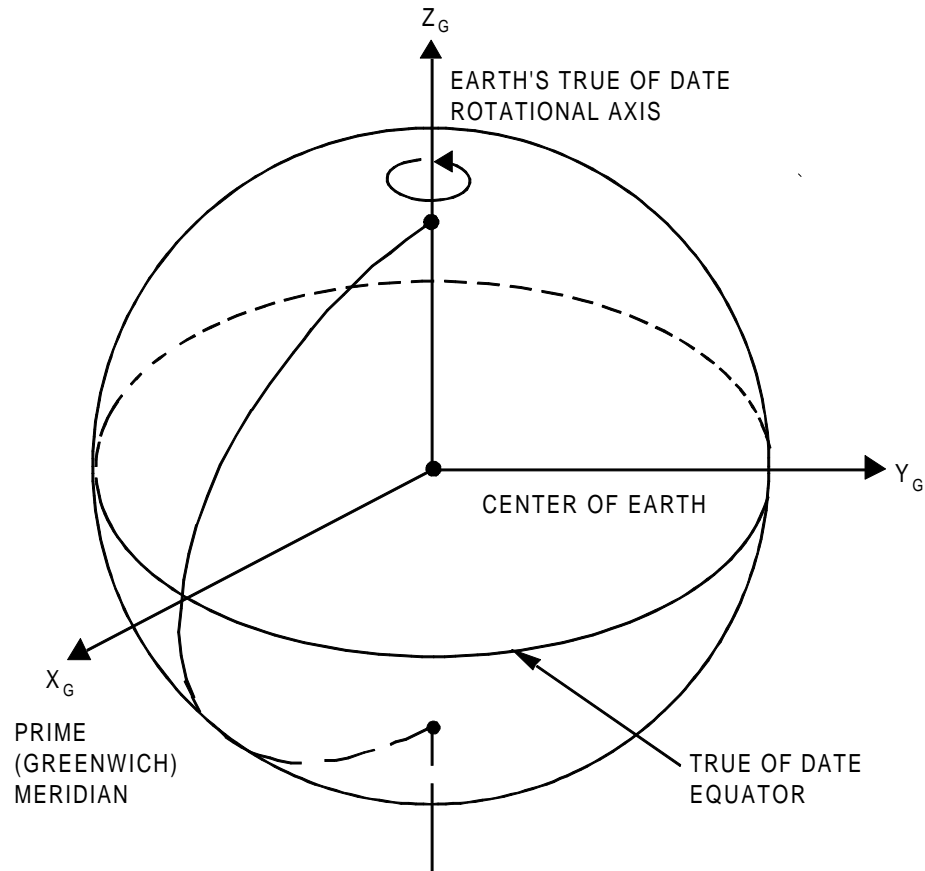
THE  $X_M$  AXIS IS DIRECTED TOWARD THE MEAN VERNAL EQUINOX OF EPOCH.

THE  $Z_M$  AXIS IS DIRECTED ALONG THE EARTH'S MEAN ROTATIONAL AXIS OF EPOCH AND IS POSITIVE NORTH.

THE  $Y_M$  AXIS COMPLETES A RIGHT-HANDED SYSTEM.

CHARACTERISTICS: INERTIAL, RIGHT-HANDED CARTESIAN SYSTEM.

FIGURE 5.3-1. Aries Mean-of-1950 Cartesian



NAME: EARTH-FIXED (GREENWICH TRUE OF DATE) COORDINATE SYSTEM

ORIGIN: THE CENTER OF THE EARTH

ORIENTATION: THE  $X_G$ - $Y_G$  PLANE IS THE EARTH'S TRUE OF DATE EQUATOR.

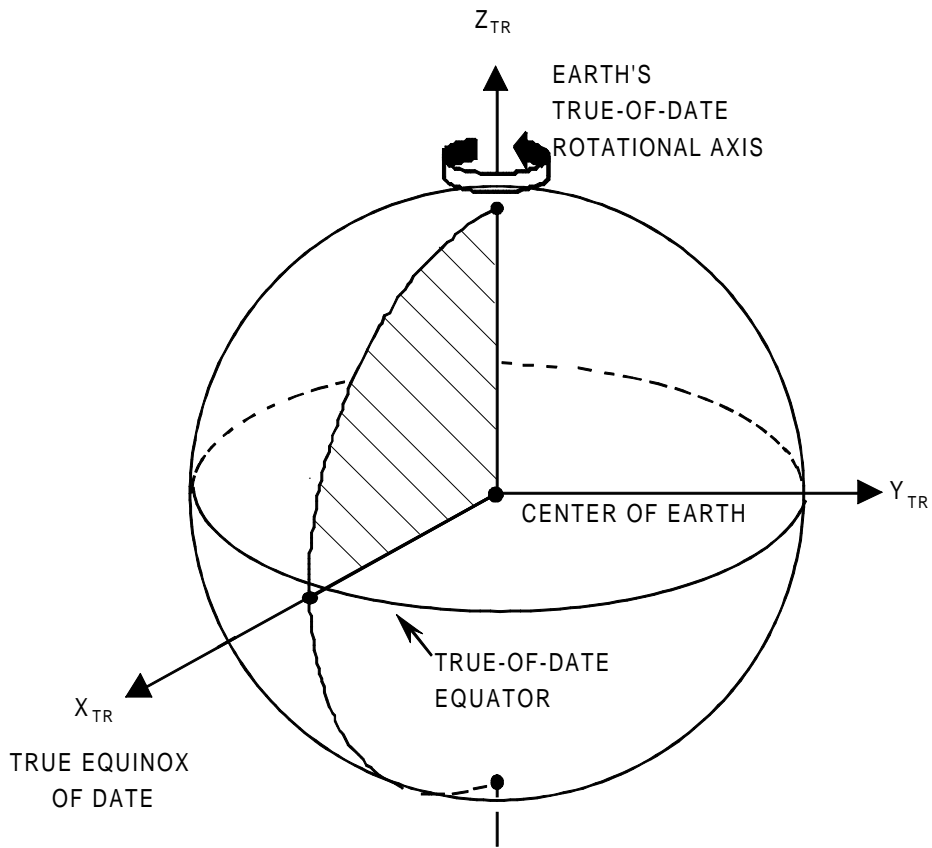
THE  $Z_G$  AXIS IS DIRECTED ALONG THE EARTH'S TRUE OF DATE ROTATIONAL AXIS AND IS POSITIVE NORTH.

THE  $+X_G$  AXIS IS DIRECTED TOWARD THE PRIME MERIDIAN.

THE  $Y_G$  AXIS COMPLETES A RIGHT-HANDED SYSTEM.

CHARACTERISTICS: ROTATING, RIGHT-HANDED CARTESIAN. VELOCITY VECTORS EXPRESSED IN THIS SYSTEM ARE RELATIVE TO A ROTATING REFERENCE FRAME FIXED TO THE EARTH, WHOSE ROTATION RATES ARE EXPRESSED RELATIVE TO THE ARIES MEAN OF 1950 SYSTEM.

FIGURE 5.3-2. Earth-Fixed, Greenwich True-of-Date



NAME: ARIES TRUE-OF-DATE, CARTESIAN, COORDINATE SYSTEM.

ORIGIN: THE CENTER OF THE EARTH.

ORIENTATION: THE EPOCH IS THE CURRENT TIME OF INTEREST.

THE  $X_{TR} - Y_{TR}$  PLANE IS THE EARTH'S TRUE EQUATOR OF EPOCH.

THE  $X_{TR}$  AXIS IS DIRECTED TOWARD THE TRUE VERNAL EQUINOX OF EPOCH.

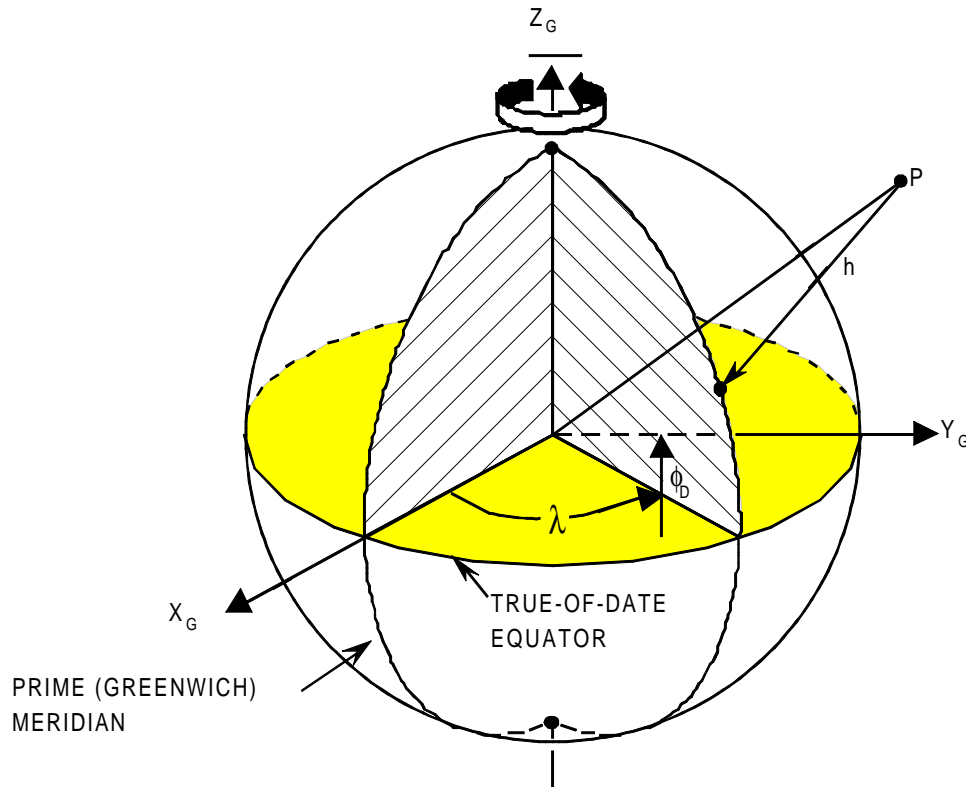
THE  $Z_{TR}$  AXIS IS DIRECTED ALONG THE EARTH'S TRUE ROTATIONAL AXIS OF EPOCH AND IS POSITIVE NORTH.

THE  $Y_{TR}$  AXIS COMPLETES THE RIGHT-HANDED SYSTEM.

CHARACTERISTICS: QUASI-INERTIAL, RIGHT-HANDED CARTESIAN.

FIGURE 5.3-3. Aries True-Of-Date, Cartesian





NAME: GEODETIC PARAMETERS

ORIGIN: THIS SYSTEM CONSISTS OF A SET OF PARAMETERS RATHER THAN A COORDINATE SYSTEM; THEREFORE, NO ORIGIN IS SPECIFIED.

ORIENTATION: THIS SYSTEM OF PARAMETERS IS BASED ON AN ELLIPSOIDAL MODEL OF THE EARTH (e.g., THE FISHER ELLIPSE OF 1960). FOR ANY POINT OF INTEREST WE DEFINE A LINE KNOWN AS THE GEODETIC LOCAL VERTICAL WHICH PERPENDICULAR TO THE ELLIPSOID AND WHICH CONTAINS THE POINT OF INTEREST.

$h$ , GEODETIC ALTITUDE, IS THE DISTANCE FROM THE POINT OF INTEREST TO THE REFERENCE ELLIPSOID, MEASURED ALONG THE GEODETIC LOCAL VERTICAL, AND IS POSITIVE FOR POINTS OUTSIDE THE ELLIPSOID.

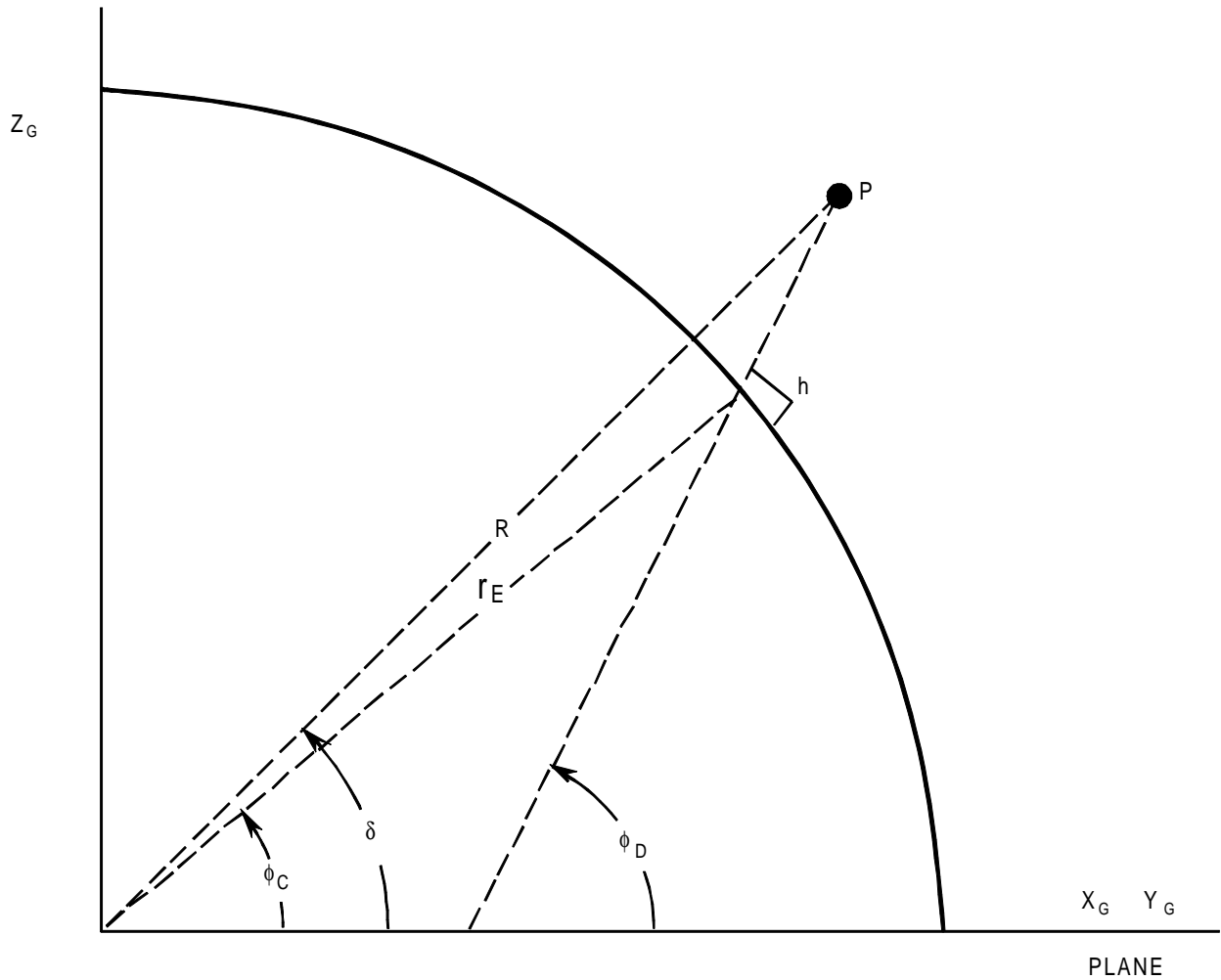
$\lambda$  IS THE LONGITUDE MEASURED IN THE PLANE OF THE EARTH'S TRUE EQUATOR FROM THE PRIME (GREENWICH) MERIDIAN TO THE LOCAL MERIDIAN, MEASURED POSITIVE EASTWARD.

$\phi_D$  IS THE GEODETIC LATITUDE, MEASURED IN THE PLANE OF THE LOCAL MERIDIAN FROM THE EARTH'S TRUE EQUATOR TO THE GEODETIC LOCAL VERTICAL, MEASURED POSITIVE NORTH FROM THE EQUATOR.

NOTE:  
A DETAILED EXPLANATION OF DECLINATION, GEODETIC LATITUDE, AND GEOCENTRIC LATITUDE IS PROVIDED IN PART B OF THIS FIGURE.

CHARACTERISTICS: ROTATING POLAR COORDINATE PARAMETERS. ONLY POSITION VECTORS ARE EXPRESSED IN THIS COORDINATE SYSTEM. VELOCITY VECTORS SHOULD BE EXPRESSED IN THE ARIES MEAN OF 1950 OR THE ARIES TRUE OF DATA POLAR FOR INERTIAL OR QUASI-INERTIAL REPRESENTATIONS, RESPECTIVELY.

FIGURE 5.3-4. (A) Basic Definitions - Geodetic Parameters



NAME: GEODETIC PARAMETERS

DEFINITIONS:  $h$  IS THE ALTITUDE OF POINT P. MEASURED PERPENDICULAR FROM THE SURFACE OF THE REFERENCED ELLIPSOID.

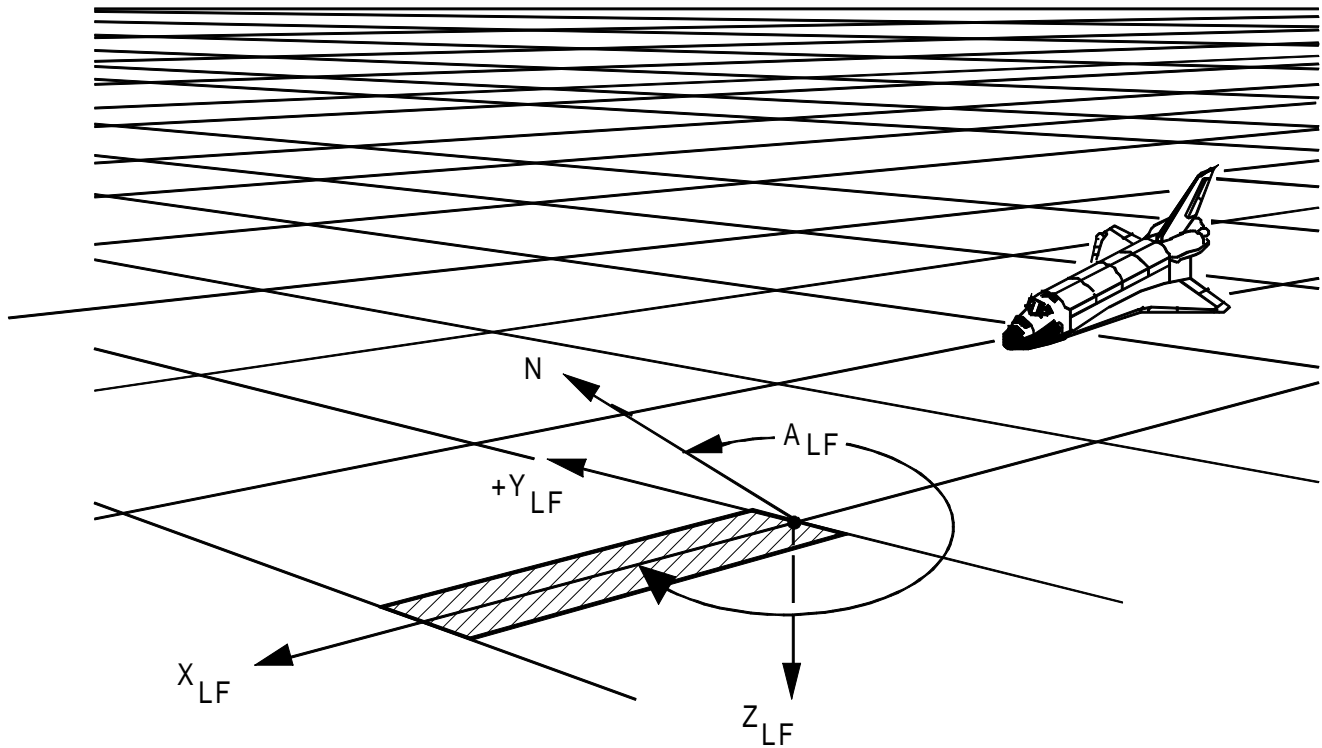
$\phi_D$  IS THE GEODETIC LATITUDE OF POINT P.

$\phi_C$  IS THE GEOCENTRIC LATITUDE OF POINT P.

$\delta$  IS THE ANGLE BETWEEN RADIUS VECTOR AND EQUATORIAL PLANE (DECLINATION)

$\lambda$  IS THE LONGITUDE OF POINT P. ANGLE (+ EAST) BETWEEN PLANE OF THE FIGURE AND THE PLANE FORMED BY THE GREENWICH MERIDIAN.

FIGURE 5.3-5. (B) Detailed Explanation - Geodetic Parameters



NAME: RUNWAY COORDINATE SYSTEM  
ORIGIN: RUNWAY CENTER AT APPROACH THRESHOLD

ORIENTATION  
AND DEFINITIONS:

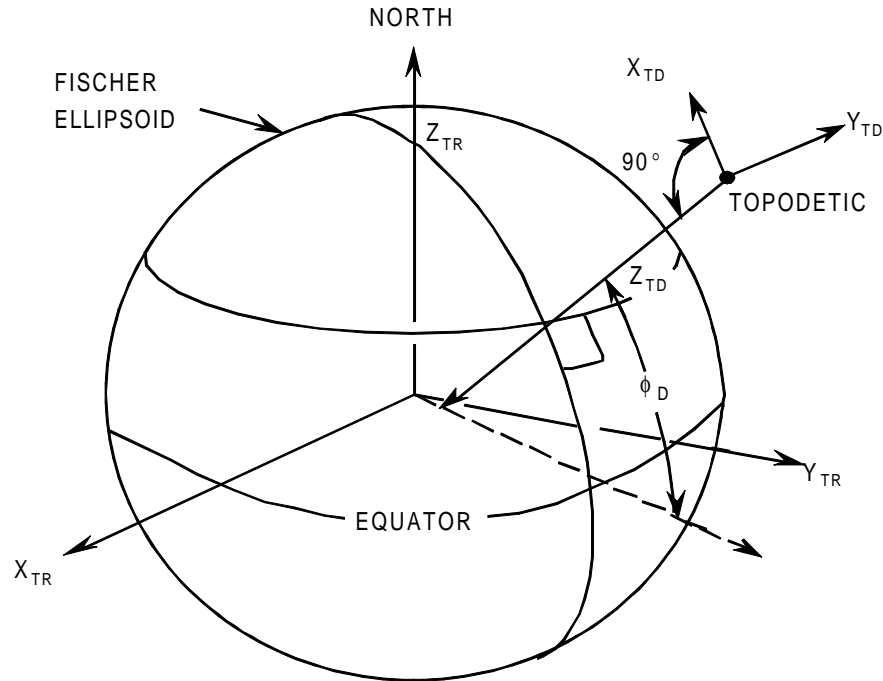
$Z_{LF}$  AXIS IS NORMAL TO THE ELLIPSOID MODEL THROUGH THE RUNWAY CENTERLINE AT THE APPROACH THRESHOLD AND POSITIVE TOWARD THE CENTER OF THE EARTH.

$X_{LF}$  AXIS IS PERPENDICULAR TO THE  $Z_{LF}$  AXIS AND LIES IN A PLANE CONTAINING THE  $Z_{LF}$  AXIS AND THE RUNWAY CENTERLINE (POSITIVE IN THE DIRECTION OF LANDING).

$Y_{LF}$  AXIS COMPLETES THE RIGHT-HANDED SYSTEM.  
 $A_{LF}$  IS THE RUNWAY AZIMUTH MEASURED IN THE  $X_{LF}$   $Y_{LF}$  PLANE FROM TRUE NORTH TO THE  $+X_{LF}$  AXIS (POSITIVE CLOCKWISE).

CHARACTERISTICS: ROTATING, EARTH-REFERENCED.

FIGURE 5.3-6. Runway Coordinate System



NAME: TOPODETTIC COORDINATE SYSTEM

ORIGIN: ORBITER CENTER OF MASS\*

ORIENTATION:  $Z_{TD}$  IS NORMAL TO A GEODETTIC LOCAL TANGENT PLANE AND IS POSITIVE TOWARD THE EARTH'S CENTER.

$X_{TD}$  IS PERPENDICULAR TO  $Z_{TD}$  AXIS AND IS POSITIVE NORTHWARD ALONG THE MERIDIAN PLANE CONTAINING THE ORBITER.

$Y_{TD}$  COMPLETES THE RIGHT-HANDED ORTHOGONAL SYSTEM.

CHARACTERISTICS: ROTATING, RIGHT-HANDED CARTESIAN SYSTEM. VELOCITY VECTORS ARE EXPRESSIBLE IN THIS SYSTEM FOR THE ORBITER, GIVEN RELATIVE VELOCITY  $V_{TD}$  IN THIS SYSTEM.

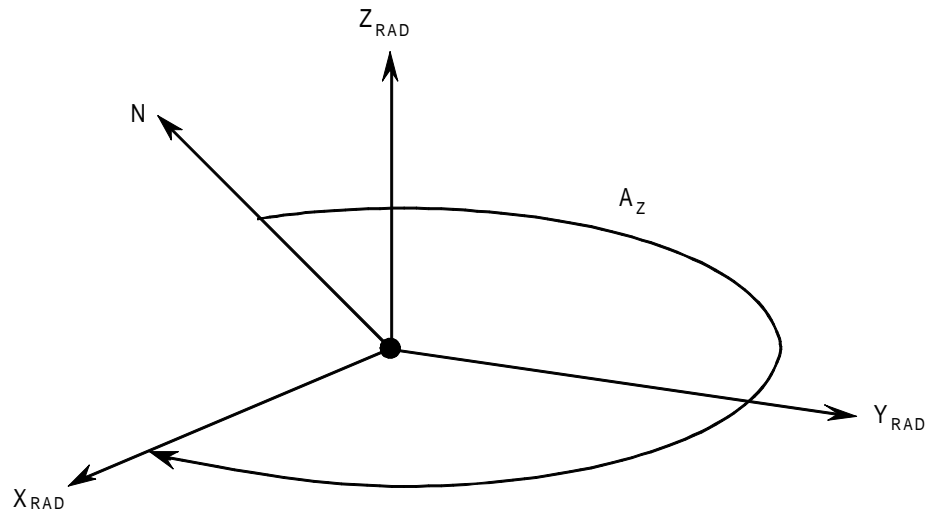
$$\lambda_{TD} = \text{SIN}^{-1} \left( \frac{\dot{Z}_{TD}}{V_{TD}} \right)$$

$$\phi_{TD} = \text{TAN}^{-1} \left( \frac{\dot{Y}_{TD}}{\dot{X}_{TD}} \right)$$

$\phi_D$  = GEODETTIC LATITUDE

\* A SIMILAR SYSTEM MAY BE DEFINED FOR ANY POINT OF INTEREST.

FIGURE 5.3-7. Topodetic Coordinate System



NAME: MSBLS RADAR COORDINATE SYSTEM.

ORIGIN: MSBLS RADAR POSITION.

ORIENTATION

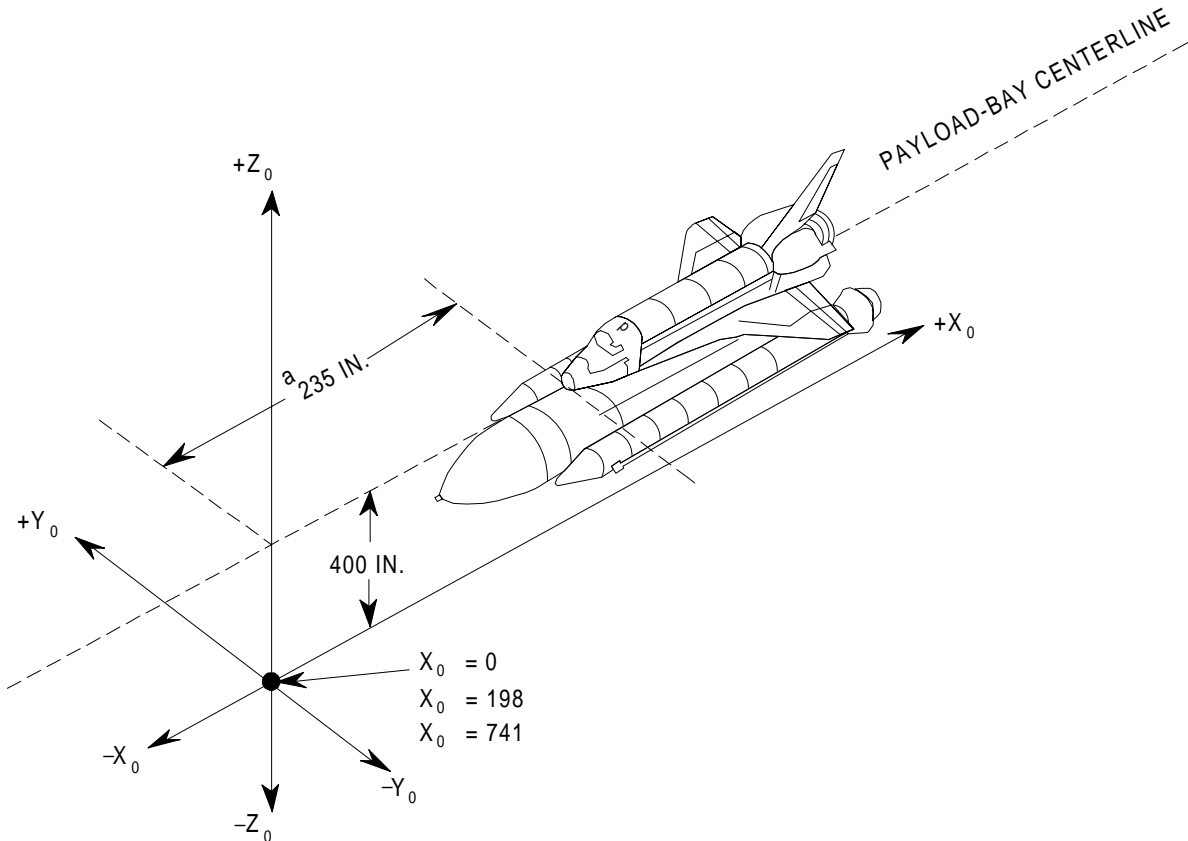
AND DEFINITIONS:  $Z_{RAD}$  IS NORMAL TO THE ELLIPSOIDAL MODEL, POSITIVE AWAY FROM THE CENTER OF THE EARTH.

$X_{RAD}$  IS THE LOCAL HORIZONTAL PLANE OF THE RADAR IN THE BORESIGHT DIRECTION OF THE RADAR ANTENNA. THE ANGLE  $A_Z$  IS MEASURED POSITIVELY CLOCKWISE FROM TRUE NORTH TO  $X_{RAD}$ .

CHARACTERISTICS:

ROTATING, EARTH-REFERENCED.

FIGURE 5.3-8. MSBLS Radar Coordinate System



NAME: BODY COORDINATE SYSTEM (STRUCTURAL)

ORIGIN: IN THE ORBITER PLANE OF SYMMETRY, 400 INCHES BELOW THE CENTERLINE OF THE PAYLOAD BAY AND AT ORBITER X-STATION = 0

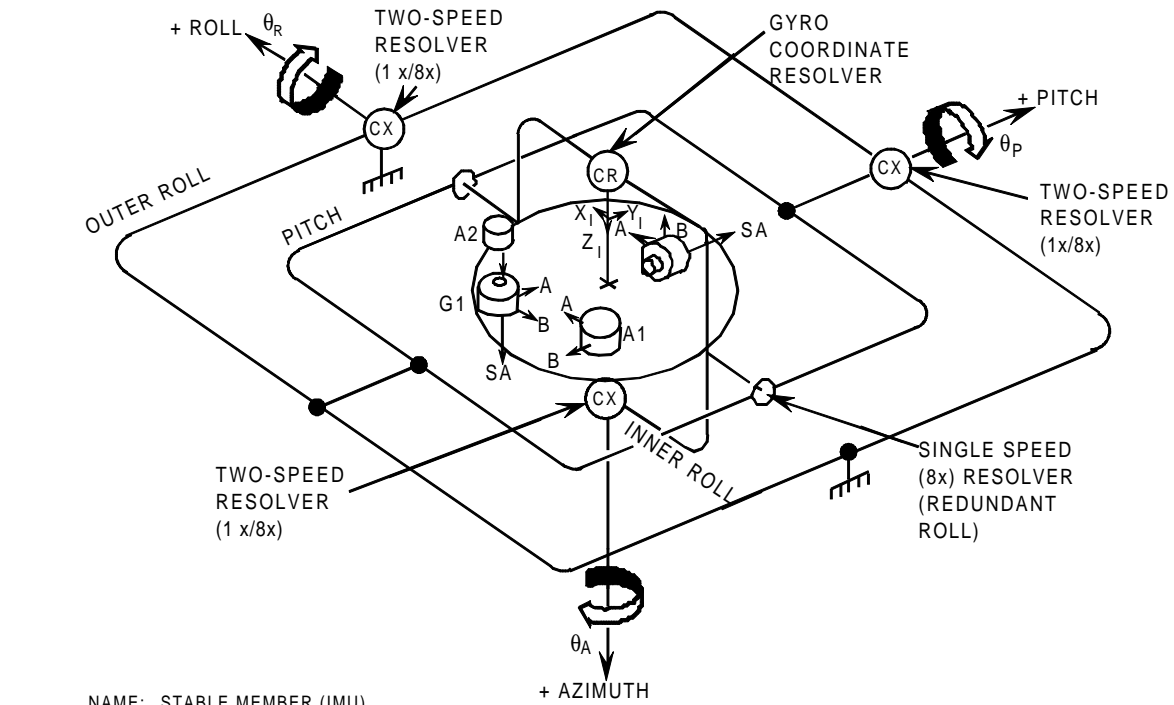
ORIENTATION: THE  $X_0$  AXIS IS IN THE VEHICLE PLANE OF SYMMETRY, PARALLEL TO AND 400 INCHES BELOW THE PAYLOAD BAY CENTERLINE. POSITIVE SENSE IS FROM THE NOSE OF THE VEHICLE TOWARD THE TAIL.

THE  $Z_0$  AXIS IS IN THE VEHICLE PLANE OF SYMMETRY, PERPENDICULAR TO THE  $X_0$  AXIS. POSITIVE UPWARD IN LANDING ATTITUDE.

THE  $Y_0$  AXIS COMPLETES A RIGHT-HANDED SYSTEM.

CHARACTERISTICS: ROTATING, RIGHT-HANDED CARTESIAN.

FIGURE 5.3-9. Body Coordinate System (Structural)



NAME: STABLE MEMBER (IMU)

ORIGIN: THE INTERSECTION OF THE INNERMOST GIMBAL AXIS AND THE MEASUREMENT PLANE OF THE XY TWO AXIS ACCELEROMETER.

ORIENTATION:

THE  $Z_1$  AXIS IS COINCIDENT WITH THE INNERMOST GIMBAL AXIS.

THE  $X_1$  AXIS IS DETERMINED BY THE PROJECTION OF THE X ACCELEROMETER INPUT AXIS (IA) ONTO A PLANE ORTHOGONAL TO  $Z_1$ .  $Y_1$  COMPLETES A RIGHT-HANDED TRIAD.

IN A PERFECT IMU, WITH ALL MISALIGNMENTS ZERO, THESE RELATIONSHIPS HOLD.

THE X ACCELEROMETER AND X GYRO IAs ARE PARALLEL TO THE  $X_1$  AXIS.

THE Y ACCELEROMETER AND Y GYRO IAs ARE PARALLEL TO THE  $Y_1$  AXIS.

THE Z ACCELEROMETER AND Z GYRO IAs ARE PARALLEL TO THE  $Z_1$  AXIS.

CHARACTERISTICS: NONROTATING, RIGHT-HANDED, CARTESIAN SYSTEM.

THE REFERENCE ALIGNMENT FOR THE GIMBAL CASE SHALL BE DEFINED WITH THE FOUR GIMBAL ANGLES AT ZERO AND WITH THE VEHICLE IN A HORIZONTAL POSITION. IN A PERFECT IMU, WITH ALL MISALIGNMENTS ZERO AND WITH ALL GIMBAL ANGLES AT ZERO, THE FOLLOWING RELATIONSHIPS HOLD.

THE OUTER ROLL AXIS AND THE  $X_1$  -AXIS WILL BE PARALLEL TO  $X_{NB}$ . POSITIVE  $X_1$  WILL BE IN THE FORWARD DIRECTION. POSITIVE ROLL GIMBAL ANGLES WILL BE IN THE SENSE OF A RIGHT-HANDED ROTATION OF THE GIMBAL CASE RELATIVE TO THE PLATFORM ABOUT THE PLUS OUTER ROLL AXIS.

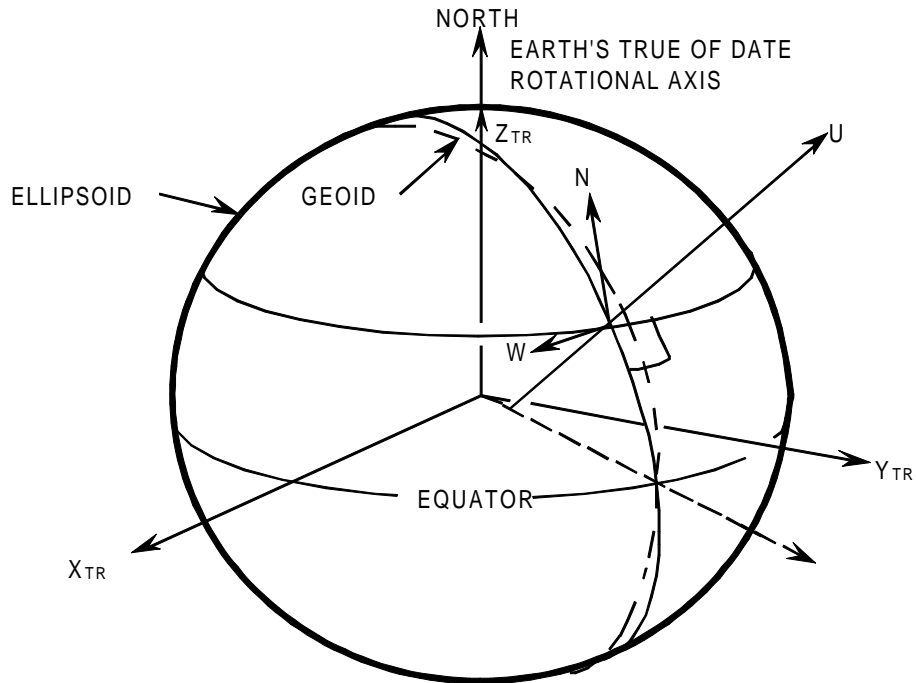
THE PITCH AXIS AND  $Y_1$  WILL BE PARALLEL TO  $Y_{NB}$ . POSITIVE  $Y_1$  WILL BE TO THE RIGHT OF AN OBSERVER LOOKING FORWARD IN THE VEHICLE. POSITIVE PITCH GIMBAL ANGLES WILL BE IN THE SENSE OF A RIGHT-HANDED ROTATION OF THE GIMBAL CASE RELATIVE TO THE PLATFORM ABOUT THE PLUS PITCH AXIS.

THE INNER ROLL AXIS WILL BE PARALLEL TO THE OUTER ROLL AXIS, WITH THE SENSE OF ROTATION THE SAME AS FOR THE OUTER ROLL AXIS.

THE AZIMUTH AXIS AND  $Z_1$  WILL BE PARALLEL TO  $Z_1$ . POSITIVE  $Z_1$  WILL BE DOWN RELATIVE TO AN OBSERVER STANDING IN THE VEHICLE. POSITIVE AZIMUTH GIMBAL ANGLES WILL BE IN THE SENSE OF A RIGHT-HANDED ROTATION OF THE GIMBAL CASE RELATIVE TO THE PLATFORM ABOUT THE PLUS AZIMUTH AXIS.

$X_{NB}$ ,  $Y_{NB}$ ,  $Z_{NB}$  ARE CARTESIAN COMPONENTS OF THE NAVIGATION BASE COORDINATE SYSTEM

FIGURE 5.3-10. Stable Member (IMU)



NAME: NWU GEOGRAPHIC COORDINATE SYSTEM

ORIGIN: POINT OF INTEREST

ORIENTATION: U IS POSITIVE UP ALONG EARTH'S ASTRONOMIC OR PLUMB-BOB VERTICAL

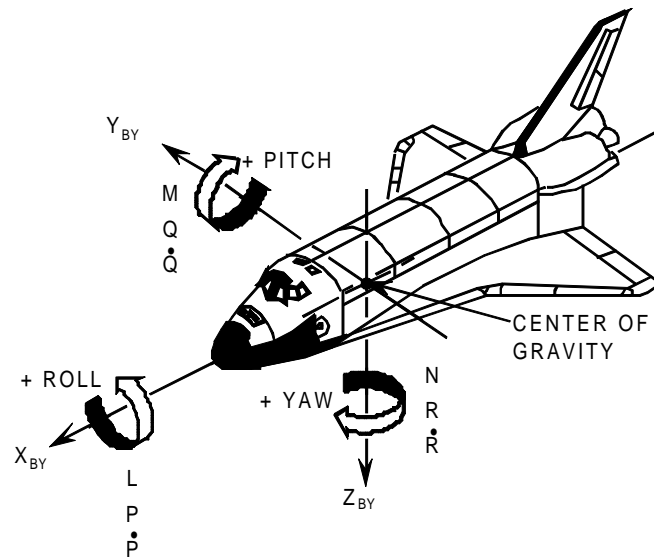
W IS POSITIVE ALONG THE CROSS PRODUCT OF U AND THE EARTH'S SPIN AXIS.

N COMPLETES THE RIGHT-HANDED ORTHOGONAL SYSTEM. ( $N = W \times U$ )

CHARACTERISTICS: ROTATING, RIGHT-HANDED, EARTH-REFERENCED COORDINATE SYSTEM.

FIGURE 5.3-11. NWU Geographic Coordinate System





NAME: BODY AXIS COORDINATE SYSTEM

ORIGIN: CENTER OF MASS

ORIENTATION:  $X_{BY}$  AXIS IS PARALLEL TO THE ORBITER STRUCTURAL BODY  $X_0$  AXIS; POSITIVE TOWARD THE NOSE.

$Z_{BY}$  AXIS IS PARALLEL TO THE ORBITER PLANE OF SYMMETRY AND IS PERPENDICULAR TO  $X_{BY}$ , POSITIVE DOWN WITH RESPECT TO THE ORBITER FUSELAGE.

$Y_{BY}$  AXIS COMPLETES THE RIGHT-HANDED ORTHOGONAL SYSTEM.

CHARACTERISTICS: ROTATING, RIGHT-HANDED CARTESIAN SYSTEM.

L, M, N: MOMENTS ABOUT  $X_{BY}$ ,  $Y_{BY}$ , AND  $Z_{BY}$  AXES, RESPECTIVELY

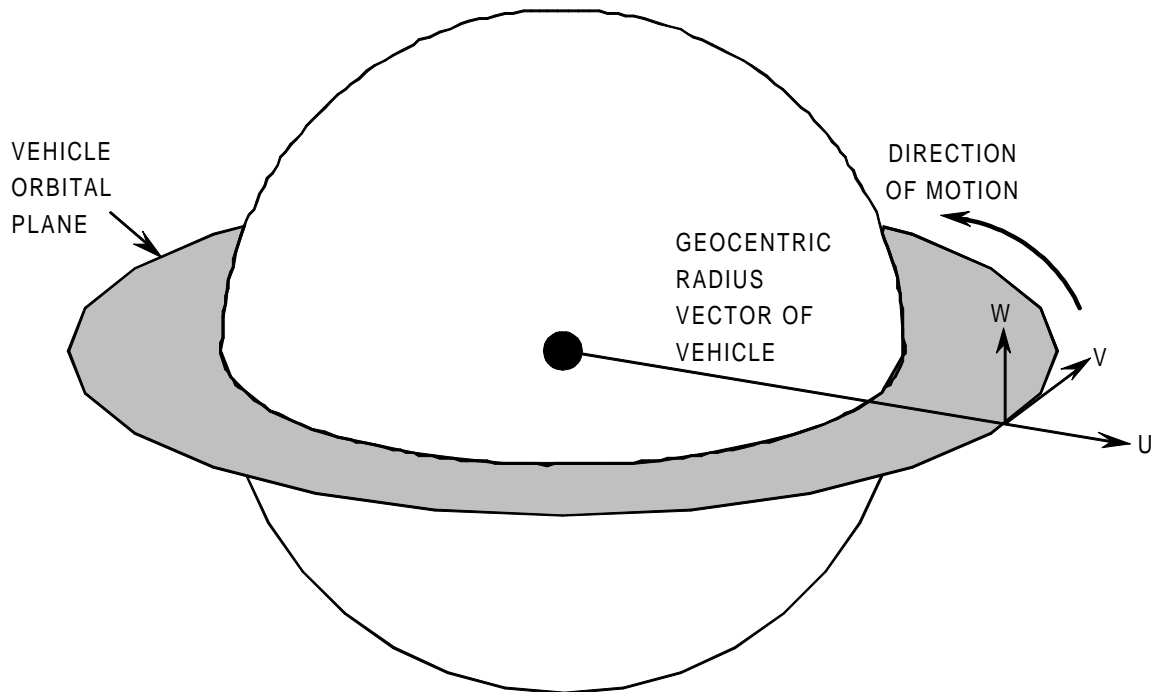
P, Q, R: BODY RATES ABOUT  $X_{BY}$ ,  $Y_{BY}$ , AND  $Z_{BY}$  AXES, RESPECTIVELY

$\dot{P}$ ,  $\dot{Q}$ ,  $\dot{R}$ : ANGULAR BODY ACCELERATION ABOUT  $X_{BY}$ ,  $Y_{BY}$ , AND  $Z_{BY}$  AXES, RESPECTIVELY.

THE EULER SEQUENCE THAT IS COMMONLY ASSOCIATED WITH THIS SYSTEM IS A YAW, PITCH, ROLL SEQUENCE, WHERE  $\psi$  = YAW,  $\theta$  = PITCH, AND  $\phi$  = ROLL OR BANK. THIS ATTITUDE SEQUENCE IS YAW, PITCH, AND ROLL AROUND THE  $Z_{BY}$ ,  $Y_{BY}$ , AND  $X_{BY}$  AXES, RESPECTIVELY.

(a) BASIC DEFINITION

FIGURE 5.3-12. Body Axis



NAME: UVW COORDINATE SYSTEM.

ORIGIN: POINT OF INTEREST.

ORIENTATION: THE U - V PLANE IS THE INSTANTANEOUS ORBIT PLANE AT EPOCH.

THE U AXIS LIES ALONG THE GEOCENTRIC RADIUS VECTOR TO THE VEHICLE AND IS POSITIVE RADIALLY OUTWARD.

THE W AXIS LIES ALONG THE INSTANTANEOUS ORBITAL ANGULAR MOMENTUM VECTOR AT EPOCH AND IS POSITIVE IN THE DIRECTION OF THE ANGULAR MOMENTUM VECTOR.

THE V AXIS COMPLETES A RIGHT-HANDED SYSTEM. ( $V = W \times U$ ).

CHARACTERISTICS: QUASI-INERTIAL, RIGHT-HANDED CARTESIAN COORDINATE SYSTEM. THIS SYSTEM IS QUASI-INERTIAL IN THE SENSE THAT IT IS TREATED AS AN INERTIAL COORDINATE SYSTEM, BUT IT IS REDEFINED AT EACH POINT OF INTEREST.

FIGURE 5.3-13. UVW Coordinate System

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
A	M(3)	0		Transformation matrix from body to M50
ALPHA	S	0	—	Angle of attack used in state prediction (radians)
ALPHAIN	S	0	—	Snapped copy of angle of attack (degrees)
ALT	S	600,000	—	Current orbiter altitude above reference ellipsoid
ALT_ABOVE_ELLIPSOID_MAXI(I)	F	I-load	—	Altitude of the TACAN station above the reference ellipse
ALT_MLSEL	S	0	—	Altitude above reference ellipsoid of MSBLS elevation scanner
ALT_MLSEL(K)	F	I-load		
ALT_MLS_R_AZ	S	0	—	Altitude of MSBLS range/azimuth scanner above reference ellipsoid
ALT_MLS_R_AZ(K)	F	I-load		
ALT_RW	S	0	—	Altitude above reference ellipsoid of runway reference point
ALT_TACAN_SL(I)	V	0	—	Altitude of TACAN station (each LRU) output from site lookup, I=1,3
ANGLE_CORR_TNTOMAG_RW	S	0	—	Angle of magnetic variation from true north at selected runway
ANGLE_CORR_TNTOMAG_SL(I)	V	0	—	Variation of magnetic north from true north at TACAN site (each LRU) output from site lookup, I=1,3
A_O	S	0	—	Local parameter in EF_TO_GEODETTIC
AREA_SEL	INT	1	—	Selected area
AREA_SEL_OPS1	INT	0	—	Value of AREA_SEL which is carried over from OPS 1 to OPS 3
ALT_SITES_RESET_INH	BIT	OFF	—	Alternate sites reset inhibit flag
AUTO_CHANNEL_ID	INT	0	—	Channel/mode identifier for the automatically selected TACAN station
AZ	S	0	—	Bearing from true north EF_TO_RUNWAY, EF_TO_SCANNER
AZIMUTH_RW	S	0	—	Bearing from true north of runway coordinate system +X axis
BETA	S	0	—	Sideslip angle used in state prediction (radians)
BETA_IN	S	0	—	Snapped copy of sideslip angle (degrees)
BIAS_AZMLS	S	0	—	MSBLS azimuth measurement bias
BIAS_AZMLS(K)	F	I-load		
BIAS_ELMLS	S	0	—	MSBLS elevation measurement bias
BIAS_ELMLS(K)	F	I-load		
BIAS_MLSRANGE	S	0	—	MSBLS range measurement bias
BIAS_MLSRANGE(K)	F	I-load		
CAZ	S	0	—	Cosine of AZ
CLAT	S	0	—	Cosine of LAT_GEOD EF_TO_TOPDET, GEODETTIC_TO_EF
CLON	S	0	—	Cosine of LON EF_TO_TOPDET

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
COS_P	S	0	—	Cosine of geocentric elevation angle
DEL	S	0	—	Delta value for radius calculation
DEL_LAT	S	0	—	Correction angle for latitude
DELH_MSL_	S	0	—	Altitude of mean sea level above reference ellipsoid at runway
ELLIPSOID_RW				
DH_TACAN_SL(I)	V	0	—	Altitude of mean sea level above reference ellipsoid at TACAN station (each LRU) output from site lookup, I=1,3
DT_MAX	S	10	—	Maximum allowable time-step size
DUM	S	0	—	Dummy variable (EF_TO_GEODETTIC, GEODETTIC_TO_EF)
DUMI	S	0	—	Dummy variable (GEODETTIC_TO_EF)
EARTH_RADIUS_	S	Constant	—	Earth equatorial radius
EQUATOR				
EARTH_RATE	S	Constant	—	Earth rotation rate
ELLIPT	S	Constant	—	Earth ellipticity constant
EL_SCANNER_BEARING	S	0	—	Bearing from true north of MLS elevation scanner boresight axis
EL_SCANNER_	F	I-load		
BEARING(K)				
FIRST_PASS	BIT	On	—	First pass flag used in entry site lookup-init
FLATCON	S	Constant	—	The eccentricity squared of the ellipsoid
$\bar{G}$ _FINAL	V	0	M50	Predicted Shuttle gravity vector
GMD_PRED	S	0	—	Gravity model degree
GMO_PRED	S	0	—	Gravity model order
$\bar{G}$ _PREVIOUS	V	0	M50	Acceleration at start of each prediction integration step
I	INT	1	—	Integer-subscript or iteration counter
J	INT	0	—	Local selected area parameter
K	INT	0	—	Local selected runway MSBLS pointer
L	INT	0	—	Local site table index parameter
LAM	S	0	—	Each rotation angle from epoch
LAT	S	0	—	Geodetic latitude of a point (EF_TO_TOPDET, EF_TO_RUNWAY, EF_TO_SCANNER, EF_TO_GEODETTIC, GEODETTIC_TO_EF)
LAT_GEOD	S	0	—	Geodetic latitude of $\bar{R}$ _EF
LATITUDE_GEODETTIC_	F	I-load	—	Geodetic latitude of the TACAN station
MAXI(I)				
LAT_MLSEL	S	0	—	Geodetic latitude of the MSBLS elevation antenna
LAT_MLSEL(K)	F	I-load		
LAT_MLS_R_AZ	S	0	—	Latitude of MSBLS range/azimuth scanner site
LAT_MLS_R_AZ(K)	F	I-load		

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
LAT_TACAN_SL(I)	V	0	—	Geodetic latitude of TACAN site (each LRU) output from site lookup, I=1,3
LENGTH_RW	INT	0	—	Runway length
LON	S	0	—	Geodetic longitude of a point (EF_TO_TOPDET, EF_TO_RUNWAY, EF_TO_SCANNER, EF_TO_GEODETTIC, GEODETTIC_TO_EF)
LONGITUDE_EAST_MAXI(I)	F	I-load	—	Longitude of the TACAN station
LONG_MLSEL	S	0	—	Geodetic longitude of the MSBLS elevation antenna
LONG_MLSEL(K)	F	I-load	—	
LONG_MLS_R_AZ	S	0	—	Longitude of the MSBLS range/azimuth scanner site
LONG_MLS_R_AZ(K)	F	I-load	—	
LONG_TACAN_SL(I)	V	0	—	Longitude of TACAN site (each LRU) output from site lookup, I=1,3
LRU_ID	INT	0	—	Index (1 to 3) input to TACAN site lookup when LRU is tuned to a ground station. Identifies which of three sets of output parameters is to be changed
M, MATRIX, MAT	M(3)	0	—	General transformation matrixes
MAGNETIC_VARIATION_MAXI(I)	F	I-load	—	Angle between true north and magnetic north at the TACAN station
M_EFTORAD_EL	M(3)	0	—	Transformation matrix from earth-fixed to MSBLS elevation radar coordinates
M_EFTORAD_R_AZ	M(3)	0	—	Transformation matrix from earth-fixed to AZ/range MSBLS radar coordinate frame
M_EFTORW	M(3)	0	—	Earth-fixed-to-prime RW transformation matrix
M_EFTOTD_TACAN_SL(I)	M	0	—	Transformation matrix from earth-fixed to topodetic coordinates at TACAN site (each LRU) output from site lookup, I=1,3
M_M50TOEF_AT_EPOCH	M(3)	Identity Matrix	—	Transformation matrix from M50 to earth-fixed at T_EPOCH
MLS_AVAIL	BIT	Off	—	Flag indicating (ON) the availability of MSBLS at currently selected runway
MSL_ABOVE_ELLIPSOID_MAXI(I)	F	I-load	—	The difference in an altitude above the reference ellipse and that altitude above mean sea level or geoid
NEW_AREA	BIT	Off	—	New landing area request flag
NEW_STATION_ID	S	0	—	Current ID of TACAN channel of the given LRU
NUMBER_STEPS	INT	0	—	Number of integration steps in the precise predictor

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
OPS_TRANS_REQUEST	BIT	Off	—	MSC provided OPS transition
OTREQ	BIT	Off	—	OPS transition request flag passed to and returned from the precise predictor
PHI	S	0	—	Geocentric elevation angle to the vehicle
PI	S	Constant	—	The constant PI
PRIME_RUNWAY_INDEX	INT	1	—	Indicator of which landing site choice is selected
PRI_SEL	BIT	Off	—	Primary runway select command
P2,P3,P4,P5,P6	S	0	—	Local variables used in QUAT_TO_MAT
Q	STR: S,V	1,0,0,0	M50	General variable for Q M50_BODY
Q_FIFTY_BODY	STR: S,V	1,0,0,0	M50	Quaternion representing the orientation of the orbiter body with respect to M50 coordinates
Q_M50_BODY	STR: S,V	1,0,0,0	M50	Quaternion representing the orientation of the orbiter body with respect to M50 coordinates
R	S	0	—	Radius magnitude of vehicle (geocentric)
RAD_P	S	0	—	Radius of earth at geocentric elevation angle, phi
RAD_PER_DEG	S	Constant	—	Radians per degree
R_AZ_SCANNER_BEARING	S	0	—	Bearing from true north of MSBLS
R_AZ_RADAR_BEARING(K)	F	I-load		range/azimuth scanner site
$\bar{R}$ _AZMLS_EF	V	0	EF	Earth-fixed position vector of MLS azimuth scanner
R_CC_LMAG_PRI	S	0	—	Magnitude of R_CC_L_PRI
R_CC_L_PRI	V	0	EF	Position vector of HAC center on the left side of the primary runway centerline in EF coordinates
R_CC_RMAG_PRI	S	0	—	Magnitude of R_CC_R_PRI
$\bar{R}$ _CC_R_PRI	V	0	EF	Position vector of HAC center on the right side of the primary runway centerline in EF coordinates
$\bar{R}$ _FINAL	V	0	M50	Position vector at end of prediction
RD_TAC_MSL_SL(I)	V	0	—	Geodetic radius of mean sea level at TACAN site to which the Ith receiver is tuned
$\bar{R}$ _EF	V	0	EF	Shuttle position vector in earth fixed coordinates
R_EF_EQUAT	S	0	—	Projection of vehicle position vector in equatorial plane
$\bar{R}$ _ELMLS_EF	V	0	EF	Earth-fixed MLS elevation scanner position vector
$\bar{R}$ _HAC_RW_L	V	K-load	RW	Position vector of the left HAC center
$\bar{R}$ _HAC_RW_R	V	K-load	RW	Position vector of the right HAC center
$\bar{R}$ _INIT	V		M50	Initial value of the orbiter position vector

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{R}_{LS\_EF}$	V	0	EF	Position vector of runway in earth-fixed coordinates
$\bar{R}_{RMLS\_EF}$	V	0	EF	Earth-fixed position vector of MLS range scanner
R_TACAN_EF_SL(I)	V	0	EF	Earth-fixed position vector of TACAN station (each LRU) output from site lookup, I=1,3
RW_ID_UPP	INT	0	—	Local runway index parameter; also first pass flag
RW_SEL_OPS1	INT	1	—	Value of PRIME_RUNWAY_INDEX which is carried over from OPS 1 to OPS 3
R_XY	S	0	—	Radius squared to projection of vehicle's position vector in $R_{EF1}$ , $R_{EF2}$ plane
RUNWAY_NAME(L)	F	I-load	—	Name of the selected landing site
RUNWAY_ALT(L)	F	I-load	—	Geodetic altitude of the selected landing site
RW_AZIMUTH(L)	F	I-load	—	Azimuth to true north of the selected landing site
RW_DELH(L)	F	I-load	—	Delta height from ellipsoid to MSL for the selected landing site
RW_LAT(L)	F	I-load	—	Geodetic latitude of the selected landing site
RW_LENGTH(L)	F	I-load	—	Runway length for the selected landing site
RW_LON(L)	F	I-load	—	Longitude of the selected landing site
RW_MAG_VAR(L)	F	I-load	—	Magnetic variation for the selected landing site
RW_MSBSL_INDEX(L)	F	I-load	—	Runway MSBSL pointer index
RW_NAME	INT	1	—	Current landing site designation for display symbol positioning
RW_NAME_PSL	CHAR		—	Primary runway name for the selected area and used for display
RW_NAME_SSL	CHAR		—	Secondary runway name for the selected area and used for display
RW_SELECT	BIT	On	—	Runway selection indicator
SAZ	S	0	—	Sine of AZ
SEC_SEL	BIT	Off	—	Secondary runway select command
SEL_SITE_ID	CHAR		—	Runway name for the selected landing site
SIN_P	S	0	—	Sine of geocentric elevation angle
SLAT	S	0	—	Sine of geodetic latitude
SLON	S	0	—	Sine of longitude
STEP_COUNTER	INT	10	—	Precise predictor integration step counter
STEP_SIZE	S	0	—	Size of integration time steps for prediction
T	S	0	—	General time variable
TACAN_ID(I)	V	0	—	ID of TACAN channel to which the Ith LRU is tuned, I=1,3

Table 5.3-1. Deorbit-Entry NAV Flow Chart Variable List

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
TACAN_ID_MAXI(I)	I	I-load	—	A three-digit channel/mode designation, unique for each TACAN station
TAC_CHANGE	BIT	Off	—	Primary/secondary TACAN select command
TAC_CHAN_OLD(I)	V	0	—	Previous value of channel/mode indicator for each TACAN station
TAC_CHAN_VALID_SL(I)	BIT(3)	Off	—	Switch indicating (ON) a valid TACAN channel has been selected (site lookup output) for the Ith receiver, I=1,3
TAC_SEL	INT	0	—	Selected TACAN index
TAC_SEL_OPS1	INT	1	—	Value of TAC_SEL which is carried over from OPS 1 to OPS 3
TAL_ABORT_DECLARED	BIT	Off	—	TAL abort declared flag
TEMP	S	0	0	Internal variable used in QUAT_TO_MAT function
T_EPOCH	S	0	—	Time tag for M_M50TOEF_AT_EPOCH and EARTH_POLE
TFINAL	S	0	—	Time at end of prediction
T_INIT	S		—	Time at beginning of prediction
TIME	S	0	—	General time variable measured in seconds from the beginning of the year of date
$\bar{U}$	V	0	M50	Unit vector in the direction of the orbiter's M50 position vector
$\bar{V}$	V	0	M50	Input velocity vector (UVW TO M50)
$\bar{V}_{FINAL}$	V	0	M50	Velocity vector at end of prediction
$\bar{V}_{INIT}$	V		M50	Initial value of the vector
$\bar{W}$	V	0	M50	Unit vector in direction of orbiter's angular momentum vector
X_DMEAZ_RW	S	0	RW	X-component of MSBLS range/ azimuth scanner in runway coordinates
X_DMEAZ_RW(K)	F	I-load		
X_EL_RW	S	0	RW	X-component of MSBLS elevation scanner—
X_EL_RW(K)	F	I-load		RW coordinates
Y_DMEAZ_RW	S	0	RW	Y-component of MSBLS range/ azimuth scanner in runway coordinates
Y_DMEAZ_RW(K)	F	I-load		
$\bar{Z}$	V	0	M50	Unit vector, $\bar{W} \times \bar{U}$



EARTH\_FIXED\_TO\_M50\_COORD (FUNCTION)

$$\text{EARTH\_FIXED\_TO\_M50\_COORD}(\text{TIME}) = \text{M\_M50TOEF\_AT\_EPOCH}^T \text{M}$$

WHERE: M\_M50TOEF\_AT\_EPOCH IS THE TRANSFORMATION FROM MEAN OF 50 TO EARTH FIXED COORDINATES AT TIME = T\_EPOCH. THIS MATRIX AND T\_EPOCH ARE OUTPUTS OF THE RNP MATRIX COMPUTATION PRINCIPAL FUNCTION.

M IS COMPUTED WITHIN THE FUNCTION (EARTH\_FIXED\_TO\_M50\_COORD) AS

$$\text{LAM} = \text{EARTH\_RATE}(\text{TIME} - \text{T\_EPOCH})$$

$$\text{M} = \begin{pmatrix} \text{COS}(\text{LAM}) - \text{SIN}(\text{LAM}) & 0 & 0 \\ \text{SIN}(\text{LAM}) & \text{COS}(\text{LAM}) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

FIGURE 5.3-14. EARTH\_FIXED\_TO\_M50\_COORD (FUNCTION)

EF\_TO\_TOPDET (FUNCTION)

$$\text{EF\_TO\_TOPDET}(\text{LAT\_GEOD}, \text{LON}) = \text{M}$$

WHERE: M IS CALCULATED WITHIN THE FUNCTION AS

$$\text{CLON} = \text{COS}(\text{LON}), \text{SLON} = \text{SIN}(\text{LON})$$

$$\text{CLAT} = \text{COS}(\text{LAT\_GEOD}), \text{SLAT} = \text{SIN}(\text{LAT\_GEOD})$$

$$\text{M} = \begin{pmatrix} -\text{SLAT} & \text{CLON} & -\text{SLAT} & \text{SLON} & \text{CLAT} \\ & -\text{SLON} & & \text{CLON} & 0 \\ -\text{CLAT} & \text{CLON} & -\text{CLAT} & \text{SLON} & -\text{SLAT} \end{pmatrix}$$

FIGURE 5.3-15. EF\_TO\_TOPDET (FUNCTION)

EF\_TO\_RUNWAY (FUNCTION)

$$\text{EF\_TO\_RUNWAY}(\text{LAT\_GEOD}, \text{LON}, \text{AZ}) = (\text{M}) \text{EF\_TO\_TOPDET}(\text{LAT\_GEOD}, \text{LON})$$

Fig 5.3-15

WHERE: M IS CALCULATED WITHIN THE FUNCTION AS

$$\text{CAZ} = \text{COS}(\text{AZ}), \text{SAZ} = \text{SIN}(\text{AZ})$$

$$\text{M} = \begin{pmatrix} \text{CAZ} & \text{SAZ} & 0 \\ -\text{SAZ} & \text{CAZ} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

FIGURE 5.3-16. EF\_TO\_RUNWAY (FUNCTION)

EF\_TO\_SCANNER (FUNCTION)

$$\text{EF\_TO\_SCANNER}(\text{LAT\_GEOD}, \text{LON}, \text{AZ}) = (\text{M}) \text{EF\_TO\_RUNWAY}(\text{LAT\_GEOD}, \text{LON}, \text{AZ})$$

Fig 5.3-16

WHERE: M IS CALCULATED WITHIN THE FUNCTION AS

$$\text{M} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

FIGURE 5.3-17. EF\_TO\_SCANNER (FUNCTION)

EF\_TO\_GEODETTIC

IN LIST =  $\bar{R}$ \_EF

OUT LIST: LAT\_GEOD, LON, ALT

```
FLATCON = 1.0 - (1.0 - ELLIPT)2
A_0 = 1.0 - FLATCON
R_XY = R_EF12 + R_EF22
R = (R_XY + R_EF32)1/2
SIN_P = R_EF3/R
COS_P = (R_XY)1/2/R
RAD_P = EARTH_RADIUS_EQUATOR/(1.0 + FLATCON SIN_P2/A_0)1/2
DEL = (FLATCON SIN_P COS_P)/(1.0 - FLATCON COS_P2)
DEL_LAT = RAD_P DEL/R
PHI = ARCTAN(SIN_P/COS_P)
LAT_GEOD = PHI + DEL_LAT
LON = ARCTAN2(R_EF2, R_EF1)
ALT = (R - RAD_P) (1.0 - 0.50 DEL DEL_LAT)
```

FIGURE 5.3-18. EF\_TO\_GEODETTIC

GEODETIC\_TO\_EF (FUNCTION)

$$\text{GEODETIC\_TO\_EF}(\text{LAT\_GEOD}, \text{LON}, \text{ALT}) = \bar{R}\_EF$$

WHERE:  $\bar{R}\_EF$  IS CALCULATED WITHIN THE FUNCTION AS:

$$\text{CLAT} = \text{COS}(\text{LAT\_GEOD}), \text{SLAT} = \text{SIN}(\text{LAT\_GEOD})$$

$$\text{DUM} = (1 - \text{ELLIPT})^2$$

$$\text{DUM1} = \text{EARTH\_RADIUS\_EQUATOR} / (\text{CLAT}^2 + \text{SLAT}^2 \text{DUM})^{1/2}$$

$$\text{R\_EF\_EQUAT} = (\text{DUM1} + \text{ALT})\text{CLAT}$$

$$\bar{R}\_EF = (\text{R\_EF\_EQUAT} \text{COS}(\text{LON}), \text{R\_EF\_EQUAT} \text{SIN}(\text{LON}), (\text{DUM} \text{DUM1} + \text{ALT})\text{SLAT})$$

FIGURE 5.3-19. GEODETIC\_TO\_EF (FUNCTION)

UVW\_TO\_M50 (FUNCTION)

IN LIST:  $\bar{R}$ ,  $\bar{V}$

$$\bar{U} = \bar{R} / |\bar{R}|$$

$$\bar{W} = (\bar{R} \times \bar{V}) / |\bar{R} \times \bar{V}|$$

$$\bar{Z} = (\bar{W} \times \bar{U})$$

$$UVW\_TO\_M50_{1\ TO\ 3,\ 1} = \bar{U}$$

$$UVW\_TO\_M50_{1\ TO\ 3,\ 2} = \bar{Z}$$

$$UVW\_TO\_M50_{1\ TO\ 3,\ 3} = \bar{W}$$

FIGURE 5.3-20. Uvw\_TO\_M50 (FUNCTION)

SBODY\_TO\_M50  
IN LIST: Q\_FIFTY\_BODY  
OUT LIST: MAT

MATRIX = QUAT_TO_MAT (Q_FIFTY_BODY)	
MAT <sub>1,1</sub>	= - MATRIX <sub>1,1</sub>
MAT <sub>1,2</sub>	= MATRIX <sub>2,1</sub>
MAT <sub>1,3</sub>	= - MATRIX <sub>3,1</sub>
MAT <sub>2,1</sub>	= - MATRIX <sub>1,2</sub>
MAT <sub>2,2</sub>	= MATRIX <sub>2,2</sub>
MAT <sub>2,3</sub>	= - MATRIX <sub>3,2</sub>
MAT <sub>3,1</sub>	= - MATRIX <sub>1,3</sub>
MAT <sub>3,2</sub>	= MATRIX <sub>2,3</sub>
MAT <sub>3,3</sub>	= - MATRIX <sub>3,3</sub>

FIGURE 5.3-21. SBODY\_TO\_M50



QUAT\_TO\_MAT (FUNCTION)

$$\text{QUAT\_TO\_MAT}(Q) = A$$

WHERE A IS CALCULATED WITHIN THE FUNCTION AS:

$$\begin{aligned} P2 &= Q_2 + Q_2 \\ P3 &= Q_3 + Q_3 \\ P4 &= Q_4 + Q_4 \\ P5 &= P2 Q_2 \\ P6 &= P4 Q_4 \\ \text{TEMP} &= 1.0 - P3 Q_3 \\ A_{1,1} &= \text{TEMP} - P6 \\ A_{2,2} &= 1.0 - P5 - P6 \\ A_{3,3} &= \text{TEMP} - P5 \\ P5 &= P2 Q_3 \\ P6 &= P4 Q_1 \\ A_{1,2} &= P5 - P6 \\ A_{2,1} &= P5 + P6 \\ P5 &= P2 Q_4 \\ P6 &= P3 Q_1 \\ A_{1,3} &= P5 + P6 \\ A_{3,1} &= P5 - P6 \\ P5 &= P3 Q_4 \\ P6 &= P_2 Q_1 \\ A_{2,3} &= P5 - P6 \\ A_{3,2} &= P5 + P6 \end{aligned}$$

FIGURE 5.3-22. QUAT\_TO\_MAT (FUNCTION)

ENTRY\_SITE\_LOOKUP\_INIT

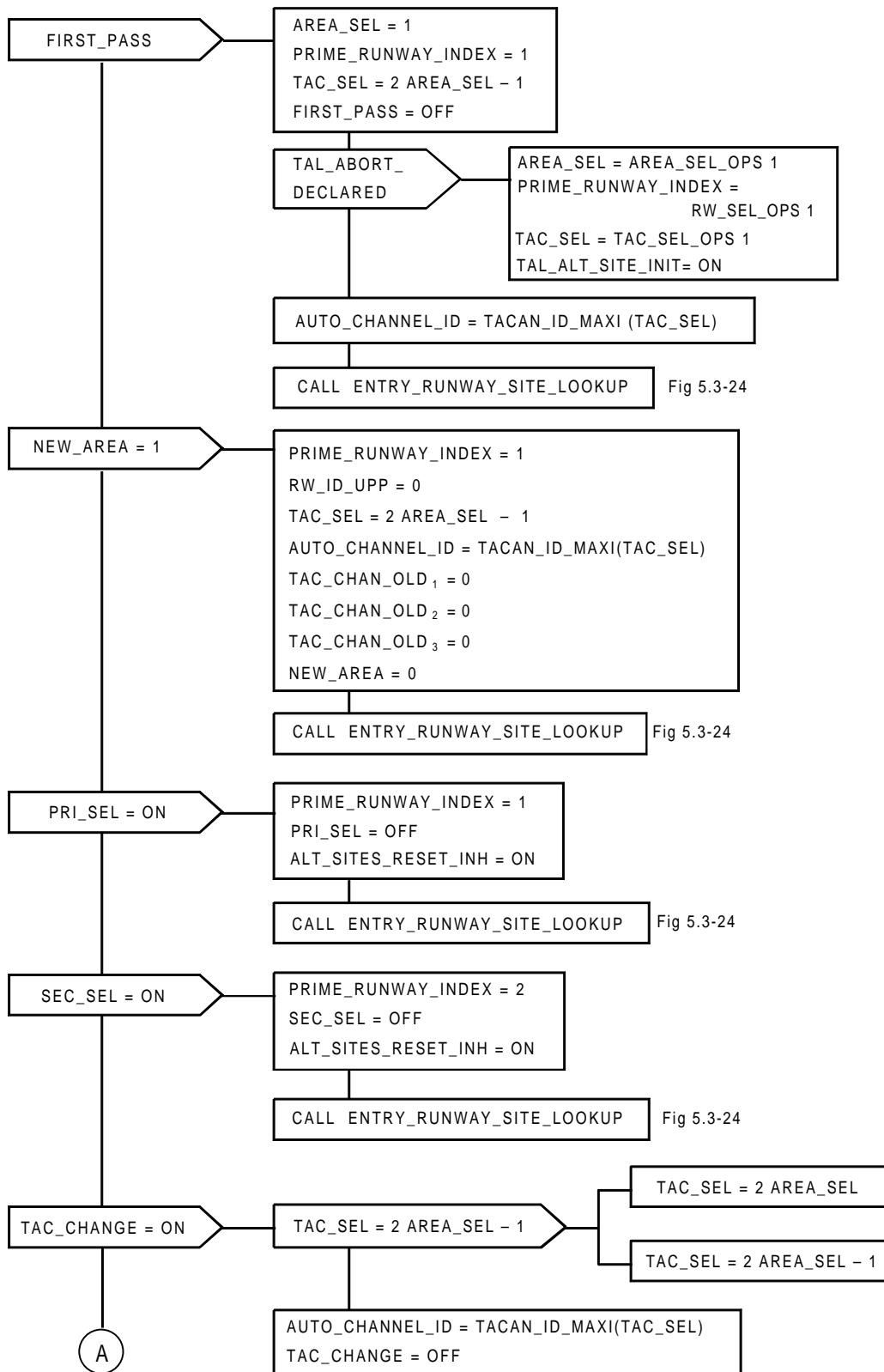


FIGURE 5.3-23.(1) ENTRY\_SITE\_LOOKUP\_INIT (Sheet 1 of 2)

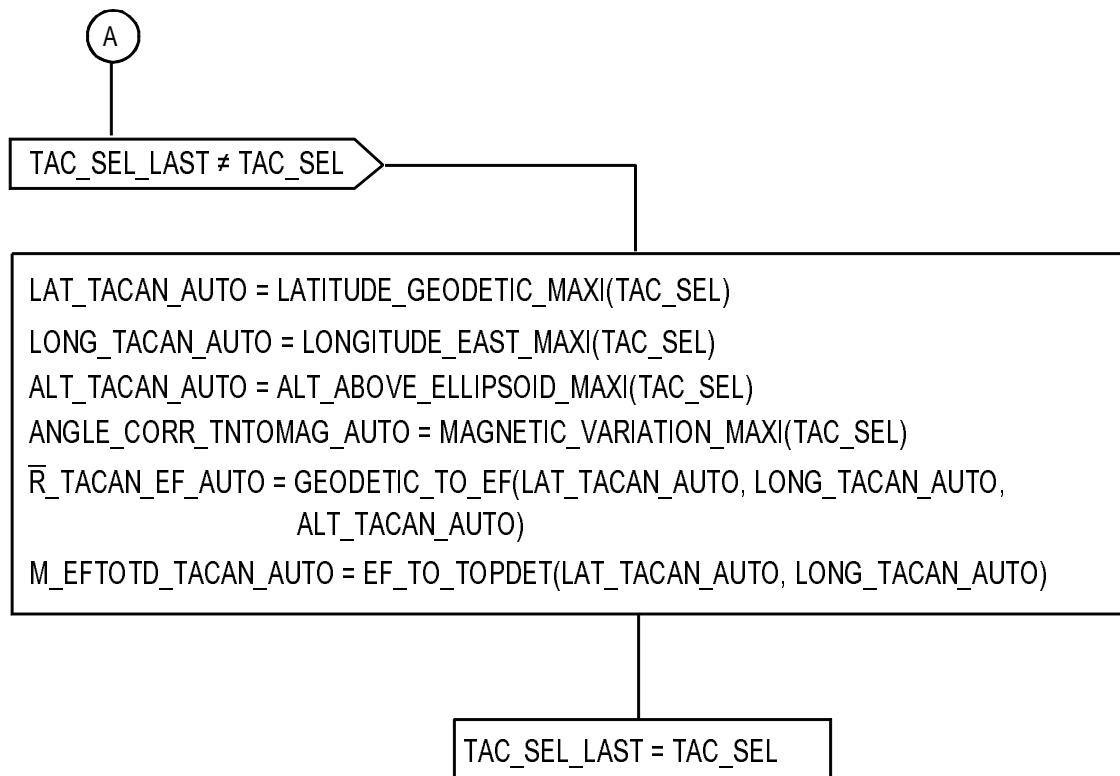
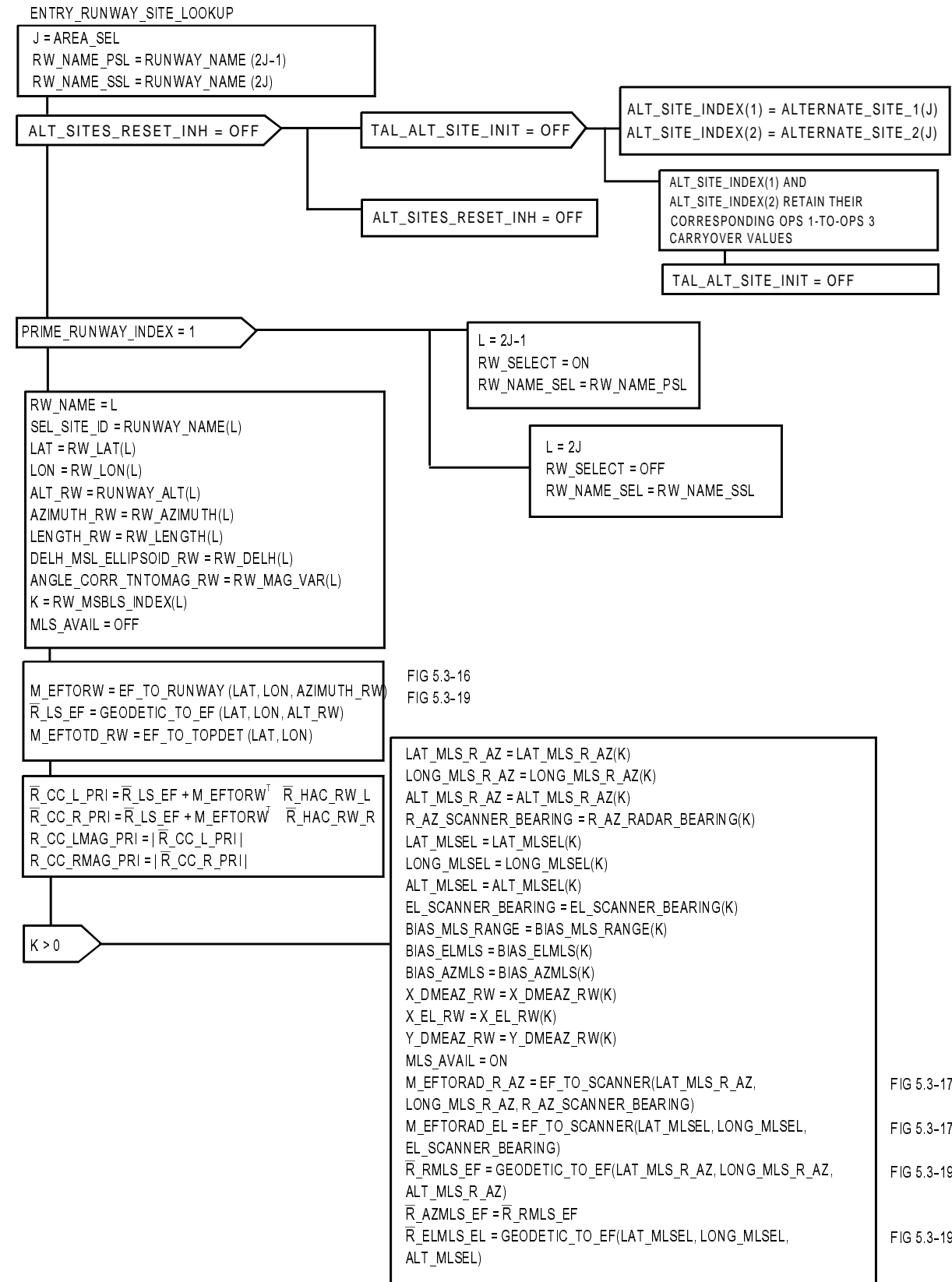


FIGURE 5.3-23.(2) ENTRY\_SITE\_LOOKUP\_INIT (Sheet 2 of 2)

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**FIGURE 5.3-24. ENTRY\_RUNWAY\_SITE\_LOOKUP**

ENTRY\_TACAN\_SITE\_LOOKUP

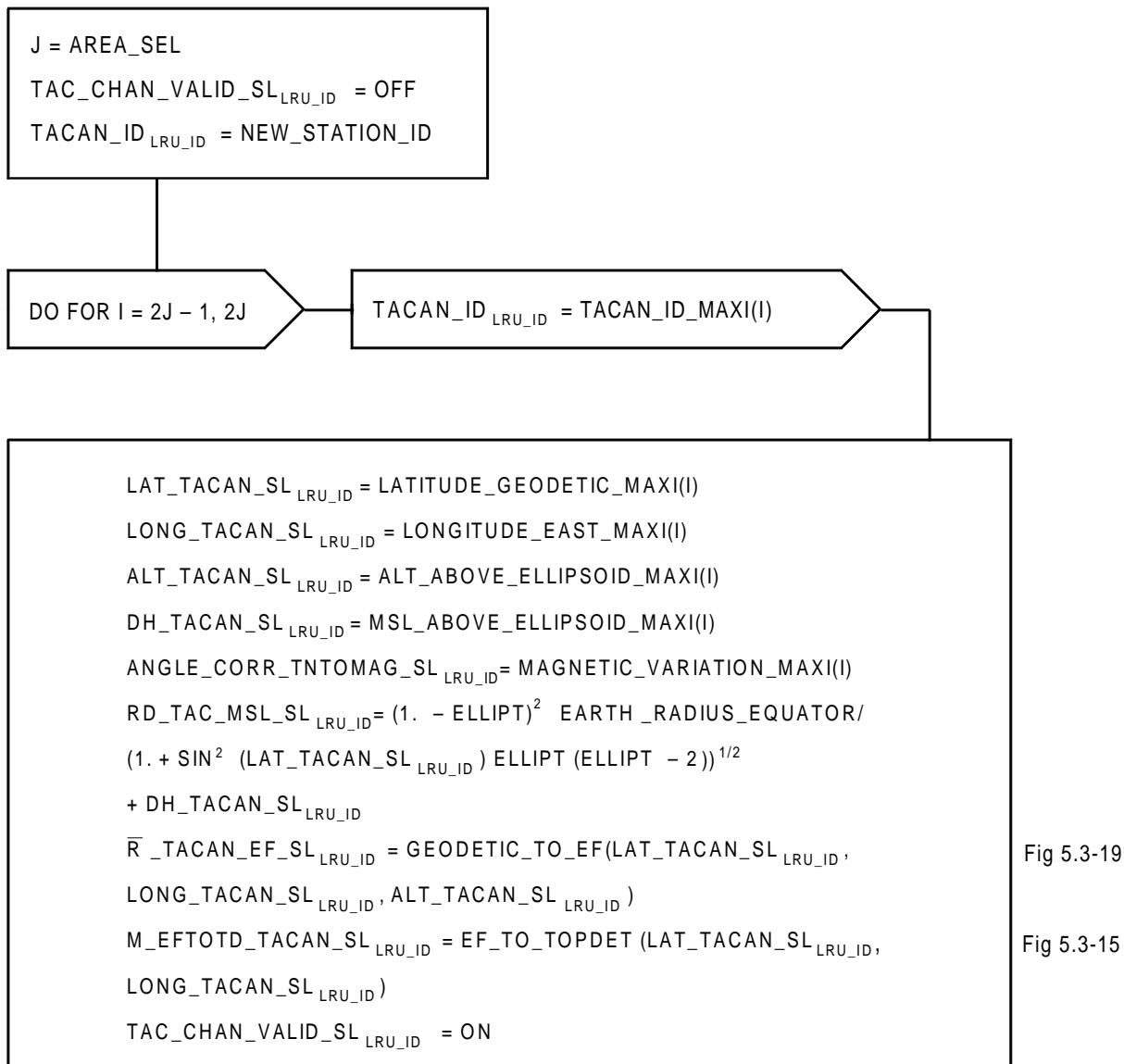


FIGURE 5.3-25. ENTRY\_TACAN\_SITE\_LOOKUP

ENTRY\_PRECISE\_PREDICTOR

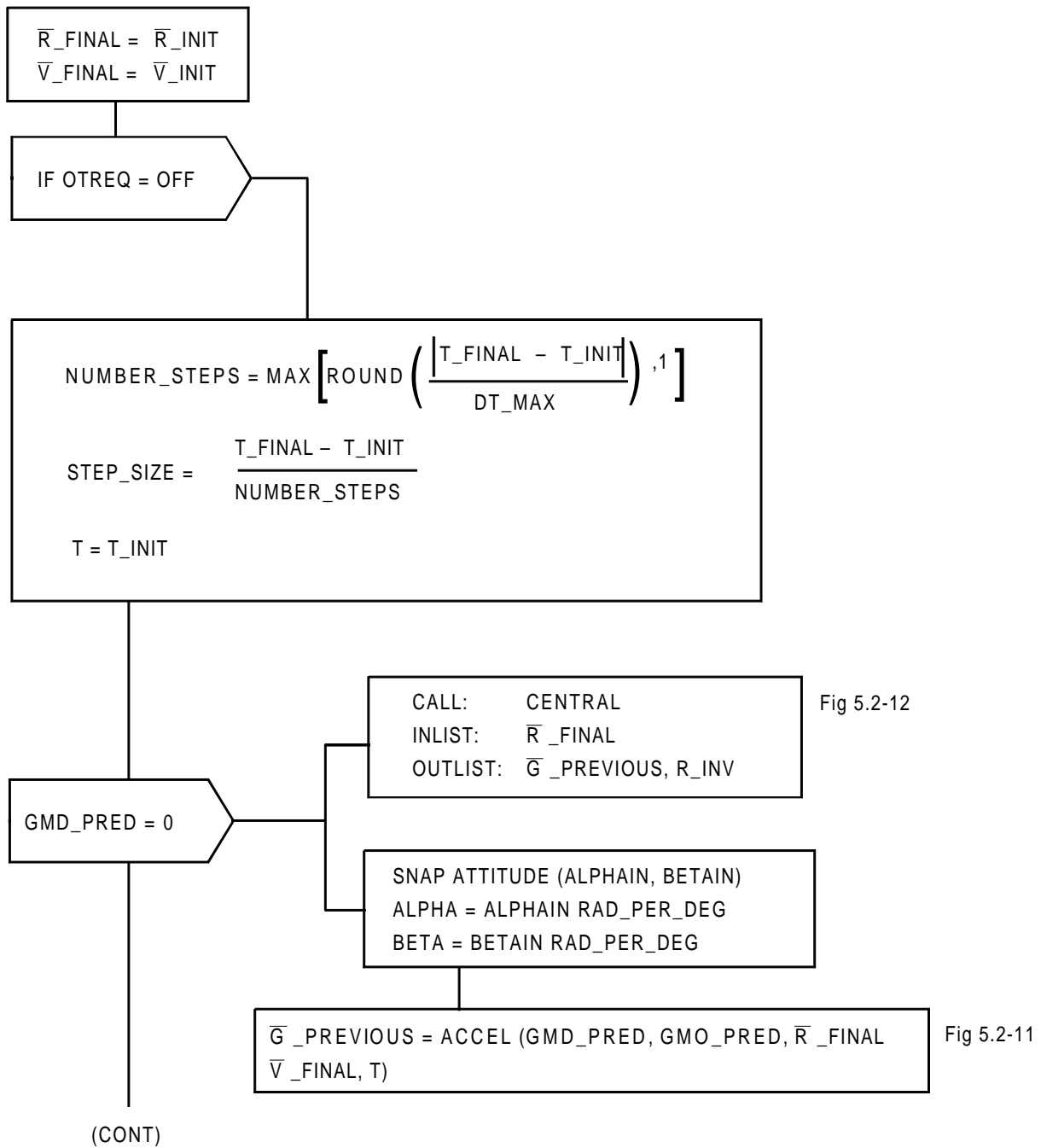


FIGURE 5.3-26.(1) ENTRY\_PRECISE\_PREDICTOR (Sheet 1 of 2)

ENTRY\_PRECISE\_PREDICTOR (CONCLUDED)

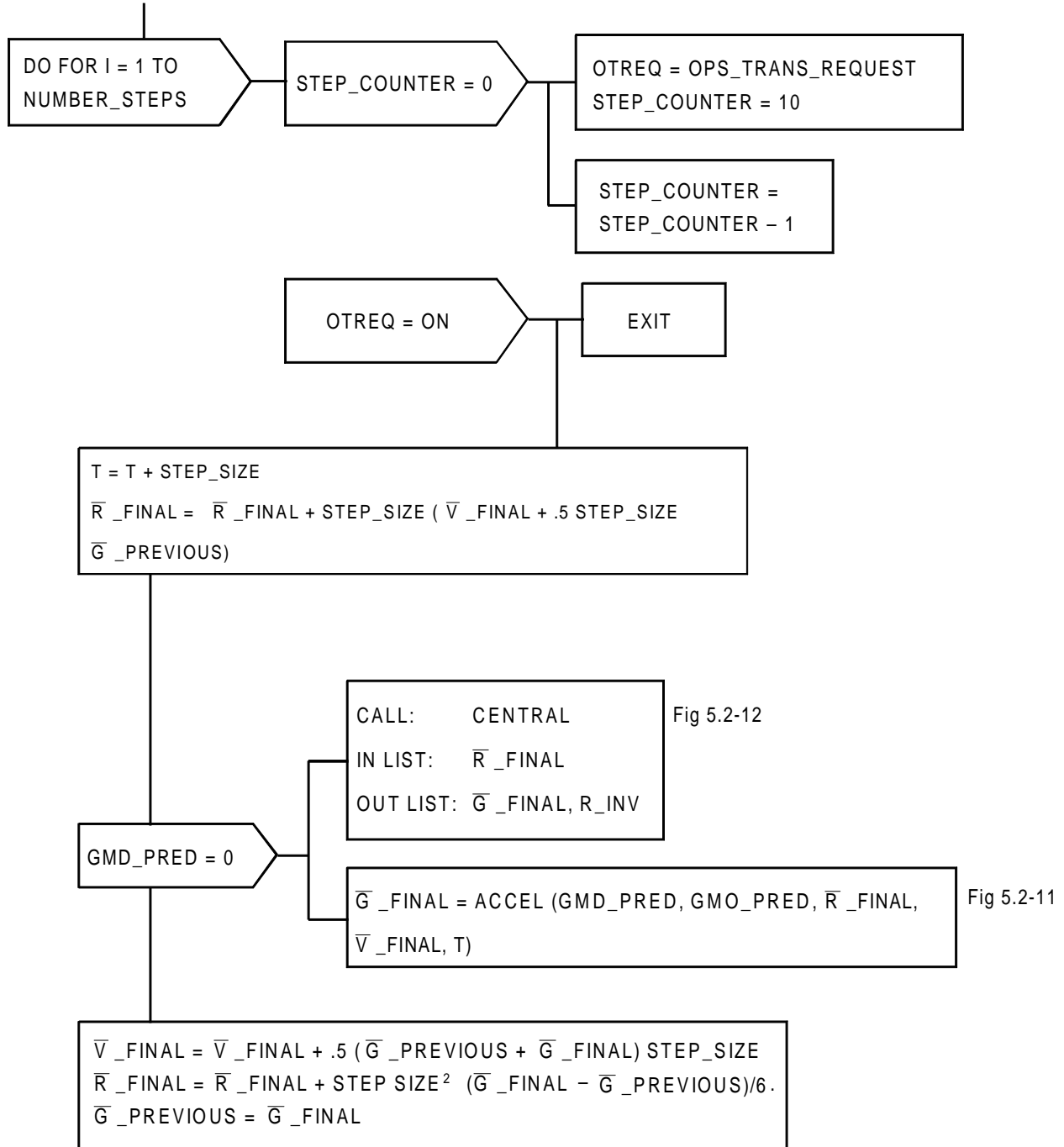


FIGURE 5.3-26.(2) ENTRY\_PRECISE\_PREDICTOR (Sheet 2 of 2)

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## 5.4 AREA NAVIGATION FLOW CHARTS, VARIABLE NAMES, AND DESCRIPTIONS

This section contains supplemental material for area navigation in the form of functional flow charts (Figures 5.4–1 through 5.4–9). Table 5.4–1 is the variable list that supports this material. The following data will aid in interpreting Table 5.4–1.

- Code Used For Variable Data Type:
  - S: scalar
  - V(n): vector (dimension)
  - M(n): square matrix (dimension)
  - INT: integer
  - BIT: bit
  - CHAR: character
  - STR: structure
  - ARR: array
- Coordinate Frame Code And Definition
  - Body: x: parallel to the longitudinal axis (positive aft)  
(structural) y: completes right-hand system  
z: perpendicular to the x-axis, positive upward
  - M50: Mean-of-50 reference coordinate system
  - RW: x: down runway centerline in direction of landing  
(runway coordinates) y: completes right-hand system  
z: down, normal to ellipsoid
  - SCAN: x: scanner boresight axis  
(MLS scanner coordinates) y: completes right-hand system  
z: up, normal to ellipsoid
  - TD: x: north  
(topodetic coordinates) y: east  
z: down, normal to ellipsoid

Table 5.4-1. Variable List - Area Navigation				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
A	S	0	—	Angle at TACAN from true north to Shuttle
A	S	0	—	Coefficient in quadratic formula
A	S	0	—	Parameter in acquisition turn arc calculation
A2	S	0	—	Angle defined by intersection of two great circle planes (one passing through the Shuttle position and HAC center, the other through the Shuttle position and WP-1)
A3	S	0	—	Angle at HAC center from WP-1 to entry point (ENT_RNG_BEAR)
ALT_DG	BIT	Off	—	Barometric data-good flag
ALT_LAND	S	0	—	Altitude for automatic switch from TAEM display mode comps to autoland display mode comps
ALT_RW	S	0	—	Altitude above reference ellipsoid of runway reference point
ALT_TACAN_SL(N)	V	0	—	Altitude of TACAN station (each LRU) output from site lookup, N=1,3
ALT_WHEELS	S	600,000	—	Altitude of orbiter c.g. (entry) or rear wheels (TAEM and A/L) above runway altitude
ANGLE_CORR_TNTOMAG_RW	S	0	TD	Angle of magnetic variation from true north at selected runway
ANGLE_CORR_TNTOMAG_SL(N)	V	0	—	Variation of magnetic north from true north at TACAN site (each LRU) output from site lookup, N=1,3
ARC	S	0	—	Angle from NEP to WP-1 measured WRT HAC center
ARCAC	S	0	—	Acquisition turn arc length
ARC_LEFT	S	0	—	HAC turn angle for previous left cycle
ARC_RIGHT	S	0	—	HAC turn angle for previous right cycle
AZIMUTH_RW	S	0	—	Bearing from true north of runway coordinate system +X-axis
B	S	0	—	Coefficient in quadratic formula
B	S	0	—	Parameter in acquisition turn arc calculation
BEAR_CC	S	0	—	Bearing at HAC center WRT true north
BRG_FLAG	BIT	Off	—	HSI data validity flag
BEAR_RW	S	0	—	Bearing to WP-1 (entry/ TAEM) or WP-2 (A/L) measured with respect to RW
BEAR_VEH	S	0	—	Bearing from Shuttle to HAC center WRT true north
BEAR_VEH_WP1	S	0	—	Bearing to WP-1 WRT true north
BEARING	S	0	—	Bearing from Shuttle to WP-1
BRG_FLAG_LEFT	BIT	Off	—	HSI data validity flag

Table 5.4-1. Variable List - Area Navigation

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
BRG_FLAG_RIGHT	BIT	Off	—	HSI data validity flag
C	S	0	—	Coefficient in quadratic formula
CDI	S	0	—	Course deviation from the extended runway centerline
CDI_FLAG	BIT	Off	—	HSI data validity flag
CDI_FLAG_LEFT	BIT	Off	—	HSI data validity flag
CDI_FLAG_RIGHT	BIT	Off	—	HSI data validity flag
CDI_LEFT	S	0	—	Course deviation from the extended runway centerline
CDI_RIGHT	S	0	—	Course deviation from the extended runway centerline
C0(1,1),C1(1,1), C2(1,1),C3(1,1), C0(1,2),C1(1,2), C2(1,2),C3(1,2)	ARR	I-load	—	Coefficients used in analytical expressions for reference altitude versus range for nominal steep glide path angle
C0(2,1),C1(2,1), C2(2,1),C3(2,1), C0(2,2),C1(2,2), C2(2,2),C3(2,2)	ARR	I-load	—	Coefficients used in analytical expressions for reference altitude versus range for high mass steep glide path angle
COSB	S	0	—	Cosine of the angle at TACAN from earth center to Shuttle
CUBRC(I), N=1,2	ARR	I-load	—	Distance from the MEP to the transition point for two analytical expressions for reference altitude versus range
D	S	0	TD	Projection of slant range from TACAN to Shuttle onto X-Y plane
D	S	0	RW	X-component of vehicle position with respect to WP-2
D_ARC	S	0	—	Arc length around the HAC from WP-1 to EP
DEG_PER_RAD	S	Constant	—	Conversion factor from radians to degrees
DELH_MSL_ELLIPSOID_RW	S	0	—	Altitude of mean sea level above reference ellipsoid at runway
DELX_MEP	S	0	—	Distance from glide slope intercept point and the MEP
DELX_NEP	S	0	—	Distance from glide slope intercept point and the NEP
DELX_REF	S	—	RW	Distance from glide slope intercept point to the polynomial reference point
$\bar{D}H\_TACAN\_SL(N)$	V	0	—	Altitude of mean sea level above reference ellipsoid at TACAN station (each LRU) output from site lookup, N=1,3
DIST_VEH_WP1	S	0	—	Surface range from Shuttle to WP-1
DIST_WP2	S	0	—	Flat earth range from Shuttle to WP-2

Table 5.4-1. Variable List - Area Navigation

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
DPSAC	S	0	—	Heading error from tangency with HAC
DR	S	0	—	Distance from vehicle ground position to the transition point for two analytical expressions for reference altitude versus range
EL_MSBLs	S	0	—	MSBLs elevation angle
FIRST_PASS	B	ON	—	First pass flag: reset to OFF after each execution
FIRST_PASS_TAEM	BIT	ON	—	Flag to indicate first cycle of TAEM_HSI_COMP subfunction
GO	S	Constant	—	Earth gravitational constant
GSI	S	0	—	Glide slope deviation for primary runway
GSI_FLAG	BIT	Off	—	HSI data validity flag
GSI_FLAG_LEFT	BIT	Off	—	HSI data validity flag
GSI_FLAG_RIGHT	BIT	Off	—	HSI data validity flag
GSI_LEFT	S	0	—	Glide slope deviation for primary runway
GSI_RIGHT	S	0	—	Glide slope deviation for primary runway
H	S	0	—	Altitude above runway
H_BARO	S	0	—	Barometric altitude obtained from selection filter
HCO(1)	S	I-load	—	Reference altitude evaluated at the NEP for nominal steep glide path angle
HCO(2)	S	I-load	—	Reference altitude evaluated at the NEP for high mass steep glide path angle
HEADING	S	0	TD	Heading angle from runway magnetic north (deg)
HEADING_LEFT	S	0	—	Heading of relative velocity vector (entry) or of body X-axis (TAEM or A/L)
HEADING_RIGHT	S	0	—	Heading of relative velocity vector (entry) or of body X-axis (TAEM or A/L)
HDG_FLAG_LEFT	BIT	Off	—	Heading validity indicator for left HSI
HDG_FLAG_RIGHT	BIT	Off	—	Heading validity indicator for right HSI
HI_WINDS	BIT	Off	—	Flag denoting high or low winds at runway during landing
H_GSI_SHALLOW	S	K-load	—	Altitude at which final flare begins and GSE_FLAG is set to OFF
HMEP(I) I=1,2	V(2)	I-load	—	Altitude (AGL) of minimum energy entry point
HPC	S	0	—	Barometric altitude obtained from the air data SOP
HREF	S	0	—	Reference altitude used to compute the glide slope deviation
HSI_MODE_INDICATOR	INT	1	—	Indicates which group of HSI comps were done (entry, TAEM, or land)
HSI_MODE_LEFT	INT	1	—	Indicates which group of HSI comps were done (entry, TAEM, or land) for the left HSI

Table 5.4-1. Variable List - Area Navigation

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
HSI_MODE_RIGHT	INT	1	—	Indicates which group of HSI comps were done (entry, TAEM, or land) for the right HSI
I	INT	—	—	Integer-subscript or iteration counter
IGS	S	0	—	Glide slope index
IPHASE	INT	1	—	TAEM guidance phase indicator
LEFT_SIDE	BIT	Off	—	Indicates for which HSI the computations are being performed
LHSI_P	S	—	—	P compute for left-side HSI
M	S	0	—	Vehicle mass
MASS_FLAG	BIT	On	—	Flag denoting computation of quantities pertinent to the NEP and MEP
MAZM_CMLK(N)	BIT	Off	—	MSBLS azimuth commfault/lock-on flag for Nth receiver, N=1,3
MEDS_AREA_NAV_FIRST_PASS	BIT	Off	—	Flag indicating Area Nav has completed and its outputs can be used
M_EFTORW	M(3)	0	—	Earth-fixed-to-prime RW transformation matrix
M_EFTOTD_TACAN_SL(N)	M	0	—	Transformation matrix from earth-fixed to topodetic coordinates at TACAN site (each LRU) output from site lookup, N=1,3
M_GSI	S	I-load	—	Boundary of high vehicle mass and low vehicle mass
MELV_CMLK(N)	BIT(3)	Off	—	MSBLS elevation commfault/ lock-on flag for Nth receiver, N=1,3
MM_CODE_304	BIT	Off	—	Major Mode 304 flag
MM_CODE_602	BIT	Off	—	Major Mode 602 flag
MODE	CHAR	—	—	Indicates setting of display mode switch (entry, TAEM, or land)
MODE_LEFT	CHAR	—	—	Indicates setting of display mode switch (entry, TAEM or land) for left-side HSI
MODE_RIGHT	CHAR	—	—	Indicates setting of display mode switch (entry, TAEM or land) for right-side HSI
MRNG_CMLK(N)	BIT	Off	—	MSBLS range commfault/lock-on flag for the Nth receiver, N=1,3
MSBAZIMO(N)	S	0	—	MSBLS azimuth for the Nth receiver, N=1,3
MSBELEVO(N)	S	0	—	MSBLS elevation for the Nth receiver, N=1,3
MSBRANGE(N)	S	0	—	MSBLS range for the Ith receiver, N=1,3
N	INT	—	—	Index for site lookup parameters (TACAN) and raw data from SOP (TACAN or MSBLS)
NAUTMI_PER_FT	S	Constant	—	Feet to nautical miles
NEP	BIT	Off	—	Flag denoting switch from NEP to MEP circle
OVHD	B	—	—	Overhead/straight-in discrete
OVHD_LAST	B	—	—	Previous pass overhead/ straight-in discrete

Table 5.4-1. Variable List - Area Navigation				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
P	S	-1	—	Sign of primary runway left/ right HAC indicator
PHAVG	S	0	—	Average roll angle during acquisition turn
PHAVGC	S	I-load	—	Constant for computing PHAVG
PHAVGLL	S	I-load	—	Lower limit for PHAVG
PHAVGS	S	I-load	—	Slope for computing PHAVG
PHAVGUL	S	I-load	—	Upper limit for PHAVG
PHI	S	0	—	Angle from runway to HAC center measured WRT Shuttle
PI	S	Constant	—	Ratio of circumference to diameter, the constant $\pi$
POSITION_WRT_RUNWAY	V	0	RW	Vehicle c.g. position vector WRT runway reference point (R_LS_EF)
PRI_BEAR	S	0	—	Primary bearing (to WP-1-entry and TAEM, to WP-2-land)
PRIBEAR_LEFT	S	0	—	Primary bearing (to WP-1-entry and TAEM, to WP-2-land)
PRIBEAR_RIGHT	S	0	—	Primary bearing (to WP-1-entry and TAEM, to WP-2-land)
PRI_RANGE	S	0	—	Primary range to WP-2 (via WP-1-entry and TAEM, direct-land)
PRIRANGE_LEFT	S	0	—	Primary range to WP-2 (via WP-1-entry and TAEM, direct-land)
PRIRANGE_RIGHT	S	0	—	Primary range to WP-2 (via WP-1-entry and TAEM, direct-land)
PSD_HSI	S	0	—	Heading with respect to runway centerline
PSHA	S	0	—	HAC turn angle
PSHARS	S	I-load	—	PSHA reset value
PSI	S	0	—	Heading WRT true north
PSI_HSIMV	S	0	—	Angle between magnetic north and Shuttle body X-axis
R	S	0	—	Distance from the vehicle ground position to the MEP by way of the HAC
R0	S	0	—	HAC radius at PSHA = 0°
R1	S	I-load	—	Coefficient of spiral equation
R2	S	I-load	—	Coefficient of spiral equation
RADIUS_EP	S	I-load	—	Radius of entry point HAC
RANGE	S	0	—	Range from Shuttle to WP-2 via WP-1
RANGE_FT	S	0	—	Range to WP-2 in feet
RC	S	0	—	Range from end of acquisition turn to WP-1
R_CC	S	0	—	Flat earth surface range from Shuttle to the HAC center

Table 5.4-1. Variable List - Area Navigation

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{R}_{CC\_EF}$	V	0	EF	Position vector of HAC center in earth-fixed coordinates
$\bar{R}_{CC\_L\_PRI}$	V	0	EF	Position vector of the HAC center on the left side (-Y) of the runway centerline
$\bar{R}_{CC\_R\_PRI}$	V	0	EF	Position vector of the HAC center on the right side (+Y) of the runway centerline
R_CC_LMAG_PRI	S	0	—	Magnitude of the vector R_CC_L_PRI
R_CC_RMAG_PRI	S	0	—	Magnitude of the vector R_CC_R_PRI
R_CC_MAG	S	0	—	Earth radius at HAC center for primary runway
RCVR	INT	—	—	Indicates setting of string selection switch (when source is MSBLS or TACAN)
RCVR_LEFT	INT	0	—	Indicates setting of string selection switch (when source is MSBLS or TACAN) on left-side HSI
RCVR_RIGHT	INT	0	—	Indicates setting of string selection switch (when source is MSBLS or TACAN) on right-side HSI
RD_TAC_SL(N)	S	0	—	Geodetic radius of mean sea level at TACAN site to which the Nth receiver is tuned, N = 1, 3
RESELVE	S	I-load	—	Overhead correction termination velocity
$\bar{R}_{EF}$	V	0	EF	Shuttle position vector in earth-fixed coordinates
RF0	S	I-load	—	Nominal HAC radius at PSHA = 0°
$\bar{R}_{LS\_EF}$	V	0	EF	Position vector of runway in earth-fixed coordinates
RTAC	S	0	—	Radius of acquisition turn
R_TAC	S	0	—	Magnitude of TACAN position vector
$\bar{R}_{TACAN\_EF\_SL(N)}$	V	0	EF	Earth-fixed position vector of TACAN station (each LRU) output from site lookup, N=1,3
RTURN_HSI	S	0	—	Radius of spiral at WP-1
RTURN_HSI_LEFT	S	0	—	Radius of spiral at WP-1 for previous left cycle
RTURN_HSI_RIGHT	S	0	—	Radius of spiral at WP-1 for previous right cycle
R_VEH	S	0	—	Magnitude of Shuttle vector computed from HBARO and TACAN position
$\bar{R}_{VEH\_EF}$	V	0	EF	Position vector of Shuttle in earth-fixed coordinates
R_VEH_MAG	S	0	—	Magnitude of R_VEH_EF
R_VEH_MAG_UPP	S	0	—	Magnitude of R_AVGG from UPP
$\bar{R}_{VEH\_RW}$	V	0	RW	Position vector of the Shuttle in runway coordinates
$\bar{R}_{VEH\_TD\_TAC}$	V	0	—	Position vector of Shuttle in TACAN topodetic coordinates
SEC_BEAR	S	0	—	Bearing from Shuttle to WP-1 for secondary runway-entry; bearing from Shuttle to center of selected HAC for primary runway-TAEM

Table 5.4-1. Variable List - Area Navigation				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
SECBEAR_LEFT	S	0	—	Bearing from Shuttle to WP-1-entry; bearing from Shuttle to center of selected HAC-TAEM
SECBEAR_RIGHT	S	0	—	Bearing from Shuttle to WP-1-entry; bearing from Shuttle to center of selected HAC-TAEM
SEC_RANGE	S	0	—	Secondary range to WP-2 via WP-1-entry and direct-land; horizontal distance to center of selected HAC for primary runway-TAEM
SECRANGE_LEFT	S	0	—	Secondary range to WP-2 via WP-1-entry and direct-land; horizontal distance to center of selected HAC-TAEM
SECRANGE_RIGHT	S	0	—	Secondary range to WP-2 via WP-1-entry and direct-land; horizontal distance to center of selected HAC-TAEM
SIGNY_HSI	S	0	—	Shuttle side of runway centerline
SIN_THET_VEH_CC	S	0	—	Sine of range angle from Shuttle to center of HAC
SOURCE	CHAR	—	—	Indicates which data source (MSBLS, TACAN, or Nav) switch is ON
SOURCE_LEFT	CHAR	—	—	Indicates which data source (MSBLS, TACAN, or Nav) switch is ON for left-side HSI
SOURCE_RIGHT	CHAR	—	—	Indicates which data source (MSBLS, TACAN, or Nav) switch is ON for right-side HSI
TACAN_CHAN_VALID SL(N)	BIT	Off	—	Switch indicating (ON) a valid TACAN channel has been selected (site lookup output) N=1,3
TACBEARO(N)	S	0	—	TACAN bearing data obtained from the SOP for each receiver, N=1,3
TACRANGE(N)	S	0	—	TACAN range data obtained from the SOP for each receiver, N=1,3
TAZ	S	0	—	Tangent of MSBLS azimuth angle
TEL	S	0	—	Tangent of MSBLS elevation angle
TEL2	S	0	—	Square of tangent of MSBLS elevation angle
TBRG_CMLK(N)	BIT	Off	—	TACAN azimuth commfault/lock-on flag for the Nth receiver, N=1,3
THETA	S	0	—	Angle which corrects Shuttle heading from the center of HAC to WP-1
TRNG_CMLK(N)	BIT	Off	—	TACAN range commfault/lock-on flag for the Ith receiver, N=1,3
V_HSI	S	0	—	Ground relative velocity magnitude
VH_HSI	S	0	—	Horizontal ground speed
$\bar{V}$ _NORM	V	0	EF	Vector normal to the great circle plane containing the Shuttle and the HAC center
$\bar{V}$ _RHO_EF	V	0	EF	Vehicle relative velocity vector in earth-fixed coordinates



Table 5.4-1. Variable List - Area Navigation

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{V}_{VEH\_EF}$	V	0	—	Velocity vector of Shuttle in earth-fixed coordinates
$\bar{V}_{VEH\_RW}$	V	0	RW	Velocity vector of Shuttle in runway coordinates
X_CC	S	0	RW	X-component of vector from the Shuttle to HAC center in runway coordinates
X_DMEAZ_RW	S	0	RW	X-component of range/azimuth antenna in runway coordinates
X_EL_RW	S	0	RW	X-component of elevation antenna, RW coordinates
X_EP	S	0	RW	Runway X-component of the HAC center
X_GSI	S	0	RW	Glide slope intercept point on extended runway center line
X_GSI_HI_WIND	S	I-load	RW	Glide slope intercept point on extended runway centerline for high wind condition
X_GSI_NOMINAL	S	I-load	RW	Glide slope intercept point on extended runway centerline for low wind condition
X_NEP	S	I-load	RW	Runway X-component of the HAC center
X_VEH_DMEAZ	S	0	RW	X-component of Shuttle position WRT MSBLS antenna
X_WP2	S	I-load	RW	Runway X-component of WP-2
Y_CC	S	0	RW	Y-component of vector from the Shuttle to HAC center in runway coordinates
Y_DMEAZ_RW	S	0	RW	Y-component of range/azimuth antenna in runway coordinates
YSGNP	S	—	—	Initial L/R HAC indicator – PRI

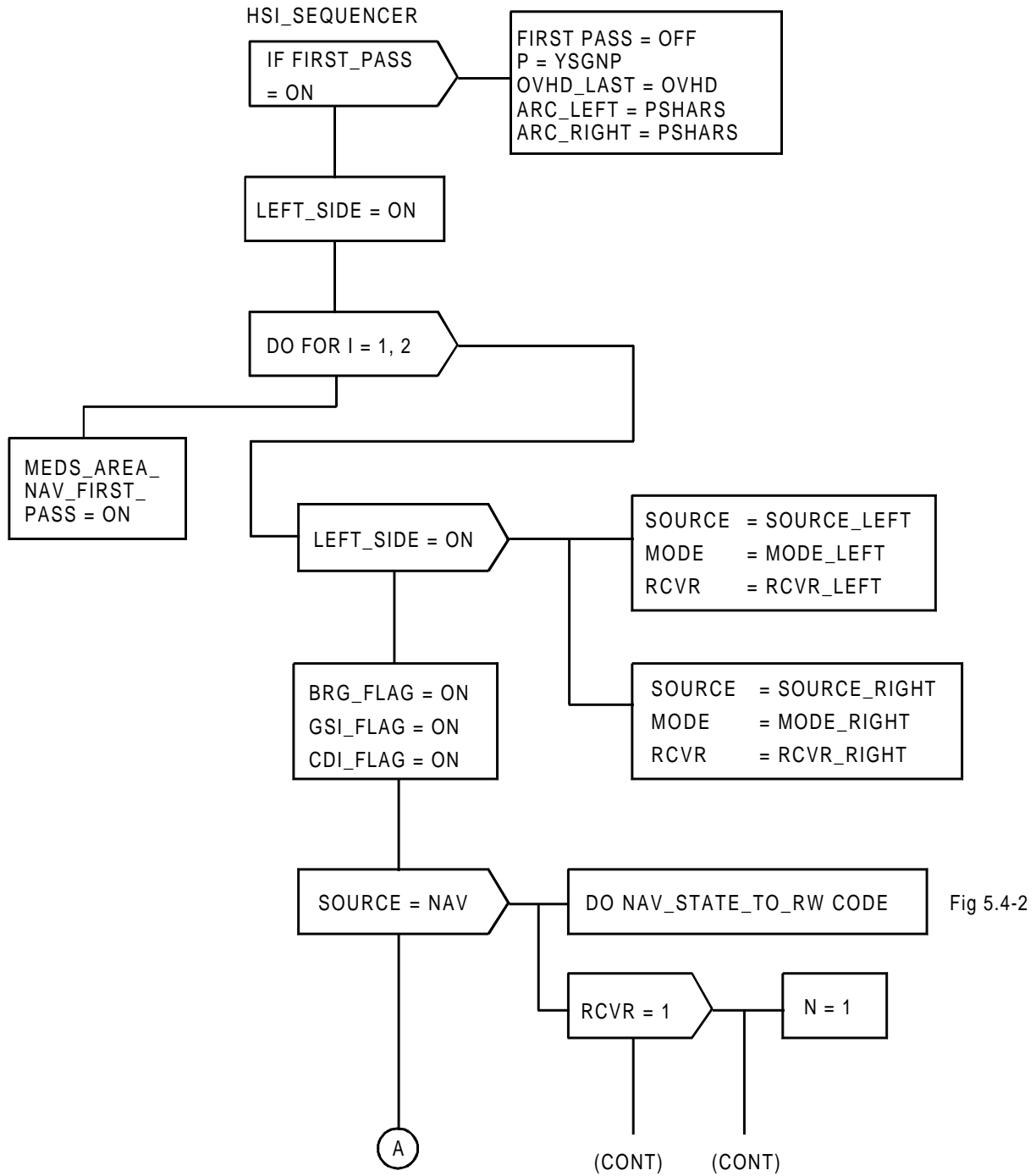


FIGURE 5.4-1.(1) HSI\_SEQUENCER (Sheet 1 of 5)

HSI\_SEQUENCER (CONT)

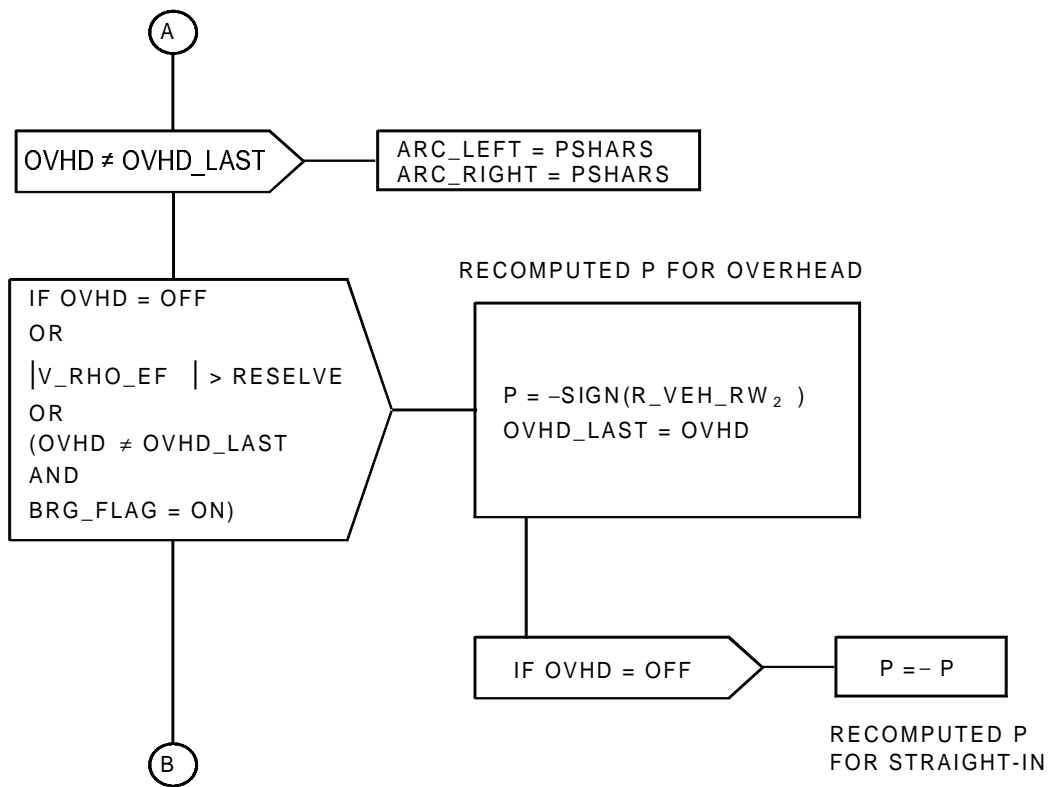


FIGURE 5.4-1.(2) HSI\_SEQUENCER (Sheet 2 of 5)

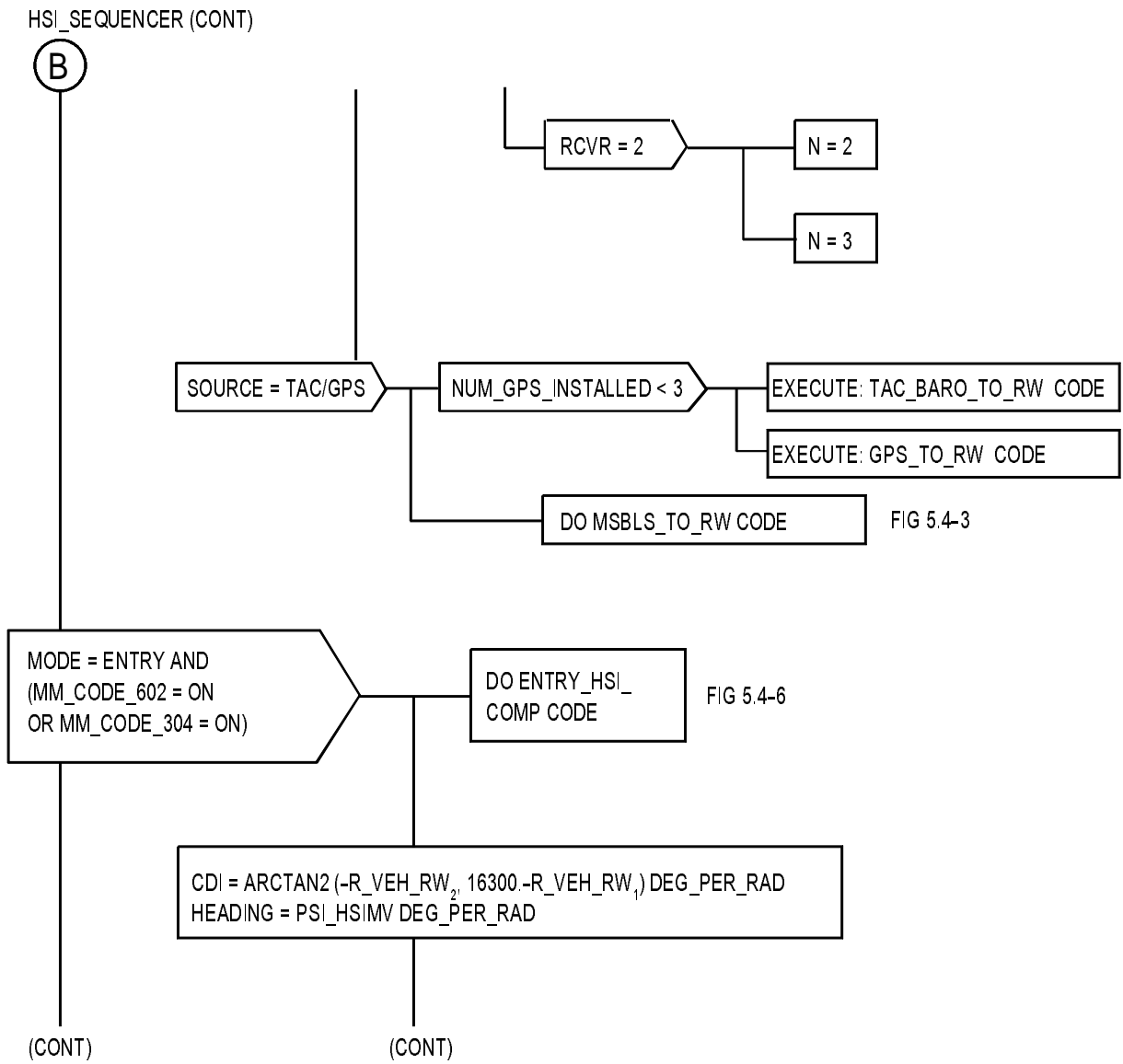


FIGURE 5.4-1.(3) HSI\_SEQUENCER (Sheet 3 of 5)



HSI\_SEQUENCER (CONT)

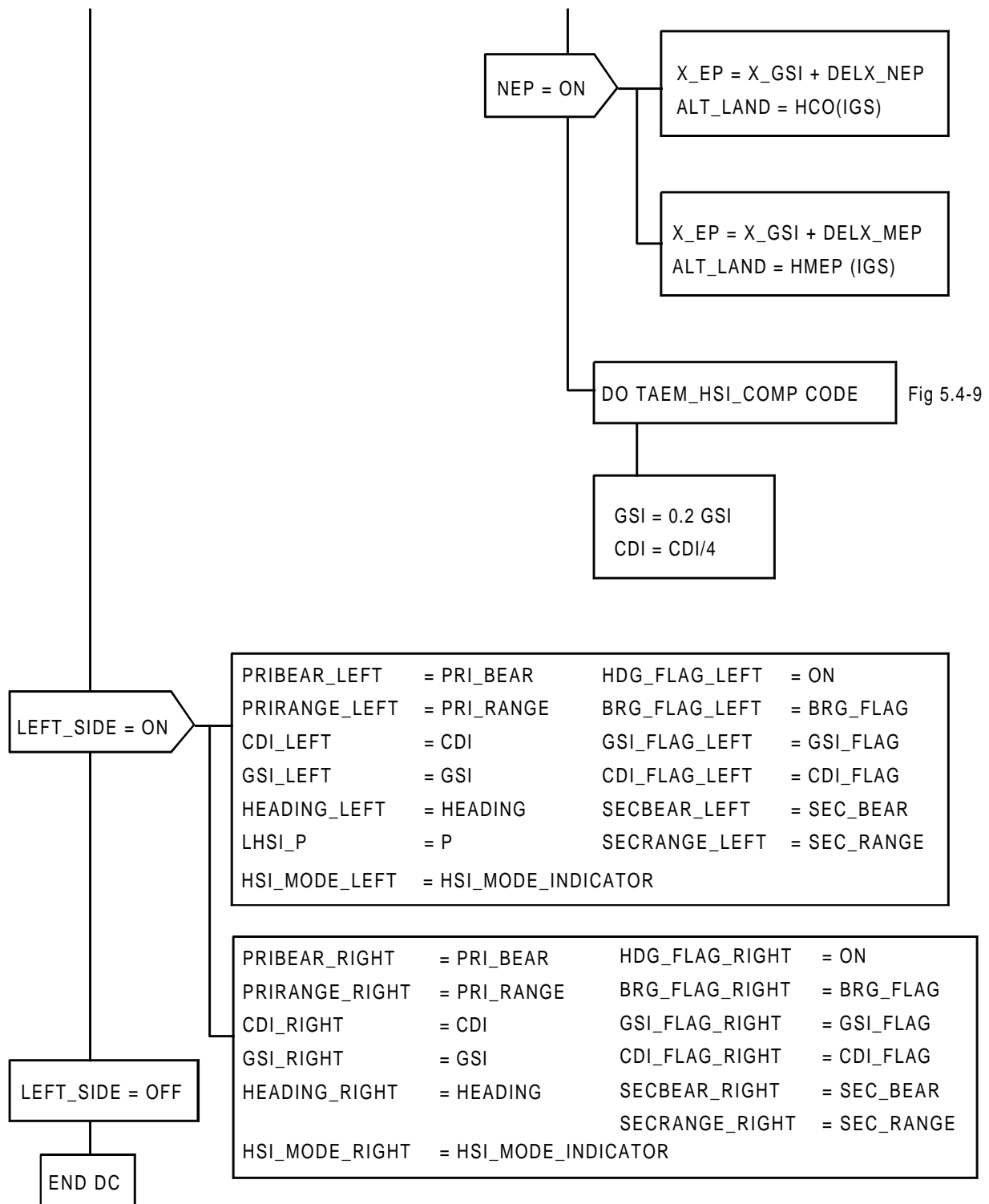


Fig 5.4-9

FIGURE 5.4-1.(5) HSI\_SEQUENCER (Sheet 5 of 5)

NAV\_STATE\_TO\_RW CODE

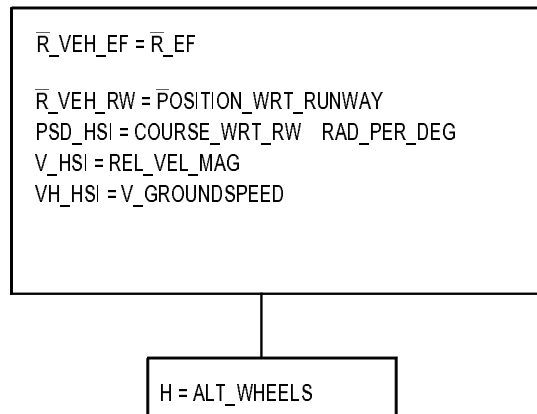


FIGURE 5.4-2. NAV\_STATE\_TO\_RW CODE

TAC\_BARO\_TO\_RW CODE

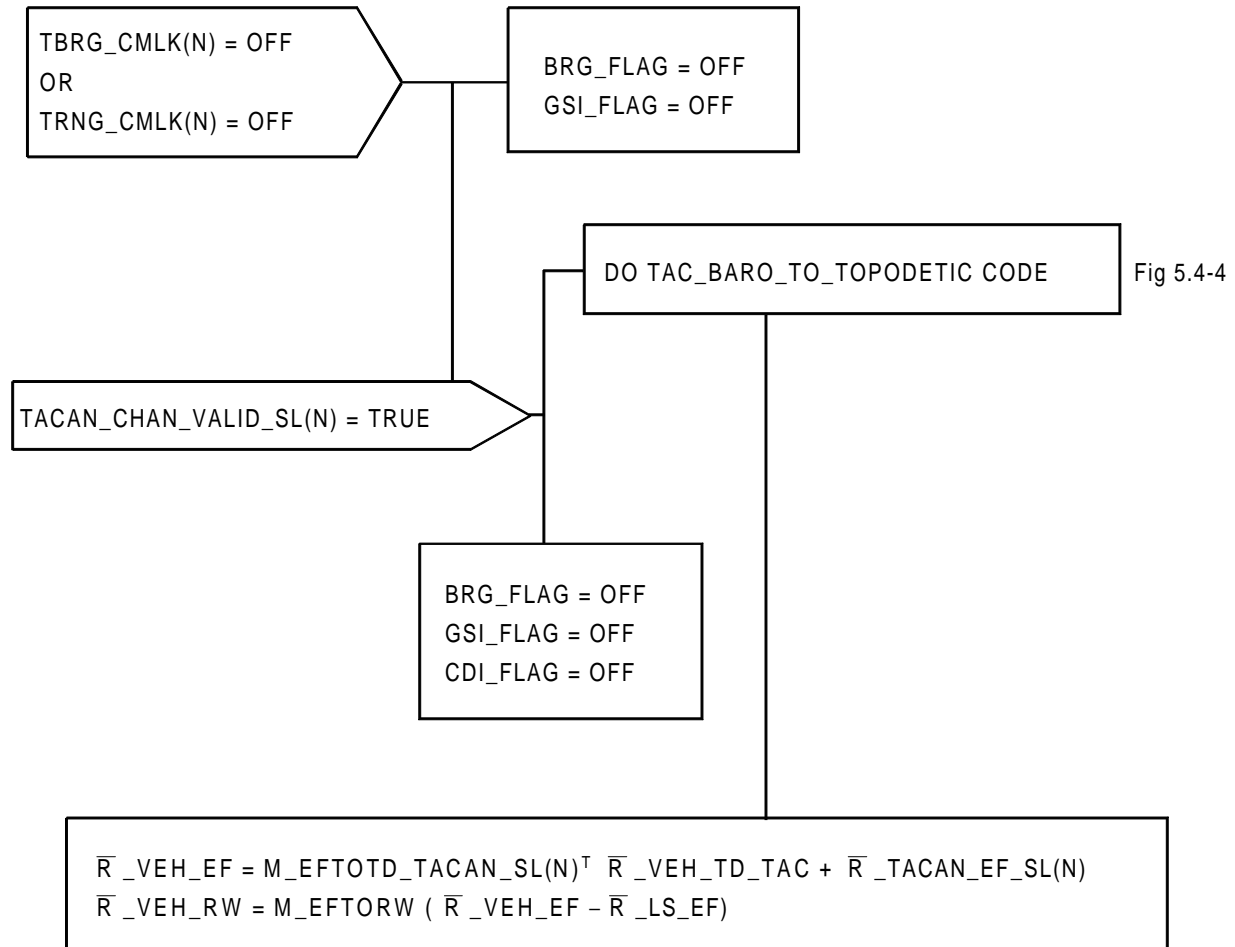


FIGURE 5.4-3. TAC\_BARO\_TO\_RW CODE



TAC\_BARO\_TO\_TOPODETTIC CODE

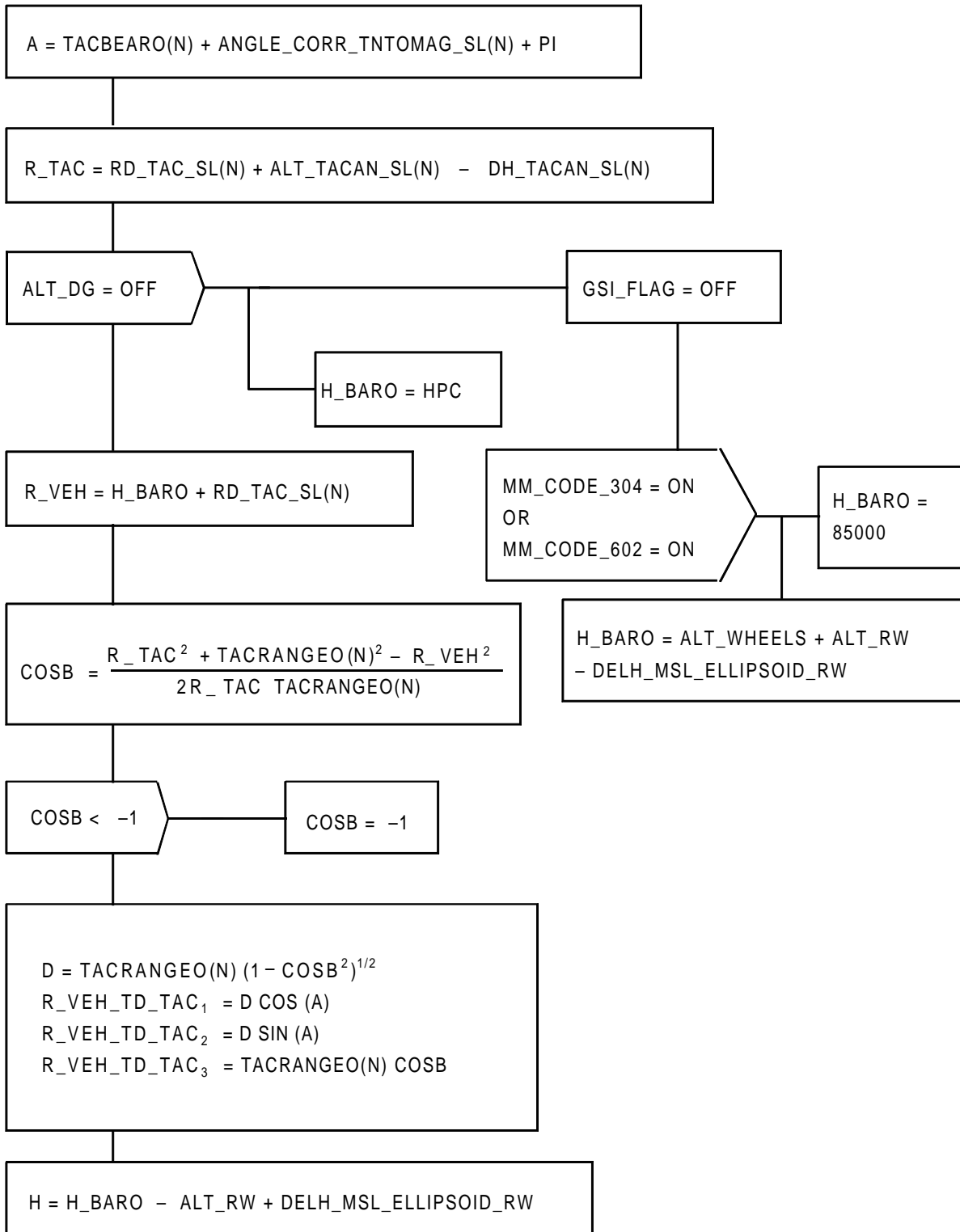


FIGURE 5.4-4. TAC\_BARO\_TO\_TOPODETTIC CODE

GPS\_TO\_RW

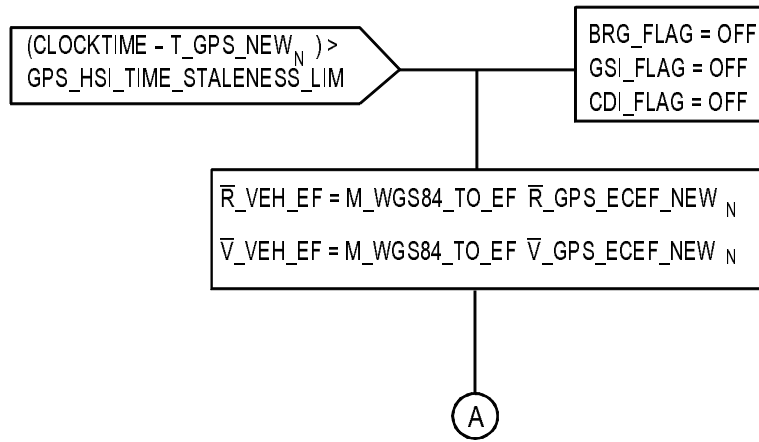


FIGURE 5.4-4A.(1) GPS\_TO\_RW (Sheet 1 of 2)

GPS\_TO\_RW(CONT)

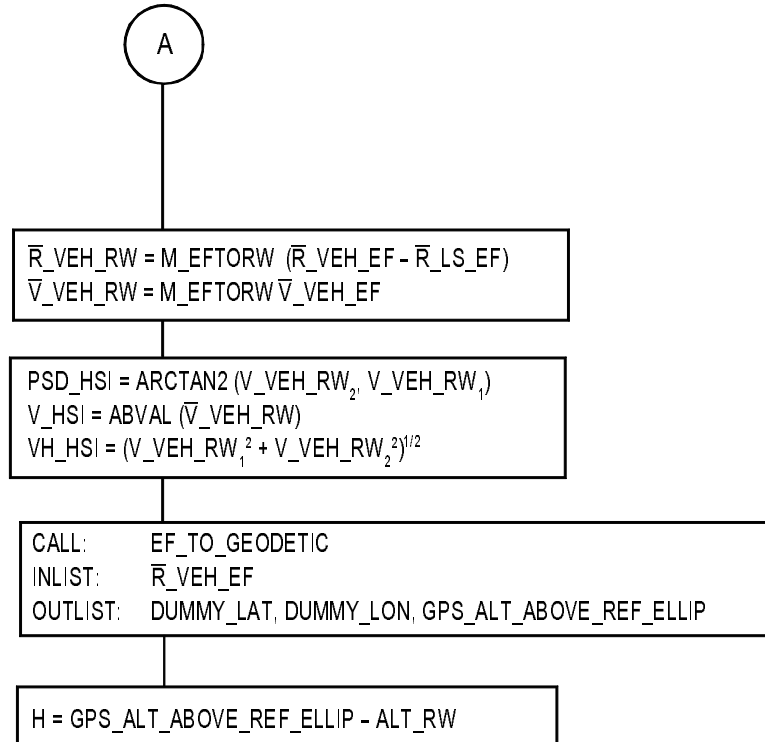


FIGURE 5.4-4A.(2) GPS\_TO\_RW (Sheet 2 of 2)

MSBLS\_TO\_RW CODE

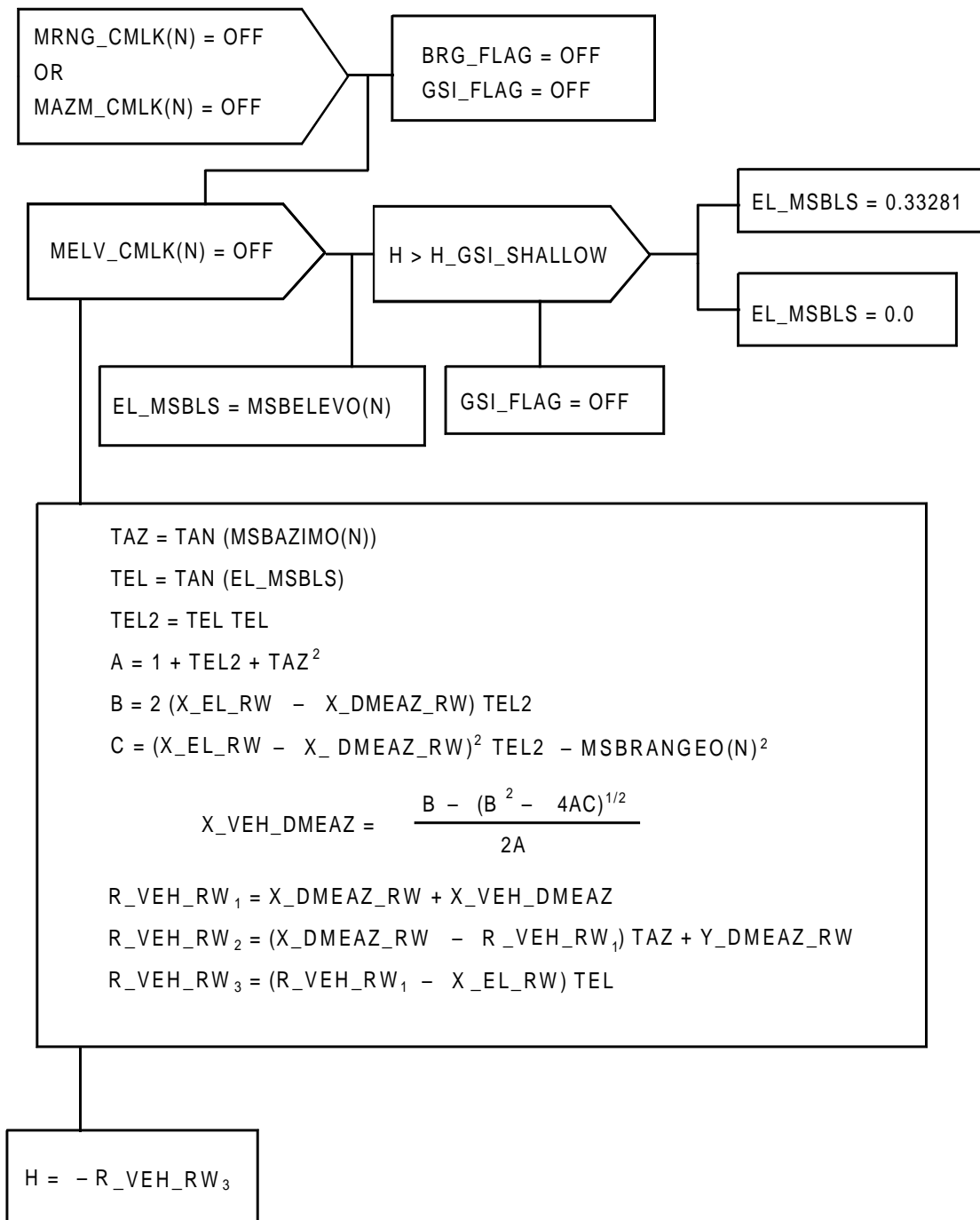


FIGURE 5.4-5. MSBLS\_TO\_RW CODE

ENTRY\_HSI\_COMP CODE

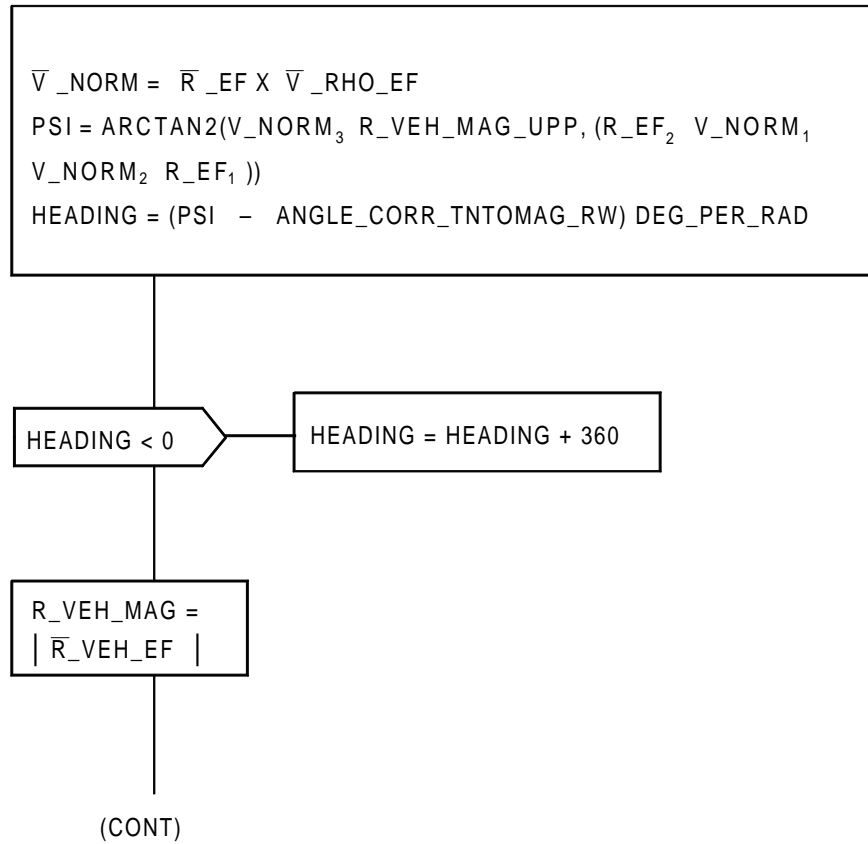


FIGURE 5.4-6.(1) ENTRY\_HSI\_COMP CODE (Sheet 1 of 2)

ENTRY\_HSI\_COMP CODE (CONT)

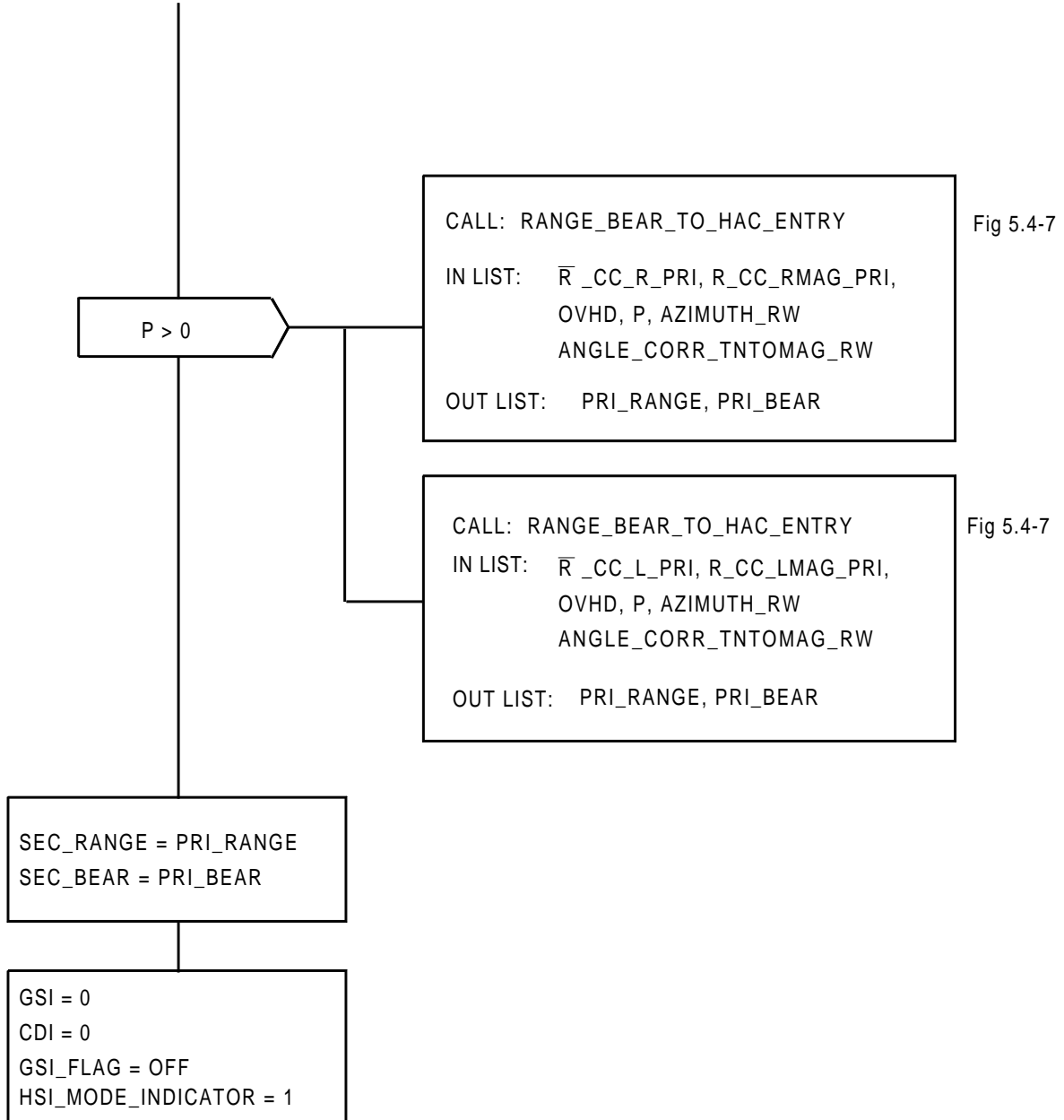


FIGURE 5.4-6.(2) ENTRY\_HSI\_COMP CODE (Sheet 2 of 2)

RANGE\_BEAR\_TO\_HAC\_ENTRY

INLIST:  $\bar{R}_{CC\_EF}$ ,  $R_{CC\_MAG}$ , OVHD, P, AZIMUTH\_RW, ANGLE\_CORR\_TNTOMAG\_RW

OUTLIST: RANGE, BEARING

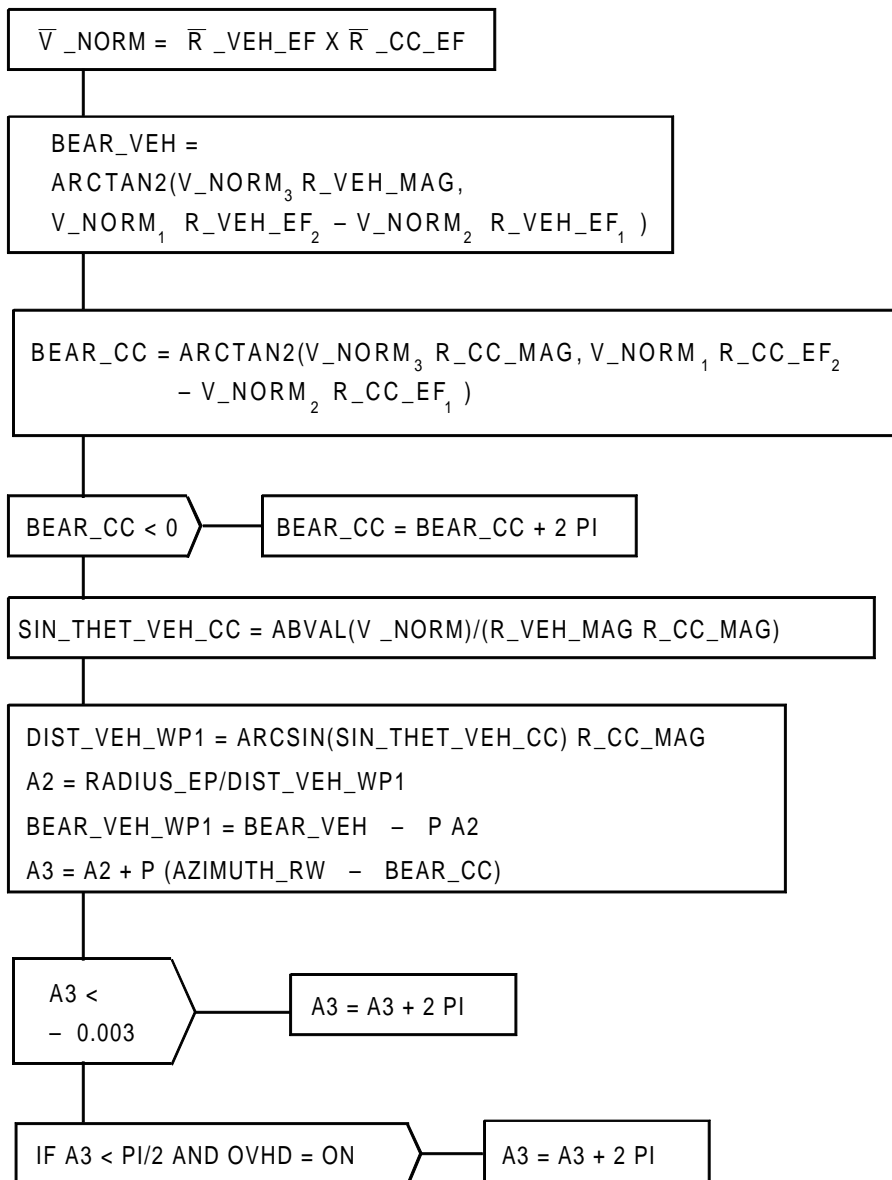


FIGURE 5.4-7.(1) RANGE\_BEAR\_TO\_HAC\_ENTRY (Sheet 1 of 2)

RANGE\_BEAR\_TO\_HAC\_ENTRY (CONT)

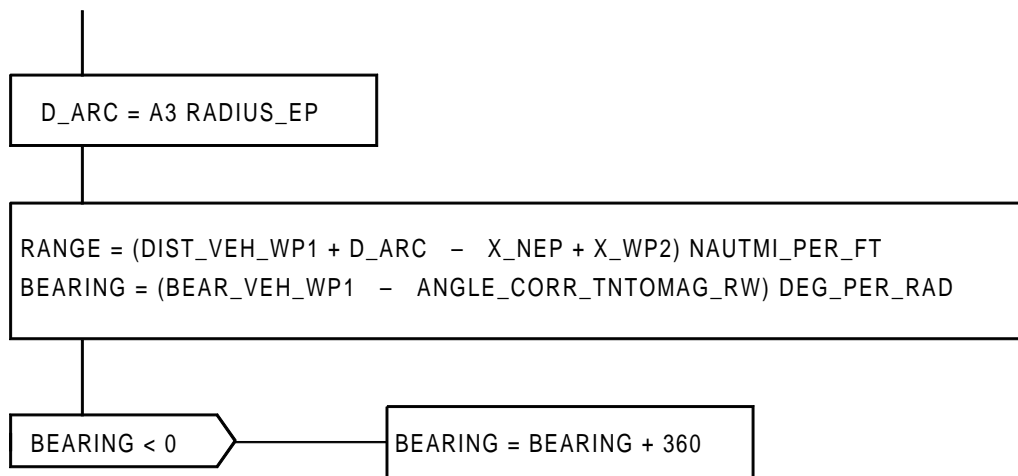


FIGURE 5.4-7.(2) RANGE\_BEAR\_TO\_HAC\_ENTRY (Sheet 2 of 2)



LAND\_HSI\_COMP CODE

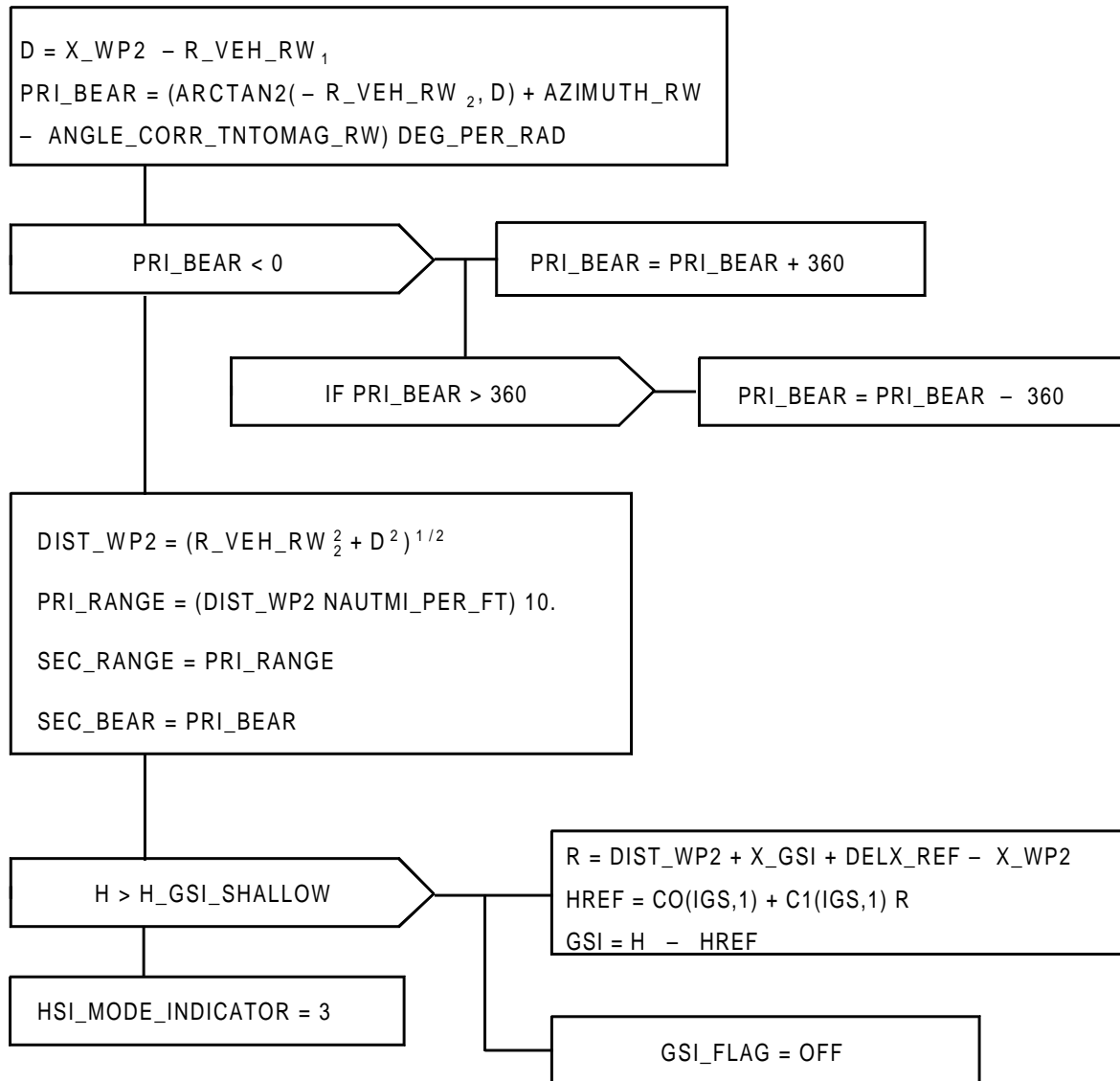


FIGURE 5.4-8. LAND\_HSI\_COMP CODE

TAEM\_HSI\_COMP CODE

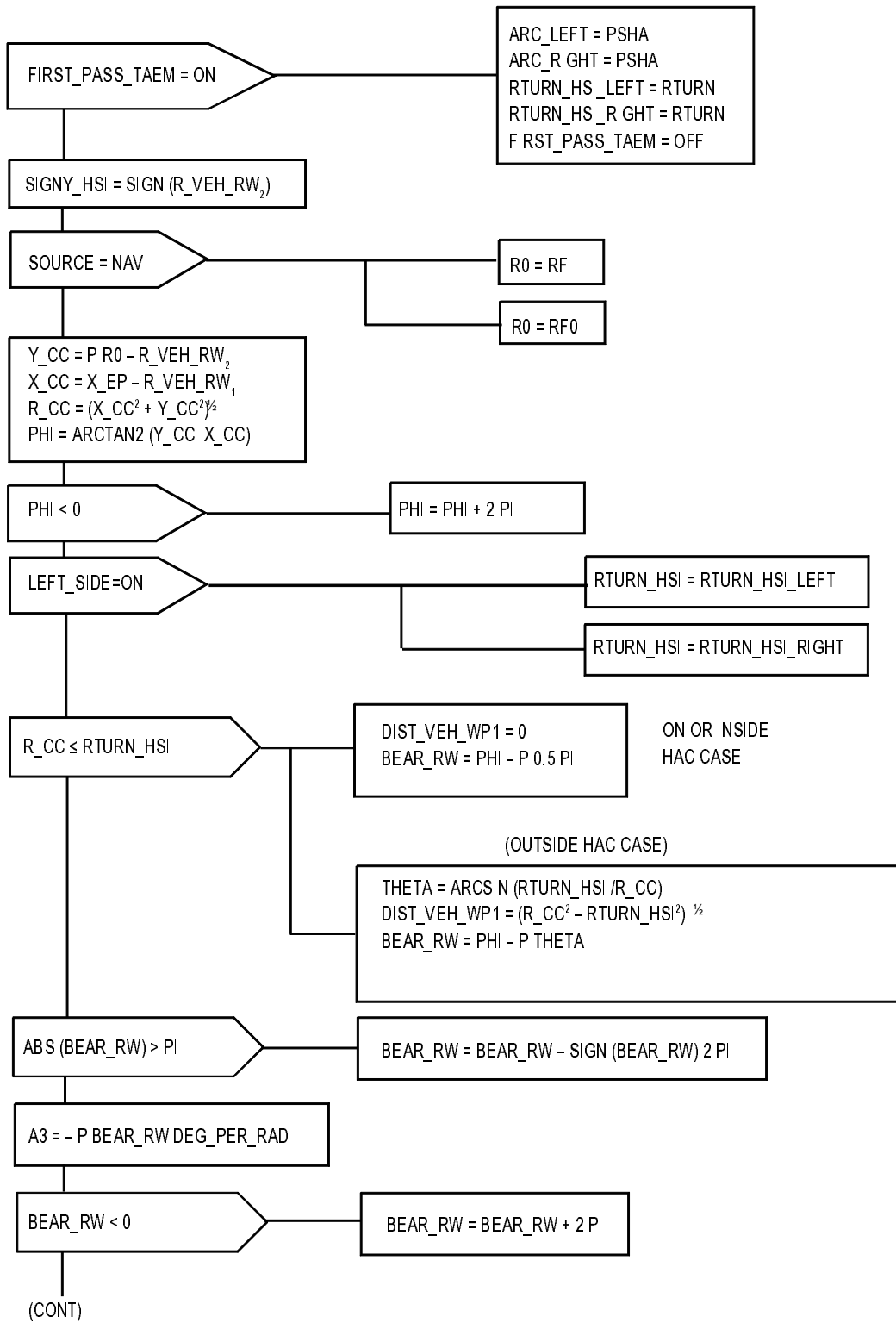


FIGURE 5.4-9.(1) TAEM\_HSI\_COMP CODE (Sheet 1 of 3)

TAEM\_HSI\_COMP CODE (CONT)

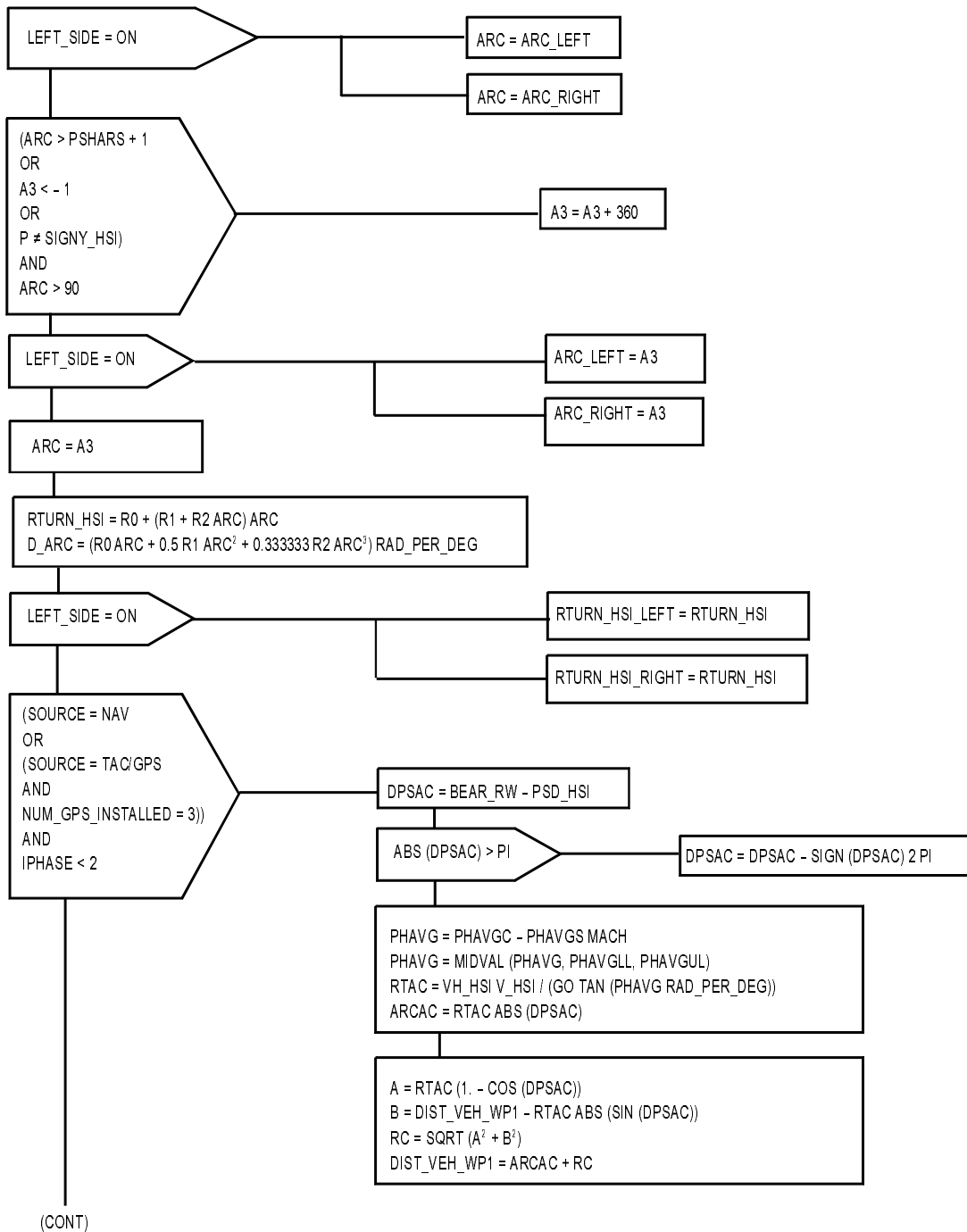


FIGURE 5.4-9.(2) TAEM\_HSI\_COMP CODE (Sheet 2 of 3)

TAEM\_HSI\_COMP CODE (CONT)

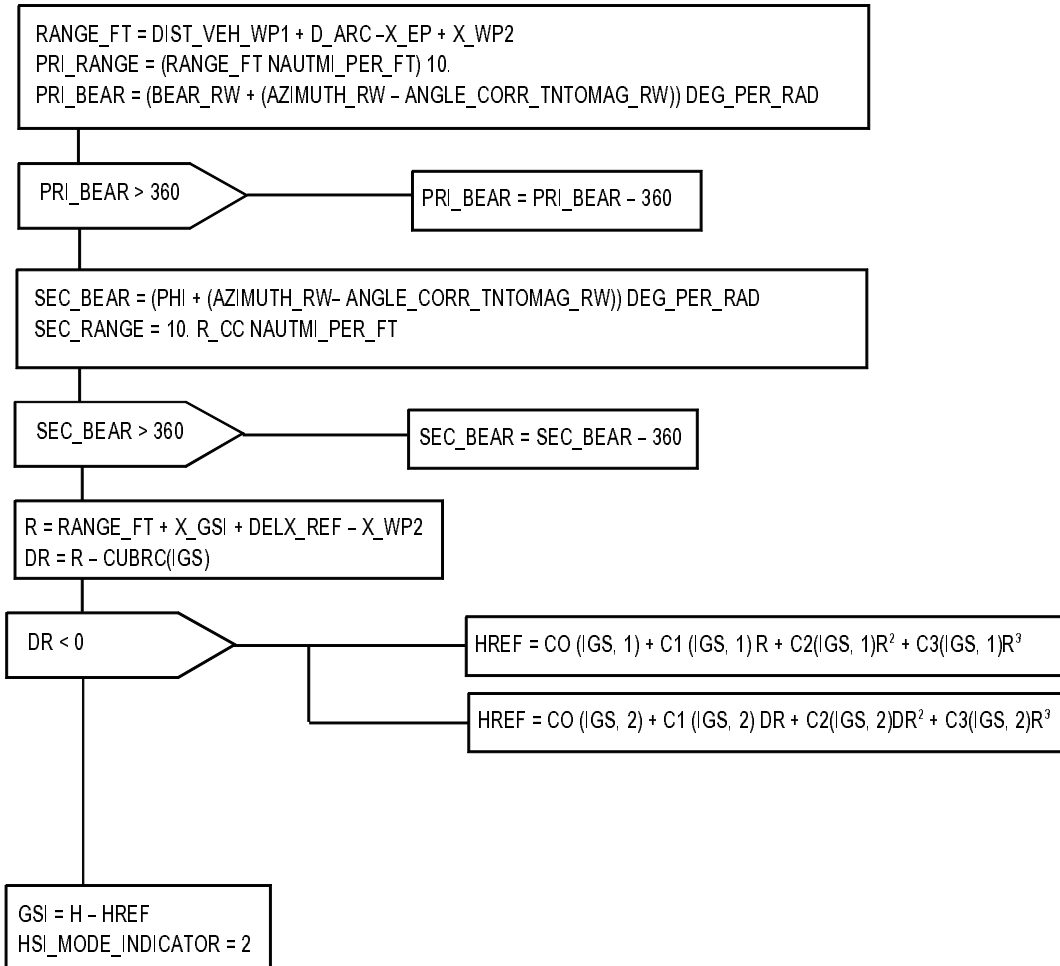


FIGURE 5.4-9.(3) TAEM\_HSI\_COMP CODE (Sheet 3 of 3)

## 5.5 SPECIALIST FUNCTIONS NAVIGATION SUPPORT FLOW FORMULATIONS CHARTS, VARIABLE NAMES, AND DESCRIPTIONS

This section provides supplemental material for specialists functions Navigation support formulations in the form of functional flow charts (Figure 5.5–1 through Figure 5.5–4). Table 5.5–1 provides the variable list that supports this material.

- Code Used For Variable Data Type:

S:	scalar
V(n):	vector (dimension)
V(3):	V
M(n):	square matrix (dimension)
INT:	integer
BIT:	bit
CHAR:	character
STR:	structure
ARR:	array
BIN:	binary

Table 5.5-1. Variable List - Specialist Functions Navigation Support Formulations				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
ALT_ABOVE_ELLIPSOID_MAXI(L)	F	I-load	—	Altitude of the TACAN station above reference ellipse
DO_DELTA_T_UPDATE	BIT	Off	—	Flag indicating (ON) that a time tag update has been performed
DELTA_T	S	0	—	Time tag increment value entered via keyboard for delta time tag state update
DO_DELTA_UPDATE	BIT	Off	—	DO delta state update command from keyboard
DO_DELTA_UPDATE_UP	BIT	Off	—	DO delta state update command for uplinked data
$\bar{D}R_{RW}$	V	0	RW	Position deviations to update on-board state vector entered via keyboard
$\bar{D}R_{RW\_UP}$	V	0	RW	Position deviations to update on-board state vectors from command uplink
J	INT	0	—	Landing site subscript
L	INT	0	—	Runway subscript
M	INT	0	—	Runway subscript
LANDING_SITE_TABLE_SLOT	BIT	0	—	Uplink index for DEORBIT_LANDING_SITE_UPLINK
LATITUDE_GEODETTIC_MAXI(L)	F	I-load	—	Geodetic latitude of TACAN station
LONGITUDE_EAST_MAXI(L)	F	I-load	—	Longitude of the TACAN station
MAGNETIC_VARIATION_MAXI(L)	F	I-load	—	Angle between true north and magnetic north at the TACAN station
MSL_ABOVE_ELLIPSOID_MAXI(L)	V (30)	I-load	—	The difference in an altitude above the reference ellipsoid and that altitude above mean sea level or geoid
OP_CODE	BIT (7)	0	—	Bit string indicating which command uplink has occurred
$\bar{R}_{GND}$	V	0	M50	Position vector to be predicted to cyclic Nav time by state vector prediction task
$\bar{R}_{FILT}$	V	—	M50	Current Nav position vector used for delta time tag update processing
RUNWAY_ALT(L)	F	I-load	—	Geodetic altitude of the selected landing site
RUNWAY_NAME(L)	F	I-load	—	Name of the selected landing site
RW_AZIMUTH(L)	F	I-load	—	Azimuth to true north of the selected landing site
RW_DELH(L)	F	I-load	—	Delta height from ellipsoid to MSL for the selected landing site
RW_LAT(L)	F	I-load	—	Geodetic latitude of the Selected landing site
RW_LENGTH(L)	F	I-load	—	Runway length for the selected landing site
RW_LON(L)	F	I-load	—	Longitude of the selected landing site

Table 5.5-1. Variable List - Specialist Functions Navigation Support Formulations				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
RW_MAG_VAR(L)	F	I-load	—	Magnetic variation for the selected landing site
TACAN_ID_MAXI(L)	I	I-load	—	A three-digit channel/mode designation, unique for each TACAN station
TACAN_TABLE_SLOT_ID	BIN	—	—	Uplink index for DEORBIT_TACAN_SITE_UPLINK
T_GND	S	0	—	Time tag of state vector to be predicted to current Nav time
T_CURRENT_FILT	S	—	—	Time tag of current Nav output state vector
$\bar{V}$ _GND	V	0	M50	Velocity vector to be predicted to cyclic Nav time by state vector prediction task
$\bar{V}$ _FILT	V	—	M50	Current Nav velocity vector used for delta time tag update processing
RW_MSBLs_INDEX(L)	I	I-load	—	Runway MSBLs pointer index
$\bar{D}$ V_RW	V	0	RW	Relative velocity deviation to update onboard velocity via keyboard
$\bar{D}$ V_RW_UP	V	0	RW	Relative velocity deviation to update onboard velocity from uplink

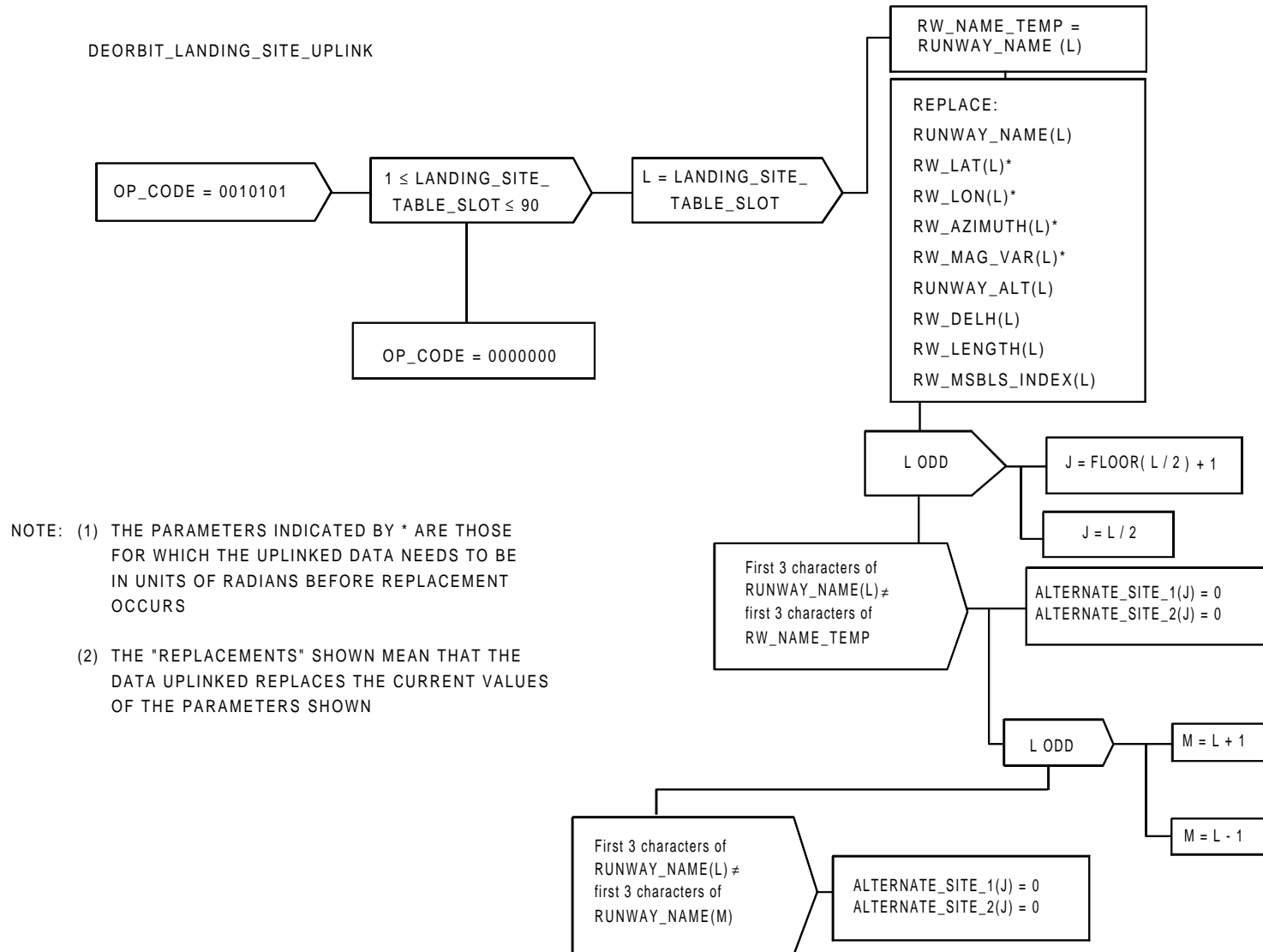
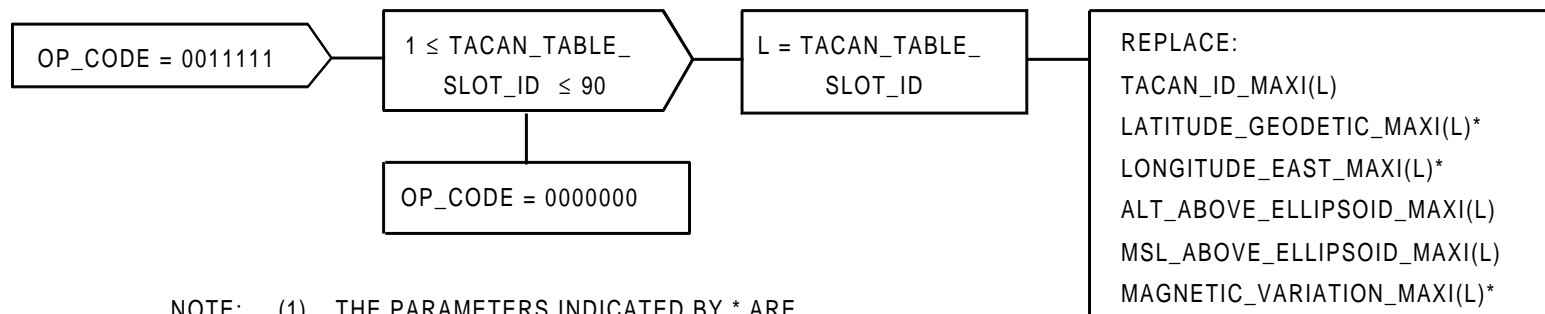


FIGURE 5.5-1. DEORBIT\_LANDING\_SITE\_UPLINK



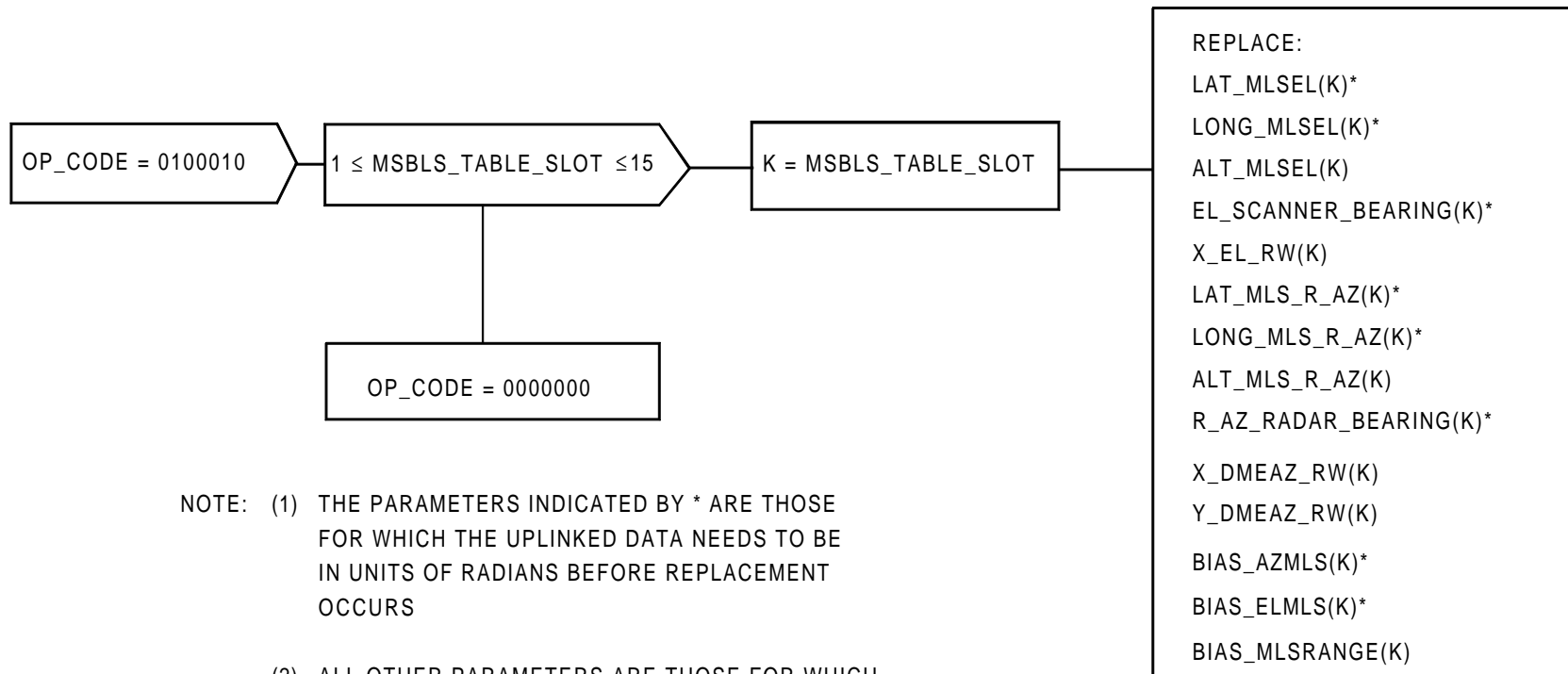
DEORBIT\_TACAN\_SITE\_UPLINK



- NOTE: (1) THE PARAMETERS INDICATED BY \* ARE THOSE FOR WHICH THE UPLINKED DATA NEEDS TO BE IN UNITS OF RADIANS BEFORE REPLACEMENT OCCURS
- (2) THE "REPLACEMENTS" SHOWN MEAN THAT THE DATA UPLINKED REPLACES THE CURRENT VALUES OF THE PARAMETERS SHOWN
- (3) TACAN\_ID\_MAXI IS THE CHANNEL/MODE IDENTIFIER FOR THE TACAN SITE

FIGURE 5.5-2. DEORBIT\_TACAN\_SITE\_UPLINK

## MSBLS\_SITE\_UPLINK



- NOTE: (1) THE PARAMETERS INDICATED BY \* ARE THOSE FOR WHICH THE UPLINKED DATA NEEDS TO BE IN UNITS OF RADIANS BEFORE REPLACEMENT OCCURS
- (2) ALL OTHER PARAMETERS ARE THOSE FOR WHICH THE UPLINKED DATA NEEDS TO BE IN UNITS OF FEET BEFORE REPLACEMENT OCCURS
- (3) THE "REPLACEMENTS" SHOWN MEAN THAT THE DATA UPLINKED REPLACES THE CURRENT VALUES OF THE PARAMETERS SHOWN

FIGURE 5.5-3. MSBLS\_SITE\_UPLINK

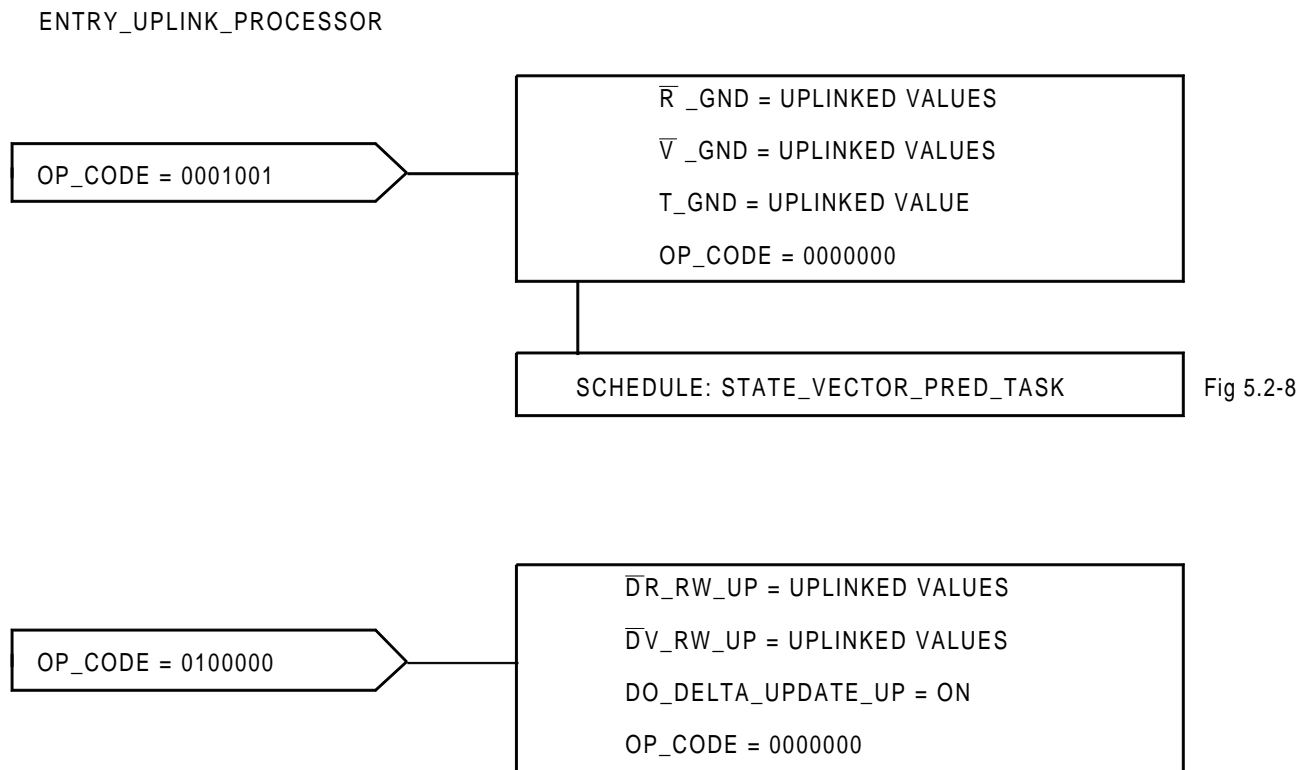


FIGURE 5.5-4. ENTRY\_UPLINK\_PROCESSOR

ENTRY\_KEYBOARD\_PROCESSOR

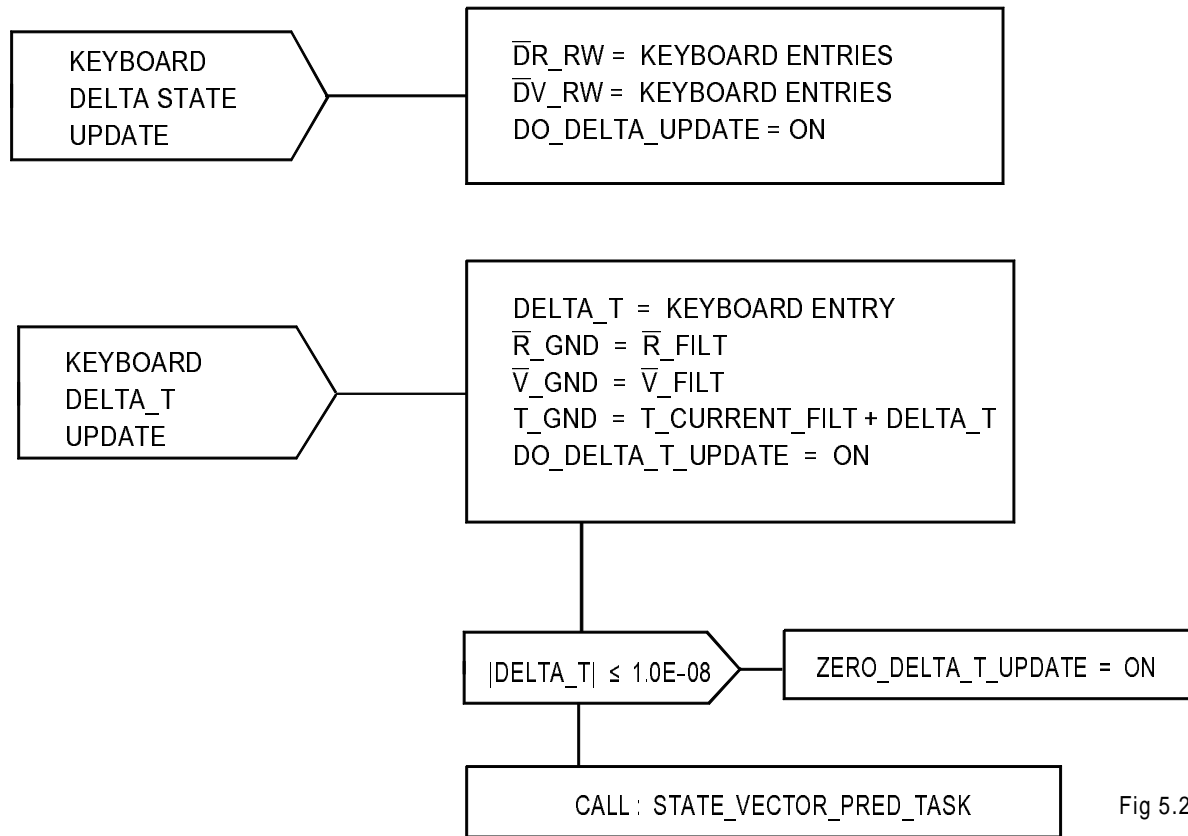


Fig 5.2-8

FIGURE 5.5-5. ENTRY\_KEYBOARD\_PROCESSOR

RNP\_MATRIX\_TIME\_UPLINK\_PROCESSING

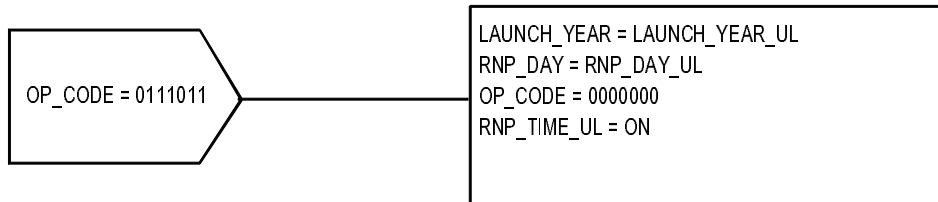


FIGURE 5.5-6. RNP\_MATRIX\_TIME\_UPLINK\_PROCESSING

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## 5.6 USER PARAMETER PROCESSING FLOW CHARTS, VARIABLE NAMES, AND DESCRIPTIONS

This section provides supplemental material for user parameter processing in the form of functional flow-charts (Figures 5.6-1 through 5.6-8). Table 5.6-1 provides the variable list that supports this material. The following data will aid in interpreting Table 5.6-1.

### Code used for Variable Data Type

S:	scalar
V(n):	vector (dimension)
M(n):	square matrix (dimension)
INT:	integer
BIT:	bit
CHAR:	character
STR:	structure
ARR:	array

### Coordinate Frame Code And Definition

Body: (structural)	x: parallel to the longitudinal axis (positive aft)
	y: completes right-hand system
	z: perpendicular to the x-axis, positive upward
M50:	Mean of 50 reference coordinate system
RW: (runway coordinates)	x: down runway centerline in direction of landing
	y: completes right-hand system
	z: down, normal to ellipsoid
SCAN: (MLS scanner coordinates)	x: scanner boresight axis
	y: completes right-hand system
	z: up, normal to ellipsoid
TD: (topodetic coordinates)	x: north
	y: east
	z: down, normal to ellipsoid

Table 5.6-1. Variable List - User Parameter Processing				
Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
A2	S	0		Angle at HAC center from Shuttle to WP-1
A3	S	0		Angle at HAC center from WP-1 to entry point
A3_TOL	S	K-load		Tolerance for correcting the range of the angle A3
ACC_DRAG	S	0		Vehicle c.g. drag acceleration
ACC_LIFT	S	0		Vehicle c.g. lift acceleration
ACC_VERT	S	0		Vertical component of vehicle c.g. acceleration WRT earth rotating frame
ACC_VERT_OLD	S	0		Previous value of ACC_VERT
ALPHA_N	S	0		Nav-derived angle of attack (input)
ALPHA_NAVDAD	S	0		Nav-derived angle of attack (output to NAVAID SOP)
ALPHA_OLD	S	0	—	Copy of last cycles ALPHA_N
ALT	S	600,000		Current orbiter altitude above reference ellipsoid
ALT_EL	V	K-load		Altitude regions for Nav event lamp processing
ALT_RW	S	0		Altitude above reference ellipsoid of runway reference point
ALT_WHEELS	S	600,000		Altitude of orbiter nav base (entry) or rear wheels (TAEM A/L) above runway altitude
ANGLE_CORR_TNTOMAG_SL <sub>1</sub>	V	0		Magnetic variation at TACAN site (each LRU) output from site lookup, I=1,3
A_O	S	0	—	One minus earth eccentricity squared
AZIMUTH_RW	S	0	—	Bearing from true north of runway coordinate system +X-axis
BEAR_CC	S	0	—	Bearing at HAC center WRT true north
BEAR_VEH	S	0	—	Bearing from Shuttle to HAC center WRT true north
BEAR_VEH_WP1	S	0	—	Bearing to WP-1 WRT true north
BIAS_ELMLS	S	0	—	MSBLS elevation measurement bias (currently used to define slope of runway)
BIAS_RADALT	S	K-load	—	Radar altimeter bias
COSTH	S	0	—	Cosine of Shuttle's pitch Euler angle (body to TD)
COS_THET_VEH_CC	S	0	—	Cosine of range angle from Shuttle to HAC center
COS_THET_VEH_WP1	S	0	—	Cosine of range angle from Shuttle to WP-1
COURSE_WRT_RW	S	0	—	Vehicle velocity direction WRT runway centerline
D_ARC	S	0	—	Arc length around the HAC from WP-1 to EP
DEG_PER_RAD	S	Constant	—	Conversion factor from radians to degrees
DELAZ	S	0	—	Azimuth error (heading of relative velocity vector minus bearing to WP-1)
DELTA_ACC_VERT	S	0		Difference between the two most recent values of ACC_VERT excluding any navigation filter update value
DELTA_T	S	0	—	Time difference associated with the calculation of DELTA_ACC_VERT



Table 5.6-1. Variable List - User Parameter Processing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
DG_RADALT	BIT	Off		Radar altimeter data-good flag
DIST_VEH_WP1	S	0		Surface range from Shuttle to WP-1
DT_IMU	S	0		State vector AVERAGE_G integration time step
$\bar{D}V_S$	V	0	M50	IMU-sensed velocity change
$\bar{E}$ ARTH_POLE	V	0,0,1	M50	Unit vector in direction of earth's axis of rotation
EARTH_RADIUS_EQUATOR	S	Constant		Earth equatorial radius
ELLIPT	S	Constant		Earth ellipticity constant
EVENT_E11A	BIT	Off		Initiate powered flight navigation
EVENT_E15	BIT	Off	—	Mode transition MM 303 from 302 event flag
EVENT_E16	BIT	Off		Mode transition MM 304 from 303 event flag
EVENT_E21	BIT	Off		Mode transition MM 305 from 304 event flag
FILT_UPDATE	BIT	Off	—	Switch indicating (ON) that the current navigation cycle is completed
FIRST_PASS	BIT	Off	—	Area Nav HAC indicator initialization flag
FLATCON	S	0	—	Earth eccentricity squared
FLT_PATH_ANG	S	0	—	Angle between navigation base relative velocity vector and ellipsoid horizontal
$\bar{G}$ _OLD	V	0	M50	Copy of $\bar{G}$ _RESET for use by user parameter propagator
$\bar{G}$ _RESET	V	0	M50	Gravity acceleration vector for user parameter state integration
H_DOT_ELLIPSOID	S	0	—	Estimated topodetic altitude rate
H_DOT_LAST	S	0	—	Previous value of H_DOT_ELLIPSOID
I	INT	0	—	Integer subscript
IPHASE	INT	0	—	Flag denoting various phases of TAEM guidance
$\bar{I}$ MU_SFC	V	0,0,0	—	IMU selection filter control vector
$\bar{I}$ MU_SFC_PREV	V	1,1,1	—	Previous value of IMU selection filter control vector
LD_GR_HYDR	BIT	Off	—	Flag which instructs MSC to initiate the LDN GEAR VLV CNTL principal function
LDGR_VEL_THRSH	S	Constant	—	Threshold value of the relative velocity below which the flag LD_GR_HYDR is set ON
LOAD_TOTAL	S	0	—	Total load factor
LOD	S	0	—	Vehicle lift over drag ratio
M	S		—	Current vehicle mass
M_EFTORW	M	0	—	Earth-fixed-to-prime RW transformation matrix
M_EFTOTD_RW	M	0	—	Transformation matrix from earth-fixed to topodetic coordinates at the runway threshold
M_EFTOTD_TACAN_SL <sub>I</sub>	M	0	—	Transformation matrix from earth-fixed to topodetic coordinates at TACAN site (each LRU) output from site lookup, I=1,3
MEDS_DELAZ	S	0	—	MEDS heading error
MLS_AVAIL	BIT	Off	—	MLS availability

Table 5.6-1. Variable List - User Parameter Processing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
MM_CODE_305	BIT	Off	—	Major Mode 305 flag
M_TEMP_TXPOS	M	0	—	Transpose of earth-fixed-to-M50 transformation matrix
NAUTMI_PER_FT	S	Constant	—	Feet to nautical miles
N_SEQ_MAX	I	K-load	—	Number of sequential failures of the Nav event lamp test criteria allowed before activating the Nav event lamp (EVENT_LAMP_FIVE)
N_SEQ_RA	I	1	—	Sequential counter for radar altimeter validity indicator
OHALRT	BIT	Off	—	Flag denoting TAEM guidance request to downmode
OPS_3_INITIALIZE_COMPLETE	BIT	Off	—	Signal indicating initialization of state parameters by Nav sequencer
OVHD	BIT	On	—	A flag denoting overhead or straight-in approach
P	S	0	—	Sign of runway Y-component of the Shuttle
PI	S	Constant	—	The constant PI
POSITION_WRT_RUNWAY	V	0	RW	Vehicle c.g. position vector WRT runway reference point ( $\bar{R}_{LS\_EF}$ )
PSHA	S	0	—	Turn angle of HAC of selected runway
PSHARS	S	I-load	—	Initial value of HAC turn angle
PSI	S	0	—	Earth relative velocity heading
Q_B_I	STR S,V	0	—	M50 to body quaternion
Q_RADALT	S	0	—	Radar altitude measurement
R1	S	I-load	—	Linear term in spiral radius equation
R2	S	I-load	—	Quadratic term in spiral radius equation
RADALT_ANG	S	K-load	—	Angle between body X-axis and vector from c.g. to radar altimeter
RADALT_NB_DIST	S	K-load	—	Navigation base to RA antenna distance
RADIUS_NEP	S	0	—	Radius of nominal HAC (local variable)
RAD_P	S	0	—	Radius of the earth at the geocentric angle of the Shuttle position vector
RAD_PER_DEG	S	Constant	—	Conversion factor from degrees to radians
RA_FLAG	BIT	Off	—	Radar altimeter validity indicator for event lamp processing
RAMP	S	0	—	Variable used in autoland phase for transition from horizontal to sloping runway coordinates
RA_TIME	S	0	—	Time at which radar altimeter measurement was read
$\bar{R}_{AVGG}$	V	—	M50	Current Shuttle position vector
$\bar{R}_{CC\_EF}$	V	0	EF	Position vector of HAC in earth-fixed coordinates
R_CC_MAG	S	0	—	Earth radius at HAC center for primary runway
RAW_RA_PROC	BIT	Off	—	Radar altimeter processing flag
$\bar{R}_{EF}$	V	0	EF	Shuttle position vector in earth-fixed coordinates
REL_VEL_MAG	S	0	—	Magnitude of vehicle relative velocity
RESELVE	S	I-load	—	Overhead correction termination velocity

Table 5.6-1. Variable List - User Parameter Processing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{R}_{EST}$	V	0	EF	Difference between Shuttle position and TACAN site location in earth-fixed coordinates (TACAN range in earth-fixed coordinates)
RFO	S	I-load	—	Constant term in spiral radius equation
R_GO_RAMP	S	I-load	RW	Preset value of horizontal distance of vehicle from RW reference point below which radar altimeter measurements will be incorporated in UPP vertical position WRT runway
$\bar{R}_{HAC\_RW}$	V	0	RW	Position vector of HAC center in runway coordinates
RI	S	K-load	—	Initial value of spiral radius
$\bar{R}_{LS\_EF}$	V	0	EF	Position vector of runway in earth-fixed coordinates
R_NEP	S	0	—	Radius of HAC of selected runway
RNG_TO_RW_THRESH	S	0	—	Surface range from Shuttle to RW threshold via WP-1
$\bar{R}_{RESET}$	V	0	M50	Vehicle position vector after all navigation updates reserved for reset of user parameter integrator position vector $\bar{R}_{AVGG}$
$\bar{R}_{TACAN\_EF\_SL_I}$	V	0	EF	Earth-fixed position vector to TACAN station (each LRU) output from site lookup, I=1,3
$\bar{R}_{TEMP}$	V	0	TD	Position vector to the Shuttle from the selected TACAN in topodetic coordinates at TACAN site
R_VEH_MAG	S	0	—	Magnitude of $\bar{R}_{AVGG}$
R_VEH_MAG_UPP	S	0	—	Magnitude of $\bar{R}_{AVGG}$
RW_ID_UPP	S	0	—	Current primary landing site selection symbol
RW_NAME	S	0	—	Current primary landing site selection symbol
SIGNY	INT	0	—	Vehicle side of selected runway centerline
SIN_B	S	0	—	Sine of earth-centered angle subtended by the radius of the HAC
SIN_BEAR_CORR	S	0	—	Sine of the angle which corrects the Shuttle heading from the center of HAC to WP-1
SINTH	S	0	—	Sine of Shuttle's pitch Euler angle (body to TD)
SIN_THET_VEH_CC	S	0	—	Sine of range from Shuttle to center of HAC
START_POSITION	S	I-Load	RW	X-runway position where conversion from horizontal sloping runway coordinates begins
STOP_POSITION	S	I-Load	RW	X-runway position where conversion from horizontal to sloping runway coordinates is completed
TACAN_CHAN_VALID_SL_I	BIT	Off	—	Switch indicating (ON) a valid TACAN channel has been selected (site lookup output)
TAC_AZ_I	S	0	—	TACAN azimuth for display in the ABS_MODE or delta azimuth in the DELTA_MODE
TACBEAR_OI	S	0	—	TACAN bearing data obtained from the SOP for each receiver, I=1,3
TAC_MODE	BIT	ON	—	Switch indicating "ON" when ABS_MODE is selected for HSD DISP and "OFF" when DELTA_MODE is selected

Table 5.6-1. Variable List - User Parameter Processing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
TAC_MODE_DISP	BIT	On	—	Switch for the HSD display indicating “ON” when ABS_MODE is selected and “OFF” when DELTA_MODE is selected
TACRANGE <sub>I</sub>	S	0	—	TACAN range data obtained from the SOP for each receiver, I=1,3
TAC_RNG <sub>I</sub>	S	0	—	TACAN range for display in the ABS_MODE or delta range when in the DELTA_MODE
$\bar{T}CG$	V	0	M50	Total acceleration of Shuttle
TEMP	S	0	—	Internal variable used in computation of topodetic unit vector ( $\bar{H}_{HDOT\_ACCVERT}$ ); azimuth difference for each TACAN (TACAN_DISP_COMPS); internal variable used in transformation from horizontal to sloping runway coordinates (GUIDECOMP)
TEST_LD_GR	BIT	On	—	Internal single pass flag
TG_END	BIT	Off	—	TAEM guidance termination flag
THETA	S	0	—	Euler angle from TD to body frame (pitch)
TIME_BIAS_RADALT	S	K-load	—	Pad-loaded bias used to correct radar altimeter time tag
T_IMU	S	0	—	Time associated with currently read IMU velocity counts from the IMU detection filter (RM)
TOGHAC	BIT	Off	—	Flag denoting crew request to change approach type (OVHD/STRT)
T_RADALT	S	0	—	Time at which radar altimeter measurement was read (biased)
T_RESET	S	0	—	Time associated with reserved reset state
T_SEC_GMT	S	0	—	Time tag associated with earth-fixed state vectors
T_STATE	S	0	—	Time tag for current user parameter state vector
T_STATE_LAST	S	0	—	Value of T_STATE at previous pass through user parameter processing
T_STATE_OLD	S	0	—	Previous value of T_STATE for case when UPP has not been updated by Nav
T_STATE_PREV	S	0	—	Previous value of T_STATE, corresponding to time tag for V_IMU_PREV
UK	S	0	—	Vector dot product of $\bar{V}_{NOR}$ and EARTH_POLE
UPP_UPDATE	BIT	Off	—	Flag indicating UPP state has been updated by navigation filter
$\bar{U}X$	V	0	M50	X-vector component of the +Z topodetic unit vector in topocentric coordinates
$\bar{V}_{AVGG}$	V	—	M50	Current Shuttle velocity vector
$\bar{V}ELOCITY\_WRT\_RUNWAY$	V	0	RW	Vehicle velocity vector WRT runway reference point ( $\bar{R}_{LS\_EF}$ )
V_GROUNDSPEED	S	0	—	Vehicle c.g. groundspeed WRT runway (A/L), reference ellipsoid (TAEM, entry)
$\bar{V}_{IMU\_CURRENT}$	V	0	M50	Current selected accumulated IMU velocity
$\bar{V}_{IMU\_OLD}$	V	0	M50	Current accumulated IMU velocity

Table 5.6-1. Variable List - User Parameter Processing

Variable Name	Data Type	Initial Value	Coord Frame	Variable Description
$\bar{V}$ _IMU_PREV	V	0	—	Previous value of IMU-measured velocities
$\bar{V}$ _IMU_RESET	V	0	M50	Copy of V_CURRENT_FILT reserved as velocity count at start of extrapolation interval when user parameter integrator is reset
V_MAG	S	0	—	Vehicle inertial speed
$\bar{V}$ NOR	V	0	M50	Unit vector colinear with the Shuttle position vector and directed in the opposite sense
$\bar{V}$ _NORM	V	0	EF	Vector normal to the great circle plane containing the Shuttle and the HAC center
$\bar{V}$ _RESET	V	0	M50	Vehicle velocity vector after all navigation updates reserved for reset of user parameter integrator velocity vector V_AVGG
$\bar{V}$ _RHO	V	0	M50	Vehicle relative velocity vector
$\bar{V}$ _RHO_EF	V	0	EF	Earth relative velocity in earth-fixed coordinates
$\bar{W}$ BR	V	0	Body	IMU-derived body rate in degrees/second
WT_GS1	S	I-load	—	Mass threshold value for determining HAC X position
X_HAC_LOW_MASS	S	I-Load	—	X-component of the nominal entry HAC in RW coordinates for low mass vehicle
X_HAC_HIGH_MASS	S	I-load	—	X-component of the nominal entry HAC in RW coordinates for high mass vehicle
X_NB_CG	S	K-load	Body	X_STRUCT_BODY distance from navigation base to c.g.
X_NB_WH	S	Constant	—	Z_STRUCT_BODY distance from navigation base to rear wheels
$\bar{Y}$ _BD_UNIT	V	0	M50	Second column of matrix M_BODYM50 expressing a unit vector in direction of +Y body axis
YSGNP	INT	0	—	Commanded HAC side of selected runway
Z_NB_CG	S	K-load	Body	Z_STRUCT_BODY distance from c. g. to navigation base
Z_NB_WH	S	constant	—	Z_STRUCT_BODY distance from rear wheels to navigation base

DEORB\_LAND\_UPP\_SEQ

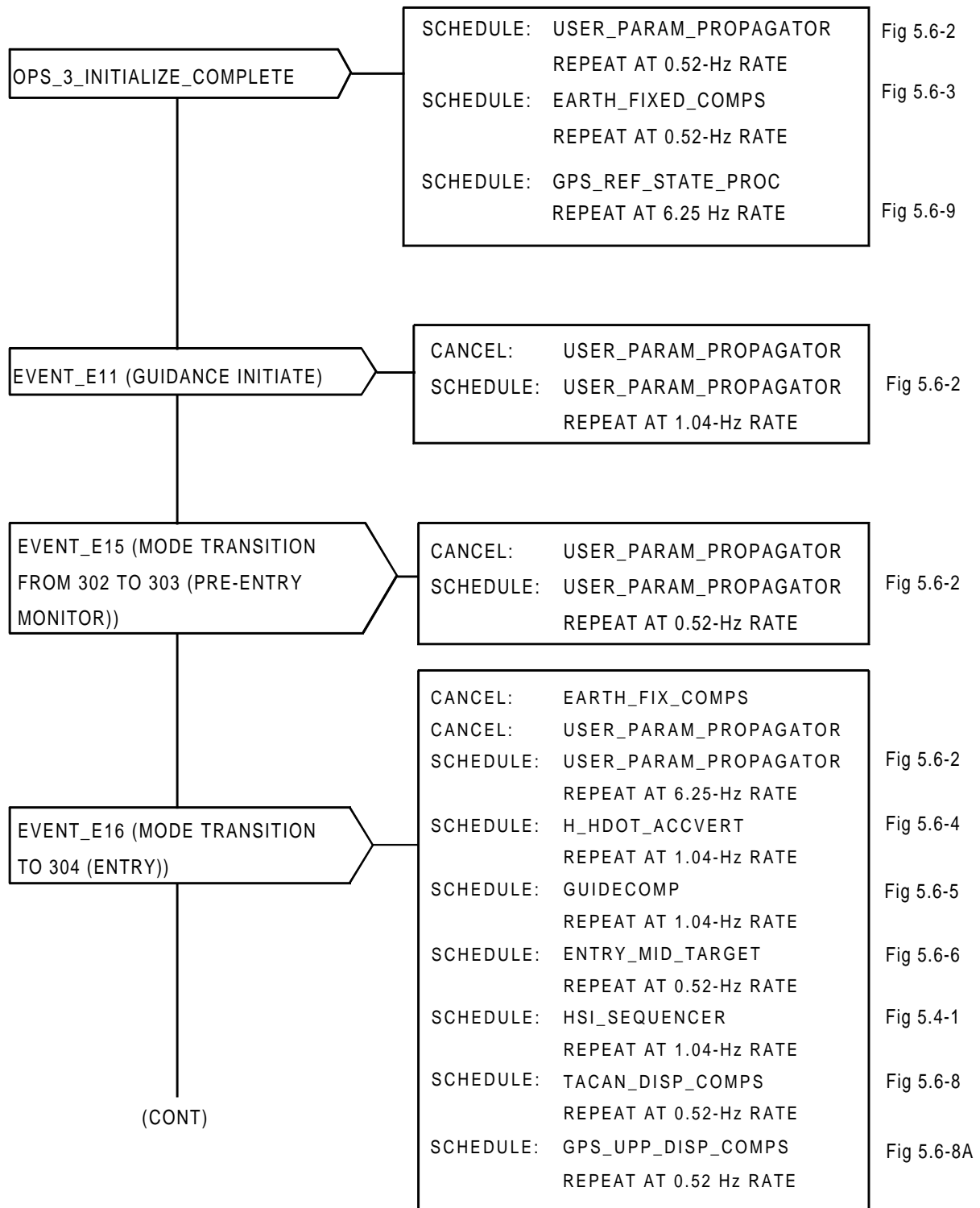


FIGURE 5.6-1.(1) DEORB\_LAND\_UPP\_SEQ (Sheet 1 of 2)

DEORB\_LAND\_UPP\_SEQ (CONCLUDED)

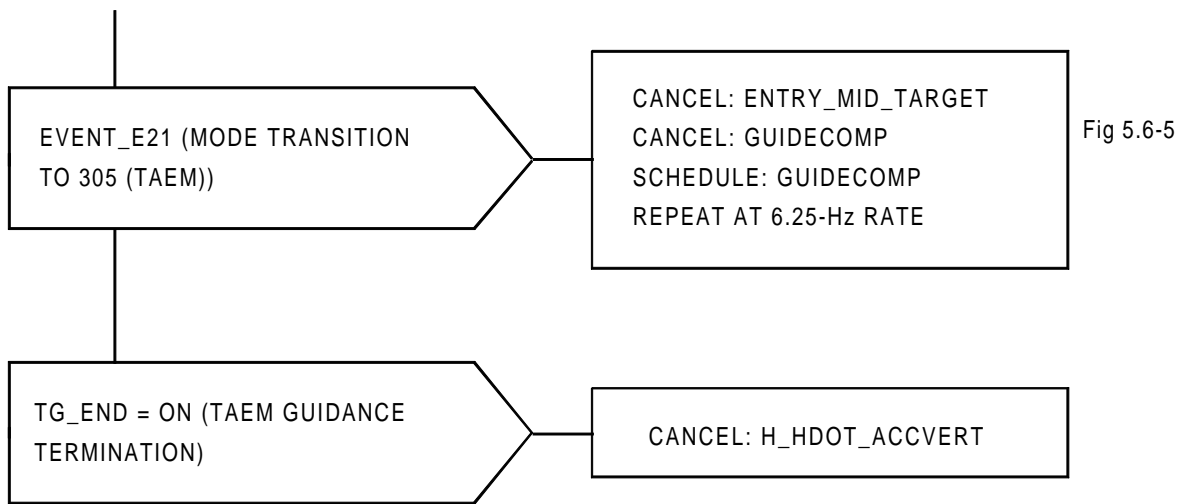


FIGURE 5.6-1.(2) DEORB\_LAND\_UPP\_SEQ (Sheet 2 of 2)

USER\_PARAM\_PROPAGATOR

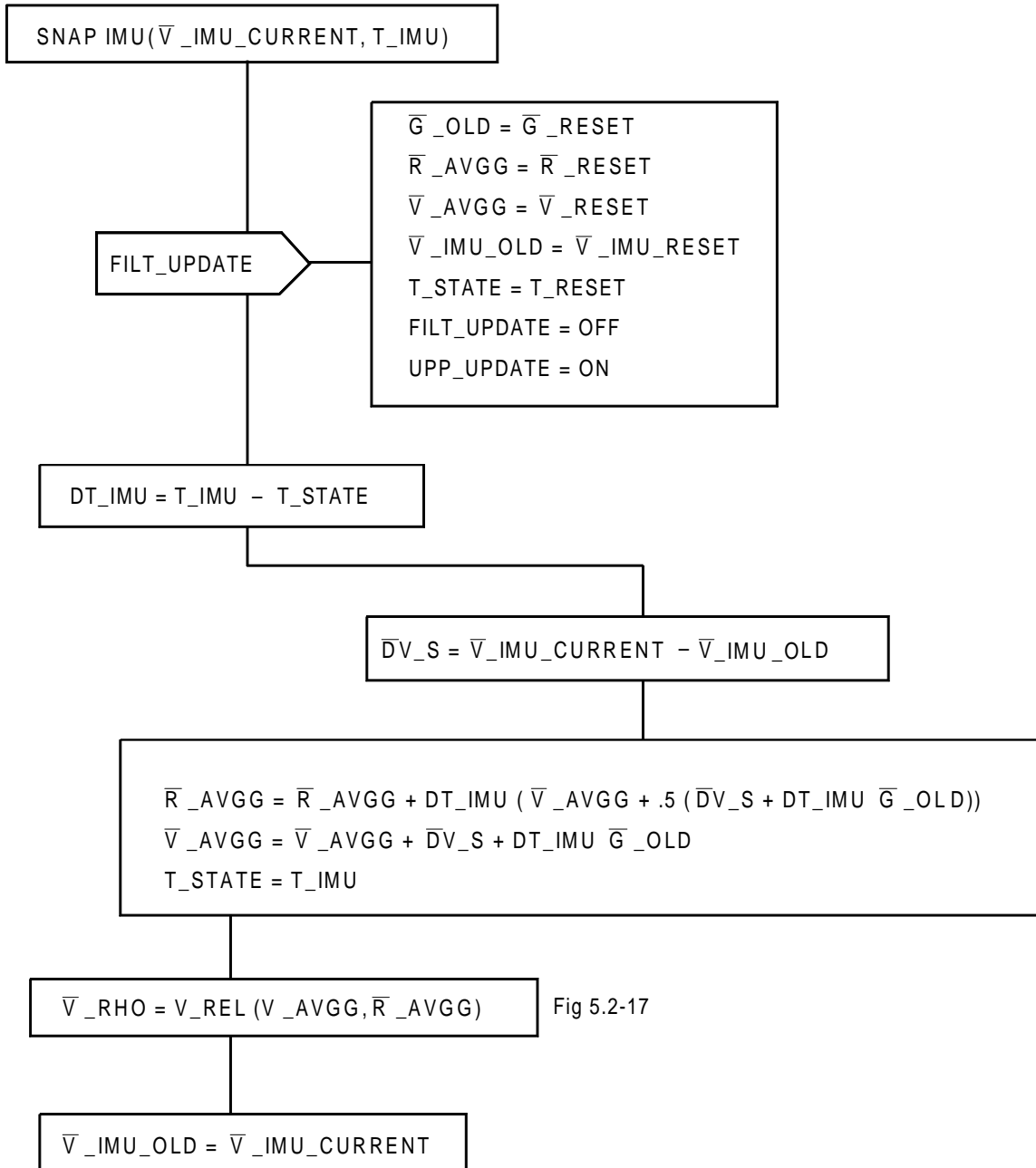


FIGURE 5.6-2. USER\_PARAM\_PROPAGATOR



EARTH\_FIXED\_COMPS

$M\_TEMP\_TXPOS = (EARTH\_FIXED\_TO\_M50\_COORD(T\_STATE))^T$ $\bar{R}\_EF = M\_TEMP\_TXPOS \bar{R}\_AVGG$ $\bar{V}\_RHO\_EF = M\_TEMP\_TXPOS \bar{V}\_RHO$ $T\_SEC\_GMT = T\_STATE$
--

Fig 5.3-14

FIGURE 5.6-3. EARTH\_FIXED\_COMPS

H\_HDOT\_ACCVERT

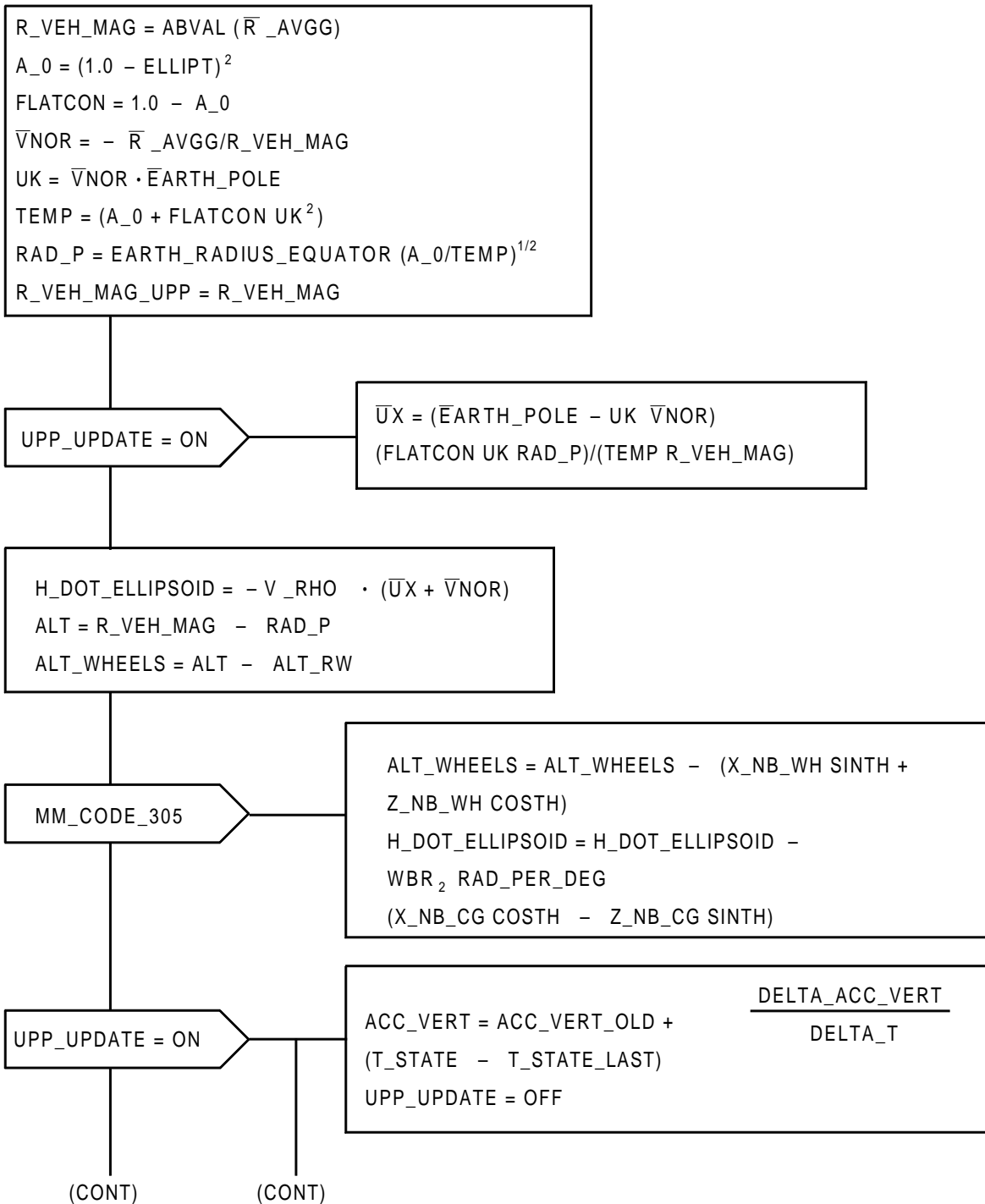


FIGURE 5.6-4.(1) H\_HDOT\_ACCVERT (Sheet 1 of 2)

H\_HDOT\_ACCVERT (CONTINUED)

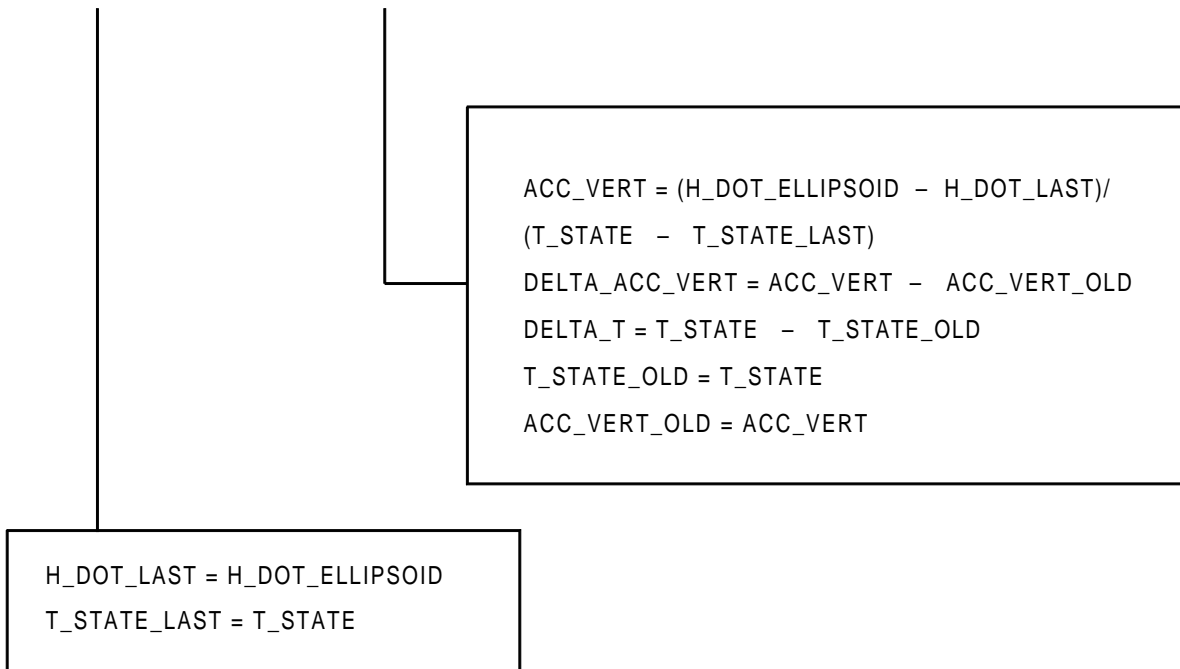


FIGURE 5.6-4.(2) H\_HDOT\_ACCVERT (Sheet 2 of 2)

GUIDECOMP

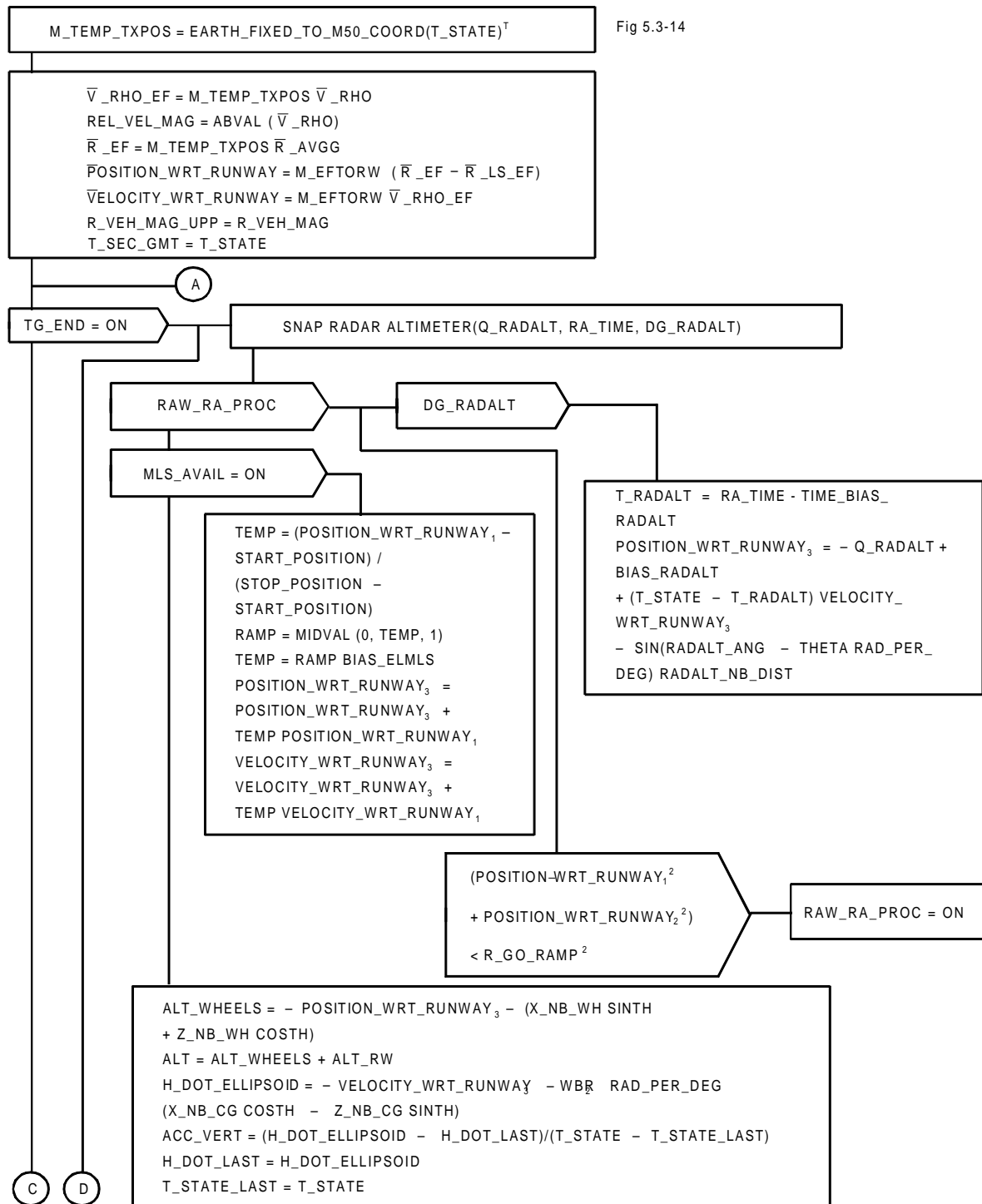


FIGURE 5.6-5.(1) GUIDECOMP (Sheet 1 of 5)

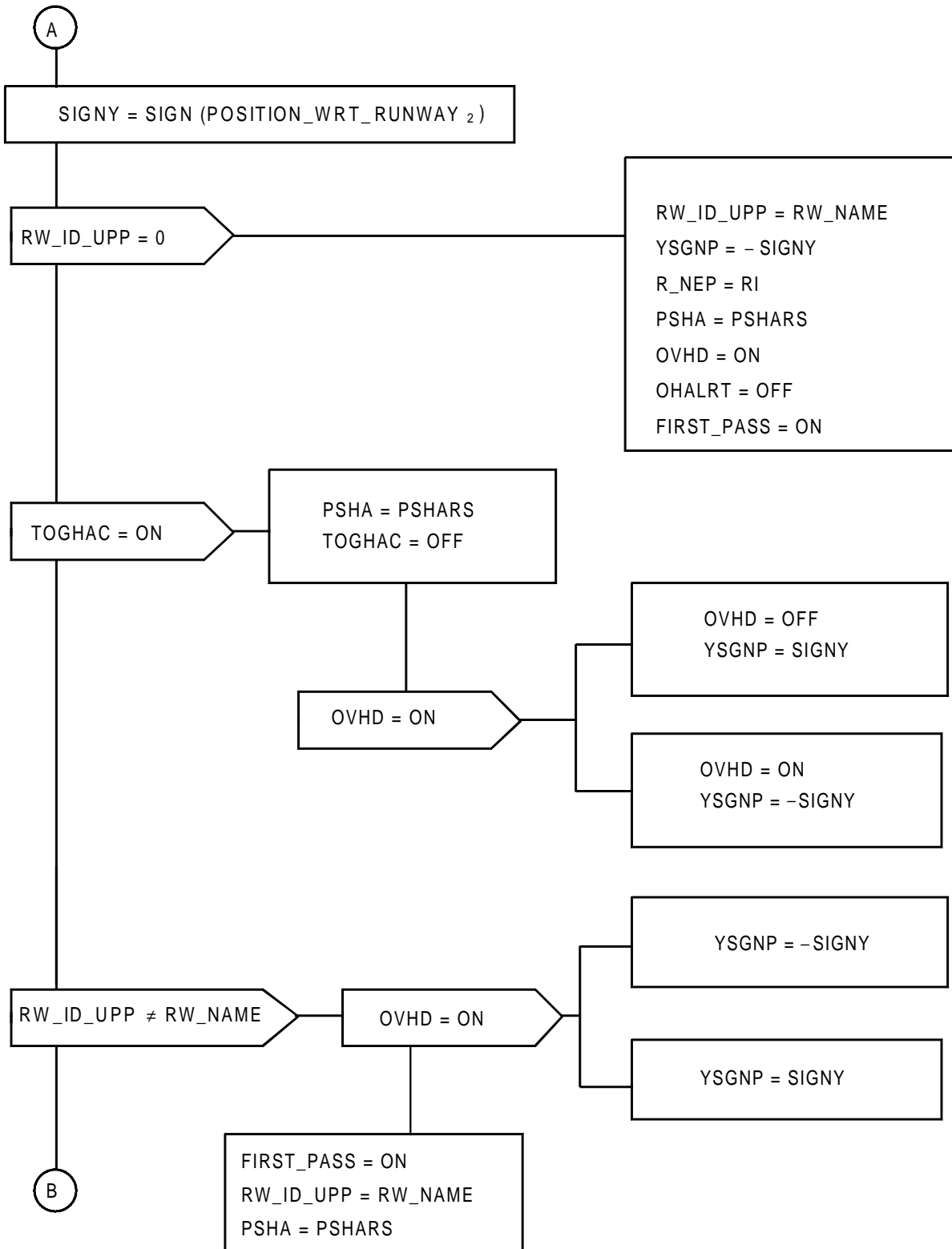


FIGURE 5.6-5.(2) GUIDECOMP (Sheet 2 of 5)

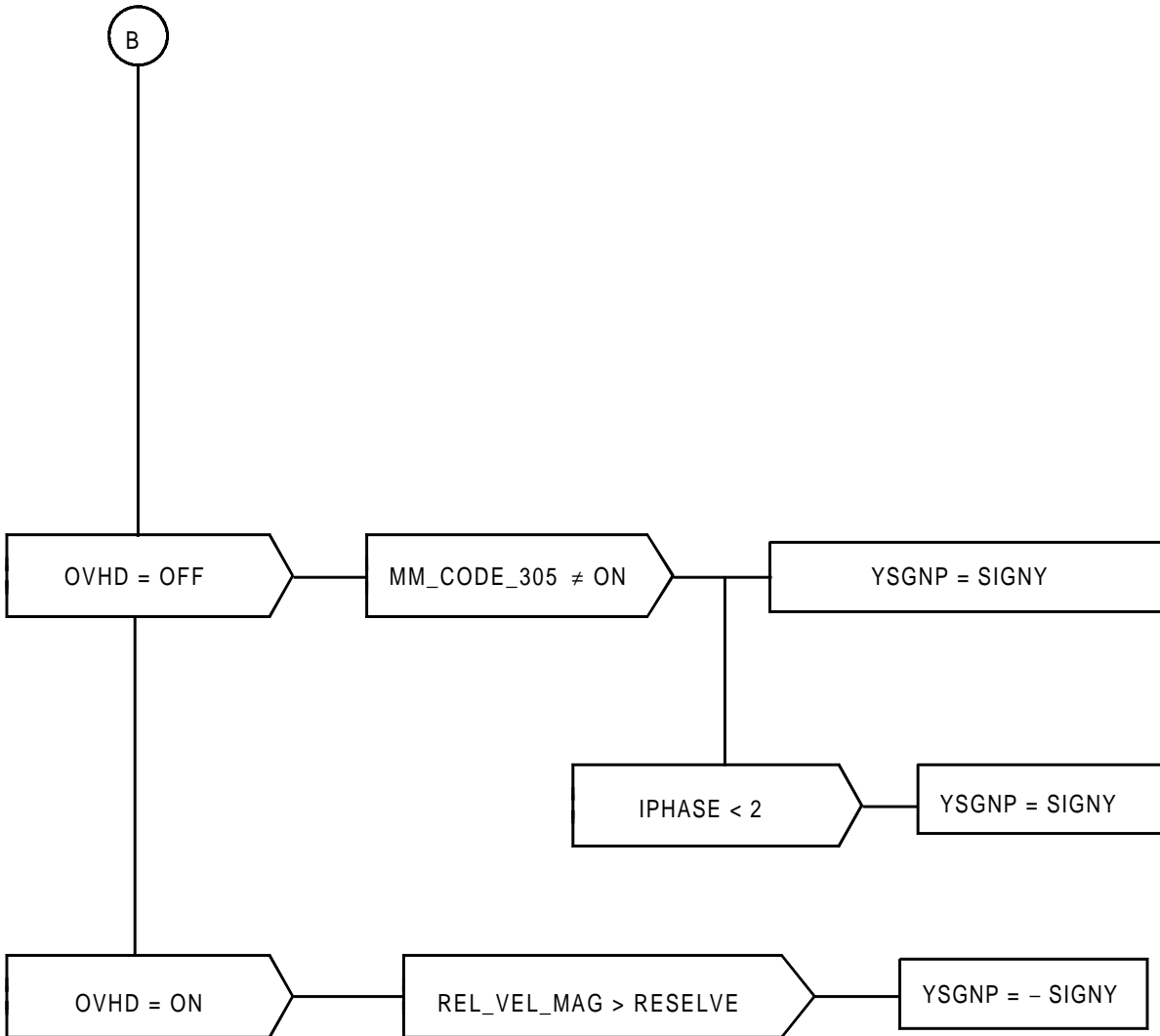


FIGURE 5.6-5.(3) GUIDECOMP (Sheet 3 of 5)

GUIDECOMP (CONTINUED)

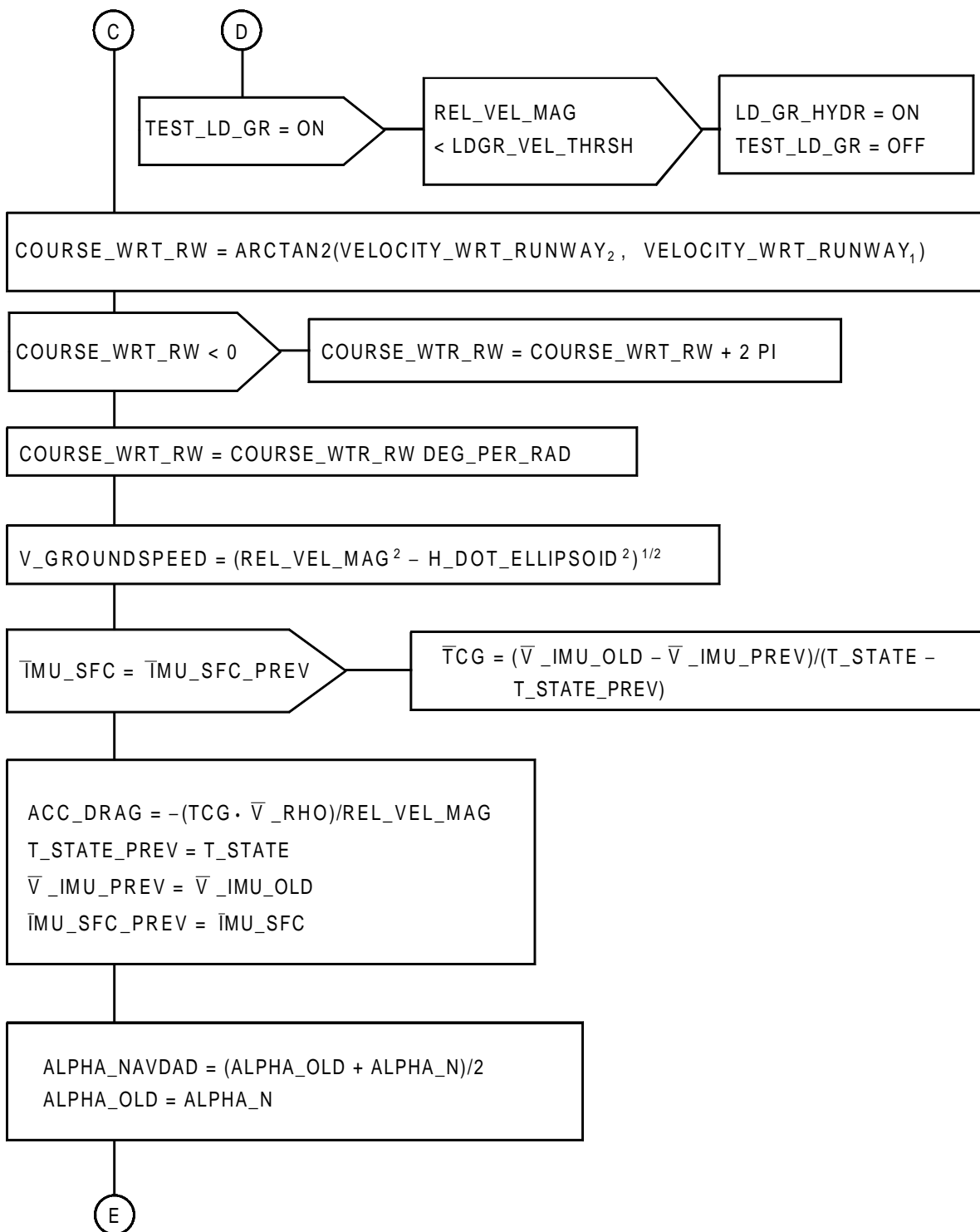


FIGURE 5.6-5.(4) GUIDECOMP (Sheet 4 of 5)

GUIDECOMP (CONTINUED)

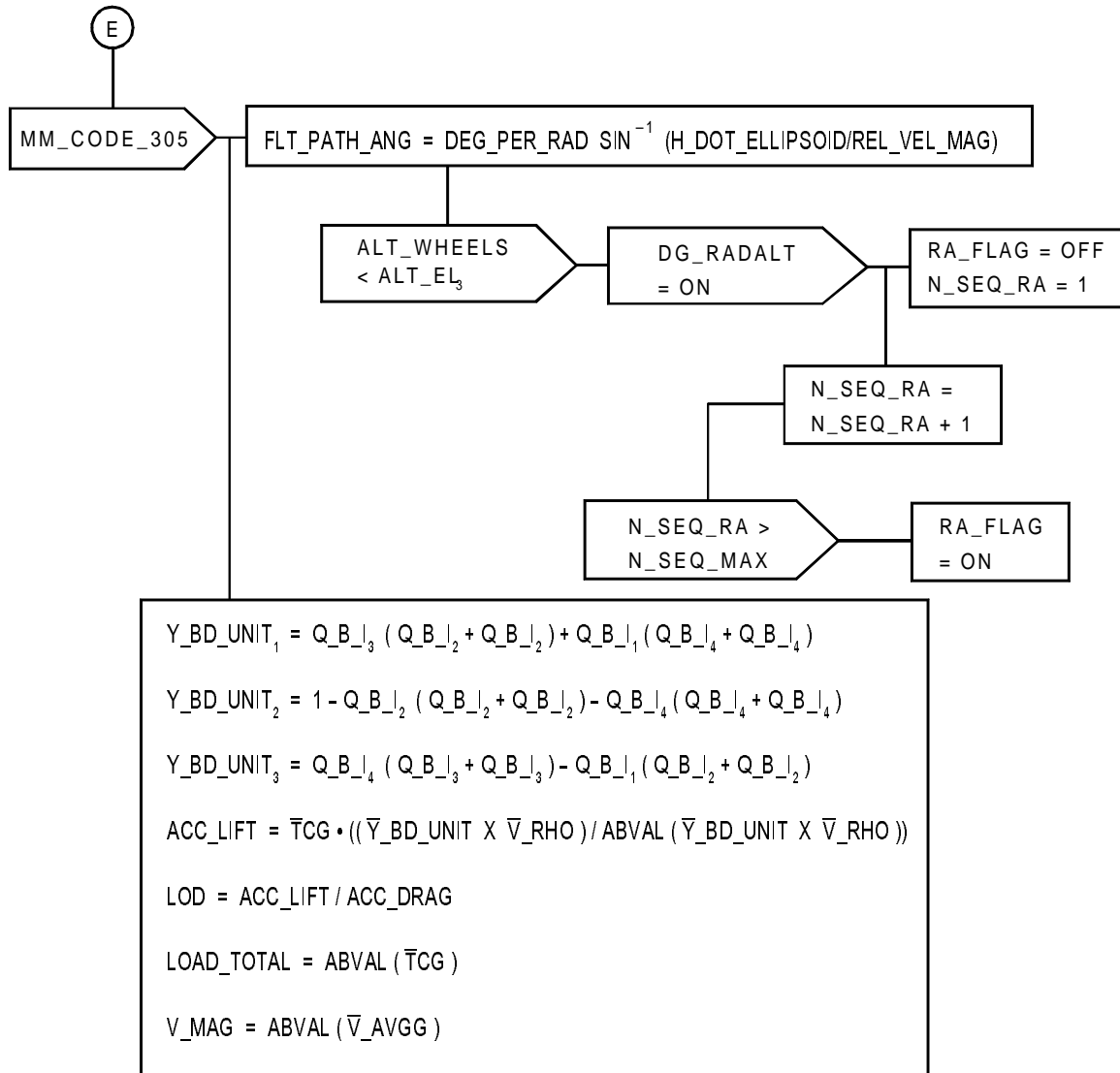


FIGURE 5.6-5.(5) GUIDECOMP (Sheet 5 of 5)



ENTRY\_MID\_TARGET

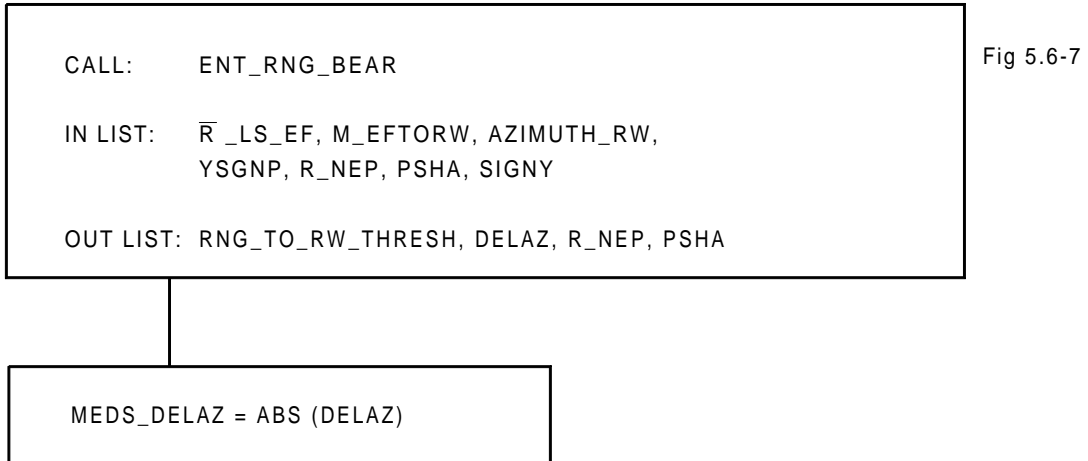


FIGURE 5.6-6. ENTRY\_MID\_TARGET

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ENT\_RNG\_BEAR

IN LIST :  $\bar{R}_{LS\_EF}$ , M\_EFTORW, AZIMUTH\_RW, P, RADIUS\_NEP, PSHA, SIGNY

OUT LIST : RNG\_TO\_RW\_THRESH, DELAZ, RADIUS\_NEP, PSHA

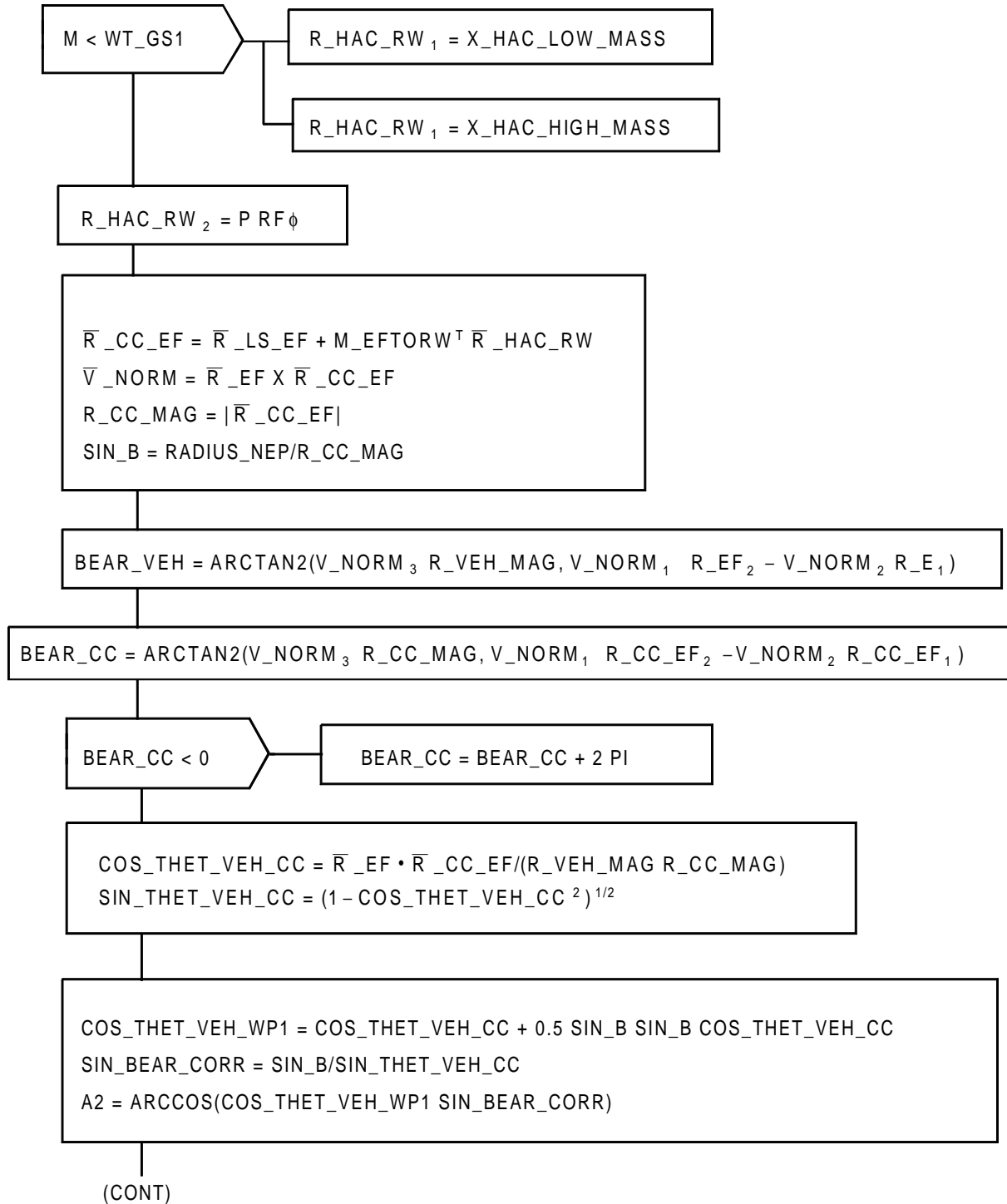


FIGURE 5.6-7.(1) ENT\_RNG\_BEAR (Sheet 1 of 2)

ENT\_RNG\_BEAR (CONT)

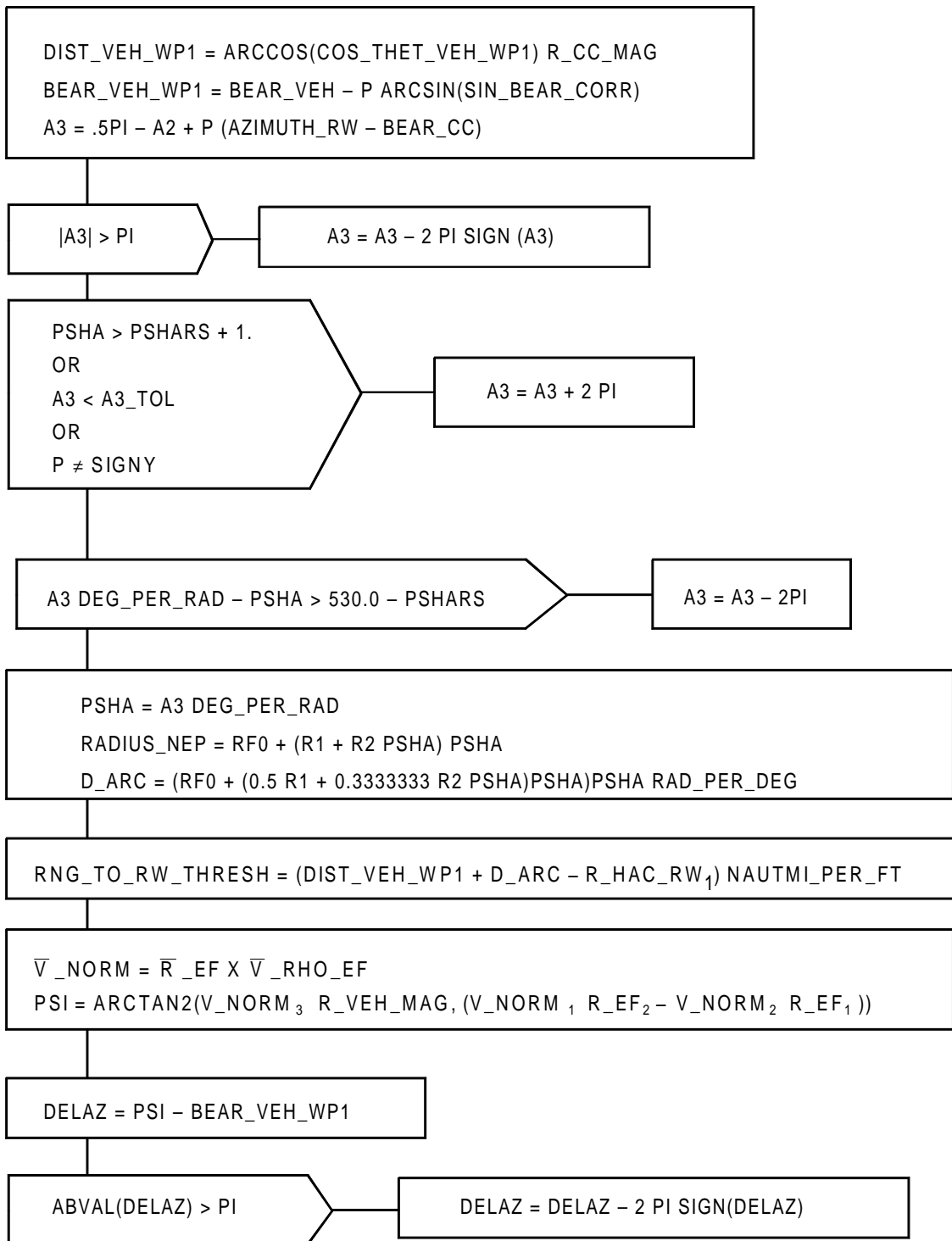


FIGURE 5.6-7.(2) ENT\_RNG\_BEAR (Sheet 2 of 2)

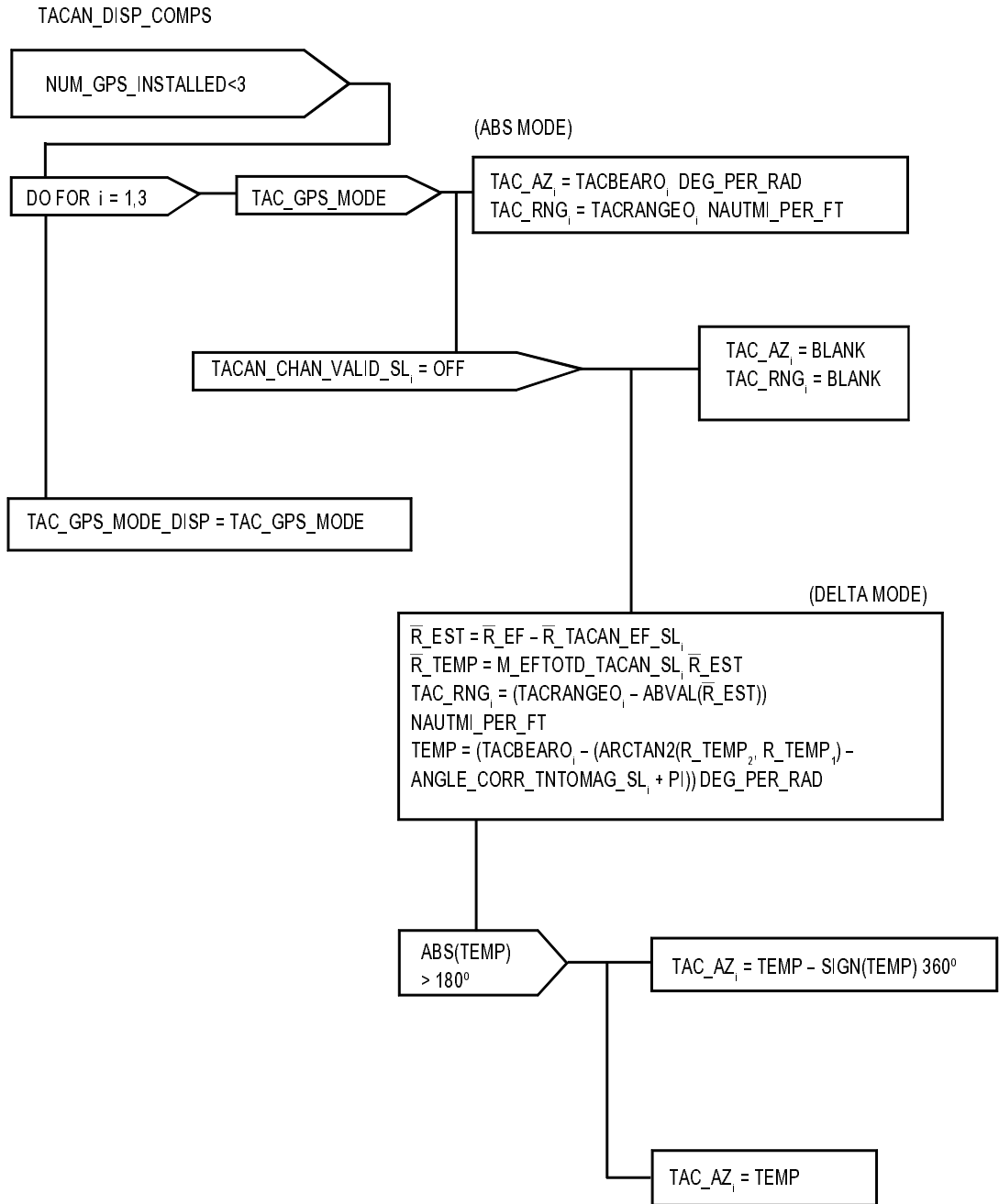


FIGURE 5.6-8. TACAN\_DISP\_COMPS

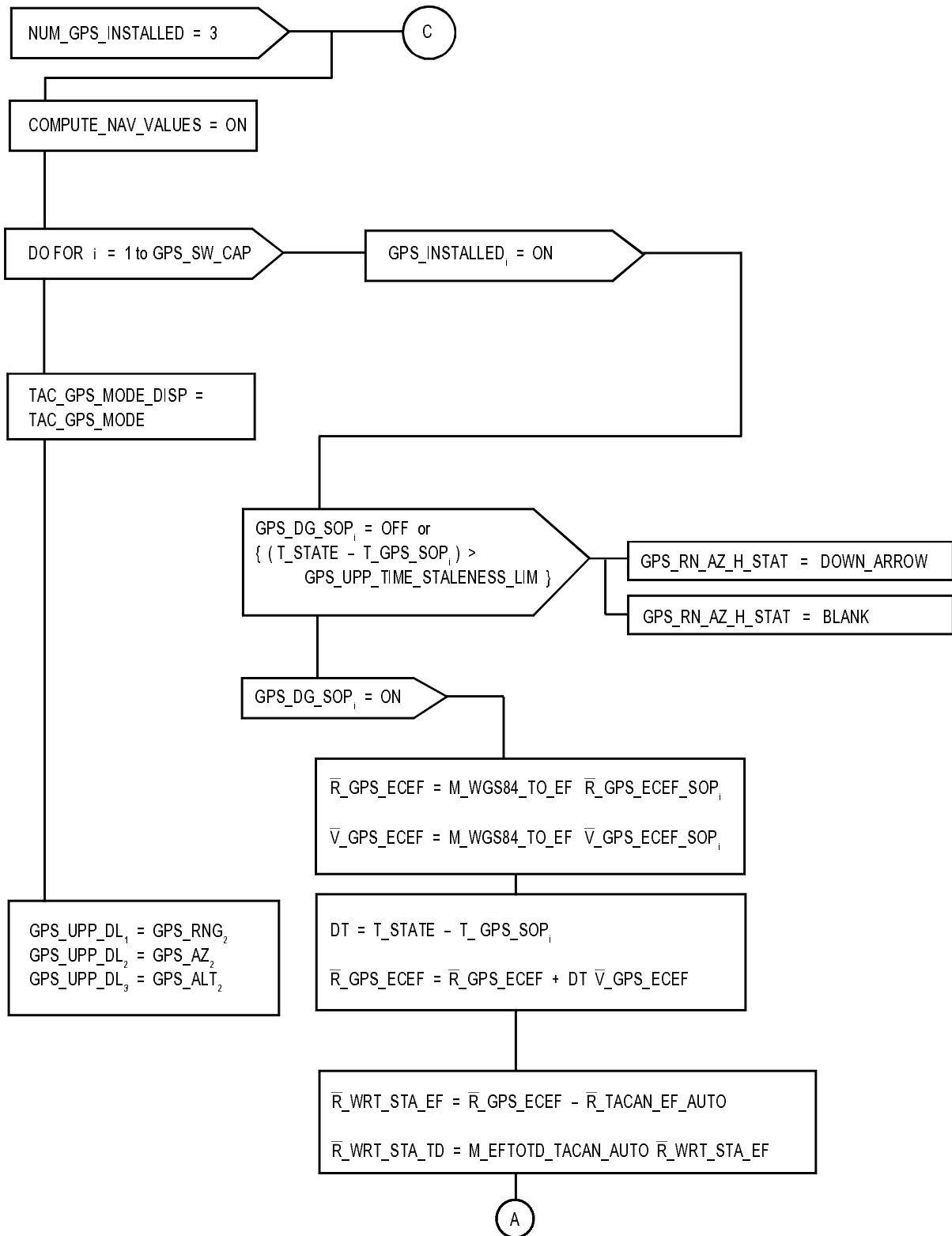


FIGURE 5.6-8A.(1) GPS\_UPP\_DISP\_COMPS (Sheet 1 of 6)

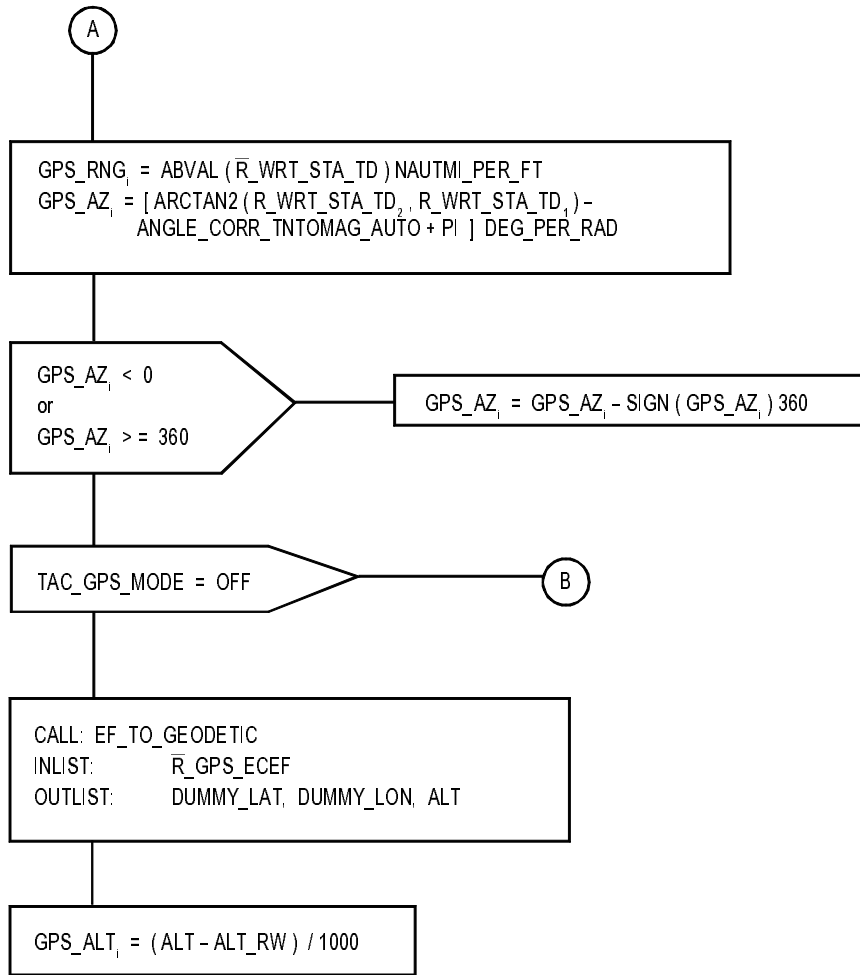


FIGURE 5.6-8A.(2) GPS\_UPP\_DISP\_COMPS (Sheet 2 of 6)

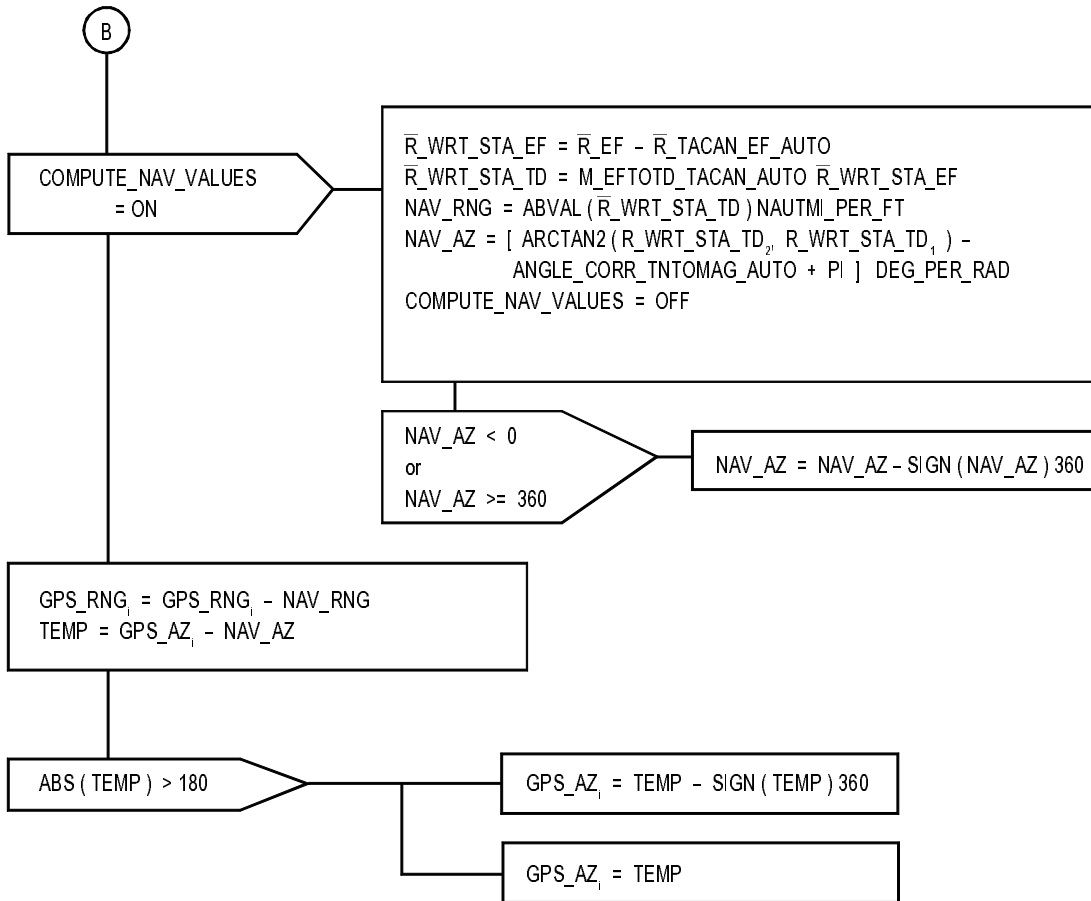


FIGURE 5.6-8A.(3) GPS\_UPP\_DISP\_COMPS (Sheet 3 of 6)

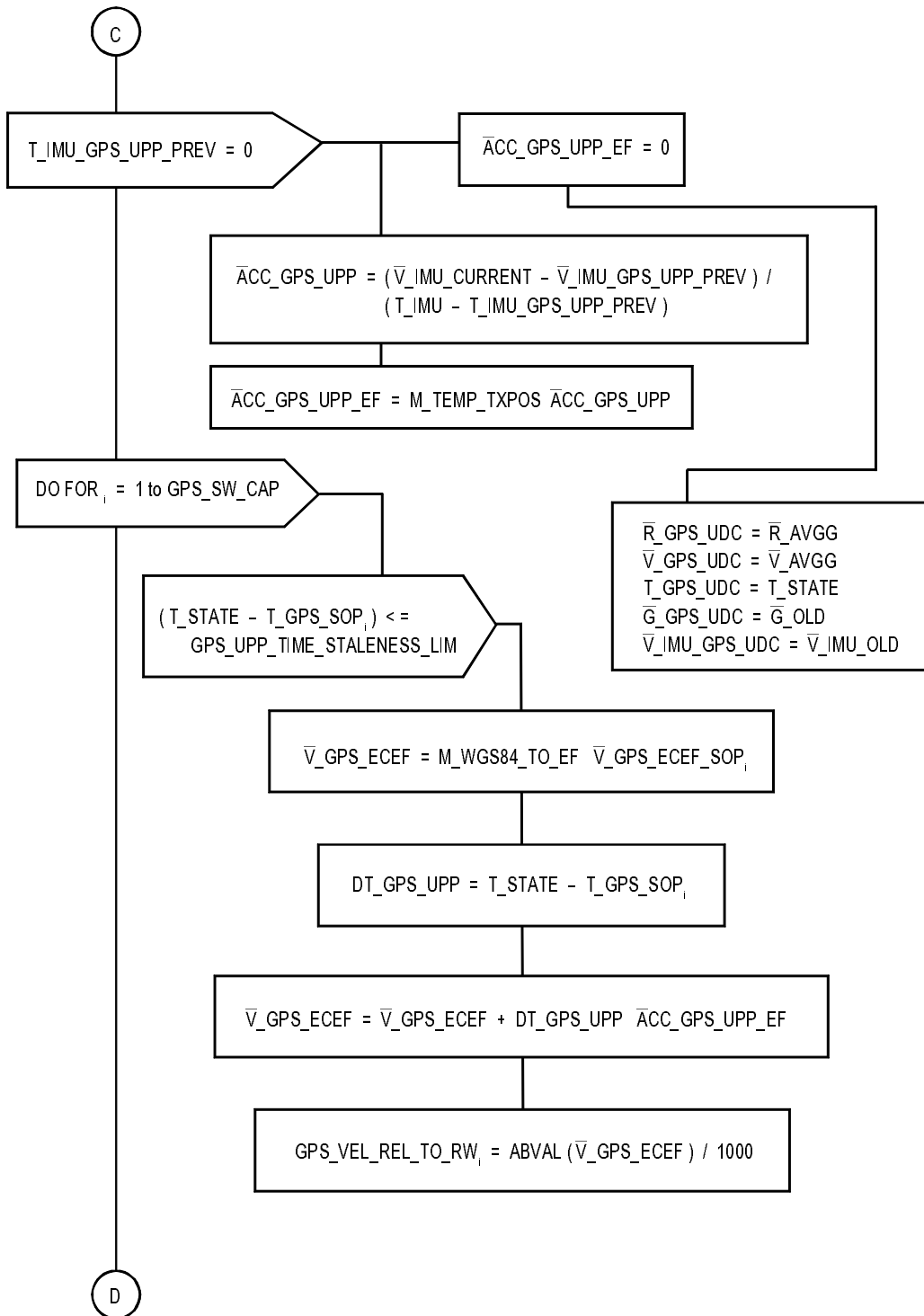


FIGURE 5.6-8A.(4) GPS\_UPP\_DISP\_COMPS (Sheet 4 of 6)



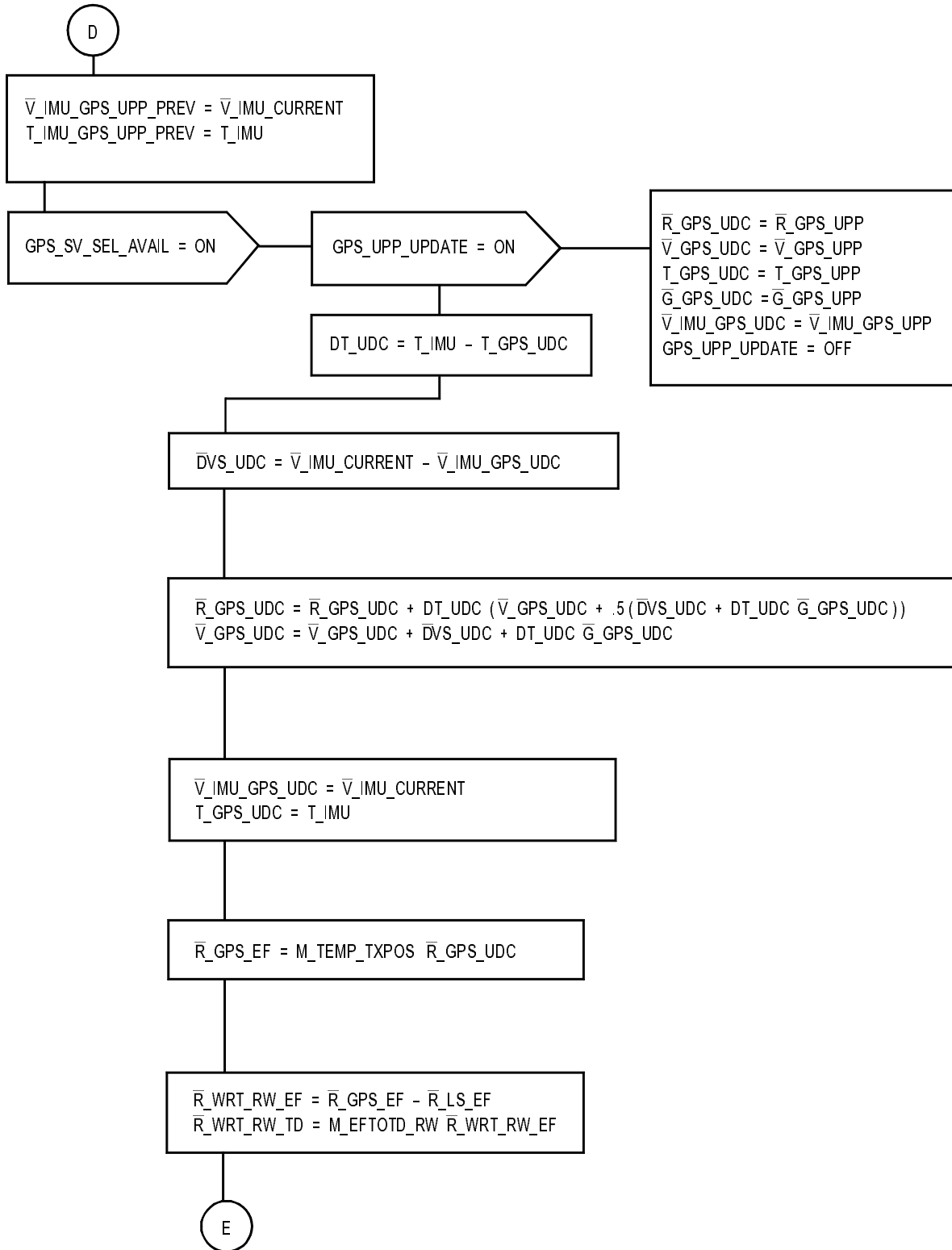


FIGURE 5.6-8A.(5) GPS\_UPP\_DISP\_COMPS (Sheet 5 of 6)

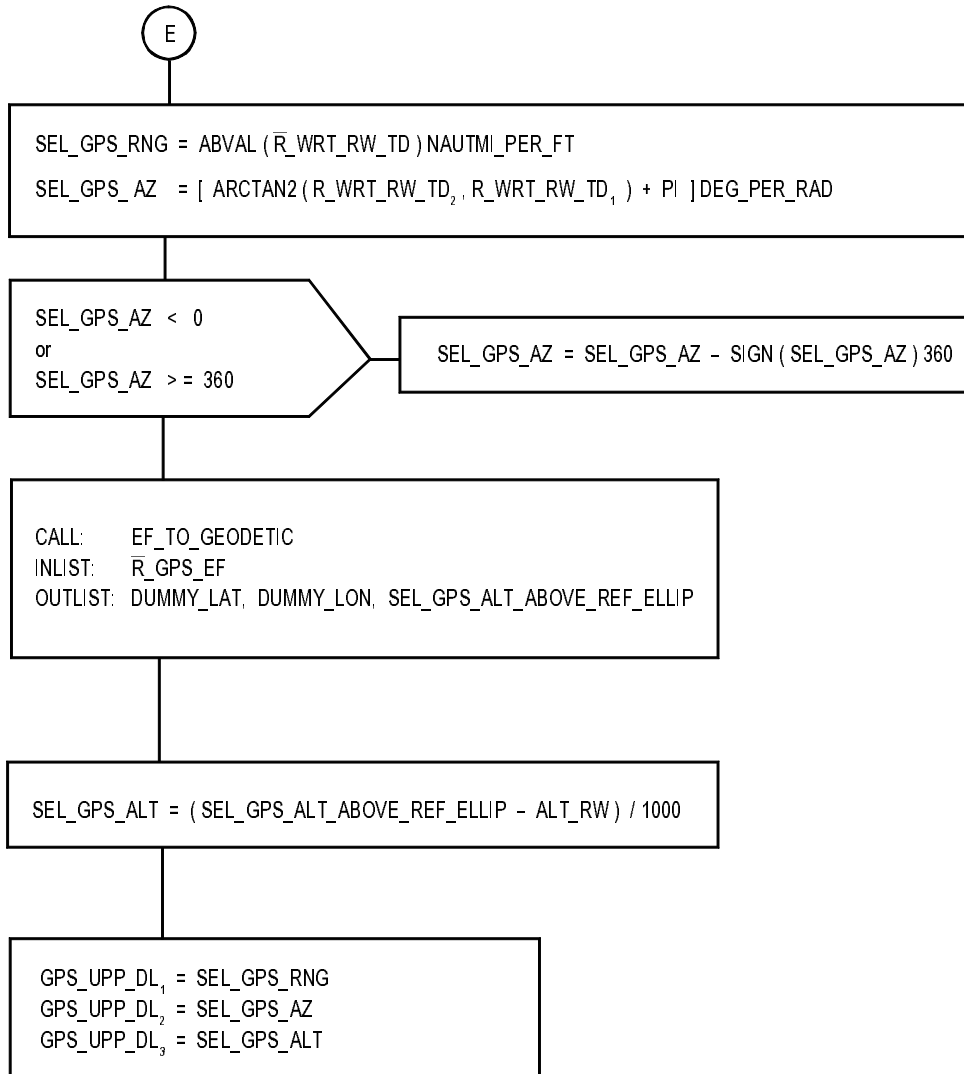


FIGURE 5.6-8A.(6) GPS\_UPP\_DISP\_COMPS (Sheet 6 of 6)

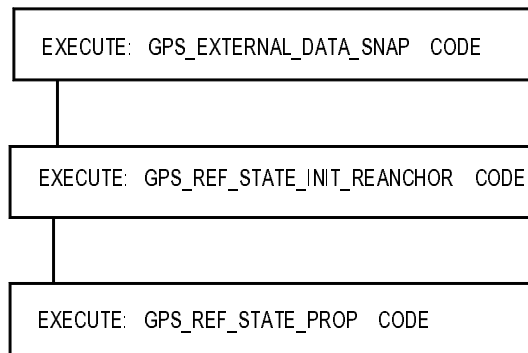


FIGURE 5.6-9. GPS\_REF\_STATE\_PROC

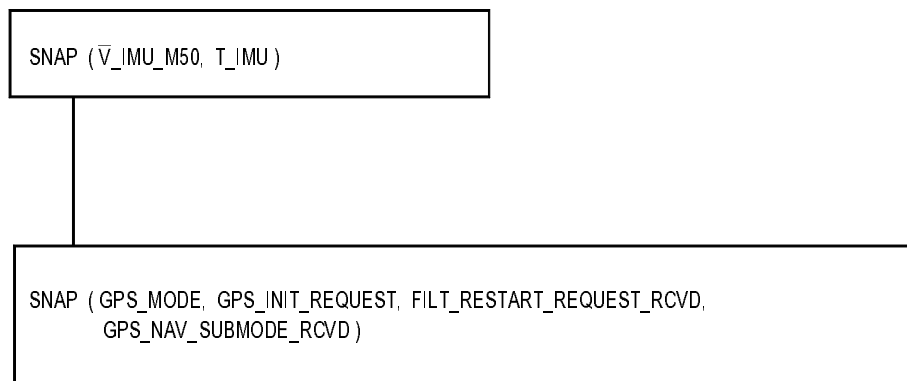


FIGURE 5.6-10. GPS\_EXTERNAL\_DATA\_SNAP

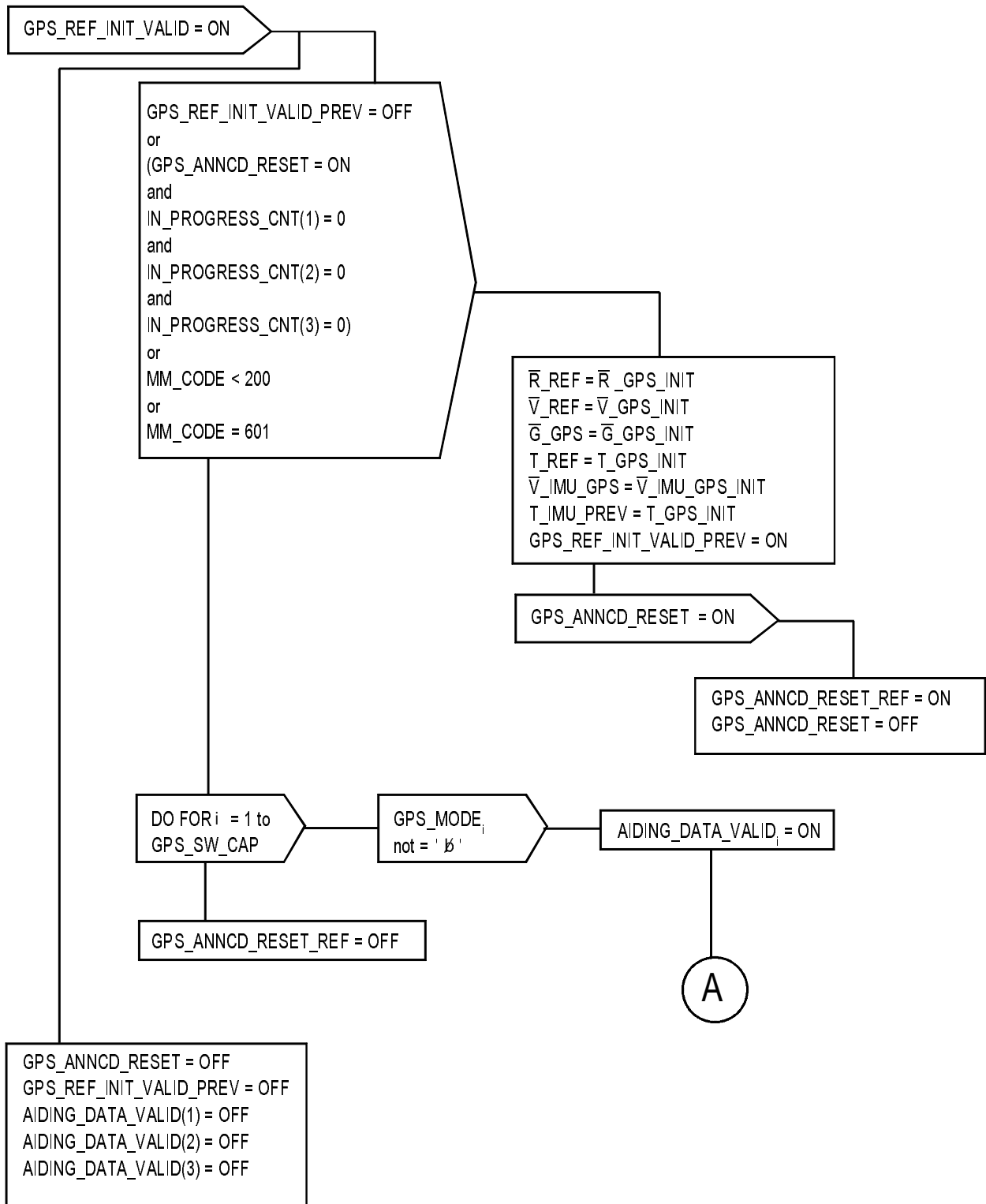


FIGURE 5.6-12.(1) GPS\_REF\_STATE\_INIT\_REANCHOR (Sheet 1 of 3)

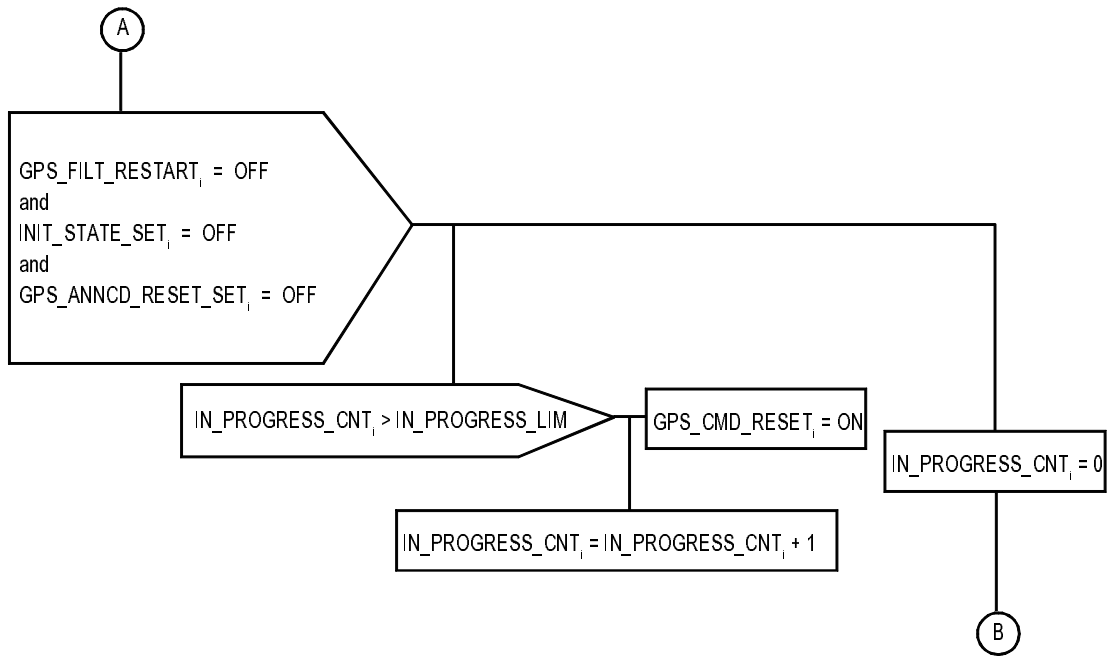


FIGURE 5.6-12.(2) GPS\_REF\_STATE\_INIT\_REANCHOR (Sheet 2 of 3)

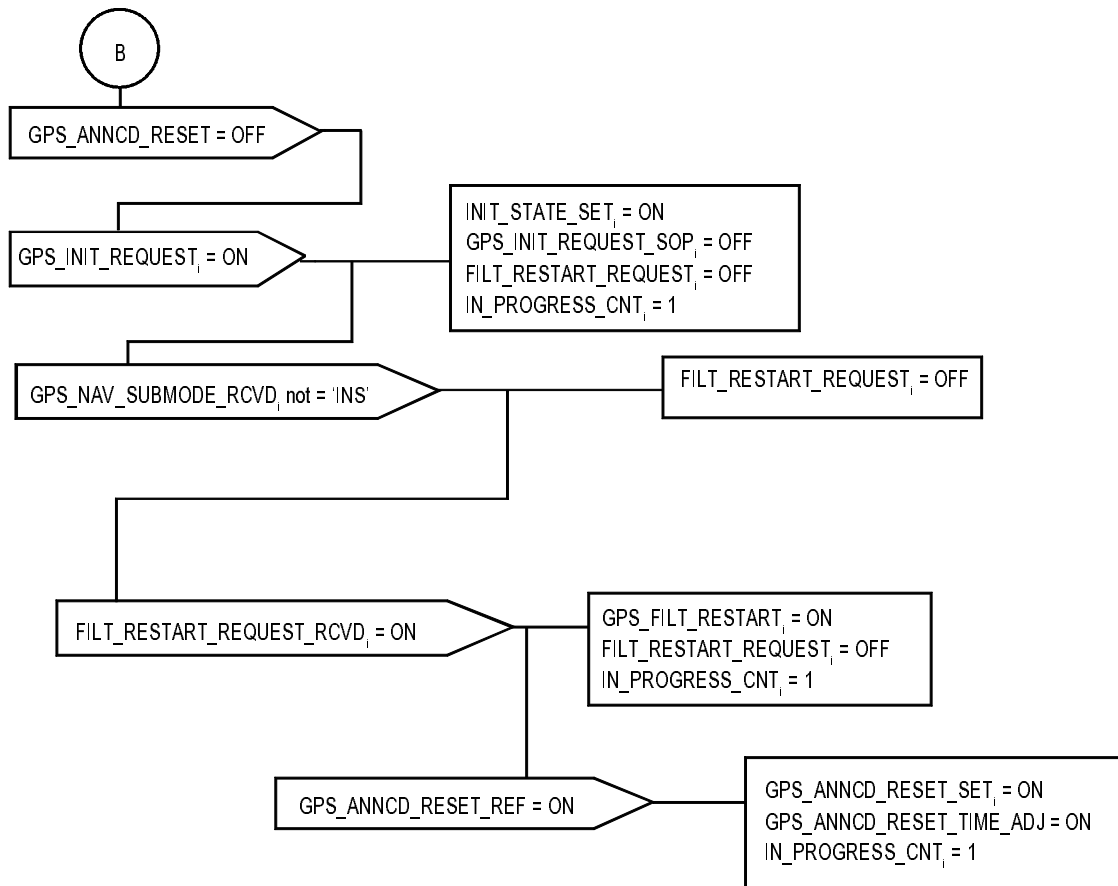


FIGURE 5.6-12.(3) GPS\_REF\_STATE\_INIT\_REANCHOR (Sheet 3 of 3)

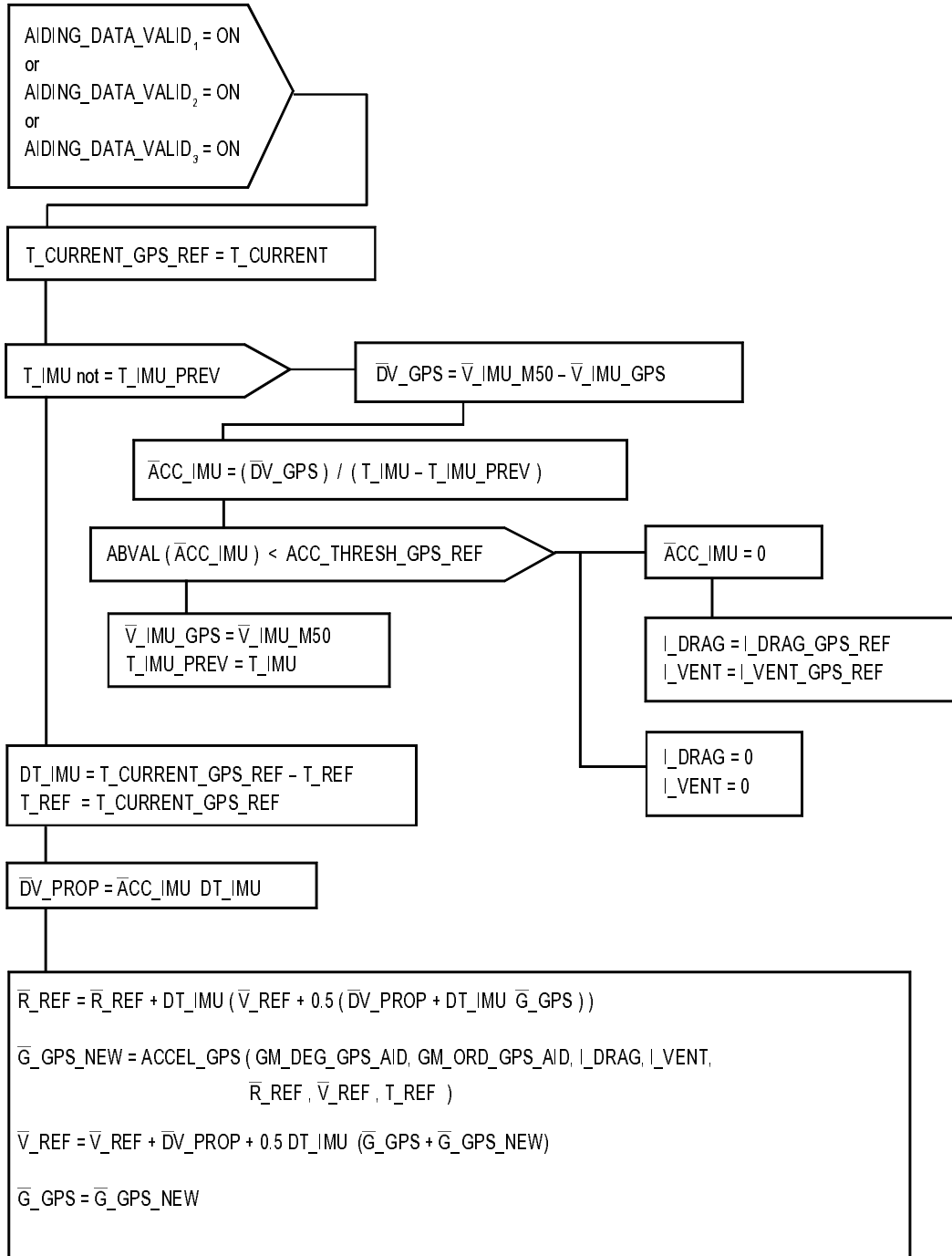


FIGURE 5.6-13. GPS\_REF\_STATE\_PROP



**APPENDIX R CHANGE AUTHORIZATION REFERENCES**

**R.1 CR REFERENCE SUMMARY**

Table R.1-1. lists the paragraphs, tables (T), and figures (F) that have been changed as a result of approved change requests commencing with OI-26 up to the current OI.Changes incorporated prior to OI-26 are listed in the Historical Change Request Summary.

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
N/A	92307	29	FSSR Format Change - Documentation Only
	92973	32	Reassign Effectivity of SCRs 92542D & 92743D to OI-32
	92983	32	Reassign Effectivity of SCR 92834C & 92931A to OI-32
	93052	32	Reassign Effectivity of SCR 92860C to Include OI-32
1.3–1. (T)	92103A	26B	FSSR Parameter Table Upgrade
3.2.1.2.3	92067D	27	Three String GPS Capability
3.3	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
3.3.1	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
3.3.4	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
3.3.4.1	91051K	26B	Streamlined Shuttle GPS Capability
3.3.4.2	91051K	26B	Streamlined Shuttle GPS Capability
	90662F	29	Automatic Reanchoring of an Upmoded IMU
	92517C	30	Expand Landing Site Table
3.3.4.3	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
3.3.4.4	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
4.0–1 (T)	92069B	26B	Single-String GPS Documentation Cleanup
4.0–2 (T)	92069B	26B	Single-String GPS Documentation Cleanup
4.1.1	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.1.1.1-1 (T)	92080B	26B	Single-String GPS UPP and SOP Corrections
	92067D	27	Three String GPS Capability
	92208C	28	GPS Issues for Correction on OI-28
	92329E	29	Onboard Calculation of RNP Matrix
	92369B	29	PASS GPS Operational Enhancements
	92067D	27	Three String GPS Capability
	92354	27	Delete Erroneous TLM Destinations
	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92225A	29	ET SEP Switch Default to Auto on a TAL Abort
	92355B	29	GPC Major Mode to MEDS
	92369B	29	PASS GPS Operational Enhancements
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
4.1.1.1-2 (T)	92542D	32	Deletion of LO2 Step Pressurization CMDS
	93064D	32	Errata Issue Clean-Up Part II
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92369B	29	PASS GPS Operational Enhancements
	4.1.1.1-3 (T)	91051K	26B
92067D		27	Three String GPS Capability
92208C		28	GPS Issues for Correction on OI-28
92287B		28	New Categories for OPS1 and OPS3 Drag Constants
92292B		28	GPS Related Category Modifications for OI-28
92369B		29	PASS GPS Operational Enhancements
92370C		29	BFS GPS Operational Enhancements
92080B		26B	Single-String GPS UPP and SOP Corrections
92080B		26B	Single-String GPS UPP and SOP Corrections
91051K		26B	Streamlined Shuttle GPS Capability
4.1.1.1-4 (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability
4.1.1.1-5. (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup
4.1.2	91051K	26B	Streamlined Shuttle GPS Capability
4.1.2-1. (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary				
Paragraph	CR No.	OI	CR Title	
4.1.2.1-1 (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup	
	91051K	26B	Streamlined Shuttle GPS Capability	
	92329E	29	Onboard Calculation of RNP Matrix	
	92355B	29	GPC Major Mode to MEDS	
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B	
4.2.1.1	92404B	29	Preserve MECO Vi, Altitude, & Altitude Rate in MM104	
	93090E	33	Bearing Displays	
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement	
4.2.1.1.1	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
4.2.1.2.2	92860C	32	Minor Documentation Update to Navigation Requirements	
4.2.1.4	91051K	26B	Streamlined Shuttle GPS Capability	
4.2.1.4.1	91051K	26B	Streamlined Shuttle GPS Capability	
4.2.1.4.2	91051K	26B	Streamlined Shuttle GPS Capability	
	92484	29	Correction to PASS GPS Operational Enhancements (CR 92369)	
4.2.5	90662F	29	Automatic Reanchoring of an Upmoded IMU	
4.2.9	92860C	32	Minor Documentation Update to Navigation Requirements	
4.2.10	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92369B	29	PASS GPS Operational Enhancements	
4.2.10.1	92067D	27	Three String GPS Capability	
4.2.10.2	92067D	27	Three String GPS Capability	
4.3.1	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92132C	27	Three String GPS GN&C Correction	
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates	
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3	
	92208C	28	GPS Issues for Correction on OI-28	
	92369B	29	PASS GPS Operational Enhancements	
	92529B	30	GPS Capability Enhancements for OI-30	
	4.3.1.1	91051K	26B	Streamlined Shuttle GPS Capability
		92067D	27	Three String GPS Capability
92132C		27	Three String GPS GN&C Correction	

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.1.1-1. (T)	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	90662F	29	Automatic Reanchoring of an Upmoded IMU
	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion
	92529B	30	GPS Capability Enhancements for OI-30
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92208C	28	GPS Issues for Correction on OI-28
90662F	29	Automatic Reanchoring of an Upmoded IMU	
92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion	
4.3.1.1-2. (T)	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92208C	28	GPS Issues for Correction on OI-28
4.3.1.2	92369B	29	PASS GPS Operational Enhancements
	92067D	27	Three String GPS Capability
4.3.1.2.1	91051K	26B	Streamlined Shuttle GPS Capability
4.3.1.2.2	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.1.2-1. (T)	92132C	27	Three String GPS GN&C Correction
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.3.1.2.-2. (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
4.3.1.3	92369B	29	PASS GPS Operational Enhancements
	92067D	27	Three String GPS Capability
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
4.3.1.3-1. (T)	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
4.3.1.3-2. (T)	92067D	27	Three String GPS Capability
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
4.3.1.9	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92369B	29	PASS GPS Operational Enhancements
4.3.1.9-1 (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92208C	28	GPS Issues for Correction on OI-28
	92237	28	IDD Documentation Cleanup of Uplink Data
	90662F	29	Automatic Reanchoring of an Upmoded IMU
	92329E	29	Onboard Calculation of RNP Matrix
	92355B	29	GPC Major Mode to MEDS
	92364D	29	Just-In-Time Flight Design (JITFD) I-Load Uplink Expansion
	92369B	29	PASS GPS Operational Enhancements
	92389C	29	Spiral HAC in TAEM Area Navigation
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.1.9-2. (T)	92450C	29	Documentation Clean-up for CR 92389
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
	92619A	30	Correction CR for CR 92522D
	92676B	30	CR 92522D / CR 92619A Correction CR
	93090E	33	Bearing Displays
	93155B	33	Bearing Displays Correction
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92369B	29	PASS GPS Operational Enhancements
4.3.1.9-3. (T)	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
	91051K	26B	Streamlined Shuttle GPS Capability
	92139	26B	GPS I-Load Categorization Updates
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92287B	28	New Categories for OPS1 and OPS3 Drag Constants
	92469A	29	Place GPS Metering I-Loads In New Category GPM
	93045A	32	Unique BFS I-Load for DEL_TIME_STEP - DR110661
	4.3.1.9-4 (T)	92069B	26B
92834C		32	Rendezvous Nav Item Entry Corrections
93090E		33	Bearing Displays
4.3.1.9-5 (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92329E	29	Onboard Calculation of RNP Matrix
	92389C	29	Spiral HAC in TAEM Area Navigation
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92522D	30	Overhaul MEDS Composite Flight Instrument Display

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.3.2	92749B	30	Universal Pointing Processor Degrees to Radians Documentation Clean-up
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
4.3.2-1. (T)	92208C	28	GPS Issues for Correction on OI-28
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
4.3.2.1	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
4.3.2.1-1 (T)	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92208C	28	GPS Issues for Correction on OI-28
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92178C	27	Altitude Threshold and Floor GPS to Nav Updates
4.3.2.1-2. (T)	92244A	27	Change V_GPS_SEL to Double Precision
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92208C	28	GPS Issues for Correction on OI-28
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to NAV Updates
	92208C	28	GPS Issues for Correction on OI-28

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.2.2	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.2.2.1	91051K	26B	Streamlined Shuttle GPS Capability
4.3.2.2.2	91051K	26B	Streamlined Shuttle GPS Capability
4.3.2.2.3	92132C	27	Three String GPS GN&C Correction
	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.2.2-1. (T)	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
	92369B	29	PASS GPS Operational Enhancements
4.3.2.2-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to Nav Updates
	92244A	27	Change V_GPS_SEL To Double Precision
	92369B	29	PASS GPS Operational Enhancements
4.3.2.3	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
4.3.2.3-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.2.3-1A. (T)	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
4.3.2.3-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.2.3-3. (T)	92067D	27	Three String GPS Capability
4.3.2.3-4. (T)	92067D	27	Three String GPS Capability
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
4.3.2.7	92067D	27	Three String GPS Capability
4.3.2.7.4	92067D	27	Three String GPS Capability
4.3.2.7.4-1. (T)	92067D	27	Three String GPS Capability



Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.3.2.7.5	92067D	27	Three String GPS Capability
4.3.2.7.5-1. (T)	92067D	27	Three String GPS Capability
4.3.2.7.6	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
4.3.2.7.6-1. (T)	92067D	27	Three String GPS Capability
4.3.2.9	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Correction
4.3.2.9-1 (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92237	28	IDD Documentation Cleanup of Uplink Data
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92369B	29	PASS GPS Operational Enhancements
	92389C	29	Spiral HAC in TAEM Area Navigation
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92450C	29	Documentation Clean-up for CR 92389
92332D	30	Add Theta Limits Bracket to MEDS ADI Displays	
92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry	
93090E	33	Bearing Displays	
93100C	33	OI-33 Remote Control Orbiter Capability Enhancement	
93155B	33	Bearing Displays Correction	
4.3.2.9-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.2.9-3. (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92208C	28	GPS Issues for Correction on OI-28
	92369B	29	PASS GPS Operational Enhancements
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
	91051K	26B	Streamlined Shuttle GPS Capability
	92139	26B	GPS I-Load Categorization Updates
	92067D	27	Three String GPS Capability
	92178C	27	Altitude Threshold and Floor GPS to Nav Updates
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
4.3.2.9-4. (T)	92287B	28	New Categories for OPS1 and OPS3 Drag Constants
	92469A	29	Place GPS Metering I-Loads In New Category GPM
	93045A	32	Unique BFS I-Load for DEL_TIME_STEP- DR110661
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
4.3.2.9-5. (T)	93090E	33	Bearing Displays
4.3.3	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92329E	29	Onboard Calculation of RNP Matrix
	92389C	29	Spiral HAC in TAEM Area Navigation
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92749B	30	Universal Pointing Processor Degrees to Radians Documentation Clean-up
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.1	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.2	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.3.2-1. (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.3.3.2-2. (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.3.3	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
4.3.3.3.1	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92244A	27	Change V_GPS_SEL to Double Precision
4.3.3.3.2	92281D	28	Post FOCI OI-28 GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.3.3	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.3-1. (T)	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
4.3.3.3-2. (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92289A	27	Post STS-91 OI-27 GPS Redesign
4.3.3.4	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.3.4.1	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.3.3.4.2	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.3.3.4.3	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
4.3.3.4.4	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92208C	28	GPS Issues for Correction on OI-28
4.3.3.4.5	92244A	27	Change V_GPS_SEL To Double Precision
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.3.3.4.6	92132C	27	Three String GPS GN&C Corrections
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
4.3.3.4.7	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
	92067D	27	Three String GPS Capability
4.3.3.4-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.3.3.4-2. (T)	92208C	28	GPS Issues for Correction on OI-28
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
4.3.3.5	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92289A	27	Post STS-91 OI-27 GPS Redesign
4.3.3.5-1. (T)	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92860C	32	Minor Documentation Update to Navigation Requirements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92289A	27	Post STS-91 OI-27 GPS Redesign
4.3.3.5-2. (T)	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
4.3.3.6	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.3.6-1. (T)	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92244A	27	Change V_GPS_SEL to Double Precision
4.3.3.6-2. (T)	92208C	28	Issues for Correction on OI-28
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
4.3.3.7	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92208C	28	GPS Issues for Correction on OI-28
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.7-1. (T)	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92292B	28	GPS Related Category Modifications for OI-28
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.7-2. (T)	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.7-3. (T)	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.7-4. (T)	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.3.3.7-5. (T)	92067D	27	Three String GPS Capability
4.3.3.7-6. (T)	92067D	27	Three String GPS Capability
4.3.3.7-7. (T)	92067D	27	Three String GPS Capability
4.3.3.8	91051K	26B	Streamlined Shuttle GPS Capability
4.3.3.8-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92165A	27	Prevent False GPS Off Alarm in MM602
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92369B	29	PASS GPS Operational Enhancements
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
	92817C	32	GPS FSW Compensation for GPC Clock Drift
	92834C	32	Rendezvous Nav Item Entry Corrections
	93090E	33	Bearing Displays
4.3.3.8-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92244A	27	Change V_GPS_SEL to Double Precision
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92208C	28	GPS Issues for Correction on OI-28
	92369B	29	PASS GPS Operational Enhancements
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.3.3.8-3. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92035D	26B	GPS SOP Processing Relief
	92056D	26B	Remove Unnecessary GPS SOP Processing in G9
	92069B	26B	Single-String GPS Documentation Cleanup
	92080B	26B	Single-String GPS UPP and SOP Corrections
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92139	26B	GPS I-Load Categorization Updates
	92067D	27	Three String GPS Capability
	92097B	27	Three String GPS for the BFS
	92132C	27	Three String GPS GN&C Corrections
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92236	27	GPS_SV_SEL_ALT_LIMIT Moved to Category GP3
	92292B	28	GPS Related Category Modifications for OI-28
	92376	28	OPS Configure GPS GAS-1 I-Loads for OI-28
	92329E	29	Onboard Calculation of RNP Matrix
	92369B	29	PASS GPS Operational Enhancements
	93000A	32	BFS GPS Aiding Enhancement for OI-32
4.3.3.8-4. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92292B	28	GPS Related Category Modifications for OI-28
4.3.3.8-5. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93090E	33	Bearing Displays
4.4.2	92099B	27	Flight Path Angle RTLS Downlist Units Correction
	92144C	27	Three String GPS Documentation Cleanup
	93023D	32	OI-32 Remote Control Orbiter Capability
4.4.3	92329E	29	Onboard Calculation of RNP Matrix
4.4.3-1. (T)	92329E	29	Onboard Calculation of RNP Matrix
4.4.3.1	92329E	29	Onboard Calculation of RNP Matrix
4.4.3.2	92329E	29	Onboard Calculation of RNP Matrix
	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion



Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.4.4	92529B	30	GPS Capability Enhancements for OI-30
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.4.6	92450C	29	Documentation Clean-up for CR 92389
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92080B	26B	Single-String GPS UPP and SOP Corrections
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
4.4.6.1	92450C	29	Documentation Clean-up for CR 92389
	92860C	32	Minor Documentation Update to Navigation Requirements
	92067D	27	Three String GPS Capability
4.4.6.2	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
4.5.1.1-1. (T)	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92297B	27	Delete Erroneous TLM Destinations for NAV
	92329E	29	Onboard Calculation of RNP Matrix
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92619A	30	Correction CR for CR 92522D
	92676B	30	CR 92522D / CR 92619A Correction CR
	93090E	33	Bearing Displays
	92287B	28	New Categories for OPS1 and OPS3 Drag Constants
	92389C	29	Spiral HAC in TAEM Area Navigation
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
4.5.1.1-3 (T)	93090E	33	Bearing Displays
	92517C	30	Expand Landing Site Table
4.5.1.1-5. (T)	93090E	33	Bearing Displays
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92254A	27	Change Three String GPS Reference State Processing During Ascent
4.5.2	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.5.2.1-1. (T)	92517C	30	Expand Landing Site Table
	92860C	32	Minor Documentation Update to Navigation Requirements
	93090E	33	Bearing Displays
4.5.2.1-2. (T)	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92517C	30	Expand Landing Site Table
4.5.2.2	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92517C	30	Expand Landing Site Table
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.5.2.2-1. (T)	92517C	30	Expand Landing Site Table
	92860C	32	Minor Documentation Update to Navigation Requirements
	93090E	33	Bearing Displays
4.5.2.2-2. (T)	92517C	30	Expand Landing Site Table
	93090E	33	Bearing Displays
4.5.2.3	91051K	26B	Streamlined Shuttle GPS Capability
	92517C	30	Expand Landing Site Table
	93090E	33	Bearing Displays
4.5.2.3-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.5.2.4-1 (T)	92517C	30	Expand Landing Site Table
4.5.2.4-2. (T)	92025B	26B	Onorbit TACAN Deletion
	92354	27	Delete Erroneous TLM Destinations
	92208C	28	GPS Issues for Correction on OI-28
	92237	28	IDD Documentation Cleanup of Uplink Data
	92225A	29	ET SEP Switch Default to Auto on a TAL Abort
	92355B	29	GPC Major Mode to MEDS
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92542D	32	Deletion of LO2 Step Pressurization CMDS
	93090E	33	Bearing Displays
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
92297B	27	Delete Erroneous TLM Destinations for NAV	

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.5.2.4-3.(T)	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93090E	33	Bearing Displays
	93155B	33	Bearing Displays Correction
	92517C	30	Expand Landing Site Table
4.6-1. (F)	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92389C	29	Spiral HAC in TAEM Area Navigation
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays
4.6-2. (F)	90996G	26	ADI & HUD Error Display Integrator MODS
	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92389C	29	Spiral HAC in TAEM Area Navigation
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92619A	30	Correction CR for CR 92522D
	93018B	32	Blank HAC Turn Angle on PFD at Heading Alignment Phase
	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays
	93023D	32	OI-32 Remote Control Orbiter Capability
	91051K	26B	Streamlined Shuttle GPS Capability
4.6-3. (F)	93023D	32	OI-32 Remote Control Orbiter Capability
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.1.1-2. (T)	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
4.6.1.2-1. (T)	92517C	30	Expand Landing Site Table
4.6.1.2-2. (T)	92067D	27	Three String GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.1.3	92517C	30	Expand Landing Site Table
	92450C	29	Documentation Clean-up for CR 92389
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
4.6.1.4	93155B	33	Bearing Displays Correction
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.1.4.1	91051K	26B	Streamlined Shuttle GPS Capability
4.6.1.4.1-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.1.4.1-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
4.6.1.4.2	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.1.4.2-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.1.4.2-2. (T)	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
4.6.1.6-1. (T)	92067D	27	Three String GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.1.6-2. (T)	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92369B	29	PASS GPS Operational Enhancements
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92619A	30	Correction CR for CR 92522D
	93090E	33	Bearing Displays
	93155B	33	Bearing Displays Correction
	91051K	26B	Streamlined Shuttle GPS Capability
92067D	27	Three String GPS Capability	

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.6.1.6-3. (T)	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92389C	29	Spiral HAC in TAEM Area Navigation
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92097B	27	Three String GPS for the BFS
	92144C	27	Three String GPS Documentation Cleanup
4.6.1.6-4. (T)	92292B	28	GPS Related Category Modifications for OI-28
	92389C	29	Spiral HAC in TAEM Area Navigation
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.6.1.6-5. (T)	92292B	28	GPS Related Category Modifications for OI-28
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
4.6.2	93090E	33	Bearing Displays
4.6.2.1-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
4.6.2.2-1. (T)	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92144C	27	Three String GPS Documentation Cleanup
4.6.2.2-2. (T)	92517C	30	Expand Landing Site Table
	92067D	27	Three String GPS Capability
	92099B	27	Flight Path Angle RTLS Downlist Units Correction
4.6.2.3.1	92517C	30	Expand Landing Site Table
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.2.3.1-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.2.3.1-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.2.3.2	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.2.3.2-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
4.6.2.3.2-2. (T)	92132C	27	Three String GPS GN&C Corrections
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.6.2.4-1 (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.2.4-2 (T)	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92355B	29	GPC Major Mode to MEDS
	92369B	29	PASS GPS Operational Enhancements
	92389C	29	Spiral HAC in TAEM Area Navigation
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92619A	30	Correction CR for CR 92522D
	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	93155B	33	Bearing Displays Correction
	90996G	26	ADI & HUD Error Display Integrator MODS
	91051K	26B	Streamlined Shuttle GPS Capability
92067D	27	Three String GPS Capability	
92099B	27	Flight Path Angle RTLS Downlist Units Correction	
92144C	27	Three String GPS Documentation Cleanup	
92214A	27	Post-CI Three-String GPS Documentation Cleanup	

Table R.1-1. CR Reference Summary				
Paragraph	CR No.	OI	CR Title	
4.6.2.4-3. (T)	92389C	29	Spiral HAC in TAEM Area Navigation	
	92522D	30	Overhaul MEDS Composite Flight Instrument Display	
	92619A	30	Correction CR for CR 92522D	
	93018B	32	Blank HAC Turn Angle on PFD at Heading Alignment Phase	
	93023D	32	OI-32 Remote Control Orbiter Capability	
	93090E	33	Bearing Displays	
	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92097B	27	Three String GPS for the BFS	
	92144C	27	Three String GPS Documentation Cleanup	
4.6.2.4-4. (T)	92292B	28	GPS Related Category Modifications for OI-28	
	92389C	29	Spiral HAC in TAEM Area Navigation	
	93090E	33	Bearing Displays	
	91051K	26B	Streamlined Shuttle GPS Capability	
	92069B	26B	Single-String GPS Documentation Cleanup	
4.6.2.4-5 (T)	92067D	27	Three String GPS Capability	
	92292B	28	GPS Related Category Modifications for OI-28	
	93090E	33	Bearing Displays	
	91051K	26B	Streamlined Shuttle GPS Capability	
4.6.3	92067D	27	Three String GPS Capability	
	92522D	30	Overhaul MEDS Composite Flight Instrument Display	
4.6-3. (F)	93090E	33	Bearing Displays	
	91051K	26B	Streamlined Shuttle GPS Capability	
	91051K	26B	Streamlined Shuttle GPS Capability	
4.6.3.1-2. (T)	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability	
	92069B	26B	Single-String GPS Documentation Cleanup	
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display	
	92067D	27	Three String GPS Capability	
	92132C	27	Three String GPS GN&C Corrections	
	92450C	29	Documentation Clean-up for CR 92389	
	92067D	27	Three String GPS Capability	
	92132C	27	Three String GPS GN&C Corrections	
	4.6.3.2-1. (T)	92144C	27	Three String GPS Documentation Cleanup
		92517C	30	Expand Landing Site Table

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.3.2-2. (T)	92067D	27	Three String GPS Capability
	92099B	27	Flight Path Angle RTLS Downlist Units Correction
	92144C	27	Three String GPS Documentation Cleanup
	92517C	30	Expand Landing Site Table
4.6.3.3	91051K	26B	Streamlined Shuttle GPS Capability
4.6.3.3.1	91051K	26B	Streamlined Shuttle GPS Capability
4.6.3.3.1-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.3.3.1-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
4.6.3.3.2	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
4.6.3.3.2-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
4.6.3.3.2-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.3.4	92144C	27	Three String GPS Documentation Cleanup
4.6.3.4-1 (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92355B	29	GPC Major Mode to MEDS
	92369B	29	PASS GPS Operational Enhancements
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92619A	30	Correction CR for CR 92522D



Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.6.3.4-2. (T)	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays
	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement
	93155B	33	Bearing Displays Correction
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92099B	27	Flight Path Angle RTLS Downlist Units Correction
	92144C	27	Three String GPS Documentation Cleanup
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92450C	29	Documentation Clean-up for CR 92389
4.6.3.4-3. (T)	93023D	32	OI-32 Remote Control Orbiter Capability
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92097B	27	Three String GPS for the BFS
	92144C	27	Three String GPS Documentation Cleanup
	92292B	28	GPS Related Category Modifications for OI-28
	92389C	29	Spiral HAC in TAEM Area Navigation
4.6.3.4-4. (T)	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92292B	28	GPS Related Category Modifications for OI-28
	93090E	33	Bearing Displays
4.6.3.4-5. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93090E	33	Bearing Displays
4.6.4	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
4.6.4.1	91051K	26B	Streamlined Shuttle GPS Capability
	92035D	26B	GPS SOP Processing Relief
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.4.1-1. (T)	92369B	29	PASS GPS Operational Enhancements
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.6.4.1-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.4.2	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
4.6.4.2-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.6.4.2-2. (T)	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
4.6.4.3	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.4.3-1. (T)	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.4.3-2. (T)	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
4.6.4.4	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92254A	27	Change Three String GPS Reference State Processing During Ascent
4.6.4.4.1	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.6.4.4.2	92254A	27	Change Three String GPS Reference State Processing During Ascent
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	92484	29	Correction to PASS GPS Operational Enhancements (CR 92369)
	92860C	32	Minor Documentation Update to Navigation Requirements
	91051K	26B	Streamlined Shuttle GPS Capability
	92369B	29	PASS GPS Operational Enhancements
4.6.4.4.3	92817C	32	GPS FSW Compensation for GPC Clock Drift
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
4.6.4.4-1. (T)	92377	27	GPS Reference State Processor OPS Transition Cleanup
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
4.6.4.4-2. (T)	92254A	27	Change Three String GPS Reference State Processing During Ascent
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
4.6.4.5	92817C	32	GPS FSW Compensation for GPC Clock Drift
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.4.5-1. (T)	92254A	27	Change Three String GPS Reference State Processing During Ascent
	92208C	28	GPS Issues for Correction on OI-28
	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92254A	27	Change Three String GPS Reference State Processing During Ascent

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.4.5-2. (T)	92289A	27	Post STS-91 OI-27 GPS Redesign
	92208C	28	GPS Issues for Correction on OI-28
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
4.6.4.6	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	91051K	26B	Streamlined Shuttle GPS Capability
4.6.4.6-1. (T)	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	91051K	26B	Streamlined Shuttle GPS Capability
	92035D	26B	GPS SOP Processing Relief
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92254A	27	Change Three String GPS Reference State Processing During Ascent
	92289A	27	Post STS-91 OI-27 GPS Redesign
	90662F	29	Automatic Reanchoring of an Upmoded IMU
	92329E	29	Onboard Calculation of RNP Matrix
	92353D	29	Automated Alpha-Beta Management During Mated Coast & MM104
	92369B	29	PASS GPS Operational Enhancements
	92392C	29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B
	4.6.4.6-2. (T)	92522D	30
93012D		32	PASS 6X TRAJ Display Enhancement
93090E		33	Bearing Displays
91051K		26B	Streamlined Shuttle GPS Capability
92035D		26B	GPS SOP Processing Relief
92067D		27	Three String GPS Capability
92289A		27	Post STS-91 OI-27 GPS Redesign
92369B		29	PASS GPS Operational Enhancements
92817C		32	GPS FSW Compensation for GPC Clock Drift

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.4.6-3. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92056D	26B	Remove Unnecessary GPS SOP Processing in G9
	92139	26B	GPS I-Load Categorization Updates
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
4.6.4.6-4. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
	92370C	29	BFS GPS Operational Enhancements
	93000A	32	BFS GPS Aiding Enhancement for OI-32
4.6.4.6-5. (T)	91051K	26B	Streamlined Shuttle GPS Capability
4.7	92067D	27	Three String GPS Capability
	92355B	29	GPC Major Mode to MEDS
	92389C	29	Spiral HAC in TAEM Area Navigation
	92450C	29	Documentation Clean-up for CR 92389
	92599A	29	Area NAV Spiral HAC Correction
	92355B	29	GPC Major Mode to MEDS
4.7-1. (T)	92355B	29	GPC Major Mode to MEDS
4.7-1. (F)	92067D	27	Three String GPS Capability
4.7-3. (F)	92389C	29	Spiral HAC in TAEM Area Navigation
4.7-4. (F)	92389C	29	Spiral HAC in TAEM Area Navigation
4.7.1-1 (T)	92067D	27	Three String GPS Capability
	92297B	27	Delete Erroneous TLM Destinations for NAV
	90724D	28	OPS 6 Entry ECAL Automation
	90914C	28	Delay MOV MPS Dump/FRCS Dump at MM602
	92355B	29	GPC Major Mode to MEDS
	92389C	29	Spiral HAC in TAEM Area Navigation
	92404B	29	Preserve MECO Vi, Altitude, & Altitude Rate in MM104
	92450C	29	Documentation Clean-up for CR 92389
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92619A	30	Correction CR for CR 92522D
	93012D	32	PASS 6X TRAJ Display Enhancement
	93018B	32	Blank HAC Turn Angle on PFD at Heading Alignment Phase
	93023D	32	OI-32 Remote Control Orbiter Capability
	93090E	33	Bearing Displays

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.7.1-2. (T)	93155B	33	Bearing Displays Correction
	92355B	29	GPC Major Mode to MEDS
4.7.1-3. (T)	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
4.7.1-5. (T)	92292B	28	GPS Related Category Modifications for OI-28
	92389C	29	Spiral HAC in TAEM Area Navigation
	92432A	29	BFS Cleanup for Spiral HAC CR 92389C
	92938B	32	BFS HUD Processor
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92395F	28	INCORPORATE G ON MEDS DISPLAYS
	92329E	29	Onboard Calculation of RNP Matrix
	92389C	29	Spiral HAC in TAEM Area Navigation
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92749B	30	Universal Pointing Processor Degrees to Radians Documentation Clean-up
	93090E	33	Bearing Displays
4.8.2	92208C	28	GPS Issues for Correction on OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
4.8.2-1(T)	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
4.8.2-2(T)	92208C	28	GPS Issues for Correction on OI-28
4.10	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion
	92529B	30	GPS Capability Enhancements for OI-30
4.10.3	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
4.10.3.1	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92517C	30	Expand Landing Site Table
	93090E	33	Bearing Displays
4.10.3.2	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92517C	30	Expand Landing Site Table
	93090E	33	Bearing Displays

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.10.3.3	92209D	28	Runway & Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92517C	30	Expand Landing Site Table
4.10.4	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion
	92529B	30	GPS Capability Enhancements for OI-30
5.1-1 (T)	92067D	27	Three String GPS Capability
	92208C	28	GPS Issues for Correction on OI-28
	90662F	29	Automatic Reanchoring of an Upmoded IMU
	92329E	29	Onboard Calculation of RNP Matrix
5.1A	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion
	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
	93045A	32	Unique BFS I-Load for DEL_TIME_STEP - DR110661
	91051K	26B	Streamlined Shuttle GPS Capability
	92056D	26B	Remove Unnecessary GPS SOP Processing in G9
	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	5.1A-1. (T)	91051K	26B
92069B		26B	Single-String GPS Documentation Cleanup
92067D		27	Three String GPS Capability
92132C		27	Three String GPS GN&C Corrections
92144C		27	Three String GPS Documentation Cleanup
92178C		27	Altitude Threshold and Floor GPS to Nav Updates
92214A		27	Post-CI Three-String GPS Documentation Cleanup
92254A		27	Change Three String GPS Reference State Processing During Ascent
92274		27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3
92289A		27	Post STS-91 OI-27 GPS Redesign
92208C		28	GPS Issues for Correction on OI-28
92369B		29	PASS GPS Operational Enhancements
92392C		29	Doc-Only Corrections for OI-29 CRs 92329E, 92364D, and 92369B

Table R.1-1. CR Reference Summary				
Paragraph	CR No.	OI	CR Title	
5.2-2. (F)	91051K	26B	Streamlined Shuttle GPS Capability	
	92080B	26B	Single-String GPS UPP and SOP Corrections	
	92067D	27	Three String GPS Capability	
	92208C	28	GPS Issues for Correction on OI-28	
	92369B	29	PASS GPS Operational Enhancements	
5.2-3. (F)	90662F	29	Automatic Reanchoring of an Upmoded IMU	
5.2-7. (F)	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92132C	27	Three String GPS GN&C Corrections	
	92178C	27	Altitude Threshold and Floor GPS to Nav Updates	
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3	
	92208C	28	GPS Issues for Correction on OI-28	
	90662F	29	Automatic Reanchoring of an Upmoded IMU	
	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion	
	92369B	29	PASS GPS Operational Enhancements	
	5.2-16.(F)	92860C	32	Minor Documentation Update to Navigation Requirements
5.2-21. (F)	92067D	27	Three String GPS Capability	
	92214A	27	Post-CI Three-String GPS Documentation Cleanup	
5.2-21.(1)(F)	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry	
5.2-35. (F)	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92369B	29	PASS GPS Operational Enhancements	
5.2-35A. (F)	92067D	27	Three String GPS Capability	
5.2-35B. (F)	92067D	27	Three String GPS Capability	
5.2-36.(3)(F)	92860C	32	Minor Documentation Update to Navigation Requirements	
5.2-37. (F)	91051K	26B	Streamlined Shuttle GPS Capability	
	92067D	27	Three String GPS Capability	
	92132C	27	Three String GPS GN&C Corrections	
	92178C	27	Altitude Threshold and Floor GPS to Nav Updates	
	92274	27	Prevent Stale GPS Data from Auto Updating Baseline Navigation in OPS 3	
	92208C	28	GPS Issues for Correction on OI-28	
	92369B	29	PASS GPS Operational Enhancements	
	5.2-37.(4) (F)	93100C	33	OI-33 Remote Control Orbiter Capability Enhancement



Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
5.2–38. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
5.2–38.(1)(F)	92571B	30	Drive HSD MLS, TAC, DRAG and ADTA A/I/F Asterisks at Item Entry
5.2–39. (F)	92067D	27	Three String GPS Capability
5.2–42. (F)	92067D	27	Three String GPS Capability
5.2–44. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.2–45. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.2–46. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92214A	27	Post-CI Three-String GPS Documentation Cleanup
	92369B	29	PASS GPS Operational Enhancements
5.2–47. (F)	91051K	26B	Streamlined Shuttle GPS Capability
5.2–47A. (F)	91051K	26B	Streamlined Shuttle GPS Capability
5.2–48. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92208C	28	GPS Issues for Correction on OI-28
	92369B	29	PASS GPS Operational Enhancements
	92369B	29	PASS GPS Operational Enhancements
5.2–48–1. (F)	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.2–48A. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.2–49. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
	92369B	29	PASS GPS Operational Enhancements
5.2–49A. (F)	92067D	27	Three String GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
5.2–50. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92208C	28	GPS Issues for Correction on OI-28
5.2–51. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
5.2–52. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
5.2–53. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
5.2–53A. (F)	92067D	27	Three String GPS Capability
5.2–54. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92069B	26B	Single-String GPS Documentation Cleanup
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
5.2–54A.(F)	92132C	27	Three String GPS GN&C Corrections
5.2–55. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
5.2–56. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
5.2–57. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
5.2–57.(1)(F)	92860C	32	Minor Documentation Update to Navigation Requirements
5.3–1. (T)	92329E	29	Onboard Calculation of RNP Matrix
5.3–14. (F)	92329E	29	Onboard Calculation of RNP Matrix
5.3–23. (F)	92049C	26B	Corrections to CR 91051K, Streamlined Shuttle GPS Capability
5.3–23.(1) (F)	93090E	33	Bearing Displays
5.3–24. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	93090E	33	Bearing Displays

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
5.4-1. (T)	92355B	29	GPC Major Mode to MEDS
	92389C	29	Spiral HAC in TAEM Area Navigation
	92450C	29	Documentation Clean-up for CR 92389
5.4-1. (F)	92067D	27	Three String GPS Capability
	92355B	29	GPC Major Mode to MEDS
	92389C	29	Spiral HAC in TAEM Area Navigation
5.4.-1.(1)(F)	92599A	29	Area NAV Spiral HAC Correction
5.4.-1.(2)(F)	92599A	29	Area NAV Spiral HAC Correction
5.4-2. (F)	92389C	29	Spiral HAC in TAEM Area Navigation
	92450C	29	Documentation Clean-up for CR 92389
	92067D	27	Three String GPS Capability
5.4-4A. (F)	92389C	29	Spiral HAC in TAEM Area Navigation
	92450C	29	Documentation Clean-up for CR 92389
	92355B	29	GPC Major Mode to MEDS
5.4-6. (F)	92355B	29	GPC Major Mode to MEDS
5.4-8. (F)	92355B	29	GPC Major Mode to MEDS
5.4-9. (F)	92355B	29	GPC Major Mode to MEDS
	92389C	29	Spiral HAC in TAEM Area Navigation
	92450C	29	Documentation Clean-up for CR 92389
5.5-1. (T)	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
	93090E	33	Bearing Displays
5.5-1. (F)	92209D	28	Runway and Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
	92517C	30	Expand Landing Site Table
	93090E	33	Bearing Displays
5.5-2. (F)	92517C	30	Expand Landing Site Table
5.5-3. (F)	92209D	28	Runway and Navaid Location Data Uplink Capability in OPS 1/6/3 PASS/BFS
5.5-5. (F)	92208C	28	GPS Issues for Correctionon OI-28
	92281D	28	Post FACI OI-28 GPS Documentation Cleanup
5.5-6. (F)	92364D	29	Just-IN-Time Flight Design (JFTFD) I-Load Uplink Expansion
	92517C	30	Expand Landing Site Table
5.6-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92329E	29	Onboard Calculation of RNP Matrix
	92522D	30	Overhaul MEDS Composite Flight Instrument Display

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
	92727A	30	Initialization of R_AVGG and V_AVGG
5.6-5. (F)	92144C	27	Three String GPS Documentation Cleanup
5.6-5.(1) (F)	93023D	32	OI-32 Remote Control Orbiter Capability
5.6-5.(2) (F)	93023D	32	OI-32 Remote Control Orbiter Capability
5.6-6.(F)	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93155B	33	Bearing Displays Correction
5.6-7.(2)(F)	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	93155B	33	Bearing Displays Correction
5.6-8. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
5.6-8A. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92080B	26B	Single-String GPS UPP and SOP Corrections
	92098D	26B	Single-String GPS RCVR STATE PROC / Status Display
	92067D	27	Three String GPS Capability
	92132C	27	Three String GPS GN&C Corrections
5.6-9. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92035D	26B	GPS SOP Processing Relief
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.6-10. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.6-11. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92369B	29	PASS GPS Operational Enhancements
5.6-12. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92254A	27	Change Three String GPS Reference State Processing During Ascent
	92289A	27	Post STS-91 OI-27 GPS Redesign
	92369B	29	PASS GPS Operational Enhancements
5.6-12.(3)(F)	92817C	32	GPS FSW Compensation for GPC Clock Drift
5.6-13. (F)	91051K	26B	Streamlined Shuttle GPS Capability
	92067D	27	Three String GPS Capability
	92254A	27	Change Three String GPS Reference State Processing During Ascent

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
5.6–13. (F)	92369B	29	PASS GPS Operational Enhancements

## R.2 HISTORICAL CHANGE REQUEST SUMMARY

Table R.2-1. is an historical record of approved change requests incorporated since the initial baseline up to OI–25. Change requests commencing with OI–26 are reformatted and listed in the CR Reference Summary.

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
2166		OFT GN&C Entry Functions Update
2182A		Ascent Integration Update (G016)
2213		Deletion of Drag Bias Internal Fdbk Lockout in Ent Guid for Rwy Redes
2265B		Add IMU Align Capability to OPS 3
2433C		Addition of GN&C/SM–PL IF (4.111) to GNC OPS 3
2463A		OPS 3 Recycle Int due to MM304–301 Transition
2474		Delete A “Destination” on a Variable in ASC UPP
2510A		Energy Tape Scale Ver Sit
12019		Standardization of FSSR Principal Function I/O Tables
12054B		Horizontal Situation Display Changes
12062A		Nav Event Flag Monitoring Rate
12063		Altitude Precision
12087		Clarification of Level C Nav FSSR Interface Between MSC and 4.214
12109		On Orbit 1, I/O Update
12148		MSBLS SOP Changes
12174A		Mod to Area Nav and the Site Lookup P.F.
12177B		Dedicated Disk Rate Reductions
12190D		PFG Mode Team Apod Changes for Ascent/RTLS Guidance
12191		Delete Rotational Accel of Nav Base WRT CG in Entry UPP
12225B		GN&C Level C Uplink Requirements
12260A		New Method for Computing $h$ , $\dot{h}$ and $\ddot{h}$ within UPP Plus consolidation of UPP Requirements for Entry, TAEM and Autoland
12266A		TACAN SOP & RM
12269		MSID Corrections to IDD Tables

Table R.2-1. Historical Change Request Summary

CR No.	OI	CR Title
12285		Structural Body to M50 Transformation Changes to Correct Formulation Errors
12307		Recompute Drag Constant After Major Mass Change
12308		Delete Unnecessary Code in Three-State-To-One State
12312		Change Criterion for Setting the Nav Edit History Indicator
12316		GN&C Switch RM Processing Rate Reduction
12324		Convert Attitude Function Output Units From Deg to Radians
12325A		Initialization of UPP Propagator During OPS-3
12328A		Event Light Modification
12336		I-Load OFT-1 Baseline
12337		I-Load OFT-1 Baseline
12338		I-Load OFT-1 Baseline of Constants
12339		I-Load OFT-1 Baseline of Removals
12349A		RCS Jet Select Logic
12353B		Entry Displays Simulation Update
12402		Measurement Dependent Scale Factor for the Filters Residual Edit Test
12403A		MSBLS Range Elevation and Azimuth Limits
12418B		Amend Previously Approved CR 12418A, Baro, Altimeter Nav Data
12423A		Changes to the Ascent/RTLS & Entry Nav FSSR's to Obtain Altitude Data
12432A		Mod to the Area Nav P.F.
12442A		Integrated Ent Nav
12443		I-Load for Entry FACI
12456A		Page Changes for CR 12338
12499D		Manual Landing SOP
12307		Raise the Use IMU Data
12517		Horizontal Situation Display Changes
12331		Change Method of Init Parameters
12561A		GAX and Sys Summary
12600C		Integration MSID Assignment for Uplink D&C and GNC Req MTS for OPS 1,2,3,6,4,9
12606A		IMU RM Mode Team
12649		Entry/Orbit Uplink
12696		UPP Drag Acceleration Protection
12698A		TACAN SOP/Site Lookup Interface
12790		Update Values of UPP Parameters Specified as Removals in CR 12443
12819A		OFT-3 and S/W Revisions to On-Orb/Rend Nav Covariance Matrix Propagation, & the On-Orbit/Rec Seq

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
12826A		Vent Door Control CPDT
12848H		Optional TAEM Targeting
12873		Correction of Equation to Compute V-mag
12974		Time-Tag Adjustment to Correct Downrange Nav Errors
19017A		Nav OFT-1 Downlist Cleanup
19041		Entry/Orbit Uplink Consistency Details to Support CR 12649
19044A		Clarification of PL/SM Interface Addition
19058A		Horiz Sit Display-Change
19188		I-Load MSID Reassignment
19256A		TAEM HAC Selection
19246		Corrections to Runway Name
19100		FSSR Update
19361A		Nav Update (STS-2)
19373B		Runway/TACAN/MLS Mini-Table Parameter
19427B		Removal of Direct Call to Precise Predictor by Cycle Nav
19548		Modification to Nav event light logic I-Load Correction for Version 2.3
19556A		I-Load Correction for Version 2.3
19557		Scrub GRTLS Guidance by Deleting Glide Slope Index
19563		Make Sure Single State Nav Always Uses IMU Data From STS PROP (Post. STS-1)
19300		FSSR Update No. 2
19550		FSSR Update No. 3
19611A		Provide Time-Homogenous Data to Navdad Sop
19679B		Horizontal Situation Display Documentation and Delta T Update Changes (STS-1)
19649A		Delete Entry Prec Pred From OPS-1 & 6 S/W (ASC GUID)
19700		FSSR Update No. 4
19710		Alteration of Preland Nav Control Sequence
19731		Use of TACAN Data Good Flags as Selection Criteria in Preland
19767		Variable Type Not Consistent in Requirements
19810B		STS-2 Nav Downlist Delta
19829		Radar SF has 3 Instead of 2 Units
19857B		UPP I-Load & Requirements Changes
19858A		Change UPP State Prop Rate in MM303
29041A		Deletion of Elev Ang Test I-Load
29149B		Add Program Interrupt Handling to Level A CPDS
29259		NAV Filter TACAN Variance IL

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
29300		FSSR Update
29312A		Range to Landing Site Task in MM303
29349		Units Correction for Nav Related I-Loads
29355		Use of IMU Sensed Velocity Within
29471B		HFE Overrun Definition
29500		FSSR Update No. 7
29508A		Position Vector SEL_DELT_STATE UPDT
29589A		Update Site Dependent Params
29591A		Update Design Dependent Params
29657C		STS-1 Cycle 3.1.1 MPAD I/L
29660A		Current Vehicle Mass Update
29699A		D&C Usage of GUID I-Load
29730C		Delta AZ Digital DISP_ENT TRA
29740		Change I/L for Nav Drag Model
29741A		Nav Drag Model Function of ALT
29781A		HSD Disp/Spec Doc. Corrections
29841A		TACAN Bias Deletion
29889		Updates for TACAN Stations
29938		STS-1 Cycle 3.2.2 – AOA to EDW
29972B		Update STS-2 D/L Loading
29999A		OTT Rewrite
39076A		I-Load Values-TACAN Site Data
39084		I-Load Value AOA/EDW
39087A		Head Up Display (HUD)
39100A		CR Implement Baseline – December 1980
39173		I-Load Discrepancy Clean-Up
39184E		STS-2 CYCLE 1 MPAD I-Loads
39264E		HUD Autoland Monitor Format (IDD Only)
39267		Cancel CR's 39255 & 39256
39365F		HUD Proc I/O Cleanup
39386B		Drag Proc Baro Display
39398		Delete RA Altitude Use in UPP
39400		FSSR Update #10
39401A		TRANSATLANTIC Abort Landing (TAL)
39405		TACAN Bearing – Variance and EDIT (Ref Only)
39406		NAV Filter DELTA_STATE I-LOADS (Ref Only)
39436F		TACAN and Runway Table Reorganization and Value Updates (Ref Only)



Table R.2-1. Historical Change Request Summary

CR No.	OI	CR Title
39463B		Delete I/L SIG_DIAG_UVW_OPS-2
39473		STS-2 Cycle 1 AOA to EDW NAV (Ref Only)
39493B		HUD Downlist (Ref Only)
39569		STS-2 Cycle 2 AOA to NOR (Ref Only)
39595		CR Implementation Baseline – August 1981
39602B		STS-3 Cycle 2 ORB/ENT I-LOADS (Ref Only)
39604B		STS-3 Cycle 2 AOA to NOR (Ref)
39608		HUD Length of Runway (Ref Only)
39622		Eliminate EDW Mobile TACAN (Ref)
39640		FSSR Update #11
39655		TACAN Y-Mode Selection Fix (IDD Only)
39658E		STS-4 Cycle 1 MPAD I-Loads (Ref)
39790		CR Implementation Baseline – November 1981
39805		Initialize Drag Alt Comp
39888A		TACAN 40 Deg Bearing Glitch (IDD Only)
39898B		I-Load Precision Change
39920		STS-3 CYC3 Seasonal Updates (Ref)
39950		FSSR Update #12
39980		CR Implementation Baseline – February 1982
39988F		STS-5 Cycle 2 DESC/ENT I-Loads (Ref Only)
59013		Add DAKAR RW Length for HUD (Ref Only)
59050		FSSR Update #13
59084A		STS-4 Runway Change (STS-4 Ref Only)
59129		DAKAR TACAN and Runway – TAL (STS-4 Ref Only)
59162		STS-5 Cycle 4 TAL to DAKAR – NAV
59166A		Constant RHO for ALT < 200K Ft
59186A		STS-6 Cycle 2 NAV I-Loads (STS-6 Only Ref)
59220A		CR Implementation Baseline – July 1982
59270A		STS-7 CY-7 NAV/ENT I/L (Ref Only)
59314C		OTT Correction
59350		FSSR Update 6
59362A		Terminate Precise Predictor
59375		CR Implementation Baseline – September 1982
59408D		STS-8 Cycle 1 NAV/ENT I-Loads (R19 Ref Only)
59426F		Landing Site Table Mode
59436		Low Alt MSBLS EL State Update
59450		FSSR Update 7

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
59452B		Stop Low Alt Baro Updates
59545		Add MSID – CR 59436 (I-Loads Ref Only)
59564B		Add MSBLS for DAKAR
59624A		Correct CR 59426F – Landing Site (IDD Only)
59649		Change DAKAR Runway (I-Loads Ref Only)
59650		CR Implementation Baseline – March 1983
59652B		STS–9 Cycle 1 NAV/LAND SITE (I-Loads Ref Only)
59750		FSSR Update 2
59772A		Bypassed HSI/OTT Comp
59876		Add Low–Altitude Check
59926D		STS–11 Cycle L NAV I-Loads (Ref Only)
59960		I-Load Scrub:Landing Site
59971		I-Load Scrub:Nav Utility
59972		I-Load Scrub:Atmosphere
59998		STS–11 and Subs Site Data (Ref Only)
69070		FSSR Update 3
69075		Add TACAN for Zaragoza (I-Loads Ref Only)
69125B		CR Implementation Baseline – September 1983
69145A		Change PASS/BFS IL’s C to X (I-Loads Ref Only)
69154A		STS–14 Cycle 1 NAV I-Loads (I-Loads Ref Only)
69166		Add MSBLS at Zaragoza STS–9 (I-Loads Only)
69189		CR 59452B Cleanup – Low Alt Baro Mod
69212		I-Loads for Zaragoza MSBLS (I-Loads Ref Only)
69221		STS–9 I-Load Patch (I-Loads Ref Only)
69251A		DAKAR Survey Update (I-Loads Ref Only)
69419		I-Load Units Configuration Change – IMRB (I-Loads Ref Only)
69449B		ENT & RTLS SENS SEL UPP RV_MAG
69451I	22	BI-LEVEL MSBLS Data Edit
69516		41–C (STS–13) Drag Const Update (I-Loads Ref Only)
69546A		41–D (STS–14) Drag Const Update (STS–14) (I-Loads Ref Only)
69550B		CR Implementation Baseline March/April 1984
69555A		TAL/RTLS Weather Alternate
69610A		MSID’s Omitted in CR 59426F (I-Loads Ref Only)
69624		41–D (STS–14) Drag Const Update (OI6 I-Loads Ref Only)
69923A		A/L Upp Corrections for Sloped Runways
69997B		Entry TAL + X Aft RCS Dump (I-Loads Ref Only)
69700		FSSR Update 4

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
79074B		Drag Alt Atmosphere Model Update
79217A		Entry Tacan SOP Interface Documentation Cleanup (IDD Only)
79425		CR Implementation Baseline—April 1985
79499		FSSR Update No. 5
79756		Initialize Relative Velocity for Centaur Vacuum Inerting
79790A		CR Implementation Baseline—November 1985
79842C		Inadvertent Mode Transitions
79865D	20	Carryover RW/TAC Design For TAL
79930D		FSSR Update No. 6
89471E		Unique AOA NAV Filter Covariance
89474B		Auto NZ For Contingency Abort (I-Loads)
89501		FSSR STS 83-0004B OI-8b Errata/Baseline
89591		COURSE_WRT_RW Comp Rate Change
89599C		Cleanup To Level B GN&C Document
89620A		Bailout System Cleanup
89625A		STS 83-0004B PCN-1 Errata
89661A		OI-8B K-Load Baseline
89662B		FSSR STS 83-0003B Errata Update
89792E	24	D/L NAV SEQ Cleanup
89805		Errata Change CR 89665B Page 3 And IDD
89864A		Change BEAR_RW Lower Limit Value
89868		Initialize T_STATE_LAST, OLD, Prev. To Zero
89945B		STS 83-0004B PCN-2A Errata
89979F	22	TAEM Guidance Energy Speedbrake Control And Nz Roll Command Limiter
89990E	21	Single Engine Auto Contingency Abort
89991E	21	Entry SSME Repositioning
90000E	20	Abort Landing Area Upgrade
90007G	23	MPS Dump Enhancements
90072	20	UPD DIS Runway Names Upon Runway SEL
90102D	21	LDG Gear Extension Isolation Valve
90112E	21	EXT Duration ORB WOW Sensing Upgrade
90114B	21	Abort Sequencing Redesign
90121B	20	Chg ASC Precise Predictor Term OPS TRANS
90133F	22	HAC Selection And Turn Angle Calculation Improvements
90182	21	SCM Scrub Completion
90185A	20	Add CR Field To FSSR I/O Tables
90256D	23	Mission Independent First Stage I-Loads

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
90265	20	Delete ALT & ALT_WHEELS INIT Requirement
90275A	20	Entry Through Landing Navigation Documentation Update
90291B	20	Ascent/RTLS NAV Doc Update
90302B	22	Entry Downlist Additions
90374C	20	Automated FSSR Constants
90476F	25	Wraparound Yaw Jet System w/PTI Effector
90528A	22	EARTH_POLE Initialization
90591B	22	Entry Downlist Correction
90690A	24	Deletion Of EQTN MSID Column From K-Load FSSR Table
90781C	24	Define Parametric Data Nomenclature(S)
90814C	24	Add Description Of Database Generated FSSR Parameter Tables
90881A	25	FSSR STS 83-0001 Documentation Changes
90883A	23	FSSR STS 83-0004 Documentation Changes
90960E	25	HAC Initiation Predictor And Position Error Displays
91066D	25	Standardize the FSSR Correlation Tables
92027B	25	TDMS-2 Required FSSR Changes