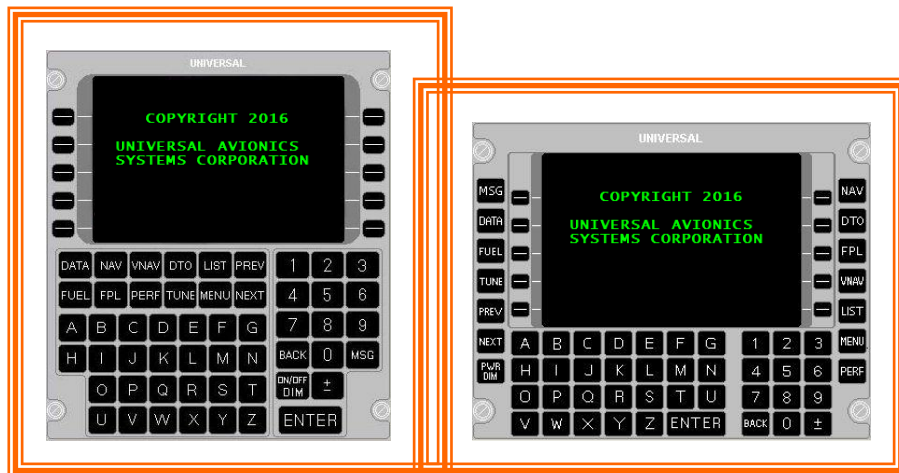


OPERATOR'S TRAINING MANUAL

for

**UNS 1Ew, 1Espw, 1Fw, & 1Lw
FLIGHT MANAGEMENT SYSTEM (FMS) SCN-100X SERIES
and
MULTI MISSION MANAGEMENT SYSTEM (MMMS)
110X SERIES**



**This manual is not for operational use;
it is intended for training purposes only.**

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**THE INFORMATION PRESENTED IN THIS
MANUAL IS FOR
TRAINING PURPOSES ONLY**

This manual is to provide the reader with a basic understanding of the system(s) described.

For detailed and current information regarding operation of equipment, refer to the appropriate UNS Operator's Manual or Technical Manual.

The information provided in this manual is correct at the time of printing however no field revision service is available.

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GENERAL DESCRIPTION

The new “W” series of Universal Avionics Flight Management systems incorporate the Global Navigation Satellite System (GNSS) Satellite Based Augmentation System (SBAS) known in North America as the Wide Area Augmentation System (WAAS), in Europe as the European Geostationary Navigation Overlay Service System (EGNOS), in Japan as the Multi-Function Transport Satellite Augmentation (MSAS), and in India as the GPS and GEO Augmented Navigation (GAGAN). Other SBAS systems in the world will also be incorporated.

The systems are one of two configurations:

1. **UNS-1Ew/1Espw** - a standalone, one unit, combined Flat Panel Control Display Unit (FPCDU) and Navigation Computer Unit (NCU) containing an internal Satellite Based Augmentation System (SBAS) GNSS receiver, navigation computer elements and liquid crystal color display. An external configuration module is mounted to the interface connector. Throughout the remainder of this manual, referral to the UNS-1Ew will include the UNS-1Espw.
2. **UNS-1Fw 1Lw**, - A display only FPCDU and a separate remotely mounted Navigation Computer Unit (NCU) with a rack mounted Configuration Module. The UNS-1Fw & 1Lw NCU also contains a SBAS receiver.

SCN-100X/110X are software versions designed to run on several Universal Avionics FMS systems. SCN 110X is a Multi-Missions version of the 100X software and is designed to run on MMMS systems. Either software version can run in the UNS-1Ew, UNS-1Espw, UNS-1Fw, and UNS-1Lw.

The system software version is displayed on the INIT (Initialization) page following completion of the power on self-test, or may be accessed under the DATA key. The version is also on the FMC/NCU data plate.

The decimal point in the software version indicates minor software changes. To the right of the decimal point for example, 1000.1 to 1000.2 are minor changes. If written in the aircraft flight manual as 1000.X, no re-certification is required, and no revision of the Flight Manual Supplement or Operators Manual is required.

Where the above software versions differ from one another in operation, a statement explaining the differences will be included.

OPERATIONAL SOFTWARE DIFFERENCES

The software differences listed below are directed at the FMS operator and specifically cover changes that will be seen by the operator. A complete description of changes and improvements are available through the corresponding Universal Avionics Service Bulletins.

SCN 100X/110X

SCN 100X and the MMM version 110X, require a new FMS. The new FMS are the 1Ew, 1Espw, 1Fw, and 1Lw. This software is adapted to integrate the Satellite Base Augmentation System (SBAS) into the navigation sensor suite. Under SBAS is WAAS for North America, EGNOS for Europe, MSAS for Japan, and GAGAN for India.

The following are operational changes from the preceding software.

SCN 1000/1100

- Added a "+" sign to indicate a positive value in the VDEV field on the VNAV Path Page.
- Improved position accuracy calculations by refining inputs to the multi-sensor Kalman filter used to determine actual navigation performance (ANP).
- Removed waypoint overfly as the default to the precision arc (RF) procedural leg type and added an "overfly" (OVFLY) option to the SID, STAR and Approach RF Leg Definition Pages.
- Improved software to ensure temperature compensation is not applied to manually entered altitudes at final approach course fixes (FACF).
- Improved synchronization functionality to ensure SYNC mode is retained when two independent FMS with Selected Crosstrack (SXTK) active are synchronized.
- Incorporated routine update to the magnetic variation model.
- Modified software to prevent erroneous NO INTERCEPT message during large course changes.
- Now shows multiple approaches of the same type to a same runway by adding an identifier suffix to uniquely identify each approach.
- Added the capability for deviation steered autopilots to fly advanced approaches. An Advanced Approach Deviation Steering configuration option was implemented to enable this functionality.
- Updated the missed approach functionality to maintain approach scaling and alerting until the missed approach waypoint is sequenced.
- Modified software to maintain approach scaling on the first missed approach leg when that leg is a TF leg type.
- Added to the crossfill functionality GPS required and approved information to ensure GPS required and GPS allowed approaches are crossfilled, and to prevent the deselection of the offside FMS's GPS when the approach is armed.
- Improved flight plan auto-link functionality to select the first instance of a waypoint when multiple waypoints exist in a terminal procedure, i.e. when a course reversal (HF leg) exists in the flight plan.
- Modified approach logic to allow approach arm/activation when the flight plan is unlinked.
- Modified software to use published required navigation performance (RNP) values from the navigation database (when an RNP value exists) for full scale lateral deviation output.

- Removed automatic approach Predictive RAIM feature as it is no longer required per TSO-146b.
- Added Satellite Based Augmentation System (SBAS); charted as RNAV (GPS or GNSS) approaches, to the navigation database.
- Added GPS/WAAS sensor configuration options (antenna offsets, approved SBAS providers, analog deviation hi/lo level voltages) to configuration pages.
- Added GPS/WAAS provisions to power-up, self-test, configuration and initialization functions, including test and status of the WAAS/ARINC board.
- Added select and deselect logic for the GPS/WAAS sensor. New WAAS sensor pages provide sensor status, integrity status, sensor and satellite selection/ deselection. Data Pages 2 and 4 have been updated to reflect GPS/WAAS sensor status.
- Added SBAS approach provisions to the flight plan function. This includes the ability to select a SBAS approach by entering its Channel ID and displaying SBAS approaches with a "W" prefix on approach lists to indicate LPV Level of Service (LOS) availability.
- Added an RNAV Approach LOS page from which the SBAS approach LOS may be viewed or selected. The Navigation and Navigation Approach pages have been modified to provide access to this page. Level of service includes LNAV, LNAV/VNAV and LPV.
- Improved the approach interface to support the selection of SBAS (RNAV (GPS)) approaches and approach guidance function.
- Revised FMS default RNP values for oceanic, enroute and approach flight phases to reflect greater accuracy requirements. Oceanic operations have been revised from 6.0 nm to 4.0 nm; enroute from 2.8 nm to 2.0 nm; and approach from 0.5 to 0.3 nm.
- Added a SBAS Approach LOS annunciation to the Navigation Approach Page.
- Adjusted inputs to the multi-sensor position filter to incorporate the GPS/WAAS sensor. Modified Navigation Approach pages to display the SBAS approach Horizontal and Vertical Protection Levels (HPL/VPL) and corresponding Horizontal and Vertical Alert Level (HAL/VAL) as a measure of position accuracy.
- Modified ANP calculation to comply with FAA guidance AC 90-101, Approval Guidance for RNP Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR), Design Assurance Level C.
- Modified estimate of position accuracy logic for LNAV approaches to employ the most precise RNP value for HAL calculation, regardless if it is manually entered or derived from the navigation database.
- Modified the navigation function to disable the position correcting function when a high integrity GPS / WAAS position is available.
- Updated synchronization function to accommodate SBAS approach capabilities.
- Improved crossfill functionality in dual FMS installations to ensure all applicable vertical waypoints are consistently crossfilled to the VNAV flight plan.
- Improved VNAV data output to ensure seamless coupling to autopilot and flight director systems interfaced with the FMS.
- Improved software to display vertical target speed (VTGT) on the Landing Performance Page.

- Improved the suggested COM frequencies list by providing arrival COM frequencies such as ATIS, Tower, and Ground Control, when approaching the destination airport.
- Added functionality to download FMS configuration settings onto a disk via the Data Transfer Unit (DTU).
- Added on the last NAV page distance and bearing to ***EOA*** when within 99nm of ***EOA***.
- Added a REFRESH option to the Level of Service (LOS) page to require the SBAS LOS to be reviewed for a change in the Level of Service. (SCN 1000.5 and subsequent)
- On an RF leg the distance is computed as along track distance. (SCN 1000.6 and subsequent)
- For LPV and LNAV/VNAV, the FMS will compute the vertical glideslope from the FAF to the MAP with intermediate stepdown waypoints providing advisory information. (SCN 1000.6 and subsequent)
- Updated software to maintain the selected state of the temperature compensation function throughout the approach and missed approach. Previously, temperature compensation was cancelled by the FMS when sequencing the FAF for LPV and LNAV/VNAV LOS approaches. (SCN 1000.8 and subsequent)

Refer to the applicable UASC service bulletins for a complete list of SCN 1000.0/1100.0 through 1000.8/1100.8 changes.

SCN 1001/1101

The following operational improvements have been implemented in SCN 1001/1101 as it evolved from SCN 1000.5/1100.5 and includes changes and improvements made through SCN 1000.8/1100.8:

- Added the capability to output and display an Active Speed Limit using procedural speed limits, airport speed restriction, and maximum holding speeds.
- Modified software allowing an FMS operator to initiate a request for updated flight level winds through UniLink and, upon reception of those winds, have them automatically applied to the flight plan predictions. UniLink required
- Added a new advanced display bus that supports UASC display products.
- Improved software allowing the FMS operator to have access to all related annunciations on the Message page (MSG).
- Updated software so CDU page references are changed from WAAS to SBAS where appropriate.
- Added the capability for the pilot to plan and direct the FMS to perform a DTO in a specified direction after sequencing a waypoint.
- Created a new SBAS DIAG page to display GPS altitude and ground speed.
- Corrected software so that when GO AROUND activates, the FMS deletes the *EOA* gap, regardless of where the EOA gap is in the Guidance Leg Set.
- Updated software to ensure that when the TEMP COMP page is accessed, after the airport has changed since the last time the page was accessed, the temperature correction is referenced to the proper airport.
- This software update erases the mark-on-target waypoint database when the FPL ERASE discrete is activated for more than 3 seconds. SCN 1101
- Modified software to display the correct bearing on the FPL pages for course and heading legs when magnetic variation is invalid when manual variation is entered and will display the Mag/True reference consistently based on the Mag/True State of the FMS. The FMS will use Airport MAGVAR when System MAGVAR is not defined at the airport reference location.
- Updated software by retaining speed limit, altitude constraint, and RNP when the inserted procedure is linked to the adjacent segments.
- Modified software so that the message "TOD ALERT" is activated when the 2-minute alert window is reentered.
- Updated software to prevent VDEV output error when a new target VS is entered.
- Modified software so that temperature compensation remains engaged when an LPV or LNAV/VNAV approach is active.
- Added FlexPerf Trip Performance function in the FMS to provide for crew planning of the performance climb, cruise and descent phases of flight, and to compute the resulting vertical trajectory of the airplane and fuel consumption. This feature is only applicable to FMS/MMMS with FlexPerf hardware installed indicated by the part number; refer to the Equipment Specifications section of the applicable FMS Installation Manual. FlexPerf requires an aircraft specific FlexPerf database. Contact Universal Avionics for a list of currently supported aircraft.

- Added a new critical guidance bus for an LP/LPV capability that emulates an ILS approach output from a VOR/ILS receiver to the flight guidance system.
- Modified software to enable the FMS to meet new requirements for handling terminal area procedures that have a mix of RNP and non-RNP legs.
 - Procedural RNP no longer propagates to subsequent legs.
 - Adherence to procedural RNP has been rendered stricter in cases of manual leg change.
 - Lateral full-scale deflection is now sensitive to crew-entered RNP.
 - Analog lateral deviation output outside of approach is now sensitive to procedural and crew-entered RNP.
 - Automatic changes to the lateral full-scale deflection is now annunciated on the NAV page.
 - Automatic changes in the lateral full-scale deflection will now occur gradually over 30 seconds.
 - Capability to manually select Lateral scaling modes has been removed.
 - Increase manual RNP limit from 5nm to 25nm.
 - Leg RNP value is propagated into the first approach waypoint when appropriate.
- Updated software to inhibit inserting manual holding (HOLD) into the approach common segment. Instead, when the approach waypoint is selected, the hold pattern is defined for off flight plan only.
- Modified software to compute a Flight Path Angle (FPA) to the first approach waypoint.
- Modified software to compute hold entry type based on bearing from present position to the hold fix when the hold is on the flight plan and there is no prior leg that provides an inbound course.
- SCN 1001.1: Add configuration option LINEAR VDEV SCALING to the configuration option list (adds VDEV configurable scaling capabilities). This adds configurable scaling capability to output VDEV scaling in Linear or Angular scaling for other than LPV approaches. When configured for linear scaling, full scale deflection is 150 feet.
- SCN 1001.1: Removed the condition where FAF must be sequenced prior to the missed approach armed state becomes active and allows selection of the missed approach procedure whenever approach mode is active.
- SCN 1001.1: If there is a missed approach in the FPL, display "MISSD APPR" option outside and inside FAF.
- SCN 1001.1: For advisory approaches, "MISSD APPR" option will not be displayed, and EOA gap will not show in the guidance leg set.
- SCN 1001.1: Adds new configurable discrete outputs and configuration options for LOW GP GNSS, LOW GP BARO, LOW GP COMB, and adds logic related to Low Glidepath alerting for SBAS/LPV, LNAV/VNAV, and baro-VNAV approaches. The new discrete output options were added to the configuration option list to annunciate when the aircraft is more than 75 feet below the vertical path after the FAF or 1.3 dots below glide path (-1.3 DDM for LPV and LNAV/VNAV approaches and -75 feet for baro-VNAV referenced approaches). This feature is meant to augment those aircraft that do not have TAWS A or EGPWS systems with Mode 5 alerting (an alert similar to TAWS Mode 5 alerting).
 - This analog discrete output is available for an aural or annunciated low glidepath alert.

- SCN 1001.1: Adds support for four new ARINC input busses and four new discrete inputs. These inputs are monitored for data indicating the state of ADS-B Out or transponder failure. This improvement adds a monitor with messaging to alert the crew to a failure of the ADS-B out system. The status labels from an ATC/Mode-S transponder system are monitored by the FMS and used to detect a failure in the system. □
 - Four (4) new configurable ARINC 429 input buses to interface with Rockwell Collins TDR-94(). These are LS XPDR 1, HS XPDR 1, LS XPDR 2, HS XPDR 2
 - Four (4) new configurable discrete inputs to support transponder fail and ADS-B OUT function fail for two transponders. These are XPDR FAIL1, XPDR FAIL2, ADS-B FAIL 1, and ADS-B FAIL 2.
- SCN 1001.1: The software change displays "DISTANCE TO GO" for RF legs on the FMS CDU NAV page to help plan for crossing altitude restrictions. DISTANCE TO GO is also output for RF and AF legs. The software change adds a new configuration option to display/transmit along-track distance or direct distance when flying RF legs.
- SCN 1001.2: This software updates logic for triggering XPDR FAIL and ADS-B OUT FAIL messages.

Refer to the applicable UASC service bulletins for a complete list of SCN 1001.0/1101.0 and SCN 1001.1/1101.1 and SCN 1001.2/1101.2 changes.

SCN 1002/1102

The following operational improvements have been implemented in 1002.0/1102.0/1102.0M as it evolved from SCN 1001.1/1101.1/1101.1M

- Adds LP Approach functionality:
 - o Transfers guidance from PAS to FMC without flagging lateral guidance when an LP approach exits for reasons other than flagging the lateral guidance (pilot-initiated missed approach, DTO, or other flight plan edits that cancel the approach).
 - o Updates IFDR and EFDR reporting to accommodate LP approaches.
- Updates multi-mission software to include a Transition-To-Hover search pattern which can be activated by the existing mark on target function. The improvement includes ARINC 429 input / output buses for integration with a Sagem Avionics CDV-155 Flight Director Coupler for guidance and steering initially for the Super Puma helicopter.
- Adds support for the Eurocopter EC155 ARINC Interface Hover Mode.

Refer to the applicable UASC service bulletins for a complete list of SCN 1002.0/1102.0 changes.

UNS-1Ew DESCRIPTION

The UNS-1Ew Flight Management System incorporates a navigation computer, a SBAS GNSS receiver, and control/display functions all contained in one DZUS-mounted unit with 5-inch color flat panel display. Analog and digital interface versions are available.

The UNS-1Ew is certified to TSO-C115b, TSO-C129a classes A1/B1/C1, TSO-C145a, and TSO-C146C. It meets the GPS navigation operational approvals and Minimum Navigation Performance Specifications (MNPS) for navigation within North Atlantic Track (NAT) airSatellite. Dual UNS-1Ew installations meet the requirements for GPS as Sole Means and Primary Means of Navigation in oceanic/remote airSatellite, IAW 8110.60, 8400.12a, and 8400.33 when installed IAW AC 20-138().

With the internal Satellite Based Augmentation System (SBAS) receiver, navigation can be done with SBAS accuracy throughout all phases of flight. RNAV, GPS, GPS-overlay and LPV approaches are contained in the database along with their transitions and missed approach procedures.

The sophisticated software program provides features including flight planning capabilities with SID/STAR procedures and airways, a Best Computed Position, auto-scanning DME-DME, enroute maneuvers such as Direct-To, heading commands, and PVOR tracking, VNAV, holding patterns; a 3-D approach mode and more. There is also fuel management and optional frequency management. In addition to a 32-megabyte NAV database capacity, memory is allocated for aircraft-specific performance features. The UNS-1Ew incorporates RS-422 inputs and outputs for support of an optional external Flat Panel Control Display Unit (FPCDU).

The color flat panel display on the UNS-1Ew can accommodate external RGB video sources. This optional feature allows you to interface exterior video cameras, as your applications require.

Video signals can also be accommodated from a Cabin Display System. These signals must be in a RGSB format.

UNS-1Espw DESCRIPTION

The UNS-1Espw incorporates the same navigation computer, SBAS GNSS receiver, and control/display functions as found in our UNS-1Ew Flight Management System, but is more compact and lighter weight. The UNS-1Espw is an all-digital system and is specifically designed to provide the most advanced flight management features and capabilities for those aircraft with full digital interface architectures.

UNS-1Fw DESCRIPTION

The UNS-1Fw FMS takes the features of the UNS 1Ew, adds additional interface capabilities, and divides it into the Navigation Computer Unit (NCU) which houses a SBAS GNSS receiver and a 5" color Flat Panel Control Display Unit (FPCDU). Because the FPCDU is only 3.5 inches deep, it will fit in either the panel or pedestal. Also available is an optional 4" color flat panel display, which is only 3.25 inches deep. Whether the cockpit is analog or digital, the UNS-1Fw communicates with most all flight guidance systems, autopilots, and cockpit displays.

UNS-1Lw DESCRIPTION

The UNS-1Lw are designed with features and capabilities from Universal's top-of-the-line Flight Management Systems (FMS). Incorporated into a more compact, lightweight system, it has a color display, line select keys, and intuitive operating program, to comfortably manage the most complex flight maneuvers efficiently and quickly for increased flight safety. The internal SBAS GNSS receiver enables operations throughout all phases of flight, including approaches.

Like the UNS 1Ew and 1Fw, the UNS-1Lw is certified to TSO-C115b, TSO-C129a classes A1/B1/C1, TSO-C145a, and TSO-C146C. It meets the GPS navigation operational approvals and Minimum Navigation Performance Specifications (MNPS) for navigation with North Atlantic Track (NAT) airspace. Dual UNS-1Lw installations meet the requirements for GPS as Sole Means and Primary Means of Navigation in oceanic/remote airSatellite, IAW 8110.60, 8400.12a, and 8400.33 when installed IAW AC 20-138().

A 4" color Flat Panel Control Display Unit (FPCDU) is used with the UNS-1Lw. Because the FPCDU is only 3.25 inches deep, it will fit in either the panel or pedestal. Also available is an optional 5" color flat panel display, which is only 3.25 inches deep.

Fuel sensor inputs are accommodated in a variety of formats. Two engine capability is standard with an option of up to four engines. The UNS-1Lw communicates with virtually all flight guidance systems, autopilots, and cockpit displays, both analog and digital.

The software provides features including access to the largest NAV database in the industry, flight planning capabilities with SID/STAR procedures and airways, a Best Computed Position (BCP) for secondary navigation functions, auto-scanning DME-DME, enroute maneuvers such as Direct-To, heading commands, VNAV, holding patterns and 3-D approach mode, fuel management, and optional frequency management. Memory has also been allocated for aircraft-specific performance features for selected aircraft types.

DATA TRANSFER UNIT DTU-100 & SOLID STATE DESCRIPTION

Universal's Data Transfer Unit (DTU) is a small lightweight drive unit that is mounted in the aircraft. The DTU will be directly wired to each FMS and will require a dedicated +28 VDC. The DTU has an Ethernet port to provide a high-speed interface to the FMS (This is also available as a Portable Data Transfer Unit). The load medium is a 100mb Zip drive for the DTU-100 and flash memory drive or SD card for the Solid State DTU

The DTU will be used for multiple tasks, which are:

- Updating navigation worldwide or regional data base every 28 days
- Loading pilot data defined off-line, such as routes, approaches, and pilot waypoints
- Down loading pilot data from the FMS, such as routes, approaches and pilot waypoints
- Loading aircraft specific performance data
- Down loading maintenance log
- Down loading flight log
- Down loading computer diagnostic data
- Down loading and up loading FMS configuration

ETHERNET INTERFACE

The FMS can interface with the Avionics Local Area Network. The FMS Ethernet controller connects to a 10BASE-T twisted shielded pair cable. The FMS, through the Avionics Local Area Network will connect to other Universal Avionics products such as the DTU and TAWS.

SYSTEM COMPONENTS

5" FLAT PANEL CONTROL DISPLAY UNIT (FPCDU),



UNS-1Ew/Espw & 1Fw

- Color display
- 5-inch diagonal high resolution flat panel active matrix liquid crystal display
- Graphics capabilities
- External Video capabilities
- Full alpha keyboard
- Full numeric keyboard
- Eleven function keys
- Ten line-select keys
- Pilot-friendly menu operation
- DZUS0 rail mount

SYSTEM COMPONENTS

4" FLAT PANEL CONTROL DISPLAY UNIT



UNS 1Lw (UNS-1Fw option)

- Color display
- 4-inch diagonal high resolution flat panel active matrix liquid crystal display
- Full alpha keyboard
- Full numeric keyboard
- Eleven function keys
- Ten line-select keys
- Pilot-friendly menu operation
- DZUS rail mount

SYSTEM COMPONENTS

MULTIFUNCTION FLAT PANEL CONTROL DISPLAY UNIT (MCDU)



UNS 1Fw (Optional)

The MCDU is designed to accommodate users with additional features the standard CDU will not provide. In addition to the standard CDU keys, there are additional line select keys, function keys, and alphanumeric keys designed to support non-Universal subsystems such as SatCom. Systems utilizing the ARINC 739 bus protocol may be integrated with the MCDU.

Specific operations of the MCDU are covered in the FMS MCDU Supplement provided upon purchase.

SYSTEM COMPONENTS

DATA TRANSFER UNIT (DTU-100)

▪



- Database loading via ZIP disk
- Accommodates PC100 ZIP disk
- Read capability:
 - Navigation Database updates
 - UNS Off-Line Flight Planning Disks
 - Jeppesen-Jet Plan Flight Plan Disks
 - Pilot defined database disks
 - Electronic Check List Disk
 - Performance database disk
- Write capability:
 - Pilot Data downloading
 - Flight Data Recording
 - Avionics Diagnostics
- Aircraft mounted or portable versions available
- Built-in self-test

SYSTEM COMPONENTS

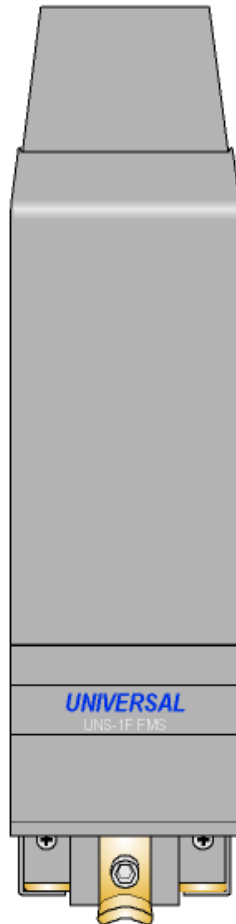
DATA TRANSFER UNIT (SOLID STATE)



- Database loading via USB Flash Memory Stick or SD Memory Card
- Accommodates Standard USB Flash Memory Stick or SD Memory Card
- Read capability:
 - Navigation Database updates
 - UNS Off-Line Flight Planning Files
 - Jeppesen-Jet Plan Flight Plan Files
 - Pilot defined database Files
 - Electronic Check List Files
 - Performance database Files
- Write capability:
 - Pilot Data downloading
 - Flight Data Recording
 - Avionics Diagnostics
- Aircraft mounted or portable versions available
- Built-in self-test

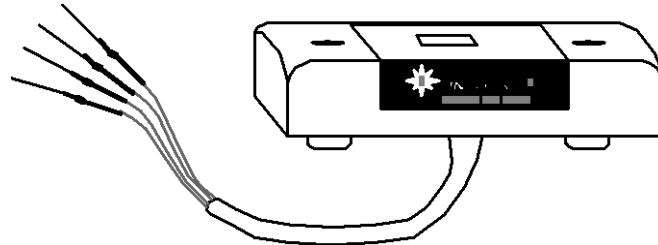
(Ethernet RJ-45 connection provisional)

SYSTEM COMPONENTS NAVIGATION COMPUTER UNIT (NCU) (UNS-1Fw, UNS-1Lw)



- Navigation Management
Digitally coupled lateral/vertical guidance
- Sensor/communications Management
Eight ARINC 429 high/low speed ports
- Fuel Management
Four Fuel Flow inputs
- Frequency Management
- 32 megabyte NAV database capacity

SYSTEM COMPONENTS CONFIGURATION MODULE

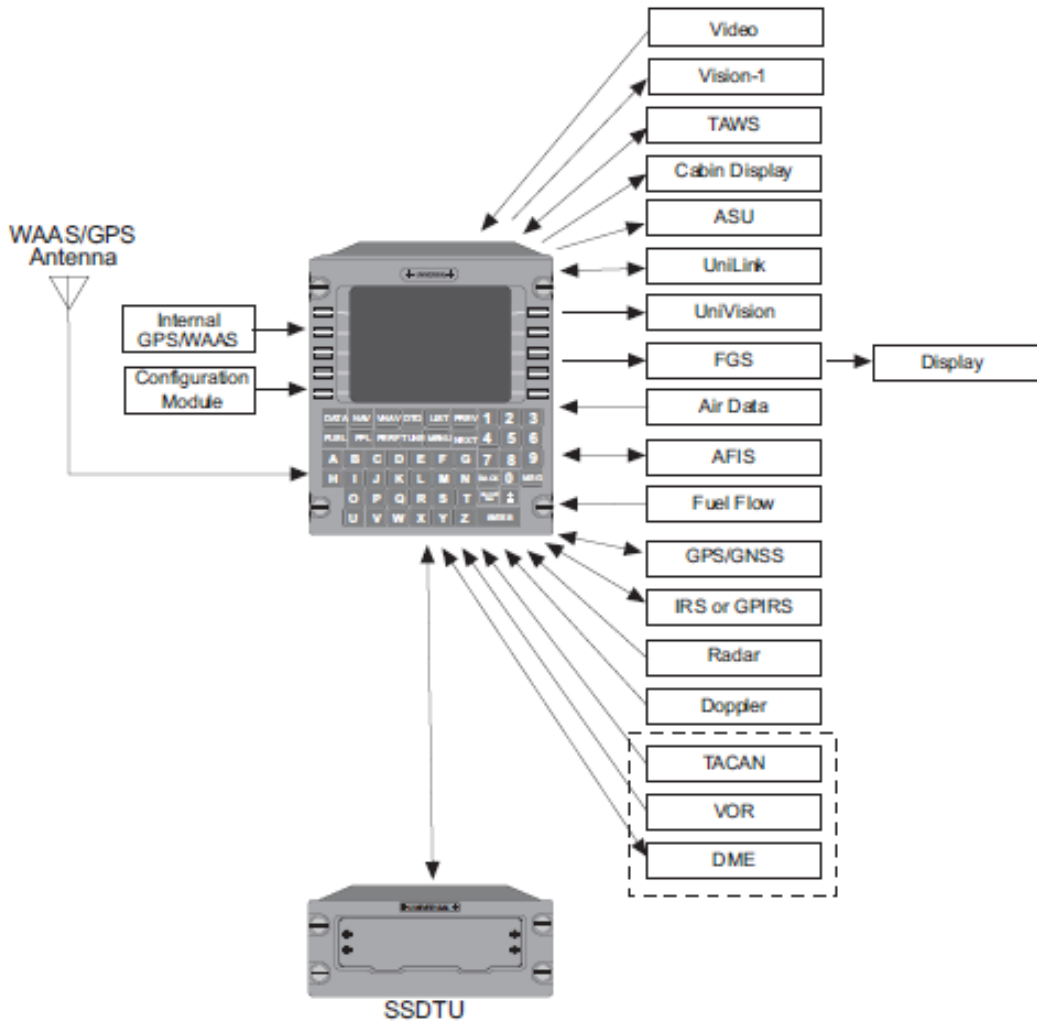


- Serially connected EEPROM
- Connector-mounted or Rack-mounted aircraft Configuration Module
- Eliminates strapping wires
- Programmed through CDU at installation
- Sets up NCU for aircraft/sensor interface:
 - Sensor Inputs
 - Fuel Flow
 - Air Data
 - Instruments
 - FGS

SYSTEM DESCRIPTION

1Ew/1Ewsp BLOCK DIAGRAM

(1Ew shown)



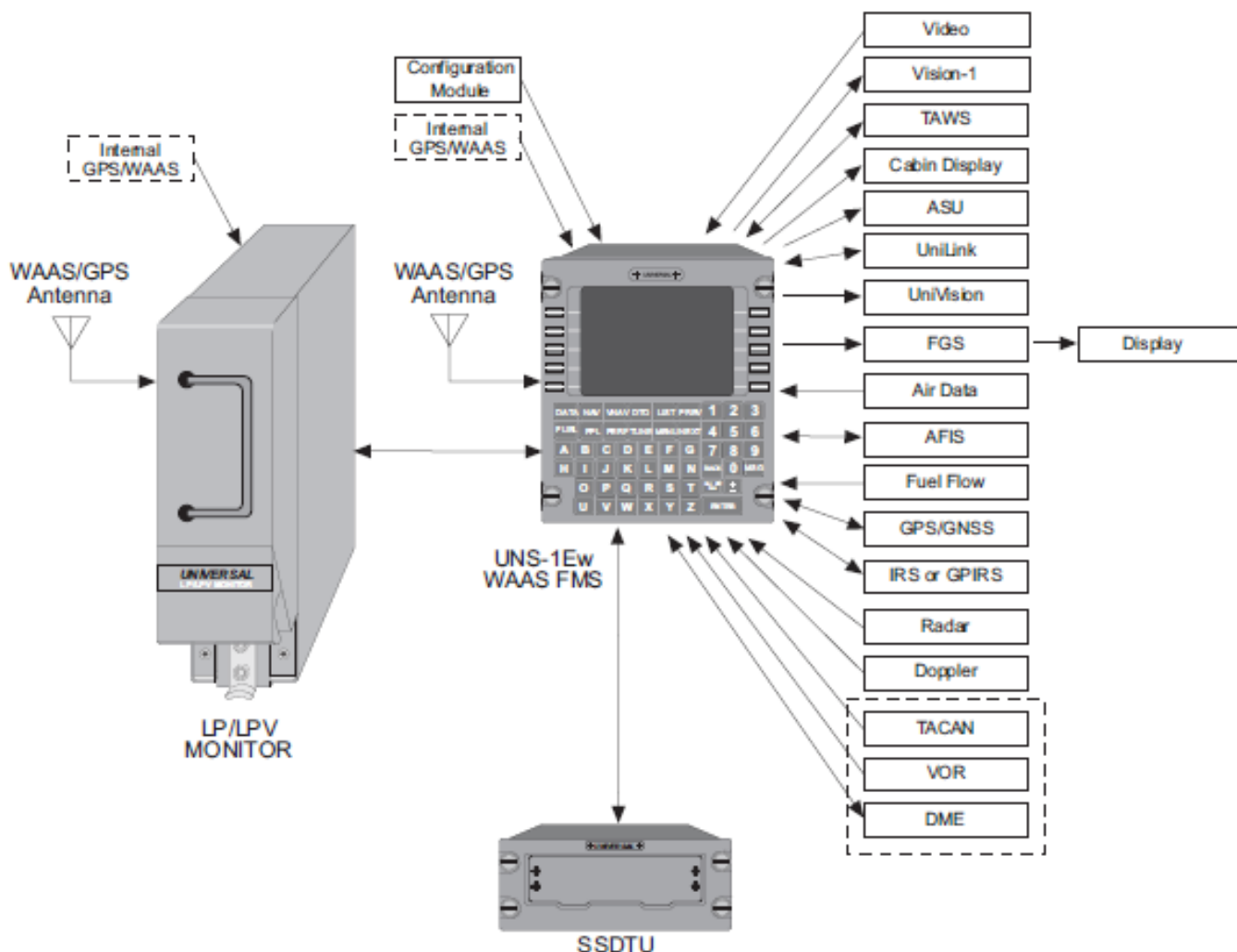
Single FMS Installation Description

The FMS computes position and provides selected information to the associated flight instruments and sensor control to all sensors. The FMS houses an internal database which includes charted data from suppliers such as Jeppesen and pilot input data such as routes and approaches.

NOTE: Single FMS installations not utilizing an LP/LPV Monitor, the UNS-1Ew will not provide precision approach functions.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Ew/1Ewsp BLOCK DIAGRAM



(1Ew shown with LPV monitor)

Single FMS Installation Description

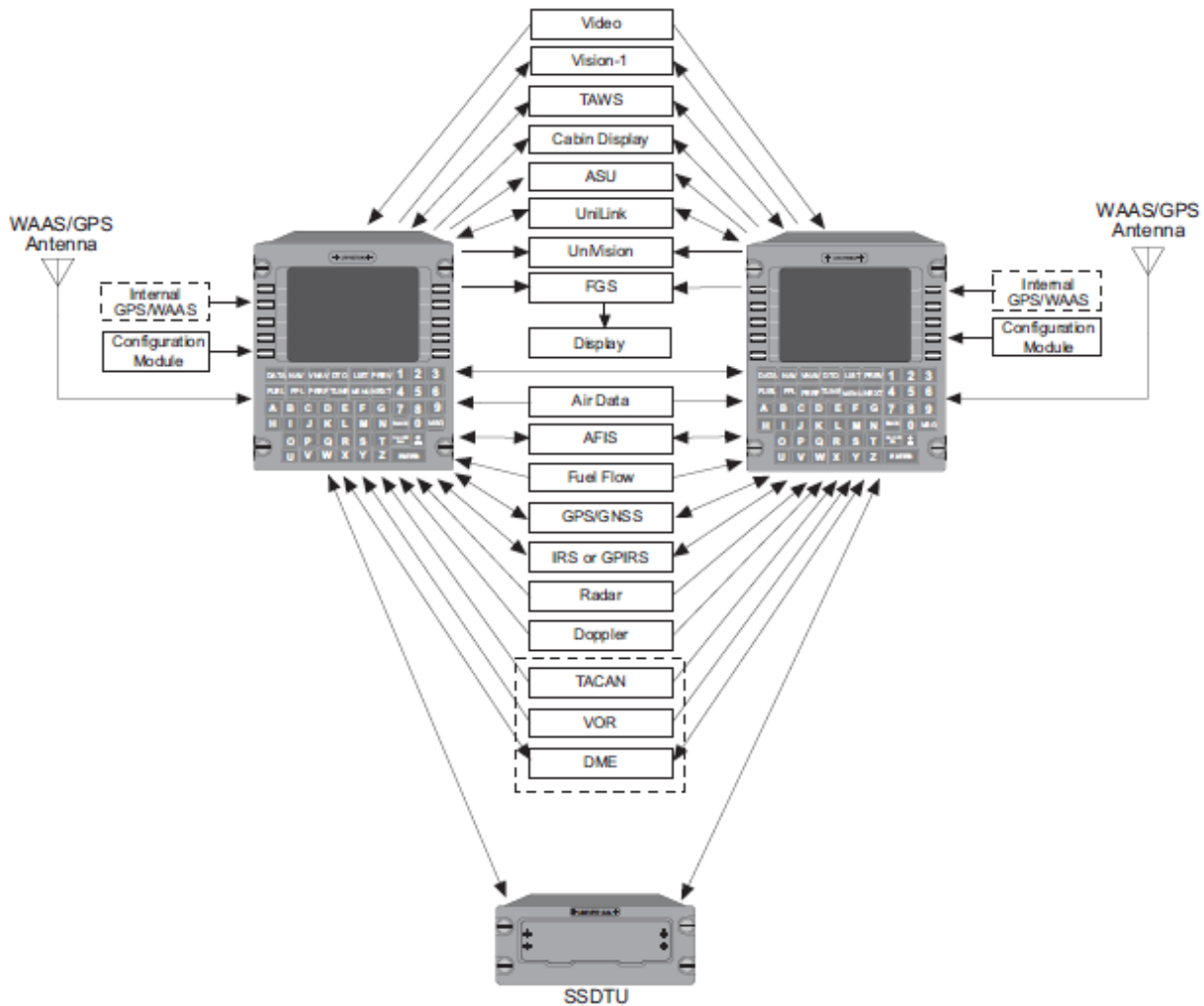
The FMS computes position and provides selected information to the associated flight instruments and sensor control to all sensors. The FMS houses an internal database which includes charted data from suppliers such as Jeppesen and pilot input data such as routes and approaches.

NOTE: Single FMS installations not utilizing an LP/LPV Monitor, the UNS-1Ew will not provide precision approach functions.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

NOTE: Shown in single FMS configuration – may be installed in multiple FMS configurations.

UNS-1Ew/1Ewsp BLOCK DIAGRAM
(1Ew shown)



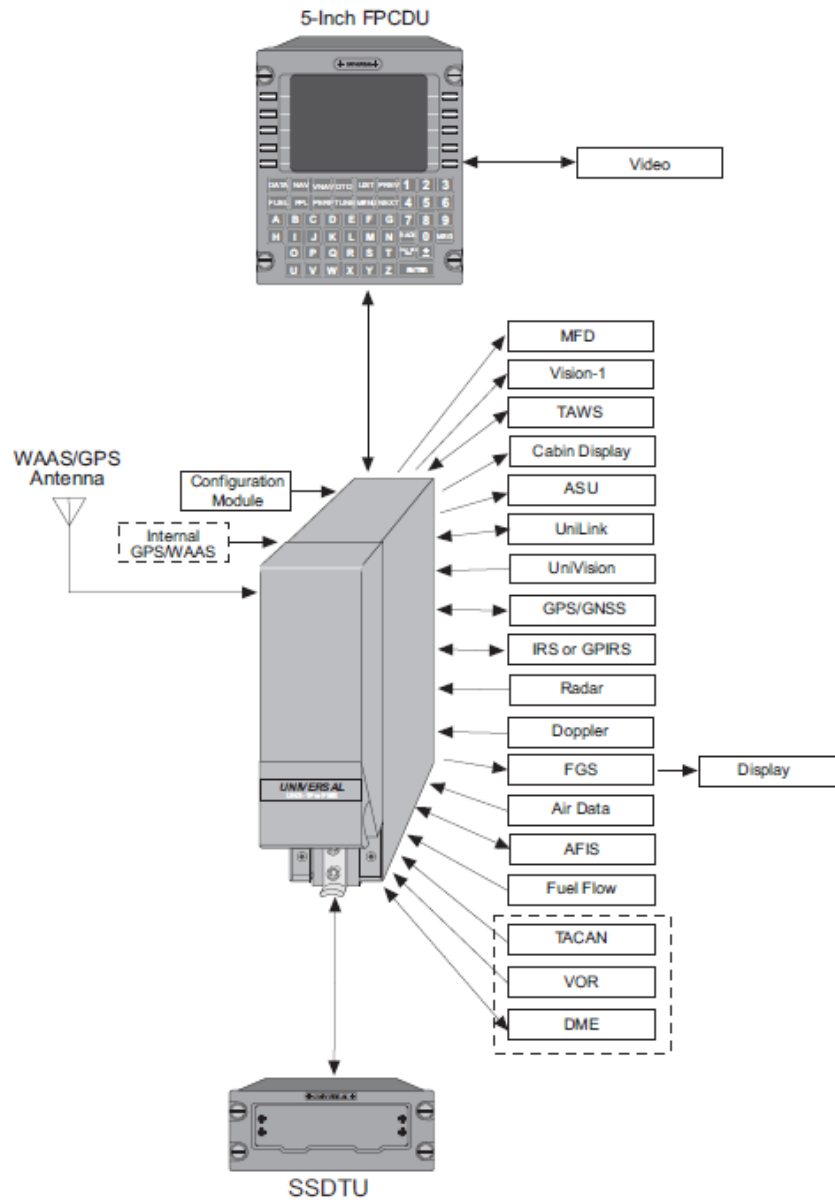
Dual FMS Installation Description

In dual installations, each FMS communicates with the other, sharing flight plan and navigational information. Typically, in dual FMS installations, all long-range navigation sensors are interfaced with both units. Each FMS computes an independent position using all available navigational sensors and provides selected information to the associated flight instruments. Each FMS shares its best best-computed position with the other system and continuously monitors the other system's position output. Each FMS houses its own internal databases. These include charted data from suppliers such as Jeppesen and pilot input data such as routes and approaches.

NOTE: The block diagram shows the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Fw BLOCK DIAGRAM

(1Fw shown with 5" CDU; 4" CDU available)



Single FMS Installation Description

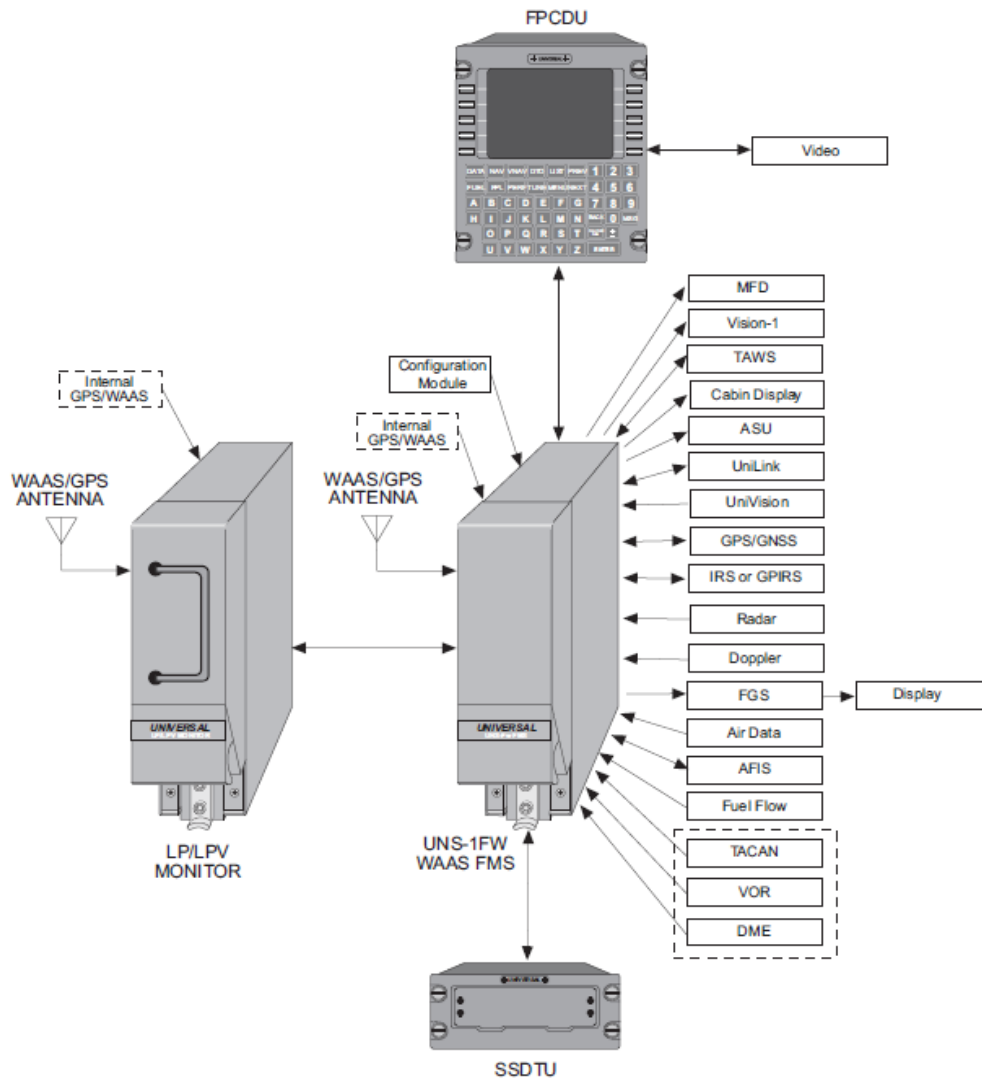
The FMS computes position and provides selected information to the associated flight instruments and sensor control to all sensors. The FMS houses an internal database which includes charted data from suppliers such as Jeppesen and pilot input data such as routes and approaches.

NOTE: Single FMS installations not utilizing an LP/LPV Monitor or second WAAS FMS will not provide precision approach functions.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Fw BLOCK DIAGRAM

(1Fw shown with LPV monitor with 5" CDU; 4" CDU available)

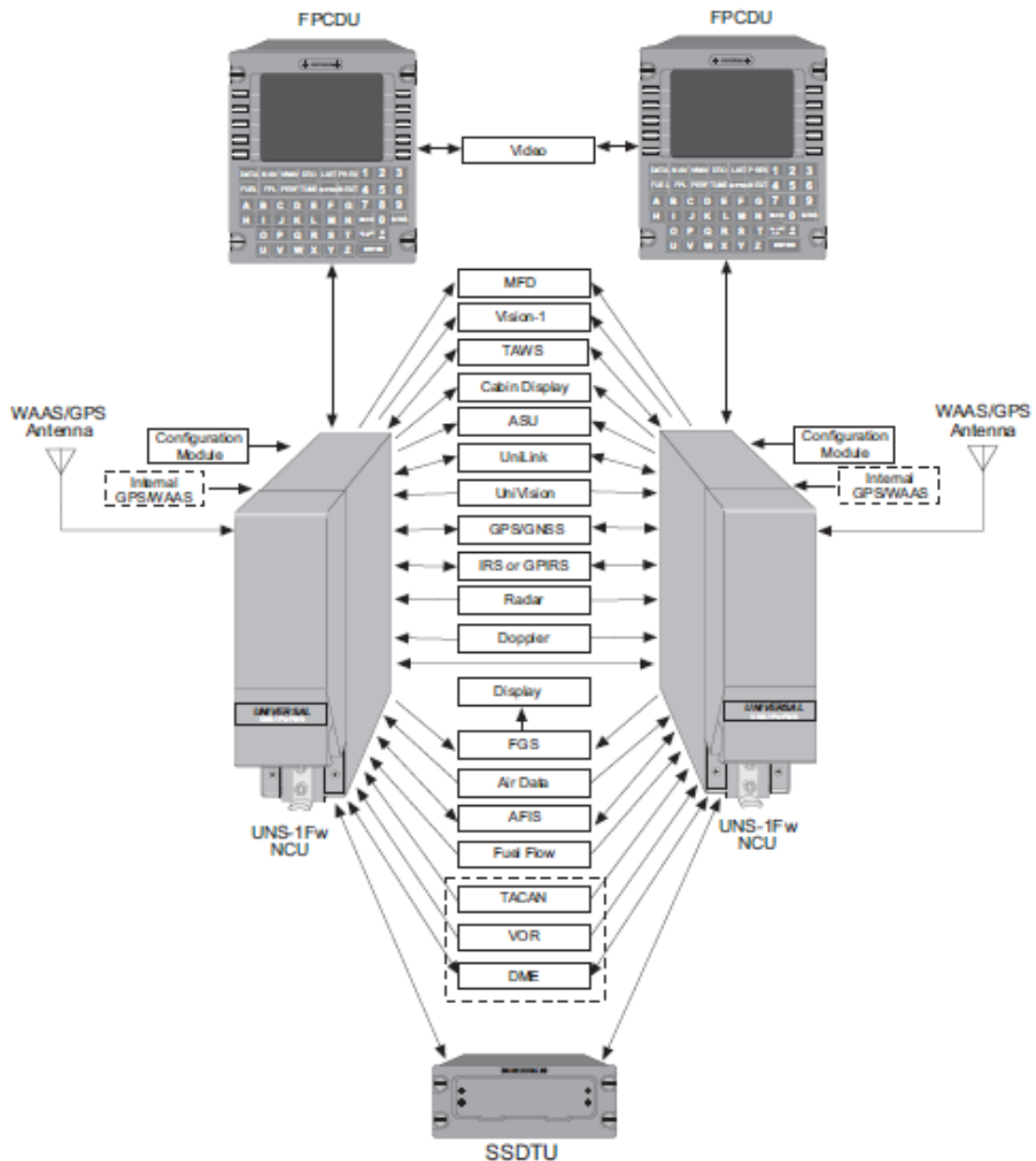


Single WAAS FMS with LP/LPV Monitor Installation Description

The use of an LP/LPV Monitor is an optional feature that can be used in an aircraft with a single WAAS FMS which requires LP/LPV capability but may not have room for a second WAAS FMS. The LP/LPV Monitor operates without a CDU or configuration module. The LP/LPV Monitor functions as an independent sensor in which redundant equipment is required to meet the integrity goals for precision approach types. The LP/LPV Monitor has its own GPS/WAAS sensor which can be wired and configured as a second GPS sensor with the single FMS.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Fw BLOCK DIAGRAM
(1Fw shown with 5" CDU; 4" CDU available)



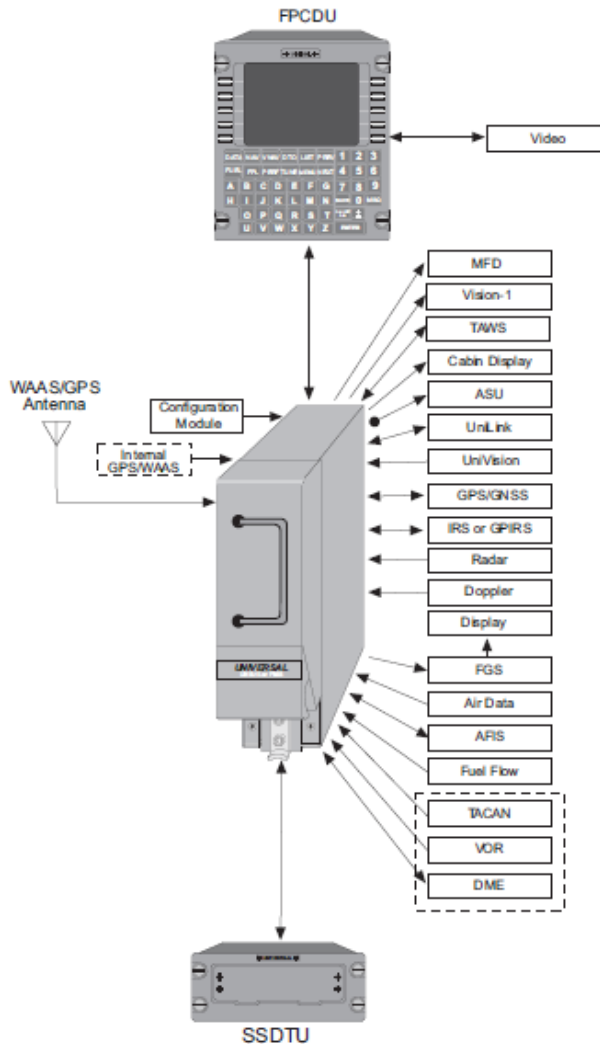
Dual FMS Installation Description

In dual installations, each FMS communicates with the other, sharing flight plan and navigational information. Typically, in dual FMS installations, all long-range navigation sensors are interfaced with both units. Each FMS computes an independent position using all available navigational sensors and provides selected information to the associated flight instruments. Each FMS shares its best best-computed position with the other system and continuously monitors the other system's position output.

NOTE: The block diagram shows the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Lw BLOCK DIAGRAM

(1Lw shown with 5" CDU; 4" CDU available)



Single FMS Installation Description

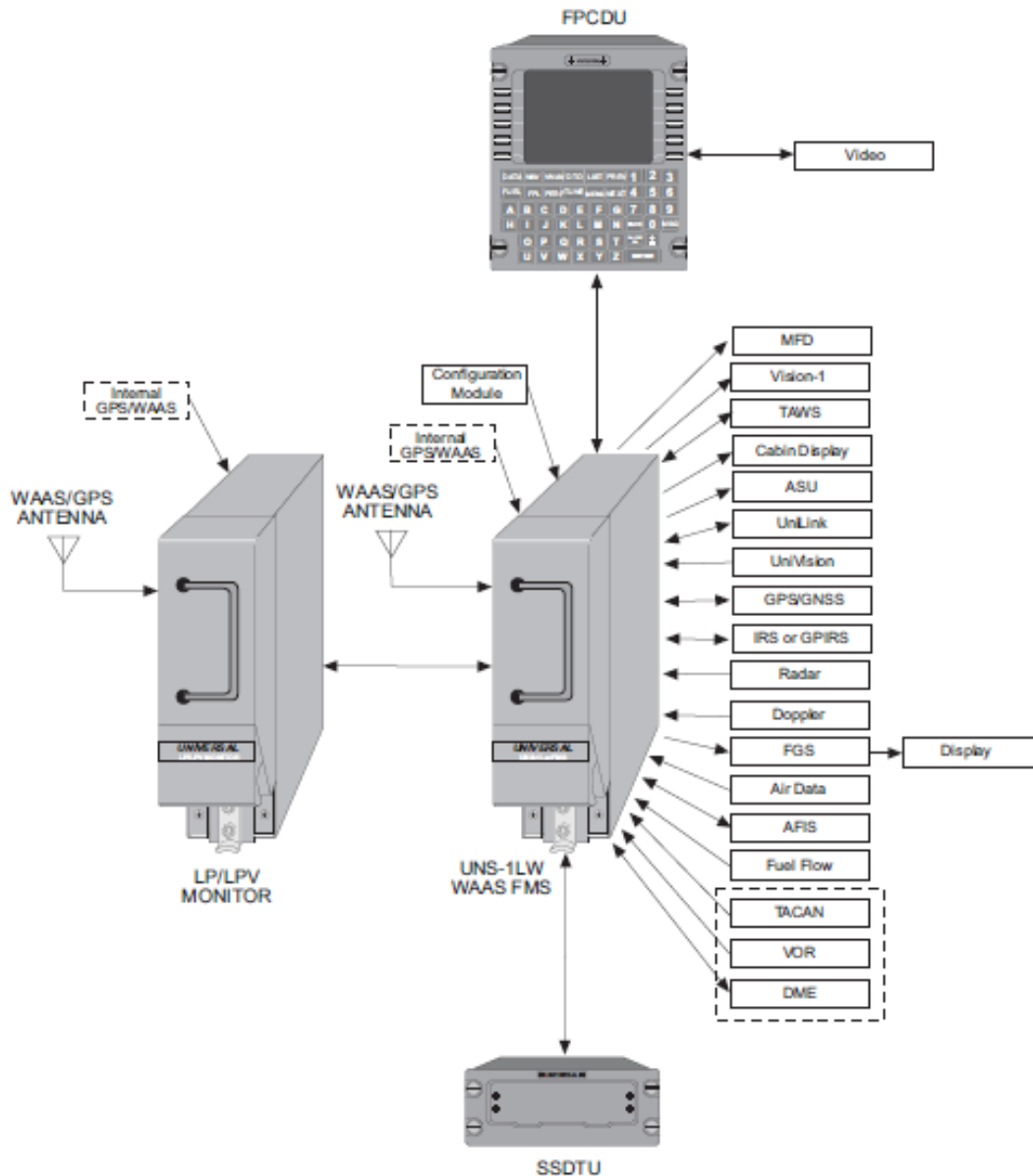
The FMS computes position and provides selected information to the associated flight instruments and sensor control to all sensors. The FMS houses an internal database which includes charted data from suppliers such as Jeppesen and pilot input data such as routes and approaches.

NOTE: Single FMS installations not utilizing an LP/LPV Monitor, will not provide approach functions.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Lw BLOCK DIAGRAM

(1Lw shown with LPV monitor with 5" CDU; 4" CDU available)



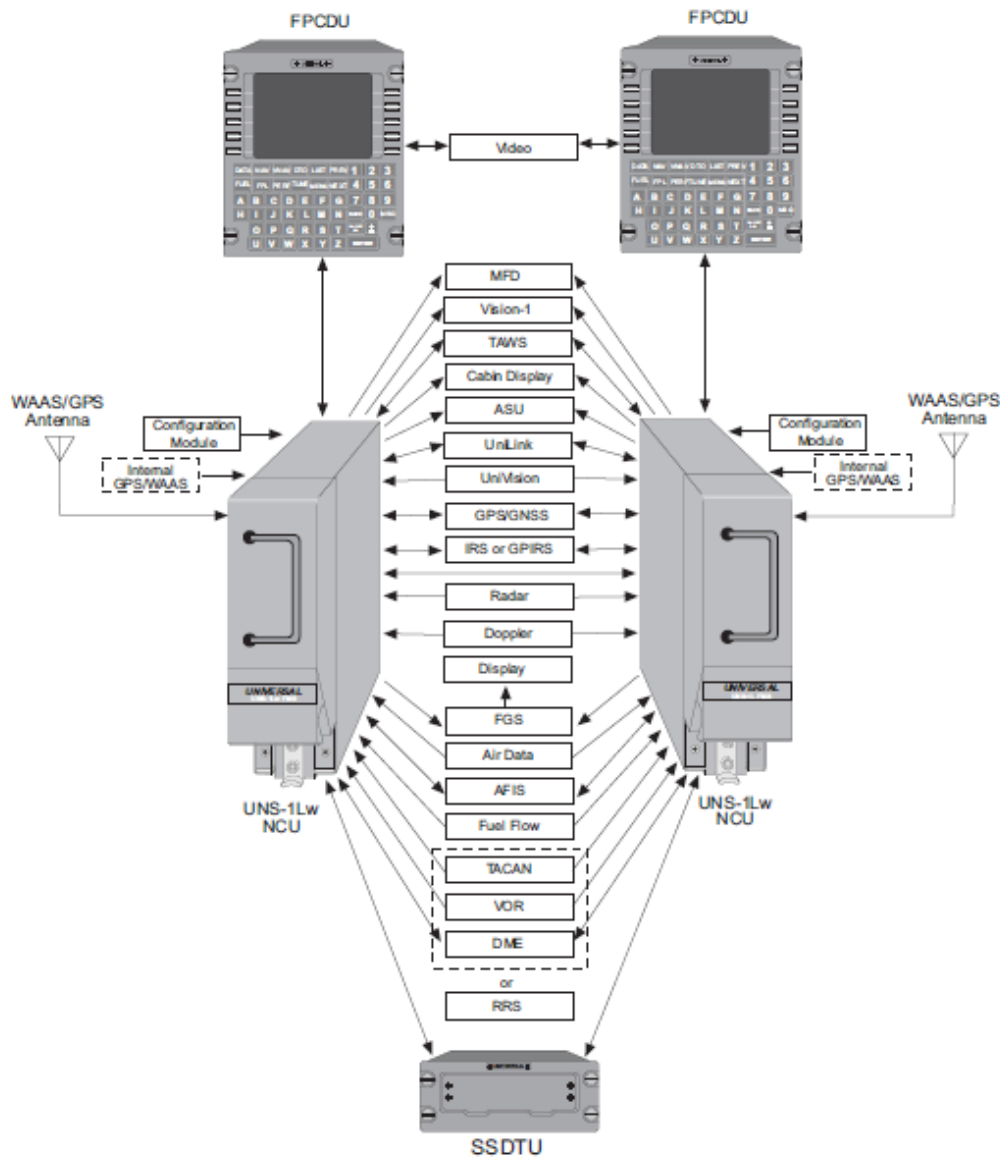
Single WAAS FMS with LP/LPV Monitor Installation Description

The use of an LP/LPV Monitor is an optional feature that can be used in an aircraft with a single WAAS FMS which requires LP/LPV capability but may not have room for a second WAAS FMS. The LP/LPV Monitor operates without a CDU or configuration module. The LP/LPV Monitor functions as an independent sensor in which redundant equipment is required to meet the integrity goals for precision approach types. The LP/LPV Monitor has its own GPS/WAAS sensor which can be wired and configured as a second GPS sensor with the single FMS.

NOTE: The block diagram illustrates the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

UNS-1Lw BLOCK DIAGRAM

(1Lw shown with 5" CDU; 4" CDU available)



Dual WAAS FMS Installation Description

In dual installations, each FMS communicates with the other, sharing flight plan and navigational information. Typically, in dual FMS installations, all long-range navigation sensors are interfaced with both units. Each FMS computes an independent position using all available navigational sensors and provides selected information to the associated flight instruments. Each FMS shares its best best-computed position with the other system and continuously monitors the other system's position output.

NOTE: The block diagram shows the various types of inputs and outputs to and from the FMS. The actual set of inputs and outputs in any particular installation is dependent on the suite of avionics equipment on the aircraft.

TECHNICAL STANDARD ORDERS, ADVISORY CIRCULARS, AND OTHER REFERENCES

Applicable TSO's

- (1) TSO-C109 (12/09/85): *Airborne Navigation Data Storage System*
- (2) TSO-C115(): *Airborne Area Navigation Equipment using Multi-sensor Inputs*
- (3) TSO-C146, 146a (9/2/05), 146b (8/10/07), 146C (5/9/08): *Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System*
- (4) TSO-C190 (03/20/07): *Active Airborne Global Navigation Satellite System (GNSS) Antenna*
- (5) JTSO C115b: *Airborne Area Navigation Equipment using Multi-sensor Inputs*

NOTE: All first time approvals using performance V speeds and engine thrust rating computations for a specific aircraft model must be approved by TC or STC process.

B. Applicable Advisory Circulars and Other References

- (1) AC 20-129 (9/12/88): *Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. National Airspace System (NAS) and Alaska*
- (2) AC 20-130A (6/14/95): *Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors*
- (3) AC 20-138() (12/22/03): *Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment*
- (4) AC 23.1309-1C (3/12/99): *Equipment, Systems and Installations in Part 23 Aircraft*
- (5) AC 25.1309-1A (6/21/88): *System Design and Analysis*
- (6) AC 25-15 (11/20/89): *Approval of Flight Management Systems in Transport Category Airplanes*
- (8) AC 90-45A (02/21/75): *Approval of Area Navigation Systems for use in the U.S. National Airspace System*
- (9) AC 90-94 (12/14/94): *Guidelines for Using Global Positioning System Equipment For IFR Enroute And Terminal Operations And For Non-precision Instrument Approaches In The U.S. National Airspace System*
- (10) AC 90-100A (03/01/07): *U.S. Terminal and Enroute Area Navigation (RNAV) Operations*
- (11) AC 90-101A (02/23/11): *Approval Guidance for Required Navigation Performance (RNP) with Authorization Required (AR) Change 1*
- (12) AC 90-105A 03/07/16: *Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System and in Oceanic and Remote Continental Airspace.*
- (13) AC 90-108 03/03/11: *Use of Suitable Area Navigation (RNAV) Systems on Conventional Routes and Procedures*
- (14) AC 91-49 (8/23/77): *General Aviation Procedures for Flight in North Atlantic Minimum Navigation Performance Specifications Airspace*

(15) AC 120-33 (6/24/77): *Operational Approval of Airborne Long Range Navigation Systems for Flight within the North Atlantic Minimum Navigation Performance Specifications Airspace*

(16) LEAFLET NO 2 Rev 1 (14.05.97): *EASA Guidance Material On Airworthiness Approval And Operational Criteria For Use Of The Navigation Systems In European Airspace Designated For Basic RNAV Operations*

(17) LEAFLET NO. 3 Rev 1 (18.12.97): *EASA Guidance Material on Airworthiness Approval and Operational Criteria for the Use of the Navstar Global Positioning System (GPS)*

(17) LEAFLET NO. 10: *EASA Guidance Material on Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace*

AMC 20-24 *Airworthiness and operational approval of the “Enhanced Air Traffic Services in Non-Radar Areas using Automatic Dependent Surveillance – Broadcast (ADS-B)” application.*

AMC 20-27A *Airworthiness Approval and Operational Criteria for RNP Approach (RNP APCH) Operations Including APV BARO-VNAV Operations*

AMC 20-28 *Airworthiness Approval and Operational Criteria related to Area Navigation for Global Navigation Satellite System approach to Localizer Performance with Vertical guidance minima using Satellite Based Augmentation System*

C. Reference Documents

(1) RTCA/DO-160E (9 December 2004): *Environmental Conditions and Test Procedures for Airborne Equipment*

(2) RTCA/DO-178B (1 December 1992): *Software considerations in Airborne Systems and Equipment Certification*

(3) RTCA/DO-187 (13 November 1984): *Minimum Operational Performance Standards for Airborne Area Navigation Equipment Using Multi-Sensor Inputs*

(4) RTCA/DO-228 (20 October 1995): *Minimum Operational Performance Standards for Global Navigation Satellite System (GNSS) Airborne Antenna Equipment*

(5) RTCA/DO-229D: *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*

(6) RTCA/DO-236B (28 October 2003): *Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation*

(7) UNS-1Ew Flight Management System Installation Manual

(8) RTCA/DO-254 (19 April 2000): *Design Assurance Guidance for Airborne Electronic Hardware*

(9) RTCA/DO-283A (28 October 2003): *Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation*

(10) ARINC Specification 419-3 (11 December 1984): *Digital Data System Compendium*

(11) ARINC Specification 424-18 (November 2005): *Navigation Systems Data Base*

(12) ARINC Specification 429-ALL: *Mark 33 Digital Information Transfer System (DITS)*

(13) ARINC Specification 561-11 (17 January 1975): *Air Transport Inertial Navigation System (INS)*

- (14) ARINC Characteristic 571-2 (15 May 1974): *Inertial Sensor System (ISS)*
- (15) ARINC Specification 578 (October 1988): *Airborne ILS Receiver*
- (16) ARINC Specification 600 (10 March 1996): *Air Transport Avionics Equipment Interfaces*
- (17) ARINC 702 (December 2006): *Advanced Flight Management Computer System*
- (18) ARINC Characteristic 704-6 (March 1993): *Inertial Reference System*
- (19) ARINC Characteristic 706-4 (January 1988): *Mark 5 Subsonic Air Data System*
- (20) FAA Notice 8110.60 Extension (11 February 1997): *GPS as a Primary Means of Navigation for Oceanic/Remote Operations*
- (21) EUROCAE ED-58 (June 1988): *Minimum Operational Performance Specification for Area Navigation Equipment Using Multi-Sensor Inputs*
- (22) EUROCAE ED-72A (April 1997): *Minimum Operational Performance Specification for Airborne GPS Receiving Equipment Used for Supplemental Means of Navigation*

NAVIGATION MANAGEMENT OR HOW IT WORKS

Universal Avionics' Flight Management Systems are centralized control and master computer systems, designed to consolidate and optimize the acquisition, processing, interpretation, and display of certain aircraft navigational and performance data.

FMS systems will be installed as GNSS/SBAS only or multi-sensor systems. Digital Air Data information (including baro-corrected altitude and true airspeed) and heading input is required in all installations.

The NCU (or FMC) has multiple ports through which data from external sensors can be received. The long range navigation sensors that may be accommodated include Inertial, GNSS, GPS, and Loran C. A radar joystick for remote waypoint entry can also be accommodated. When a DME interface is included, the DME input is considered a short range sensor and is from a multi-channel DME. All DME stations within approximately 300nm of the aircraft position are scanned, and up to 15 are continuously tracked. If VOR input is provided, it will be used for VOR/VOR-DME /RNAV (VOR DME) approaches when SBAS does not meet requirements. VOR will be used enroute as a last resort sensor, and any VOR used must be less than 180nm away.

Each individual navigational sensor is specifically designed for primary navigation. The FMS takes advantage of a particular sensor's good properties while minimizing its liabilities. The system processes multiple range information from the DME, velocity and/or position information from the long range navigation sensors, and aircraft heading, in order to derive one Best Computed Position (BCP). This is accomplished through the Kalman Filtering of the various sensors.

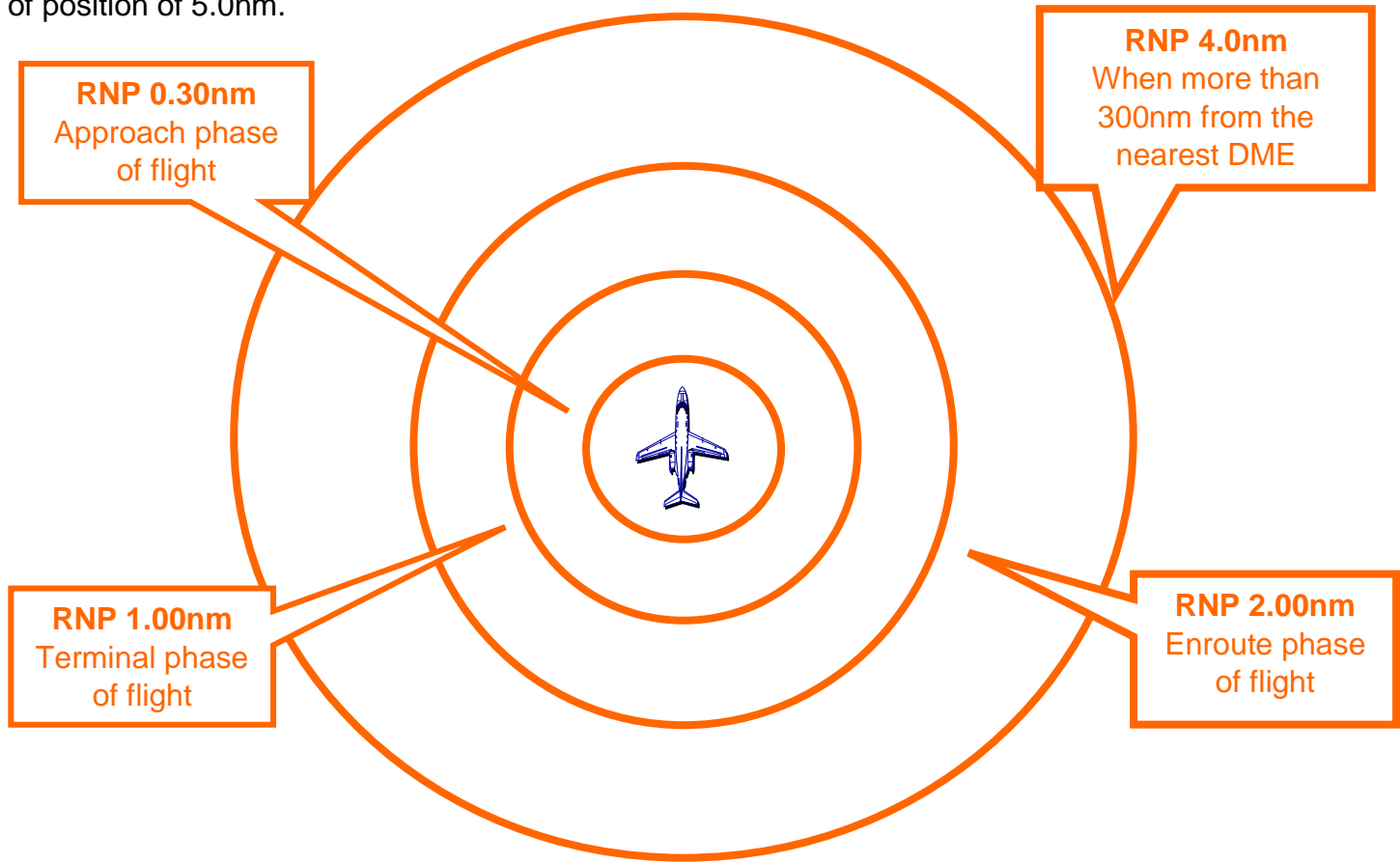
A Brief Summary

HOW THE UASC FMS NAVIGATES

In a brief summary: The FMS flies in Dead Reckoning (DR) which requires 5 factors (some say 3 factors): a starting point, a map or reference point, heading, speed, and a measurement of time, (a clock) to calculate distance. The FMS uses an initial Lat/Long for its starting point, usually provided by GPS, but could be entered manually. The map is the Lat/Long FMS database which some may call a map of the world. For heading the FMS can use an analogue, AHRS, or inertial source. For speed the FMS uses true airspeed provided by the ADC and an internal FMS clock to calculate distance (velocity x time = distance). To keep the FMS navigating accurately, the DR position is continually being compared to the Best Computed Position (BCP). The BCP is a Kalman filtered input of whatever navigation sensors are provided to the FMS. On most aircraft that's GPS; legacy TSO 129 or current TSO 146 with SBAS; and DME, though some aircraft may also have an IRS. VOR and TACAN are used primarily for approaches, but, as last resort, can be used to help compute a position. Kalman Filtering weights each sensor according to its accuracy. GPS is normally the most accurate so it's weighted the heaviest. If the DR position and the BCP differ as a result of a change in winds, the FMS will correct the DR course to the BCP. Because the FMS receives the required information of heading, track, true airspeed, and ground speed it can calculate the direction and velocity of wind. Normally a basic GPS navigator only has track and ground speed. Since position monitoring and adjustments are a continual process all the pilot notices are heading and ground speed adjustments. The benefit of this system is that the FMS can lose a navigation sensor and the BCP will continue with the remaining NAV sensors. If all navigation sensor inputs fail, with the air data computer providing true airspeed and a heading source the FMS can continue in DR mode. Of course, because the FMS has lost the ability to calculate track and ground speed due to lack of navigation sensor input, in DR mode the FMS position accuracy will degrade over time.

POSITION UNCERTAIN

Once established, the confidence, or certainty of the FMS BCP to a 95% probability is expressed as Actual Navigation Performance (ANP). ANP is expressed in hundredths of a nautical mile (0.07). The lower the value, expressed in nautical miles, the more accurately is the position. For example, an ANP of 0.10 means the FMS is 95% confident of its position within a circle whose radius is 0.10 nautical mile. If ANP = 1.00, it is only confident of its position within 1.0nm radius of a circle. An ANP of 5.00 would indicate a confidence (certainty) of position of 5.0nm.



There are set maximum boundaries for the size of the ANP circle, or the amount of uncertainty that the FMS is permitted to have. This is called Required Navigation Performance (RNP). When enroute and over 300nm from the nearest DME station, typically when oceanic, the RNP factor is set to 4.00 nm. When the aircraft is within DME range, typically over land, the RNP is set to 2.00nm. For terminal operations, the RNP is set to 1.00nm. For approach operations RNP is set to 0.30nm. If these parameters are exceeded, the system will display a “position uncertain” message and during an approach the system will go invalid for navigation causing the navigation display to be red flagged. RNP values may also be included in the navigational database and will override the default values.

RNP parameters are continually being reviewed and changed by Civil Aviation Authorities and ICAO. To allow the FMS the flexibility to accommodate the ever changing RNP standards, an FMS feature is available that allows for Required Navigation Performance to be manually set by the pilot when the default FMS values do not monitor what is required.

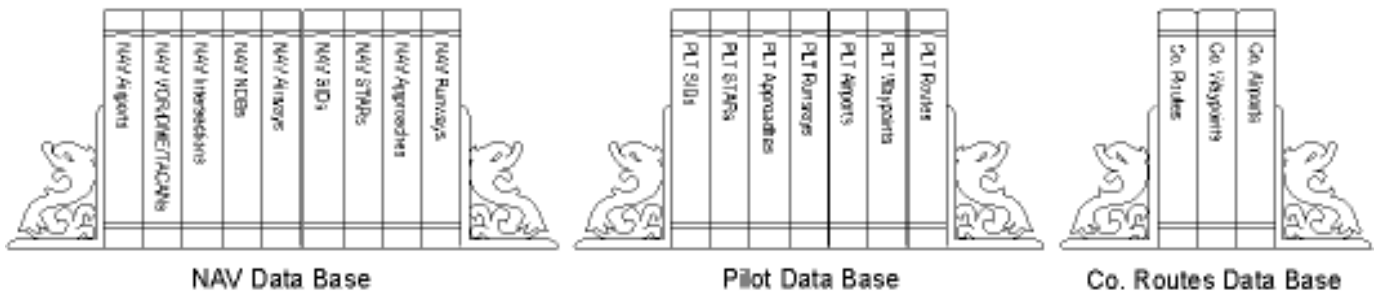
NAVIGATIONAL FEATURES

NAVIGATION DATABASE

The FMS memory is a non-volatile flash RAM (no battery required). The stored navigation database provides the capacity for complete coverage for SID, STAR, Approaches, High/Low Airways, Navaids, IFR intersections, airports with IFR Approach, and Navigation Reference System data points in the worldwide database. Worldwide 5000 foot runway length, 4000 foot runway length, or 2000 foot runway length database subscription services are available. In addition, trip kits for other than the subscribed runway length are available upon request.

DUAL CYCLE DATABASE

The UNS-1Fw, UNS-1Ew, UNS-1Espw, and UNS-1Lw contain a dual memory bank that is capable of holding the next cycle database before it becomes effective. When the current database expires, the next cycle database will automatically become active. When the FMS is powered up, one of the functions of the self-test is to determine which database is active by comparing effective dates and expiration dates. When an expired database is manually activated, it will remain the active database until the current database is manually activated.



PILOT DATA STORAGE

Extensive memory space is also allocated for Pilot Defined Data. The system can store up to 200 pilot created flight plan routes comprised of up to 98 waypoints each, and up to 200 pilot defined waypoints, 100 arrivals/departures, 100 approaches, 100 runways, 100 airports, 100 alignment points, and 100 tactical waypoints. Up to 25 radar waypoints can be stored in volatile memory. Once stored, pilot defined data is easily accessed and may be added to the flight plan with a few simple keystrokes.

COMPANY ROUTES DATA

A protected company routes database can be created using an off-line, Universal's Flight Planning Program. The FMS allows for the creation and storing of a maximum of 2000 routes, with the ability to create and store 200 Company Waypoints and 100 Company Airports. Each route will consist of at least one but not more than 98 legs (route elements). Route elements reference waypoints, airways and terminal area procedures (SID, STAR, and approaches) from the navigation database by use of reference pointers. Company Routes can be given names of up to eight characters in length. A Company Routes database will allow routes to be viewed and copied to the active flight plan, but the flight crew cannot modify the routes themselves. A configuration option has been added that will cause all pilot data to be cleared at each power on cycle. This feature is mainly for airline operations in which no leftover pilot data are allowed in the FMS between power cycles.

A Company Route database must be loaded with the same NAV data that was used for its creation. The Company Routes database disk is loaded through the Data Transfer Unit (DTU) by using the same procedures as loading the NAV data disk.

OFF LINE FLIGHT PLANNING

FMS-created pilot data can be downloaded to a Flash Memory Drive, Secure Digital Card, or Zip disk through the DTU for review using a compatible PC computer. The off line features allow you to modify or add to your pilot defined data and upload it via Flash Memory Drive, Secure Digital Card, or Zip disk to the FMS, determine ETE while varying routes, study the effect of winds, compute fuel requirements and reserves, upload flight plans from various flight planning services and do FDE predictions for GPS remote oceanic routes outside SBAS coverage, IAW AC 20-138().

FUEL MANAGEMENT MONITORING

The fuel management function enables the pilot to plan fuel requirements while on the ground. Input from the aircraft's fuel flow sensors, along with pilot supplied data, enable the FMS to calculate and display significant real-time fuel management information throughout the flight. Enroute, alternate destinations, ground speed, or fuel flow values may be temporarily entered to check various "what if" scenarios. In SCN 1001/1101 and subsequent a fuel performance profile may be created for more accurate fuel calculations.

FREQUENCY MANAGEMENT

With compatible radio tune head and/or an optional Radio Tune Unit (RTU), the communications transceivers, and VOR receivers may be tuned through the CDU. This function provides 4 presets for each radio that may be stored by alpha identifiers or tuning from a list of identifiers and instant recall of the last frequency entered. A frequency database is available through the **[LIST]** function.

LATERAL GUIDANCE AND STEERING

Using the best computed position and the flight plan created by the pilot, the FMS computes Great Circle route legs to navigate the aircraft along the programmed flight path. Optional maneuvering procedures provided include; direct to (DTO), Pseudo – VOR (radial tracking), FMS Heading, Selected Cross-Track (SXTK), Holding Patterns, SID, STAR, and Approaches. The FMS provides desired track, bearing, cross-track, lateral deviation, and related data to the flight guidance system for the EFIS displays, and roll steering commands for the autopilot/flight director system. The system anticipates leg changes and provides "smart turns" to eliminate "S" turning. Pilots can designate waypoints for over flight. The roll steering command is gain-scheduled based on altitude for gentle turns and a configurable multiplier for ILS approach emulations. The bank limit is configured at time of installation to match flight guidance system limits.

VERTICAL GUIDANCE

A 6-waypoint enroute vertical navigation descent profile may be programmed through the VNAV page and additional waypoints may be entered through the flightplan or the FMS will calculate an optimum descent path for "descent via arrivals". The FMS will display the vertical speeds required based on present ground speed to obtain the target altitudes at the VNAV waypoints. A computed Top of Descent Point, based on target vertical speed, is displayed. When the Top of Descent Point is reached, the system provides vertical deviation from the vertical flightpath for output to a vertical deviation indicator. The resultant calculated Flight Path Angle (FPA) is limited to settings in the configuration set at time of installation. Vertical steering is also provided to the autopilot. A Vertical Direct To (VTO) feature is available. In the approach mode, a glidepath from the NAV database may be defined. Deviation signals similar to an ILS glide slope are available for output to the EFIS and flight guidance systems.

UNILINK

The FMS can interface with the UASC UniLink unit that supports air-to-ground digital data communications. UniLink uses a variety of media, such as VHF radio and SatCom to communicate with service providers such as Universal Weather. Automatic Dependent Surveillance – Contract (ADS-C) for Future Air Navigation System (FANS) including Controller Pilot Data Link Communications is available.

AFIS INTERFACE

The FMS system provides for interface with the Airborne Flight Information System Weather Advisory Services. AFIS data may be transferred to the FMS for display on the CDU. Through a VHF data link the interface provides the capability for two way data transfer between the aircraft and the ground, providing messaging, weather, and flightplan service uploading.

SENSOR WATCHDOG

A sensor “watchdog” automatically detects sensor information that appears erroneous that could cause an error in the best computed position. This is accomplished by comparing each sensor, the unweighted average of all sensors and deselecting faulty sensors. If the difference exceeds a preset value, the “watchdog” will activate the appropriate messages to alert the pilot and in extreme cases automatically deselect the sensor.

FMS OPERATIONS IN HIGH LATITUDES

The Universal FMS requires a true heading source (IRS) or true heading AHRS when flying in the Polar Regions starting at 73° North and 60° South latitude. The magnetic variation model that the FMS uses to convert between magnetic and true heading does not extend into the Polar Regions, thus, a true heading source is required for the FMS to navigate in these regions. No input into the FMS is required by the pilot; however, the True/Mag switch installed in the aircraft must be placed in the True position. In these regions all FMS heading and bearing information will be presented in true. At 72° 45' North and 59° 45' South latitude, a message will be presented by the FMS warning that the aircraft is about to leave the zone where the magnetic variation is automatically calculated by the FMS.

NOTE: For short flights, there are techniques for aircraft without a true heading source to operate within these Polar Regions or in areas of magnetic unreliability.
Contact UASC Customer Training for more information @ 1-800-595-5906.

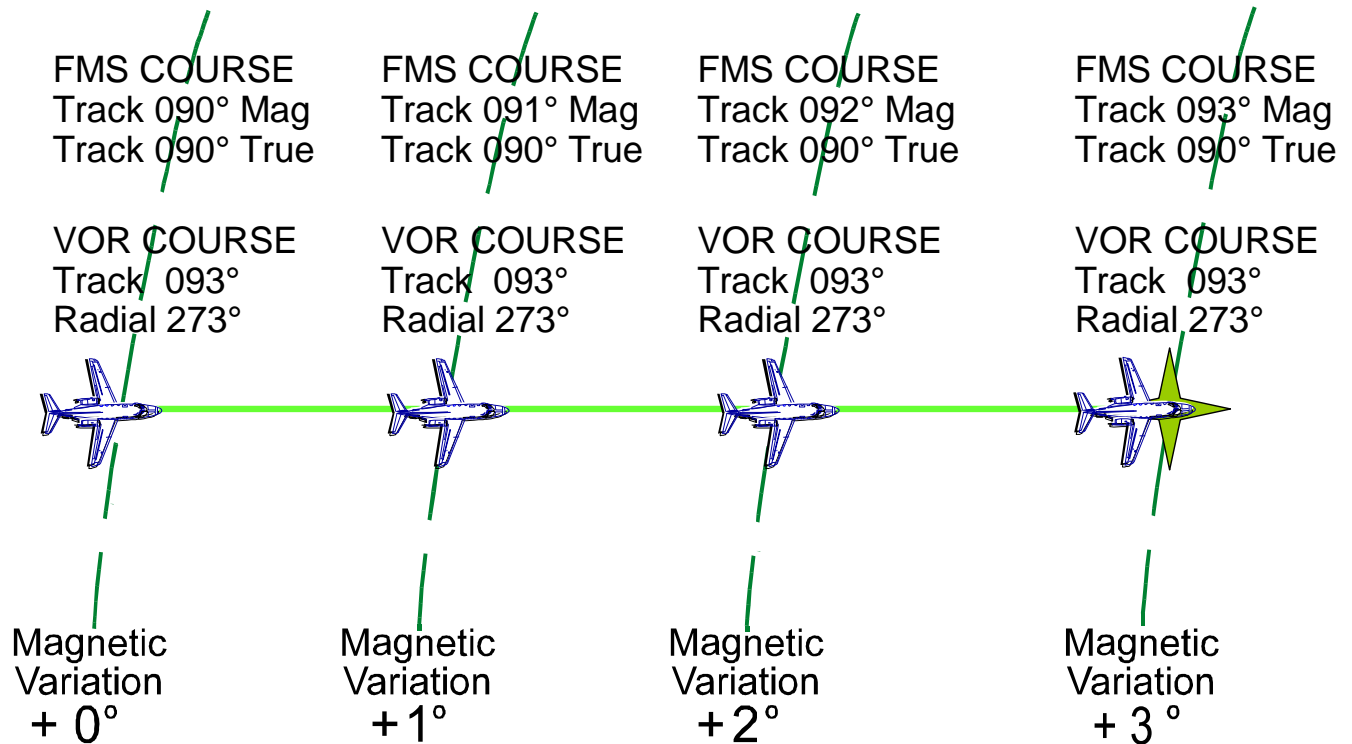
THE WORLD MAGNETIC MODEL

The Universal Avionics FMS uses a magnetic variation model to convert true heading to magnetic heading and magnetic heading to true heading.

The World Magnetic Model is a joint product of the United States' National Geospatial-Intelligence Agency (NGA) under the National Oceanographic and Atmospheric Administration (NOAA) and the United Kingdom's Defense Geographic Centre (DGC). The WMM was developed jointly by the National Geophysical Data Center (NGDC, Boulder CO, USA) (now the National Centers for Environmental Information (NCEI)) and the British Geological Survey (BGS, Edinburgh, Scotland).

The World Magnetic Model is the standard model used by the U.S. Department of Defense, the U.K. Ministry of Defense, the North Atlantic Treaty Organization (NATO) and the International Hydrographic Organization (IHO), for navigation, attitude and heading referencing systems using the geomagnetic field. It is also used widely in civilian navigation and heading systems. The model, associated software, and documentation are distributed by NCEI on behalf of NGA. The model is produced at 5-year intervals, with the model expiring on 31 December 2019 and again on 31 December 2024.

FMS vs VOR NAVIGATION



The FMS navigates by use of true heading and computes a great circle course between lat/long waypoints. Any magnetic input to the FMS is converted to true by use of a magnetic variation model. This model covers latitudes from 73°N to 60°S. FMS navigation in the Polar Regions requires a true heading source (IRS or true heading AHRS) input to the FMS. FMS output to the aircraft flight instruments uses the same magnetic model for conversion. The magnetic variation model converts the FMS true heading to magnetic heading based on the current lat/long of the aircraft. As the track of the aircraft passes over magnetic variation changes, the FMS magnetic heading, bearing, & track changes although the true heading, bearing, & track remains the same. A VOR extends radials in all directions, it is known as a rhomb line. The magnetic bearing of these radials is based on the magnetic variation or declination of the VOR station and does not change regardless of the distance from the VOR. When a FMS bearing is compared to a VOR bearing, a difference may be observed. This difference is the magnetic variation difference between the lat/long of the aircraft and the lat/long of the VOR and the difference between the types of navigational courses.

FMS vs VOR COURSE

Great Circles (FMS)

A *great circle* is the shortest path between two points along the surface of a sphere. The precise definition of a great circle is the intersection of the surface with a plane passing through the center of the planet. Thus, great circles always bisect the sphere. The equator and all meridians are great circles. All great circles other than these do not have a constant azimuth, the spherical analog of slope; they cross successive meridians at different angles. That great circles are the shortest path between points is not always apparent from maps, because very few map projections (the Gnomonic is one of them) represent arbitrary great circles as straight lines.

Rhumb Lines (VOR)

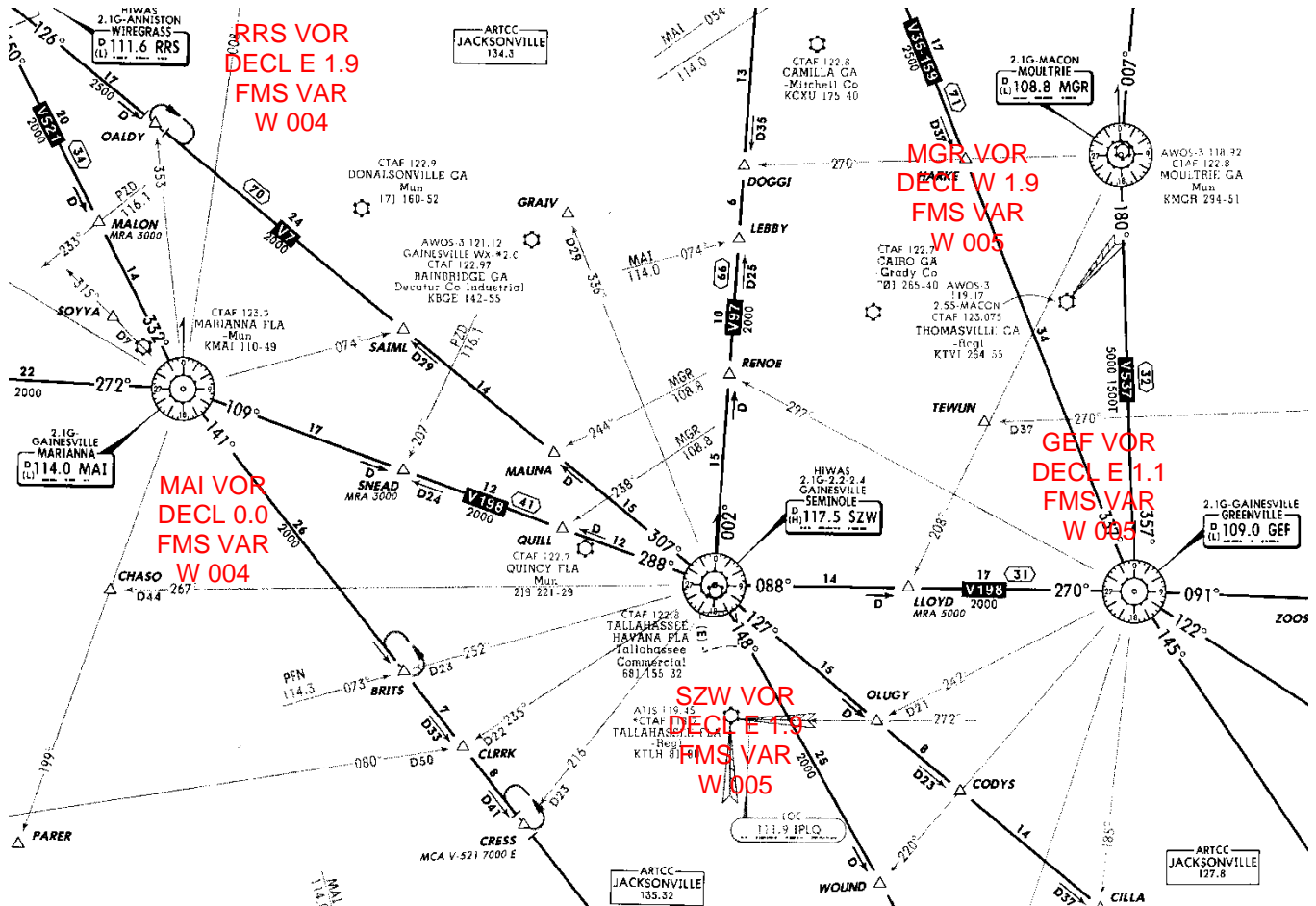
A *rhumb line* is a curve that crosses each meridian at the same angle. Although a great circle is a shortest path, it is difficult to navigate because your bearing (or *azimuth*) continuously changes as you proceed. Following a rhumb line covers more distance than following a geodesic, but it is easier to navigate.

All parallels, including the equator, are rhumb lines, since they cross all meridians at 90°. Additionally, all meridians are rhumb lines, in addition to being great circles. A rhumb line always spirals toward one of the poles, unless its azimuth is true east, west, north, or south, in which case the rhumb line closes on itself to form a parallel of latitude (small circle) or a pair of antipodal meridians.



MAGNETIC VARIATION ANOMALIES

FMS VARIATION & VOR DECLINATION



At the publishing of this book, the NAV database VOR declination for the above navigation facilities is compared to the SCN 100X magnetic variation model. If the pilot were to compare the course information of the FMS against the VOR, a significant differential would be seen. The FMS magnetic variation model is updated through a change in the Software Control Number and periodically the VOR declinations are updated by the controlling authority.

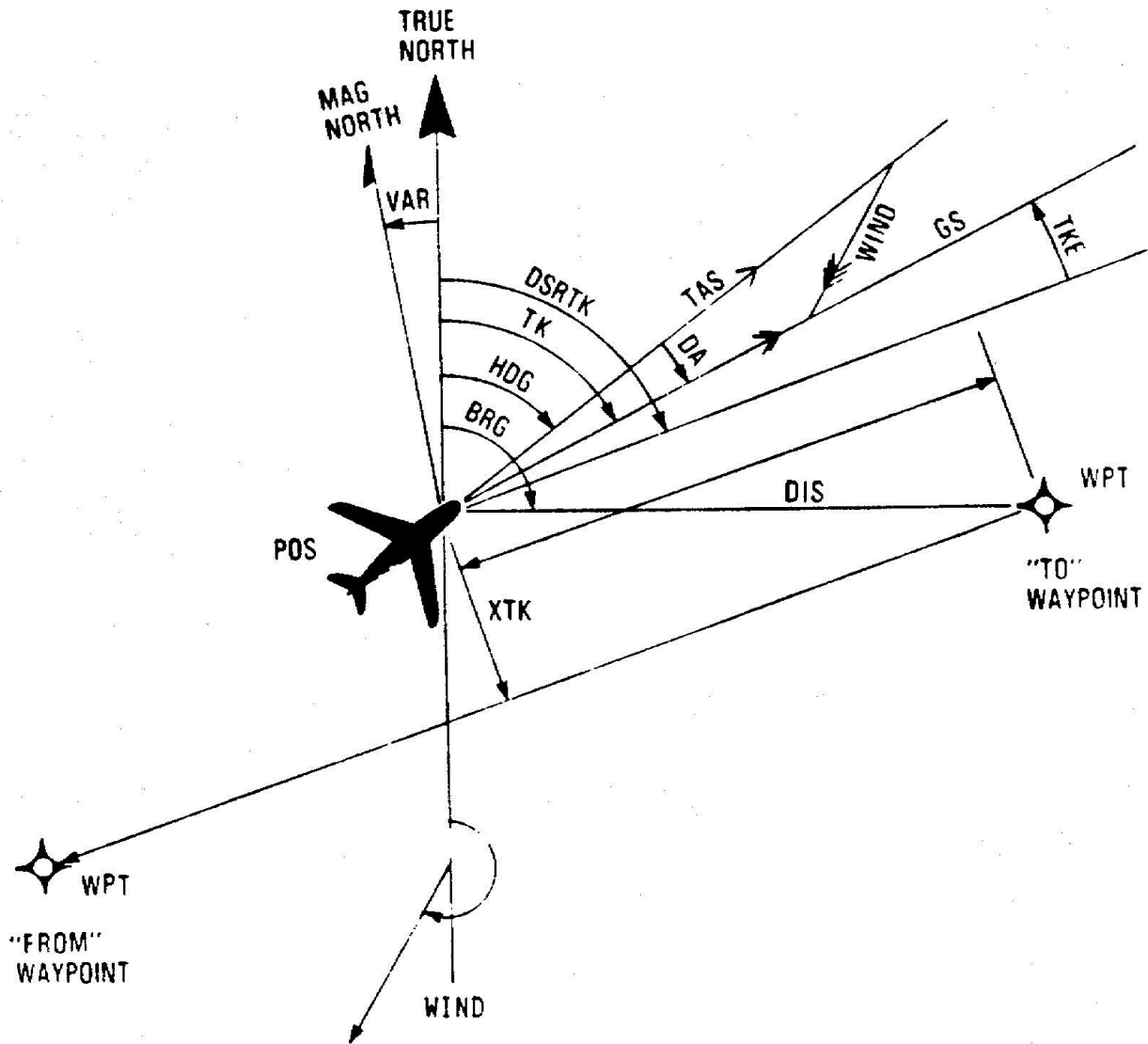
APPLICATION OF MAGNETIC VARIATION TO FMS NAVIGATION

Compliance requirements for application of magnetic variation to various navigation leg types of the FMS is dependent upon the type of leg and where in the navigational process it is used. If the leg is part of a database terminal area procedure, the magnetic variation to be used is the value that the system extracts from the database as specified per RTCA DO-201A/EUROCAE ED-77.

The chart below explains the application of magnetic variation to the leg types listed.

Leg Type	MAGVAR Region Reference Point	MAGVAR Source for Procedure Leg
CA, CD, CI, CR, VA, VD, VI, VM, VR	Departure or Arrival Airport as appropriate	Airport MAGVAR if available, else System MAGVAR at airport
CF (not in approach common segment), FA, FC, FD, FM, PI, AF	Reference Fix	Fix Declination if available, else System MAGVAR at Reference Fix
DF, IF, RF (not in approach common segment)	Reference Fix	System MAGVAR at Reference Fix
TF (not in approach common segment)	Prior Fix of leg	System MAGVAR at Prior Fix
IF, TF, CF, RF (in approach common segment)	Airport	Facility declination if available, else Airport MAGVAR if available, else System MAGVAR at Airport

NAVIGATIONAL RELATIONSHIPS



NAVIGATION RELATIONSHIP DEFINITIONS

BRG	Bearing – it is the direction of waypoint from the aircraft usually measured in magnetic degrees, but could be provided in true degrees.
DA	Drift Angle – it is the effect of wind on the aircraft heading resulting in the track of the aircraft.
DIS	Distance – it is the measured length between two navigational points or the aircraft and a waypoint.
DSRTK	Desired Track – it is the preferred path over the ground.
GS	Ground Speed – it is the speed of the aircraft relative to the ground.
HDG North.	Heading – it is the direction of the aircraft relative to either magnetic or true North.
POS	Position – it is the current location of the aircraft usually identified by a latitude and longitude or radio navigational aid.
TAS	True Air Speed – it is the speed of the aircraft relative to the air mass with in which it's flying.
TK	Track – it is the actual path of the aircraft over the ground.
TKE	Track Error – it is angle between the desired track and the actual track of the aircraft.
VAR	Variation – it is the angular measurement between magnetic and true North.
WPT	Waypoint – A navigational point usually identified by a latitude and longitude or radio navigational aid, but with a modern FMS, could be a condition.
XTK	Crosstrack – The distance of the aircraft from the desired track usually measured in nautical miles.

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

The Global Navigation Satellite System is a navigational system using orbiting satellites to plot latitude and longitude positions on the earth. Currently supporting GNSS programs are the United States of America with the Global Positioning System (GPS), Russia with the Global Orbiting Navigation Satellite System (GLONASS), and Europe with Galileo. Galileo is a joint initiative of the European Commission (EC) and the European Space Agency (ESA). Another GNSS program under development is China's Beidou Compass with a planned 30 medium orbit and 5 geosynchronous satellites. Currently the US GPS is required when flying GPS approaches, but Galileo may be available in the near future.

GLOBAL ORBITING NAVIGATION SATELLITE SYSTEM (GLONASS)

GLONASS is a Soviet space-based navigation system, now operated by Russia, comparable to the American GPS system. The operational system contains 21 satellites in 3 orbital planes, with 3 on-orbit spares. GLONASS provides 100 meters accuracy with its C/A (deliberately degraded) signals and 10-20 meter accuracy with its P (military) signals. Satellite design life is 1 to 2 years. There is an on-board cesium clocks that provides time accuracy to 1000 nanoseconds. GLONASS uses Frequency Division Multiple Access (FDMA) as a means of satellite identification which is not compatible with the US GPS. Russia has plans to transmit CDMA from its satellites in the future.

GALILEO POSITIONING SYSTEM

The Galileo Positioning System, simply known as Galileo, is named after the Italian astronomer Galileo Galilei. The system will be comprised of 30 spacecraft on three orbital planes at an altitude of 23,222km. The satellite life expectancy is less than 12 years and will use Code Division Multiple Access (CDMA) technology, the same as is used by GPS. A reason given for an independent system is that GPS is a military system and that a civil infrastructure, including airplane navigation and landing, should not rely solely upon GPS.

Galileo's open service will be broadcast in two bands. Reception of two bands will achieve an accuracy of 4m horizontally and 8m vertically; one band will provide 15m horizontally and 35m vertically. The encrypted commercial service will be available for a fee and use three bands with accuracy of less than 1m. An encrypted public regulated service and safety of life service will be more robust to help prevent jamming and enhance problem detection reliability to within 10 seconds.

BEIDOU SATELLITE NAVIGATION AND POSITIONING SYSTEM

Beidou Navigation System is named after the Big Dipper constellation, which is known in Chinese as *Běidǒu*. The new system will be a constellation of 35 satellites, which include 5 geostationary orbit (GEO) satellites and 30 Medium Earth Orbit (MEO) satellites that will offer complete coverage of the globe. There will be two levels of service provided; free service for those in China, and licensed service for the military.

- The free service will have a 10 meter location-tracking accuracy, will synchronize clocks with an accuracy of 50 ns, and measure speeds within 0.2 m/s.

The licensed service will be more accurate than the free service, can be used for communication, and will supply information about the system status to the users.

GLOBAL POSITIONING SYSTEM (GPS)

GPS satellites continuously transmit highly monitored position and timing data that allows a GPS receiver to determine its range to the transmitting satellite. By observing and tracking multiple satellites, the GPS receiver can determine its position in longitude, latitude, and altitude, allowing navigation to be performed. Additionally, the GPS receiver can independently monitor the integrity of its own position without reference to other navigation systems. GPS permits earth-centered position coordinates to be determined which provides aircraft position referenced to the World Geodetic System of 1984 (WGS-84).

GPS has achieved its Initial Operating Capability but is subject to some limitations and gaps in coverage. Current receiver technology is capable of determining (and predicting) satellite availability and the resultant level of GPS usability for various phases of flight. GPS is approved, when using properly certified and installed equipment for IFR enroute, terminal operation, and GPS approaches. GPS based approaches are found in countries throughout the world.

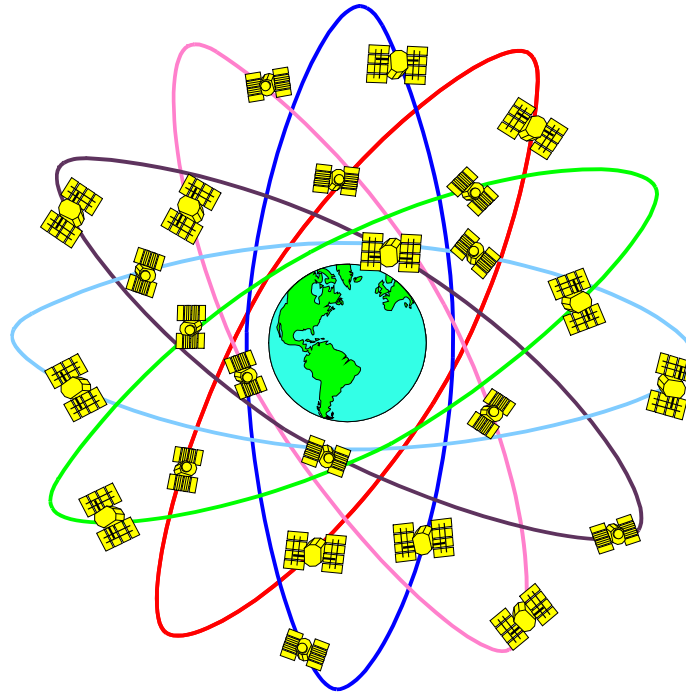
GPS PRINCIPLES OF OPERATION

GPS consists of three distinct functional segments: the space segment, control segment and the user segment. Following discussion of those elements includes coverage of Receiver Autonomous Integrity Monitoring (RAIM), Fault Detection and Exclusion (FDE) and Horizontal protection level (HPL).

The space segment consists of a minimum constellation of 24 with 30 satellites being the current norm allowing for the worldwide reception of at least 4 satellites in view with at least 5 being the norm. The satellites are arrayed in six planes. Each plane is inclined 55 degrees to the Equator and contains a minimum of four satellites in 10,898 nautical mile orbits. Each satellite completes an orbit in 11 hrs 58 min or slightly more than two orbits per day. When 24 satellites are available, this will insure a minimum of four satellites to be in view from any point on the Earth's surface 24 hours per day. When 30 satellites are available, this will insure a minimum of five satellites to be in view from any point on the Earth's surface 24 hours per day.

The principle behind GPS operation is in knowing the precise location of each satellite in the system and when each satellite transmits specially coded information. The GPS receiver, by knowing where each satellite is located and exactly when it transmits its data, measures the length of time it takes for the data to arrive and so determines its range to each visible satellite. GPS uses Code Division Multiple Access (CDMA) as a method of satellite identification. By using multiple satellites, the GPS receiver can then calculate its position. Some GPS systems allow for a minimum of three satellites and an altitude input from the aircraft Air Data computer to calculate a position, known as "ALTITUDE AIDING". Four satellites are required for the GPS receiver to solve for position and altitude. The Universal Avionics GPS requires the acquisition of four satellites in order to go to the NAV mode and can use the "ALTITUDE AIDING" mode once airborne.

On May 1, 2000 Selective Availability, or “S/A” was set to zero for the civilian GPS channel eliminating the intentional error input by the US Military. With the current level of satellite position and timing accuracy available to civil users, GPS provides a minimum position resolution of less than 20 meters. In practice, with good satellite coverage, much finer resolutions are possible. With single channel the GPS position error should be less than 20 meters 95% of the time and less than 30 meters 99.99% of the time.



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
▪ 4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

The data, sent to the GPS receiver, includes vehicle status, clock correction, synchronization, signal propagation corrections, and precise satellite ephemeris (position) data. Collectively, this information is referred to as an almanac and is the data from which the GPS receiver measures its distance from the satellite(s) in view. Almanac data is encoded such that the receiver can verify that only valid and current information is being sent.

There are two levels of system accuracy (or Code) available; Coarse Acquisition (C/A) Code and Precision (P) Code. To date, P-Code data is restricted to military applications and with the use of two channels for increased position accuracy provides better accuracy than the single channel provided to civilian users.

The user segment consists of the GPS receiver/processor and its associated antenna(s). In aircraft applications, the preferred antenna location is on the upper fuselage where the antenna can have the best horizon-to-horizon, unobstructed view.

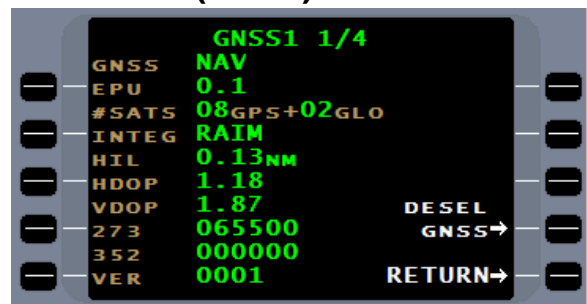
The GPS receiver looks for and selects the best positioned satellites, determines its range to each of them and using the location of each satellite, converts that into GPS position. Doppler shift measurement of the signal can be used to determine aircraft velocity.

GPS derived position information is provided to the FMS as a part of its position determining processes.

The GPS receiver downloads and stores the “almanac” data transmitted by each satellite as a background processor function. New almanac data is uplinked to the satellite system weekly. Clock correction data is received and processed by the GPS receiver. This automatically updates FMS UTC time by subtracting from GPS time the difference between UTC and GPS. Almanac data is used to perform RAIM prediction calculations. TSO C-146 does not require RAIM prediction prior to executing a GPS based approach.

RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM)

A minimum of four satellites is required for the GPS to determine position and enter “NAV” mode. If any of the satellites received and tracked were providing erroneous data, these errors could cause significant navigation errors. To reduce this possibility the GPS receiver incorporates a process known as RAIM (Receiver Autonomous Integrity Monitoring). This is a process that involves using signals from five or more satellites to verify accuracy. With at least five satellites tracked, one satellite can be dropped from the position solution and range to the satellite back calculated from the position solution determined by the remaining satellites. This calculated value is compared with the received pseudo-range to determine validity. With only five satellites, which satellite is providing faulty data cannot positively be determined. The RAIM status of the GPS sensor is displayed on the GPS sensor status page, accessed under DATA page 2.



The integrity status will be displayed as RAIM, RADIO (in DME-DME installations where this data can be used to ensure GPS integrity), NONE or ALARM (accompanied by annunciator and message).

FAULT DETECTION AND EXCLUSION (FDE)

If six or more satellites are received, the GPS can determine whether errors exist and determine which satellite is providing faulty data. The GPS can then exclude that satellite from the position solution, still leaving five satellites available to protect RAIM. This process is known as FDE (Fault Detection and Exclusion). Remote/Oceanic operations certification requires that FDE be provided and continuously monitored by the GPS when outside SBAS coverage.

HORIZONTAL PROTECTION LEVEL (HPL)

Using Fault Detection to calculate the Horizontal Protection Limit occurs when the FMS is not within SBAS coverage area. The definition is as follows: At any given time, the GPS or GNSS sensor’s ability to perform FDE is determined by the number of satellites in view and their geometric position relative to the aircraft. The SBAS/GPS will compute a parameter called the “Horizontal Protection Limit” (HPL). HPL is defined as the radius of a circle in the horizontal plane, with its center being at the true position that describes the region that is assured to contain the indicated horizontal position. HPL will bind the true position with a probability of 95%. It is the region where the missed alert requirement can be met and is based on error estimates provided by FDE. Certification requirements for use of GPS require that the GPS be able to exclude errors within specific HPL limits for various phases of flight. If the HPL value exceeds the requirement for the current phase of flight beyond a specified time limit, the integrity status goes to “ALARM” and a GPS integrity message and annunciator will be presented. Since the limits are tighter for the approach phase of flight than the enroute and terminal phases, alarms are more likely to occur in this phase of flight. With the removal of SA in year 2000, violating any of the HPL parameters is highly unlikely. The calculated HPL value will be displayed on the WAAS/SBAS status page accessed under the DATA 2 page and on the NAV page when approach active.



SBAS ALARM LIMITS

<u>Phase of Flight</u>	<u>Alarm Limit</u>	<u>Time to Alarm</u>
ENROUTE (Outside 30nm from Departure or Destination)	2.0 Nautical miles	After 27 seconds
TERMINAL (Within 30nm of Departure or Destination)	1.0 Nautical miles	After 7 seconds
APPROACH (Approach mode active on FMS)	0.3 Nautical miles	After 7 seconds

If the GPS integrity annunciator illuminates, pilot action will vary with phase of flight as well as navigation sensor options connected to the FMS.

SBAS/GPS AS STAND-ALONE AIRBORNE NAVIGATION SYSTEM

The Universal Avionics UNS-1 FMS with SCN 100X/110X is TSO C-146C GAMA 3 certified. TSO-C146C certified equipment meets the criteria to operate as stand-alone navigation system.

GPS PRIMARY MEANS OF NAVIGATION

When operating outside the SBAS coverage area, the FMS is certifiable for use as a primary means of navigation in remote/oceanic airspace using GPS in accordance with the provision of FAA AC 20-138(). Software requirements in addition to a RAIM prediction program are required to verify that adequate integrity will exist for the proposed flight. Universal Avionics Service Letter No. 2738 provides additional details on this subject.

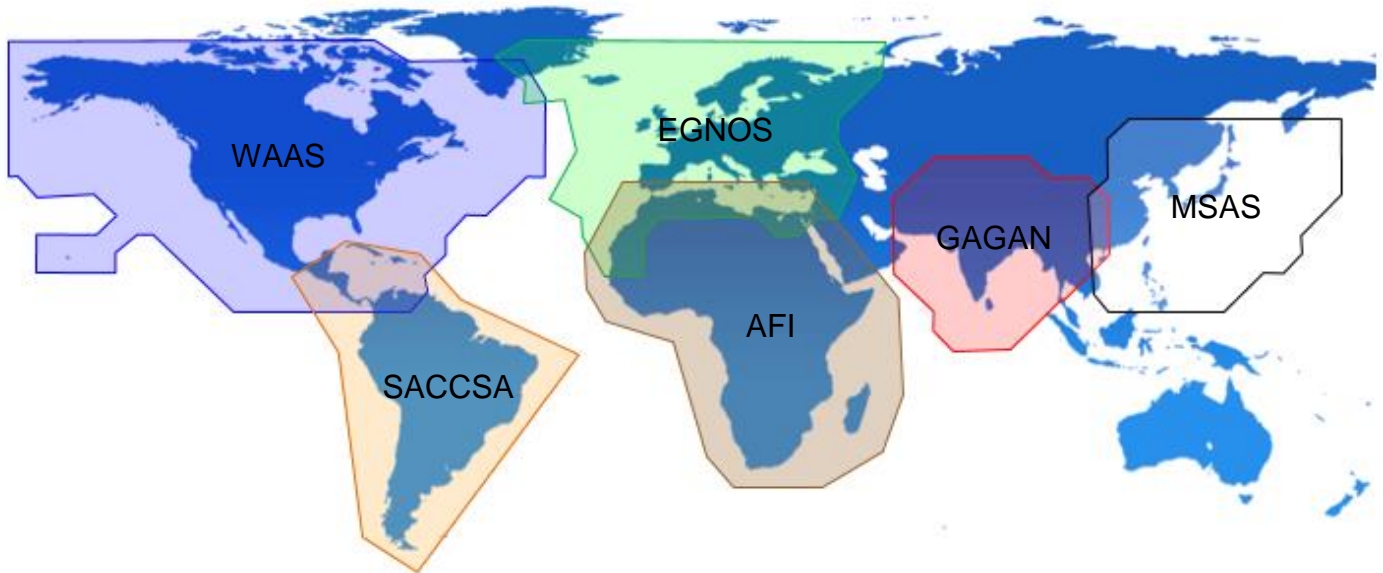
GPS SYSTEM INFORMATION AND STATUS

Information concerning the current operational status of GPS is available from the US Coast Guard Navigation Center:

- (a) (703) 313-5900 24 Hour Service Desk
- (b) (703) 313-5907 a continually updated taped message of satellite status, signal outages, and duration.
- (c) Home page <http://www.navcen.uscg.gov/>
- (d) Yuma Almanac <http://www.navcen.uscg.gov/?pageName=gpsAlmanacs>

SATELLITE BASED AUGMENTATION SYSTEM

Satellite Based Augmentation System (SBAS) is a system used to enhance the three dimensional accuracy of GNSS by relaying to SBAS capable receivers correction data that is used to refine its position. Covering North America is the Wide Area Augmentation System (WAAS), covering Europe is the European Geostationary Navigation Overlay Service System (EGNOS), covering Japan is the MTSAT Satellite Augmentation System (MSAS), and covering India is the GPS And GEO Augmented Navigation (GAGAN). Being considered are Solucion de Aumentacion para Caribe, Centro y Sudamerica (SACCSA) and Africa-Indian Ocean (AFI).



The Satellite Based Augmentation System is used to measure and correct GNSS satellite errors. This is used to refine the GPS position both laterally and vertically. FMS installations that have SBAS certification will allow the aircraft to fly RNAV approaches with a SBAS calculated glideslope.

SBAS uses a series of ground base stations that dynamically determine satellite error and transmit this data to a central processing computer. This computer maps a correction grid for the SBAS coverage area. Geosynchronous satellites transmit this data to SBAS capable GNSS which use the data to refine the GNSS position.

WIDE AREA AUGMENTATION SYSTEM (WAAS) (NORTH AMERICA)

The Wide Area Augmentation System (WAAS) is an [air navigation](#) aid developed by the [Federal Aviation Administration](#) to augment the [Global Positioning System](#) (GPS); improving its accuracy, integrity, and availability. WAAS is intended to enable aircraft to rely on GPS for all phases of flight, including [precision approaches](#) to any airport within its coverage area.

WAAS uses a network of ground-based reference stations, located in [North America](#) and [Hawaii](#), to measure small variations in the GPS satellites' signals in the [western hemisphere](#). Measurements from the reference stations are routed to master stations, which generate and send the correction messages to geostationary WAAS satellites. Those satellites broadcast the correction messages back to Earth, where WAAS-enabled GPS receiver uses the corrections while computing its position to improve accuracy.

Accuracy

The WAAS specification requires it to provide a position accuracy of 7.6 meters or better (for both lateral and vertical measurements), at least 95% of the time. Actual performance measurements of system at specific locations have shown it typically provides better than 1.0 meters laterally and 1.5 meters vertically throughout most of the [contiguous United States](#) and most of [Canada](#) and [Alaska](#).^[2] With these results, WAAS is capable of achieving the required Category I precision approach accuracy of 16 m laterally and 4.0 m vertically.

Integrity

Integrity is the ability of a navigation system to provide timely warnings when its signal is providing misleading data that could potentially create hazards. The WAAS specification requires the system detect errors in the GPS or WAAS network and notify users within 5.2 seconds. Certifying that WAAS is safe for IFR flight requires proving there is only an extremely small probability that an error exceeding the requirements for accuracy will go undetected. Specifically, the probability is stated as 1×10^{-7} , and is equivalent to no more than 3 seconds of bad data per year.^[3] This provides integrity information equivalent to or better than [Receiver Autonomous Integrity Monitoring](#) (RAIM).

Availability

Availability is the probability that a navigation system meets the accuracy and integrity requirements. Without the WAAS improvement, GPS could be unavailable for up to a total time of 4 days per year. The WAAS specification mandates availability as 99.999% throughout the service area, equivalent to a downtime of just over 5 minutes per year.

WAAS Segments

Ground Segment

The Ground Segment is composed of multiple Wide-area Reference Stations (WRS). These precisely surveyed ground stations monitor and collect information on the GPS signals, and then send their data to the Wide-area Master Stations (WMS) using a terrestrial communications network. The reference stations also monitor the signal from the WAAS geostationary satellites, providing integrity information regarding them as well. As of October 2007 there are WRS, in the [contiguous United States](#) (CONUS), in Alaska, in Hawaii, in Puerto Rico, in Mexico, and in Canada.

Using the data from the WRS sites, the WMS generate two different sets of corrections: fast and slow. The fast corrections are for errors which are changing rapidly and primarily concern the GPS satellites' instantaneous positions and clock errors. These corrections are considered user position independent, which means they can be applied instantly by any receiver in the WAAS broadcast [footprint](#). The slow corrections include long-term [ephemeris](#) and clock error estimates, as well as [ionospheric](#) delay information. WAAS supplies ionospheric delay corrections for a number of points (organized in a grid pattern) across the WAAS service area. Once these corrections are generated, the WMS then send them to the two pairs of Ground Uplink Stations (GUS) which transmit them to the satellites in the Space segment for broadcast to the User segment.

Space Segment

The space segment consists of multiple [geosynchronous communication satellites](#) which broadcast the correction messages generated by the Wide-area Master Stations for reception by the User segment. The satellites also broadcast the same type of range information as normal GPS satellites, effectively increasing the number of satellites available for a position fix.

User Segment

The User segment is the GPS and WAAS receiver, which uses the information broadcast from each GPS satellite to determine its location and the current time, and receives the WAAS corrections from the Space segment. The two types of correction messages received (fast and slow) are used in different ways.

The GPS receiver can immediately apply the fast type of correction data, which includes the corrected satellite position and clock data, and determines its current location using normal GPS calculations. Once an approximate position fix is obtained the receiver begins to use the slow corrections to improve its accuracy. Among the slow correction data is the ionospheric delay. As the GPS signal travels from the satellite to the receiver, it passes through the ionosphere. The receiver calculates the location where the signal pierced the ionosphere and, if it has received an ionospheric delay value for that location, corrects for the error the ionosphere created.

While the slow data can be updated every minute if necessary, [ephemeris](#) errors and ionosphere errors do not change this frequently, so they are only updated every two minutes and are considered valid for up to six minutes.

EUROPEAN GEOSTATIONARY NAVIGATION OVERLAY SERVICE SYSTEM (EGNOS) (EUROPE)

The European Geostationary Navigation Overlay Service (EGNOS) is Europe's first venture into satellite navigation. It augments the two military satellite navigation systems now operating, the US GPS and Russian GLONASS systems, and makes them suitable for safety critical applications such as flying aircraft or navigating ships through narrow channels.

Consisting of three geostationary satellites and a network of ground stations, EGNOS achieves its aim by transmitting a signal containing information on the reliability and accuracy of the positioning signals sent out by the Global Positioning System (GPS) and the Global Orbiting Navigation Satellite System (GLONASS). It allows users in Europe and beyond to determine their position to within 2 meters, compared with about 20 meters for GPS and GLONASS alone.

EGNOS is a joint project of the European space agency (ESA), the European Commission (EC) and Euro control, the European Organization for the Safety of Air Navigation. It is Europe's first activity in the field of global navigation satellite systems (GNSS) and is a precursor to Galileo, the full global satellite navigation system under development in Europe.

GPS AND GEO AUGMENTED NAVIGATION (GAGAN) (INDIA)

The GPS Aided Geo Augmented Navigation or GPS and Geo Augmented Navigation system (GAGAN) is a planned implementation of a [Satellite Based Augmentation System](#) (SBAS) by the [Indian government](#). (*Gagan* is the transliteration of a [Hindi](#) word that means sky.) It is a system to improve the accuracy of a [GNSS receiver](#) by providing reference signals. Being developed jointly by the [Airports Authority of India](#) (AAI) and the [Indian Space Research Organization](#) (ISRO), the project is being integrated with the [geostationary satellite](#) GSAT-4 and has a goal of being operational in 2013.

The Indian government has stated that it intends to use the experience of creating the GAGAN system to enable the creation of an autonomous regional navigation system called the [Indian Regional Navigational Satellite System](#) (IRNSS) and that it might use the [GSAT-4](#) satellite as a technology demonstration system phase of the proposed navigational system.

MTSAT SATELLITE AUGMENTATION SYSTEM (MSAS) (JAPAN)

The Japan Civil Aviation Bureau (JCAB) had been implementing the MTSAT Satellite-based Augmentation System (MSAS) to utilize GPS signal for aviation use.

MSAS provides GPS augmentation information to aircraft through MTSAT (Multi-functional Transport Satellite) located 36000km above the ground over the equator (geostationary earth orbit).

MSAS generates GPS augmentation information by analyzing signals from GPS satellites received by monitor stations on the ground. This augmentation information consists of GPS-like ranging signal and error correction information caused by GPS satellite itself or caused by ionosphere.

MSAS signal provides accurate, stable, reliable GPS position solutions to aircraft. This leads to a considerable improvement in the safety and reliability of GPS positioning, which, therefore, enables the aviation user who are under very strict safety regulations to use GPS positioning as a primary means navigation system.

MSAS for aviation use was commissioned September 27, 2007.

LONG RANGE SENSORS

ENHANCED DIFFERENTIAL LORAN (eDLORAN)

LORAN and eDLORAN are currently decommissioned in the United States, but other countries are still using this technology.

Enhanced Differential Loran is an internationally standardized positioning, navigation, and timing (PNT) service for use by many modes of transport and other applications. It is the latest in the long-standing and proven series of low-frequency, LOng-RANGE Navigation (LORAN) systems and takes full advantage of 21st century technology.

eDLORAN meets the accuracy, availability, integrity and continuity performance requirements for aviation non-precision instrument approaches, maritime harbor entrance and approach maneuvers, land-mobile vehicle navigation and location-based services, and is a precise source of time and frequency for applications such as telecommunications.

eDLORAN is an independent, dissimilar, complement to Global Navigation Satellite Systems (GNSS). It allows GNSS users to retain the safety, security and economic benefits of GNSS, even when their satellite services are disrupted.

The US modernization program resulted in this new version of Loran with significantly improved performance. It has much better accuracy, integrity and continuity while continuing to meet Loran-C's traditional availability requirements. This improvement is realized through the addition of a data channel. This data channel allows eLORAN to meet the very demanding requirements of landing aircraft using so-called non-precision instrument approaches, and bringing ships safely into harbor in low-visibility conditions. eDLORAN was also shown to be capable of providing the exceedingly precise time and frequency references needed by the telecommunications systems that carry voice and internet communications.

As eDLORAN uses high-powered transmitters and low-frequency signals (not microwatts and microwaves like GNSS), it is very unlikely to be disrupted or jammed by the same causes that would disrupt GNSS signals. This means that small, low-cost, eLORAN receivers, even built into GNSS units, can mitigate the impact of disruptions to GNSS. Moreover, eDLORAN can do things GNSS cannot, such as acting as a static compass. At sea, a new concept of navigation – enhanced navigation (e Navigation) – is being developed which requires an exceptionally reliable input of position, navigation and time data. Uniquely, the combination of GNSS and eDLORAN has the potential to meet its needs.

LORAN C SENSOR

The UNS FMS is compatible with several models of Loran C Sensors. The Loran C Sensor is not selected on the ground but is automatically selected upon lift-off. The Loran C Sensor uses ground stations to compute its position. The position accuracy is sufficient for enroute navigation. Loran C has a limited coverage area in the world. Loran-C, delivered a positioning accuracy of 460m, principally to mariners sailing in coastal and oceanic waters. When the Global Positioning System (GPS) appeared in the 1980s, with its positioning accuracy of tens of meters, many began to regard Loran-C as irrelevant. But others saw it as an essential source of position and time that could still be relied upon if GPS failed.

INERTIAL REFERENCE SENSOR (IRS)

Inertial Reference Sensors are designed around either conventional gyroscopes or the ring-laser gyroscopes. Those sensors utilizing conventional gyros depend upon accelerometers mounted on a gyro stabilized platform to sense velocity in all three axes. With laser-reference gyros, the difference in resonant frequency between light beams traveling in opposite directions is used to sense the rotation about each aircraft axis. These angular rate changes are combined with accelerometer measurements on each of those axes to determine the aircraft's orientation in space and to track its position. Whichever method is used, conventional or laser, the acceleration forces are the basis for computing directional velocities and for keeping track of the aircraft's present latitude/longitude position in the earth's coordinate system. Units from several manufacturers can be accommodated.

GPIRS: Combination GPS/IRS sensors are able to provide position and velocity data that take advantage of the best attributes of individual GPS and IRS sensors. GPS data has good long term accuracy, but its accuracy can vary on the short term. IRS has good short term accuracy, but can drift on the long term. GPIRS uses the best attributes of both systems.

AIR DATA

The UNS FMS accepts digital air data from a remote air data computer, with the UNS-1Fw also accepting analog air data. True Airspeed, barometrically corrected or non-corrected altitude, and Static Air Temperature are utilized. Baro-corrected altitude is required for vertical guidance display during approaches and for VNAV below 18,000 feet. Air Data Computers from various manufacturers can be interfaced with the FMS.

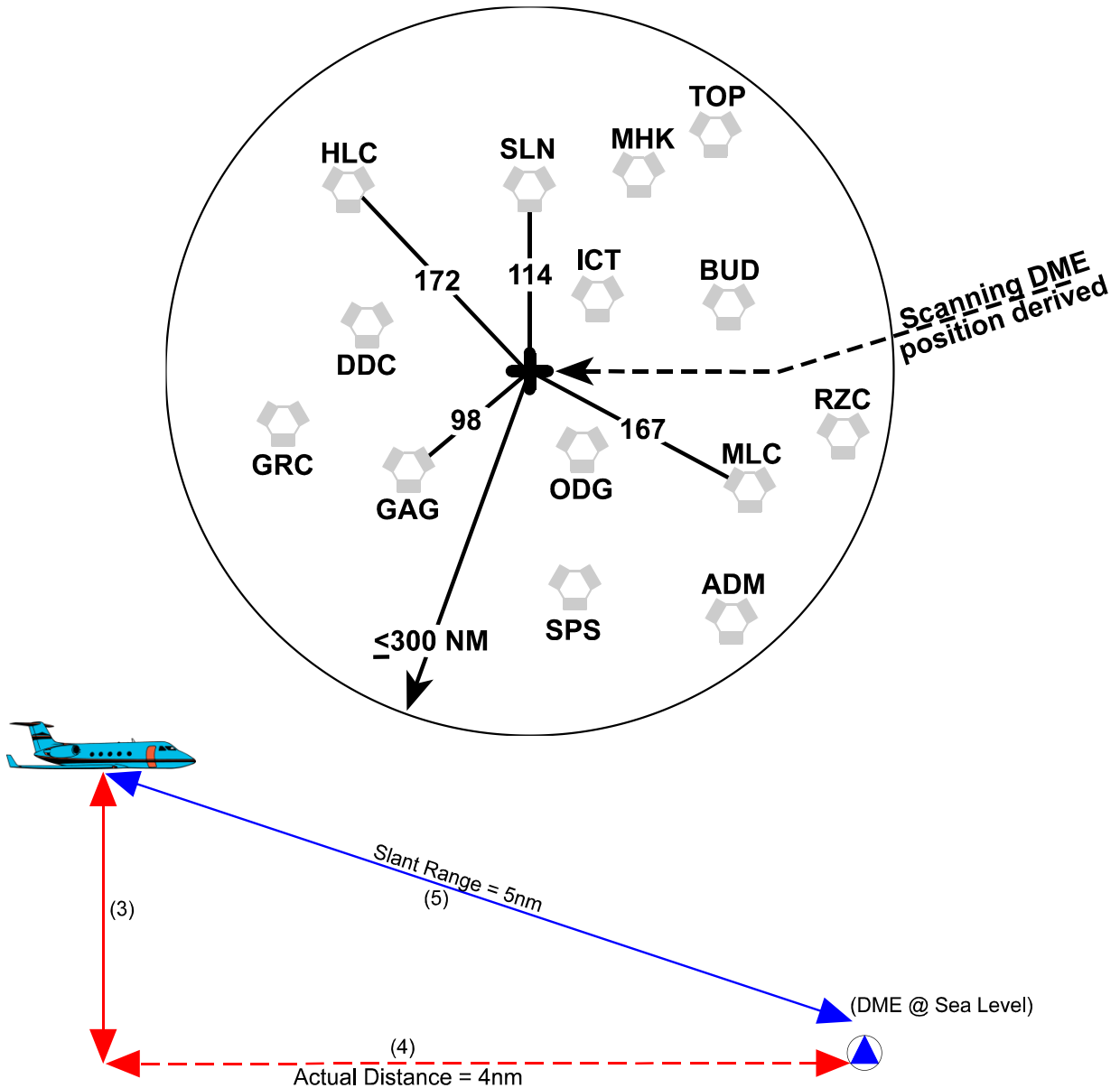
SCANNING DME OPERATION

RHO/RHO/RHO NAVIGATION

Using the “SCANNING DME” (or DME/DME/DME) function position is determined by measuring ranges to multiple DME sites of known location (longitude, latitude). The system’s own position can be determined to typically 0.3nm accuracy, although < 0.1nm accuracy is possible. The accuracy is a function of the number of DME available and the relative positioning of the DME sites. The more there are and the more widely dispersed they are, the better the accuracy of calculated position. The FMS will use the NAV database and find the 15 closest DME stations within 300nm. It then uses the 3rd channel of the DME to take a 4 second interrogation of the station. The FMS knows its own altitude (from the air data system) and the elevations (MSL from the navigation database) of each DME site. It’s therefore able to correct for “slant range” errors. A quality control of the acquired distance is accomplished by comparing the distance received to FMS calculated distance to the station. If the two distances do not agree within required parameters, the received DME distance is not used in the DME position calculation. The only time the FMS drops below 15 stations is if it cannot receive a total of 15 stations or if there are fewer than 15 stations within 300nm.

RHO/RHO/RHO POSITIONING

Continuous Automatic DME/DME/DME Position



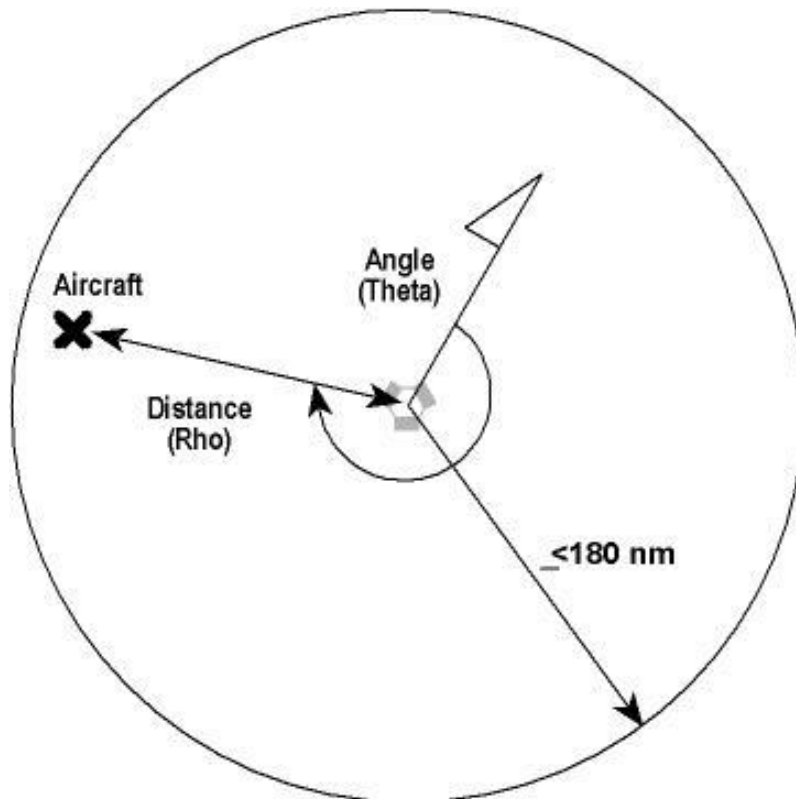
From Navigation Sensors and Air Data Computer:
 Approximate aircraft position
 Aircraft altitude

From database:
 VORTAC, VOR/DME, and ILS DME
 Frequency
 Coordinates
 Elevation

POSITION BY RADIAL AND DISTANCE

RHO/THETA POSITIONING

VOR is only used for enroute position information when the aircraft is located in a part of the world where only one DME is available. The FMS will then use radial and distance from a VOR/DME for position information. Distance is calculated by DME and the FMS corrects for slant range. The radial is provided by the VOR. Knowing the lat/long of VOR/DME will allow the FMS to calculate the aircraft position.



From Navigation Sensors and Air Data Computer:

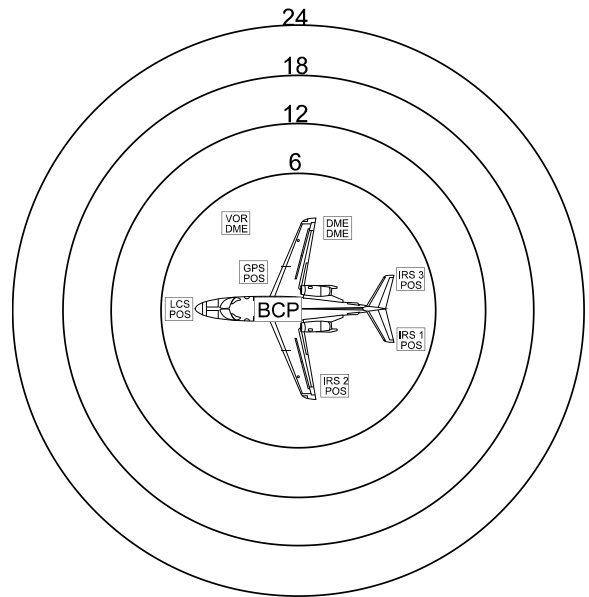
- Approximate aircraft position
- Aircraft altitude

From database:

- VORTAC and VOR/DME
- Frequency
- Coordinates
- Elevation

SENSOR DIFFERENCES

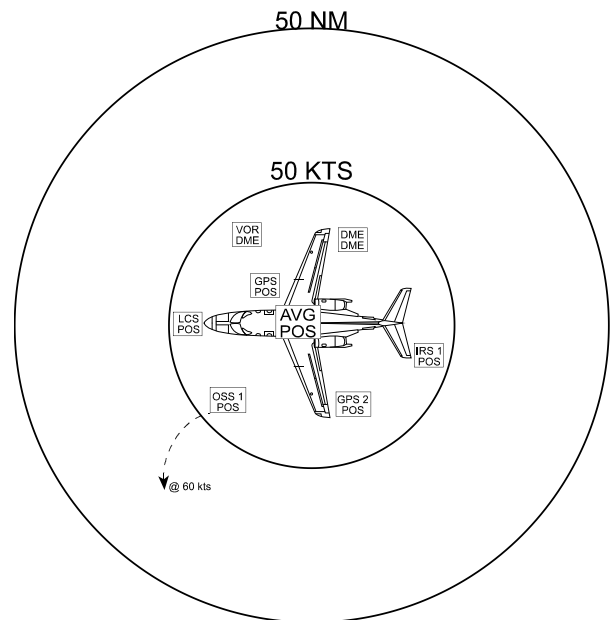
A sensor watchdog gives position difference warnings with FMS messages for a second FMS in dual installations and LCS sensors at 6, 12, 18, and 24nm from the FMS Best Computed Position. For IRS, the sensor watchdogs compare the rate of change of the IRS position against that of the FMS Best Computed Position. A decision on the part of the pilot to update or to deselect a sensor must take into account the position error involved, the error growth rate, and the stations being received.



MESSAGE -- LCS1 DIFFERENCE > 6NM

SENSOR MONITOR

For highly divergent sensors, based on the average position of all the other sensors, an individual sensor will be automatically deselected if the sensor's position differs from the FMS position by more than 50nm or if the sensor position is changing from the FMS position at a rate exceeding 50 kts. The DME derived position is used twice in this average position computation.



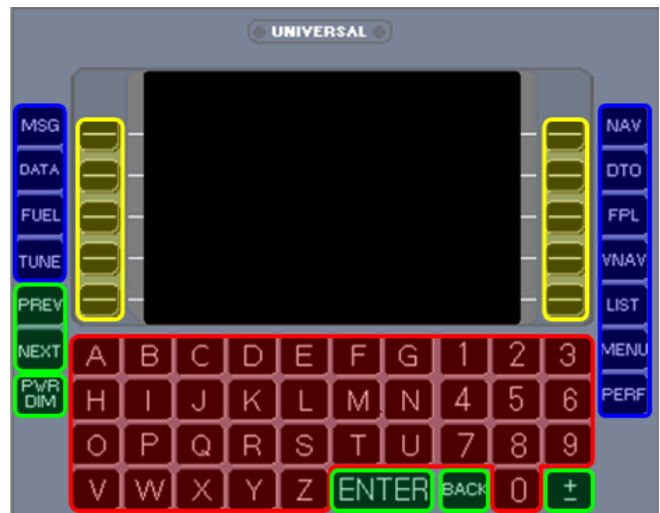
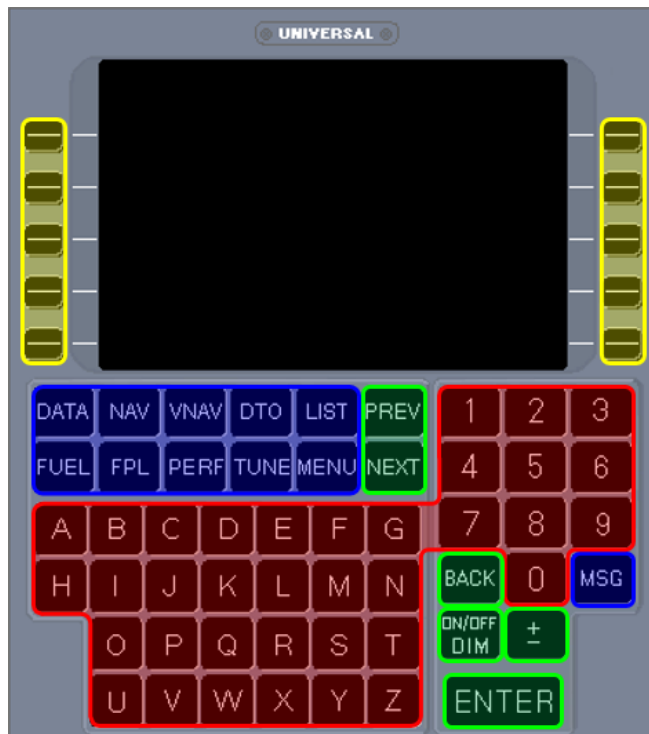
CDU OPERATIONS GENERAL PROCEDURE FORMAT

DATA ENTRY

- Data entry is at the cursor location.
- The cursor may be moved over a data entry field by Line Select [LS] keys, sometimes by the [ENTER] key, or sometimes automatically.
- Until the [ENTER] key is pressed, the value at the cursor has no effect.
- Some data entry fields are restricted to numbers only.
- Waypoint identifiers may be input by direct entry of the alphanumeric identifier or by reference number when included on a list.
- Any selection which will change the active flight plan, guidance of the aircraft, or stored database, requires confirmation by pressing the key a second time.

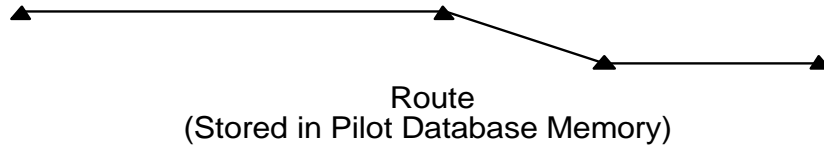
KEYBOARD

- 36 Alpha and numeric keys.
- 11 Function keys, **MSG** **DATA** **FUEL** **NAV** **FPL** **VNAV**
PERF **DTO** **TUNE** **LIST** and **MENU**
- 6 Control keys, **PREV** **NEXT** **BACK** **±** **ENTER** and **ON/OFF DIM**
- 10 Line Select keys, [LSK-1Lw] top left [LSK-5R] bottom right.

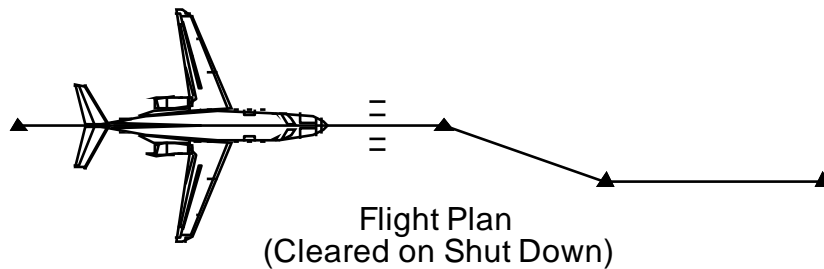


ROUTES VS FLIGHT PLAN PHILOSOPHY

- A. With Universal FMS systems, the FLIGHTPLAN is always the “Active” plan you are flying now. When the FMS is turned off, the flightplan is cleared.
- B. ROUTES are permanently stored groups of waypoints which may be assembled, viewed, edited, or deleted independently of the flightplan. Routes are stored in the pilot database for later use.



- C. The flightplan may be a copy of a stored ROUTE, and may be assembled, viewed, edited, or deleted independently of the stored Routes.
- D. A copy of the flight plan may be stored as a ROUTE through the FPL MENU page. As a ROUTE it may be further edited without affecting the flightplan.



FMS & GNSS SCALING & ALERTING

In accordance with TSO C-146 the chart below provides the CDI scaling and RNP and GNSS alerting.

When the FMS is in Enroute or Terminal phase of flight and RNP is exceeded a Position Uncertain message is pushed, but no HIS red flagging will occur. If GNSS Horizontal Alert Limit (HAL) and time to alarm is exceeded, the FMS will push the GNSS or GPS Integrity annunciator light.

When the FMS is approach active and approach RNP is exceeded or GNSS Horizontal Alert Limit (HAL) and time to alarm is exceeded, the FMS will red flag the HSI navigation.

Scaling & Alerting

TSO C-146


Phase of Flight	CDI Scale (2 dots)	FMS RNP (95%)	GNSS HAL (95%)
Enroute	2.0 nm	2.00 nm	2.00 nm (>27 sec)
Terminal	1 nm to 350' 2°	0.30 nm	0.30 (>7 sec)
Approach	1.0 nm	1.00 nm	1.00 nm (>7 sec)
Remote Oceanic	2.0 nm	4.00 nm	2.00 nm (>27 sec)

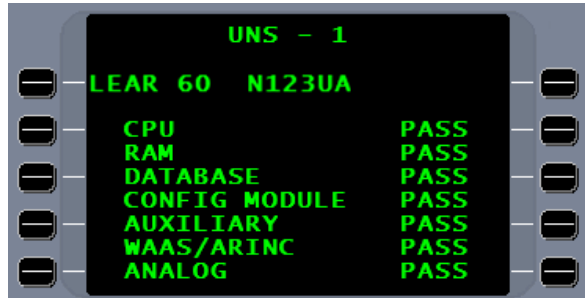


SCN 1000/1100 will maintain Terminal Phase of Flight throughout the entire departure/arrival procedure (IAW DO 229)

Remote Oceanic when aircraft more than 300 nm from nearest DME

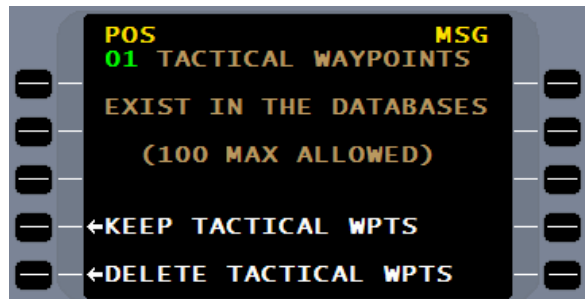
POWER ON

Press  key to power up. The system will perform a Power On Self-Test (POST). This checks both hardware and software components of the FMS and, if all test areas “PASS”, then the FMS is operating correctly. If a “**FAIL**” occurs, it could be either critical or non-critical. If a non-critical fail occurs, the FMS will continue to the initial page, but the FMS will not be working at optimum. By cycling power, a reboot of the FMS may clear non-critical failures. A critical fail will halt the FMS POST. An attempt to clear the fault by cycling power has only a limited chance of working, but is still worth a try. Unless the fail is expected, maintenance will be required for any failure.

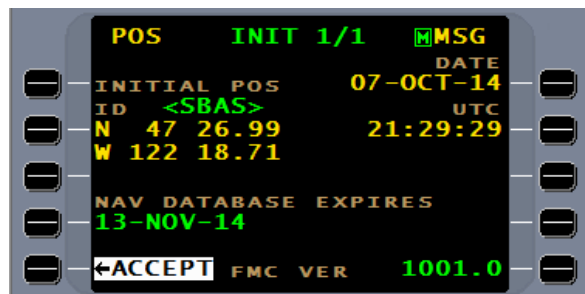
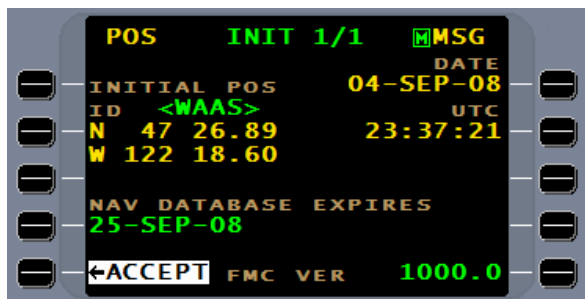


CAUTION: DEMO mode configured in the FMS sets the unit to a test demonstration capability. It should not be configured in the aircraft prior to flight. If an aircraft FMS is configured as DEMO, the FMS will ignore sensor inputs and WILL NOT navigate.

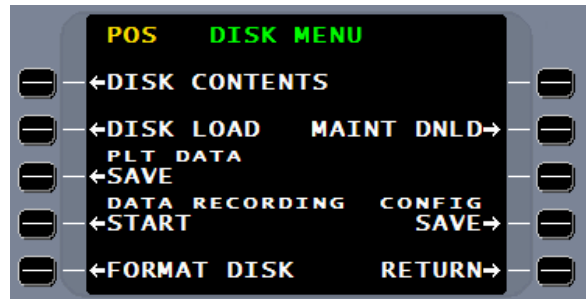
Following the POST, if tactical waypoints exist in the pilot database, a statement “**TACTICAL WAYPOINTS EXIST IN THE DATABASES (100 MAX ALLOWED)**” will be presented. Also presented are two line select keys, 1) KEEP TACTICAL WPTS, 2) DELETE TACTICAL WPTS. A choice must be made to advance to the initial page. Tactical waypoints are covered later.



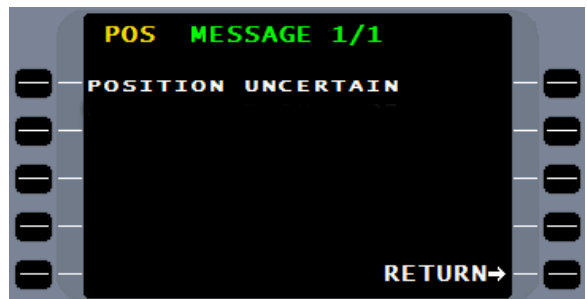
After successful completion of self-tests and copyright display and possible need to make a Tactical Waypoint determination, the initialization page will be displayed. The colors presented on the FMS are dependent on whether the aircraft has an EFIS and, if so, the EFIS manufacturer and model. The display colors do not affect the operation of the FMS.



The **M** symbol displayed indicates the availability of a MENU page for that function and can be accessed using the **MENU** key. Pressing the **MENU** key from the initialization page will display the **DISK MENU** page to allow DTU operations for entering of databases, etc. The use of this page will be covered later.

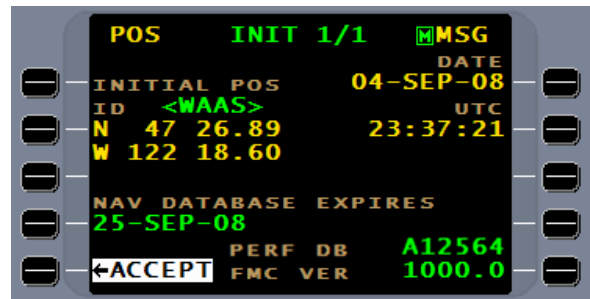


Pressing the **MSG** key will display current system messages. Pressing the **MSG** key again or the "RETURN" line select key will return to the previously displayed page.

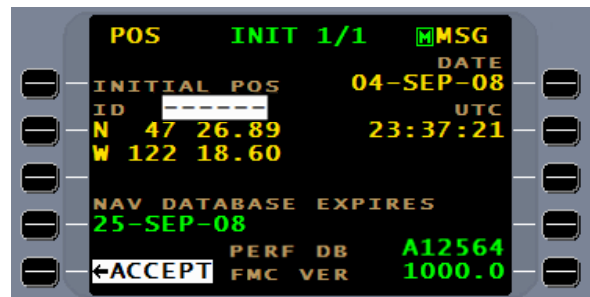


INITIALIZATION

The “**INITIAL POS**” displays the Latitude and Longitude and the source. If “<WAAS>” (SCN 1000/1100 or “<SBAS>” (SCN 1001/1101 and subsequent) is present next to “ID”, the source for the FMS position is the SBAS or in non-SBAS coverage areas it indicates that GPS is the position source.



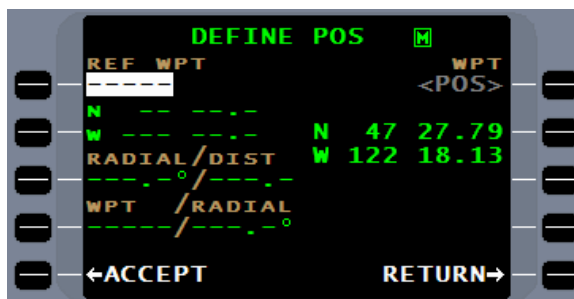
Normally the SBAS is the most accurate source and pressing the line select key next to “ACCEPT” will position the FMS at the displayed coordinates. If the “<WAAS>” or “<SBAS>” is not displayed, the displayed coordinates are those of the FMS when it last stopped navigating. These coordinates can be accepted through the “ACCEPT” line select key. By selecting the number 1L line select key, the cursor will be placed next to “ID” allow the entering of an align point. Pressing **LIST** will present a list of airports and pilot created align points although an entry can be made with the use of the alphanumeric keys. Since it is important for the initial position to be as accurate as possible, the use of the “<WAAS>” or “<SBAS>” coordinates should be the highest priority. If “<WAAS>” or “<SBAS>” coordinates are not available, use a pilot created align point or manually insert the aircraft parking spot coordinates.



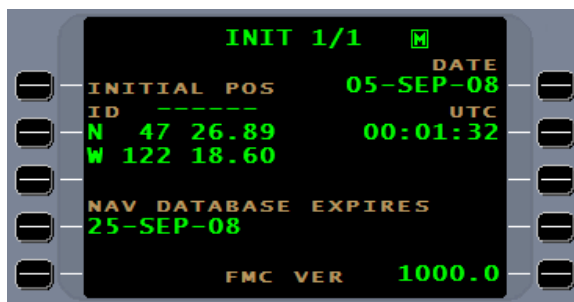
With the cursor in the ID field, by pressing the **LIST** key the airport’s/pilot’s align point list will be displayed. Ten pages of lists are available. The cursor will pre-fill the list number of the waypoint closest to the initial position coordinates. Distances from initial position are shown. If an ALIGN PT is created it will appear under the **APT/PLT** listing. Enter the correct number in the cursor field and press **ENTER**.



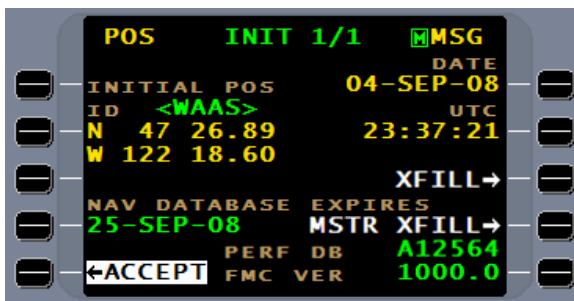
By selecting the 2L line select key, a “**DEFINE POS**” page will appear. This page may be used to define the aircraft’s position in relation to a known fix or by the direct entry of latitude and longitude. The procedures to use this page will be discussed later.



If the “<WAAS>” or “<SBAS>” position is accepted (strongly recommended), initialization is complete. If the initial position identifier is filled in and entered, the cursor moves to the date entry field. Revise date and time as necessary. When the SBAS is in NAV mode, UTC and date are automatically updated. Allowing the GPS to correct the date and time is strongly recommended. Press **ENTER** to advance the cursor. When all data is correct, press the ACCEPT line select key to accept the data. When pressed, the ACCEPT line select key will disappear as will “<WAAS>” or “<SBAS>” if used for initial coordinates.




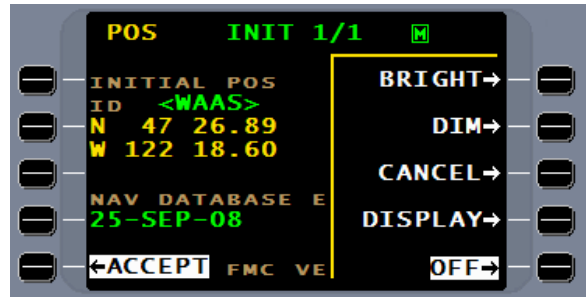
In Multiple FMS installations, an "Xfill" line select key will be available to crossfill initialization data. After initialization is completed on the first system "Xfill" is available to crossfill data. The Xfill feature is configured at time of installation and may be initialization data only, fuel initialization data only, flight plan data only, or "Master Xfill" which crossfills all three. Master Xfill is only available on the ground and will be available only after initialization, flight plan, and fuel entries have been made on one FMS. During crossfill operations, the banner CROSSFILL RECEIVE IN PROGRESS will blink to show system activity.



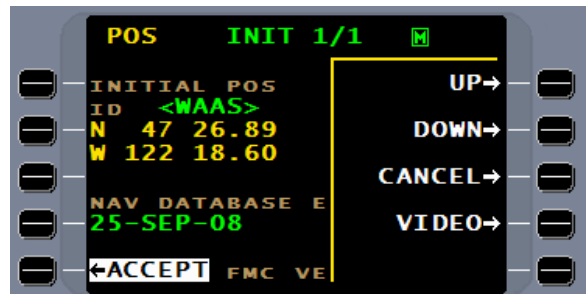
NOTE: Crossfill operation can be configured to push data to the other FMS or pull data from another FMS. Check with the appropriate flight manual supplement for the proper operation.

NOTE: If Synchronous mode is configured, many crossfill functions are incompatible and will not be available. Synchronous features will replace those crossfill functions lost.

By pressing the  key, an overlay will be brought up that allows for controlling the brightness of the screen. Press and hold the BRIGHT or DIM line select key to set the preferred screen brightness.

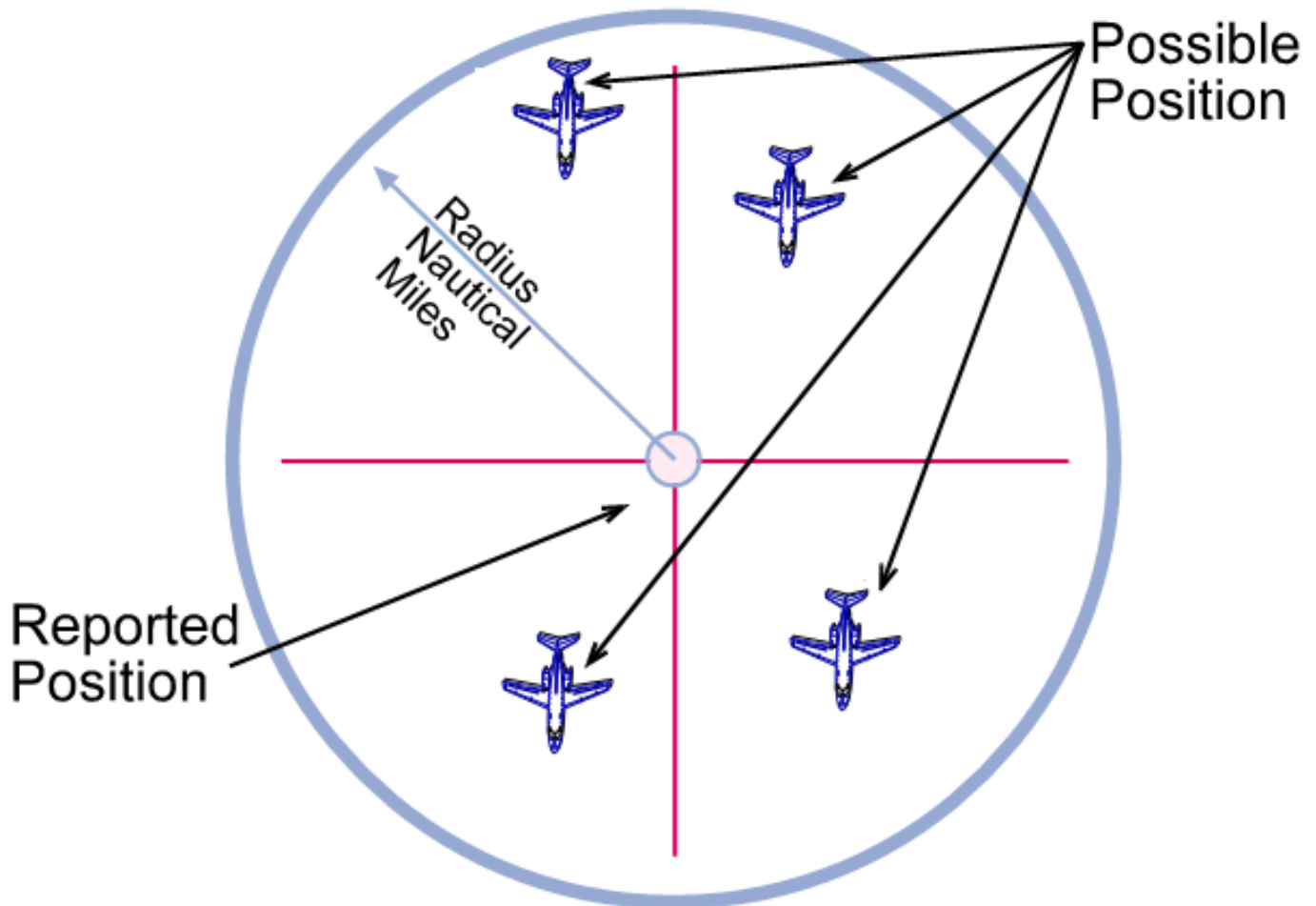


The position of the FMS relative to the pilot may cause a parallax between the display on the screen and the line select keys. To correct any parallax, press the DISPLAY line select key and an overlay will be presented that allows for UP and DOWN line adjustment. The VIDEO option is available for special equipment interface.



Press the CANCEL line select key to remove the current overlay or the  key to close the entire overlay.

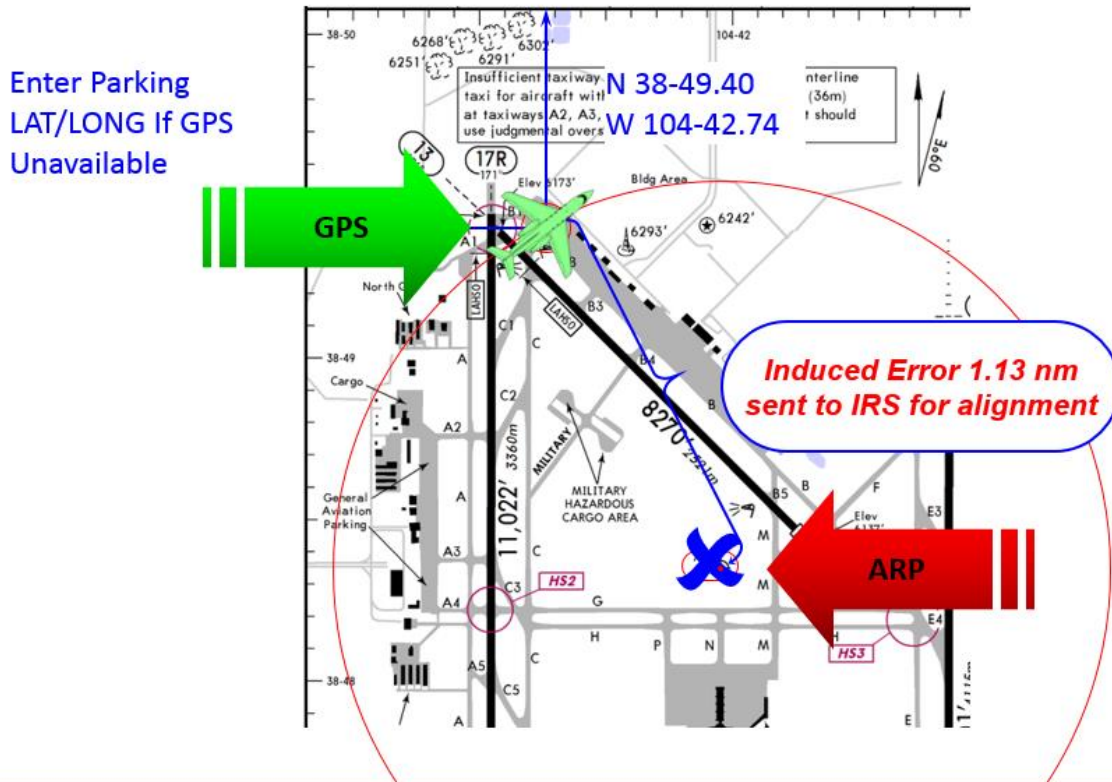
CIRCLE OF POSITION



All navigation sensors will produce not a position, but a circle of position. The sensor will compute a position, but because of errors induced by the limits of the sensor's capabilities, other possible positions exist. A circle is drawn around 95% of the possible positions computed as a result of the measured sensor error (2 Sigma). This becomes the Circle of Position. The accuracy of the sensor is measured by calculating the radius of the circle. Thus the true position of the sensor has a 95% probability of being within the defined Circle of Position. The radius of the Circle of Position for the FMS best computed position is known as the Actual Navigation Performance (ANP) of the FMS and is displayed in hundredths of a nautical mile.

USING SBAS FOR THE FMS INITIAL POSITION

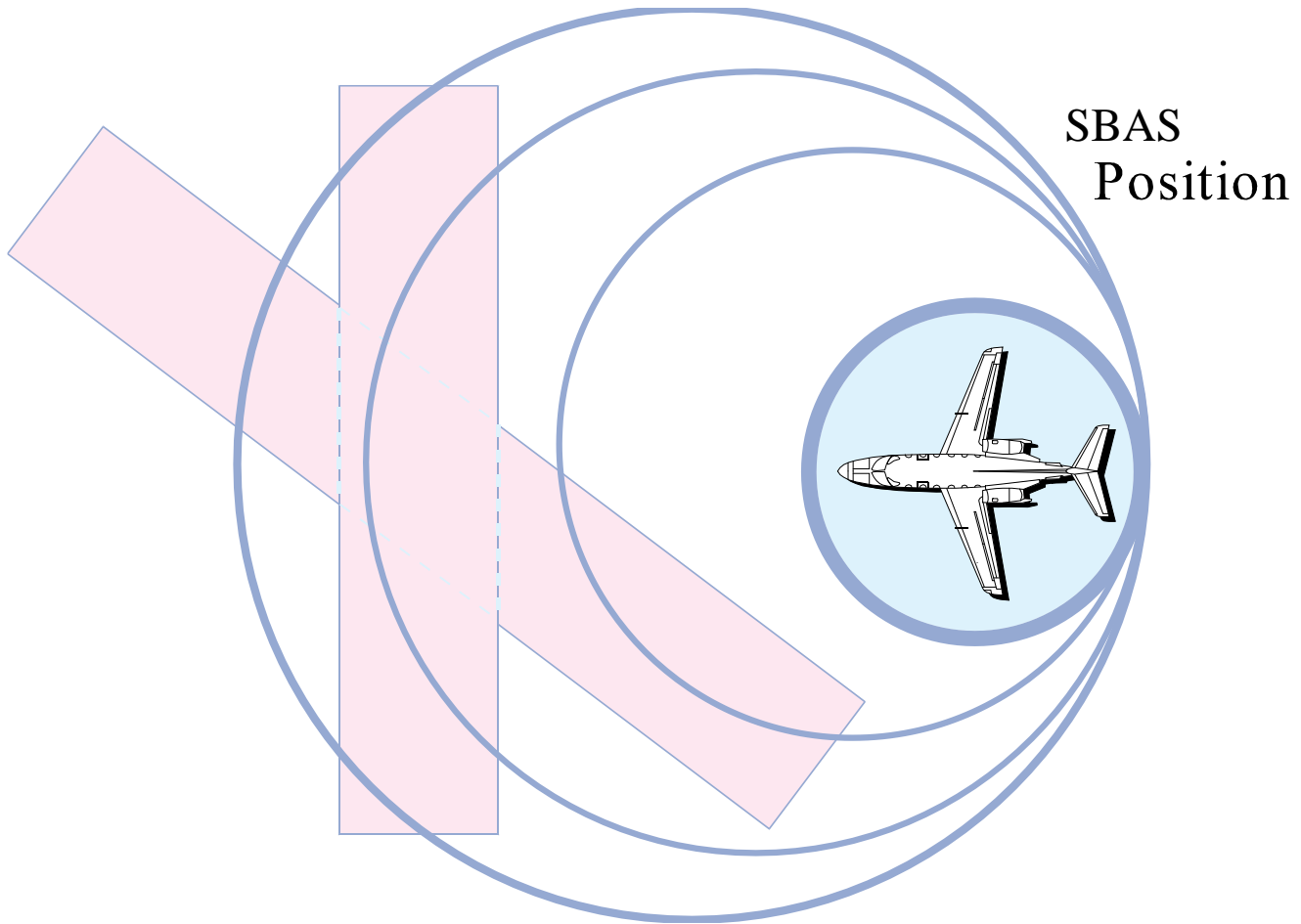
FMS Initial Position Resolution



Entering airport identifier not recommended!!

To support the justification for accepting the SBAS position in lieu of the ICAO airport identifier, the following is presented. SBAS will acquire the position of the aircraft at its current parking location and present that position to the pilot for initialization. If the pilot decides to place the airport identifier in the ID field in lieu of the <WAAS> or <SBAS> indicator, the Airport Reference Point (ARP) will be used to initialize the FMS position. Now the FMS has two sources for its position, the ARP and the SBAS position. With this position information the FMS calculates its circle of position to include both points. This circle could be very large depending on the distance of the aircraft from the ARP. If the aircraft were to takeoff with the circle of position larger than the RNP for the terminal phase of flight, a position uncertain message will appear. Using the SBAS position for the initial position will avoid this and is strongly recommended. The ARP will also be the position transmitted to the IRS/IRU if installed and in align mode.

CONSOLIDATING THE FMS POSITION



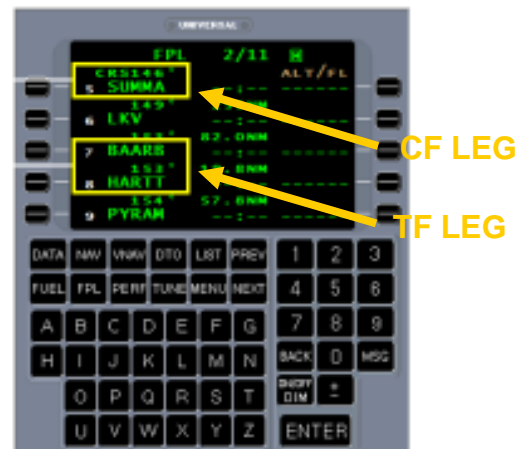
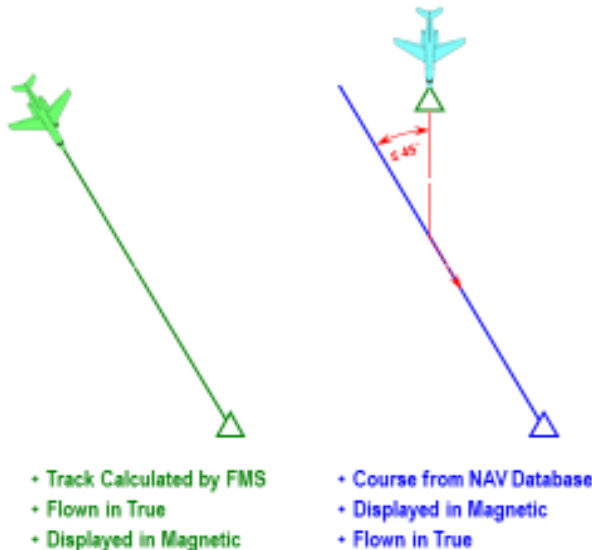
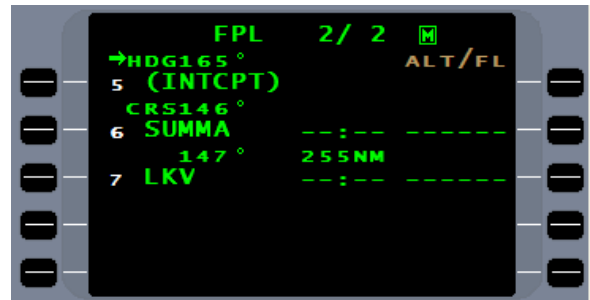
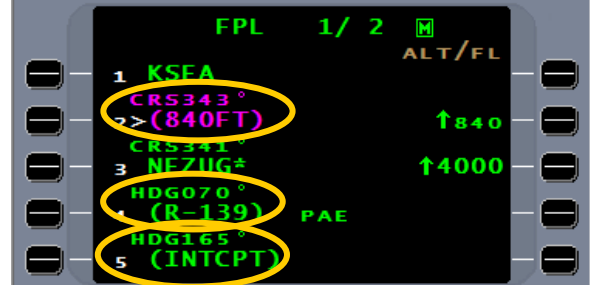
If the ARP is used to initialize the FMS position, the accuracy of the initial position could produce a large circle of position. With time, the FMS will reduce the size of the circle of position to the Horizontal Protection levels of the SBAS and the FMS position will become the SBAS position. This, however, could take some time. If the FMS presents a position uncertain message (ANP exceeds RNP) after takeoff, the FMS will continue to consolidate the NAV sensor input and eventually the position uncertain message will disappear. Even during the time the position uncertain message is displayed, the FMS will continue to navigate to the best tolerances possible.

NAVIGATIONAL LEGS

For the FMS to navigate requires a path over the ground and a point of termination to signal the FMS to sequence to the next leg. Aeronautical Radio Incorporated (ARINC), in their specification 424, defines 23 navigational legs that are used by industry software engineers. These navigational legs enable the FMS to emulate a pilot navigating the aircraft. The specific leg types are defined later in this manual.

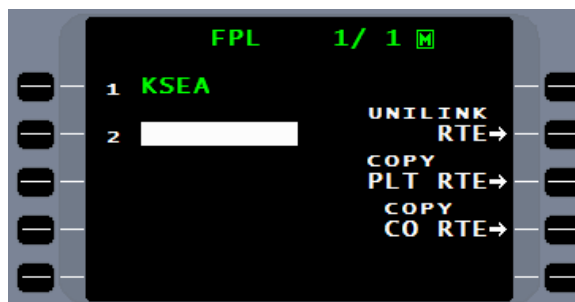
Newer generation FMS provide the ability to terminate a navigational leg by other than a lat/long. This would be a condition and, therefore, the terminating waypoint would be referred to as a conditional waypoint. Conditional waypoints are identified by parentheses. When the condition is met, such as by reaching an altitude, the FMS will sequence to the next leg. Conditional waypoints are found in departure and arrival procedures.

Two of the ARINC 424 leg types are similar and tend to confuse pilots; these are Track to Fix (TF) and Course to Fix (CF). A TF leg is created within the FMS using starting and ending lat/long waypoints. The FMS calculates a great circle course between the two points using true heading. A continuation of this course line would bisect the center of the earth and, if flown without stopping, would return to the starting point. A CF leg is created and stored in the NAV database in departure and arrival procedures and is identified by CRS preceding the course. If the previous leg terminates at a point not directly in line with the CF leg, the FMS will command a turn to intercept that leg. The maximum intercept angle is 45°, but will turn only to what is calculated for the intercept.

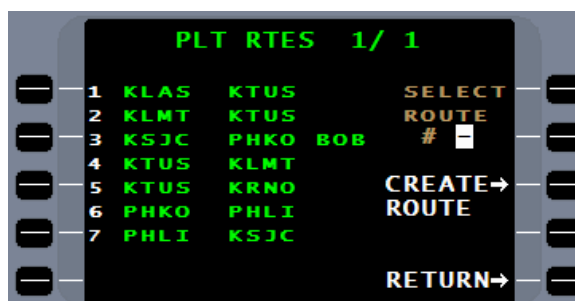


FLIGHTPLAN

Pressing the **FPL** key will display the first flightplan page. The first flightplan waypoint will pre-fill with the nearest airport if the ARP is less than 3nm from the aircraft. The cursor will be ready to accept the next point. The COPY PLT RTE and COPY CO RTE (if applicable) line select key will be displayed. The flightplan may be constructed, or a route from the pilot or company database may be copied into the flightplan by pressing the appropriate line select key.

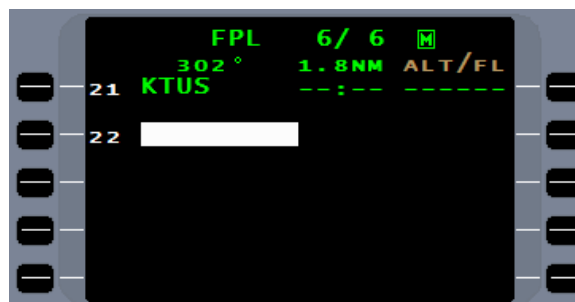


The routes' directory of all existing stored routes may be accessed through the COPY (CO) (PLT) ROUTE LIST pages. Listed routes will be in geographical/alphabetical order. The **PREV** or **NEXT** keys may be used to move to the page with the desired route.



At the cursor enter the list number of the desired route and press **ENTER**.

The route will be copied and the cursor will return after the last waypoint to enter additional points if desired.



Several ROUTE segments can be assembled to the flightplan by the use of the copy route available on the LIST page.

A "Company Routes" database can be created off line with the Universal Flight Planning program and loaded via flash memory drive. This database will allow routes to be viewed and copied to the active flightplan, but the flight crew cannot modify the stored routes themselves. Company waypoints and airports can also be created offline.

FLIGHTPLAN CREATION TIPS

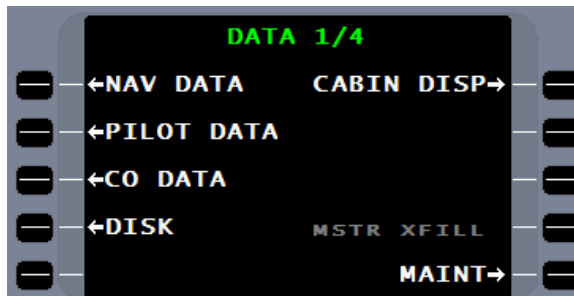
The following tips will assist the new FMS user in remembering how to enter into the flightplan the various flightplan components. The information following the flightplan creation tips will cover flightplan creation in detail.

1. Placing a departure airport on the flightplan/route is required for selection of a SID. This should be accomplished automatically by the FMS during Initialization. It is not recommended that the arrival airport be added to the flightplan until after all airways are entered. This will create a NO LINK and airway entry problems.
2. A departure is created through the FPL MENU key by selecting DEPART.
3. Airways are selected through the LIST function.
4. To enter an airway, use the LIST function which requires a reference waypoint. On the flightplan, this is accomplished by placing a cursor on the flightplan with a line select key. The waypoint prior to or above the cursor position is the reference waypoint.
5. Placing a destination airport on the flightplan /route is required for selection of a STAR and/or approach.
6. A STAR and an approach are selected through the FPL MENU key by selecting ARRIVE.
7. The selection of a runway on the arrival page is used to direct a STAR to a specific runway.
8. A STAR need not be entered for an approach to be selected. Pressing the line select key next to APPR will bring up the available approaches for that airport.
9. When selecting an approach, recommend selecting a transition for the approach when available; unless the STAR contains the transition waypoints.

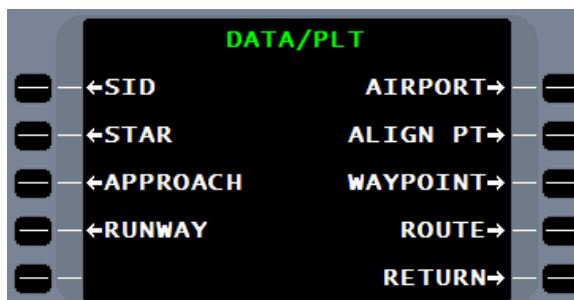
FLIGHTPLAN & ROUTE CREATION

Although Pilot Flightplans and Pilot Routes are accessed through different function keys, the method for their creation is basically the same.

The UNS-1 provides for storage of up to 200 pilot defined routes. Stored routes may contain a SID, route of flight waypoints, a STAR, and an approach. To create a pilot defined route or edit an existing one, press the "PILOT DATA" line select key.



Press the ROUTE line select key for the routes catalog page.

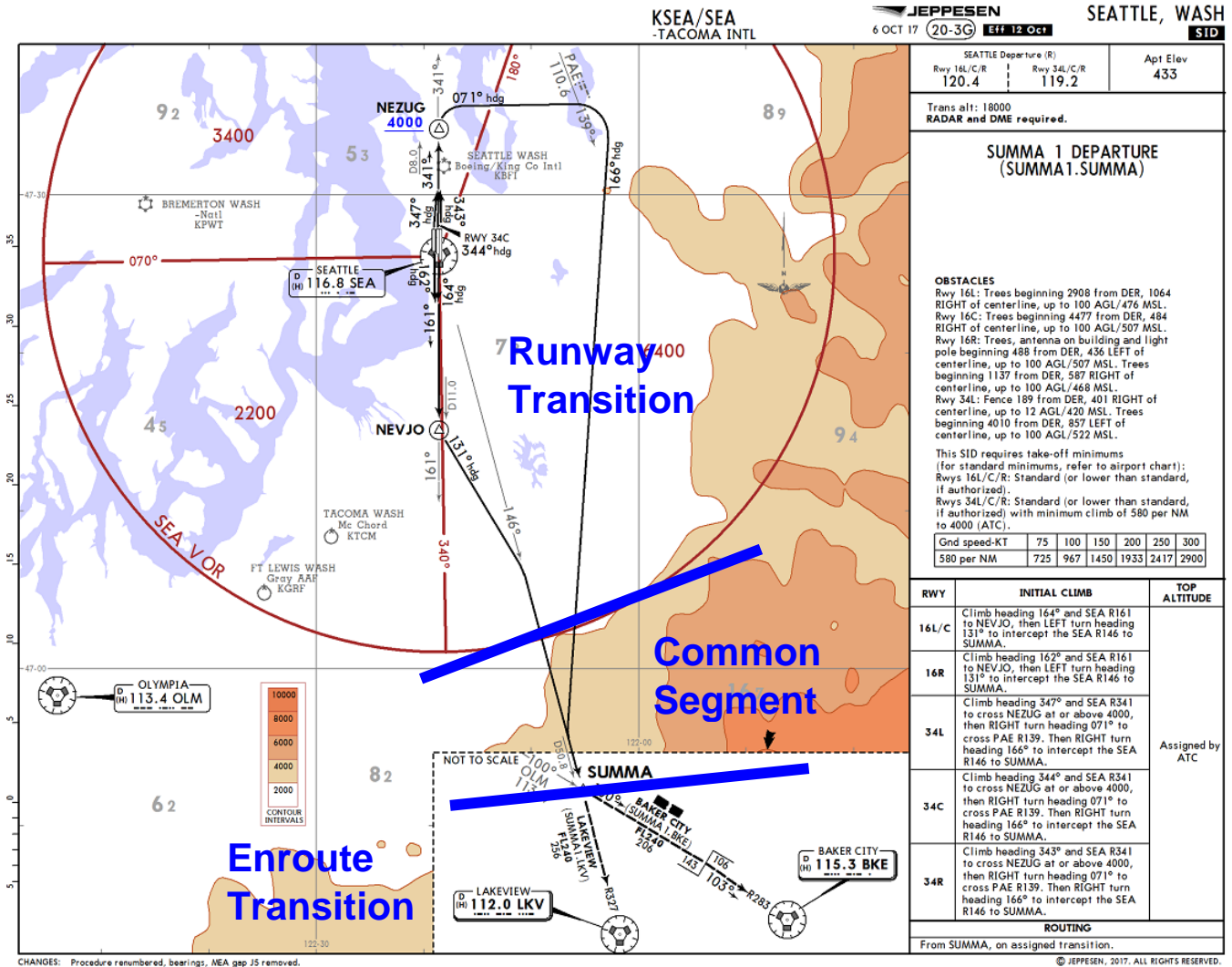


The stored routes will be listed in alphabetical order. The route titles listed here will always begin with the first route waypoint, plus the route name defined by the pilot, or the last waypoint if no name is entered during route construction.

To view or edit an existing route, enter the number of the route from the list at the cursor. Where NAV data has changed within a PLT RTE with the activating of a new NAV database, the route will flash indicating that editing is required. To create a new route, press the CREATE ROUTE line select key.



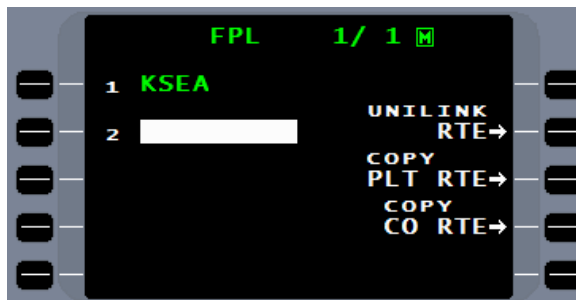
DEPARTURE SELECTION OF THE SID



Standard Instrument Departures (SID) can have up to three segments.

1. Runway Transition – unique routing from one or more runways
2. Common Segment – all transitions pass through this segment
3. Enroute Transition – unique routing to one or more enroute waypoints

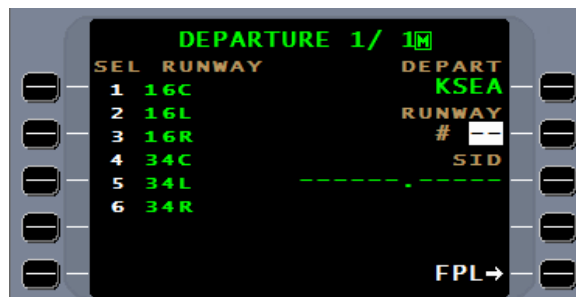
Enter a SID or if there is no SID at the airport, enter the first waypoint on the route of flight. A radar vector or direct type SID will not appear in the SID listing.



Press the **MENU** key to display the flightplan menu. Press the DEPART line select key.



The DEPARTURE 1/1 page will be displayed. Select Runway 34C by entering number 4 from the runway list in the cursor then press **ENTER**. This will identify the Runway Transition.



Select the Summa 9 SID by entering number 7 in the cursor then press **ENTER**. This will identify the SID and take the routing through the Common Segment.



Select the LKV transition by entering number 2 in the cursor and then pressing **ENTER**. This will identify the Enroute Transition.



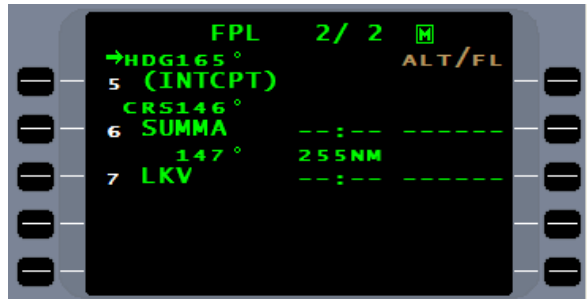
The SID is now linked to the flightplan. Return to the flightplan by pressing the FPL line select key.



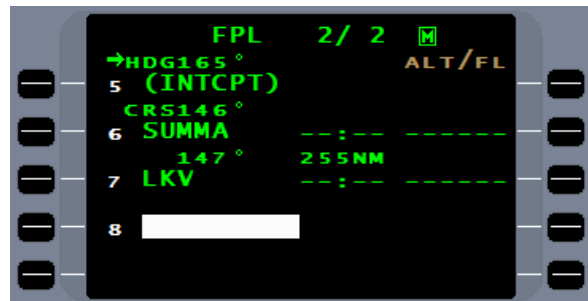
Page 1/2 of the flightplan page will appear.



By using the **NEXT** key, move to page 2/2 to continue building the route of flight.



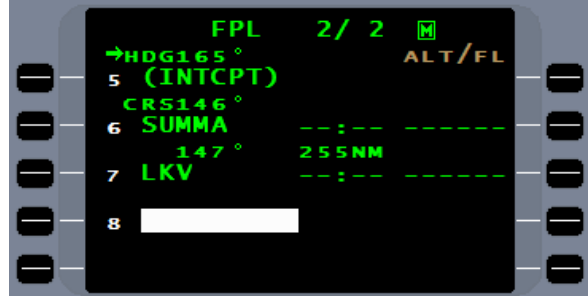
Use the line select key to place a cursor on the page below **LKV**. The **ENTER** key will also make the cursor appear and move down the page.



LIST FUNCTION

The LIST function allows for direct entry of a VOR, APT, NDB, Intersection, Airway, GAP, or another route.

The LIST function begins by using the waypoint above the cursor as the reference point. Thus, before the LIST function will work, a cursor must be placed on the page. If the cursor position is a “*NO LINK*”, the “*NO LINK*” must be deleted before using the LIST key or the AIRWAYS line select key will not be selectable.



The LIST function uses a smart search to take the seven closest waypoints in an elliptical pattern in the current direction of the aircraft’s route of flight and presents them on page 1/10 in alphabetical order. The remaining nine pages will continue to present waypoints in an ever increasing distance from the reference point.



The PLN LANG line select key will display the name of the fix beside the identifier where applicable. Placing the number of the desired waypoint in the cursor will enter the fix in the flightplan cursor. The closest waypoint to the reference waypoint is defaulted in the field, but entering a number will overwrite the default number.



Selecting the AIRWAYS line select key will present a list of airways that use LKV as a waypoint. The AIRWAYS selection will not be available where the LIST reference point is not a waypoint on an airway. The route of flight calls for J5. Enter 2 in the cursor field and press **ENTER**



NOTE: The active NAV database being used will affect the data that is provided by the list function.

A list of waypoints for airway J5 is presented on two pages.



Use the **NEXT** key to move to page 2/ 2 for selection of **LANDO** the airway change over point. Enter 2 for **LANDO** and press **ENTER**. Use the airway list function to enter J65 to KOFFA and J104 to TUS with the same procedure as above.



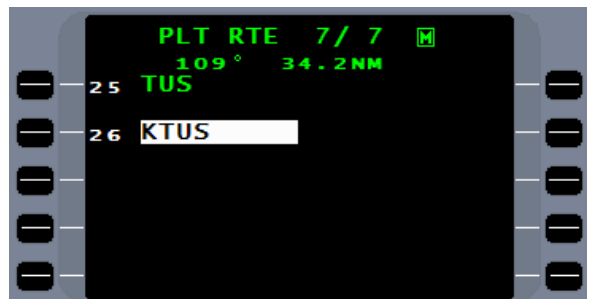
An alternate method for selection of an airway end point is to directly, with the use of the alphanumeric keys, enter the waypoint in the **TO** field. A waypoint entry not on the airway will result in a flashing waypoint in the **TO** field.



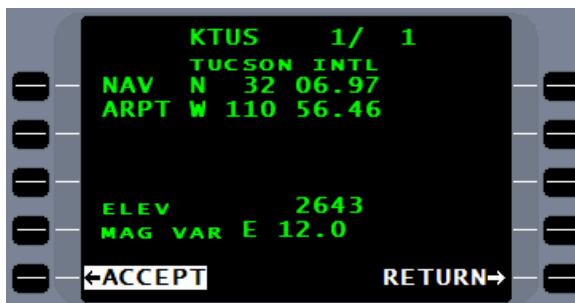
With the route of flight completed to **TUS**, the entry of the destination airport is necessary for the FMS to present the STAR and Approach.



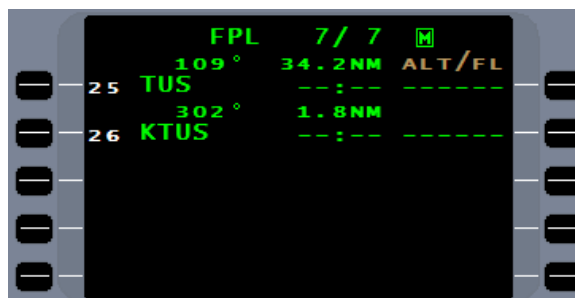
Either enter KTUS directly in the cursor field or use the airport option in the **LIST** function to search for KTUS.



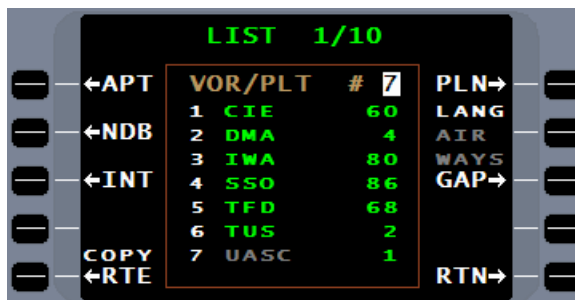
Pressing **ENTER** will cause the FMS to access the NAV database and present the found information. Verify the information before accepting it. With the cursor over the ACCEPT line select key, the **ENTER** key will accept the displayed information.



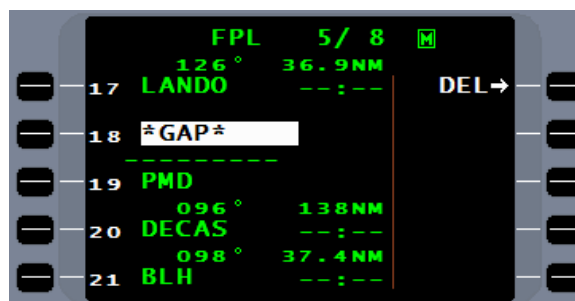
The Pilot Route creation may be terminated at this point for entry of the STAR and Approach at the time of the flight. If runway information for selection of the STAR and Approach are not available at the time of departure, the flightplan can be edited in flight to add them.



The COPY RTE line select key will allow selection of an existing route and copy it into the route being created. This feature can be useful if a series of waypoints that aren't part of a published procedure are routinely issued in a clearance. This small segment of waypoints can be stored as a pilot route and inserted where required to expedite creation of the route of flight.



The GAP line select key in the LIST function will insert a *GAP* into the route of flight preventing automatic leg sequencing beyond the *GAP*. This feature can be used to mark a clearance limit or allow a break for search and rescue.



If a cursor is placed over a *GAP* or *NO LINK* on the flightplan, the AIR WAYS option on the LIST page will not be selectable.



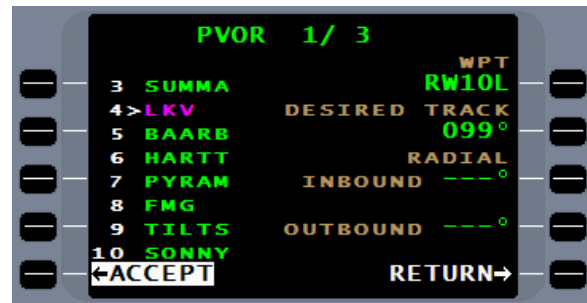
When doing tactical operations such as PVOR, DTO, and HOLD, the LIST function will provide a RWY option.



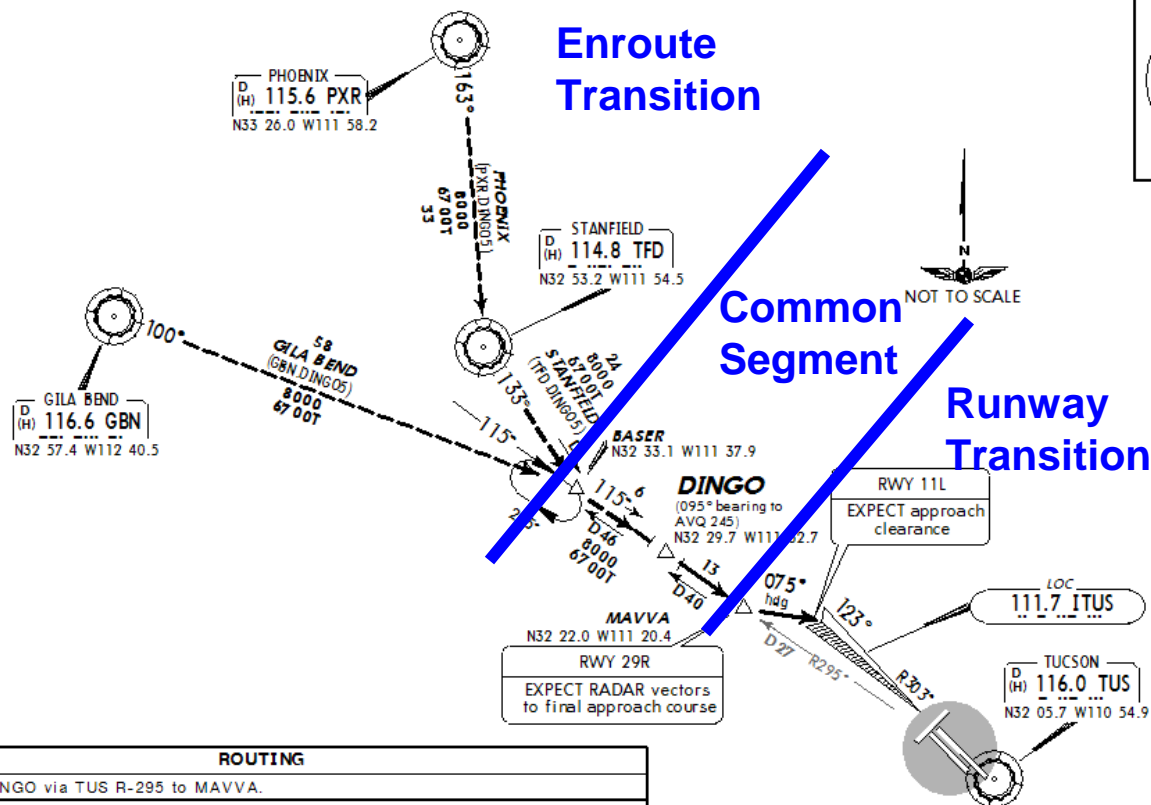
The RWY option will present the airport identifier and runway. The runway coordinates are that of the runway threshold.



When the RWY option is used with PVOR, the runway heading is automatically entered as the DESIRED TRACK. Accepting this will present, on the NAV page, a PVOR with runway course information.



ARRIVAL SELECTION OF STAR AND APPROACH



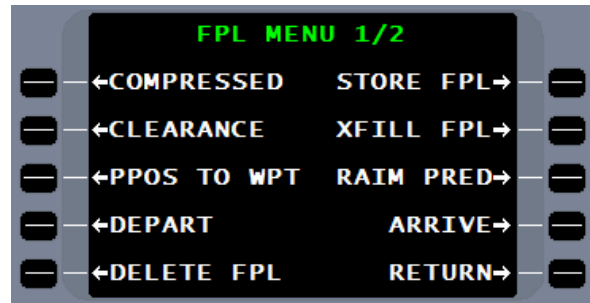
DINGO FIVE ARRIVAL (DINGO.DINGO5)

ROUTING	
From over DINGO via TUS R-295 to MAVVA.	
RWY	LANDING
11L	From MAVVA via 075° heading to intercept ITUS localizer or TUS R-303 and EXPECT approach clearance for runway 11L.
29R	EXPECT RADAR vectors to final approach course for runway 29R.

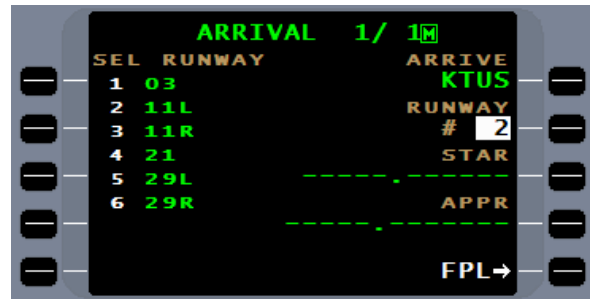
Standard Terminal Arrival Route (STAR) can have up to three segments.

1. Enroute Transition – unique routing from one or more enroute waypoints
2. Common Segment – all transitions pass through this segment
3. Runway Transition – unique routing to one or more runways

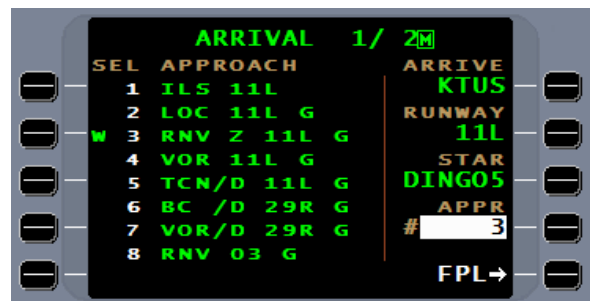
To add a STAR and/or approach, select the flightplan or route menu. Then press the ARRIVE line select key.



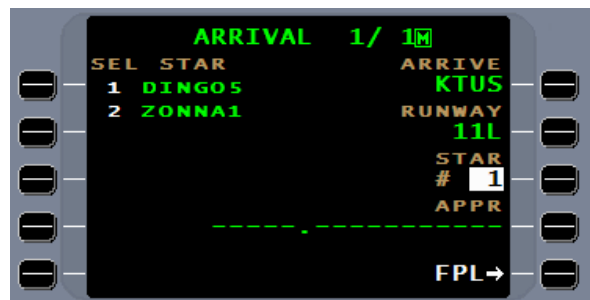
Select the arrival runway, **11L**, by entering 2 in the cursor field. The selection of the runway is necessary for determining the runway transition of the STAR. When entering an arrival, always enter a runway. Select the one most likely to be the active runway for landing. If the selection is incorrect, it can be changed by returning to the arrival page and pressing the runway line select key.



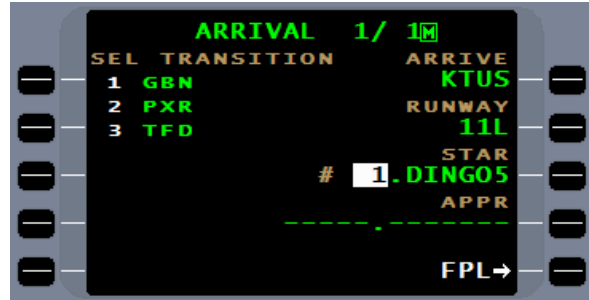
If no STAR is available, use the line select key and go directly to APPR for selection of the Approach.



Enter the number for selection of the STAR and press the **ENTER** key.

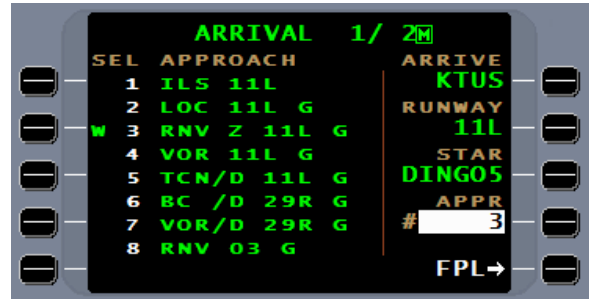


If a transition is presented, enter the number and the cursor will move to the approach selection. If (NONE) appears, press the **ENTER** key or APPR line select key for the approach selection.



Select the approach by entering the corresponding number in the cursor and pressing enter.

More approaches are available in the approach section through **ARRIVAL** page 2.



NOTE: The “G” following the approach does not indicate the approach is a GPS approach overlay, but merely that the FMS will retain the SBAS/GNSS sensor to assist in navigation accuracy. The “G” will not be present for approaches not surveyed in accordance with WGS-84 or when SBAS/GNSS is not authorized by the country of origin.

NOTE: For SCN 1000/1100 the “W” preceding an RNAV approach indicates the approach has LPV minima and is capable of LPV level of service. For SCN 1001/1101 the “W” is removed.

If a transition is presented, make the appropriate selection and the arrival is complete. With the introduction of RNAV arrivals, many of these arrivals have incorporated the approach transition into the arrival. When that occurs, the approach transition should be omitted.



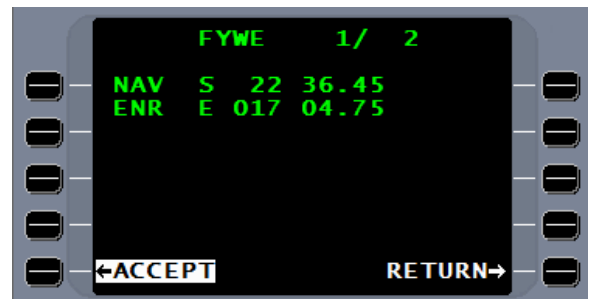
Press the PLT RTE or FPL line select key to return to the pilot route or flightplan.



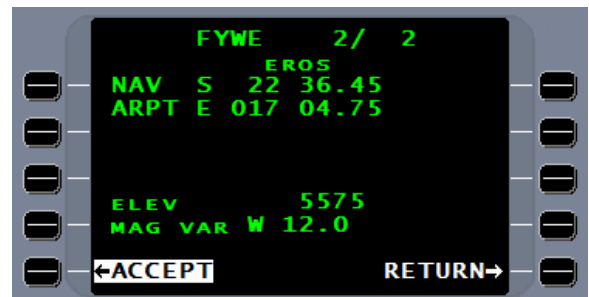
WHEN AN AIRPORT IS A WAYPOINT

The navigation database contains several waypoints that share the same identifier. For example, there are 29 waypoints throughout the world with the identifier of "R". For more information on this issue, please see Service Letter No 2825.

This issue can affect approaches in a particularly annoying way. If you were to enter FYWE into your flightplan, you would get the page 1 of 2. This is the waypoint FYWE.



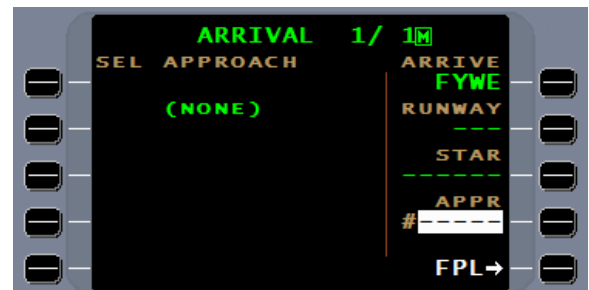
Pressing the NEXT key would give you the second page. Both waypoints have the same coordinates, but page 2 is the airport (ARPT). (*The current database has 120 airports throughout the world that have enroute waypoints by the same name, with half of these the airport is the exact same coordinates as the enroute waypoint.*)



If you were using SCN 1000.2 and previous you would actually be able to build an approach to a waypoint, however, there is no MAG VAR associated with enroute waypoints as there is for airports. As a result, the FMS will calculate the approach course incorrectly.

To fix this anomaly in the above SCN, insure you select the identifier that is the airport. In SCN 1000.3 and subsequent this was corrected and will not allow selection of an approach from the enroute waypoint.

In 1000.3 and subsequent if you were to select the waypoint thinking it was the airport, the ARRIVAL page would show no procedures.



STORING & NAMING THE ROUTE

If the plan is to use this flightplan in the future, the flightplan needs to be stored as a pilot route. The flightplan menu offers the STORE FPL line select key for this purpose. Pressing this key will make an electronic copy of the flightplan and store it as a pilot route.



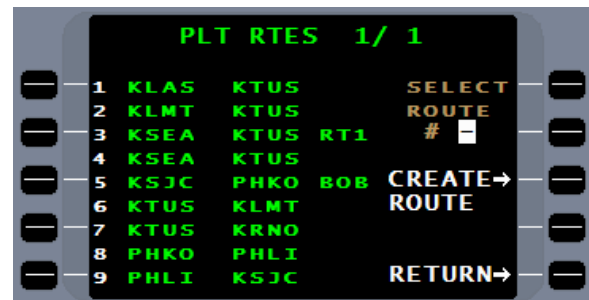
A route may be given a name with up to 8 alphanumeric characters if desired. The name on the route directory will be the first waypoint plus the given name. If no name is entered, the FMS default name is the first waypoint plus the last waypoint. An example for the route Seattle International to Tucson International is “KSEA KTUS”.



By entering a unique name, this route can be identified from another KSEA KTUS route. Enter the desired title at the cursor (the \pm key will place a period that can be used for a space), and press **ENTER**. It is recommended that the destination identifier be used in the title since the title will automatically replace the destination on the RTE page.



The name field is especially useful when 2 routes have the same origin and destination but different routing.



To move the cursor to the title field, remove the cursor from the page and then press **ENTER**.

The title will not be copied with the route to the flightplan.



ROUTE AND FLIGHTPLAN SUMMARY PAGE

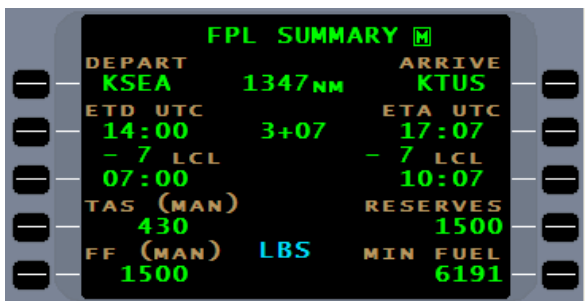
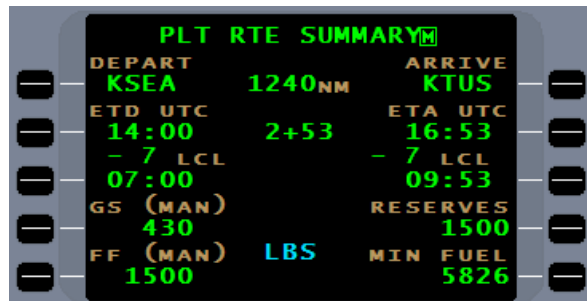
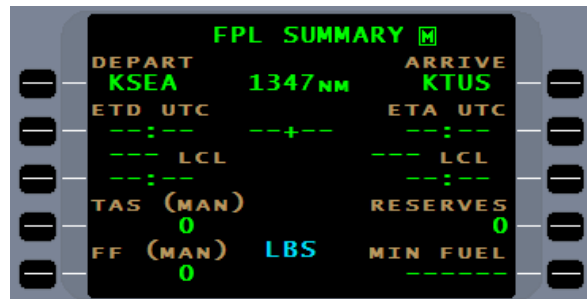
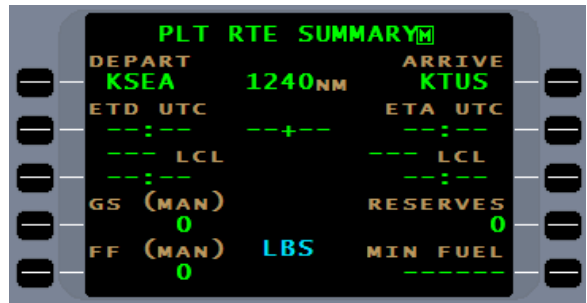
Located after the last page of the pilot route or flightplan is the **PLT RTE SUMMARY** or **FPL SUMMARY** page. This page can be used to estimate time enroute and fuel required. It can be used to determine takeoff and arrival times for both UTC and local. The **FPL SUMMARY** page is available only on the ground because real time information is available in flight. The **PLT RTE SUMMARY** page is always available to the associated pilot route.

Using the associated line select keys for **TAS** or **GS**, **FF**, and **RESERVES**, the necessary information can be entered for the FMS to do the required calculations. These figures will become default for future SUMMARY pages.

On the **FPL SUMMARY** page **TAS** is used and, as a result, time in route can be adjusted for wind. The forecast wind page is discussed later.

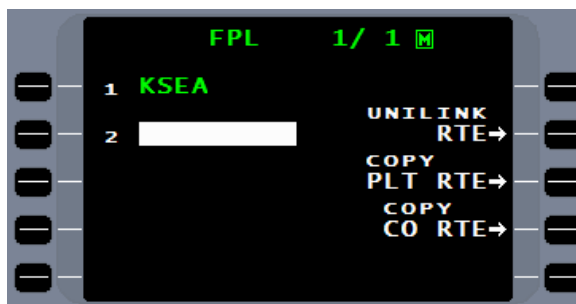
By entering **GS**, **FF**, and **RESERVES** along with the **ETD UTC** the arrival time can be calculated in UTC. By entering the local differential from UTC, local arrival can be determined. To access the **LCL** line, press lineselect key 2 followed by the **ENTER** key. By entering a new time in either **ETD** or **ETA**, the associated times will be adjusted. By entering the forecasted winds into the flightplan (discussed later), the **FPL SUMMARY** page will adjust the time in route.

The **FPL SUMMARY** page is similar to the **PLT RTE SUMMARY** page. A CO RTE SUMMARY page is also associated with each company route.



COPYING PILOT ROUTE TO FLIGHTPLAN

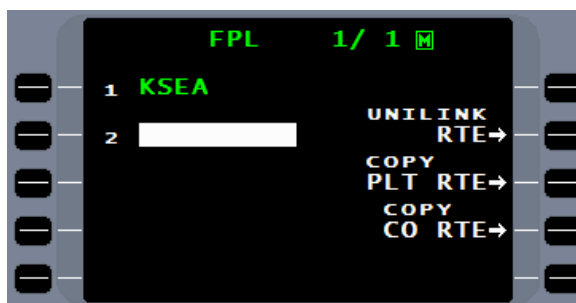
Pressing the **FPL** key will display the first flightplan page. If required, to delete an existing flightplan and copy a ROUTE, press the **MENU** key and then the “DELETE FPL” line select key. The key must be pressed a second time to confirm deletion. The “COPY RTE” line select key will be displayed. A route from the pilot database may be copied into the flightplan by pressing the COPY PLT RTE line select key.



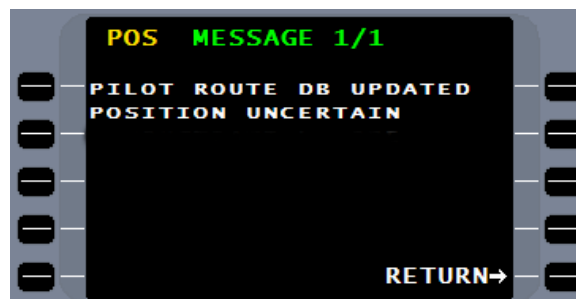
The route directory of all existing stored routes is accessed through the COPY ROUTE LIST pages. The route titles will always begin with the first waypoint plus the pilot defined route name or the last waypoint if no route name was entered. Listed routes will be in geographical/alphabetical order. The **PREV** and **NEXT** keys may be used to move through the pages. Enter the route number into the **SELECT ROUTE** field and press **ENTER**. The selected route will be copied to the flightplan.



Company routes and Unilink routes can be accessed in the same manner as the pilot routes and copied to the flight plan.



The Navigation database is updated every 28 days. As a result of refined methods for determining positions, the location of some waypoints may change with a new database. If changes to the pilot database occur, a message will be presented following the accepting of the initial page. If a relocated navigation waypoint is contained within a stored route or in pilot defined data, the change will be noted by flashing of the name of the stored route or procedure, and the individual waypoint as follows:



Minor Change - waypoint name flashes
To remedy, place cursor over the waypoint and press **ENTER**.

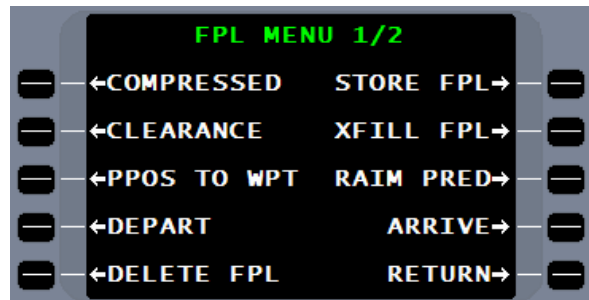
Major Change - flashing ***GAP*** appears
To remedy, reenter the waypoint if it's still in the NAV database, delete the ***GAP*** from the route, or edit the flightplan to establish a new routing.

FLIGHTPLAN AND PILOT ROUTE MENU

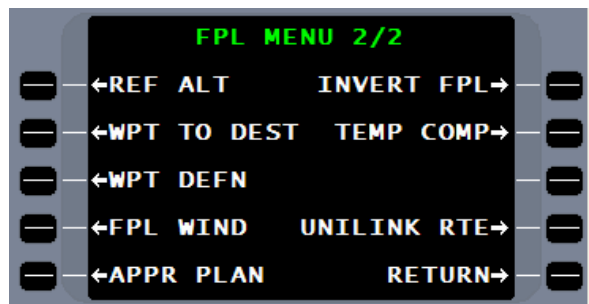
The availability of a menu is identified by **M** in the upper right corner of the page. Pressing the **MENU** function key will present the corresponding menu.

The **FPL MENU** and **PLT RTE MENU** have many of the same options.

The DEPART and ARRIVE options are the same for both the FPL and PLT RTE.

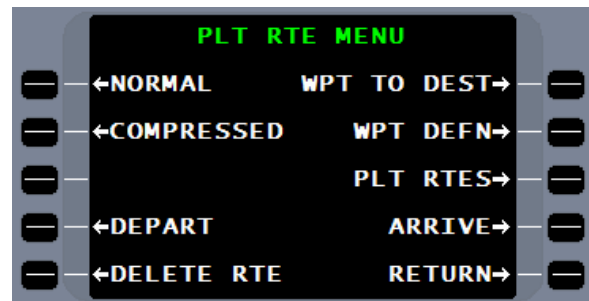


Pressing the **MENU** key a second time or using the **NEXT** key can access **FPL MENU 2/2**.

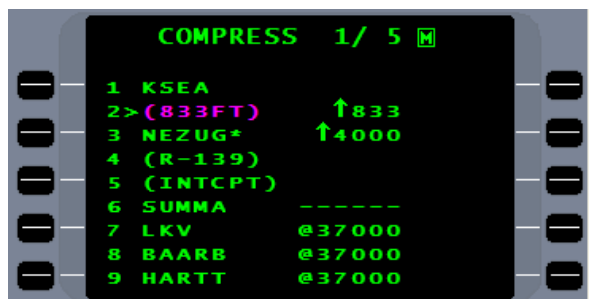


Both the DELETE RTE and DELETE FPL selections will delete the selected pilot route or the current flightplan. A double push of the line select key is required.

Selection of PLT RTES returns to the PLT RTE catalog page.



The COMPRESSED option will take the flightplan or pilot route and compress the waypoint list for quick review of the route of flight. No editing can be done through this option. This option will also show any database altitude restrictions.



The CLEARANCE option presents the flightplan in a format that resembles an ATC clearance. This option is available for the flightplan and pilot route menus.



The PPOS TO WPT option will present the flightplan waypoints with the distance from the aircraft's present position and the time. Time enroute for FPL on the ground is a function of the speed entered on the SUMMARY page. In flight, time is calculated using the current aircraft ground speed or if flightplan forecast winds are entered, TIME will be adjusted for forecast winds.



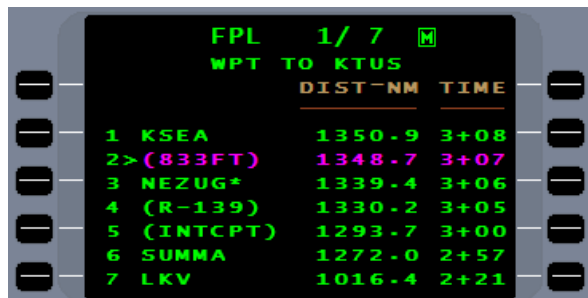
On FPL MENU 1/2, XFILL FPL and RAIM PRED are discussed later.



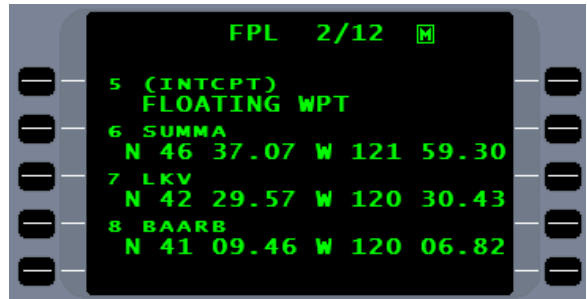
On FPL MENU 2/2, if a UASC TAWS is installed, REF ALT is on line select key 1L to display TAWS and VNAV altitudes and database altitude constraints.



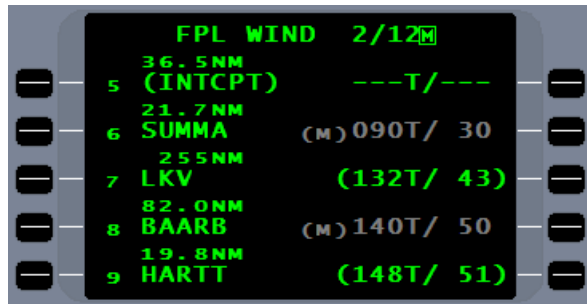
WPT TO DEST or waypoint to destination is distance from a listed waypoint to the flightplan destination. Time enroute for FPL on the ground or pilot route is a function of the speed entered on the SUMMARY page. In flight, for the flightplan, time is calculated using the current aircraft ground speed or if flightplan forecast winds are entered, TIME will be adjusted for forecast winds.



WPT DEFN will show how the waypoint is defined. A floating waypoint (also known as a conditional waypoint) is not terminated at a latitude/longitude position or fix, but by a set of conditions such as a course to altitude or heading to intercept. (See Procedural Leg Types)



Forecasted winds can be entered into the flightplan through the FPL WIND menu option. Pressing the line select key on the right side adjacent to the waypoint allows for a manual entry of wind direction (true heading) and velocity. A manual wind entry need not be input at every waypoint. The FMS will interpolate winds between manual entries. During flight the FMS will use the current wind for time calculations to the next manual wind entry waypoint and forecast winds from that point on. As the waypoint with the manual wind entry is over flown, the manual wind will be replaced with the current wind and the subsequent waypoints will reflect the current wind until the next waypoint with a manual wind entry.



In SCN 1001/1101 and subsequent, an installation with UniLink will provide a method of entering enroute winds acquired through a UniLink request from a provider. The UniLink winds are requested through the UPLINK WINDS page.



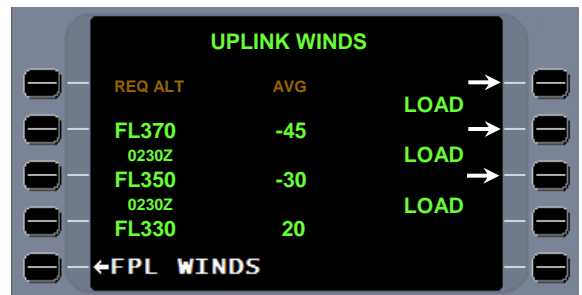
The **UPLINK WINDS** page provides a requested altitude line and a send line. When there is no connection through UNLINK, a **NO COMM** will be presented.



Winds can be entered as a flight level or MSL altitude. Three numbers will be interpreted as a flight level. With UNILINK in communication and with the entry of an altitude request, a **SEND** prompt will be presented. A SENDING line will show when the UNILINK is sending the request.



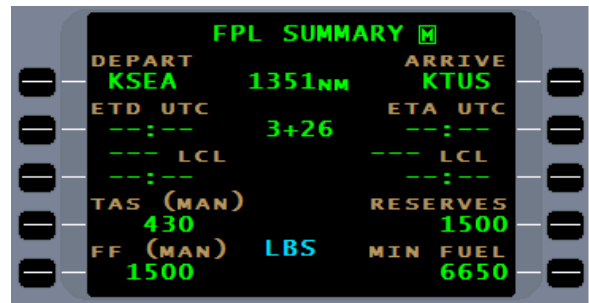
When the requested winds are received, a time and average wind will be presented. The **LOAD** prompt will send the wind to the flightplan.



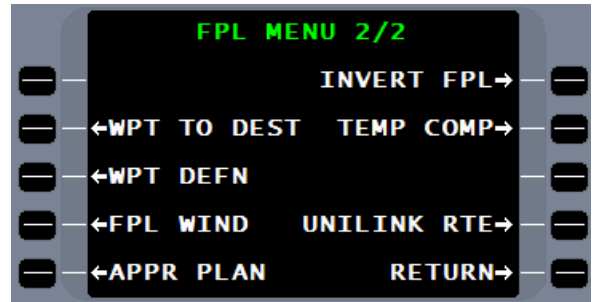
The loaded winds may be seen on the **FPL WINDS** page.



Together with the pilot route summary page, the effect of forecast winds on time enroute and fuel required can be estimated.



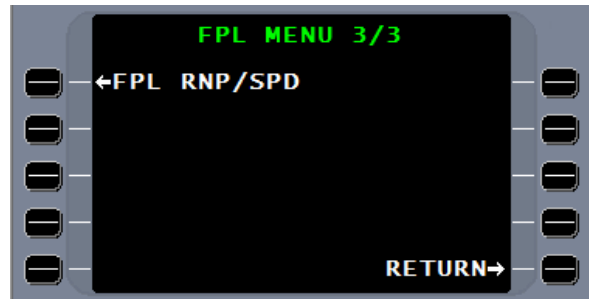
Selection of the INVERT FPL option will result in the flightplan route of flight being reversed. The SID, STAR, and Approach will be dropped and with the entry of a new SID, STAR, and approach, the FMS will present a new flightplan to the original departure point.



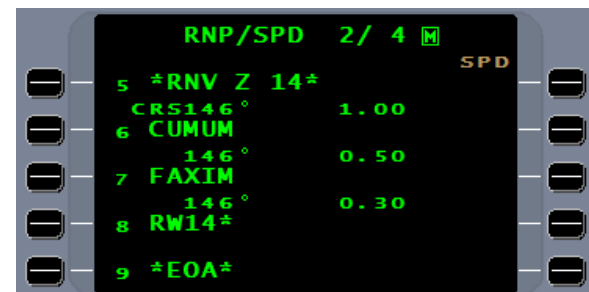
TEMP COMP will be covered in the approach section.

Other MENU options such as UNILINK RTE are covered with the purchase of optional FMS equipment.

SCN 1001/1101 and subsequent have added a third flightplan menu page. On this page by selecting FPL RNP/SPD is access to NAV leg RNP restrictions and leg speed restrictions.

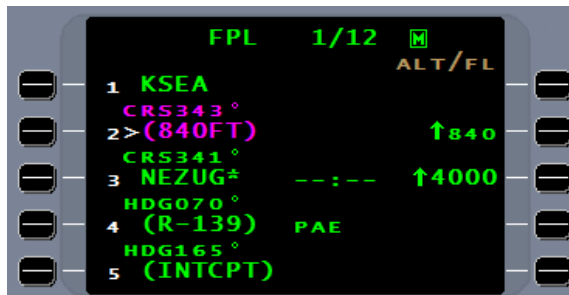


For the KAPA PUFFR4 arrival the procedure airspeed restrictions are shown and for the KICT RNAV Z Rwy 14 RNP leg values are shown.



FLIGHTPLAN ANALYSIS AND EDITING

FPL 1/12 offers the following information. The “TO” waypoint is identified by the change in color and by the “>” sign. When a SID is used for the departure, in most cases, the first navigation leg will reflect a climb in the takeoff corridor in accordance with standard takeoff procedure. In this case, runway course to 840ft MSL equals 400ft AGL rounded up. The FMS will then command the aircraft to turn and intercept the 343° course to **NEZUG**. The identifier, **NEZUG** is followed by an “*”. This indicates that it is an overfly waypoint, requiring the aircraft to physically fly over the waypoint before the FMS will sequence to the next leg. The aircraft will then turn right as indicated by the “→” to a heading of 070°. Upon crossing the **PAE** 139° radial the aircraft will be commanded to turn right to a heading of 165° to intercept the SEA 146° course to **SUMMA** intersection. ETA time is computed based on groundspeed when airborne. Altitudes displayed to the right of the page are advisory only. Only altitudes displayed on the left, as leg terminators, will affect a leg change.



NOTE: When a leg terminates with an altitude, that altitude must be met before the FMS will sequence to the next leg.

If a runway change occurs, a new SID can be selected by pressing the **MENU** key, then DEPART.



By pressing the RUNWAY line select key, the runway options will appear. Select the new runway such as number 2 for 16R and press enter.



Since the SID selection remains the same, press FPL to return to the flightplan.

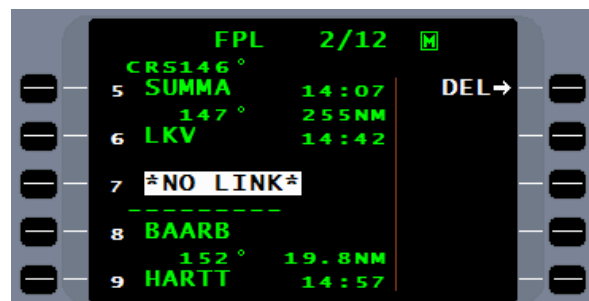
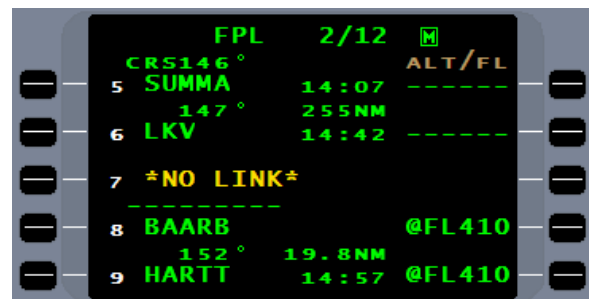
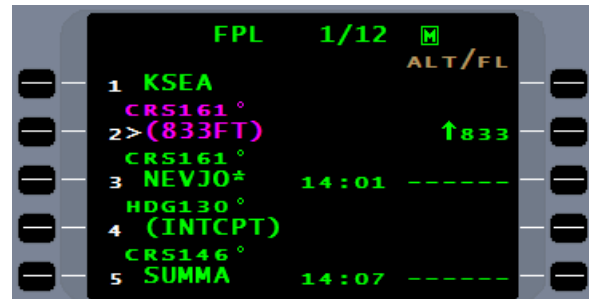
The new SID routing reflecting a runway 16R departure has replaced the old SID routing for runway 34R.

When the SID, Route of Flight, STAR, and approach are linked together to make the flightplan, a common point between each part is required to maintain continuity. When that point does not exist, the FMS places a flashing “*NO LINK*” in the flightplan to alert the pilot of the need to review, and if necessary, edit the flightplan. When the flightplan was created the SID terminated at LKV and the airway began at LKV; continuity. The waypoint LKV however was linked to the SID not to the airway. In the process of replacing the SID routing from runway 34R to 16L, LKV along with the rest of the 34R SID was deleted leaving BAARB as the beginning of the airway. The new SID routing for 16L was then entered with LKV as the SID termination. Since the airway now begins at BAARB, there is no common point for continuity thus a “*NO LINK*”. SCN 100X/110X has logic that has improved the linking process and in some instances when a runway change is made for a SID or STAR continuity will be maintained.

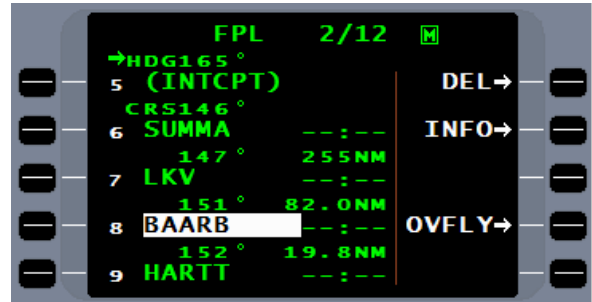
To remove the “*NO LINK*” press the adjacent line select key which will bring up an overlay with DEL. Pressing the DEL line select key will highlight DEL and pressing it a second time will delete the “*NO LINK*”.

NOTE: It is important to review the route or flightplan after linking a SID or STAR procedure to address any “*NO LINK*” messages that may have been added. A flashing “*NO LINK*” indicates that pilot attention is needed. Whether action is required or not will be decided by the pilot; the FMS software cannot make that determination.

NOTE: At the end of the approach segment, a non-flashing “*NO LINK*” will separate the last waypoint of the approach from the destination airport. This “*NO LINK*” does not need to be deleted. Upon exiting the end of an approach procedure, currently that’s at the end of the missed approach procedure, the “*NO LINK*” will continue FMS navigation straight ahead instead of directing the aircraft to the airport reference point.

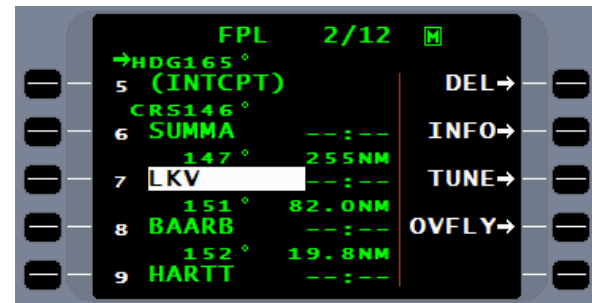


The “*NO LINK*” is removed and the cursor is now over BAARB. The overlay window in addition to DEL also contains INFO and OVFLY.



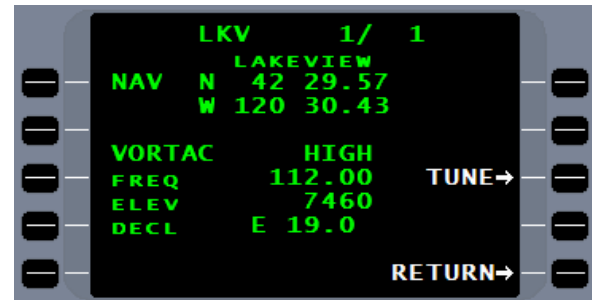
Press the line select key for the VOR LKV and the overlay window appears.

If the aircraft is equipped with remote tune-able VHF NAV radios, the LKV frequency can be tuned by pressing the TUNE line select key.

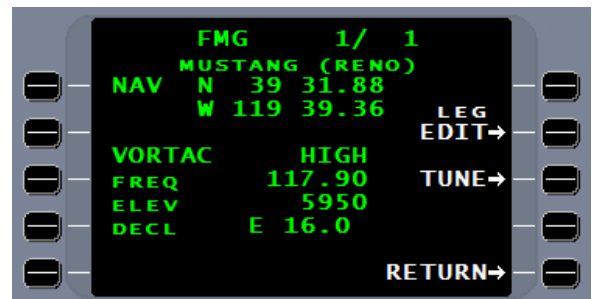


Pressing the INFO line select key will access information about this VOR.

The TUNE option is again available.



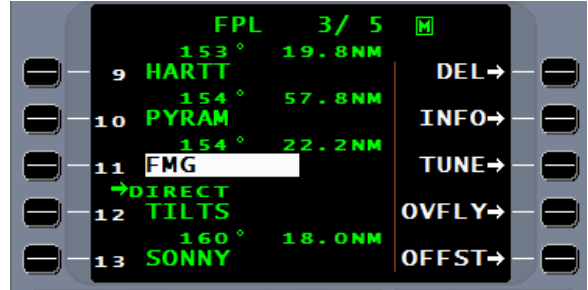
SCN 1001/1101 and subsequent adds an option to edit the NAV leg.



By selecting LEG EDIT, the pilot may choose a turn direction or leave AUTO selected which will always turns the shortest direction. The pilot may change the leg type from Track to Fix (TF) to Direct to Fix (DF).

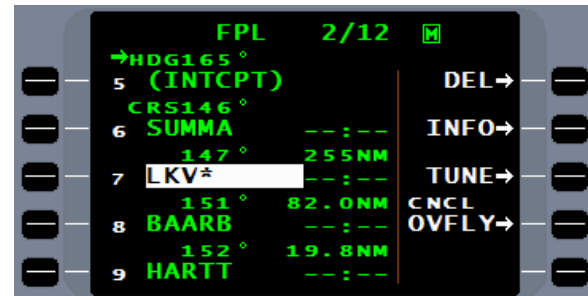


By selecting Right and Direct, the FMS will force a right turn direct from FMG to TILTS.

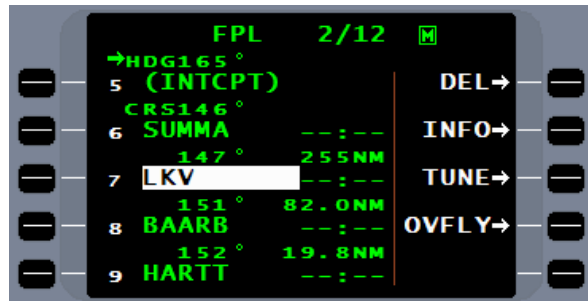


A waypoint can be designated as an overfly waypoint by pressing the OVFLY line select key. The asterisk identifies the waypoint as over fly.

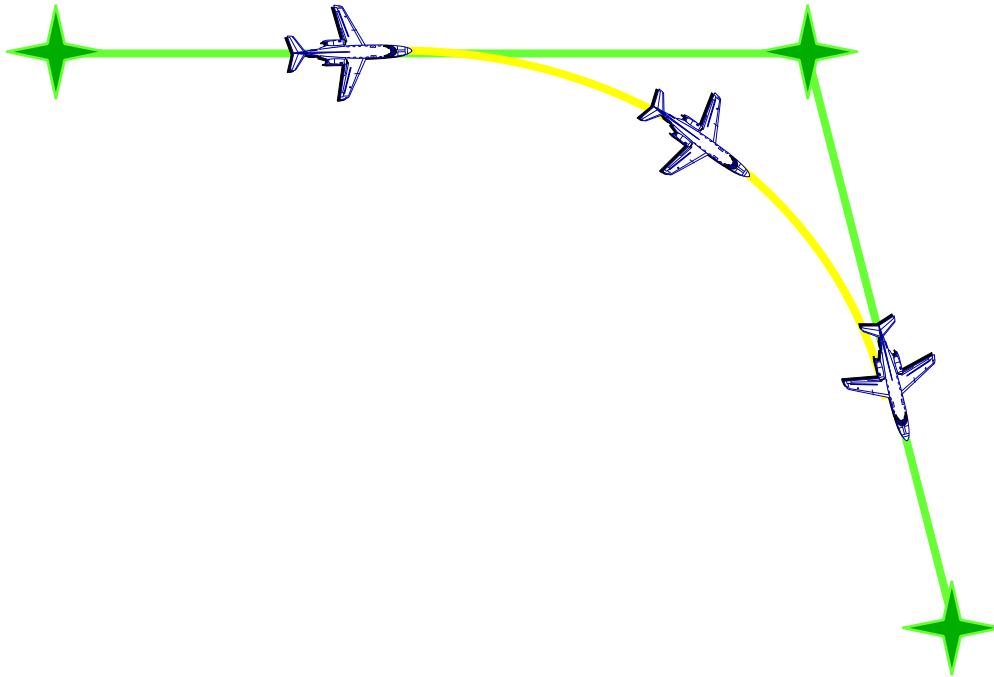
To cancel an overfly waypoint press the CNCL OVFLY line select key.



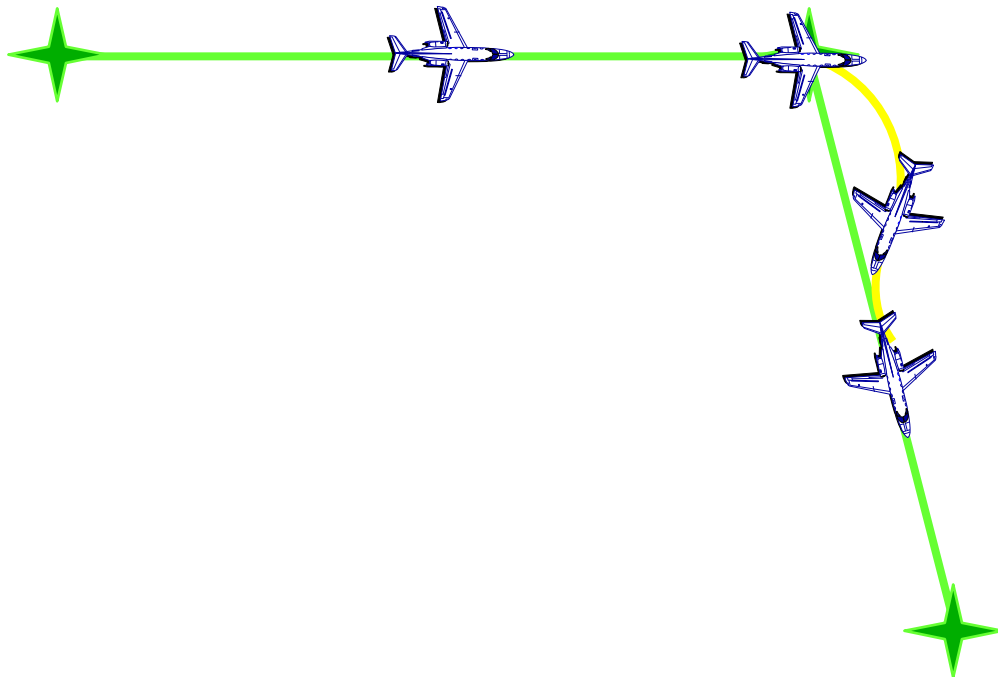
The FMS will make most turns as “Smart Turns”. In a smart turn the FMS will mathematically calculate a lead point to start the turn. Some call this turn anticipation or leading the turn. (See following figure)



WAYPOINT AND TURN TYPES

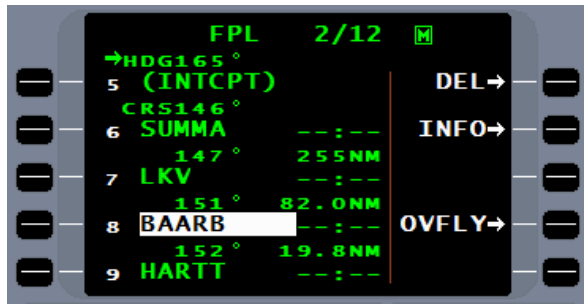


Fly By Waypoint & Smart Turn
Turn anticipation based on angle of turn, ground speed, and bank limits

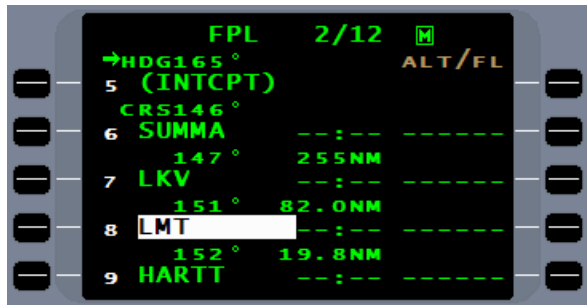


Fly Over Waypoint
Indicated by waypoint being followed by an “*”

To add a new waypoint to the flightplan, first place the cursor at the point on the page where the waypoint will be entered.

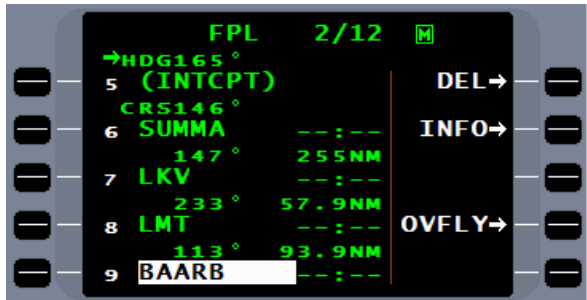


When the new waypoint is entered, the existing waypoint will be moved down.



New waypoints may be added with use of the LIST function or by direct entry with the alphanumeric keys.

A pilot waypoint can be created directly in the flightplan. (Covered later)

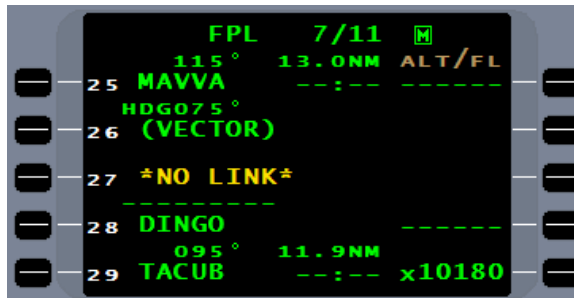


Frequently a STAR will terminate at one point and the approach will begin at another. When this is the case, a “*NO LINK*” will appear indicating that the flightplan requires review, and if necessary, editing.

When a VECTOR is included in the procedure, this represents a “VM” leg or vector to manual termination. Pilot intervention will be required for the FMS to sequence beyond this leg. Pilot intervention

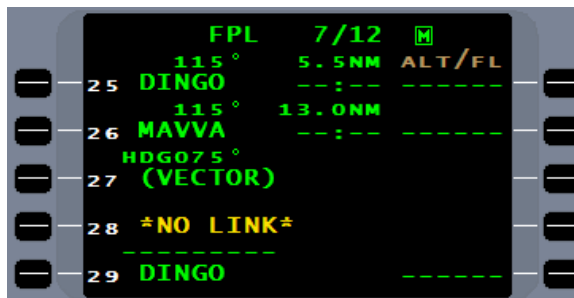
may be in the form of a FMS heading change, a manual leg change, or a Direct To (DTO).

Caution should be used when deleting the vector leg, for the vector leg represents a required heading as a terminator to a SID or STAR. In such cases, it may be prudent to leave the vector leg and the “*NO LINK*”. If an ATC clearance is issued to bypass the vector leg, use of the DTO function will direct the aircraft to the correct waypoint.

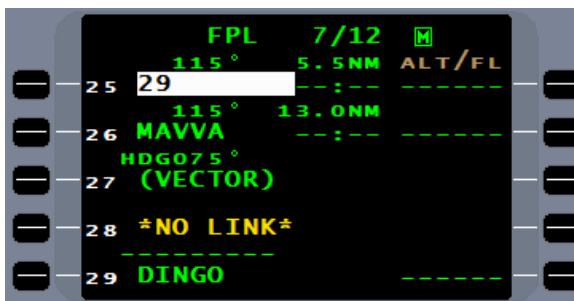


NOTE: When a SID or STAR terminates in a HEADING to VECTOR (VM), the FMS uses an arbitrary 20nm to define the vector; A COURSE to VECTOR (FM) is 50nm. This additional mileage is added to the overall flightplan distance.

A method to quickly edit out multiple waypoints is as follows. To establish continuity between the STAR and approach, waypoints, 26, 27, and 28, must be edited out of the flightplan. Place the cursor over the first waypoint to be deleted.



Determine the first waypoint number that will replace the waypoint or waypoints to be deleted and enter that number in the waypoint field. In this case, the approach waypoint, DINGO, will replace the STAR waypoint, DINGO. Enter the number “29” at waypoint number 25.



After pressing the **ENTER** key, the approach waypoint, DINGO will be moved into waypoint 25 and all intervening waypoints will be deleted.



WAYPOINT NAMING CONVENTIONS

ARINC 424 provides waypoint naming conventions that are used by the database supplier in the database. Listed below are the most common ones that may be encountered when accessing the navigation database.

D235H	DME waypoint on the 235° radial at 8nm (H is 8th letter of the alphabet)
XYZ29	'x' point on enroute chart, 29nm from the XYZ VOR
12ABC	'x' point on enroute chart, 112nm from ABC VOR
FF26	Final Approach Fix for Runway 26
OM26	Outer Marker for Runway 26
CF26	Final Approach FAF for Runway 26 (usually located on final approach course outside of FAF)
RW26	Threshold coordinates for Runway 26
MX26	Missed Approach point for Runway 26

Latitude/Longitude Named Waypoints (Oceanic) listed in Navigation database. Not all Latitude/Longitude waypoints are listed in the NAV database. When entering a waypoint name not covered in the NAV database a DEFINE WAYPOINT page will appear.

ARINC 424 Format	SCN 100X/110X
5540N	-----55N040W
50N30	-----50N130W
5705E	-----57N005E
48E70	-----48N170E
5275W	-----52S075W
52W20	-----01S160W
6030S	-----60S030E
02S70	-----02S170E

NOTE: The Navigational Database contains latitude longitude waypoints in those areas where air navigation is probable. The Navigational Database contains many of the above examples, but some of the examples lie within areas of the world where there is little air navigation. In those areas where latitude longitude named waypoints do not produce a Navigational Database waypoint; a Pilot waypoint must be created.

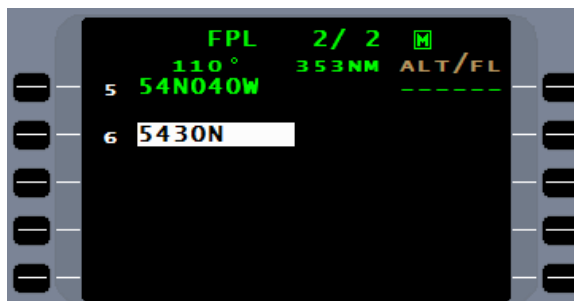
OCEANIC WAYPOINTS

The NAV database contains latitude and longitude identified waypoints for many areas of the world. These are areas where the aircrew would expect to receive lat/long waypoints, such as the North Atlantic Track (NAT) between North America and Europe.

Latitude/Longitude (lat/long) waypoints listed in the flightplan will be displayed in a seven character alphanumeric format and can be entered in the flightplan in this format or the ARINC format.



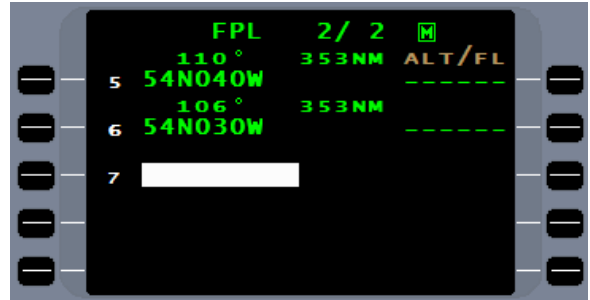
The ARINC lat/long waypoint naming convention is also recognized by the FMS and lat/long waypoints can be entered into the flightplan in this format.



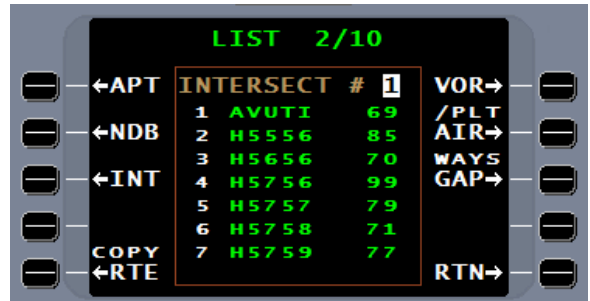
After entering the desired lat/long waypoint into the flightplan press the **ENTER** key. The lat/long will be displayed in degrees, minutes, and hundredths of minutes. All lat/long waypoints are stored in both the NAV and pilot database using the ARINC format, but the seven character format is recognized and can be used to enter the lat/long waypoint.



Once entered into the flightplan, the waypoint will be displayed in the seven character format. An example the lat/long format of xxNxxxW is 54N030W.



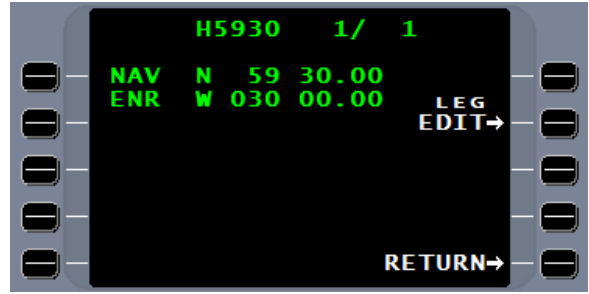
To expand the number of North Atlantic Tracks, half degree waypoints are being used. These waypoints are being identified with an “H” at the beginning of the lat/long identification. H5556 is 55° 30’ North and 56° West. Currently these waypoints are only being used in the North Atlantic Tracks.



The use of these waypoints will increase the number of tracks in the North Atlantic Track region.



H5930 is translated into 59° 30.00' N and 030° 00.00' W.



When using 1101 and subsequent Multi Mission Management software a LEG EDIT option is available. The pilot may choose a turn direction or change the leg type.



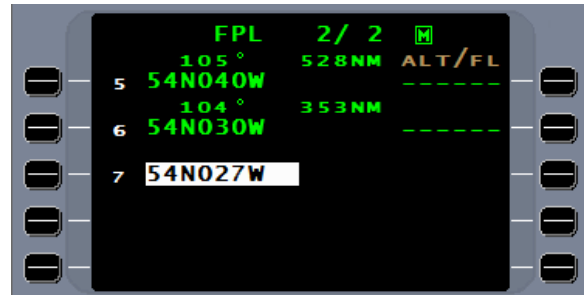
With the selection of the direct option the leg becomes a DF or Direct to Fix leg.



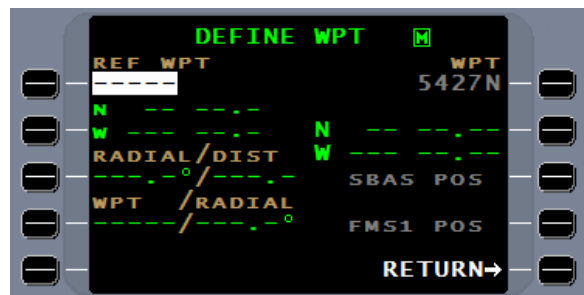
PILOT DEFINED WAYPOINTS

A pilot defined waypoint can be created using one of three techniques. Pilot defined waypoints can contain up to 5 alphanumeric characters or seven for lat/long. Pilot waypoints can be created almost anywhere a NAV waypoint can be entered and are stored in pilot data.

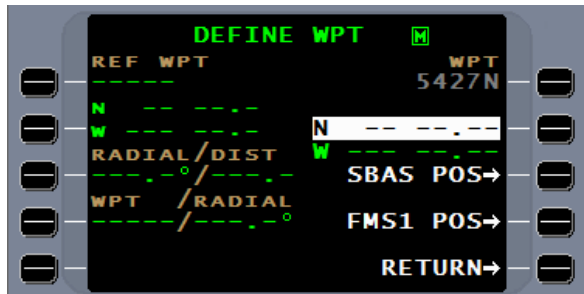
The first method to define a waypoint is by latitude and longitude. The waypoint 54°00.00'N 027°00.00'W is entered using either the ARINC naming convention, entered as 5637N, or enter the waypoint using the format 56N037W. Enter this directly into the flightplan by first pressing the line select key at the desired location and entering 56N037W and press **ENTER**.



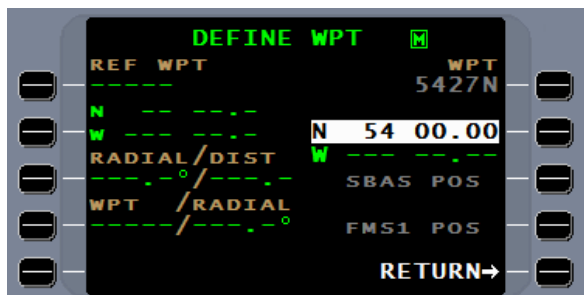
Since this waypoint is not in the NAV database, the DEFINE WPT page will automatically appear. Notice that the ARINC format is used to name the waypoint.



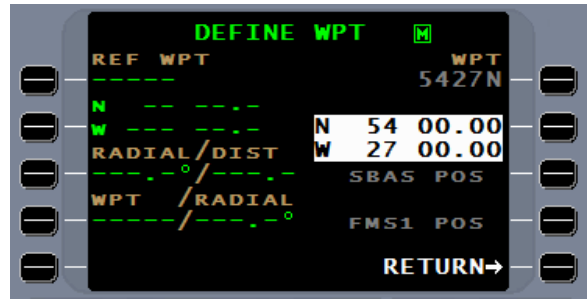
Since defining this waypoint is by latitude and longitude, press the line select key 2R to bring a cursor to the North coordinates.



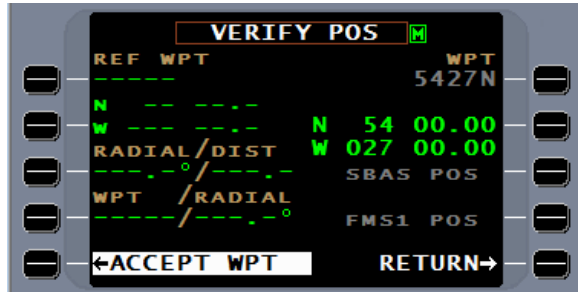
Enter the coordinates in degrees, minutes, and 100^{ths} of minutes or, with a menu selection, 1000th of minutes and press **ENTER**.



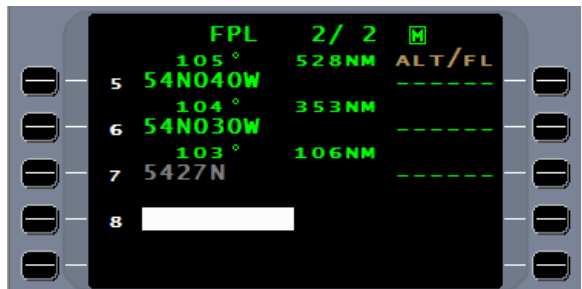
The cursor moves from latitude to longitude. Enter the coordinates and press **ENTER**.



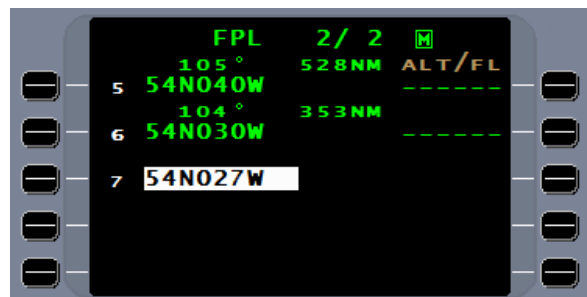
If the coordinates are acceptable, press **ENTER** or ACCEPT WPT line select key.



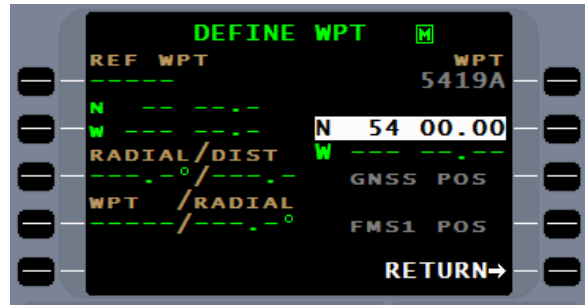
The new waypoint is entered into the flightplan. The color of a pilot waypoint is different to identify it as a pilot created waypoint.



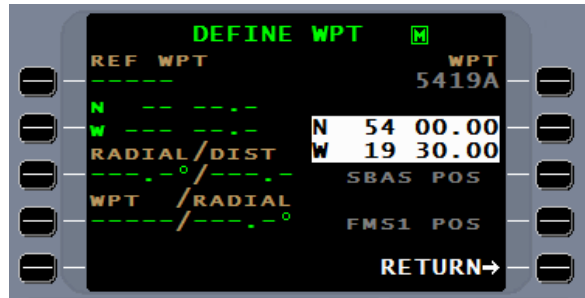
Once the pilot waypoint is created, it can be used and entered using either the ARINC format or the seven character format, but will be displayed using the ARINC format.



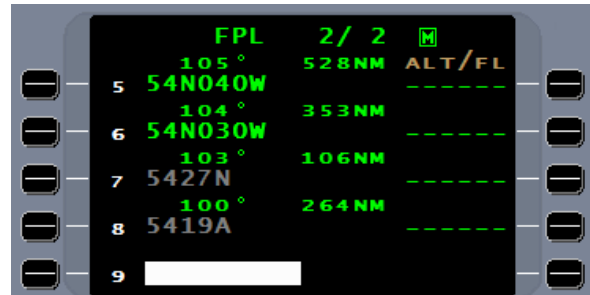
If the naming convention does not provide a name for the waypoint or the name selected is already in use, create a name up to five characters and place it in the flightplan.



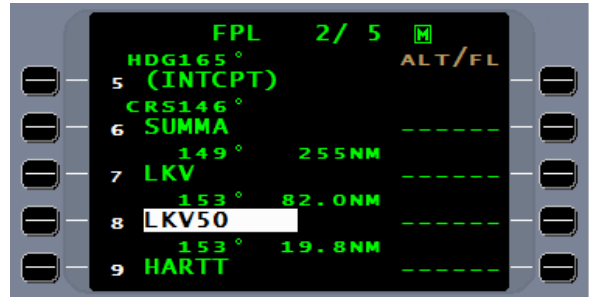
The coordinates 54°00.00'N 19°30.00'W are to be entered into the flightplan. The naming convention name of 5419N is in use.



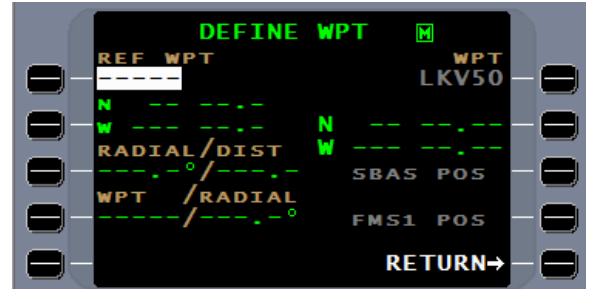
With a small modification to the name, **5419A**, and using the above procedures the waypoint is added to the flightplan.



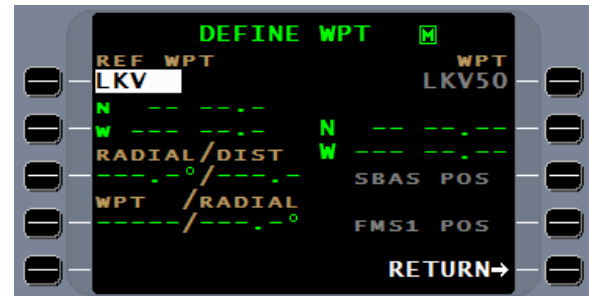
The second way to define a pilot waypoint is to use radial and distance from a known fix. The known fix can be either a NAV waypoint or a previously created pilot waypoint. The waypoint LKV50 is defined as 50 nautical miles on the 150-degree radial from the LKV VOR. The name, LKV50 is based on the ARINC naming convention by using the first three letters of the reference waypoint and the distance from that waypoint.



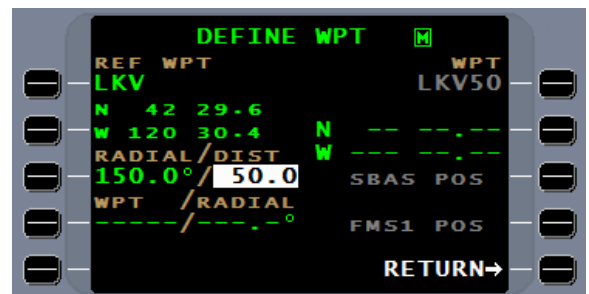
Since the waypoint name of LKV50 does not exist in the database, when LKV50 is entered into the flightplan, the DEFINE WPT page is presented.



The reference waypoint is LKV; enter this at the REF WPT line select key, press **ENTER**, verify, and accept.

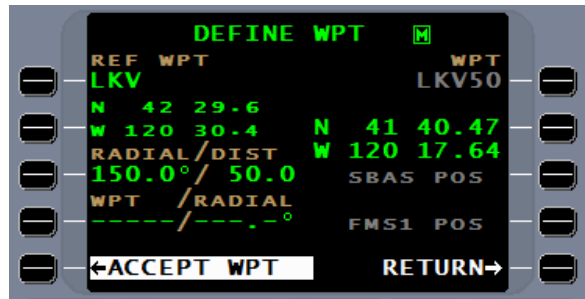


The cursor will move to allow entry of the radial.

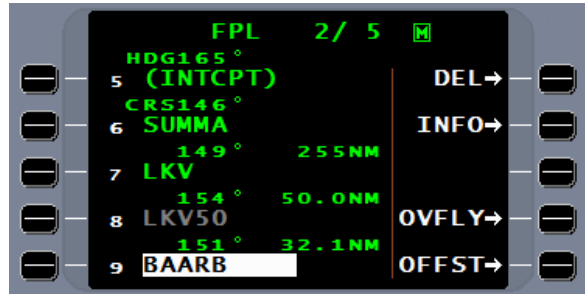


Pressing the **ENTER** key will move the cursor to the distance line. After entry of the distance, pressing the **ENTER** key will command the FMS to calculate a Lat/Long.

NOTE: The radial and DME entries are four character fields requiring the inclusion of a tenth of a degree or mile respectively.



Accepting the Lat/Long will place the waypoint into the flightplan.

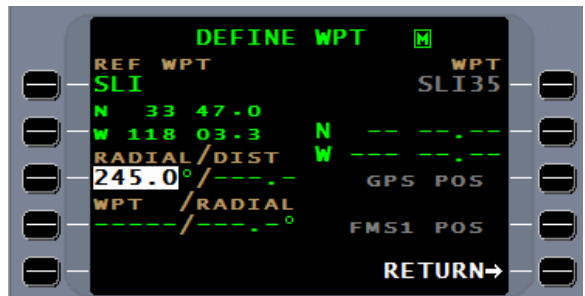


The third method of defining a pilot waypoint is to use the crossing radials of two fixes. This method is particularly good when changing from one VOR radial to another or one airway to another where no turn point is defined.

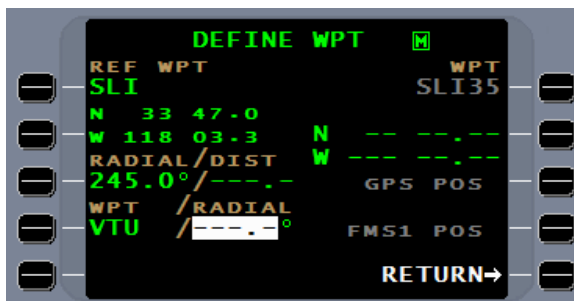


Naming this type of waypoint is not covered in the ARINC 424 naming convention, therefore a name must be created that helps to identify the location. The example uses crossing radials of two VOR.

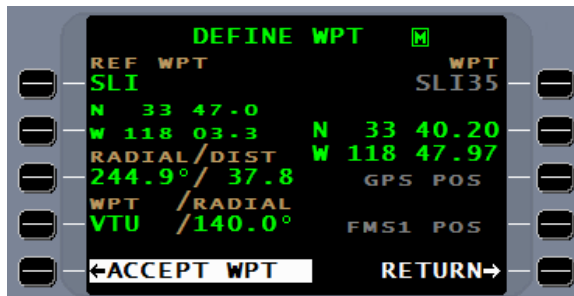
The clearance is to depart KLGB on runway 12 and intercept the SLI VOR 245° radial and proceed west until intercepting the VTU 145° radial. Fly north to VTU and then flightplan route. Entering a waypoint name will again present the DEFINE WPT page. Enter SFL and the radial. Enter SLI and the 245.0° radial.



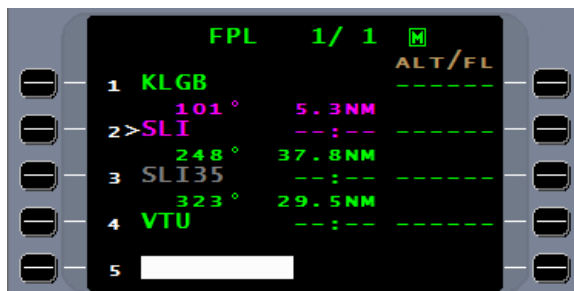
Do not enter a distance for the first fix, instead, with the **ENTER** key or the line select key, move the cursor to WPT; enter the second fix, VTU.



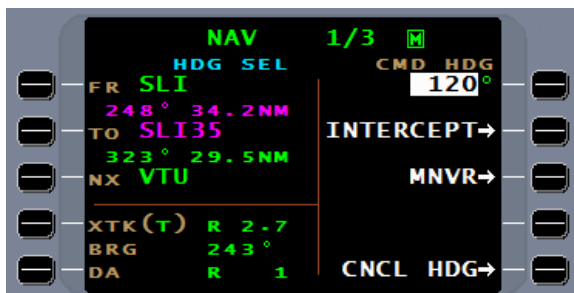
Entering the radial and pressing **ENTER** will cause the FMS to calculate the lat/long of the crossing point. If the two radials do not intersect, the last waypoint radial will flash. If the two reference waypoints are more than 199nm from each other, a waypoint will not be calculated.



Accepting the new waypoint will place it in the flightplan. The turn point is now identified and the follow on waypoint can be entered into the flightplan.



In addition, after takeoff the FMS CMD HDG will guide the aircraft to intercept the first radial.



PILOT WAYPOINTS AND CUSTOMIZED FLIGHTPLAN

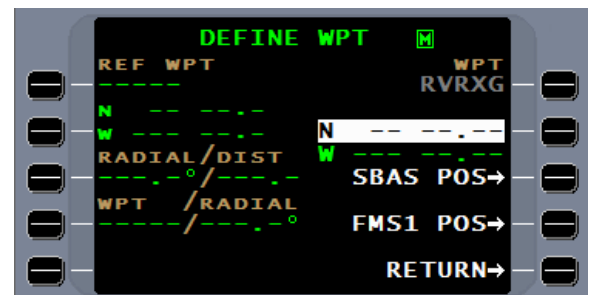
To create a customized route of flight in a flightplan using pilot waypoints for landmarks, the following technique may be of value.

First map out the route of flight and identify the landmarks, then name the waypoints with a maximum of five alphanumeric characters.

Through visual pilotage, navigate the aircraft towards the waypoint. Enter the name of the waypoint in the flightplan and press **ENTER**.

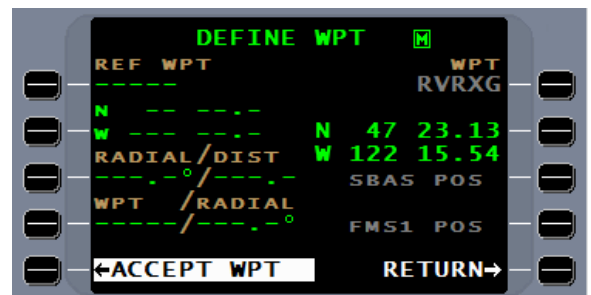


On the DEFINE WPT page, press the lat/long line select key. Notice that SBAS POS and FMS1 POS lines become bold and selectable.



As the aircraft crosses the landmark for RVRXG, press either SBAS POS or FMS1 POS and the lat/long is entered into the field.

Pressing GNSS POS will use the pure GNSS position. Pressing FMS POS will use the FMS best computed position.



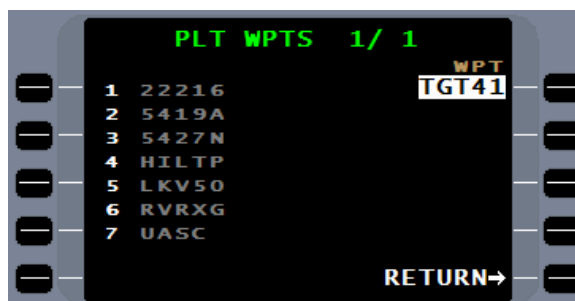
Accepting this waypoint will enter it into the flightplan. By storing this flightplan as a pilot route, this flightplan may be flown exactly as it was created.



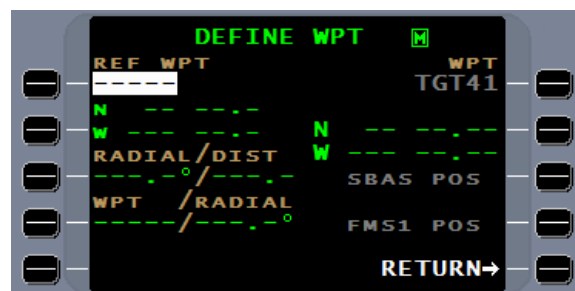
TACTICAL WAYPOINTS

Tactical waypoints were created primarily for military use. Up to 98 Tactical waypoints may be created with the same procedure as in creating a pilot waypoint. A menu option will allow for designation of the waypoint as Tactical. Once a waypoint is created, the user should retain the name of the waypoint, for there is no easily obtainable list of Tactical waypoints viewable in the FMS. Tactical waypoints can be used in the FMS flightplan but cannot be stored in the pilot database as part of a Route, SID, or STAR. If a Route, SID, or STAR is stored with Tactical waypoints, a *GAP* will be entered in lieu of the Tactical waypoint. Tactical waypoints are available through the LIST function under VOR/PLT. The special missions erase discrete, when activated, will erase all Tactical waypoints along with the pilot database.

To create a Tactical waypoint, enter up to 5 alphanumeric characters in a waypoint field.



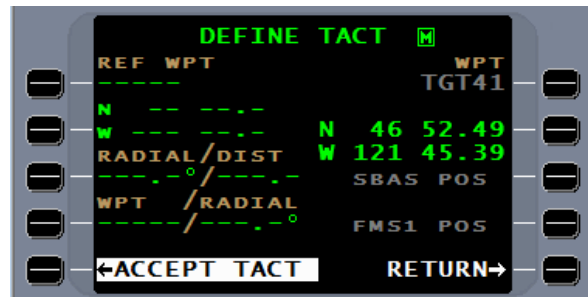
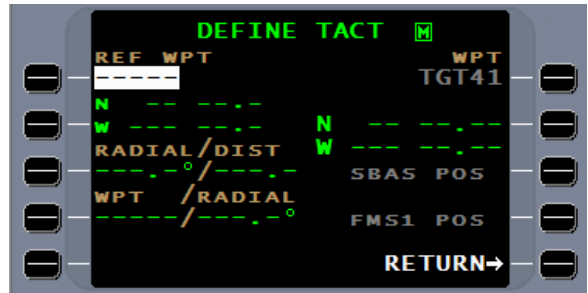
As with pilot waypoints, the new waypoint name must not be in use in another database. After entry of the waypoint the DEFINE WPT page will be presented.



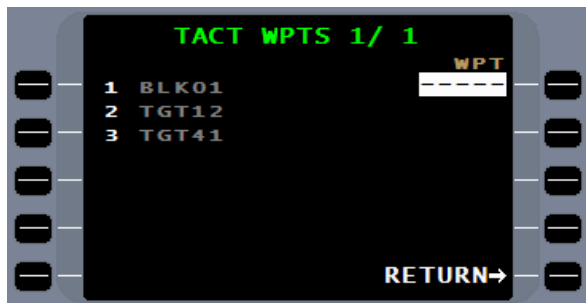
Pressing the **MENU** key will present the POSITION MENU. Selecting the TACT line select key will change the waypoint to a Tactical waypoint. In addition there are other line select key options for to further define the lat/long or designate the type of waypoint to be defined.



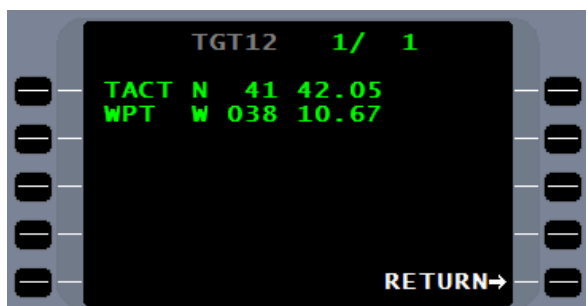
With the waypoint labeled as Tactical, the DEFINE TACT page is presented. From this page the creation data is entered in the same way as in creating a pilot waypoint.



When the tactical waypoint is accepted, the FMS will present a **TACT WPTS** page, listing all of the Tactical waypoints.



From this page, entering the reference number will produce the lat/long of the tactical waypoint,

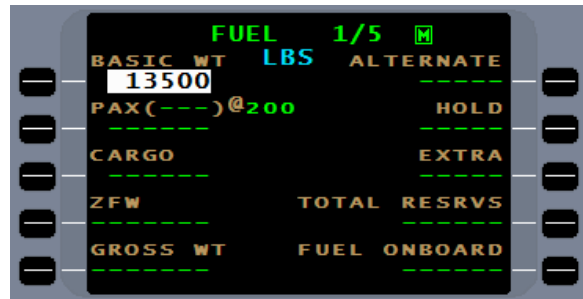


NOTE: If the FMS contains tactical waypoints, upon FMS power up and following the power on self-test, a question page will be presented asking whether to operator wants to retain or delete tactical waypoints. See POWER ON section.

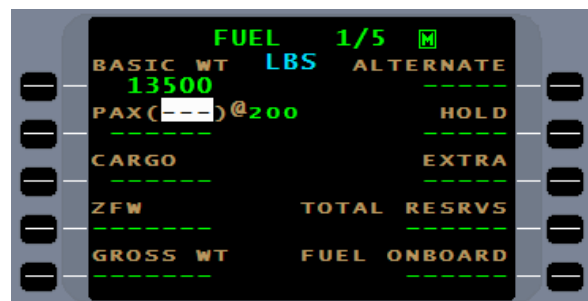
FUEL PLANNING

The FMS can assist the pilot in managing and forecasting fuel usage. This feature is optional and for best results, fuel initialization should be accomplished before takeoff, but can be done anytime during the flight.

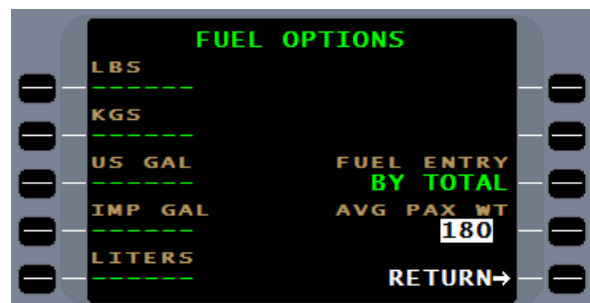
Pressing the **FUEL** key will access the first **FUEL** page for initialization of fuel data. The basic weight or basic operating weight (BOW) displayed here is stored in the FMS configuration module programmed at time of installation. If needed, the weight may be adjusted by using the line select key to place the cursor here.



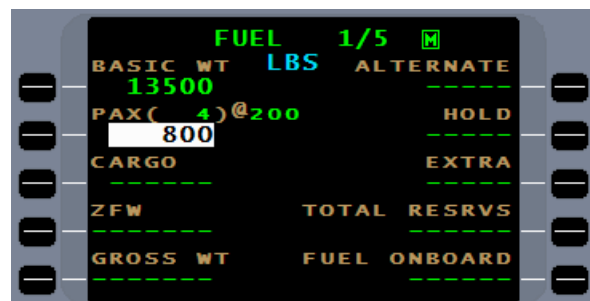
Entries made in the PAX field will be calculated at the weight displayed. Use a weight that reflects the average weight of passengers most frequently on this aircraft. Since this calculation is most frequently used in aircraft performance calculations, the more accurate the weight, the more accurate the calculation.



The "default" weight setting may be changed by pressing the **MENU** key. The 4R line select key will allow access to set the "**AVG PAX WT**".

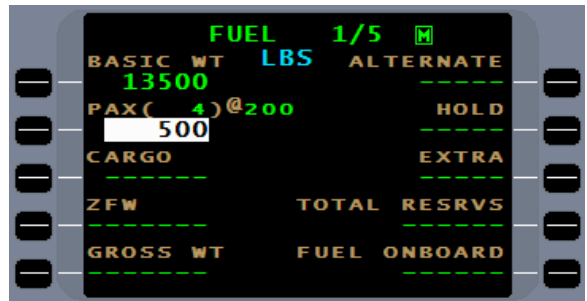


When the number of **PAX** is entered, the FMS computes the total passenger weight.

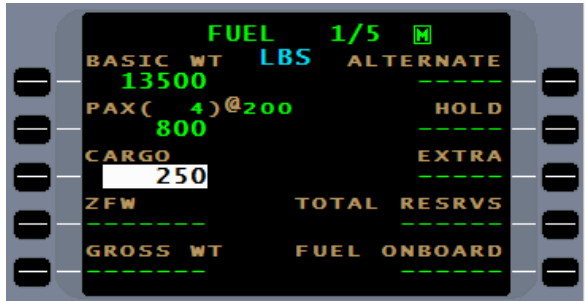


NOTE: The fuel initialization page will not suffice as a replacement for required weight and balance computations for certificate holders.

The **PAX** total weight field will allow for further adjustments in the passenger weight, if necessary, by directly entering the desired value. Press the **ENTER** key to confirm passenger weight.



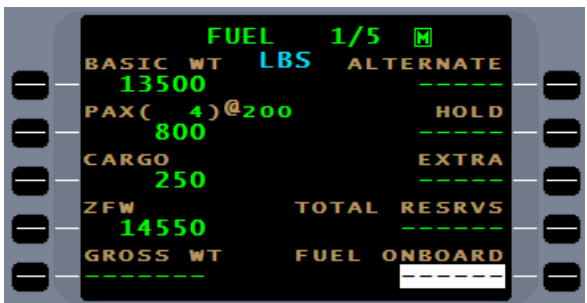
Enter the **CARGO** weight. Enter "0" if appropriate.



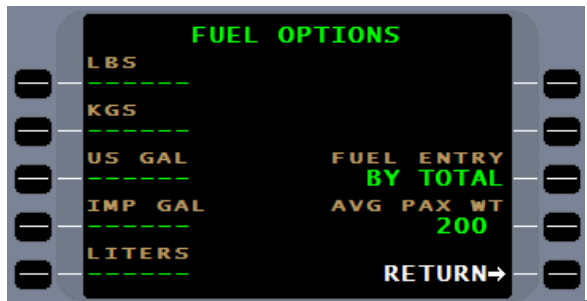
NOTE: Fuel initialization requires that the **PAX** and **Cargo** field have an entry to calculate **ZFW**. If "0" is appropriate, enter "0".

With the **CARGO** weight entered, the FMS computes the zero fuel weight (**ZFW**) and the cursor moves to the **FUEL ON BOARD** field.

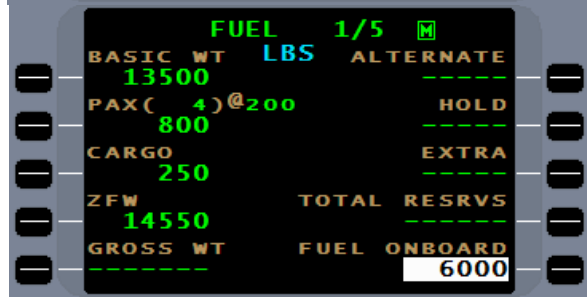
If desired, the **ZFW** field can be entered directly by pressing the adjacent line select key. An entry directly in the **ZFW** field will remove the **PAX** and **CARGO** entries.



There are two entry methods for entering **FUEL ONBOARD**. Entering fuel **BY TOTAL** is recommended.

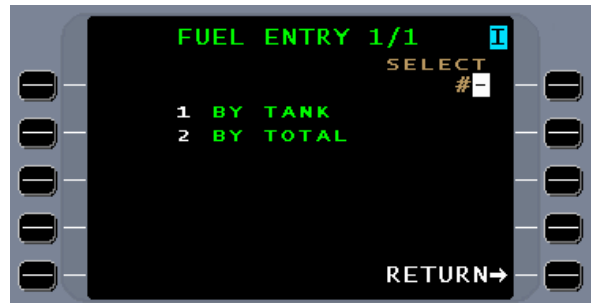


The **BY TOTAL** method will allow a direct fuel entry into the **FUEL ONBOARD** field.

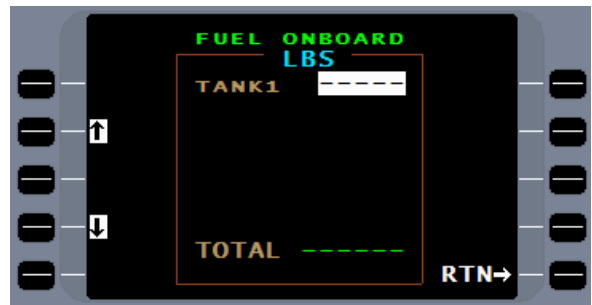


NOTE: For those aircraft with digital fuel quantity systems that enter the fuel directly into the FMS, the pilot must confirm the quantity by pressing **ENTER**.

The **BY TOTAL** or **BY TANK** method can be selected through the **FUEL OPTIONS** menu. The **FUEL ENTRY** line select key will allow for a selection of the preferred method.

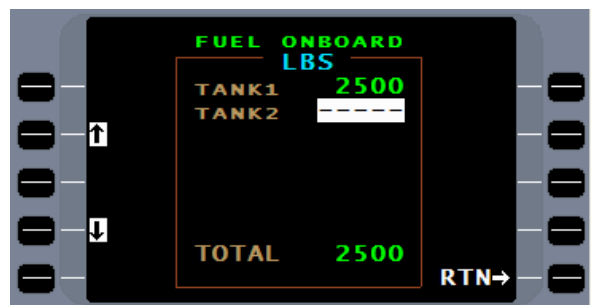


Entering fuel BY TANK can be used if the aircraft has no fuel totalizer. Pressing the **FUEL ONBOARD** line select key of the FUEL page 1/ 5, will present the fuel entry by tank page.



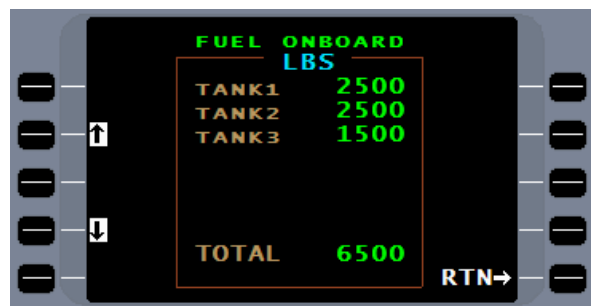
When the **TANK 1** quantity is entered, the cursor moves to **TANK 2**

Line select keys 2L and 4L will move the cursor up or down if needed.



By pressing the **ENTER** key on a blank tank cursor field the total fuel is computed. Pressing the RTN line select key will cause a return to the FUEL page 1/5.

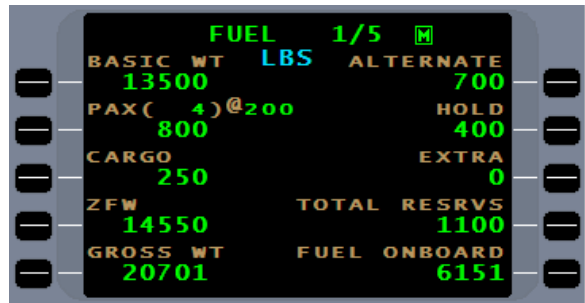
The Fuel on board entry should be made as accurately as possible to provide the best fuel predictions. The maximum fuel entry for each tank is 99,999. There is no correlation between a specific aircraft fuel tank and the FMS tank entries.



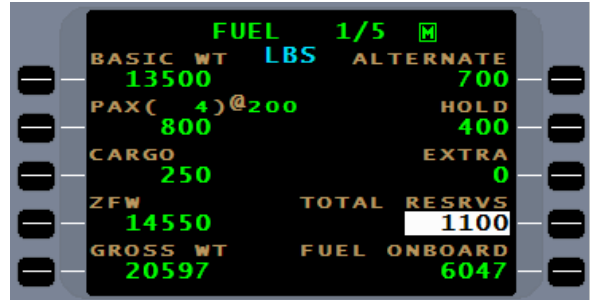
CAUTION: It is important to note that all fuel quantity readings on the FMS are based on fuel quantity inputs by the pilot, minus the fuel flow inputs to the system by the aircraft. On most aircraft there is no connection between these readings and the aircraft's fuel gauging system. On aircraft with digital fuel quantity systems, direct entry by the aircraft to the FUEL ONBOARD field is possible.

Entry of the **ALTERNATE**, **HOLD**, and **EXTRA** fields will result in the FMS calculating the aircraft fuel reserves. A number must be entered into each field is required to complete the calculation.

The **TOTAL RESRVS** are used for FMS fuel management calculations and in enroute performance calculations.

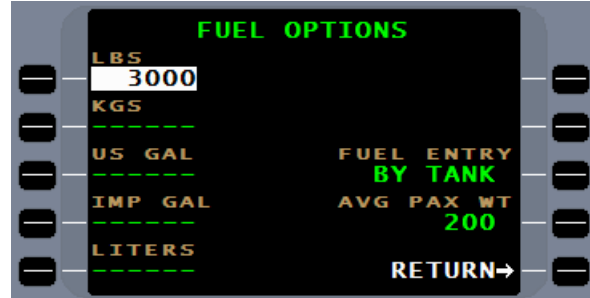


An entry into the **TOTAL RESRVS** field can be made directly by pressing the adjacent line select key.

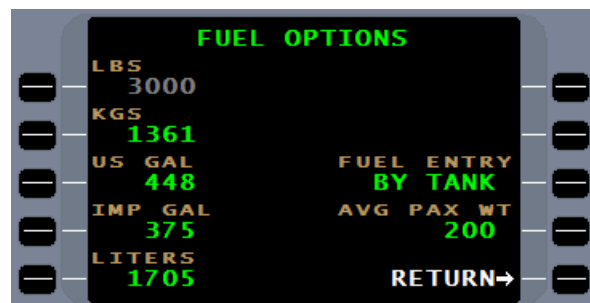


NOTE: If the **FUEL** key is pressed after fuel data has been initialized, the first page displayed will be FUEL page 2/5.

Pressing the **MENU** key for the **FUEL OPTIONS** menu page displays the FMS conversion calculator. This calculator will convert the weight of fuel to the volume of fuel. It uses the standard weight of Jet A fuel which is 6.7 pounds per gallon.



Conversions are made automatically by pressing any line select key on the left and entering a number value followed by pressing **ENTER**. This is a very useful tool on international trips.



When in flight pressing **FUEL** will default to page 2. Flightplan information is imported to this display.

Press the line select key 3L to enter the UTC offset time for the calculation of destination ETA local.

FUEL 2/5		
FUELFLOW	LBS	GS
1205		428
T/O	22:52	ELAPSED 0+01
TO	KTUS	895NM
ETA UTC	00:59	
- 7 LCL	17:59	
NOW	OVHD	KTUS
5966	FUEL ONBRD	3457
4+57	ENDURANCE	2+52
2117	RANGE	1226

Page 3 will display the current fuel summary information.

FUEL 3/5		
FUELFLOW	LBS	GS
1205		429
FUEL		
AT DEPARTURE		6000
USED		134
ONBOARD		5865
REQUIRED		2463
OVERHEAD	KTUS	3402
RESERVES		1500
EXCESS		1902

On page 4 a summary of aircraft weight information is displayed along with specific range and other information.

FUEL 4/5		
LBS		
GROSS WT		20373
FUEL ONBOARD		5823
LANDING WT		17937
OVERHEAD	KTUS	3387
GND NM/LB		0.352
AIR NM/LB		0.357
HEADWIND		6
ESAD		60
TEMP		ISA+02

FUEL page 5 displays the fuel flow inputs received from each engine, and totals used. Number of engines is configurable at time of installation. Should fuel flow input fail or be inaccurate, pressing the appropriate ENG line select key will allow for manual fuel flow entries.

FUEL 5/5		
	FLOW	USED
	LBS	
ENG 1	600	112
ENG 2	605	113
TOTAL	1205	224

In the event of a fuel flow failure lasting longer than four minutes, the flow field will show FAIL. The fail can be removed and input restored by placing the cursor over the FAIL with the adjacent line select key and pressing the **BACK** key followed by the **ENTER** key. If fuel flow input has returned (such as after an engine shut down and restart), normal operation should be apparent.

NOTE: To reset fuel used without first turning off the FMS, use the right line select keys adjacent to each engines fuel used. Place the cursor into the field, enter a “0” and press the **ENTER** key.

NOTE: It should also be noted that APU fuel flow from aircraft with an on board APU could be monitored by the FMS with proper installation and the selection of a configuration option.

DESTINATION/ALTERNATE FUEL PLANNING

Fuel page 2/5 will allow planning to an alternate destination. The "TO" field displays the flightplan destination as the default. Press line select key 2L to place the cursor over the "TO" field to calculate a "what if" scenario to an alternate destination. Manually enter the alternate ICAO identifier or press the **LIST** key to access the AIRPORTS list with distances from present position. Choosing an alternate airport from the list will return to the **FUEL 2/5** page and **(A)** will indicate alternate airport calculations.

FUEL 2/5		
FUELFLOW	LBS	GS
1205		423
T/O	22:52	ELAPSED 0+18
TO	KPHX(A)	1+23 587NM
ETA UTC	00:34	121°
- 7	LCL	17:34
NOW		OVHD
5624	FUEL ONBRD	3950
4+40	ENDURANCE	3+16
1972	RANGE	1385

Alternate calculations are based on the aircraft fuel consumption from present position to overhead the alternate airport. Fuel on Board overhead the alternate, endurance, and range is based on present fuel on board, present groundspeed, and present fuel flow. Manual fuel flow and Manual groundspeed may be entered by using line select keys [1Lw] and [1R] for planning purposes and may be deleted by using the back key or exiting the fuel pages.

On Fuel pages 2 and 3, line select key 1Lw displays current fuel flow.

FUEL 3/5		
FUELFLOW	LBS	GS
1205		433
FUEL		
AT DEPARTURE		5000
USED		34
ONBOARD		4966
REQUIRED		3505
OVERHEAD	KTUS	1461
RESERVES		1500
EXCESS		-39

By pressing the line select key an alternative fuel flow can be manually entered that will allow for hypothetical fuel planning scenarios. A manual **GS** may also be entered to see the effect of changes in groundspeed.

FUEL 3/5		
FUELFLOW	LBS	GS
1100(EST)		433
FUEL		
AT DEPARTURE		5000
USED		63
ONBOARD		4936
REQUIRED		3171
OVERHEAD	KTUS	1765
RESERVES		1500
EXCESS		265

To return to actual fuel flow, press the 1Lw line select key, press the **BACK** key followed by the **ENTER** key.

NAVIGATION DISPLAYS

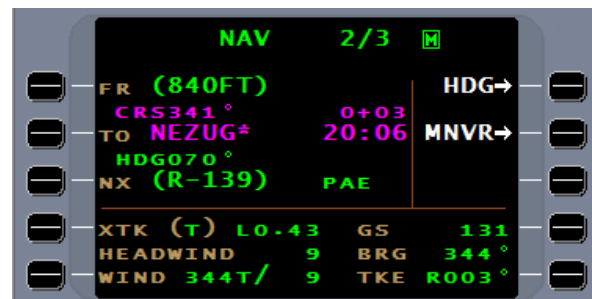
During normal navigation, three NAV pages are displayed. When needed, additional pages are added as in the case when approach mode is active or if the command heading mode is in use.

On most departure procedures, a takeoff leg will be included in the NAV database that allows the FMS to provide guidance from takeoff roll to the end of second segment climb which is normally 400ft. This leg may not be included on the departure chart. Where departure procedures require a higher altitude, that altitude terminator will replace the 400ft terminator.

The FMS can be used to maintain heading on the runway, with the current NAV leg from KSEA of CRS343° to the leg terminator, 840 feet, and HSI displayed as it would appear during takeoff. The course arrow will provide heading prior to rotation. The heading bug may require manual slewing to the runway heading.

After becoming airborne, the FMS will provide course steering to the HSI for this leg.

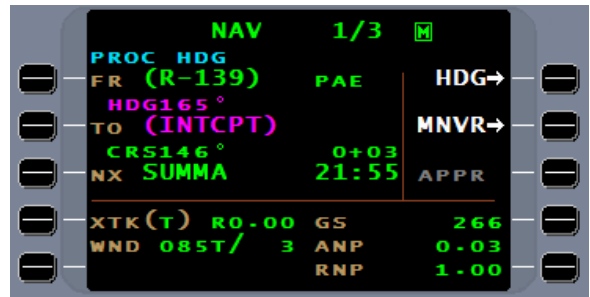
NAV page 1 and 2 are similar in what they display. Both will display from (FR), to (TO), and next (NX) information, crosstrack (XTK), phase of flight ("T" terminal shown), wind heading and speed (WIND), and ground speed (GS), but, in addition, NAV 1 will display ANP and RNP. In addition, NAV page 2 will display tailwind or headwind component, bearing (BRG), and track error (TKE).



In-flight, NAV page 1 and 2 will display from (FR), to (TO), and next (NX) waypoints with course, distance, time remaining, and estimated time of arrival in UTC for the next waypoint.



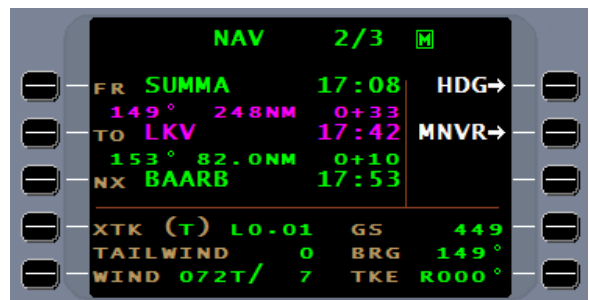
When flying procedural legs distance may not be displayed on the FMS NAV page,



...but will be presented on the HSI.



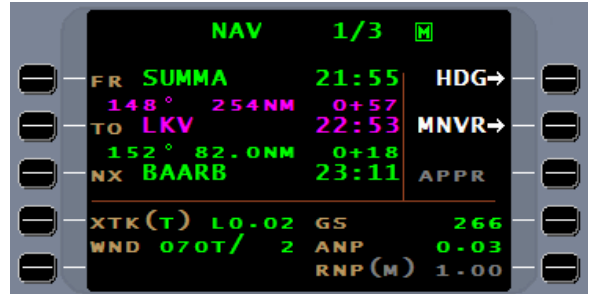
XTK (cross track), defines actual aircraft distance right or left of course centerline. The (T) designates that the FMS is in the terminal phase of flight. Wind information displayed is direction (true enroute and terminal, and magnetic when approach active) and speed. **HEADWIND** or **TAILWIND** component is displayed on page 2. **BRG** (bearing) from the aircraft position to the “TO” waypoint and **GS** (ground speed) are also provided. **TKE** (track error) is displayed in degrees right or left of the course centerline.



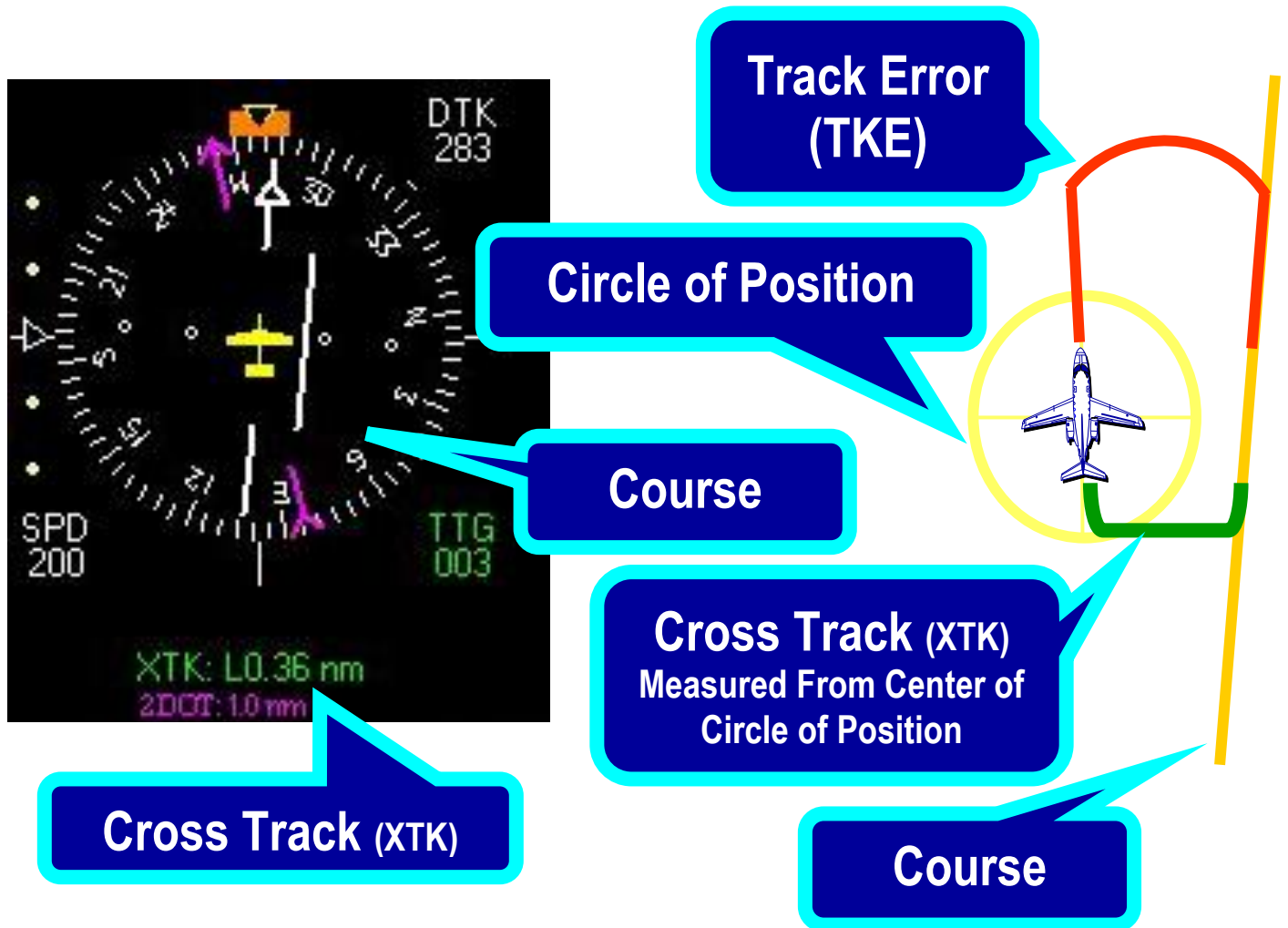
If it becomes necessary to set **RNP** to other than default, press line select key 5R.



Enter the desired **RNP** and press **ENTER**. The **(M)** will indicate that the **RNP** is manually set. To remove the manual entry and revert to default, press the **RNP** line select key, press **BACK** followed by **ENTER**.

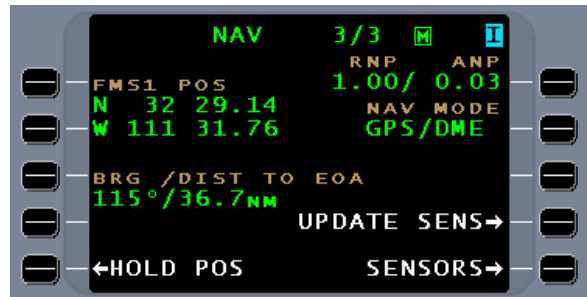


CIRCLE OF POSITION AND COURSE



ANP is the radius of the circle of position based on a 95% probability that the aircraft is within the circle. The FMS uses the center of the circle of position to determine the crosstrack distance. It is necessary that the pilot ensure the entire circle of position clears all obstacles and airspace restrictions, since the location of the aircraft within the circle of position cannot be determined. The track error is the angle of the path over the ground relative to the course.

NAV page 3 displays the FMS best computed present position, the Actual Navigation Performance (**ANP**), Required Navigation Performance (**RNP**), and the most significant NAV sensor(s) currently used. When two sensors have close to equal weighting in the NAV solution, they will be displayed together, under **NAV MODE**, such as **GPS/DME**.



By pressing the 1R line select key, **RNP** can be entered to meet the current flight requirements as on NAV page 1.

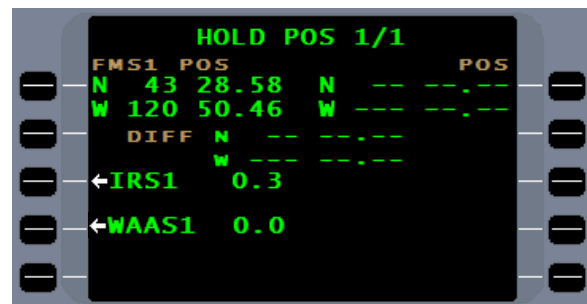
Also available are line select keys for BRG/DIST TO EOA, UPDATE SENSORS, SENSORS, and HOLD POSITION.

When within 100nm of the EOA, the BRG/DIST TO EOA will become active.

When on the ground, the UPDATE SENS (update sensors) line select key will send a 30-second present position to a compatible IRS set to align mode. The IRS can use the lat/long information to complete alignment. The Inertial Reference System or Inertial Navigation System cannot currently be updated in flight through the FMS.

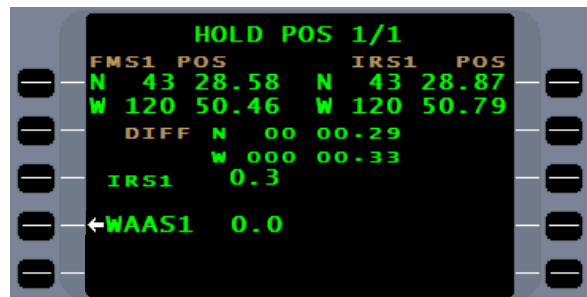
The SENSORS line select key is a shortcut to DATA page 3.

The HOLD POSITION line select key will take a snapshot of FMS and all sensor position's at the moment it is pressed. This would normally be used to verify or update the FMS position over a known geographical point. It may also be used to record the coordinates of a location over flown.



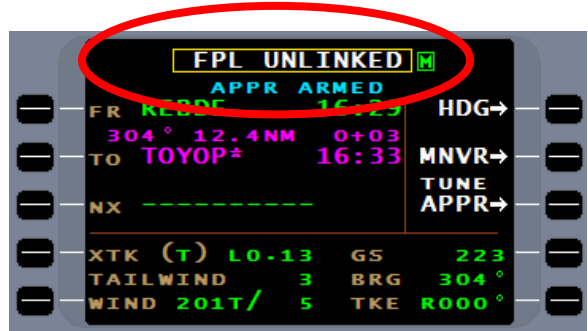
Press the HOLD POS line select key to display the **HOLD POS** page. The frozen FMS position is displayed and line select keys are available for all sensors connected.

With the selection of a NAV sensor, the right hand field will display the sensor position and below it is the difference in position between this sensor and the FMS position. Each available sensor may be compared to the FMS position in this way. While the coordinates shown on the **HOLD POS** page are frozen, the FMS will continue to navigate normally, and this view of sensor positions has no effect on navigation.



FLIGHTPLAN UNLINKED

Whenever the FMS cannot connect the current NAV leg (the “FM” “TO” leg) to the flightplan, a FPL UNLINKED banner or message will appear at the top of the page. This can occur when going direct to a waypoint that is not part of the current flightplan, if manually changing the NAV leg to a leg that is not part of the flightplan, or if going direct to a waypoint that is currently part of a departure or arrival procedure.

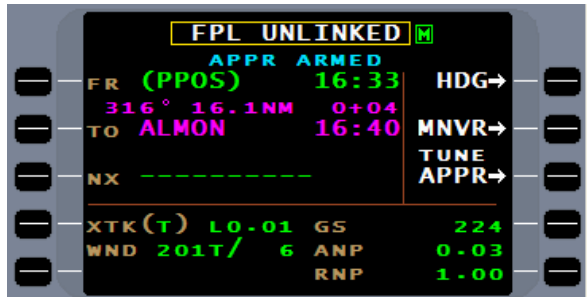


In most cases, but not all, the FMS will prompt for a “NX” waypoint,



...but if one is not selected, a **FPL UNLINKED** message will be presented.

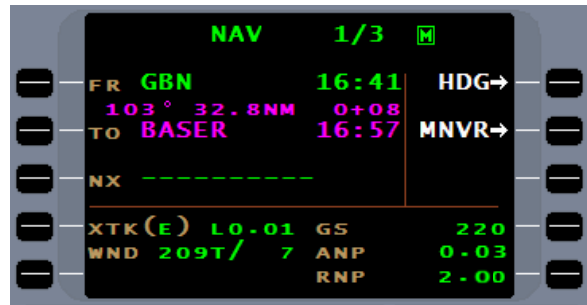
When the FPL UNLINKED message is present, on NAV page 1 or 2 the “NX” line will be empty.



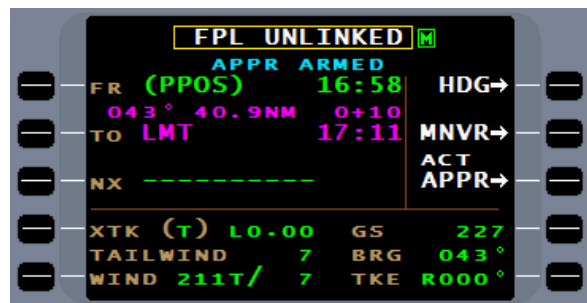
The “NX” line is the interface between the NAV leg and the flightplan.



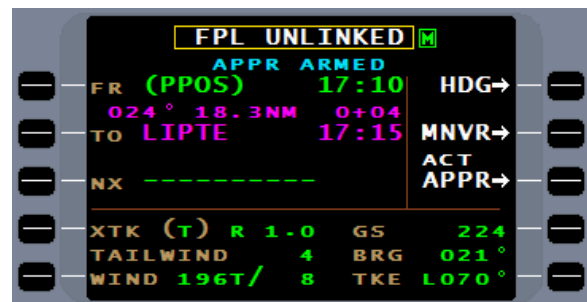
Once the waypoint in the “**NX**” line moves to the “**TO**” line, it no longer belongs to the flightplan. If the flightplan is deleted or modified, the waypoints in the “**FM**” “**TO**” lines will be unaffected, but the waypoint in the “**NX**” line will be deleted.



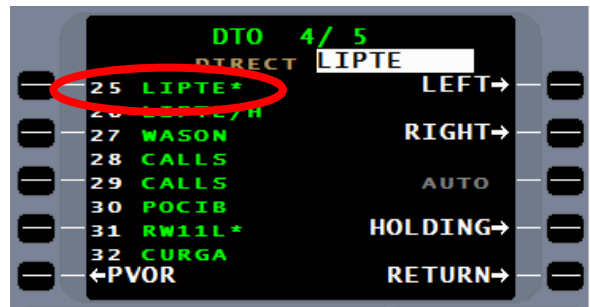
It may be correct to have the **FPL UNLINKED** message if the current NAV leg does not have a follow on waypoint; such as going direct to a fix and expecting vectors.



If, however, the NAV leg needs to reconnect to the flightplan, the pilot must use one of the two following procedures.



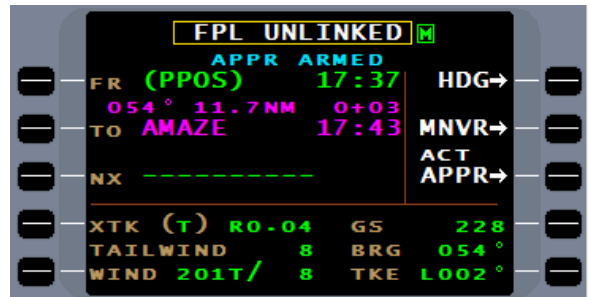
Press the DTO function and a list of the flightplan waypoints will be presented. From the list, select the current **"TO"** waypoint of the current NAV leg and press the **ENTER** key.



The FMS will reconnect the NAV leg to the flightplan. The aircraft should be unaffected.



Another method is to press the **"NX"** line select key. When there is no waypoint in this line, the **"NX"** key will respond by listing the flightplan waypoints.



Enter the reference number of the follow on waypoint and the FMS will connect the NAV leg to the flightplan.



The NAV leg will now sequence into the flightplan.



CROSSTRACK INSTRUMENT DISPLAY SCALING

Crosstrack Instrument Display Sensitivity is automatically selected by the phase of flight but can be manually selected in SCN 1000/1100 by using the NAV DISPLAY page. Bring up NAV MENU by pressing the **MENU** key when NAV page is displayed. Press the NAV DISPLAY line select key.



The NAV DISPLAY selection is removed from SCN 1001/1101 and subsequent.

CAUTION: Selecting ENROUTE or TERMINAL during approach mode will cancel the approach mode.

The CDI scale is set automatically according to the aircraft's phase of flight. The NAV DISPLAY will allow the CDI scale to be changed from the default, which is based on phase of flight. A selection of a scale other than default will result in that scale staying in effect through a phase of flight change. To restore the default scale, select the scale appropriate for the phase of flight.



Selecting the TERMINAL line select key or the APPROACH line select key will change the CDI scaling, but will not change the GPS and FMS position error alarm limits. This must be accomplished by manually changing the RNP.

In accordance with TSO 146C the following apply to CDI display sensitivity.

Full scale deflection (2 dots)

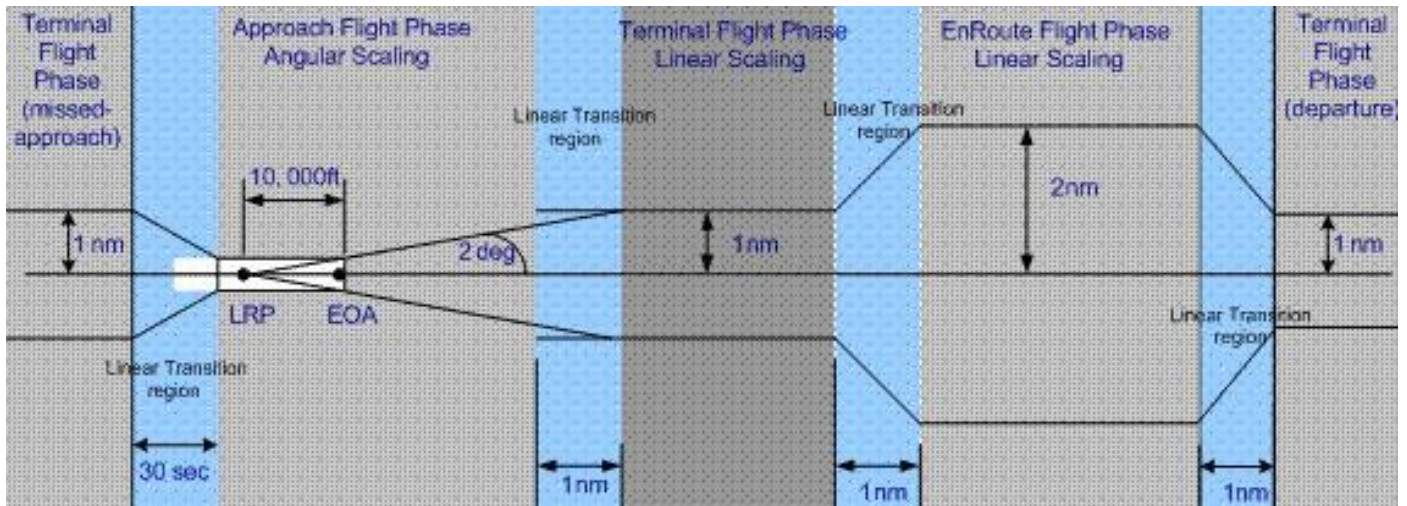
Enroute display sensitivity	$\pm 2.0\text{nm}$
Terminal display sensitivity	$\pm 1.0\text{nm}$
Approach display sensitivity	$\pm 1\text{nm } 2^\circ \text{ to } \pm 350\text{ft @ TH}$

NOTE: If the pilot commands a DTO to the FAF or MAP leg while the aircraft is greater than 30nm from destination, the NAV scaling will remain at the enroute value (2.0nm) until the aircraft reaches 30nm from destination. At that time the scaling will automatically change to the terminal value (1.0nm).



PHASE OF FLIGHT

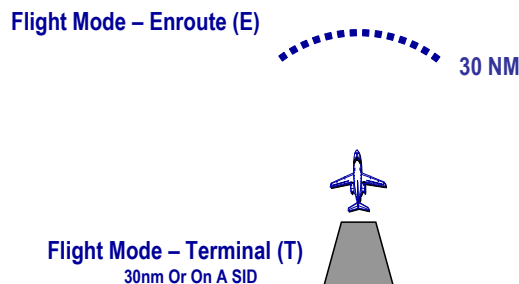
Enroute, Terminal, and Approach are the three phases or modes of flight programmed into the FMS. Although the Terminal phase of flight will be defined as 30nm from the departure or arrival airport, beginning with SCN 1000/1100, to comply with DO 229, the FMS will stay in the Terminal phase of flight for the complete SID, STAR, or Approach Transition. When not on a departure or arrival procedure, the terminal phase of flight will be defined as 30nm from the departure or arrival airport.



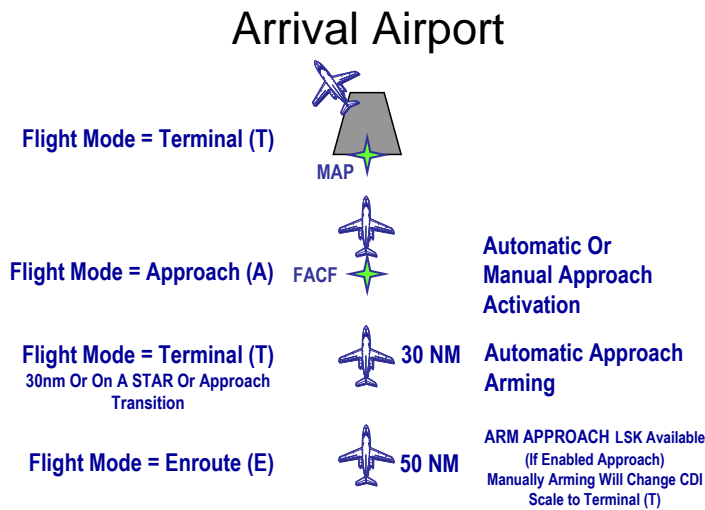
The linear transitioning between phases of flight together with a visual description is diagrammed above.

The terminal phase of flight will automatically be set upon completing initialization and is the airspace within 30nm of the departure airport. The 30nm is the radius of a circle measured from the departure airport's ARP. Upon crossing this circle the FMS will automatically change to the enroute phase of flight unless on a SID at which time the FMS will change upon exiting the SID.

Departure Airport



When approaching the arrival airport, how the FMS operates depends upon whether an FMS flyable or enabled approach is entered into the flightplan. With an approach in the flightplan, the FMS will offer an ARM APPR (arm approach) line select key. If selected, as part of arming the approach, the FMS will set the CDI scale to terminal. If not manually selected, at 30nm, which is the beginning of standard terminal airspace, the FMS will automatically set the CDI to terminal and arm the approach. With no FMS approach in the flightplan and not on a STAR procedure, flight mode terminal will automatically occur at 30nm with no manual method of changing it prior to 30nm. The reference location for the 30nm or 50nm regarding change of flight phase is the ARP; for auto approach arming, the reference point is the end of approach point. If on a STAR, the terminal phase of flight will begin upon entering the STAR.



NAV DATABASE SOURCES FOR CDI SCALING AND RNP

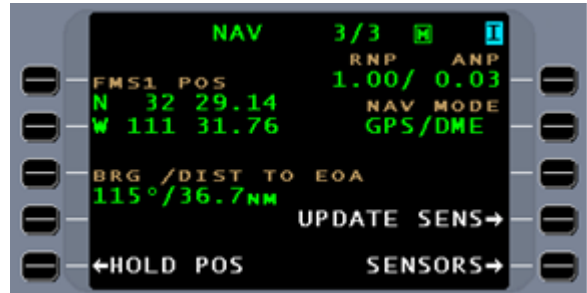
When the NAV database is the source for CDI scaling and RNP values the XTK and RNP symbology will change; (R) will be used for the crosstrack CDI scaling and (P) for the RNP value. These are normally seen on Authorization Required (AR) procedures.



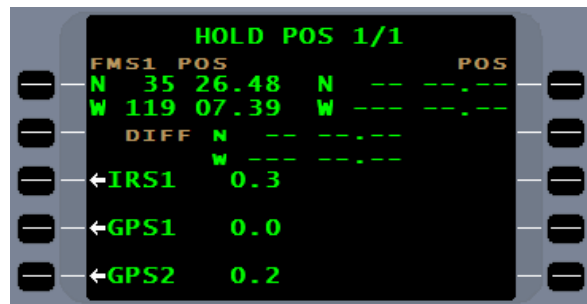
FMS AND SENSOR POSITION UPDATING

CAUTION: UNS systems are designed so that manual position updating should not be necessary during normal operations. Manually updating a FMS that uses GPS for navigation could result in the GPS being deselected and the FMS reverting to DR navigation. **Strongly recommend that manual update not be used unless there is a loss of ALL NAV sensors except ADC and heading.**

Press the **NAV** key until displaying the NAV page with the LAT/LONG; normally **NAV 3/3**. Press the HOLD POS line select key while over a known reference point.



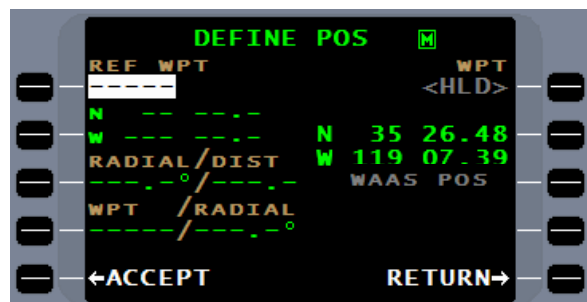
Press the 1Lw line select key to move to the DEFINE POS page.



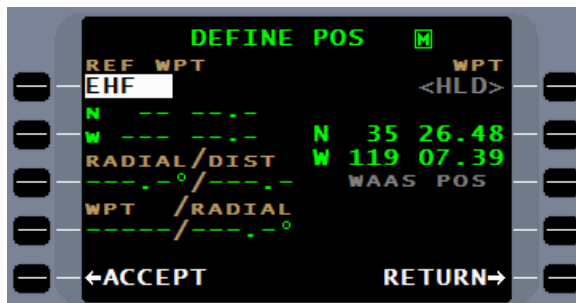
The **DEFINE POS** page will be displayed and the cursor will default to the **REF WPT** field. If the correct hold position coordinates are known, they could be entered directly by pressing the coordinates field line select key 2R.

This will allow entry of known coordinates or the **WAAS** or **SBAS POS** by pressing the line select key [3R] if SBAS is operational. The position can also be updated by reference to a known position.

Press the **REF WPT** line select key to display the cursor. The identifier of a known position may be entered directly or by the LIST function.



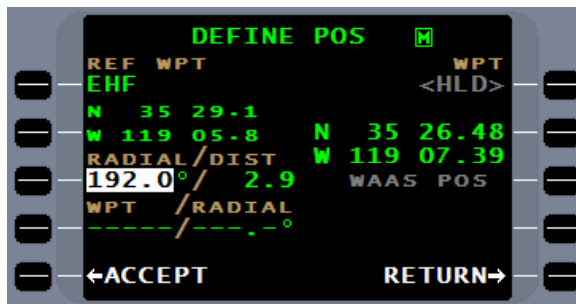
With the FMS position near EHF, enter EHF and press **ENTER**.



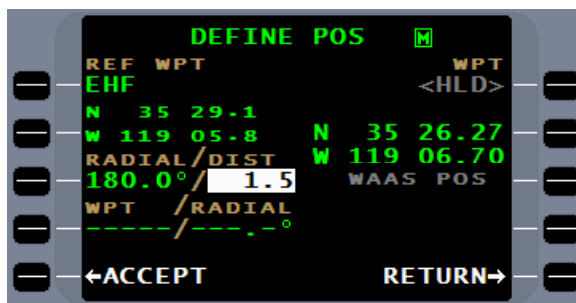
Accept the navigation data.



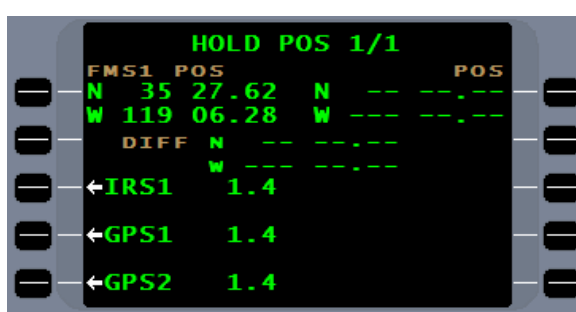
The display will now show the calculated radial and distance of the FMS from the referenced facility.



A check of the aircraft VOR and DME reveals that it was on the EHF 180-degree radial at 1.5nm at the time the HOLD line select key was pressed. To update the FMS position to reflect the VOR radial and DME, enter 180.0 for the radial and 1.5 for the distance and press **ENTER** or ACCEPT.



The new position coordinates for the 180° at 1.5nm position from the EHF VORTAC will be calculated and displayed. If this position update to the FMS position is greater than 10 arc minutes, a VERIFY pop up message will be displayed. The FMS will be updated to the new position and a position update will be transmitted to all sensors. Capable sensors will be updated. The display will return to the HOLD POS page and the magnitude of the update to each sensor will be displayed.



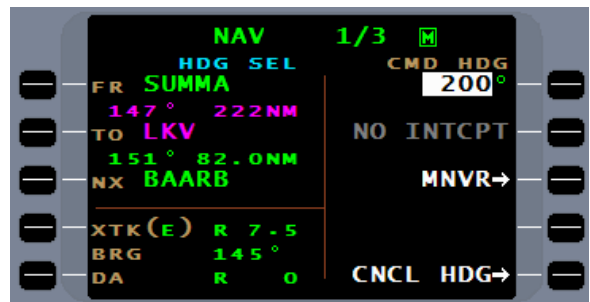
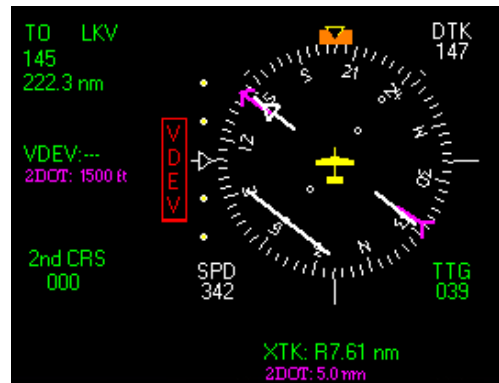
FMS HEADING MODE

The FMS has two heading functions, procedural heading and command heading. Procedural heading is used when the FMS is navigating on departure or arrival procedures. The FMS will align the HSI course arrow with the procedural heading. No action is required on the part of the pilot; intercepts and leg sequencing are controlled by the FMS.

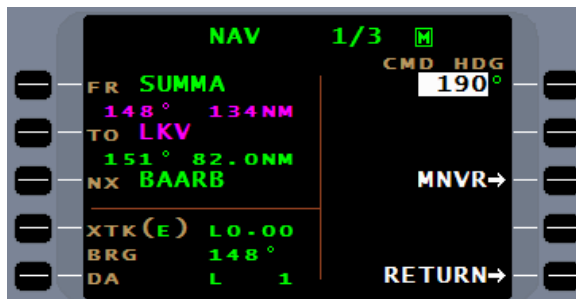


Selecting HDG on the NAV page will allow the pilot to control the heading of the aircraft through the FMS.

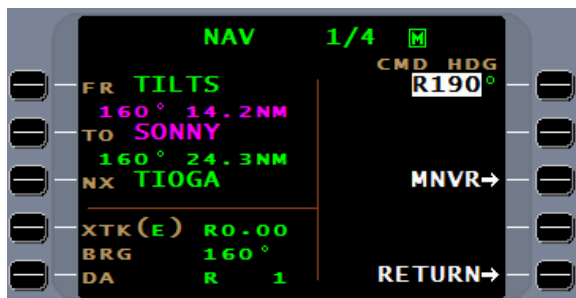
Most current generation EFIS allow for interactive heading. This means that by selecting HDG and pressing **ENTER**, the pilot can turn the heading bug to the desired heading and the aircraft will turn to that heading. That heading will also be presented in the command heading field.



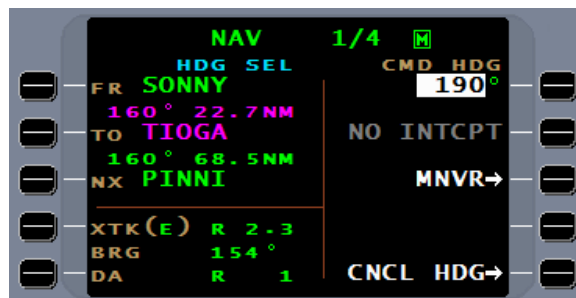
For aircraft without interactive heading or, if by choice, the pilot may enter the desired heading into the **CMD HDG** field directly; press HDG and the current heading of the aircraft will be presented in flashing mode. Enter the desired heading and press **ENTER**.



The FMS will ask to confirm the turn direction or allow the pilot to change the turn direction. To change the turn direction, use the **±** key. Press **ENTER** to confirm the turn direction.



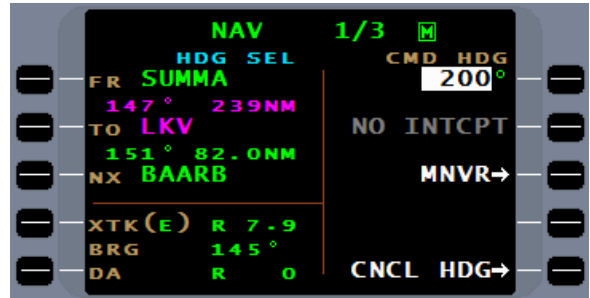
The FMS will command a heading change to the CMD HDG, but the heading bug will only respond if the EFIS has interactive heading.



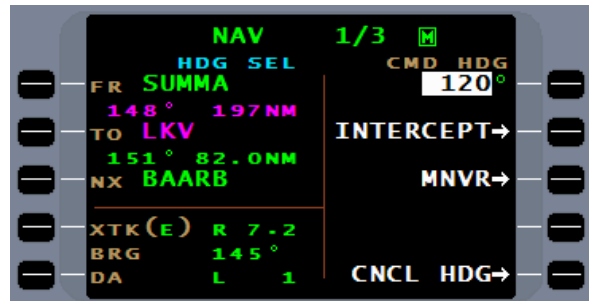
Once the FMS is placed in command heading, it will stay in command heading until the pilot initiates a process to exit command heading.

There are three ways to exit command heading, one is to use DTO. Selection of a DTO waypoint will automatically cancel command heading.

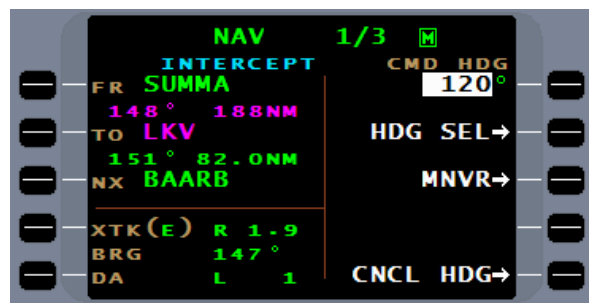
Another way to exit command heading mode is to press CNCL HDG. When CNCL HDG is pressed, the FMS will exit command heading and establish a heading that will return to the FR/TO NAV leg. The maximum intercept angle will be 45°, but the FMS will only turn to the intercept angle required depending on crosstrack distance.



The last way to exit command heading is to enter a new heading that will intercept the current NAV leg and then tell the FMS to intercept.

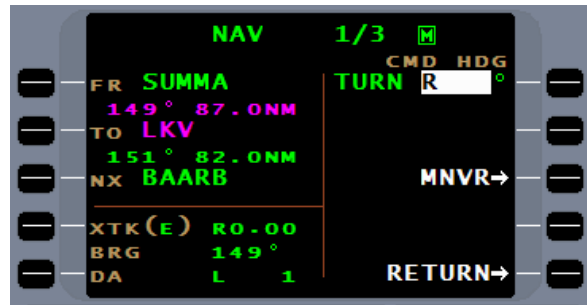


Pressing INTERCEPT will display an **INTERCEPT** subheading, resulting in the FMS intercepting and joining the current FR/TO leg. In the enroute and terminal phase of flight, an **INTERCEPT** option will be presented with an intercept angle less than 135° of the from/to course.

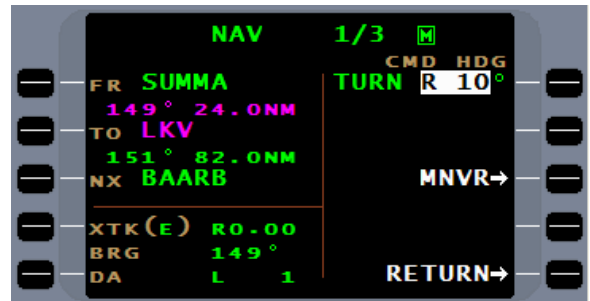


At any time there is a need to cancel intercept, pressing HDG SEL will cause the FMS to revert back to command heading in a non-intercept mode; the **INTERCEPT** option will again be presented.

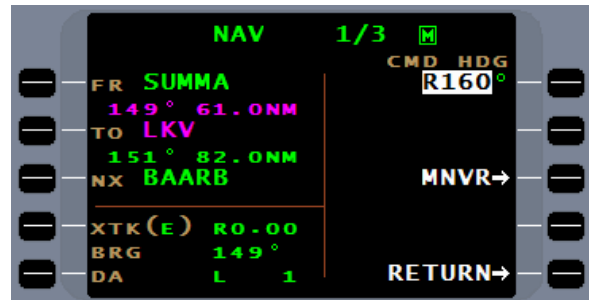
Another command heading function is to turn left or right a specific number of degrees. This is accomplished by first selecting the turn direction. Press the “L” or “R” key to select the direction of turn.



With **TURN R** presented, enter the number of degrees.



Pressing **ENTER** will result in the new heading being computed. Pressing **ENTER** again will cause the FMS to command a turn to the computed heading.

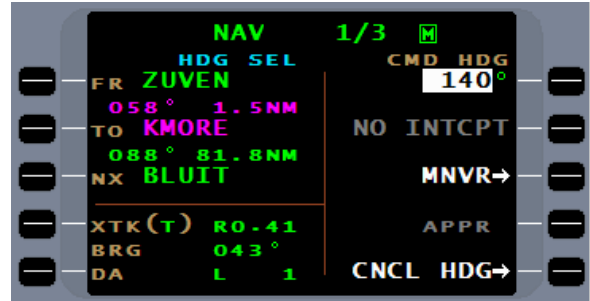


CAUTION: Selecting the turn direction first will result in the FMS changing the aircraft direction by the number of degrees entered; the number entered is not the heading to which the aircraft will turn.

MANUAL LEG CHANGE OPERATION

Manual leg changes can be made from the NAV page 1 or 2. To change the leg, press the line select key adjacent to the “FR” or “TO” field, as desired.

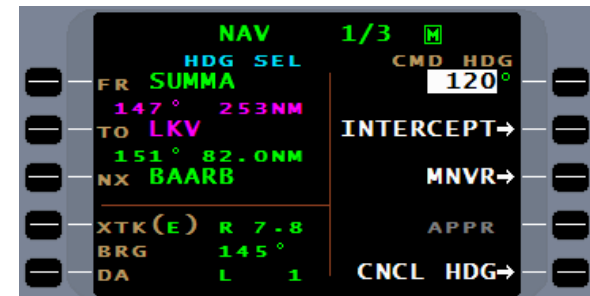
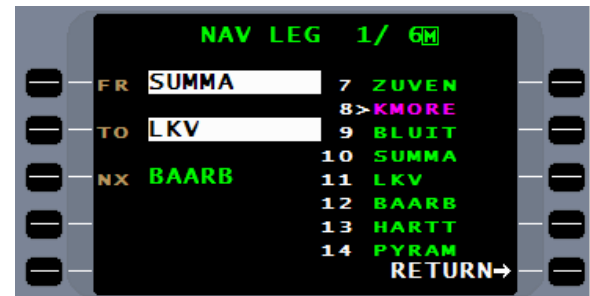
This procedure can be used when ATC gives vectors to intercept a NAV leg or airway which is not currently the active NAV leg.



When the line select key is pressed, the display will show a list of current flightplan waypoints for selection. Enter the number for the new “FR” waypoint and press **ENTER** or enter any lat/long waypoint using the LIST function or with the alphanumeric keys enter a waypoint.



The cursor will move to the “TO” field and default to the next sequential waypoint. Either push **ENTER** a second time which will return the screen back to NAV page 1 or 2 with the new “FR” – “TO” waypoints, or enter the number of the desired “TO” waypoint and then push **ENTER**. If only a new “TO” waypoint is desired, move the cursor by using the **ENTER** key and enter the appropriate number. In lieu of using waypoint numbers from the flightplan list, any waypoint name can be entered by using the **LIST** function or typing in the name directly.



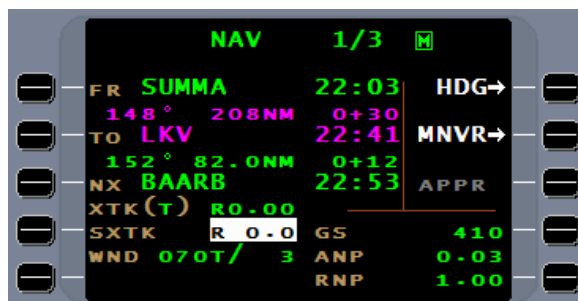
SELECTED CROSSTRACK OPERATION (Lateral Offset)

Use the selected cross-track feature to parallel the entire flightplan.

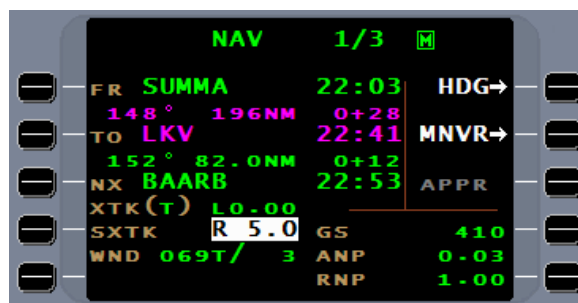
Crosstrack is available on the **MANEUVER** page by selecting SXTK.



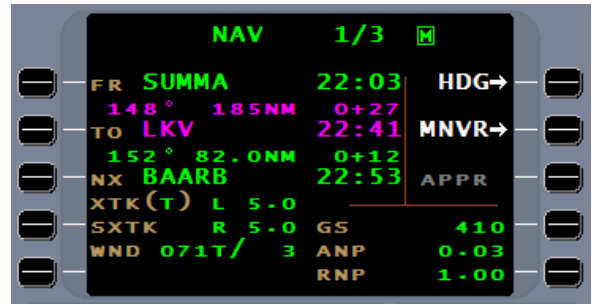
Selecting SXTK will display the SXTK field and cursor on the NAV pager. A desired offset may be entered either left or right of course in tenth of a nautical mile updates.



Press the \pm key to select left or right of course. Then enter 5.0 for the crosstrack distance followed by the **ENTER** key.



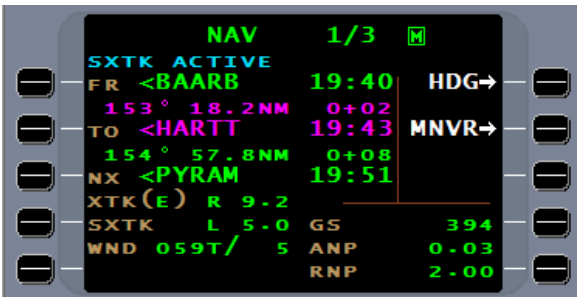
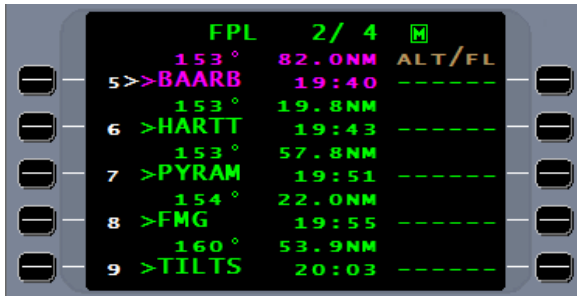
Pressing the **ENTER** key will result in the FMS commanding a turn to intercept the SXTK course. The intercept angle will be only what is needed, but will be limited to a maximum of 45°. For more than a 45° intercept angle, CMD HDG will need to be used.



For SCN 1000/1100, on most map displays, the original course line will remain and show the relationship of the SXTK course on the HSI to the original course.



For SCN 1001/1101 and subsequent, **SXTK ACTIVE** is added as a mode indication with the ">" icon showing a right of course SXTK on both the NAV page and FPL page. A "<" icon will be presented for a left of course indication. Most MAP displays will show the new SXTK course line with the ">" or "<" icon showing the direction of offset.



To cancel selected crosstrack, use the MNVR line select key then press CNCL SXTK. The FMS will then command a change in heading to intercept the original NAV leg.

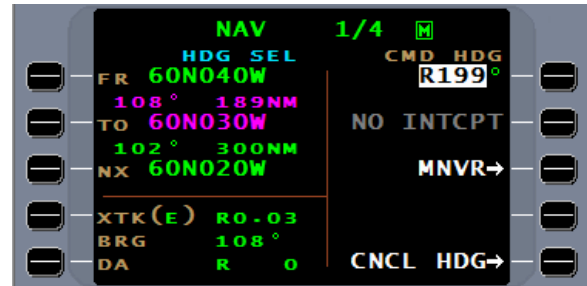
The selective crosstrack will continue paralleling the current flightplan until reaching the FMS approach which will result in automatic cancellation or use the above procedure to cancel SXTK early.



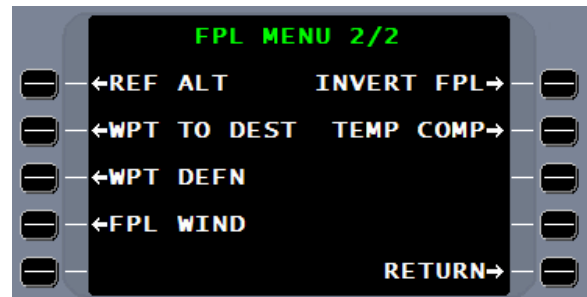
OCEANIC COURSE REVERSAL

If the aircraft is not beyond the equal time point or point of no return and an emergency requires the aircraft to return to the coast-out point, the FMS procedure to accomplish this is as follows.

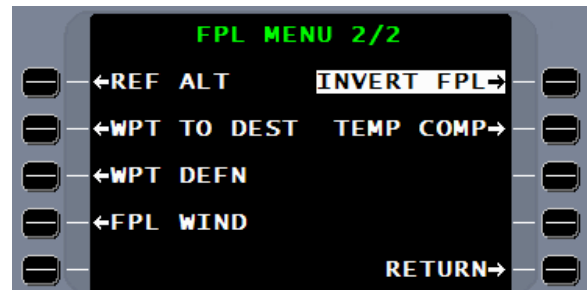
The first step is to turn the aircraft 90° to the current course. There may be specific turn directions required, observe regulatory requirements.



Under **FPL MENU 2/2** use the INVERT FPL tool to reverse the flightplan.



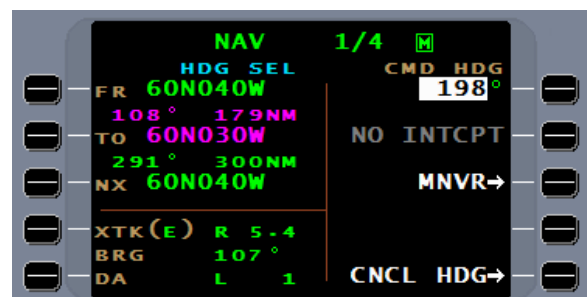
This will require a double push on the line select key.



This flightplan will now show the return routing.



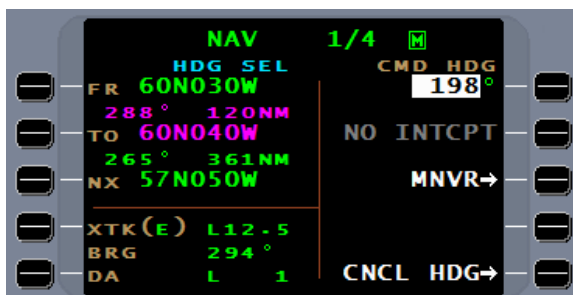
Although the flightplan may show return routing, the NAV page will still retain the original NAV leg.



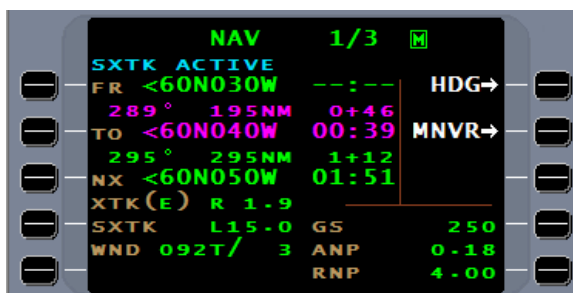
A manual leg change will be needed to provide the new NAV leg. Push the “FR” line select key and enter the correct “FR” waypoint.



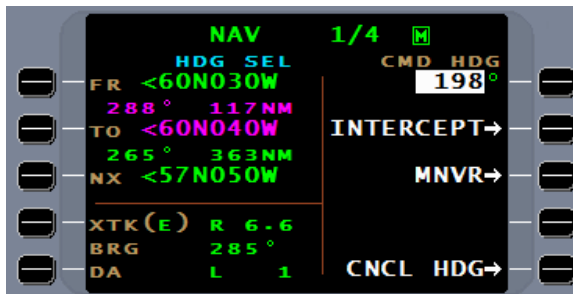
Complete the NAV leg by entering the correct “TO” waypoint and press the **ENTER** key.



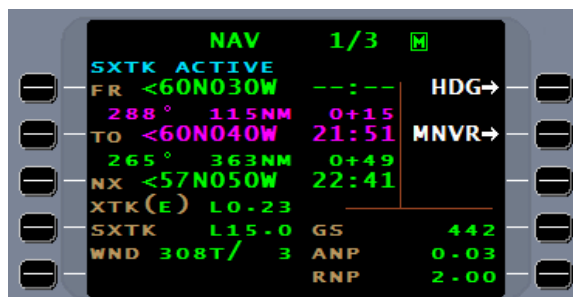
Although this represents the correct NAV leg, reversing course requires an offset. Use selective crosstrack (SXTK) and enter the appropriate offset distance. If a right turn was initially made, with the flightplan reversed, the SXTK will be to the left of the new NAV leg.



On the CMD HDG page press INTERCEPT to have the FMS intercept and navigate the NAV leg.



The FMS will follow the SXTK offset for as far as needed along the new flightplan route.



PSEUDO VOR OPERATION (RADIAL TRACKING)

The FMS provides the capability to track to or from any known waypoint on a programmed radial; similar to tracking on a VOR radial. This Pseudo VOR feature is accessed from the NAV page, by pressing the MNVR line select key.

From the **MANEUVER** page, select the PVOR line select key.



The **PVOR** definition page will display the current "TO" waypoint from the flightplan, and subsequent waypoints will be displayed in a list. The desired PVOR point may be chosen from the list, manually entered at the cursor, the **LIST** feature may be used or a pilot waypoint may be created. After the waypoint is identified, the cursor will move to the **DESIRED TRACK** field.



A desired track may be entered directly and the radial for inbound tracking will be calculated...



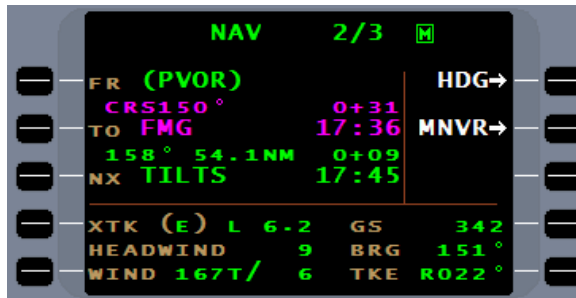
...or by using the line select key or **ENTER** key to move the cursor to the **INBOUND** field, an inbound radial may be defined and the desired track will be calculated.



Once the definition is made, the ACCEPT line select key will be available.

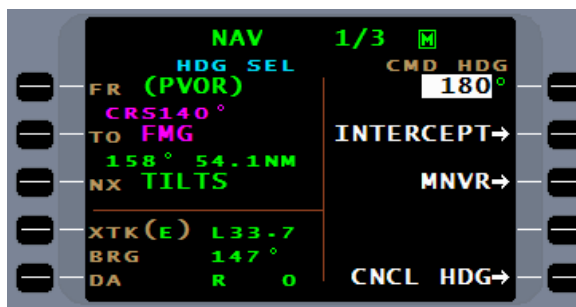
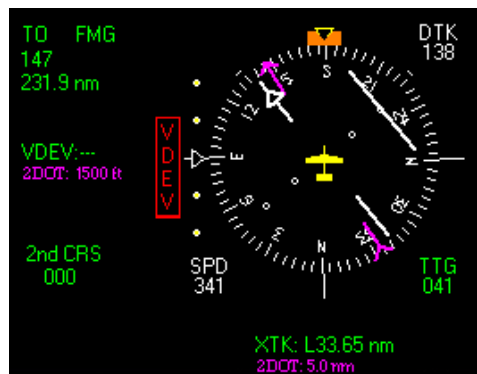


Pressing ACCEPT will change the current NAV leg to the PVOR and an intercept angle of up to 45° towards the defined radial will be commanded.



If on radar vectors, the CMD HDG mode may be used to fly the intercept. In this case, the INTERCEPT line select key under HDG must be pressed for the aircraft to intercept the PVOR radial.

Performing a DIRECT TO, making a manual leg change or selecting the approach mode will cancel the PVOR mode.

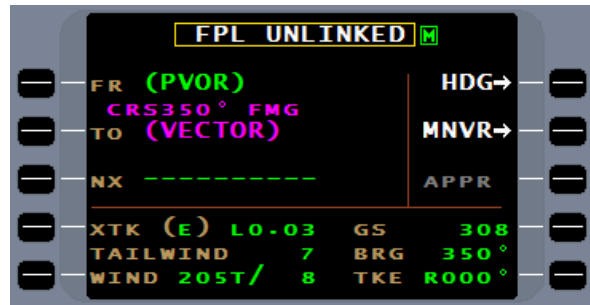


When a PVOR inbound to a waypoint not on the flightplan is selected, the leg will terminate at the PVOR waypoint and the system will prompt entry of a next point.

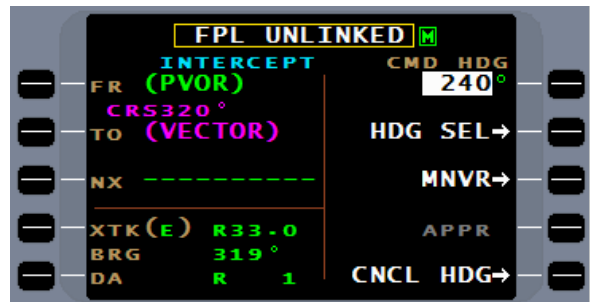
To fly outbound on a radial, first select a waypoint from which to fly. If the waypoint is on the flightplan, do not select it from the flightplan list, but enter it with either the LIST key or type it in manually. Another option is to place a GAP following the flightplan waypoint. This will help prevent inadvertent leg sequencing.



When a PVOR outbound is defined, the next leg will be undefined. It will be up to the pilot to exit PVOR by a manual leg change, DTO, or selecting approach arm when available.



Again, if on a heading that will intercept, remember to press the INTERCEPT option on command heading or the aircraft will fly through the PVOR course.



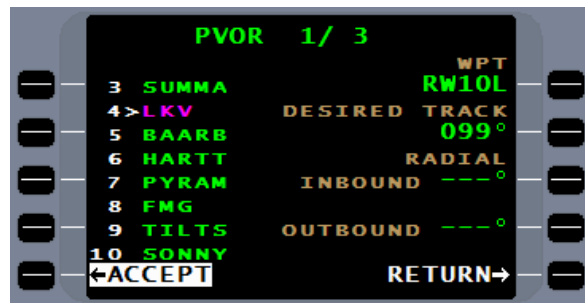
To assist with flying to a runway the LIST function will provide a RWY option.



The RWY option will present the airport identifier and runway. The runway coordinates are that of the runway threshold.



When the RWY option is used with PVOR, the runway heading is automatically entered as the **DESIRED TRACK**. Accepting this will present, on the NAV page, a PVOR with runway course information.

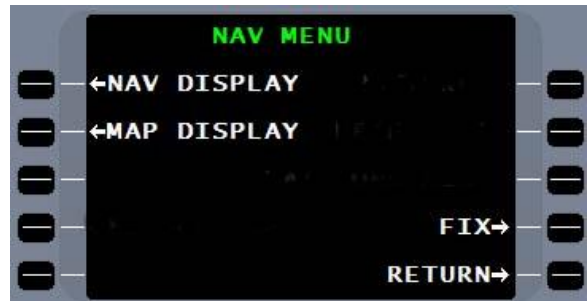


ABEAM POINT & RADIAL CROSSING

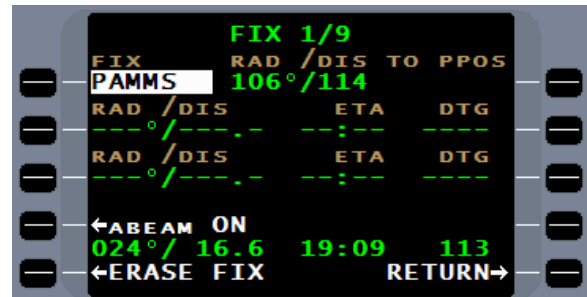
The clearance is direct Grand Turk (GT) report abeam PAMMS intersection.



To have the FMS assist in identifying when the aircraft is abeam the requested waypoint, go to the **NAV MENU** and select the FIX line select key.



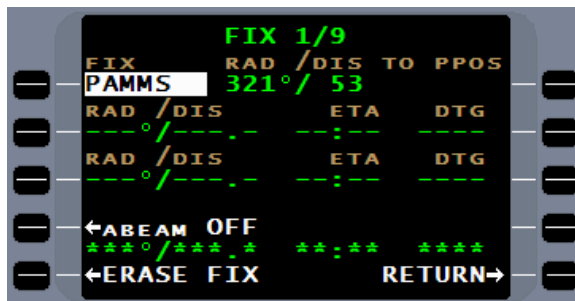
The FMS will present the **FIX 1/9** page. There are 9 duplicate pages allowing for 9 fixes. Entering the FIX for which you are to report abeam, the FMS will present the current radial and distance from that fix. At the bottom of the page is the calculated abeam point, with **ETA** (estimated time of arrival) and **DTG** (distance to go). The “ABEAM ON/OFF” option will turn off the abeam alert. “ERASE FIX” will clear the fix cursor field to allow entry of a new fix.



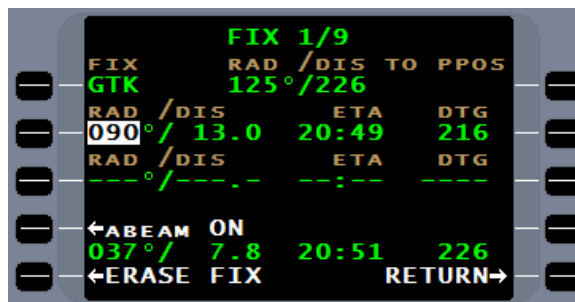
Following the line select key “ABEAM WAYPOINT ALERT” will be by either “ON” or “OFF”. With “ON” in view, 15 seconds before reaching the abeam point the FMS will present an ABEAM WAYPOINT ALERT message.



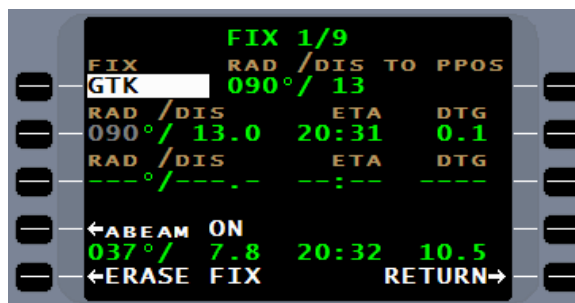
When past the abeam point, the abeam field will present "***".



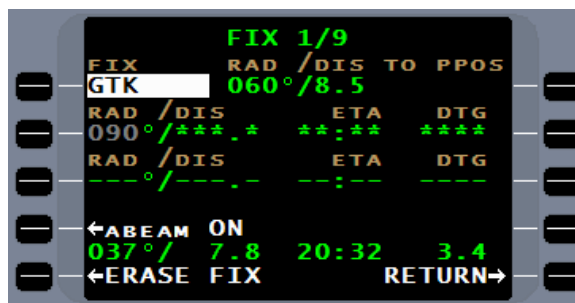
The **FIX** page can also calculate a distance, **ETA**, and **DTG** to a crossing radial from the fix.



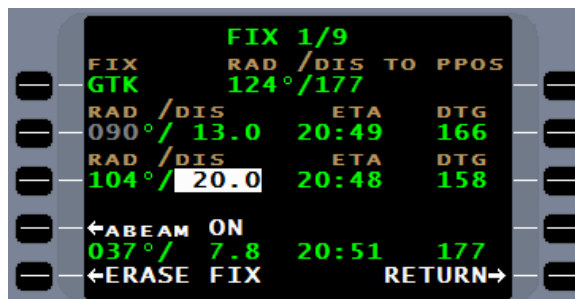
No message will be presented when the entered radial is crossed.



The fields will present "***" upon crossing the radial.



By entering a distance into the **DIS** field, the FMS will calculate the crossing radial for that distance. To get to the **DIS** field, press the adjacent line select key and press **ENTER**.

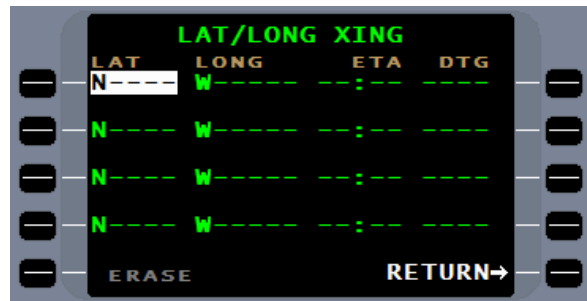


LATITUDE LONGITUDE CROSSING (LAT/LONG XING)

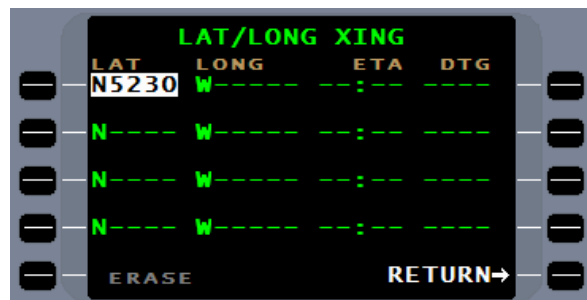
Selectable through the **NAV MENU** is a LAT/LONG XING feature that will alert the pilot when a desired latitude or longitude is being crossed.



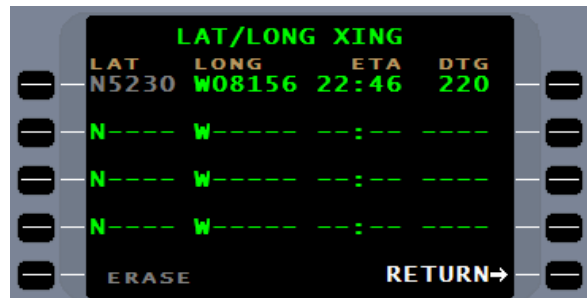
After pressing the LAT/LONG XING line select key, the **LAT/LONG XING** page will be displayed and the cursor will default to the first **LAT** field.



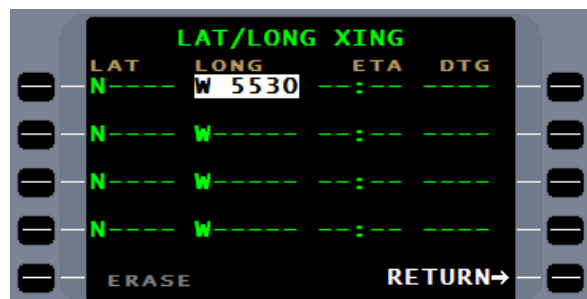
Enter the latitude in degrees and minutes...



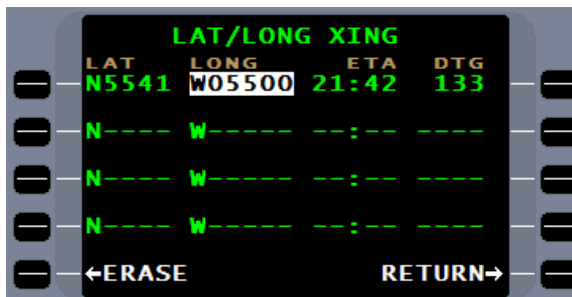
...and the FMS will calculate the longitude for the crossing waypoint. In addition, the FMS will calculate Estimated Time of Arrival (**ETA**) and Distance To Go (**DTG**).



With the cursor in the **LAT** field, pressing the **ENTER** key will move the cursor to the **LONG** field.



By entering the longitude the FMS will calculate the latitude, **ETA**, and **DTG**.

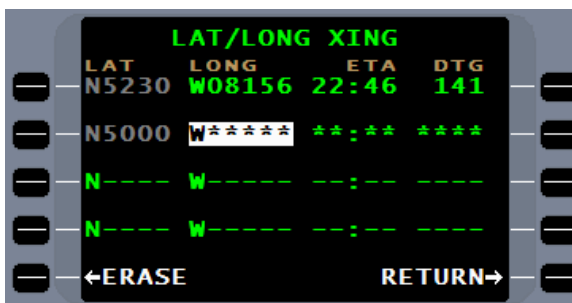


When within 15 seconds of the LAT/LONG waypoint, the FMS will present the message LAT/LONG XING WPT ALERT.



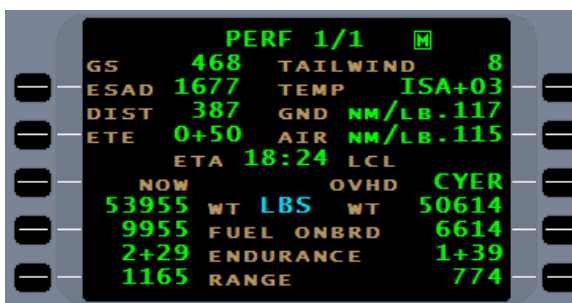
The entering of invalid data will result in the FMS being unable to calculate a waypoint.

The “ERASE” option will erase the line on which the cursor field is active.



CRUISE PERFORMANCE

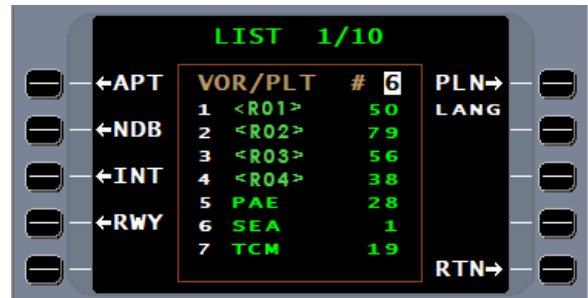
When airborne, by pressing the PERF line select key, the **PERF 1/1** page will provide a synopsis of inflight performance information found on the fuel and flightplan pages. Manual entries may not be made on this page.



NOTE: Aircraft with performance databases will have more than one **PERF** page, but page one will not change. Use of the performance database is covered later.

RADAR WAYPOINT ENTRIES

Radar waypoint entries may be made in the FMS. This requires an Avionics System with a Radar/MFD and FMS interface. When entered, radar waypoints will appear on the VOR/PLT waypoint list and the Direct To function may be used or waypoints may be added to the flightplan by way of the **[LIST]** key. Up to 25 waypoints may be entered and they will be identified as <R1> through <R25>. All radar waypoints are erased upon the next initialization. During DTO the last radar waypoint defined will be the first choice on the list.



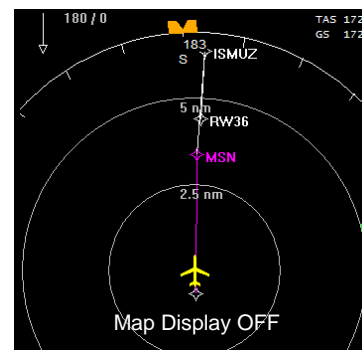
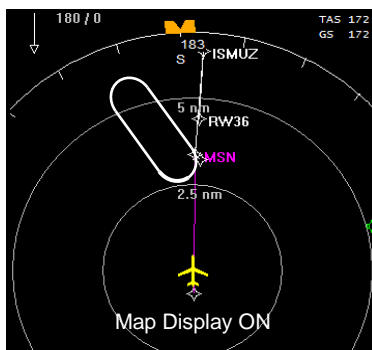
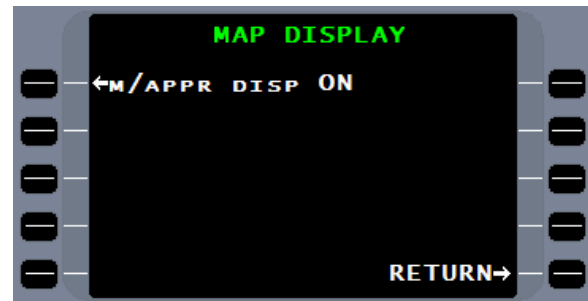
MAP DISPLAY & NAV DISPLAY

On the **NAV MENU** is the MAP DISPLAY option. This will allow the pilot to inhibit the display of the missed approach segment on the mapping mode of the pilot flight display or MFD. This will help declutter the map presentation when a missed approach procedure overlaps the approach inbound course.



The MAP DISPLAY will automatically turn on if any of the following occur:

1. Either the TO or the NX waypoint is a missed approach segment waypoint
2. The approach is cancelled prior to reaching the FAF
3. The approach is exited because of a manual leg change
4. A new approach is inserted into the flightplan

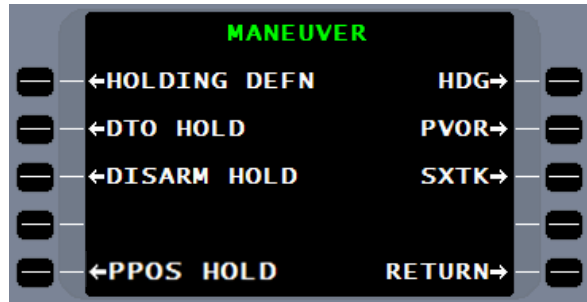


HOLDING PATTERNS

The FMS will define holding patterns, determine holding pattern entry procedures, and fly three types of holding patterns; hold to manual termination (HM), hold to fix (HF), and hold to altitude (HA). The FMS NAV database will include holding patterns required to complete the SID, STAR, or approach procedure. A pilot can only create an HM or hold until manually terminated pattern.

The automatic holding pattern feature of the FMS is accessed from the NAV page using the MNVR line select key.

The **MANEUVER** page allows access to select the HOLDING DEFN line select key.



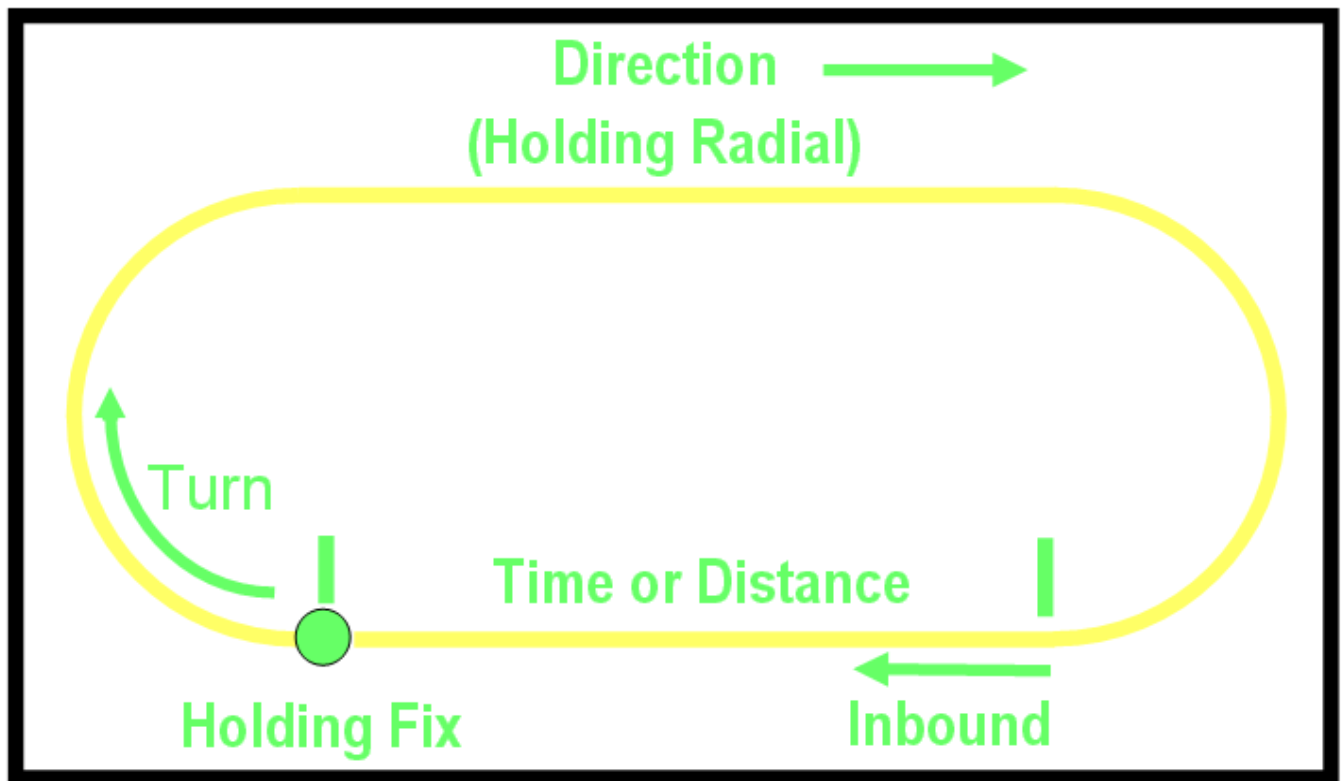
The **HOLDING** definition page will be displayed if the flightplan contains a holding plan. There is a published holding pattern shown at BASER intersection on the DINGO5 arrival chart, but since the holding procedure is not required to complete the STAR, it will not be found in the database. If there is a requirement to anticipate holding at BASER as published, the holding pattern must be defined in the FMS and entered into the flightplan. To build this holding pattern, first press the line select key adjacent to **FIX**, to enter **BASER** intersection.



If there is no holding pattern defined in the flightplan, the **HOLD FIX** page will be displayed in lieu of the **HOLDING** definition page. A waypoint can be entered into the **HOLD FIX** cursor field by direct type in, use of the LIST key, by selecting a waypoint from the flightplan list, or creating a pilot waypoint. A waypoint selected from the flightplan list will allow the holding pattern to be entered into the flightplan. Use the reference number for **BASER** to select it as the FIX on the HOLDING definition page.



Holding Patterns (RH)



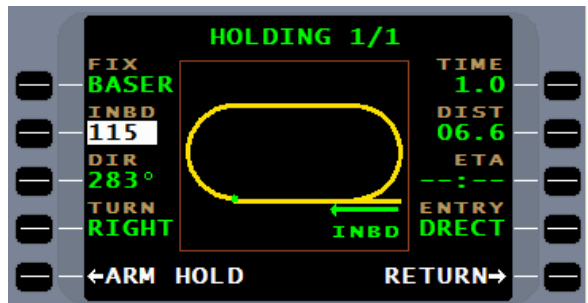
The FMS flies holding patterns according to TERPS procedures, but is accepted in countries using PANS-OPS procedures. The HOLDING definition diagram will define time or distance relative to the inbound leg. DIR is the direction of the outbound leg, but it is also the holding radial. The FMS will compensate for the effect of winds to fly the inbound leg according to the time or distance entered.

To fly holding patterns, the FMS uses in-flight winds. The vector trigonometry that the computer does is the classic wind triangle problem that can be done on an E6B computer. The track / ground speed vector is known from a succession of position fixes. The heading / TAS vector comes from the aircraft's heading source and air data systems. Any differences between heading TAS and track / ground speed are assumed to be wind.

To edit the holding pattern inbound radial (**INBD**), use the adjacent line select key to activate the field.



Press **ENTER** following the entry of the holding pattern inbound course. The cursor will advance to complete the editing.



The **DIR** field is the course outbound. If the clearance is to hold on a radial, the radial can be entered into the **DIR** field and the **INBD** field will be automatically calculated and entered.



The holding pattern turn direction may be changed by using the \pm key or entry of L or R key.



The cursor will automatically advance to **TIME**. Time is entered in minutes and tenths of a minute and will default to one minute.

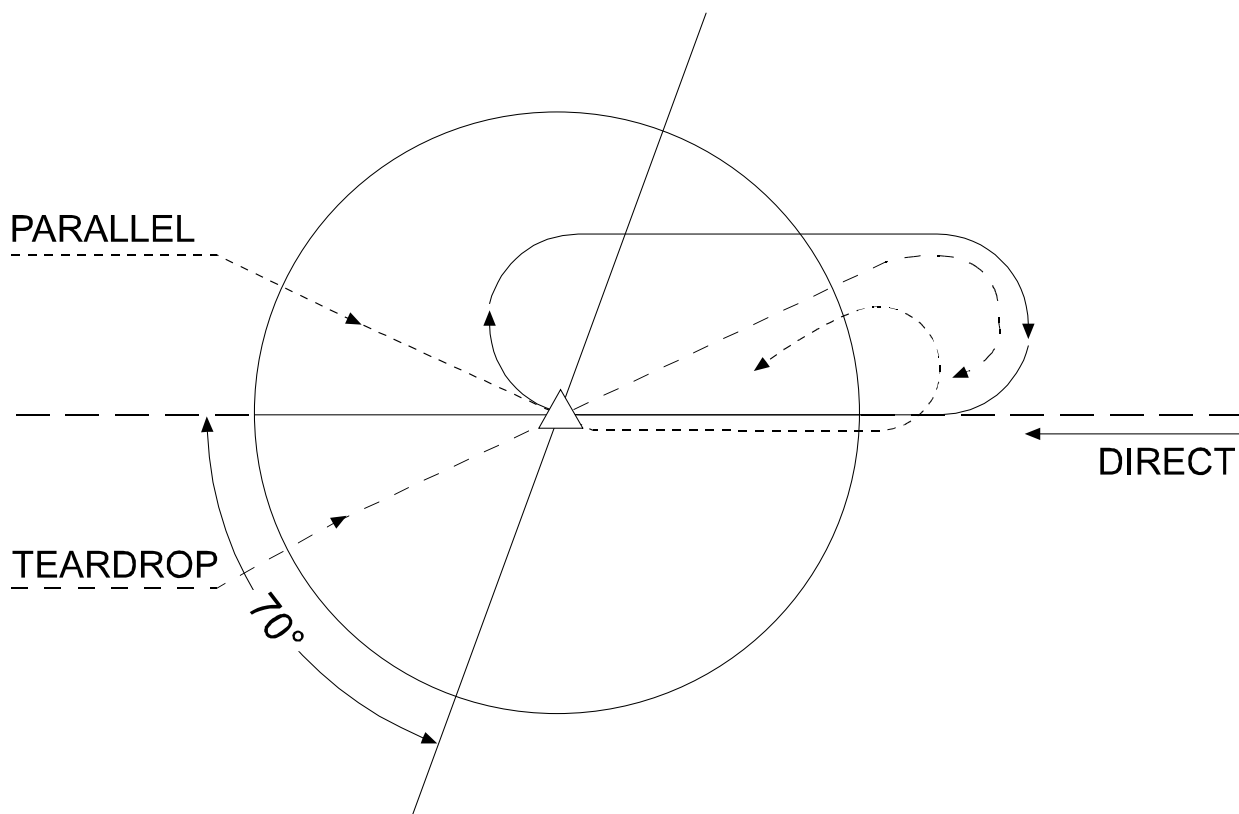


To enter a distance for the inbound leg requires manually selecting the **DIST** line select key. Distance for the inbound leg is entered in nautical miles and tenths of a nautical mile. When distance is selected, the diagram will show **DIST** for the inbound leg.



The entry procedure is calculated based on the navigational leg prior to the holding waypoint.

Depending on the inbound course to the hold, the FMS will enter the pattern using a direct, teardrop, or parallel entry, per standard procedure, as shown below:



A parallel or teardrop entry will recalculate from the lateral guidance legs when 15 seconds from the hold fix, in order to use the most current wind and ground speed. While in the holding pattern and 15 seconds from the hold fix, the next holding pattern is computed. PROCEED entered any time will take effect immediately and upon the passing of the holding fix the FMS will proceed to the next waypoint. If distance is used for leg determination and a teardrop entry is being made, the track out bound will be calculated to afford a continuous turn inbound to roll wings level on the inbound course.

Based on the dividing line between entry procedures, the FMS will allow a $\pm 20^\circ$ area where either entry may be used.



By pressing the **ENTYRY** line select key, an alternate entry procedure may be selected if available. If not with in the $\pm 20^\circ$ area, no option will be presented.



With the holding definition completed, it can be entered into the flightplan.



Pressing the ARM HOLD line select key will enter the holding definition into the flightplan.



A DTO HOLD option is presented and can be used to go present position direct to the holding entry waypoint.



The holding fix will be coded as overfly with the addition of the (*). The terminator for the holding pattern is (HOLD), which indicates it is a manually terminated holding pattern. The → indicates direction of turn, in this case, a right hand turn. HLD indicates it's a holding pattern and 115° indicates the inbound course.



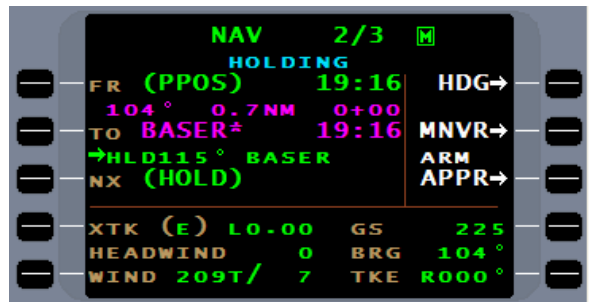
An off flightplan waypoint will present only a DTO HOLD option. The HOLDING page will retain the definition for the holding pattern if a nother page is selected, but if a new holding fix is selected, the current holding pattern definition will be lost.



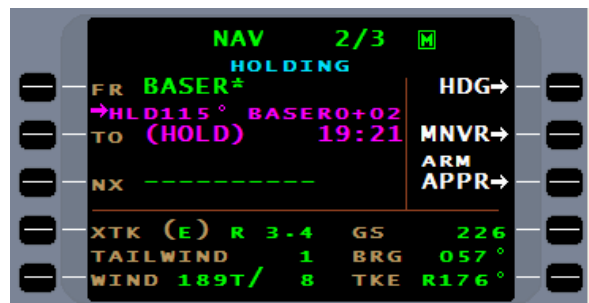
The NAV page will present **HOLD ARMED** when on the navigational leg prior to the holding fix.



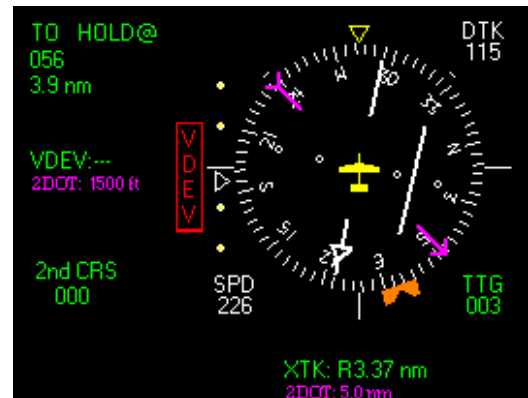
When within 15 seconds of crossing the holding fix, the FMS will present **HOLDING**. At this time the FMS holding definition is locked and the FMS has calculated the affect of wind. The pattern will be flown so as to fly the inbound leg according to the defined time or distance.



When the holding pattern is entered, the leg terminator **(HOLD)** will be the **TO** waypoint.



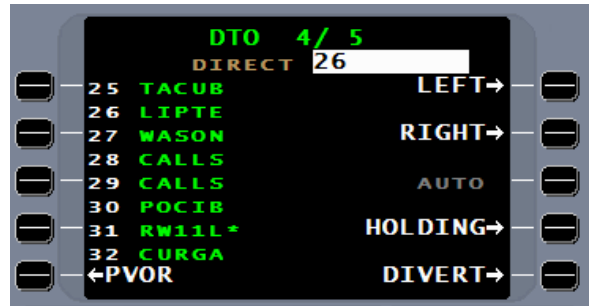
With the holding leg active, the HSI course arrow will define the holding pattern inbound leg, the milage window will be line of sight nautical miles to the holding fix, and the FMS bearing pointer will point to the holding waypoint.



With the aircraft established in holding, there are three ways to exit the holding pattern.



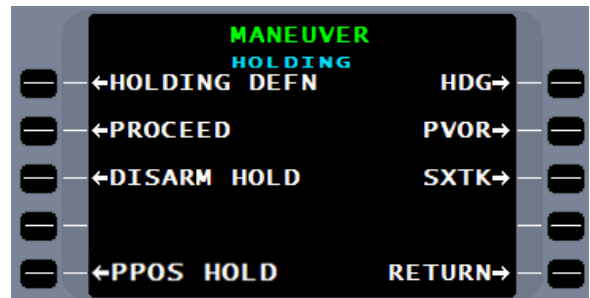
The direct to (D**T**O) function with the selection of a new waypoint will automatically cancel the holding pattern.



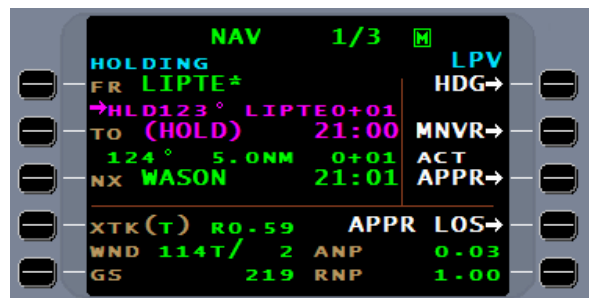
A manually terminated holding pattern with follow on waypoints can be exited by proceeding on course with the use of PROCEED. This is the second method of exiting a manually terminated holding pattern.



Under the M**A**NEUVER page is a PROCEED option that will, in effect, change the HM leg to an HF leg. Selecting PROCEED will also remove the holding pattern from the flightplan.



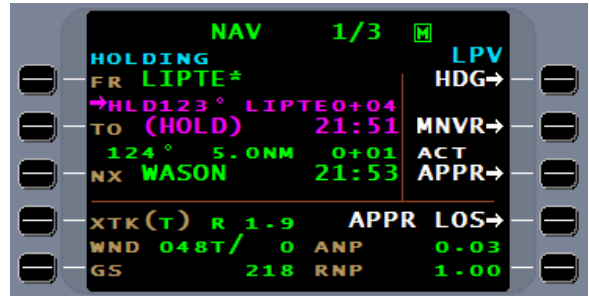
Selecting PROCEED will result in the aircraft finishing the holding pattern and upon crossing the holding fix the next time will result in the aircraft exiting the holding pattern and proceeding on course.



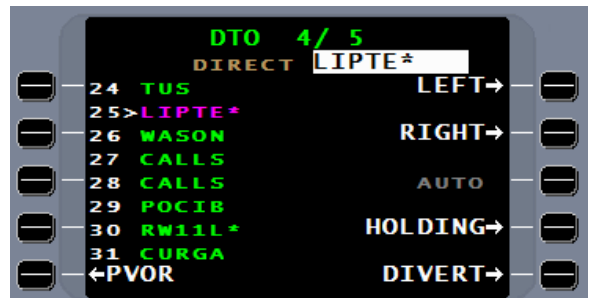
To terminate the holding pattern early, first select PROCEED.



As above, PROCEED will result in the FMS exiting the holding pattern upon crossing the holding fix.



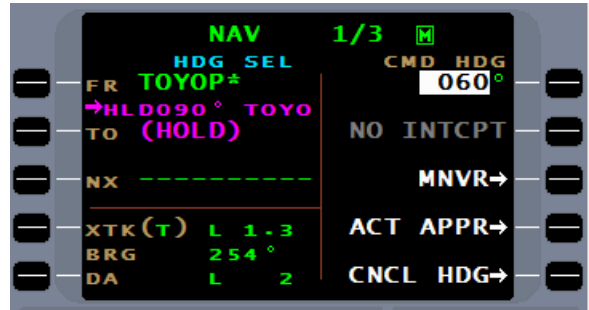
To initiate an early exit, use DTO to turn direct to the holding fix.



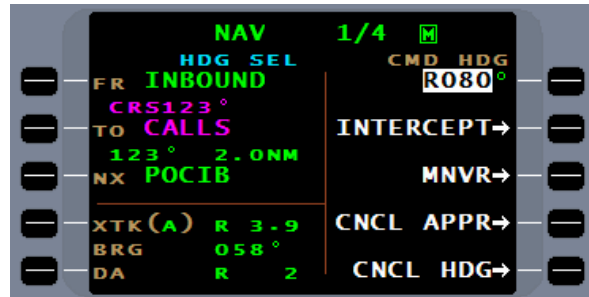
PROCEED will remove the holding pattern and upon crossing the holding fix, the aircraft will continue on course.



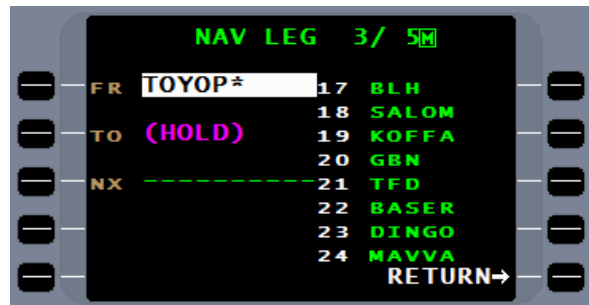
Radar vectors to either a manually activated approach or to a new manually selected NAV leg is the third way to exit a holding pattern.



Once the new heading is entered into the **CMD HDG** function, activate the approach.



To intercept a NAV leg, with the new heading active, manually select the new NAV leg using the manual leg change procedure.



To remove a holding pattern from the flightplan prior to reaching the hold, press the DISARM HOLD line select key. This will produce the HOLDING page with an option to DISARM HOLD.



Pressing the DISARM HOLD line select key will remove the holding pattern from the flightplan and the aircraft will continue on the flightplan.



The DISARM HOLD function will not remove the holding pattern if the FMS is committed to the holding pattern. The subheading **HOLDING** indicates the FMS is committed to holding.

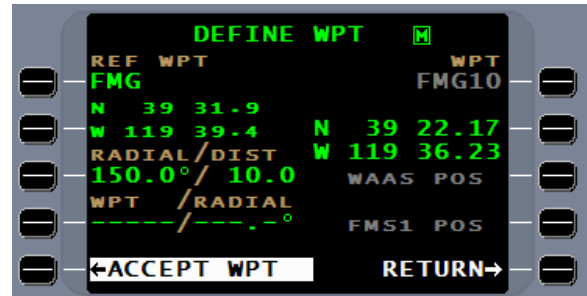


HOLDING WITH PILOT WAYPOINT

To hold at a non-database waypoint requires the creation of a pilot waypoint. Enter the name of the pilot waypoint; recommend the use of the ARINC waypoint naming convention presented in the pilot waypoint section of this manual.



Use one of the procedures described in the section on creating pilot waypoints to define the fix over which the aircraft will hold.



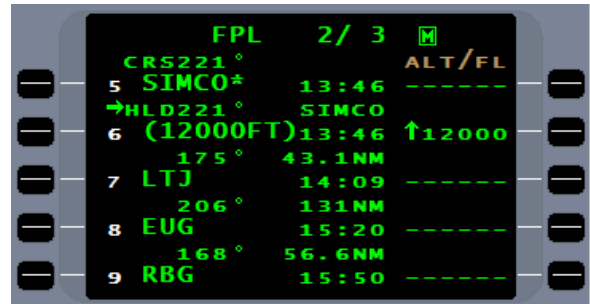
Once the fix is accepted, the FMS will return to the HOLDING 1/1 page to enable the pilot to complete the definition of the holding pattern.



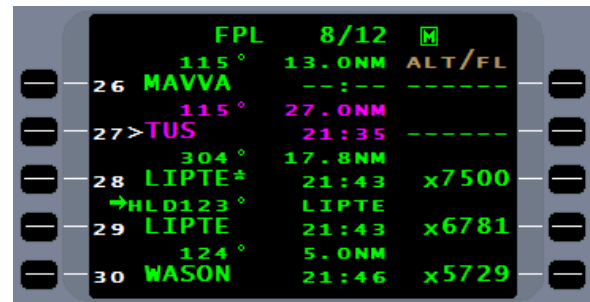
PROCEDURAL HOLDING PATTERNS

When holding patterns are part of a published procedure (SID, STAR or Approach) they are stored in the navigation database. By linking the procedure into the flightplan, any holding patterns that are part of the procedure are included at the designated holding fixes. Holding patterns are identified by ARINC 424 as HA, HF, and HM leg types. They are all defined in the same manner except for the type of leg terminator. The FMS will fly each of these legs as follows:

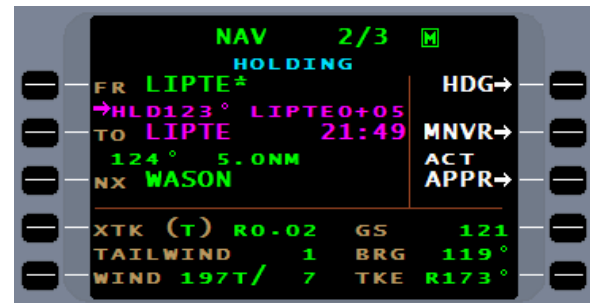
HA (Hold to an altitude terminator) - The aircraft will stay in the holding pattern until the specified altitude is reached, then a sequence to next leg will occur the next time the aircraft crosses the holding fix. HA type holding is generally found in a SID. To exit the holding pattern prior to reaching the termination altitude, use the PROCEED line select key on the MANEUVER page.



HF (Hold to a fix terminator) - The aircraft will sequence to the next leg after crossing the holding fix the second time. HF holding patterns are usually used as course reversals in lieu of procedure turns. The terminator is the second LIPTE. This leg type is easily identified by the same identifier being repeated with the hold path as the separator.



Once the aircraft has entered the HF pattern ...



...the FMS will present an option under the **MANEUVER** page to CONTINUE HOLD. This will, in effect, change the HF leg to an HM leg.



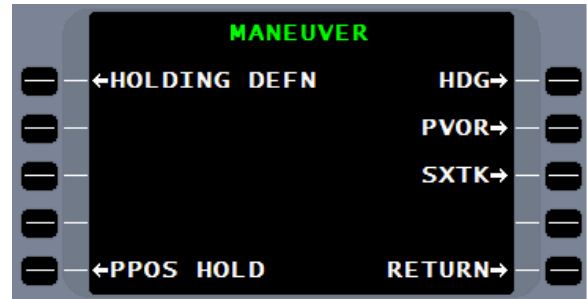
The normal way to exit the holding pattern when flying an approach transition, is to use the proceed option on the maneuver page.

To terminate the holding pattern early, first select PROCEED, and then DTO the holding fix. PROCEED will remove the holding pattern and upon crossing the holding fix, the aircraft will continue on course.



HOLD AT PRESENT POSITION

On the **MANEUVER** page, is the option PPOS HOLD.



Selection of this option will display the **HOLDING 1/1** definition page. A standard holding pattern will be defaulted onto the page with PPOS1 as the FIX and INBD the track of the aircraft. PPOS1 is a point 15 seconds ahead of the aircraft when DTO HOLD is pressed. The default holding pattern may be edited if necessary. Pressing DTO HOLD will result in the FMS commanding the aircraft to proceed to the defined holding pattern.



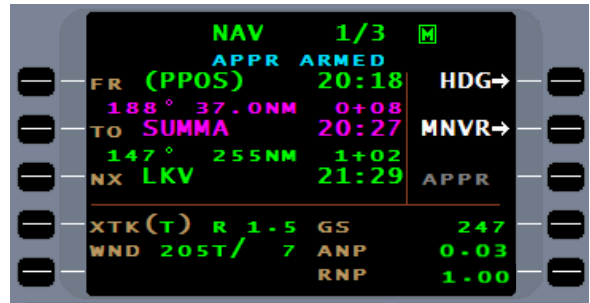
The first holding fix will be named PPOS1. Subsequent present position holding fixes will be named PPOS2, PPOS3, etc.; to a max of nine. The FMS power cycle will clear the holding waypoints for the next flight.



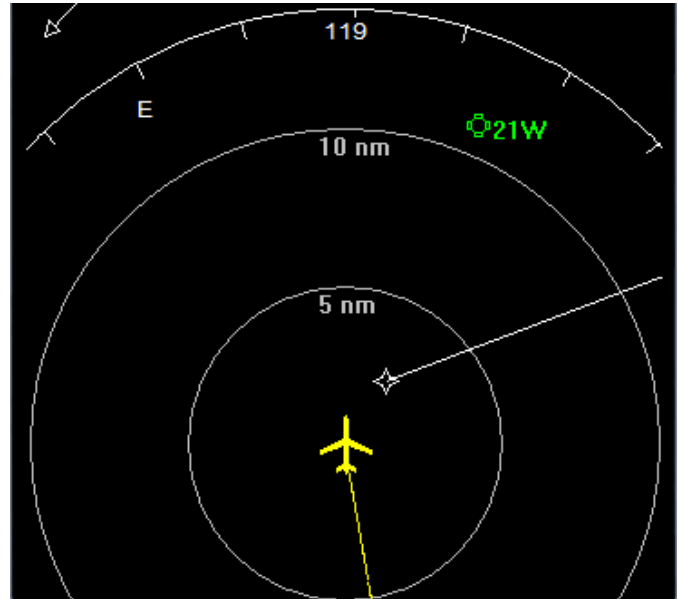
If PROCEED is used to exit the holding pattern, the FMS will prompt for the follow-on waypoint. It will not automatically select a point. With an approach in the flightplan and an ACT APPR line select key available, activating the approach will produce the approach inbound course and put the FMS in CMD HDG mode with the current heading of the aircraft being used as the command heading. See approach operations for more information.



With a direct to procedure, the FMS will calculate **(PPOS)**, present position, and then calculate a TF or Track to Fix leg to the **“TO”** waypoint.

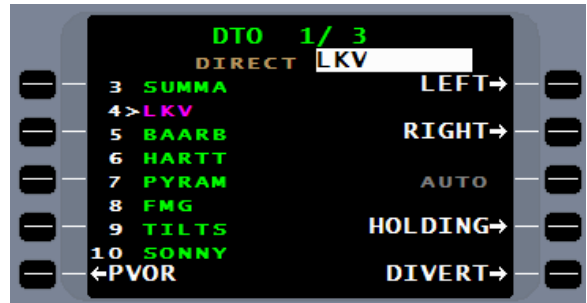


The PPOS is calculated at a point where the aircraft is estimated to complete the turn on a heading that will proceed direct to the select waypoint. The PPOS will be displayed on a MAP, indicating the point at which the FMS has estimated the aircraft will complete the turn.

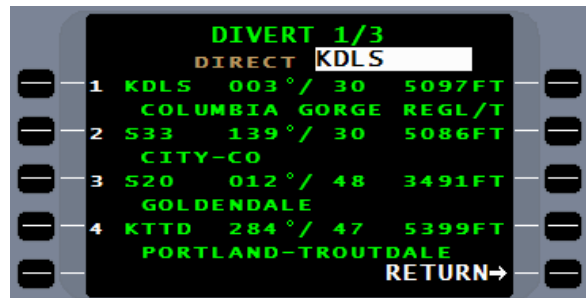


EMERGENCY DIVERT

From the DTO page, line select key 5R offers DIVERT.



When selected, the divert option will present three pages showing the twelve nearest airports. Included is the dynamically calculated bearing and distance to that airport, the length of the longest runway, and the airport name.



Entering the identifier or the reference number will produce a direct to NAV leg. This airport identifier will automatically be added to the end of the flightplan for quick addition of an FMS approach.



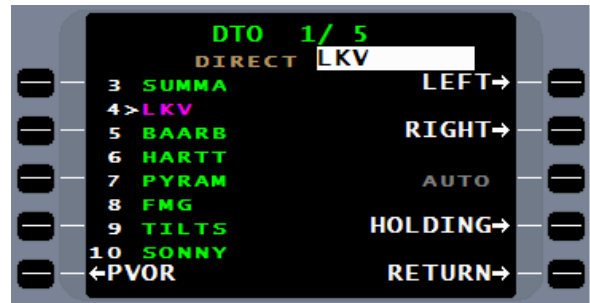
AREA NAVIGATION (RNAV) WITH DIRECT TO

The FMS is capable of navigating to any point that is defined or can be defined. The DTO or direct to function can be used for Area Navigation (RNAV).

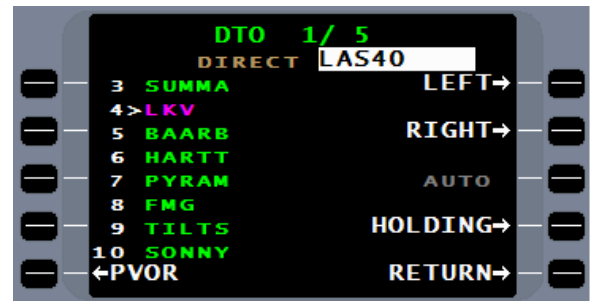
Pressing the DTO key displays the standard **DTO** page.

The FMS is capable of navigating to any point that is defined or can be defined. The DTO or direct to function can be used for area navigation (RNAV).

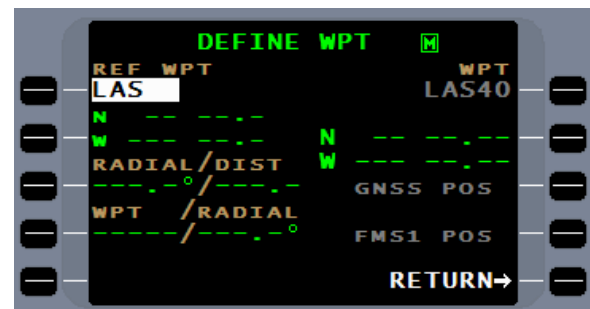
Pressing the DTO key displays the standard DTO page with the TO waypoint as the default in the cursor field.



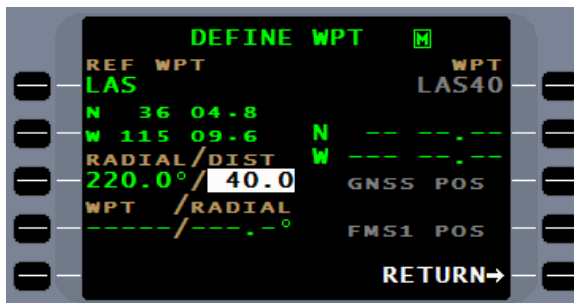
The random waypoint is the LAS 220 radial at 40nm. Using the ARINC 424 naming convention, the waypoint LAS40 is entered into the cursor. If the name LAS40 is in use, modify it slightly to a waypoint name that is not in use.



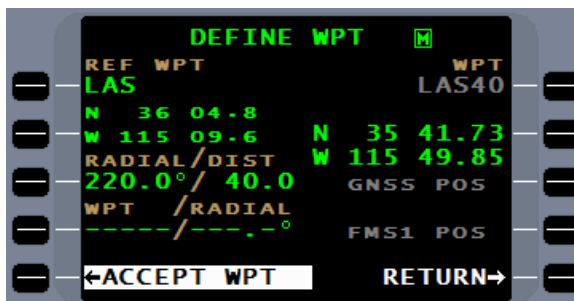
Press the **ENTER** key and the **DEFINE WPT** page is displayed. Since the random or pilot created waypoint is defined relative to LAS, LAS is entered into the **REF WPT** cursor field.



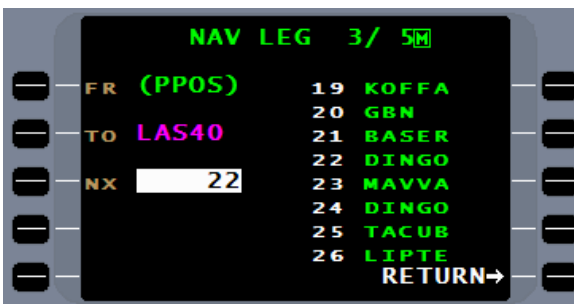
Enter 220.0 and 40.0nm to define the new waypoint. The **ENTER** key will move the cursor from **RADIAL** to **DIST**.



Pressing the ACCEPT WPT line select key will move to a page that prompts for the next waypoint. To make this waypoint a Tactical waypoint, press **MENU** and select TACT.



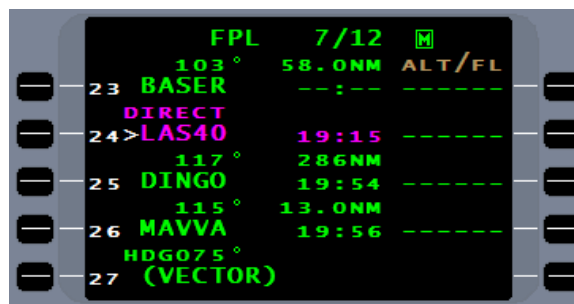
Select the NX waypoint and press **ENTER**. If no NX waypoint is selected, the flightplan will become unlinked from the NAV page.



The **NAV 1/3** is now displayed with the FMS directing the aircraft from **(PPOS)** present position direct to **LAS40** with **DINGO** as the **NX** waypoint.



Any "TO" waypoint that is followed with a "NX" waypoint is "linked" to the flightplan and will appear on the FPL pages prior to the "NX" waypoint.



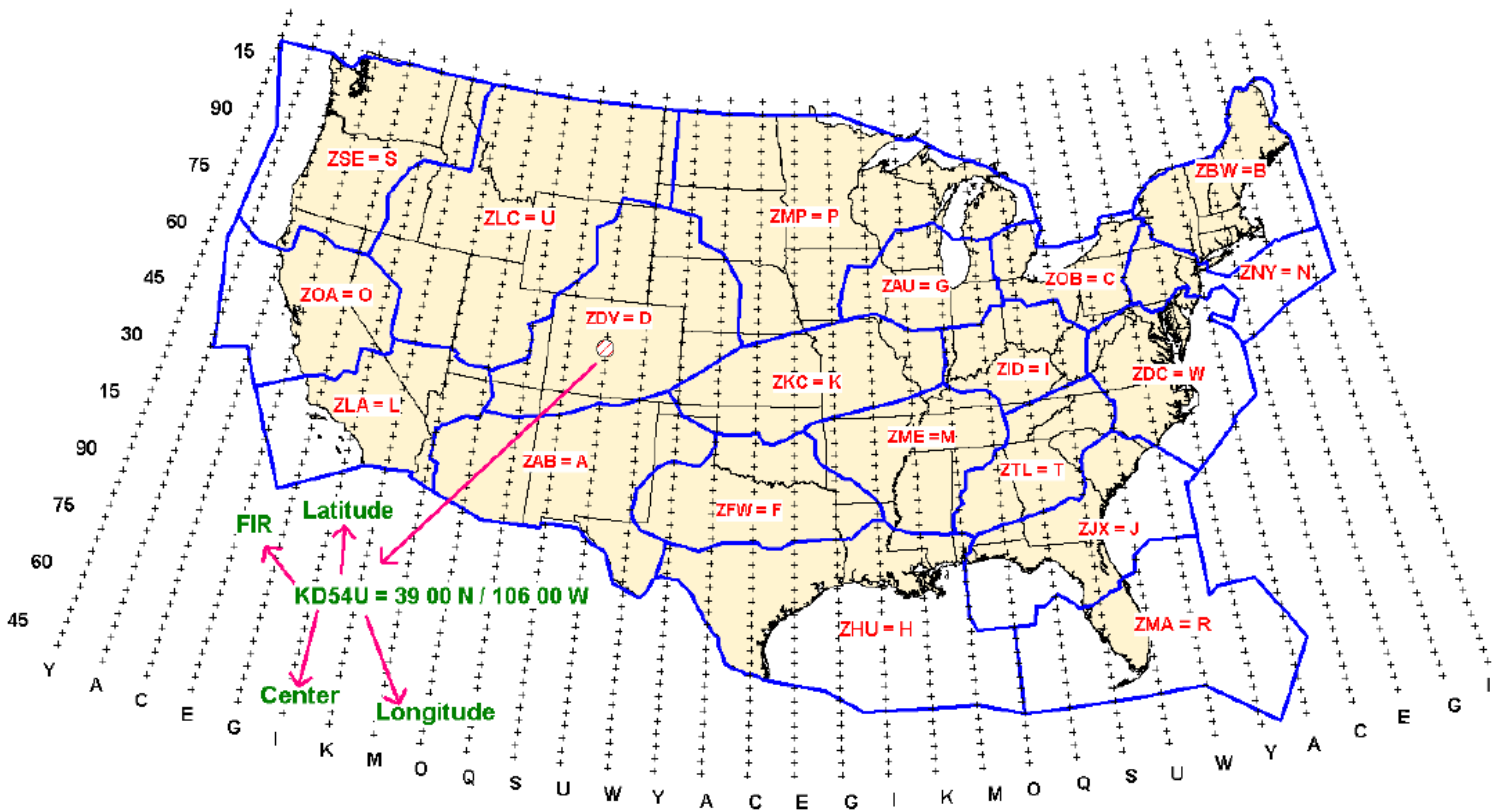
NAVIGATION REFERENCE SYSTEM

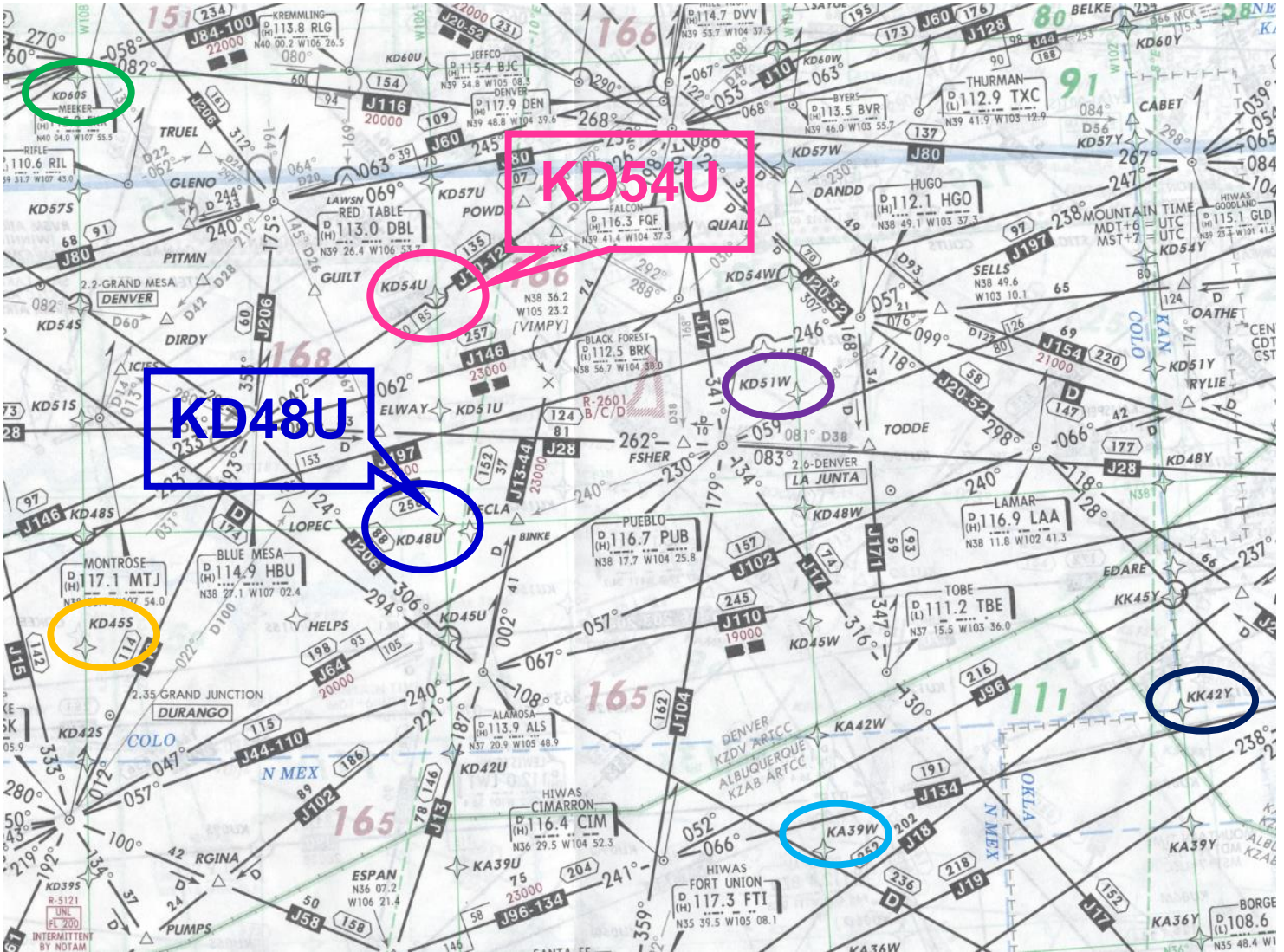
By definition, aircraft navigating by IFR approved GPS are considered to be area navigation (RNAV) aircraft and have special equipment suffixes. Most aircraft using Universal Avionics FMS have IFR approved installations and, therefore, fall under the above definition. The FAA High Altitude Airspace Redesign (AC 90-99) uses the Navigation Reference System (NRS) of waypoints enabling capable aircraft to fly point-to-point navigation or RNAV.

The waypoints defined under the Navigation Reference System are included in the SCN 100X/110X navigation database.

Navigation Reference System

Waypoints every 30 minutes of latitude and every 2 degrees of longitude
(Grid origin is at the Equator south of Greenwich, England)





NRS waypoints are entered manually by typing in the waypoint identifier, pressing the **ENTER** key, verifying, and accepting it. They can also be found by selecting **LIST** under INT (intersections). Refer to appropriate FAA documentation for further guidance on using the Navigation Reference System.

	FPL	3/ 6	M
	111°	130NM	ALT/FL
9	KS06I	248NM	-----
	118°	-----	-----
10	KU78M	472NM	-----
	112°	-----	-----
11	KD48U	112NM	-----
	111°	-----	-----
12	KA42W	153NM	-----
	124°	-----	-----
13	PNH	-----	-----

VERTICAL NAVIGATION OPERATIONS

Six waypoints are available under the VNAV function and additional waypoints are available through the flightplan pages. Descent through a holding pattern and enhanced VNAV interface between enroute and approach are available. The VNAV page will display the vertical speeds required based on present ground speed to obtain the target altitudes at the VNAV waypoints. When a target vertical speed is entered, it will also display Top Of Decent (TOD) with distance and time to top of decent and Flight Path Angle (FPA).

Aircraft deviation from the vertical flight path is output to the flight guidance system vertical deviation indicator (VDI). Scaling of the VDI is EFIS and phase of flight specific.

Enroute VNAV profiles may be flown on many aircraft while coupled to the Flight Guidance System (FGS). The FMS computes a Vertical Pitch Command that is recognized when VNAV is selected on the FGS Mode Select Panel.

The VNAV mode will be exited and all vertical waypoints will be canceled if any of the following conditions occur while in the VNAV mode:

- ADC altitude becomes invalid
- ADC altitude is not baro-corrected below 18,000 feet
- ADC is deselected
- A manual altitude is entered
- POSITION UNCERTAIN message appears
- Selected Crosstrack Mode is activated
- Cancel VNAV line select key is activated
- Crosstrack deviation becomes greater than 12.5nm
- Enroute FPL gap is encountered
- Enroute/Approach VNAV waypoint gap is encountered
- A valid vertical leg does not exist after sequencing a Hold Fix

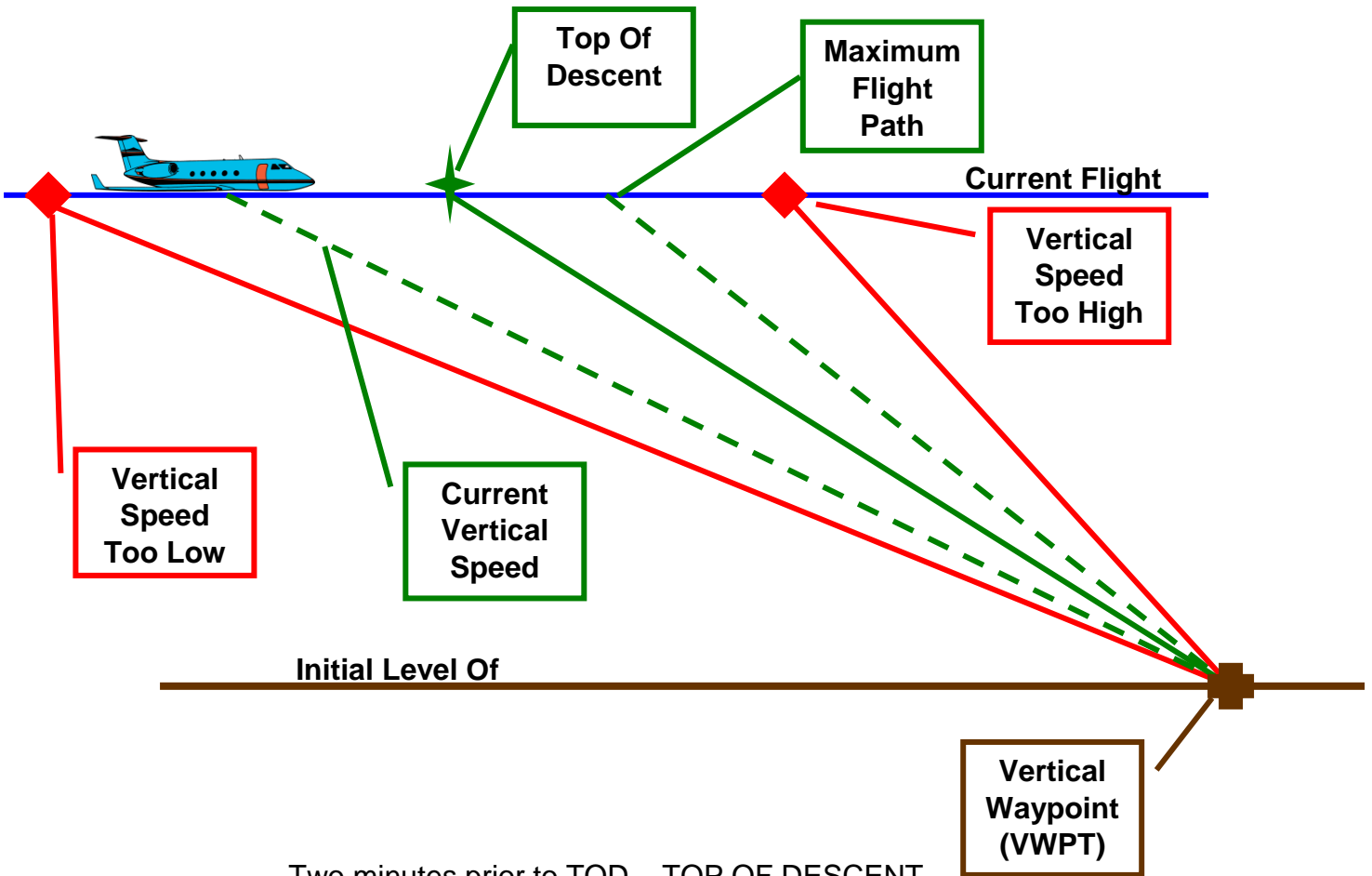
If any of the above occurs prior to entering a VNAV leg, the VNAV page will not be canceled and the VNAV data on the page may be used for planning purposes.

Should any target vertical speed value be rejected, a message will be displayed at the top of the path VNAV page giving the reason.

VNAV provides for a complete overfly of the descent waypoint prior to descent and a level off prior to the level off waypoint.

VERTICAL NAVIGATION

TOP OF DESCENT (TOD)

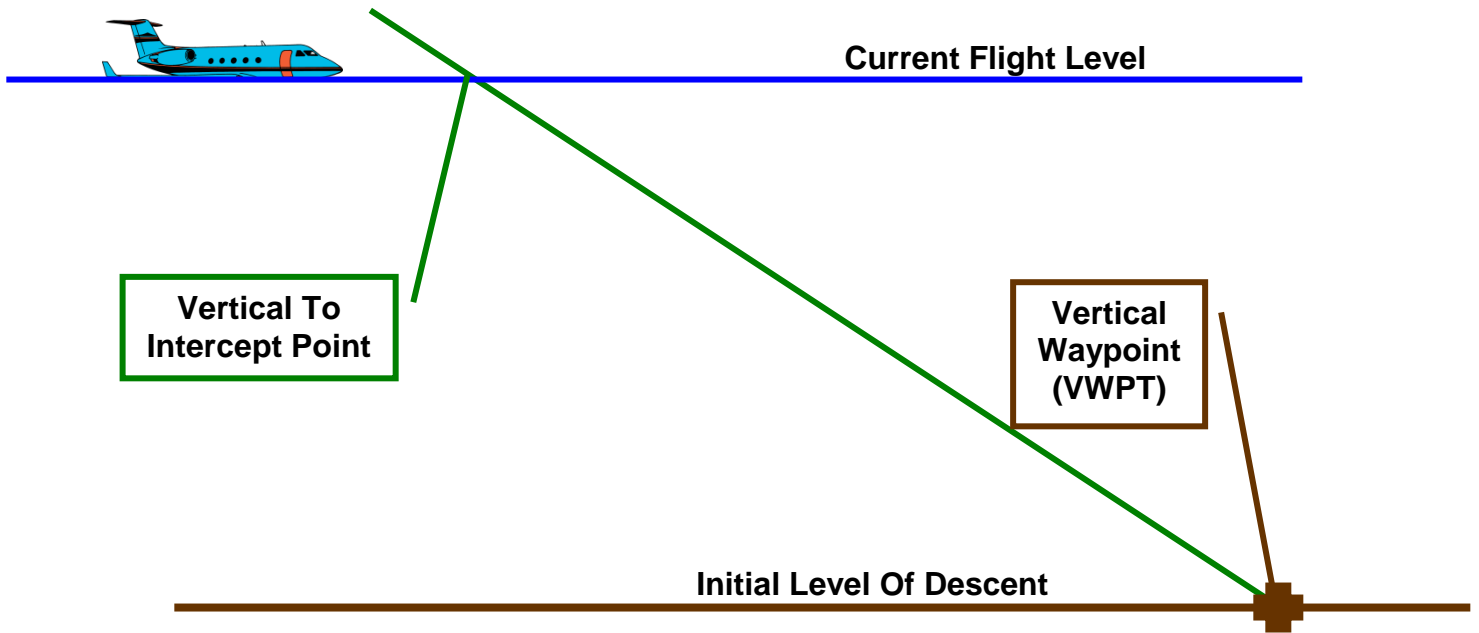


Two minutes prior to TOD – TOP OF DESCENT

Fifteen seconds to TOD – VPATH CAPTURE

Fifteen seconds to VWPT – VERTICAL WAYPOINT ALERT

VERTICAL TO (VTO)



“Vertical To” intercept point ahead of aircraft to allow ease of capture
Fifteen seconds to VWPT – VERTICAL WAYPOINT ALERT
Level Off calculated to be level prior to VWPT

VNAV ERROR MESSAGES

The following error messages will appear on the VNAV page whenever an invalid entry is made in the TGT V/S or altitude data fields.

ADC ALT INVAL – 1 Aircraft altitude is < FL 180 and only pressure altitude is available, or
2 ADC altitude is failed

APPR ALT – RESTR – An altitude entry for an approach waypoint that violates the database constraints is entered

CLEAR MAN ALT – A manual entry for altitude was made on the ADC status page

CLR SXTK – Aircraft is flying a selected crosstrack distance prior to VNAV activation

CLR XFIL ALT – A VNAV plan is defined, but crossfilled altitude is being used by the system

FPA TOO STEEP – Flight path angle is steeper than maximum FPA configured at time of installation

LEG RESTRICTION – Entry is attempted when the active vertical leg is a GAP, HA, FA, CA, VA, HM, HF, or PI leg that does not have an altitude constraint

LINK NAV/FPL – VNAV distance is invalid because the VNAV plan is not linked to the guidance legs

NO CLIMB VTO – The FMS does not permit a VTO procedure that results in a climb.

NO ENTRY – APPR – Entry is attempted for an approach waypoint when the approach is active

NO ENTRY – HOLD – Entry is attempted during an active vertical holding leg

NO ENTRY – VERT – Entry is attempted when the aircraft is in active VM or FM leg

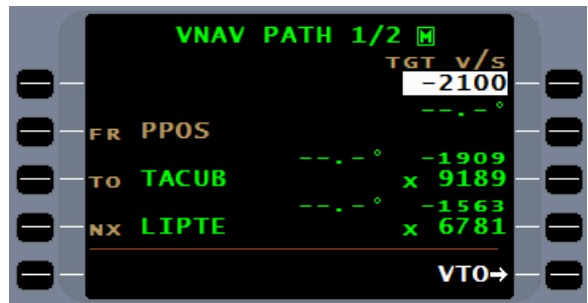
NO VWPT ALT – VNAV distance is invalid because the VNAV TO waypoint is undefined

TARGET V/S HIGH – Value exceeds 6000 fpm or maximum flight path angle programmed in configuration module.

TARGET V/S LOW – Entered value is less than minimum required value

XTK TOO GREAT – Current crosstrack is > 12.5nm.

Press **VNAV** to display the VNAV definition page. The cursor will default to the TGT V/S line.



To create a Top of Descent point (TOD), first determine a bottom of descent and altitude. Then press the line select key for the VNAV **TO** waypoint and select the bottom of descent point from the list.

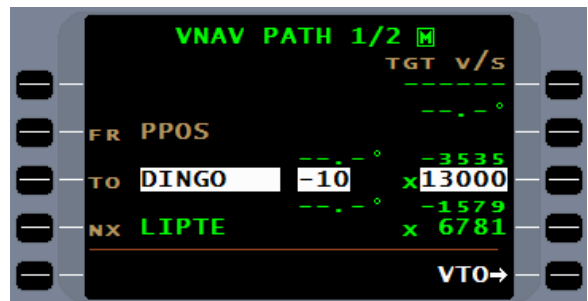
Select the reference number for the desired waypoint from the list, and press **ENTER**.



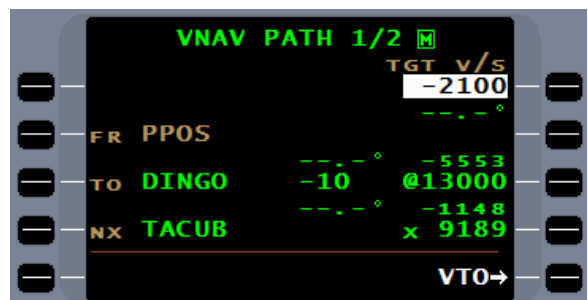
The cursor remains over the waypoint to allow an offset to be entered, if desired. This will move the vertical waypoint. With “ - ” the waypoint is moved to a point prior to the FIX and with the “ + ” the waypoint is moved after the FIX. The **±** key toggles the “ + ” and “ - ”.



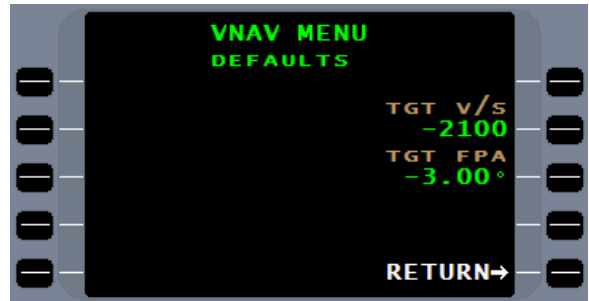
Press **ENTER** and the cursor will move to the altitude entry field. ALT field entries can either be in altitude or flight level. If 4 or 5 digits are entered, the entry will be interpreted as an altitude. If 2 or 3 digits are entered, the entry will be interpreted as a flight level and, once the **ENTER** key is pressed, the letters “FL” will be inserted ahead of the digits. To enter 850 feet, it must be entered as 0850 or the FMS will consider it a flight level.



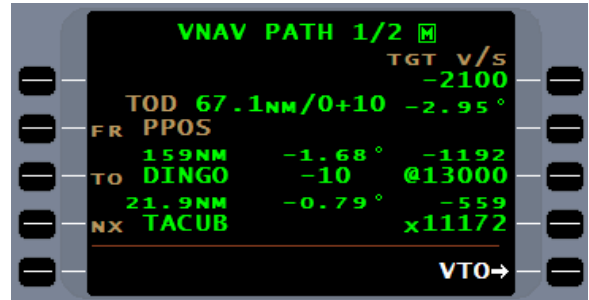
Press **ENTER** and the cursor will move to the TGT V/S field. The target vertical speed calculation is used for the first VNAV leg from the top of descent to the first VNAV waypoint.



A VNAV MENU allows for creating a DEFAULT TGT V/S. The TGT V/S can be changed as desired on the VNAV PATH page without affecting the default value. The TGT FPA field is used for interface between the enroute VNAV and approach VNAV and is covered later.



The distance and time are computed to the TOD and the FPA of -2.95° will be displayed. Once the FPA is calculated it becomes the criteria for the descent. Changes in ground speed will result in the TGT V/S changing in order to fly the FPA.

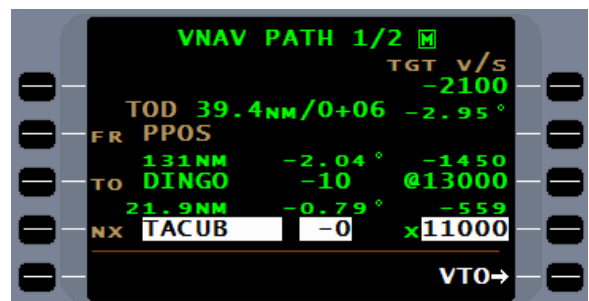


A holding pattern entered in the flightplan between the aircraft and the TOD will result in cancelation of the TOD calculation. An attempt to reenter the TOD information will result in a LEG RESRICTION message being presented. No TOD calculation can be made until the aircraft is past the holding pattern or the holding pattern is removed from the flightplan.

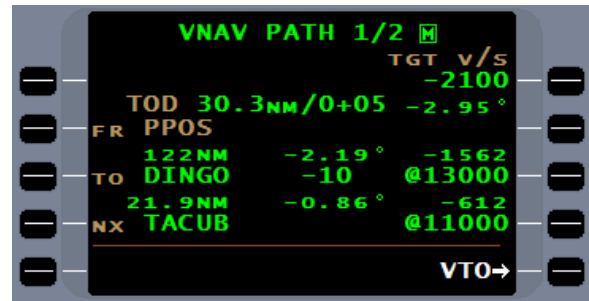
To create a vertical profile by entering followon waypoints, start by pressing the **NX** line select key. Additional vertical waypoints are created by using the line select keys following the **NX** line select key and on page 2.



Enter the reference number for the next waypoint and press **ENTER**. Complete the field entries in the same manner as in creating the TOD.



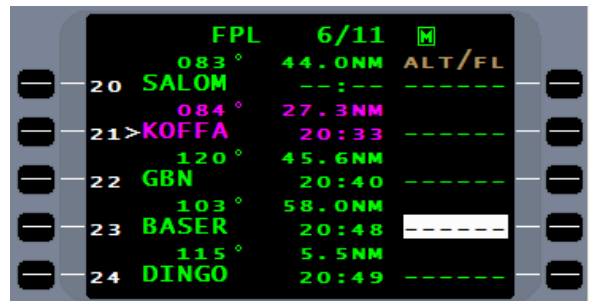
Distance, FPA (flight path angle), and VSR (vertical speed required) have been calculated between the TO VNAV waypoint and the NX VNAV waypoint



A total of 6 VNAV waypoints can be created in the VNAV pages. Two on page 1 and four on page 2. The CNCL VNV (cancel VNAV) line select key is available on page 1 and 2.



Direct entry of VNAV altitudes may be made in the flightplan. Adjacent to the flightplan waypoints are dashed lines that can be selected by the adjacent line select key for entry of an @ altitude or flight level. Waypoints selected and their altitudes will automatically appear on the VNAV page.

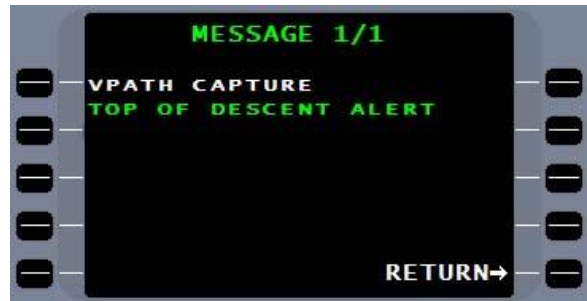


Two minutes prior to the TOD, the “TOP OF DESCENT ALERT” message will appear and remain on the message page until passing TOD.



NOTE: For aircraft with flight guidance capable of coupling to the FMS VNAV, to capture FMS VNAV the pilot must first acknowledge the TOP OF DESCENT ALERT message, and then arm flight guidance VNAV.

Fifteen seconds prior to the TOD, a VPATH CAPTURE message will appear indicating capture of the vertical path.



Fifteen seconds prior to a vertical waypoint (not the TOD) the VERTICAL WPT ALERT message will be presented.



VDEV and an indication of deviation, in feet, above or below the programmed flight path will replace the TOD. The HSI vertical deviation indicator will display this deviation if the aircraft is capable. Vertical steering signals will be provided to a compatible Flight Guidance System (FGS).

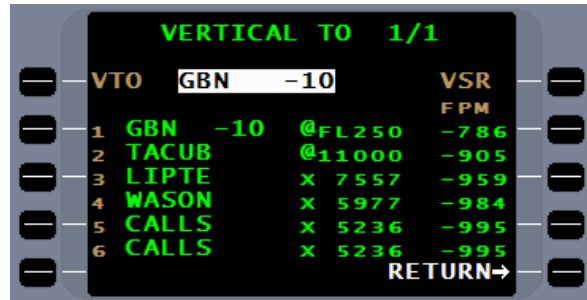


VERTICAL DIRECT TO (VTO)

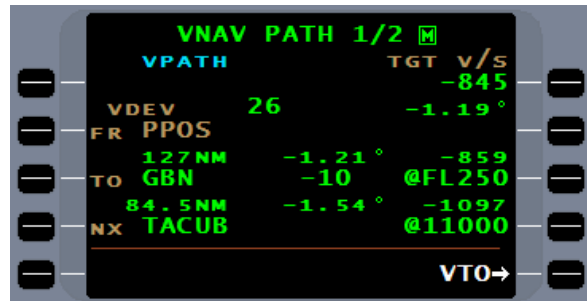
To access the Vertical Direct To mode on the VNAV PATH page, press the VTO line select key. This mode allows for creating an immediate descent FPA to a vertical waypoint. If the VNAV waypoint has not been previously created, create the VNAV waypoint by pressing the VNAV “TO” line select key and define the point.



The VERTICAL TO list page will display a listing of all defined VNAV waypoints. Enter the reference number of the desired waypoint in the cursor field to proceed vertically direct to the VNAV waypoint. After **ENTER** is pressed the display will change back to the VNAV descent page.



The TGT V/S will be the vertical speed required that is displayed when VTO was selected. The VTO line select key is still available to establish a new vertical clearance.



Using DTO or the DTO Holding Fix feature will not cancel the VNAV mode for waypoints prior to TOD.

Pressing the CNCL VNAV line select key on VNAV PATH at any time will cause the mode to cancel and VNAV displays will go invalid. To continue the descent simply press VTO line select key then the **ENTER** key.



CAUTION: Once a descent is commenced, entering a higher TGT V/S to comply with a “best rate” clearance from ATC may result in the aircraft leveling off and proceeding to a newly computed TOD and FPA based on the higher descent rate. If ATC request a “best rate” descent, **DO NOT** use FMS VNAV.

VNAV DESCENT IN HOLDING

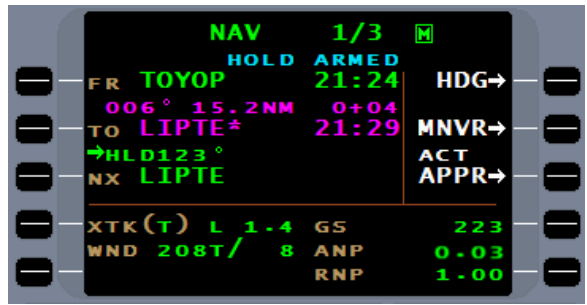
When a holding pattern is inserted into a flightplan, a holding pattern entry altitude may be programmed at the holding fix. VNAV descent to the holding point entry altitude, prior to entering the hold, may be performed by creating a TOD or by using VTO as with any enroute waypoint.

Once a holding pattern is programmed and armed, a (HOLD) waypoint field will be inserted into the flightplan. To descend during the holding pattern, a (HOLD) altitude must be programmed for this waypoint in the altitude field of the FPL or VNAV page that is lower than the Holding pattern entry altitude. This allows descending to the holding fix with VNAV active and descending to a lower altitude during the hold. Since the holding pattern legs may vary due to wind and changing airspeeds, a fixed VPATH calculation to the lower altitude is impractical. The lower holding pattern altitude will represent a level VNAV path and the initial vertical deviation in the hold will equal the difference between the entry altitude and the holding descent altitude. Depending on the vertical scaling of the particular indicator or EFIS, this may result in a full scale down deflection of the VDEV indicator when the difference between entry altitude and the lower (HOLD) @ altitude exceeds the scale of the display. Vertical Deviation Scaling (feet per dot) is determined by the display device and may be different for enroute, terminal, and approach modes. Consult the Aircraft Flight Manual or Supplement for the specific scaling. As the aircraft descends during the hold to the (HOLD) @ altitude, the deviation will decrease to centered deviation when reaching the level VPATH of the (HOLD) altitude.

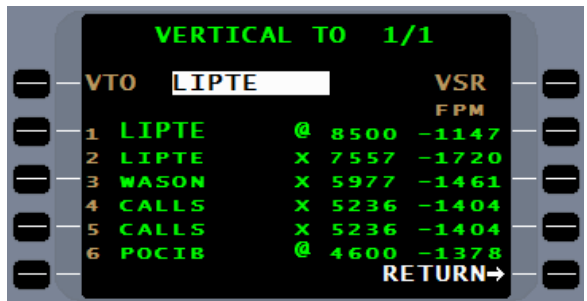
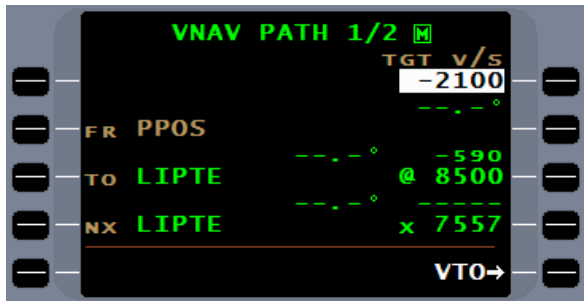
In installations that provide coupled VNAV enroute operations, the FMS will provide vertical steering to the entry altitude and subsequent vertical steering in the hold at a constant vertical speed of approximately 650 feet per minute. Pitch steering commands to Flight Guidance Systems with coupled VNAV will provide smooth transitions during the hold entry to hold descent path change and level off commands when the lower altitude is reached.

CAUTION: In installations that do not provide coupled enroute VNAV or when pilots choose not to use coupled enroute VNAV, but are provided VDEV displays, the pilot must use great care to avoid excessive descent rates caused by trying to push the nose of the aircraft over in an attempt to center the vertical deviation indicator (VDI). Recommend disregarding the VDI when using a manual descent or use vertical flight guidance mode; selecting either VS or IAS as appropriate to descend to the holding altitude.

To descend in holding, first create the holding pattern or use holding pattern from the NAV database. A holding pattern cannot be created in an active VNAV leg. At the (HOLD) waypoint enter the desired altitude. The altitude must be equal to or less than the hold entry altitude.

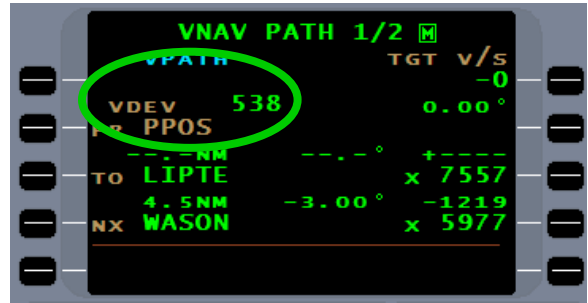


To activate the VNAV leg during the hold, the vertical entry of the holding pattern must be via an active VNAV leg. In other words, by either a VTO to the holding entry waypoint or TOD VNAV leg that goes to the holding entry waypoint, VNAV must be active prior to entering the holding pattern. If you're entering the holding pattern at your current altitude, then starting the descent once established in holding, use the VTO function and initiate a level VTO VNAV leg to the holding entry waypoint.

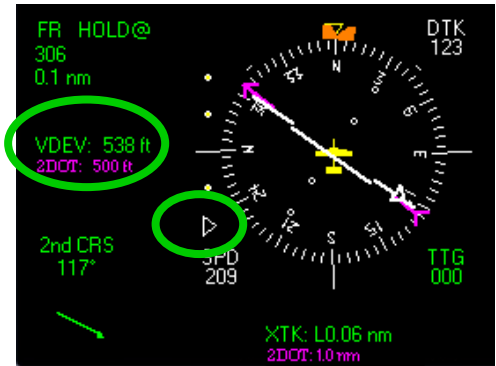


VNAV cannot be initiated if the aircraft is established in holding; a pilot controlled descent must be used. Once the aircraft exits the holding pattern a TOD NAV leg or VTO NAV leg may be initiated.

Once in the holding pattern the VNAV page will show the aircraft in a descent. The VDEV will represent the altitude remaining during the descent and will indicate "0" once the altitude has been reached.



The Vertical Deviation Indicator (VDI) of the pilot's flight display will show the bottom of the descent and will center when the aircraft reaches that altitude. The FMS will command to the flight director and autopilot to descend at approximately 650 feet per minute rate of descent. The pilot must follow the flight director or use the autopilot VNAV during this operation. To follow the VDI will result in an excessive rate of descent. For advisory VNAV, the pilot should use the flight director with vertical speed selected and the altitude select set to the final holding pattern altitude.



During the holding descent the NAV page will show the aircraft in holding, but will not indicate that VNAV is active.

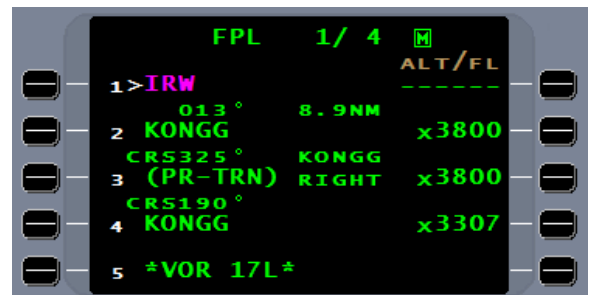


VNAV DESCENT DURING A PROCEDURE TURN

SCN 1000/1100 will calculate the vertical profile based on the default target flightpath angle on the VNAV menu. The descent during the procedure turn will not violate any altitude restrictions by placing the VNAV procedure turn waypoint at the intercept point of the inbound course. The termination altitude will be in line with the approach glidepath altitude at the FACF.



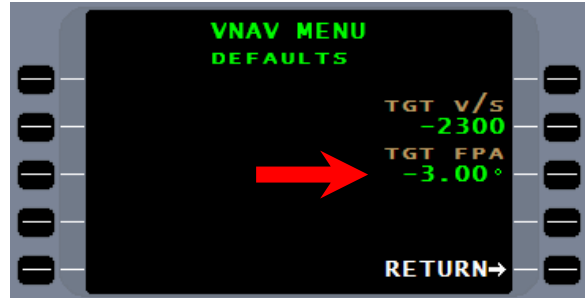
SCN 1001/1101 and subsequent will use the charted procedure turn altitudes from the NAV database. VNAV will be to the waypoint prior to the procedure turn, then the VNAV will use the charted altitude until inbound course intercept, then complete the descent to the waypoint following the procedure turn. Further VNAV will terminate at the approach glidepath altitude at the FACF.



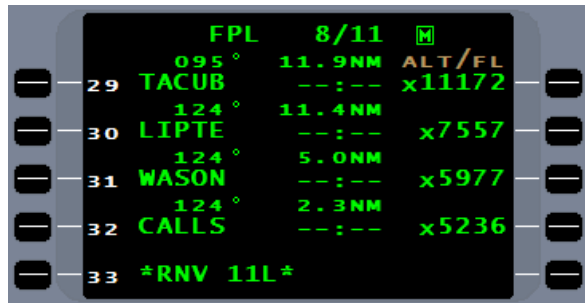
ENROUTE VNAV

Enroute VNAV is an FMS tool designed to establish a flight path angle designed to minimize power adjustments during descent and comply with the “Descent Via” clearances on RNAV arrivals.

The vertical flight path is based on a target flight path angle set by the pilot under the VNAV MENU. The pilot can set the target flight path angle (**TGT FPA**) between 0.00° and 9.00°. During installation a maximum of less than 9.00° can be set in the FMS configuration. The pilot will set the **TGT FPA** according to the descent characteristics of the aircraft. Recommend starting at -3.00° and adjusting as necessary. Many of the new arrival procedures do better at -2.50°



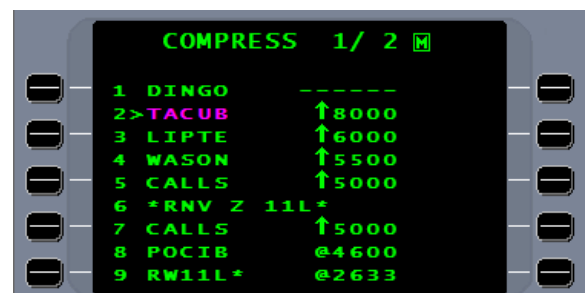
When an approach transition or, in some cases, a STAR procedure is entered into the flightplan, the FMS will calculate vertical crossing altitudes based on the **TGT FPA** entered by the pilot.



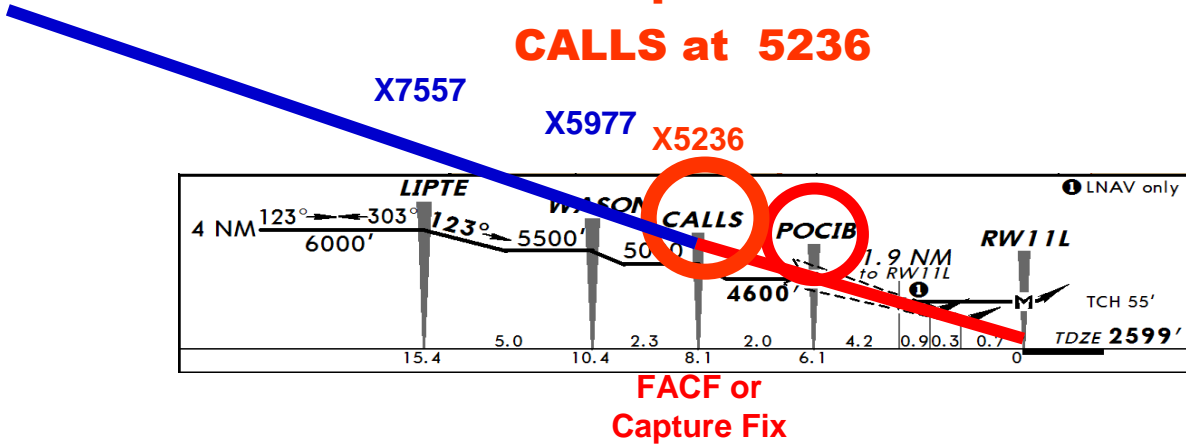
An “X” preceding the altitude in the flightplan and on the VNAV page indicates the altitude was calculated by the FMS.



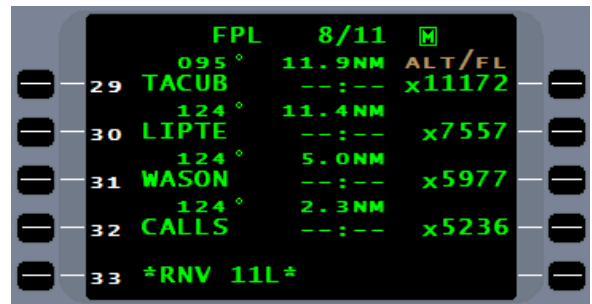
To view database altitude restrictions select flightplan menu COMPRESSED.



Glideslope Crosses CALLS at 5236

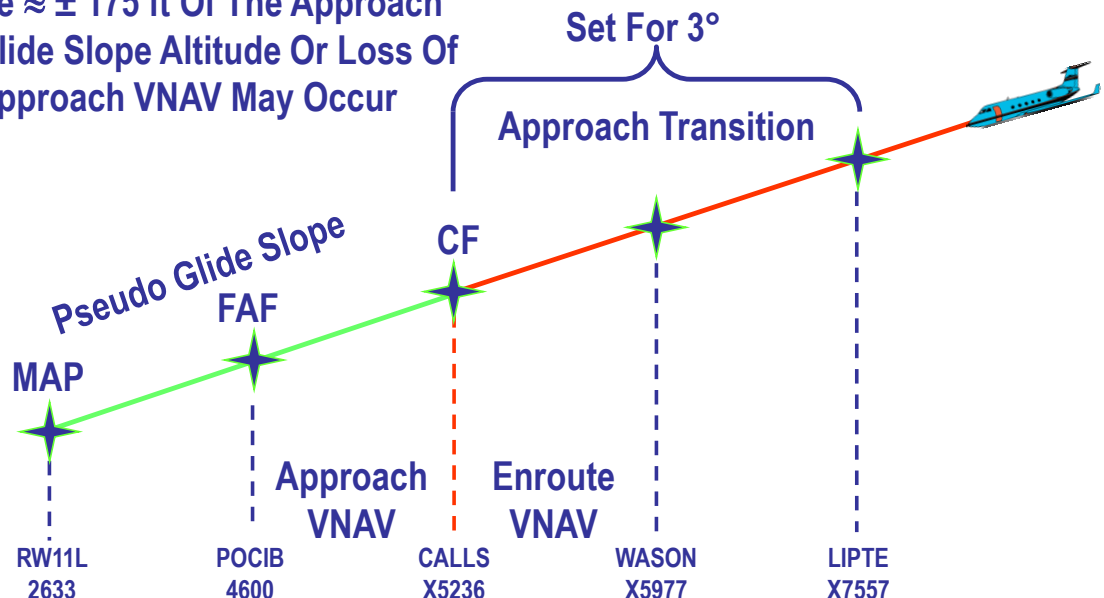


The FMS will use the approach segment, final approach course fix (FACF) or approach capture fix and approach glidepath crossing altitude to back calculate the enroute VNAV flightpath angle. To calculate this starting point, the approach database glidepath is projected by the FMS and where that glidepath crosses the approach FACF, in this case CALLS intersection, an altitude is calculated, 5236. This altitude is used by the FMS enroute VNAV to start the back calculation of waypoint VNAV crossing altitudes. Database altitude restrictions, "at, at-or-above, or at-or-below", are entered into the calculation to insure these restrictions are not violated. These altitude restrictions may result in the FMS creating an angle that is different than the TGT FPA entered by the pilot.



VNAV Transition

The Altitude Of The Aircraft Must Be $\approx \pm 175$ ft Of The Approach Glide Slope Altitude Or Loss Of Approach VNAV May Occur



It is

possible for the FMS enroute VNAV to interface directly into the FMS approach glideslope/glidepath. Since the termination point of the enroute VNAV through the approach transition is at the start of the approach glidepath, the FAF, the FMS should drop the enroute VNAV and immediately activate the approach VNAV. For the transition to be successful the aircraft must be within plus or minus 175 feet of the transition altitude, in this case the transition altitude is 5236 feet MSL.

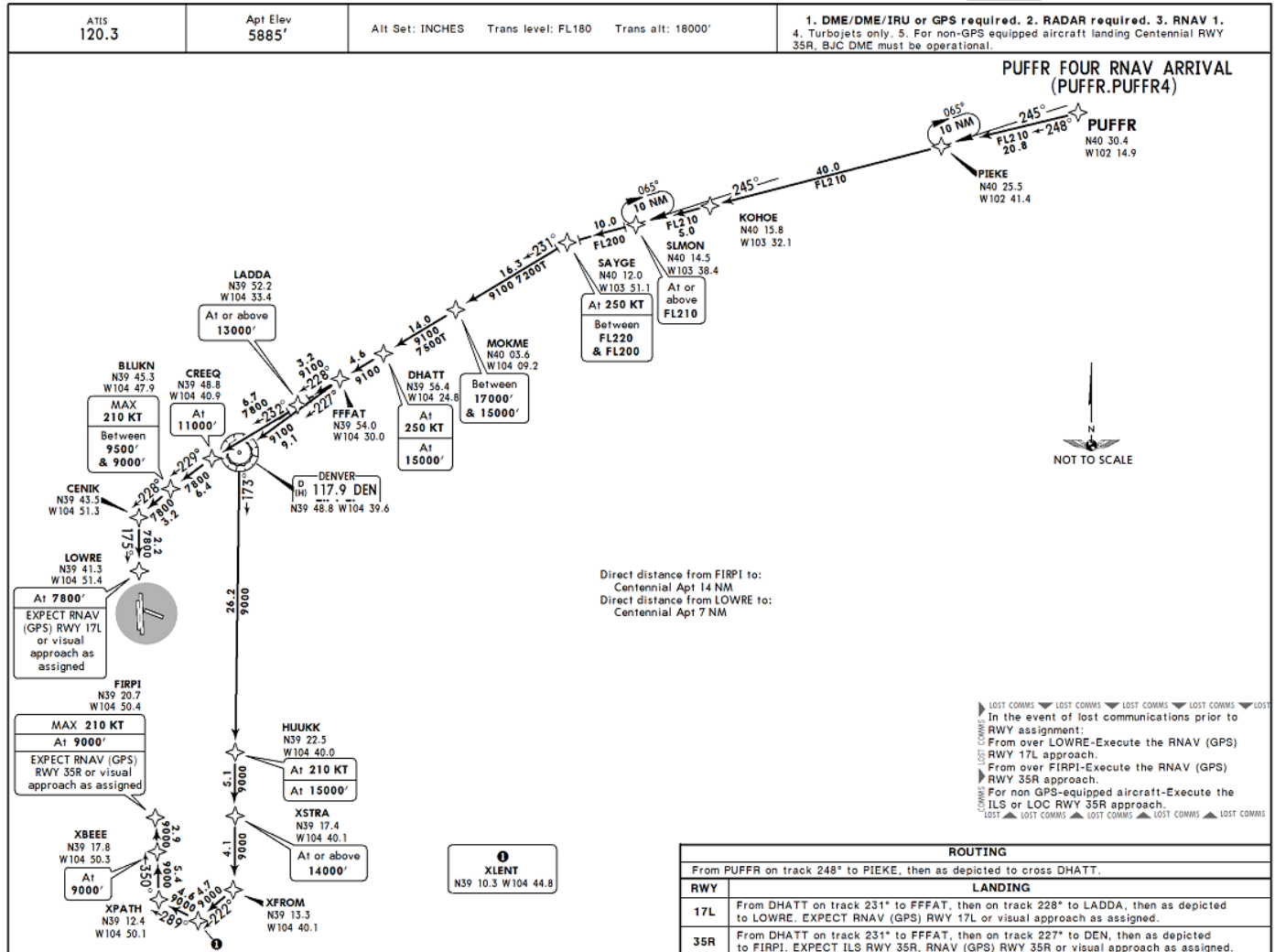
NOTE: It is possible to manually enter an enroute VNAV transition waypoint altitude that is below the FAF altitude. The VNAV leg following this lower altitude will be calculated by the FMS as a climb, which the FMS cannot do. The result will be a cancellation of the approach glidepath.

RNAV ARRIVALS

“Descend Via the PUFFR4 RNAV ARRIVAL.” This clearance requires the pilot to fly the arrival both laterally, vertically, and comply with speed restrictions.

KAPA/APA
CENTENNIAL

JEPPESEN DENVER, COLO
20 MAY 16
EFT 26 May (40-2A) RNAV STAR



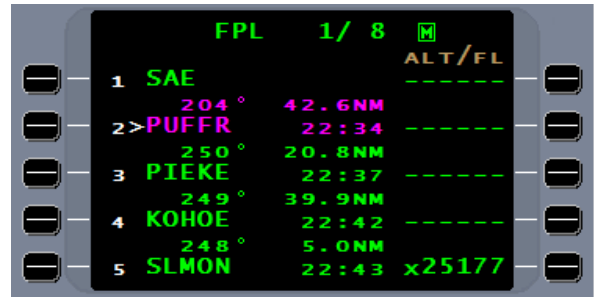
CHANGES: SKARF 3 STAR cancelled (reverse side).

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The Universal Avionics FMS with software 100X/110X will use the ENROUTE VNAV function to automatically calculate crossing altitudes, thus greatly simplifying flying these procedures. Using the target flight path angle (TGT FPA) available on the VNAV menu page and database altitude restrictions, an optimum vertical flight path is computed by the FMS minimizing attitude and power adjustments. While the pilot must comply with speed restrictions the FMS will fly the arrival both laterally and vertically.

Caution: Adjusting the TGT FPA on the VNAV MENU may be necessary to avoid abrupt changes between VNAV legs. Example: Changing from 3.00 to 2.50 or 2.00 may be necessary for passenger comfort. Check the VNAV page for legs with a high rate of descent and change the TGT FPA to see if the descent rate changes.

Reviewing the flightplan page after loading the PUFFR FOUR ARRIVAL into the flightplan, one sees both the waypoints and their associated crossing altitudes in the ALT/FL field. Where possible the FMS uses the target flightpath angle entered on the VNAV MENU such as when there is a crossing window rather than a mandatory crossing altitude. The target flightpath angle is default to 3°, but can be set between 0° and 9°. An “X” prior to the altitude indicates it’s an FMS calculated crossing altitude.



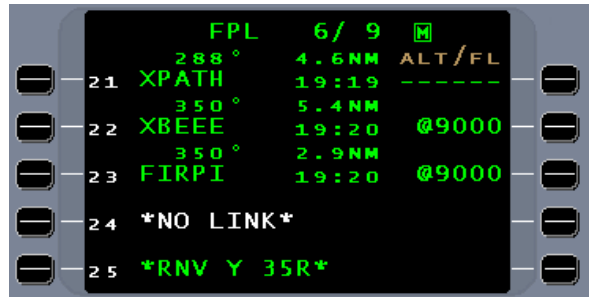
An “@” symbol adjacent to an ALT/FL indicates a mandatory crossing altitude.



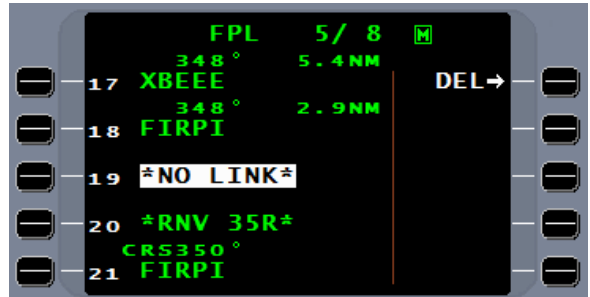
Where there is no altitude entered or an “X” altitude exists, the pilot may manually enter a crossing altitude. If that crossing altitude is lower than the subsequent altitude, the FMS will lower the subsequent altitude unless it’s a mandatory crossing altitude.



Some RNAV arrivals end at the final approach course or capture fix (FACF) waypoint. Because the approach label is not the same as the arrival end waypoint, the FMS will enter a “*NO LINK*” prior to the approach label.



In cases where the STAR is intended to join an approach, such as this case, delete the “*NO LINK*” to allow automatic sequencing into the approach.



As the FMS sequences FIRPI, the FACF, the FMS will initiate approach active mode.



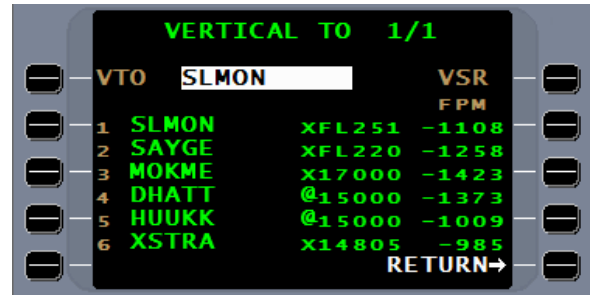
Using either the top of descent (TOD) tool or...



...by using the Vertical TO (VTO) tool,



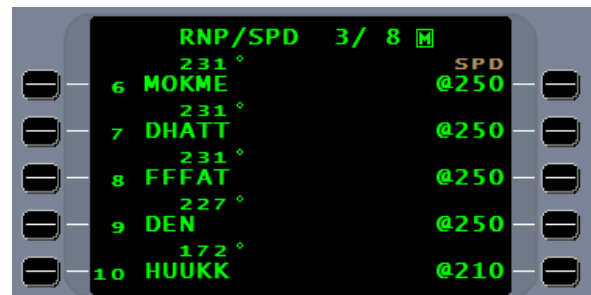
The FMS will enter the enroute VNAV profile.



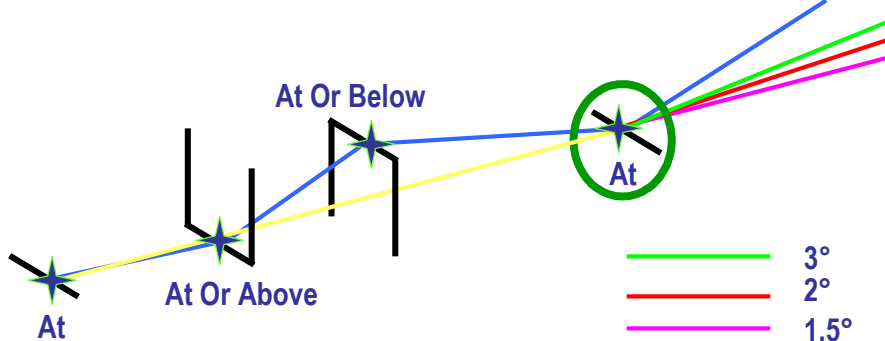
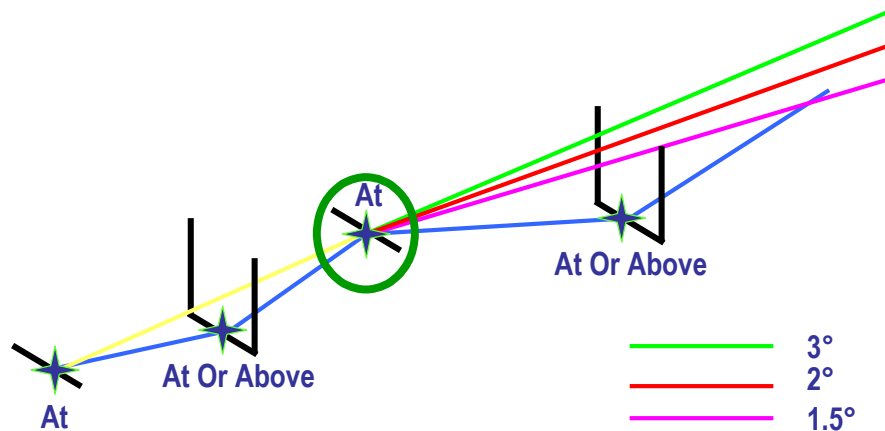
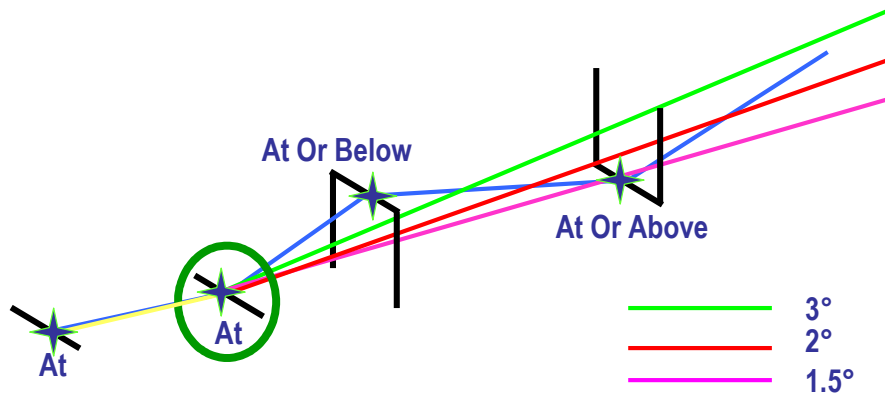
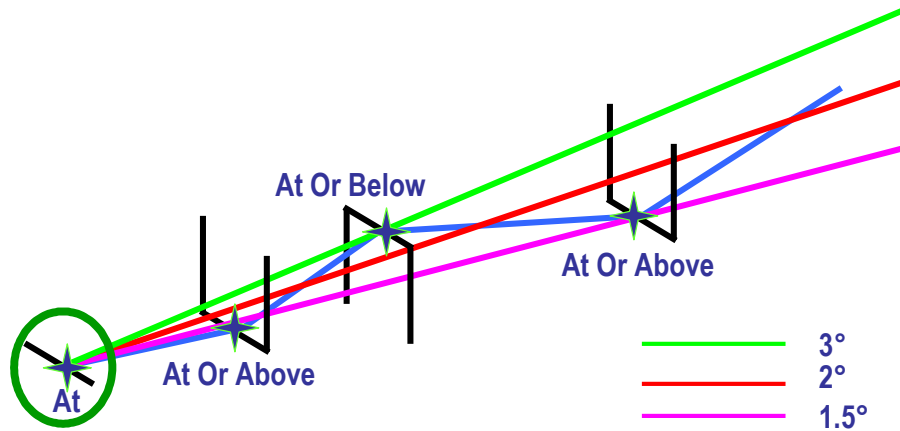
SCN 1001/1101 and subsequent has added a third flightplan menu page. On this page by selecting FPL RNP/SPD is access to NAV leg RNP restrictions and leg speed restrictions.



For the PUFFR4 arrival the procedure airspeed restrictions are shown. Since the NAV database contains no RNP leg restrictions, there are none shown.



Altitude restrictions may result in the enroute VNAV creating angles other than that of the TGT FPA. The examples below show three flight path angles.



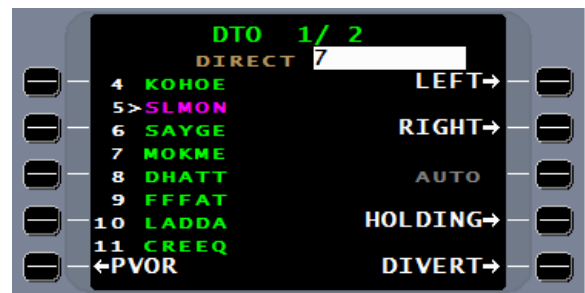
RNAV ANOMALIES

Unfortunately we don't fly in a perfect world. Changes to the aircraft's three dimensional flightpath can be initiated by ATC resulting in a VNAV disconnect.

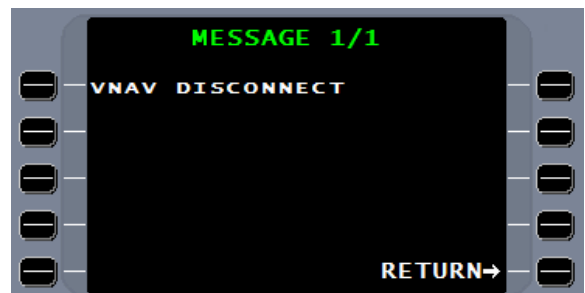
Vertical navigation is calculated by knowing the lateral distance. The FMS can calculate the vertical profile on an arrival because it knows the distances between waypoints.



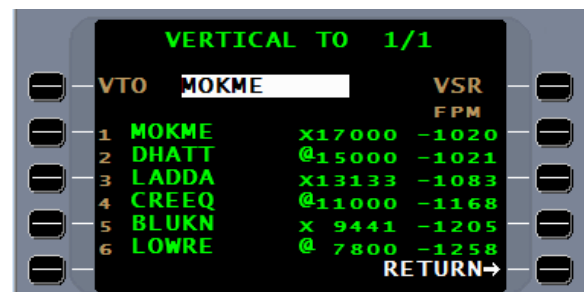
One cause of a VNAV disconnect may occur with a change in the current destination waypoint via a "Direct To" (DTO). Because the lateral distance will change, the vertical distance will also not remain the same.



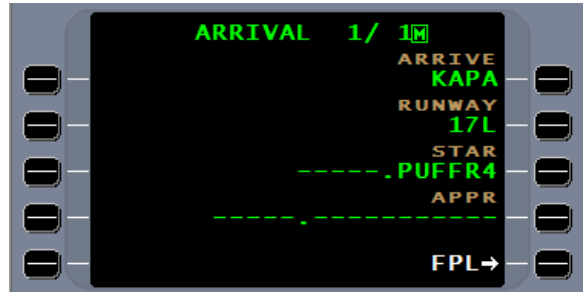
This will result in a "VNAV DISCONNECT".



To reestablish the vertical path use the VTO tool and the FMS will recalculate the vertical path. Remember to reengage the autopilot VNAV if it disconnects.



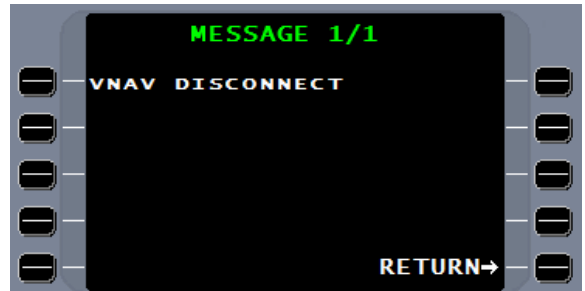
You're planning on runway 17L, but the winds have changed.



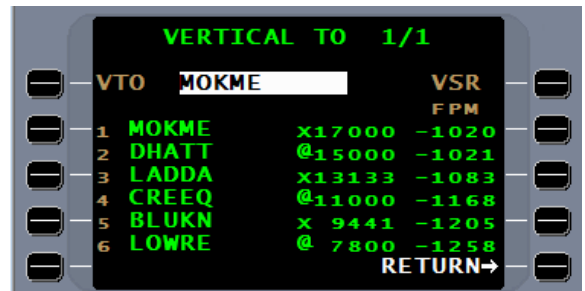
ATC gives you runway 35R. You enter the new runway on the ARRIVAL page and a MSG alert appears.



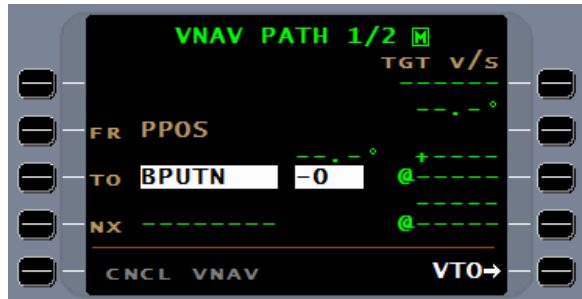
A VNAV DISCONNECT message.



The FMS created a new arrival and a new VNAV path needs to be created. VTO is the tool to use and a new VNAV path is established.



Sometimes the FMS will not populate the VNAV page with the ENROUTE VNAV profile. This may occur following a missed approach or just changing arrivals mid-stream.



By pushing the "TO" line select key and entering the first VNAV waypoint and continue pressing the **ENTER** key, the FMS will reenter the VNAV profile in the flightplan.



By entering any VNAV waypoint on the VNAV page will initiate the ENROUTE VNAV tool to create or enter from the flightplan a VNAV path profile.



ARRIVAL PROCEDURES

Using the FMS during approaches is discussed in detail in the FMS approach section. The following is a brief overview of the arrival.

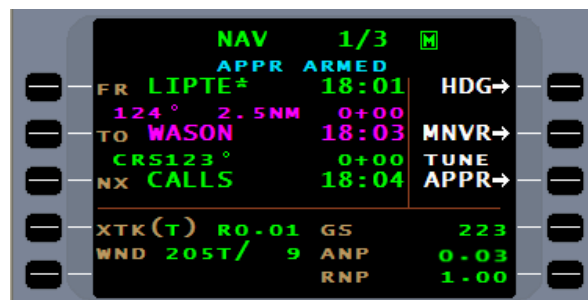
With the aircraft more than 50nm from the arrival airport and an FMS approach in the flightplan, a subdued **APPR** will be presented at line select key 3R.



With an approach entered in the flightplan and within 50nm of the missed approach point, the **ARM APPR** line select key is made available. Pressing **ARM APPR** line select key may be done at this time, but auto arming is the normal procedure.

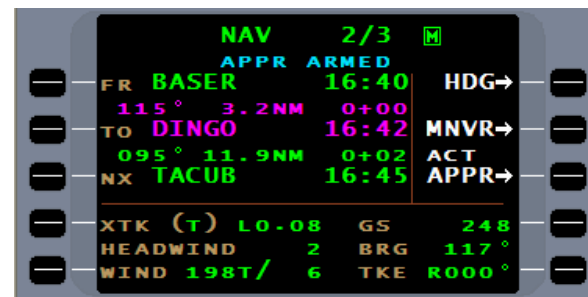


If NAV radios are required for the approach, are not already set to the correct frequency, and are remotely tunable through the FMS, the **TUNE APPR** line select key will be presented. If not previously manually armed, when 30nm from the end of approach, the system will auto arm the approach. Line select key 3R will then indicate **TUNE APPR** if the NAV radio are required. A subheading of **APPR ARMED** is presented.



When within 30nm or if the approach is manually armed, the FMS will change the CDI scale from enroute (**E**) to terminal (**T**). If on an arrival procedure this would have already been done.

With remote tunable radios, pressing the **TUNE APPR** line select key will tune the radio to the approach reference facility, and then change to **ACT APPR**. If NAV radios are not remotely tunable or the NAV radio is already tuned to the approach facility, **ARM APPR** will go directly to **ACT APPR**. At the same time the NAV receiver is tuned, the system will deselect any sensors not meeting approach criteria. If an RTU is installed a **TUNE APPR** line select key will momentarily appear, otherwise, the **ACT APPR** key will be presented.



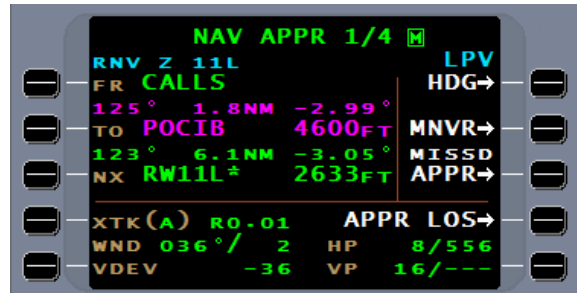
APPROACH ACTIVATION

When to use automatic and manual approach activation is covered in detail in the Approach Operations section of this manual. Approach activation is characterized by two changes in the interface to the aircraft flight guidance system and EFIS or flight instruments. The FMS will output expanded left/right deviation signals and vertical glidepath/glideslope steering, and the XTK (T) (Terminal) changes to XTK (A) (Approach) changing HSI scaling to approach scale deflection.

ENROUTE TO APPROACH VNAV

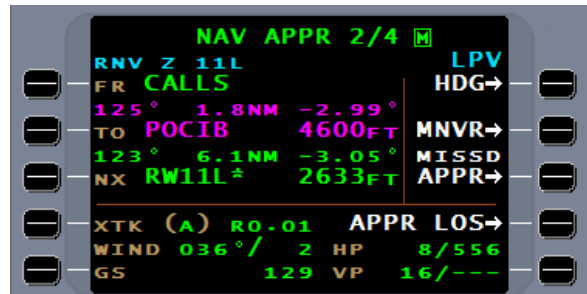
The procedure for the aircraft to perform a flight director/autopilot coupled enroute VNAV to the approach VNAV transition is covered in both the VNAV and FMS Approach Operations section. If not done correctly, a VNAV disconnect may occur when the approach activates or is manually activated by the pilot. This automatic VNAV disconnect is intentional, and provides protection from a sudden pitch-over or pitch-up to capture the final approach glidepath. In these cases the flight director will automatically change from VNAV to PITCH HOLD mode. See FMS Approach Operations for more information.

When the FMS goes into the approach active mode, two **NAV APPR** pages are added. These pages will differ between RNAV and non-RNAV approaches. For RNAV approaches, **NAV APPR 1** will present the approach waypoints with distance, altitude, and glidepath angle. Winds will be presented in magnetic degrees and **VDEV** (vertical deviation) display distance above or below the glidepath. When flying an RNAV (GPS) approach with SBAS, **NAV APPR 1/4** will be modified to show Level Of Service (LOS). Non-RNAV approaches will provide ANP and RNP

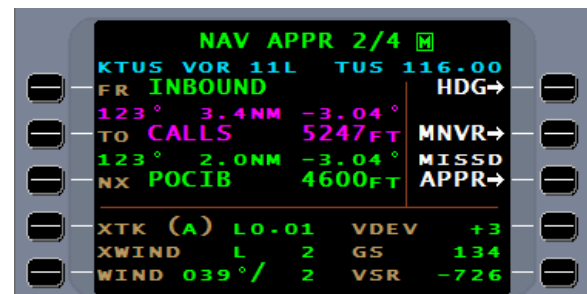


The lower section of the **NAV APPR 2** will provide additional information.

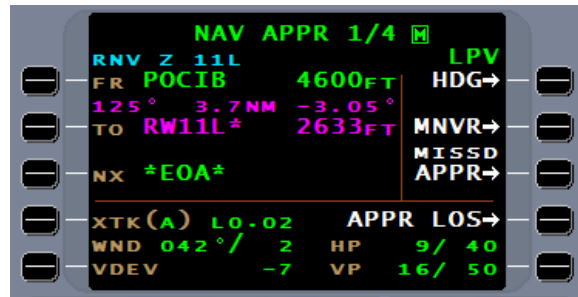
In SCN 1001.1/1101.1 the MISSD APPR line select key is presented anytime the FMS is approach active, there is no cancel approach option.



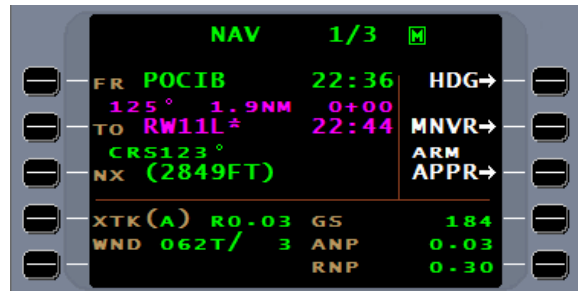
Non-RNAV approaches on page 2 will provide **XWIND** (crosswind) and **VDEV** (vertical deviation) and **VSR** information.



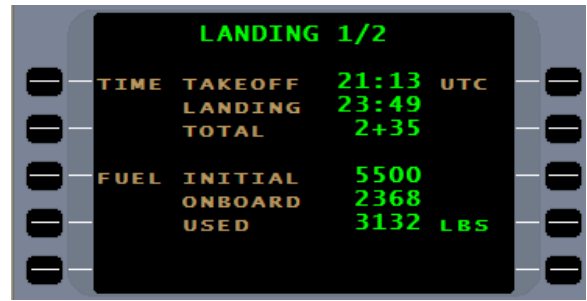
At the FAF (Final Approach Fix) POCIB, inbound, on an RNAV approach with LPV LOS the FMS will go to LPV mode. In the lower right corner the navigation accuracy is displayed with the standards being shown.



In the event of a missed approach, the FMS offers the option of flying the missed approach procedure through the FMS. All "Missed Approach" waypoints (MAXX or RWXX) and "Missed Approach" holding waypoints are automatically designated as "Fly Over" waypoints. If the approach linked to the flightplan is navigation database defined, the published missed approach procedure is included with the approach; if it is pilot defined, during creation of the approach, the missed approach procedure can also be defined. In either case, when you press MISSED APPR, line select key, ***EOA*** is deleted from the NX line of the NAV page and the first waypoint of the missed approach is entered. The aircraft will continue to the missed approach waypoint followed by the first leg of the missed approach procedure. On aircraft with a go-around mode interfaced to the FMS, pressing the go-around button while the MISSED APPROACH option is displayed will have the FMS electronically press the MISSED APPR line select key.

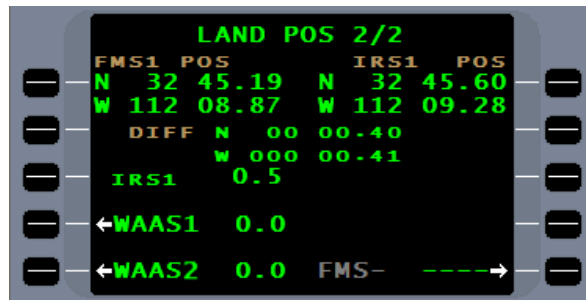


Upon touchdown, the **LANDING** summary page will be displayed. This is triggered by a 3 second input from the squat switch.



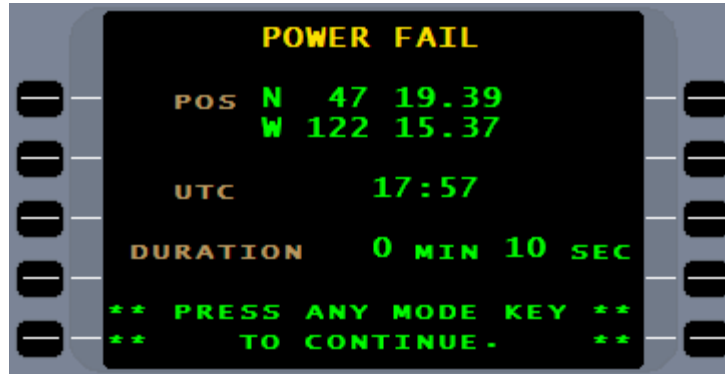
Press the **NEXT** key for landing page 2. This page will provide lat/long for NAV sensors to FMS best computed position.

From the **LANDING** page only the MSG and TUNE pages can be accessed and still return to the **LANDING** page. Once any another function is selected, the **LANDING** pages cannot be accessed.



POWER FAILURE PROCEDURES

These procedures are to be followed after electrical power is restored following a power failure or interrupt to the FMS. This may include a simultaneous power loss to the GPS and other NAV sensors.



POWER FAILURE FOR UP TO SEVEN MINUTES

If the time span is less than seven seconds, the FMS, with no input from the operator, will power up and display the same page that was in view prior to the power interruption.

If the time span of the power failure exceeds seven seconds but less than seven minutes, the FMS will automatically power up and a **POWER FAIL** page will be displayed.

1. Press the **NAV** key to access the NAV pages. Check the FMS position and navigation sensors.
2. If the position is reasonable and GPS is in NAV, check NAV page 1 or 2 to verify correct NAV leg.
3. Monitor GPS position until aircraft is back on track and the WIND on the NAV page stabilizes.

POWER FAILURE OVER SEVEN MINUTES


The following procedure should be applied when electrical power is restored or if the system is turned on in flight for the first time.

This procedure takes into consideration that the GPS will find the aircraft's position. The time required for this to happen depends on how long the system was without power and how far the aircraft has flown from the shutdown position of the FMS. The GPS will use its Almanac data and its last known position to acquire satellites.

1. Press the **ON/OFF**
DIM key. The system will run through the self-test and then display the Initialization page. The latitude/longitude will be the coordinates displayed at the time of power loss.
2. Wait for the <GPS> to appear in the ID field, press the ACCEPT line select key to accept the GPS position for initialization.
3. If <GPS> does not appear in the ID field in a reasonable length of time, enter the best estimate of the aircraft's position in the Lat/Long field. If radial and DME from a nearby VOR is available, this can be used to initialize the aircraft position. Press line select key 2L for the DEFINE POS page. If DME/DME is part of the NAV sensor array, the FMS will attempt to use it for navigation.
4. Once the system is initialized and the FMS position is accepted, press the **FPL** key and reenter the flightplan. The flightplan will not be found intact. It may be necessary to do a manual leg change on NAV page 1 or 2 to insure the aircraft will rejoin the desired flight path as smoothly as possible. The FMS will begin navigating immediately.
5. Monitor the FMS position until aircraft is back on track and the WIND on NAV page stabilizes.
6. Previously entered fuel data under the **FUEL** function key will not be found intact. Following a power loss, the current fuel on board must be reentered into the total fuel on board field along with other FUEL page initialization information. For those aircraft with digital fuel quantity systems, the pilot must accept the fuel quantity on line select key 5R.


NOTE: Loss of power will cause the FMS screen to go full bright when power is restored.



SYSTEM SHUTDOWN PROCEDURE

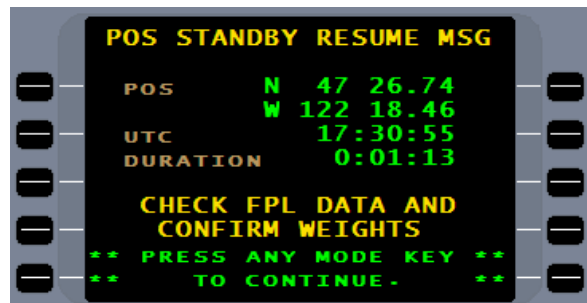
Press the  key. In the overlay, press the OFF/STBY line select key, and then select the CONFIRM OFF line select key. The FMS will shut down. It is strongly recommended that the FMS be shut down by the normal shutdown method before removing power from the FMS by turning off the avionics master switch or the aircraft's batteries. Failing to do so will place the FMS in a power failure mode.

PLEASE INCLUDE THIS ON YOUR CHECKLIST.

FMS STAND-BY MODE

When the standby mode is activated, the FMS will hold flight plan and fuel inputs for a configurable time of 0, 2, 4, 6, or 8 hours. The FMS will power down, but the flightplan and fuel inputs are saved. Press the  key and line select key 5R will present OFF/STBY. Select this line select key and CONFIRM STBY will appear adjacent to line select key [5R].

Using the  will reactivate the FMS and, following the power on self-test (POST), a **STANDBY RESUME** page will appear. Press any MODE key (i.e. NAV, DATA, or FPL) to move to the initialization page. After initialization a check of the flightplan and fuel pages will show flightplan and fuel information will be present. Confirm the flightplan waypoints and confirm the fuel on board on FUEL page 5 by pressing the  key.



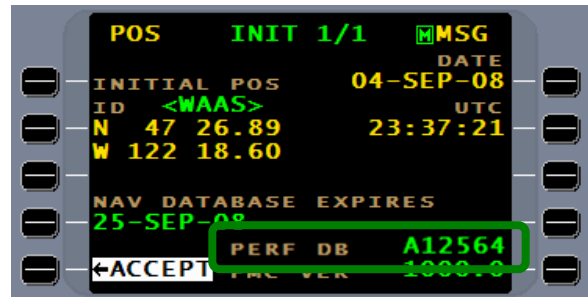
It is recommended that the FMS be put in STBY if electrical power will be removed from the FMS during engine start.

NOTE: SCN 1000.5 has corrected problems with the standby mode that were reported in earlier SCN 1000 versions. See SB 3455.

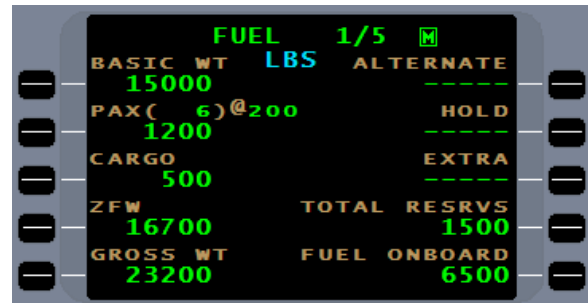
AIRCRAFT PERFORMANCE TAKEOFF & LANDING

The Universal Avionics FMS, for some aircraft, will provide a program to calculate aircraft performance. With the aircraft performance database loaded, the performance pages are accessed by pressing the **PERF** key. Performance calculations may include V speeds, balanced field length, climb and cruise, and other information. For Aircraft with an available performance database installed on the FMS, procedures are as follows. (The examples are of an Advanced Performance Database for a Learjet 60, but other database procedures are similar. Contact Universal Avionics for a complete list of aircraft with a performance database.)

FMS containing a performance database will show on the initial page a **PERF DB** line and a number that indicates the aircraft for which the performance data is created.



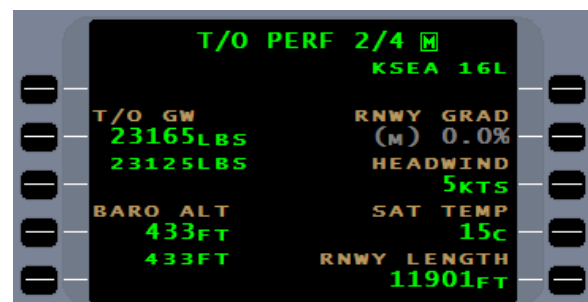
Before accessing the performance database, complete **FUEL** page 1.



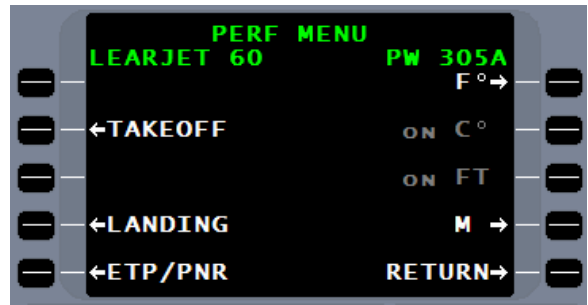
While on the ground, press **PERF** and the FMS will automatically display the **T/O PERF 2/4** page. For the FMS to provide data to compute takeoff performance, the aircraft must be on the ground. The computed gross weight from FUEL page 1 is taken and entered into the **T/O GW** field. If desired, a manual figure can be entered. Press the **ENTER** key to confirm takeoff gross weight and the cursor moves to the **BARO ALT** field.



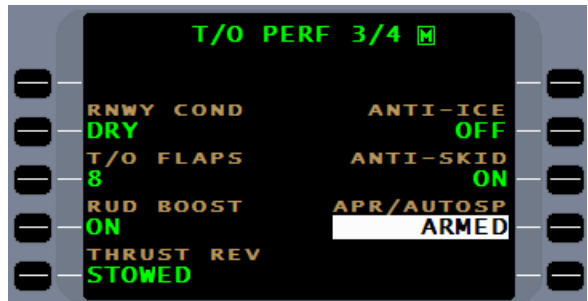
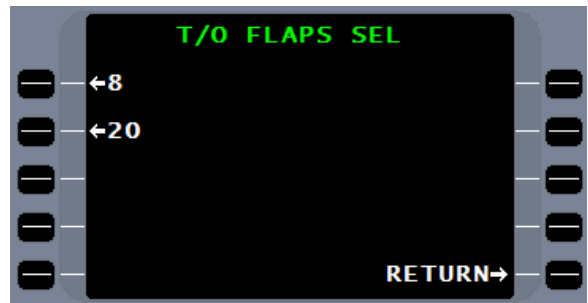
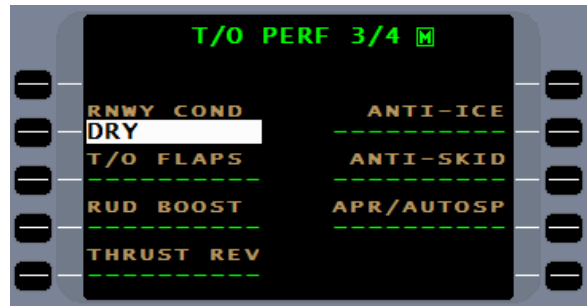
Confirm the existing entries or enter the required information into **BARO ALT**, **RNWX GRAD**, **SAT TEMP**, and **RNWX LENGTH** fields. Baro Alt and SAT are taken from the ADC input. Runway length is taken from entering the runway on the departure page.



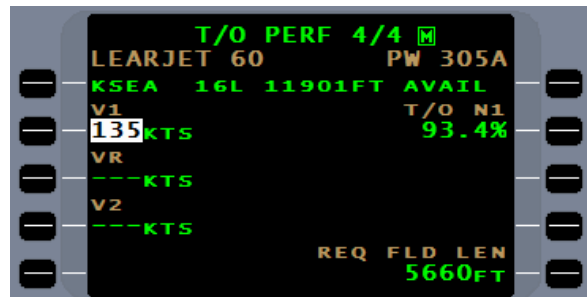
A performance menu allows for changing the temperature scale from Fahrenheit to Celsius and the runway length from feet to meters. It also allows for selection of TAKEOFF or LANDING for out of sequence computations.



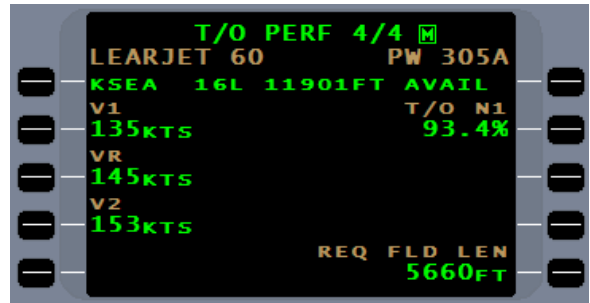
Upon completion of page 2, the cursor will move to page 3. Confirm the existing entry or enter the required information and the cursor moves to the next field. Pressing the line select key adjacent to the entry field will provide options for the field. Once all fields are complete, the next press of the **ENTER** key will advance the cursor to the next page.



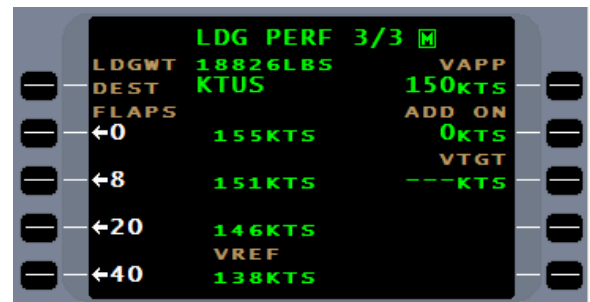
When all required information is entered into the FMS, the **V₁** speed will be calculated and subsequent pushes of the **ENTER** key will calculate and confirm **V_R** and **V₂** speeds. With the Advanced Performance Database data such as **T/O N1** and **REQ FLD LEN** are calculated.



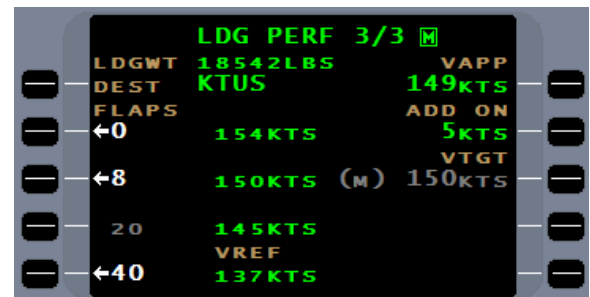
On some aircraft the V speeds can be entered directly from the FMS to the EFIS airspeed indicator. See aircraft flight manual/supplement.



The landing performance page will automatically become available when the aircraft is within 120nm of destination airport, but can be selected earlier in the flight by going to the menu page. Pressing the **PERF** key will immediately present **LDG PERF 2/3**. When within 120nm of the arrival airport, the FMS will calculate an estimated landing weight and place it in the **LDG WT** field. Accept this weight or enter a manually calculated weight and press **ENTER**. With an approach and runway selected, the **APRT ELEV** field will be prefilled when the cursor is moved to that location. The cursor will move through the remaining fields as it did in the takeoff mode.



Depending on the aircraft type, further V speed adjustments can be made. In this example, an additional 5 knots are added for wind gusts.



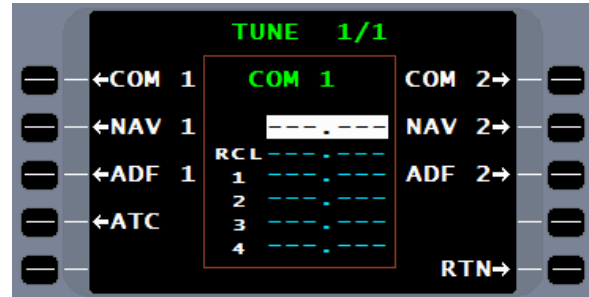
Procedures may differ for calculating performance for different aircraft types.

FMS REMOTE TUNE

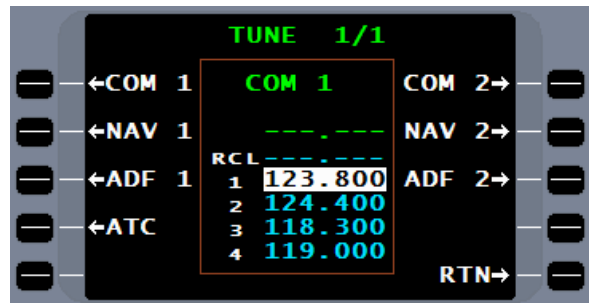
Aircraft with compatible radio tune heads will allow the FMS to remotely tune radios.

Press the TUNE function key to bring up the **TUNE** page.

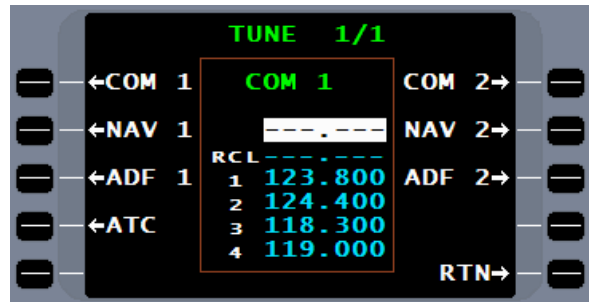
When configured to 8.33 kHz spacing during installation, three spaces to the right of the decimal place are presented.



To preprogram frequently used frequencies, press the **ENTER** key and the cursor moves to preset frequency 1. Enter the desired frequency and press **ENTER**. The cursor will then move to frequency 2. Proceed as with preset frequency 1 until the four preset frequencies are filled and...

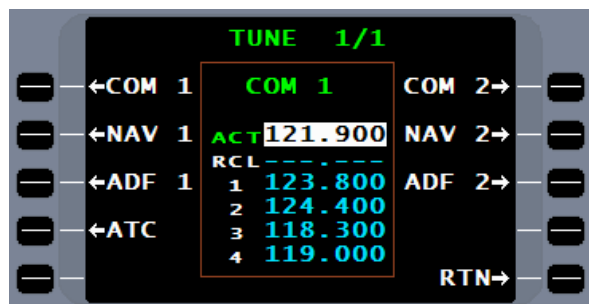


...when completed with frequency 4, press the **ENTER** key and the cursor moves to the **ACT** field.

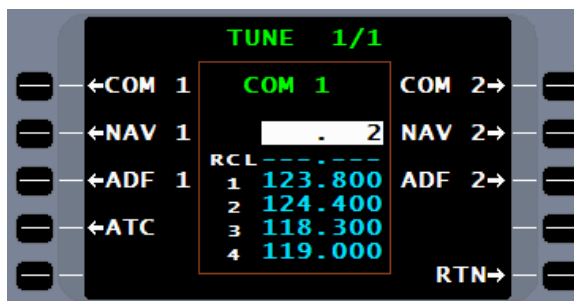


The frequency **ACT** or activation field will, when a frequency is entered, request the radio tune head to tune the selected radio.

Enter the desired frequency and press the **ENTER** key. When the frequency stops blinking and ACT appears, the selected radio is tuned. The radio tune head will reflect the new frequency.

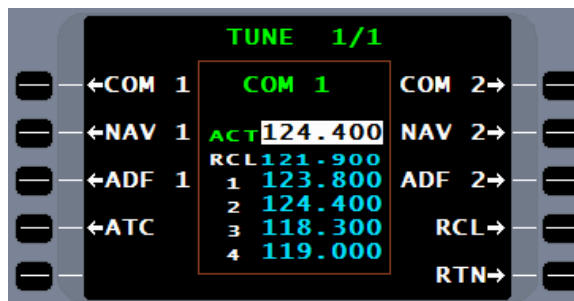


To use the preset frequencies, enter the desired preset line number (1 – 4) and press **ENTER**

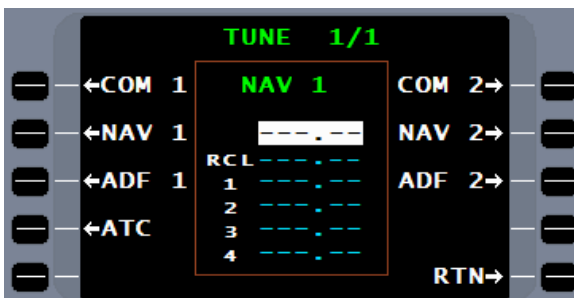


The selected frequency will appear in the **ACT** field and be tuned.

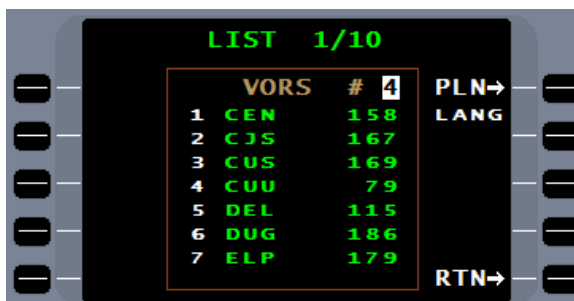
The frequency previously in the **ACT** field will move to the RCL or recall field. If this frequency needs to be recalled, press the RCL line select key and the RCL frequency will appear in the **ACT** field and be tuned. The RCL frequency is replaced by the frequency in the **ACT** field when it is superseded.



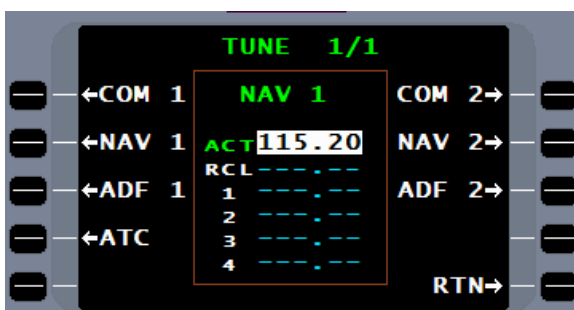
Use the line select keys to select the desired radio. Only those radios that can be remotely tuned will appear next to line select keys.



For ADF and NAV radios, entering the identifier by the **LIST** key or direct entry...



...will result in the frequency being entered into the frequency field.

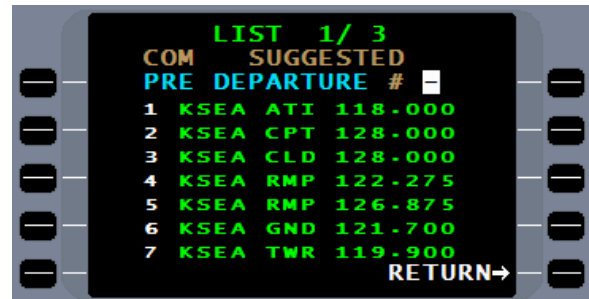


Communication frequencies are imported through the NAV database. To access the frequency database, with the cursor in the COM frequency field, press the LIST key.

Depending on the phase of flight, a list of frequencies will appear over several pages. Entering the number of the desired frequency in the cursor field will enter that frequency into the COM frequency field.

Following are screens presenting selected phases of flight.

In the **PRE DEPARTURE** phase, the FMS lists frequencies from the closest airport with in 50nm. Power up or changing the flightplan will cause the FMS to enter the **PRE DEPARTURE** phase.

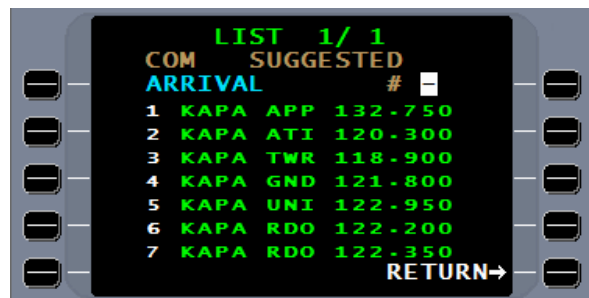


The DEPARTURE phase is entered when the FMS transitions from ground to flight.

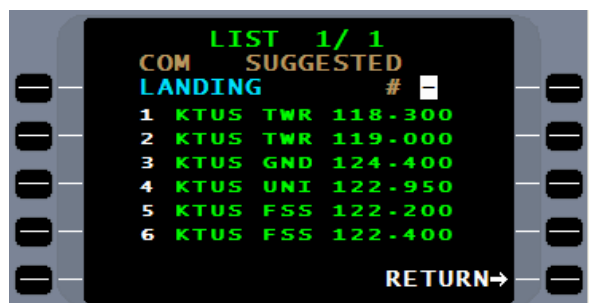
The **ENROUTE** phase is entered when the aircraft is more than 15nm from the departure airport, but less than 40nm from the arrival airport.



The **ARRIVAL** phase is entered when the aircraft is within 40nm of the arrival airport. Frequencies are from the flight plan arrival airport or, if no arrival airport in the flightplan, the closest airport with in 50nm.



The **LANDING** phase is entered when the aircraft transitions from flight to ground. The FMS lists frequencies from the closest airport with in 50nm.



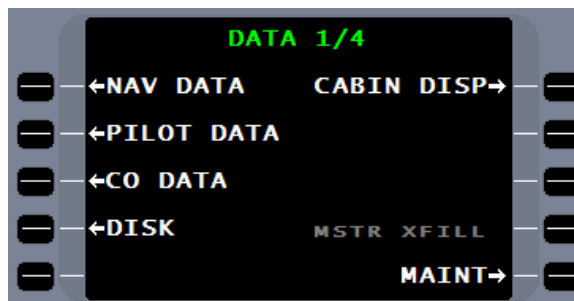
DATA FUNCTION PAGES

DATA 1/4 is the database menu page. It allows access to the navigation database, pilot database, company database, and disk or DTU operations.

PERF, UNILINK AFIS, MFD DISP, and CABIN DISP line select keys will be displayed on aircraft that have these options. The MAINT line select key is a maintenance function and allows access to the configuration mode.

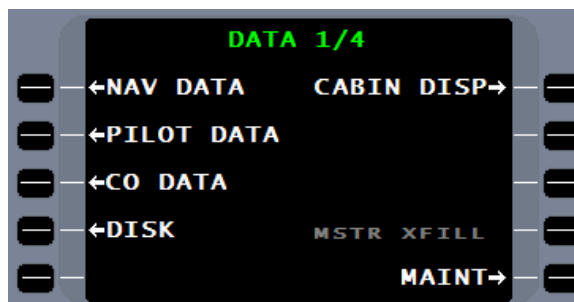
The MFD DISP line select key (not shown) allows selection/deselection of the progress data on the MFD in Pro Line IV installations.

NOTE: CABIN DISP on DATA page 1 is only applicable with installation of the UASC CD2000 or UniVision.

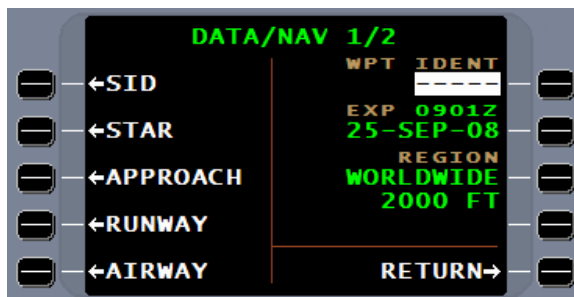


NAVIGATION DATABASE INTERROGATION

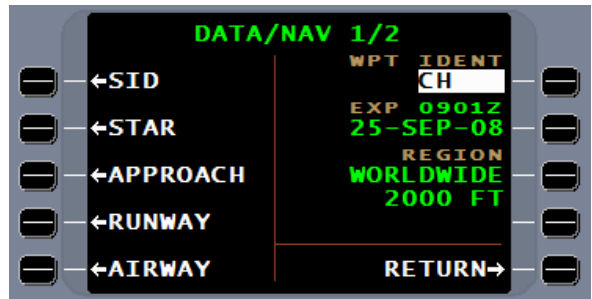
To interrogate the contents of the navigation database, press the “NAV DATA” line select key.



The **DATA/NAV** page allows access to airports and waypoints by identifier, SID, STAR, APPROACHES, RUNWAYS, and AIRWAYS. The active database region and its expiration date are displayed.



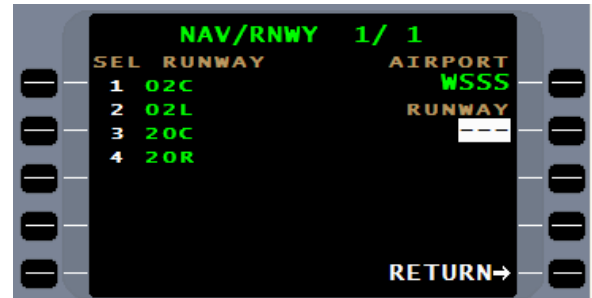
By entering an ICAO identifier, into the **WPT IDENT** field, the database information will be displayed.



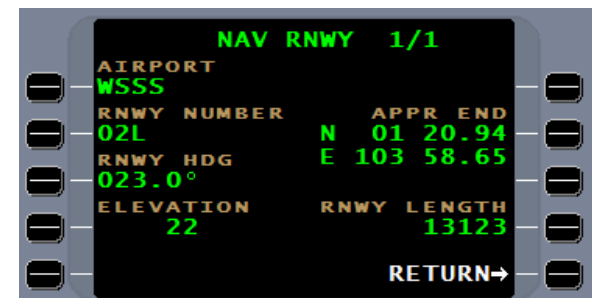
For identifiers with more than one waypoint, use the **NEXT** or **PREV** key to cycle through the pages.



To access SID, STAR, APPROACH, RUNWAY, or AIRWAY, first select the appropriate line select key then enter the ICAO identifier.

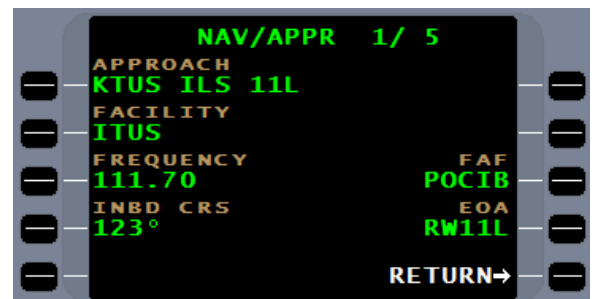


The runway database includes magnetic heading, elevation, approach end lat/long, and length.



The Navigation Database includes ILS, GLS, LOC, BC, RNAV, GPS, VOR, and NDB approaches.

ILS facilities (ident, frequency, inbound course, final approach fix, and end of approach) are included in the approach database.



NAVIGATION DATABASE INFLIGHT

The UASC FMS navigation database has a 28 day cycle. Fourteen days before the current NAV database expires, UASC will issue a new NAV database. This database may be downloaded through the UASC website by logging in through UniNet. An alternate method is to have the NAV database sent to the user. Contact UASC NAV Database Department.

Loading the NAV database can only be accomplished with the aircraft on the ground. (See loading procedures later in this manual) On the day of expiration the FMS during the next power cycle will automatically change to the new, current NAV database. The FMS **will not** automatically change to the new database while the aircraft is inflight.

Regulatory requirements from various countries Civil Aviation Authority (CAA) require the aircrew have a procedure to handle a NAV database that expires while the aircraft is inflight to insure the NAV data being used is current during the duration of the flight. An example:

FAA AC 90-105A, A.7.1.2

Note 1: Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight. This may be accomplished by verifying electronic data against paper or Electronic Flight Bag (EFB) products. One acceptable means is to compare aeronautical charts (new and old) to verify navigation fixes prior to dispatch. If an amended chart (hard copy amendment not in the database) is published for the procedure, the database must not be used to conduct the operation.

Note 2: On U.S. IAPs only, the "Procedure Amendment Effective Date" may be used to ensure the accuracy of the navigation data contained in an expired database. If the Procedure Amendment Effective Date falls on or after the navigation database expiry date, the procedure should not be flown using the out-of-date database.

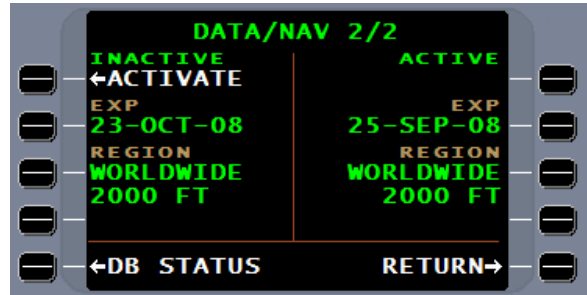
Two recommendations to accomplish this are:

1. Compare the NAV data being used for a specific route of flight to any charted data to see if the NAV data has changed. Check the date of the SID, STAR, and Approach chart to see if it is still current. For enroute waypoints, compare the FMS flightplan against the new charts to determine if the waypoints are still current. Once the aircraft has landed, cycle FMS power to activate the new NAV database.
2. For dual FMS installations, while inflight, one FMS at a time may be power cycled. Insure that FMS is not being used as primary for the aircraft navigation before power cycle. When initialized, the new NAV database will be current. Crossfill flightplan and fuel or Sync the repowered FMS to the FMS currently being used for navigation. Verify the flightplan has not be corrupted. Change to the power cycled FMS for aircraft navigation and cycle power on the second FMS. When initialized, the second FMS may have the flightplan and fuel crossfilled or synced to the FMS currently navigating the aircraft. Verify the flightplan has not be corrupted.

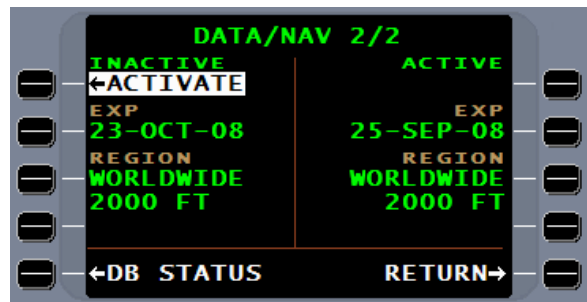
DUAL DATABASE

The UNS 1Ew, 1Fw, and 1Lw have dual navigation database storage. This allows for one database to be active for current navigation and a second database to be inactive and used for past or future navigation.

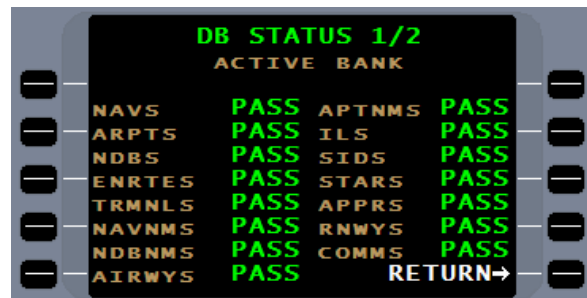
From **DATA/NAV 1/2** press the **NEXT** key to move to page 2. The subheading **ACTIVE** indicates the database currently being used for navigation. The **INACTIVE** database is either an expired database or a future database. When a new database is loaded, it automatically erases the inactive database and replaces it. When the active database expires, which occurs in most locations at 0900 UTC on the date of expiration the FMS upon the next power up will activate the now current NAV database. A configuration option allows for configuring a different time for countries requiring it. **ACTIVE** will now be the subheading of the newly activated database. Automatic activation of a new NAV database will only occur on the ground during FMS power on and self-test.



The need for manual activation of the inactive NAV database is rare, but can be accomplished by pressing twice the ACTIVATE line select key. This will result in the FMS automatically rebooting with the selected database now being active. Manual activation of a database can only be accomplished on the ground and flightplan and fuel entries will be lost during the reboot. The reasons for activating an inactive database may be selecting a new regional database or to temporarily activate an old database if the current database is corrupt.

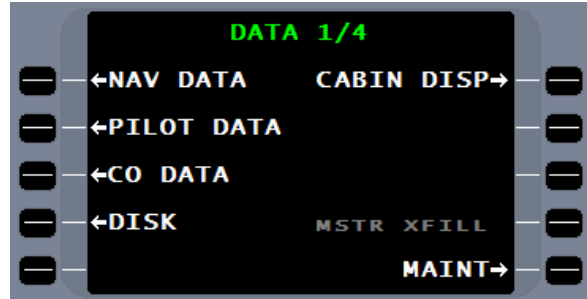


The DB STATUS line select key allows the operator to check the results of the database test. Page 2 is the INACTIVE BANK of the NAV database.

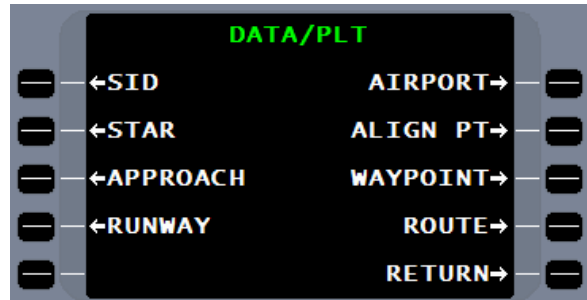


PILOT DATA

The PILOT DATA line select key will access the PILOT DATA page.



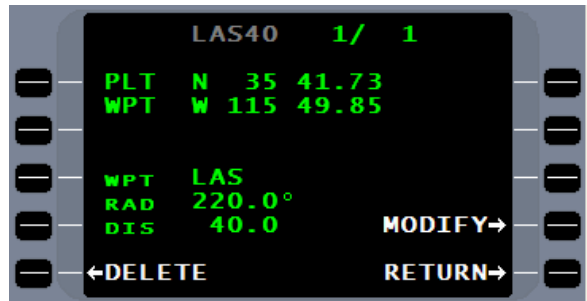
Pilot created data can be accessed through selection of the appropriate line select key. The ROUTE selection was covered earlier under flightplan and Route Creation. Pilot creation of SID, STAR, Approaches, Runways, and Airports will be discussed in another section.



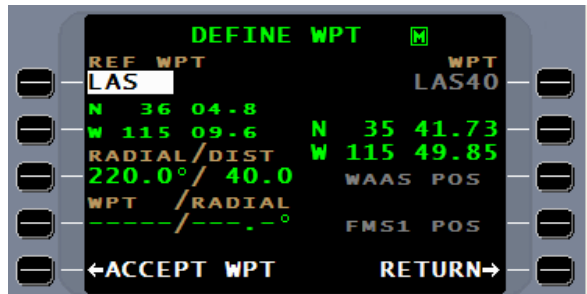
The creation of pilot waypoints was presented earlier under Pilot Defined Waypoints. Two hundred pilot waypoint can be created. Pressing the WAYPOINT line select key will bring up a list of the created waypoints in alphabetical order. To view waypoint creation information, either enter the number of the waypoint or the alphanumeric designator for the waypoint into the WPT field and press **ENTER**.



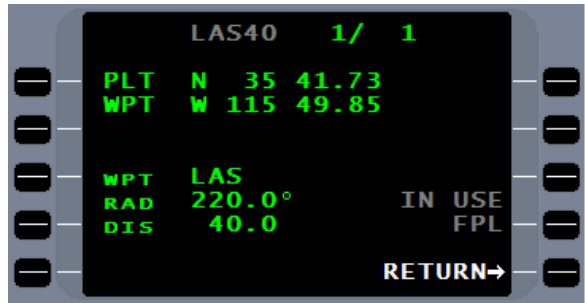
The latitude and longitude, and creation information, i.e., reference waypoint, radial, and distance, is presented along with line select keys for DELETE and MODIFY. Pressing the DELETE line select key twice will remove the pilot waypoint from the database.



The MODIFY line select key will bring up the DEFINE WPT page and allow for modification of the waypoint position.



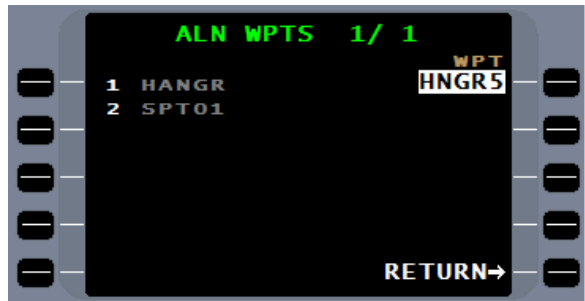
If the selected pilot waypoint is in use by the current flight plan (or a pilot created route, airport, SID, STAR, or approach) IN USE FPL will be presented on the right side of the page. No modification or deletion of the waypoint will be allowed.



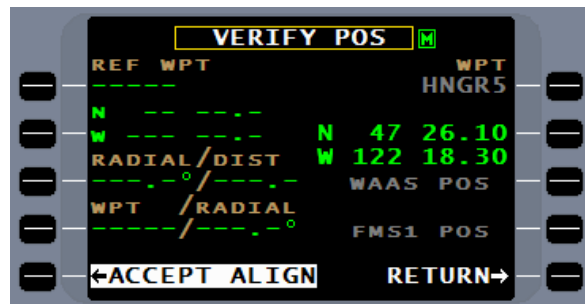
By pressing the ALIGN PT line select key, the ALN WPTS page is available to create up to one hundred alignment points on an airport for IRS or INS navigation equipment. A hangar align point may be created for initialization in a hangar where GPS reception would be inhibited.



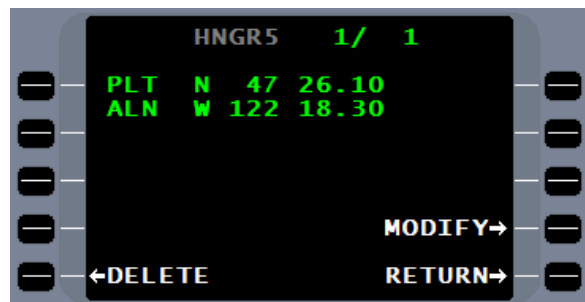
With the alphanumeric keys insert a pilot created name into the WPT field and press the **ENTER** key.



The DEFINE ALIGN page follows the same format as defining a waypoint.



To modify or delete the alignment point, use the appropriate line select keys.

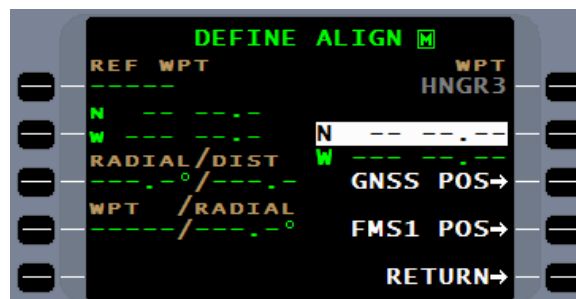


A technique to create an alignment point to be used during initialization for an aircraft in a hangar, first, park the aircraft just in front of the hangar in a location where a lat/long position can be determined by the GPS.

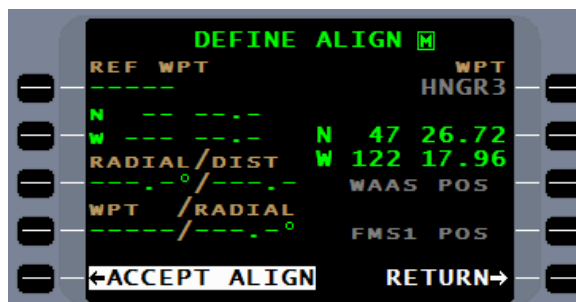
Go to the align page and give the alignment point a four or five character alphanumeric name.



Enter the name by pressing the **ENTER** key and the **DEFINE ALIGN** page appears. Press the 2R line select key as if to enter a lat/long. The GNSS POS and FMS1 POS line select key will become available for selection. Press the GNSS line select key and the GPS lat/long will be entered.



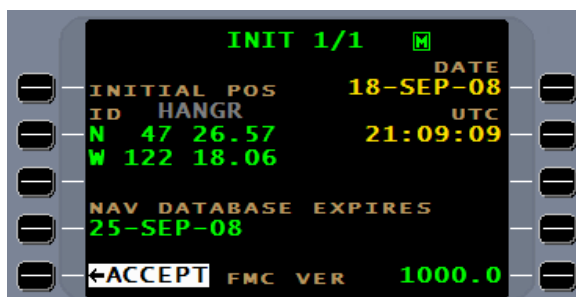
Accept the alignment point and it will now become part of the pilot database.



On the initialization page with the cursor in the ID field, press the **LIST** key. A list of airports and pilot alignment points will be presented. Enter the reference number for the **HNGR3** align point and press the **ENTER** key.



HNGR3 is entered in the **ID** field and the associated lat/long is listed below.



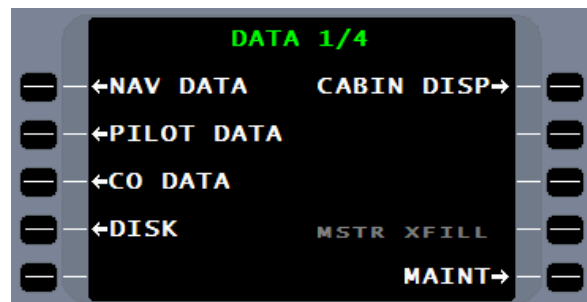
COMPANY ROUTES DATA

A protected company routes database can be created using Universal's Offline Flight Planning Program and may be downloaded to a flash memory drive or secure digital card. A total of 2000 routes and 250,000 route elements may be stored. Each route will consist of at least one but not more than 98 waypoints (route elements). Route elements will reference waypoints, airways, and terminal area procedures (SID, STAR, and approaches) from the Navigation database by use of reference pointers. Company routes can be given names of up to eight characters in length. A company routes database will allow routes to be viewed and copied to the active flightplan, but the flight crew cannot modify the routes themselves until copied to the flightplan page. Also included are company defined waypoints and airports. A maximum of 200 company waypoints and 100 company airports may be created using the Universal flight planning Program.

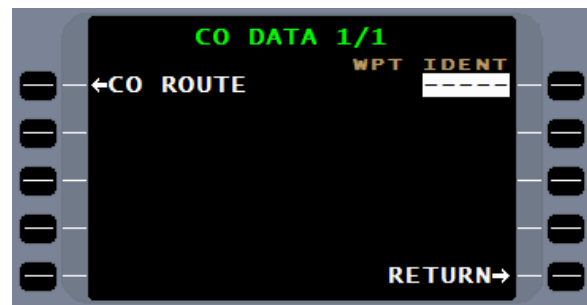
A company routes database must be loaded with the same Navigation data that was used for its creation. Company routes database is loaded through the Data Transfer Unit (DTU) by using the same procedures as loading Navigation database.

NOTE: A configuration option is available that will clear all pilot defined data at power-up. This feature is intended for airline operations in which the FMS will always power up in a cleared state with no leftover pilot defined data from a previous crew.

Company routes are not created on the FMS but through the Universal Flight Planning program on a PC computer. These routes are entered into the FMS through the DTU after a NAV database update and must be updated through UFP and reentered after each NAV database update. These routes may be viewed through the CO DATA line select key on **DATA 1** which will present the **CO DATA** page.



Company routes may be accessed through the CO ROUTE line select key. Company waypoints and airports may be viewed through the **WPT IDENT** field. Enter the identifier of the company waypoint or airport and the FMS will present the waypoint information. The FMS will not list the company waypoints or airports as it does in the pilot database. The Universal Flight Planning Program must be used to view a list of company waypoints and airports.

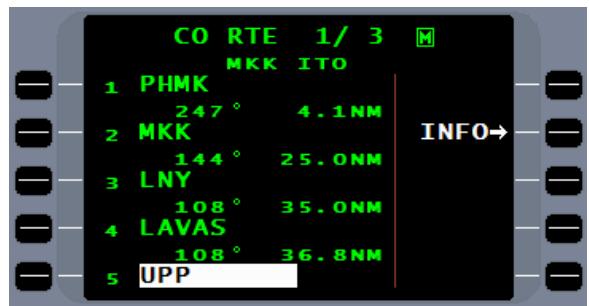


For the SSDTU, CO data must come from a uasc folder on the flash memory drive or SD memory card. See LOADING THE NAV DATABASE.

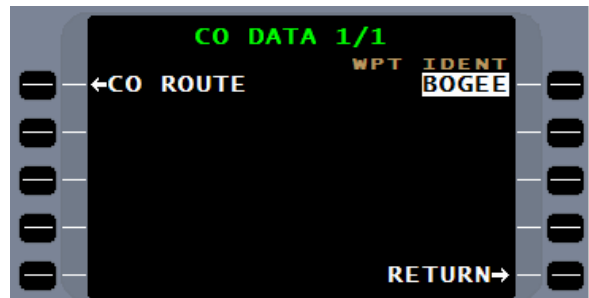
Select the company route to be reviewed and press the **ENTER** key. The route number, name, or a reference fix may be used for selection.



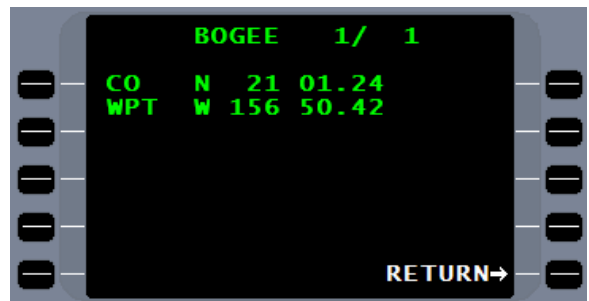
The route structure can be reviewed, but no alteration can take place until the company route is copied into the flightplan function.



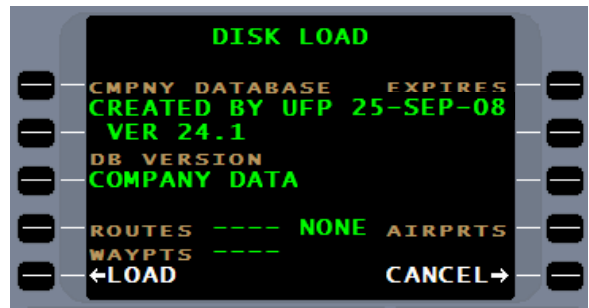
To view the coordinates of a company waypoint, enter the identification of the waypoint into the **WPT IDENT** field and press **ENTER**.



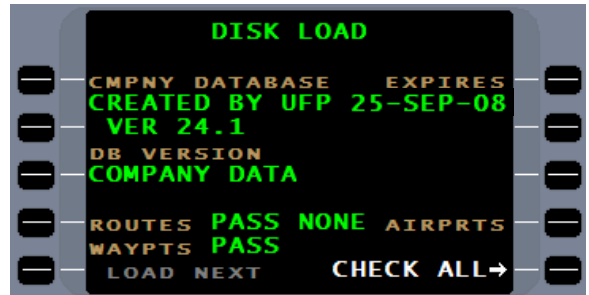
The lat/long coordinates are displayed.



To load the company database, first insure the NAV data for period of the company database is loaded. Then insert the company data disk and press load. If following a NAV database load, press load next. Company data information will be presented. Press load.



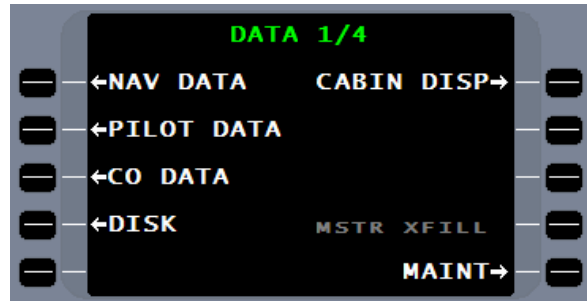
The FMS will load the database and, when testing is complete, a CHECK ALL line select key will be presented. CHECK ALL must be pressed to advance the FMS.



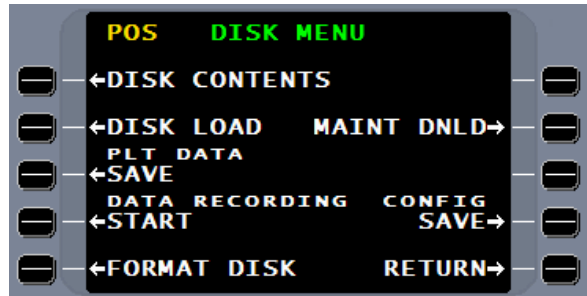
The company database is now loaded.

DATA DISK FUNCTIONS

Press the **DATA** key, and then press the DISK line select key to access the DTU functions.



The **DISK MENU** page provides line select keys for access to DISK CONTENTS, DISK LOAD, PLT DATA SAVE, and FORMAT DISK. The DTU is also used for maintenance functions such as START DATA RECORDING, MAINT DNLD, FLIGHT LOG, and CONFIG SAVE.



The disk format function is available for the reuse of disks when saving pilot data.

Formatting with the SSDTU will automatically add a “uasc” folder to the drive.

CAUTION: Disk format will erase all data in the uasc folder and prepare it for entry of new data.

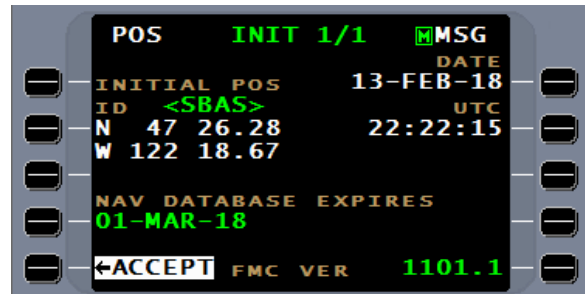
LOADING THE NAV DATABASE

The Solid State Data Transfer Unit (SSDTU) is the primary means of data entry into the FMS. Many DTU 100 units are still in existence, but will be replaced in the future. The SSDTU uses either a flash memory drive or secure digital (SD) card and an Ethernet data bus for a high speed data transfer. The DTU 100 uses one ZIP disk to load the NAV database and an Ethernet data bus for a high speed data transfer. A normal database load should take approximately three minutes for either system. Lift the cover. The DTU 100 is spring loaded to close after inserting the Zip disk. Once power is applied to the FMS both the SSDTU and the DTU 100 are powered and in communication with the NCU. The navigation database will be totally contained on a flash memory drive, SD card, or 100mb or 250mb Zip disk. Use the following procedure to load the NAV database in your FMS.

For the SSDTU, a folder named “uasc” must reside on the flash memory drive or SD card. The NAV data files are placed in the uasc folder. If you download your NAV database from UASC, unzip the NAV data into the uasc folder. A Flash memory drive received from UASC will already contain the uasc folder with the NAV data.

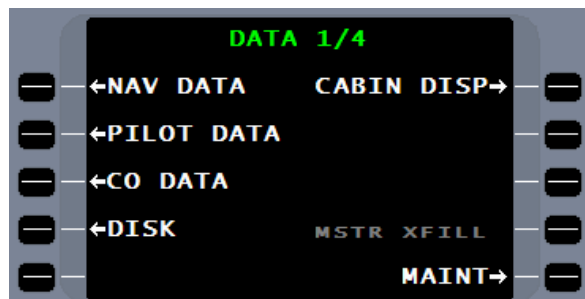
The DISK MENU may be located by two means.

Turn on the FMS. After the FMS completes its power on self-test and the **INIT** page appears, press the **MENU** key.

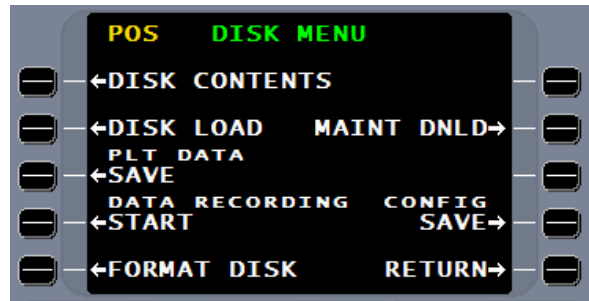


NOTE: The expiration date shown on the initialization page is the expiration date of the ACTIVE database. The expiration date of the newly loaded database will not be shown until it becomes active.

If you are no longer on the INIT page, press the DATA key and you should be on **DATA 1/4**.

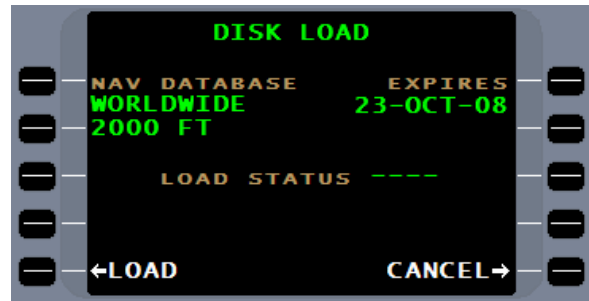


Press the DISK line select key and the **DISK MENU** will appear. Insure the flash memory drive, SD card, or ZIP disk is inserted into the DTU then press DISK LOAD to start the load process.

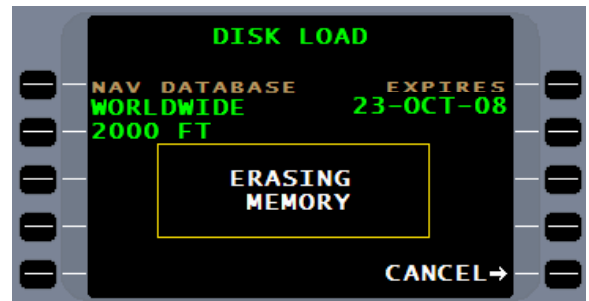


NOTE: The DISK LOAD and PLT DATA SAVE functions are available only when the aircraft is on the ground.

The FMS will read the disk and display the data to be loaded.

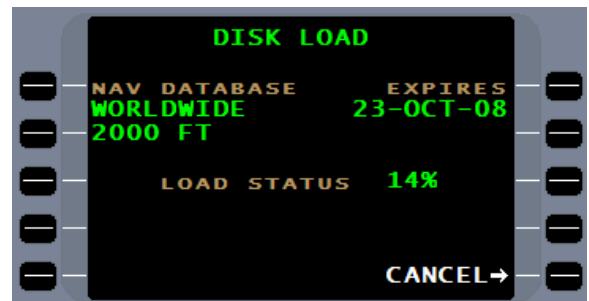


Press LOAD and the FMS will first erase the inactive database preparing it to receive the data to be loaded.

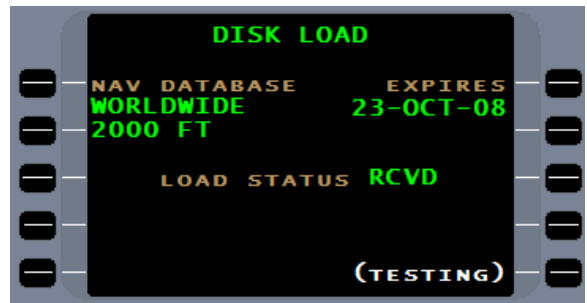


Multi FMS NAV database loads need not be done simultaneously. Pressing LOAD at any time on the number 2 or 3 FMS will load the NAV database independent of the number one system.

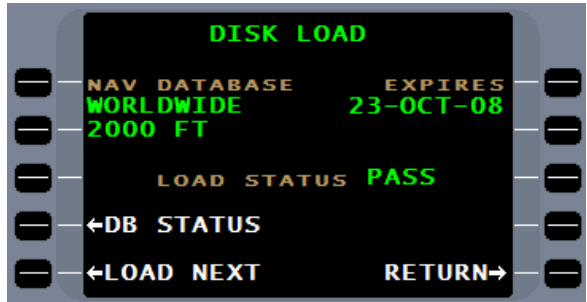
The FMS will load the NAV database with the percent load status being displayed.



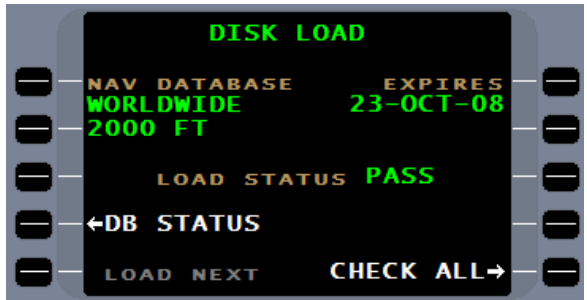
Once download is complete, the FMS will test the download to insure all data is correctly received.



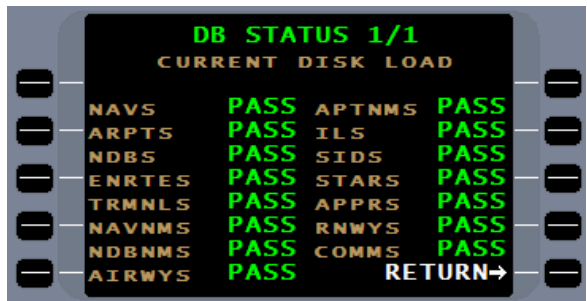
Once the testing is complete, a **LOAD STATUS** of **PASS** or **FAIL** will be presented and the FMS will offer options to load another flash drive, SD card, or ZIP disk such as a company database or view the database status in its entirety.



If the entered NAV database will become the active database, a CHECK ALL line select key will be presented. Press the CHECK ALL line select key to advance the FMS. CHECK ALL will always be present when a current database is loaded.



Pressing the DB STATUS line select key will present the **DB STATUS** page to check the status of the **CURRENT DISK LOAD**.

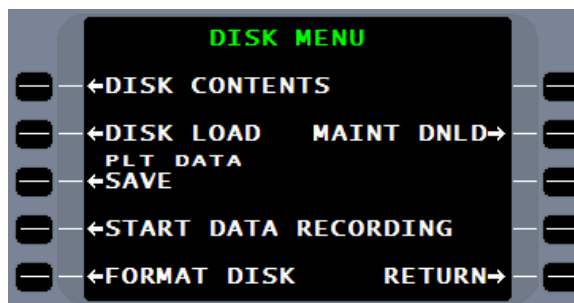


The loading of the NAV Database is now complete.

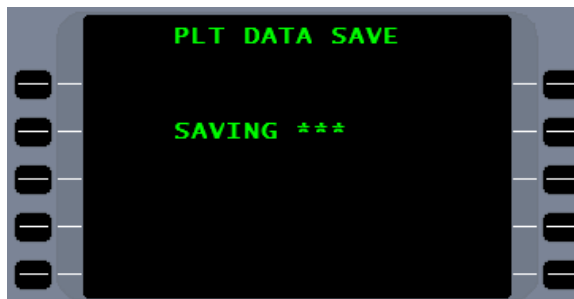
PILOT DATA SAVE

The PLT DATA SAVE line select key provides for the saving of pilot created routes, waypoints, align points, airports, SID, STAR, approaches, and runways. Saving is done through an SSDTU or DTU 100, via a flash memory drive, SD card or ZIP disk. The pilot data save function is a method of transferring data from the FMS to the Universal Flight Planning program. It is also a method of backing up the pilot data for the same reason as backing up a computer hard drive. If a requirement to service the FMS develops, the saved pilot data may be required for reloading of pilot data in the FMS.

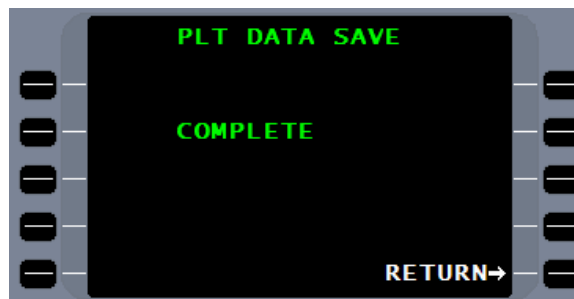
First insert a flash memory drive or SD card with an empty uasc folder or a blank Zip disk into the DTU. Then, press the PLT DATA SAVE line select key. Formatting with the SSDTU will automatically add an empty “uasc” folder to the drive.



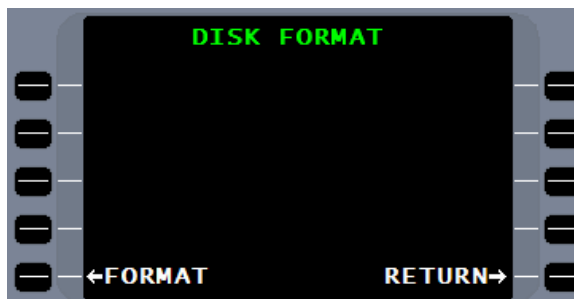
The FMS will first determine if the drive folder or disk is blank, then it will present a **PLT DATA SAVE** page indicating the pilot data is being saved.



When the FMS is completed saving the pilot data, a **COMPLETE** will be presented.



DISK FORMAT can be used to create an empty uasc folder or erase a Zip disk, thus, making it useable to save pilot data. Press the DISK FORMAT line select key on the DISK MENU page and a **DISK FORMAT** page will be presented. Pressing the FORMAT line select key will immediately start the format process. Formatting with the SSDTU will automatically add an empty “uasc” folder to the drive.



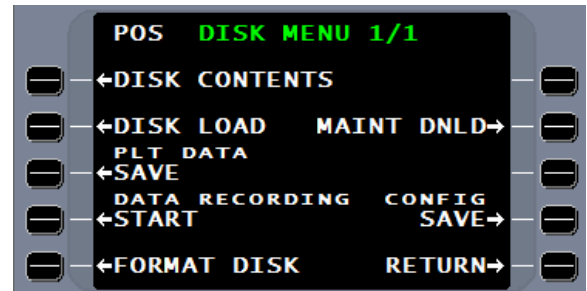
CAUTION: Disk format will erase all data in the uasc folder or on the disk and prepare it for recording.

UPLOADING PILOT DATA

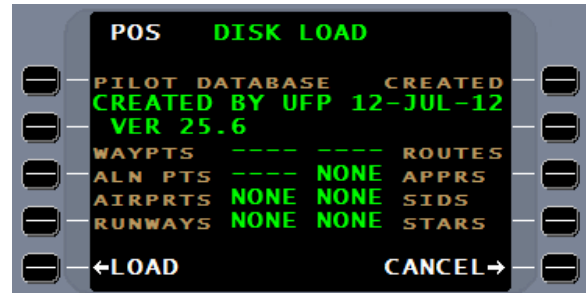
Uploading pilot data from a flash drive, SD card, or Zip disk is done in the same manner as loading a NAV database through the DTU.

CAUTION: Uploading the Pilot database will erase all Pilot data currently on the FMS and replace it with the Pilot data on the flash drive, SD card, or Zip disk.

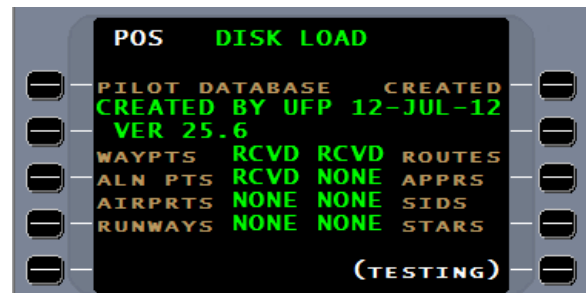
With the data drive inserted in the DTU and on the **DISK MENU** page, press DISK LOAD.



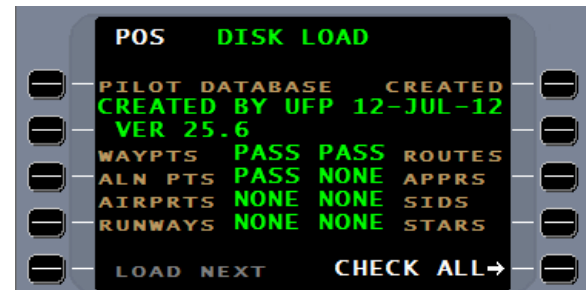
The **DISK LOAD** page will show the PILOT DATABASE and provide the method of creation. Press LOAD to start the upload of Pilot data.



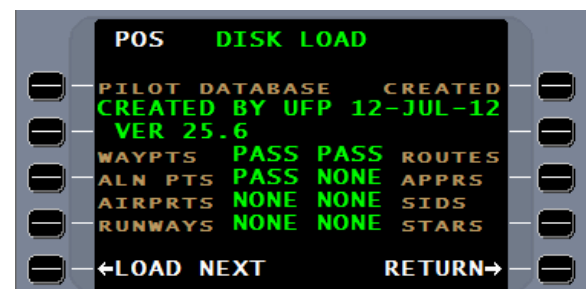
When the data is uploaded **RCVD** will be shown. TESTING will insure accuracy of the upload. When TESTING is complete, **RCVD** will change to **PASS**.



Select CHECK ALL to make the data immediately available. CHECK ALL replaces the test that is normally done during the Power On Self-Test (POST).



When CHECK ALL is complete return to normal operation.

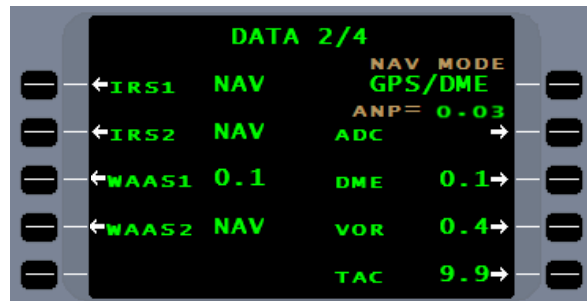


NAVIGATION SENSORS

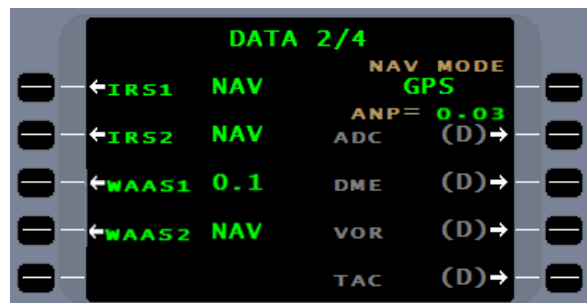
DATA 2/4 is the sensor summary page. Here is displayed the status of all sensors. Through this page is access to sensors for control and more detailed information.

Also displayed are the primary sensors currently in use to calculate the best computed position and the “ANP”, actual navigation performance.

DME, VOR, and TAC status will not be presented in installations where these sensors do not provide inputs to the FMS.



Sensors other than GPS, IRS, or GPIRS will normally be deselected on the ground.



Pressing the line select key adjacent to a NAV sensor will bring up more information about that sensor. Examples are WAAS/SBAS and DME. In SCN 1001/1101 WAAS was updated to SBAS.

The **WAAS1 1/4** information is as follows: the WAAS is in SBAS mode, The number of GPS satellites being used is 12, the integrity is SBAS, the HPL or horizontal protection limit is 27.8m and the HAL or horizontal alert limit is 1852m, the VPL or vertical protection limit is 41.0m and the VAL or vertical alert limit is presented just prior to crossing the final approach fix, HFOM or horizontal figure of merit is 27m, VFOM or vertical figure of merit is 40m, the status line or code 252 is 000000, the error code line or 354 is 000000, and the software version is 0010.0.



NOTE: “WAAS” is replaced by “SBAS” in SCN 1001/1101 and subsequent.

WAAS1 2/4 and **WAAS 3/4** will present satellite information to include satellite vehicle number, azimuth, elevation, signal to noise ratio, and used.

SV#	AZ	EL	SNR	USED
013GPS	310T	54°	44	Y
014GPS	066T	43°	43	Y
020GPS	166T	14°	39	Y
021GPS	065T	42°	43	Y
022GPS	299T	42°	43	Y
024GPS	245T	18°	40	Y
025GPS	240T	06°	36	Y
027GPS	289T	14°	39	Y

RETURN→

SV#	AZ	EL	SNR	USED
122GEO	206T	32°	42	N
134GEO	247T	11°	38	Y
002GPS	322T	10°	38	Y
015GPS	245T	45°	43	Y

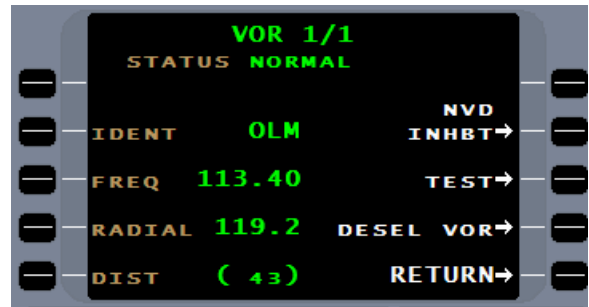
RETURN→

WAAS1 4/4 allows for manual deselection of satellites. This feature should not be used except by qualified avionics technicians. The automatic fault detection and exclusion function will automatically remove unusable or faulty satellites from the WAAS accuracy calculation.

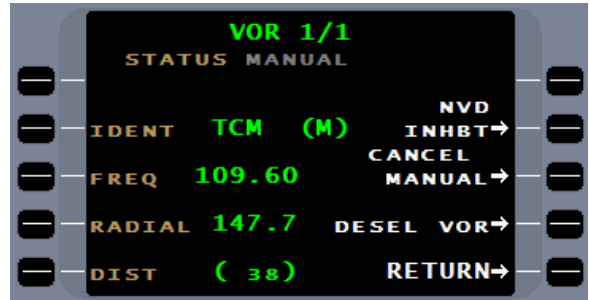
MANUAL	SAT	DESEL	DES	GPS
			SV#	---
GPS			DES	GEO
			SV#	---
	GEO		SEL	GPS
			SV#	---
			SEL	GEO
			SV#	---

RETURN→

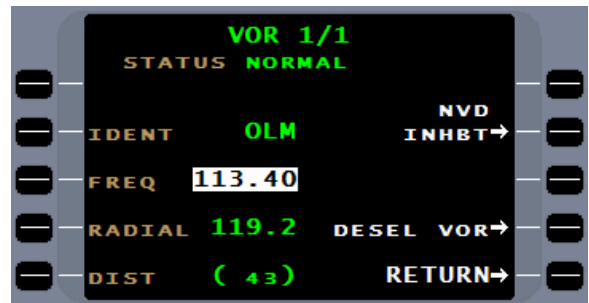
The VOR is primarily used during the flying of a VOR or LOC approach. Enroute, if the FMS can only receive one DME station, the VOR radial of that station will be used to do a Rho – Theta calculation of a lat/long for inclusion in the FMS best computed position. A reasonableness test will be done to ensure the selected VOR is valid.



The VOR can be tuned through the VOR page by use of the LIST function to enter the ident or frequency. The (M) indicates manual selection.

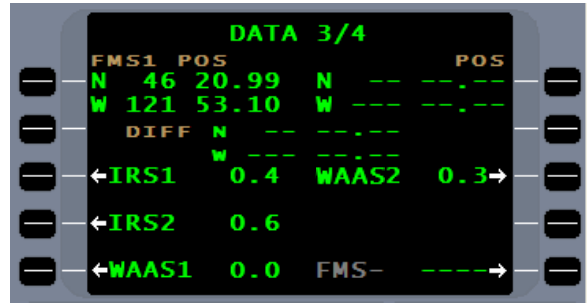


Pressing the TEST line select key will allow the entry of a VOR frequency. This function is primarily used by an avionics technician when integrating the VOR and FMS, but can be used by the pilot to test the remote tuning capability of the FMS and when doing a periodic calibration test of the VOR.

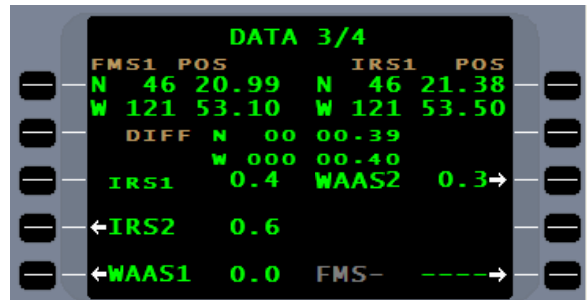


POSITION SUMMARY PAGE

DATA 3/4 is the position summary page. FMS position may be compared to another long range sensor listed by pressing the appropriate line select key. It is primarily used to check the drift of an inertial system.

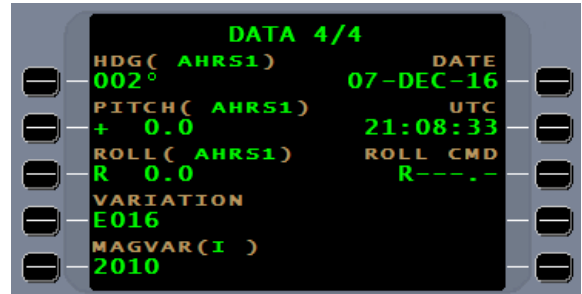


The difference between the two sensors will be computed and displayed.



GENERAL DATA PAGE

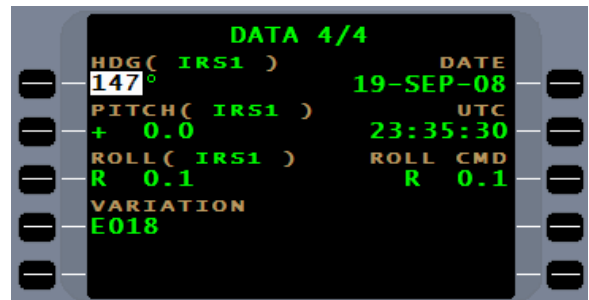
DATA 4/4 is the general data page. Date and time corrections can be entered here after initialization, but should not be necessary as updating is automatic by the GPS when in NAV mode. A manual heading entry can be made here in the event of a system failure. The **PITCH** and **ROLL** lines will display output from and IRS or AHRS if sent to the FMS. Roll command (**ROLL CMD**) is the bank angle output from the FMS to the aircraft FGS. If failed, can be reset at the adjacent line select key (See FMS Trouble Shooting for Pilots).



The magnetic variation is automatically computed and displayed between the latitudes of S60 and N73. If (MAN) is displayed, it indicates the variation displayed is a manually input.

SCN 1001/1101 has added a **MAGVAR** line to show the date of the MAGVAR model. In parentheses the "I" indicates internal (original MAGVAR) model or "DB" indicates database (updated MAGVAR model).

Pressing the HDG data field line select key will bring the cursor into view over the current heading. A manual heading entry may be entered, or the **LIST** function may be selected to change the heading source.



CAUTION: You should only enter a manual heading if you intend to update this field with every heading change made by the aircraft.

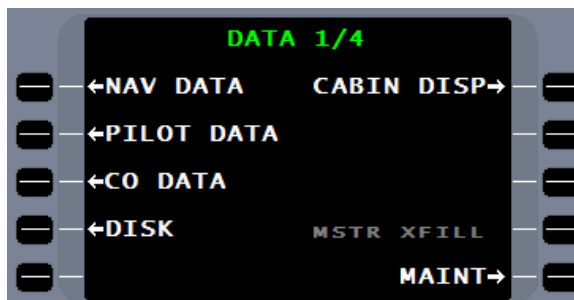
This list shows all heading sources available to the FMS. A different heading source may be manually selected by pressing the appropriate line select key. If a manual heading is entered, to exit the manual heading requires selection of a heading source from the **HDG SRC** page.



If multiple heading sources are available, in the event of loss of the primary source, the FMS will automatically select the back-up source from its priority list.

MAINTENANCE

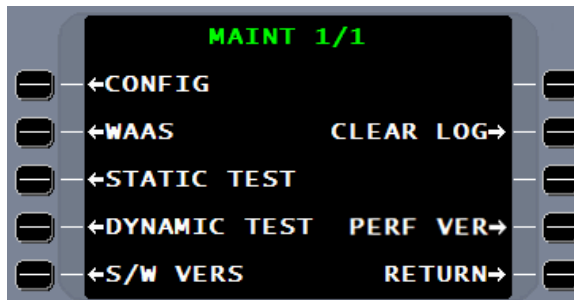
Selection of the MAINT line select key will allow access to the maintenance pages. This function is used during installation to configure and test the FMS. Changing the configuration should only be done by qualified personal and requires an access code to unlock the configuration edit function.



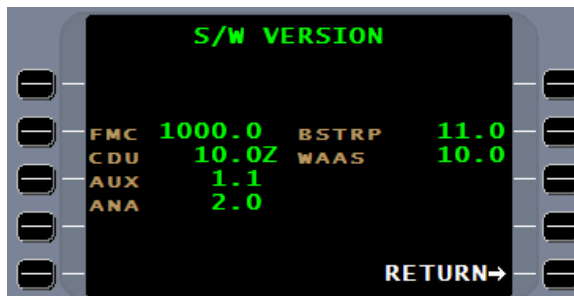
IMPORTANT! The configuration of the FMS should be on file with the aircraft records. If not, press the CONFIG line select key and copy the information on each page or, on the DISK MENU, download the configuration onto a data storage medium then file with the aircraft records. Universal Avionics does not maintain a record of aircraft configurations; **this configuration is necessary for FMS maintenance and software upgrades.**

MAINT 1/1 will allow access to the S/W VERS (Software Version) and PERF VER (Performance Version) line select keys.

CLEAR LOG, STATIC TEST, and DYNAMIC TEST are maintenance functions and are not discussed here.

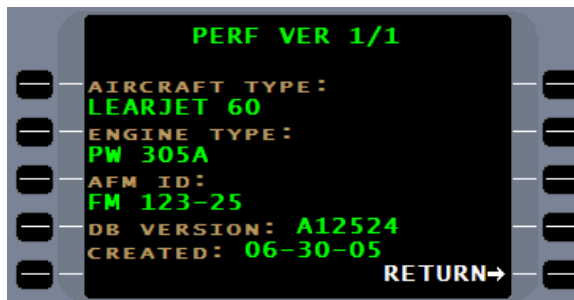


The **S/W VERSION** page will list all software within the FMS and the current version. FMC (Flight Management Computer) is the current operating system on the FMS.



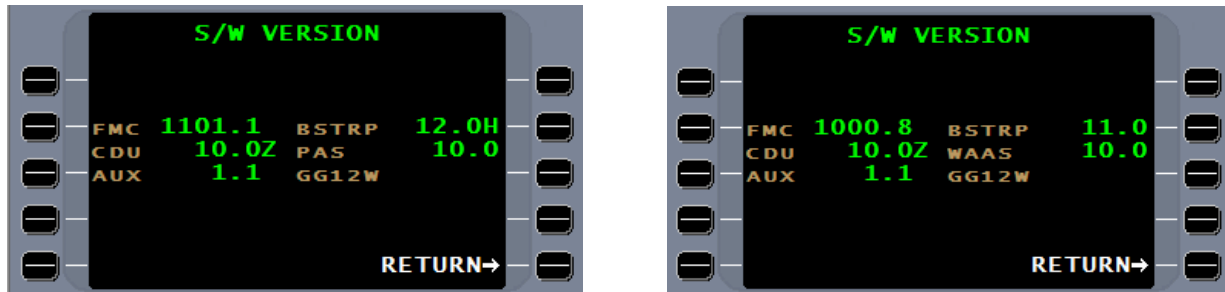
If there is a performance database for aircraft in which the FMS is installed, the **PERF VER** page provides information about that database.

Contact the aircraft OEM for Performance Database availability.



SOFTWARE

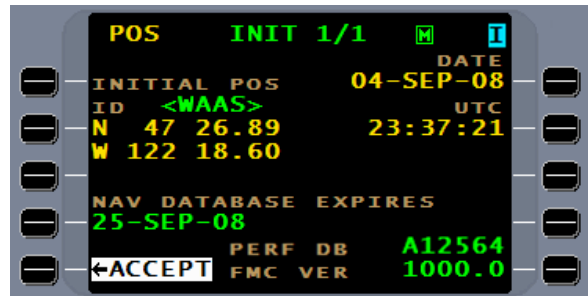
S/W VERSION – The system software version numbers are displayed as follows (these are for information only):



- **FMC** – Flight Management Computer, the system software version number. The basic software version number will be followed by a decimal point and number (1000.1). The original software release will be “.0”, and any subsequent variations on that basic software will be “.1”, “.2”, etc. These variations of the basic software version will contain changes of minor impact only and should not require a new Supplemental Type Certificate (STC), as operational features will be unaffected, but the need for an STC is controlled by the CAA certification office.
- **CDU** – Control and Display Unit software
- **AUX** – Software version number of the AUX processor in the FMS
- **ANA** – Analog-to-digital input board software version number, when installed
- **BSTRP** – Bootstrap software version
- **WAAS** – The SBAS software version
- **ARINC** – Software version number of the ARINC board
- **ASCB** – Software version of the ASCB Board, when installed
- **ERP** – Appears in lieu of RTU when EFIS Radar Panel is installed
- **RTU** – For configurations with the optional frequency management capabilities, this is the radio tuning unit software version number.
- **GG12W - Thales Navigation SkyNav GG12W GPS/SBAS**

SYNCHRONOUS DUAL FMS OPERATIONS

A configuration option in dual FMS installations is synchronous. Synchronous dual FMS operations allow for a two FMS installation to appear to operate as one. The two FMS can be operated in independent mode or SYNC mode. When in independent mode, an “I” will appear in the upper right corner.



The FMS may be configured to start in either Synchronous or Independent mode.

SYNC mode will automatically transfer the following data between the two FMS:

- Flightplan entry or modification
- Direct To (DTO) operations
- Selective Crosstrack (SXTK)
- Vertical Navigation (VNAV)
- Command Heading
- Pseudo VOR (PVOR)
- Temperature Compensation
- Manual RNP entry
- FMS approach arm and activation
- Manual leg changes
- Fuel page 1 entries and local time difference on Fuel page 2
- Approach tuning for NAV radios when tune prompt is manually selected.

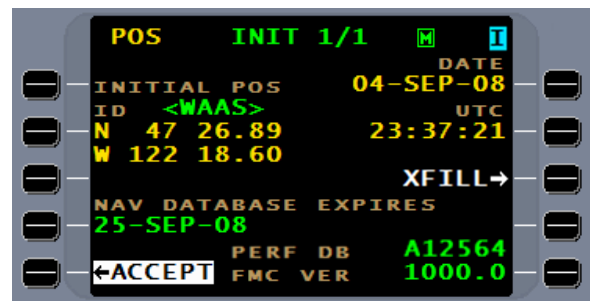
When in SYNC mode, each FMS will maintain its own navigation, sensor monitoring, databases, performance, and radio management. Navigation cues will be independent (time-to-go, distance-to-waypoint, crosstrack error, bearing-to-waypoint, etc.). Moving map displays will be independent. The message function will be independent. Manual selections of pilot preferences such as map display of missed-approach and EFIS scaling will be independent.

Because each FMS is navigating independently even while in SYNC mode, it is possible for one FMS to leg sequence slightly ahead or behind the other FMS.

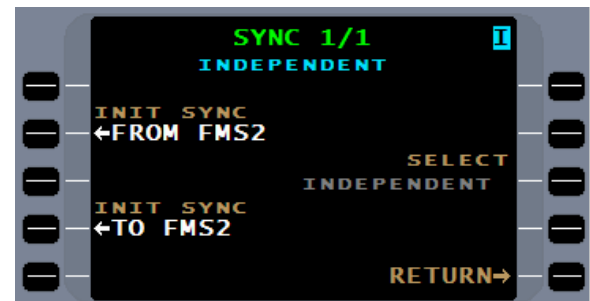
NOTE: Sync mode will not be available for Special Missions mode (SCN 110X). Search pattern operation will be independent.

NOTE: For triple FMS installations, Sync mode will be available for only two of the FMS. Communication with the third FMS can be established through Crossfill.

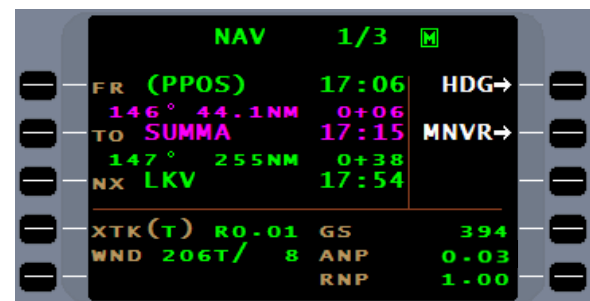
When configured for synchronous operation, the limited crossfill functions available are initial, tune presets, and ADC. All other crossfill functions are part of synchronous operations. With the acceptance of one initial page, crossfill becomes available. Crossfill with pull configurations is displayed to the right. In triple FMS installations, only two FMS can be configured for SYNC mode, the third FMS is configured for crossfill and can receive information from the other two FMS by normal crossfill.



After accepting the INIT page and so configured, the two FMS will automatically attempt to synchronize; a “SYNC IN PROGRESS” message may be displayed at this time. To manually initiate synchronous operations, select the NAV menu and the SYNC option. Choose the direction for the first transfer of information. If current navigational information is on FMS 1, to sync FMS 2 with FMS 1, select TO FMS2. This will send FMS 1 information to FMS 2. After the initial sync, inputs on either CDU will automatically be transferred to the other. Synchronous operation can be initiated from either FMS.



When in synchronous operation, the “I” will disappear and any NAV, VNAV, flightplan, or fuel inputs on one FMS control display unit (CDU) will automatically be sent to the other FMS and be displayed on that CDU. When in synchronous operation, INDEPENDENT can be initiated from the SYNC option on the NAV menu and will require pushing the line select key twice. An “FMS SYNC LOSS” message will appear if loss of the FMS sync mode occurs that was not initiated by the pilot.



An FMS in SYNC mode will remain in SYNC mode at approach activation.

When two FMS are synced, there are three reasons the FMS may revert to independent mode

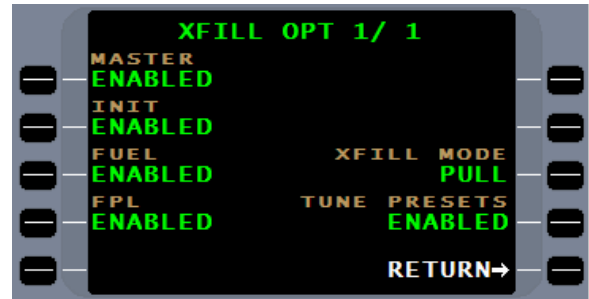
1. Both pilots are entering data on the CDU at the same time.
2. There is a communications fault when processing a sync event
3. When during an exchange of flightplan status there is a miss compare between the two FMS. Example FMS 1 has 20 legs and FMS 2 has 19 legs. A re-initiation of SYNC mode will be needed to resolve the miss-compare.

“XFILL” IN MULTIPLE FMS INSTALLATIONS

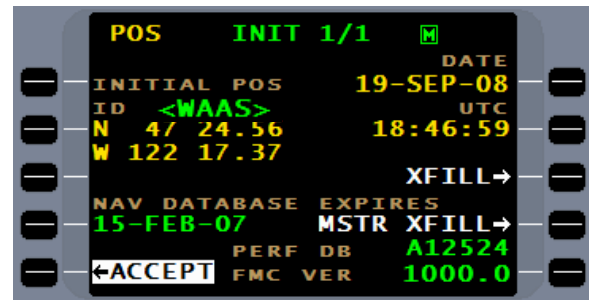
In multiple FMS installations, a “XFILL” option will be available (if so configured) to crossfill initialization, flightplan, and fuel data. In addition, other Xfill features are available when needed by the pilot.

NOTE: With synchronous mode configured in dual FMS operations, crossfill will be automatic and manual crossfill will not be available for many functions.

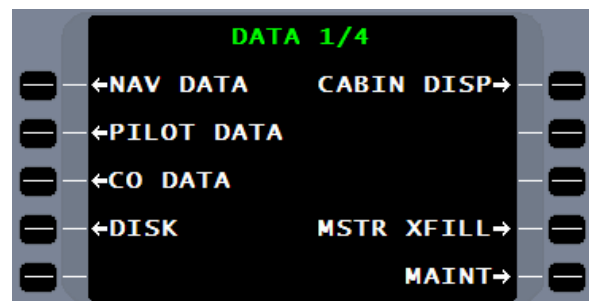
The FMS can be configured by maintenance for either PUSH or PULL. With the PUSH mode the transmitting FMS will initiate the crossfill process. With the PULL mode the receiving FMS will initiate the process. The PULL configuration is the default configuration.



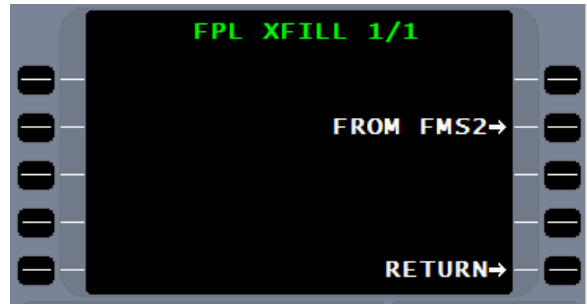
On the initial page MSTR XFILL and XFILL are options that can be selected. XFILL will crossfill date, time, and position. The MSTR XFILL will crossfill initial page, flightplan, and fuel information. Through the crossfill bus each FMS is made aware of the crossfill status of the other FMS. Before the MSTR XFILL option is made available the transmitting FMS must show that initialization, flightplan, and fuel information is complete and available. Also, with the PULL option selected, the receiving FMS should not be initialized. The procedure for the receiving FMS is to turn it on only, do not activate the ACCEPT key.



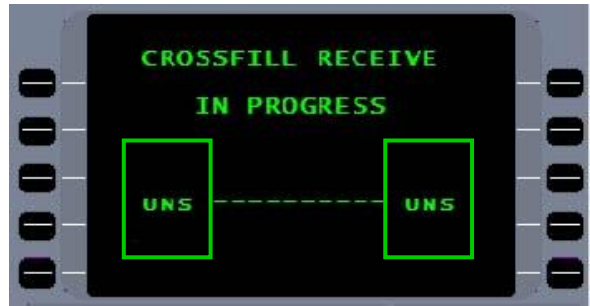
If the accept key is pressed, on **DATA 1/4** the MSTR XFILL option is also available. With the pull option configured, pressing this MSTR XFILL will execute the crossfill and return to the initial page. With the push option configured, use this MSTR XFILL to push data to the other FMS.



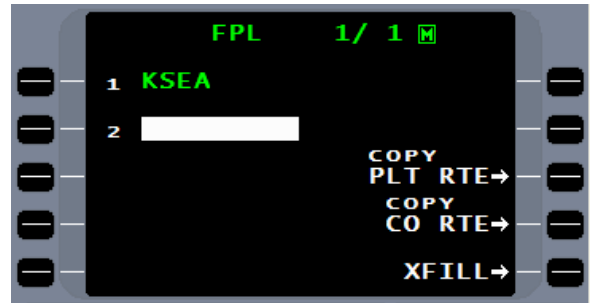
On a dual installation, a crossfill request will result in the presentation of a **FPL XFILL** page with a line select key for a "TO" or "FROM" the other FMS. With a triple FMS installation a crossfill request will be followed by the presentation of the dual crossfill screen. The specific FMS must be selected for crossfill to continue. A FROM will be presented in a PULL mode and a TO will be presented in a PUSH mode.



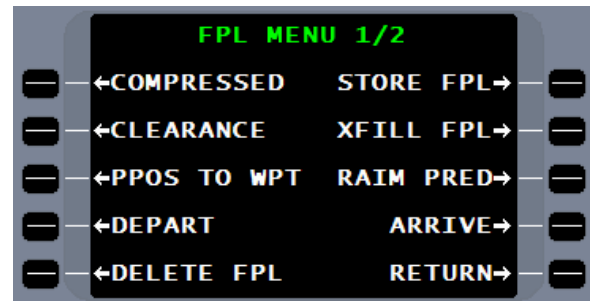
When crossfill commences, a CROSSFILL RECEIVE page will be presented showing that the crossfill is in progress. This page will remain until the crossfill is complete.



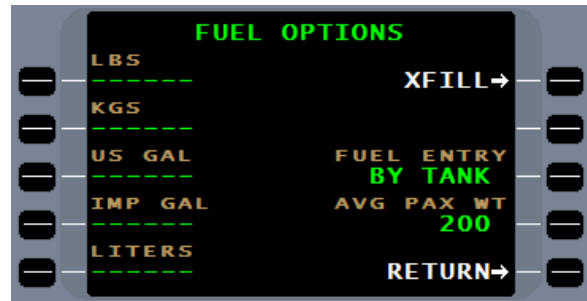
When an empty flightplan exists, a flightplan PULL mode XFILL option is available on FPL page one. Pressing the XFILL line select key will pull the flightplan from the other FMS.



A XFILL FPL option exists on the **FPL MENU 1/2** page to crossfill a flightplan following a flightplan edit; use the FPL MENU XFILL FPL line select key. A crossfill of the flightplan will overwrite the existing flightplan.

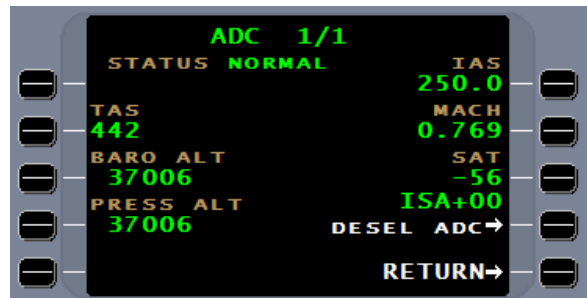


To crossfill fuel information requires selection of the **FUEL OPTIONS** menu. Selecting the XFILL line select key will crossfill all information on FUEL 1/5 and destination local time difference from FUEL 2/5.



In addition to the above crossfill capabilities, in multiple FMS configuration, one FMS will monitor position and NAV sensor information of the other FMS(s) and notify the pilot if a discrepancy occurs.

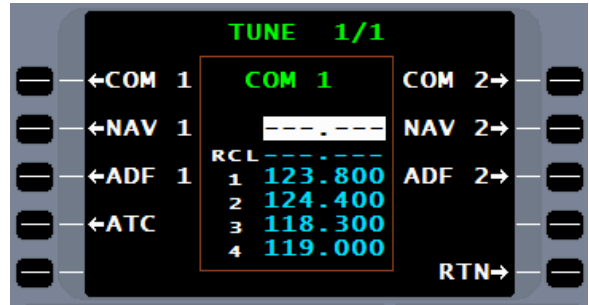
Air Data Computer information, including TAS, SAT, and Altitude, in one FMS can be crossfilled to another FMS through a XFILL line select key if the aircraft has dual air data computers. The receiving FMS ADC page will indicate that the data is crossfill data. In addition, the XFILL line select key of the transmitting FMS will disappear. The receiving FMS XFILL line select key will change to LOCAL allowing for selection of the FMS own ADC. Also on the receiving FMS, when crossfill is in effect, IAS and Mach data will disappear.



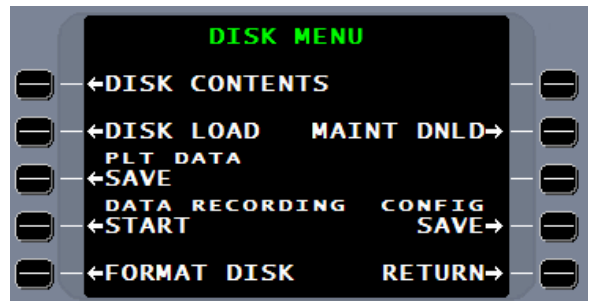
On DATA page 4, pressing the heading line select key followed by the **LIST** key will produce the HDG SRC page. The line select key, FMS 2, when selected, will crossfill the heading source used by FMS 2 to FMS 1. The transmitting FMS ability to crossfill will now disappear thus preventing the FMS from selecting each other when no heading source exists.



In a multiple FMS configuration the pilot stored pre-select frequencies will automatically be sent to the other FMS(s) via the crossfill bus unless this option has been disabled through the crossfill configuration page.



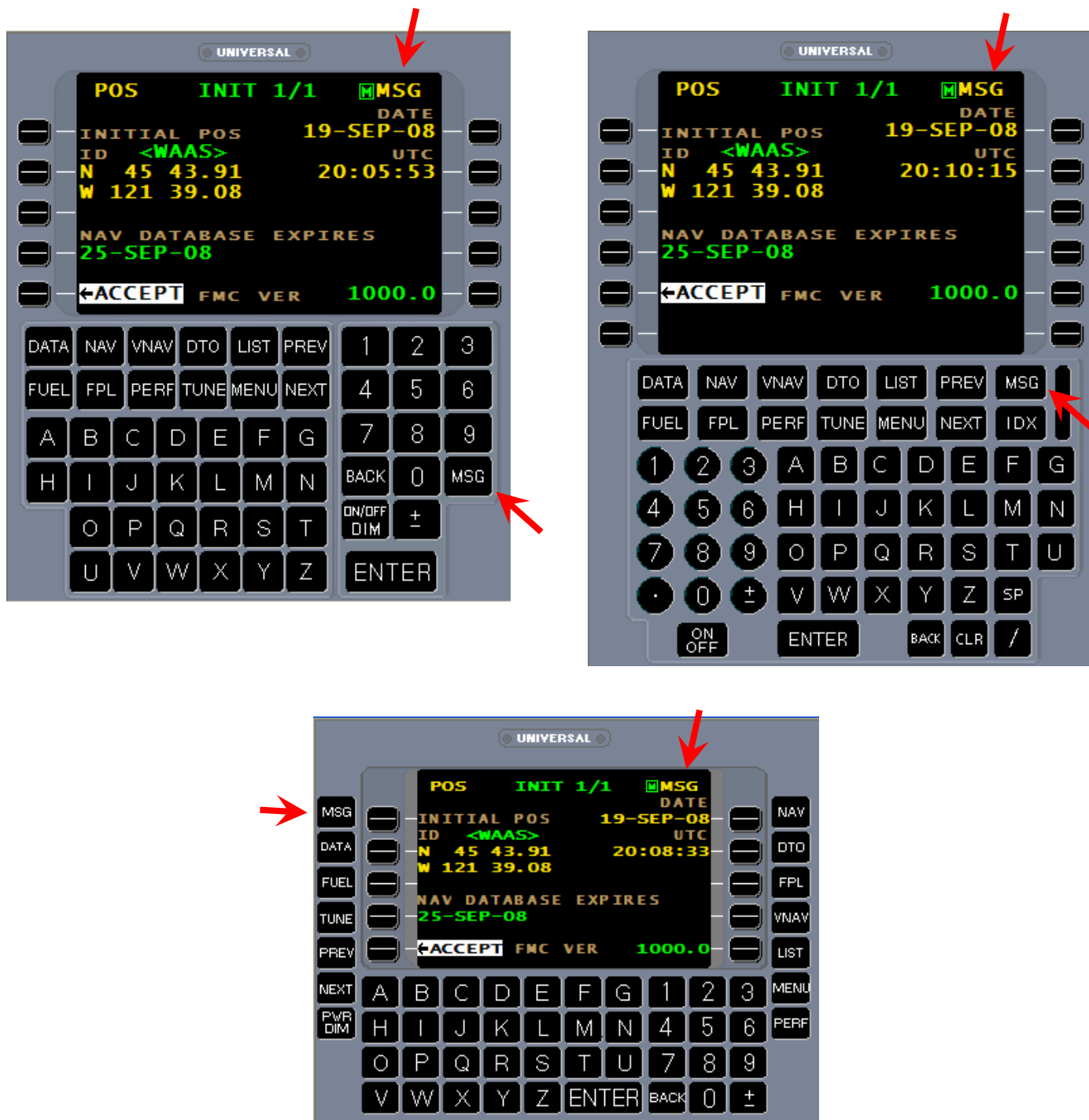
In multiple FMS installations, there exists the ability to load the NAV database into all FMS. It is not necessary to synchronize the data load process, just push DISK LOAD on the selected FMS at any time and the FMS will load the NAV database.



MESSAGE (MSG) FUNCTION

A message annunciator on the instrument panel or EFIS along with a flashing MSG in the upper right corner on the FMS display will announce the presence of a new message on the MSG page.

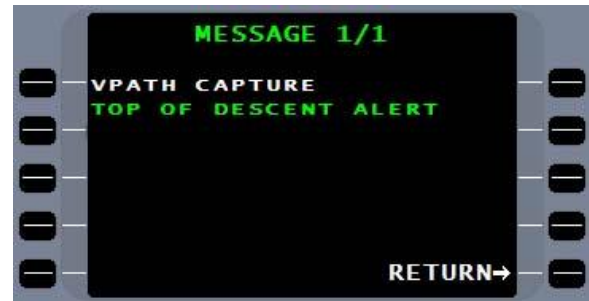
By pressing the **MSG** key, located to the lower right of the numeric keys on the 1Ew and 1Fw with both CDU and MCDU, and the upper left of the CDU on the 1Lw, the message page will be presented.



Messages displayed on the message page will be color-coded. The specific color will depend on FMS DISPLAY configuration. A message presented for the first time will be in either white or amber. Some messages will drop off after the first interrogation of the message page or if the message is automatically resolved.



Other messages will reappear until the condition is corrected or changed. After the first interrogation, these messages will reappear in green or white.



FMS DISPLAYED MESSAGES

INTRODUCTION

This section contains the FMS system messages. Each message the system can display is detailed below, including any action(s) that may be necessary by the crew to correct the abnormality. A box around the procedures following the message definition indicates crew action. No action is specified for messages that are of an advisory nature only.

MSG KEY

If the Position Uncertain message is active, "POS" will be displayed on the far left side of the top line on the CDU display. When a new system message becomes active, "MSG" will appear on the far right side of the top line on the CDU display. Pressing the MSG key will cause the MESSAGE page to be displayed showing the active messages. The current messages (those messages generated since the page was last accessed) will be displayed at the top of the list. After the messages are viewed, the CDU display is returned to the previous page by selecting the RETURN option on the MESSAGE page or by pressing either the MSG or BACK keys.

SYSTEM MESSAGES

System messages are presented in alphabetical order on the following pages. Messages specifying the sensor number (GPS1, IRS2 and LCS2) are listed below with the number symbol (#) in place of the sensor number. However, the sensor number is used in the actual message. All messages are suppressed for the first thirty seconds after takeoff in order to minimize distractions to the pilot.

A/D CODE # – The A/D (Analog/Digital Board) self-test failed during self-test. "#" is the error code from 1 to 9. This message will only appear following system initialization. Heading and fuel flow inputs may be affected and should be checked if the system must be used. Codes are as follows:

- A/D Program Checksum Fail
- +15 VDC Self-test Fail
- -15 VDC Self-test Fail
- No Communication between A/D board and FMS

A/D HEADING FAIL – The present system heading source, A/D (synchro analog-to-digital), was serving as the primary heading source but has failed. This message will be removed after it is displayed. Unless a NO HEADING message is also active, the system will have automatically selected another valid heading source. No action is necessary if another valid heading was selected. A check should be made on the appropriate Data Page to ensure that the heading source selected is the one desired and the heading is correct. This message is suppressed while the aircraft is on the ground.

Check the heading source on Data Page 4:

1. Press [DATA], then [NEXT] to display Data Page 4.
2. Press LSK [1L].
3. Press [LIST] to access a display of alternate heading sources.
4. Select an alternate heading source and press [ENTER].
5. Or, enter a manual heading in the HDG field on Data Page 4.

ABEAM WAYPOINT ALERT – This message is displayed fifteen seconds prior to the sequencing time for an abeam intersection.

ABNORMAL CKLIST DB FAIL – Appears if the abnormal Checklist Database has failed (only with Collins Pro Line 4 800 configuration).

Reload the Checklist Database.

ADC ALT REQD FOR APRCH – Approach is active and the pilot has selected either a manual or crossfill altitude, which cannot be used for approach guidance.

ADC ALT REQD FOR VNAV – VNAV mode is either cruise or descent and the pilot has selected either a manual or crossfill altitude, which cannot be used for VNAV guidance.

ADC INPUT FAIL – An Air Data Computer (ADC) failure is detected. If the failure cannot be cleared, manual entries of TAS and altitude may be made on ADC Page 1.

1. Press [DATA], then [NEXT] to display Data Page 2.
2. Press the LSK at ADC to access ADC Page 1.
3. Press LSK [2L]. Enter current true airspeed. A manual TAS overrides any ADC input.
4. Press LSK [3L]. Enter the current BARO altitude.
5. TAS and altitude inputs must be updated as required.
6. If a second FMS is installed, air data may be crossfilled from the other system.

NOTE: Without valid air data inputs to the FMS, VNAV is not available and any leg type terminators requiring altitudes will not be sequenced.

AHRS # HEADING FAIL – The AHRS heading has failed while in use as the FMS heading source. This message is suppressed while the aircraft is on the ground.

7. Press [DATA] / [PREV] / LSK [1L].
8. Press [LIST] to access a display of alternate heading sources.
9. Select an alternate heading source and press [ENTER].

AHRS # INPUT FAIL – The AHRS input has failed or its status word indicates failure.

AIRPORT DATABASE FAIL – A problem has been found in the airport section of the Navigation Database. Verify airport coordinates of interest. There is a high probability that the system will fail the initial self-tests the next time it is turned on. After landing and shutdown, turn the system off and then on again in order to troubleshoot.

Reload the Navigation Database.

AIRWAY DATABASE FAIL – A problem has been detected in the airway section of the Navigation Database.

Reload the Navigation Database.

ALERter ABOVE VNAV ALT – In the Primus 1000 installation, VNAV is in descent mode and the altitude alerter has been dialed above the VNAV altitude.

ALERter ALT INVALID – In the Primus installation for Cessna Excel, the selected altitude is either not received over the Primus input bus or it is invalid. This message will display until alerter altitude is received and valid.

ALIGN PT DATABASE FAIL – A problem has been detected in the alignment waypoints database.

Reload Pilot Defined Database.

ALT INVALID FOR VNAV – VNAV is in descent mode, but (1) only pressure altitude is available and the aircraft is below 18,000 feet, or (2) ADC altitude has failed.

ALTITUDE INVALID – The ADC altitude input is invalid. This message is suppressed while a GWS approach is active since baro altitude is not used for guidance. A manual entry of altitude may be made on the ADC Status Page.

10. Press [DATA], then [NEXT] to display Data Page 2.
11. Press the LSK adjacent to ADC to access the ADC Status Page.
12. Press LSK [3L]. Enter the current BARO altitude.

ANALOG ATTITUDE FAIL – Displayed if analog inputs are being used for Doppler navigation and become invalid for more than five seconds. This message remains while inputs are invalid.
ANALOG BOARD FAIL – A failure is detected on the Analog Board. The outputs to the HSI may be affected, and depending upon installation, heading and fuel flow in some systems may also be affected. Verify on the Data Pages that the heading, TAS, and altitude inputs are reasonable.

13. Press [DATA], then [NEXT] to display Data Page 2.
14. Press the LSK adjacent to ADC to access the ADC Status Page.
15. Verify TAS and altitude.
16. Press [DATA], then [NEXT] to display Data Page 4.
17. Verify HDG.
 If HSI is analog type, do not use for navigation display.

ANALOG INST FAIL – The Analog Waypoint Bearing or Desired Track self test has failed or the instrument reference is missing.

APC INPUT FAIL – In the RC-135 aircraft installation, the aircraft performance computer (APC) Receive Bus is configured but no signal has been received for three seconds.

APC STATUS – In the RC-135 aircraft installation, the APC has detected a partial failure or sensor input failure.

APPR FACILITY INVALID – Presented with no message annunciator if the approach facility becomes invalid during an approach.

APPROACH DATABASE FAIL – A problem has been detected in the approach section of the Navigation Database that has rendered it unusable.

Reload the Navigation Database.

APPROACH IN USE – The currently accessed approach is in use in the flight plan and cannot be modified or deleted.

APPROACH SEGMENT FULL – A leg has been inserted into the approach segment and the approach segment leg limit has been reached.

ARPT COMS DATABASE FAIL – A failure has been detected in the airport communications section of the Navigation Database. Access to some airport communications will be prevented.

Reload the Navigation Database.

ARPT NAME DATABASE FAIL – A failure has been detected in the airport geographical names database. Access to some airport names will be prevented.

Reload the Navigation Database.

AUXILIARY BOARD FAIL – The Auxiliary Board has failed self test.

BACKUP DATABASE FAIL – The backup navaid database has failed.

BARO ALT NOT AVAILABLE – Barometric altitude is not available from installation of an ADC without barometric altitude or from loss of barometric altitude. This message will clear after acknowledgement or when the condition clears.

CANCELED LOC STEERING – This message is displayed when prior to the FAF and a LOC, or BC approach is active and the localizer signal and computed crosstrack has exceeded limits.

CDU DATA BUS FAIL – This message is generated by the CDU when it has not been refreshed by the FMS. The message indicates that the CDU is functioning properly and that either an FMS problem or a wiring problem might exist.

18. Press [ON/OFF/DIM] to power down the FMS (do NOT use the circuit breaker to cycle power to the FMS, and do NOT secure power to the aircraft without first properly powering down the FMS).
19. Press [ON/OFF/DIM] to power-up the FMS again and observe the indicators and annunciators for the FMS power-up self-test.
20. If the CDU DATA BUS FAIL message appears again and the FMS power-up self test occurs normally, a wiring problem exists.
21. If the CDU DATA BUS FAIL message appears again and the FMS power-up self test does not occur, then a problem exists with the FMS.

CFG DATA LOAD MODIFIED – The FMS configuration data loaded from disk does not fully specify all configuration parameters. The FMS retains existing settings for undefined parameters. This condition occurs when the disk revision number is less than the FMS revision number.

CKLIST DATABASES FAIL – Appears if all Checklist Databases have failed (only with Collins Pro Line 4 interface).

Reload the Checklist Database.

CLOCK TIMER FAIL – The clock timer on the CPU board has failed self-test.

COMP ARPTS DATABASE FAIL – A part or the entire company airports database has failed.

COMP ROUTE DATABASE FAIL – A part or the entire company route database has failed.

COMP WPTS DATABASE FAIL – A part or the entire company waypoints database has failed.

CONFIG DATA FAILED – The FMS configuration data has failed.

CONFIG MODULE FAILED – Communication with or data in the configuration module has failed. Attempt to store configuration to determine cause.

CONFIG UPDATE REQUIRED – Configuration module and FMS configuration data has failed, requiring the FMS to be configured for installation.

CREW CKLIST DB FAIL – Appears if the crew notes database has failed (only with Collins Pro Line 4 interface).

CROSSFILL FAIL: BAD DATA – A flight plan crossfill task has failed due to a communications error.

CROSSFILL FAIL: BUS – A crossfill task has failed due to a crossfill bus timing out or an ARINC board failure.

CROSSFILL FAIL: FPL CHGD – A flight plan crossfill task has failed due to the flight plan being edited in the other FMS during crossfill.

CSDB SELFTEST FAIL – CSDB serial ports have failed self test. VOR, DME, or RTU function may be disabled.

CURRENT LEG EXTENDED – Presented when the aircraft flies past the terminator of the current leg and no next leg is defined, resulting in guidance displays being an extension of the current leg. TO/FROM will show FROM and distance from waypoint will increase.

DATABASE CORRECTING – A minor failure has been detected in the database and an error correcting process is being run. Access to the database is restricted until the correction process has been completed and the database passes its self-test.

DATABASE EXPIRED – The current date is past the Navigation Database Expiration Date as displayed on the Initialization Page and the Data Pages.

Load an up-to-date Navigation Database.

DATABASE FAIL – Part or all of the Navigation Database has failed.

Reload the Navigation Database.

DATABASE FULL – The particular Pilot Defined Database (SID, STAR or Approach) is full and a procedure is created or modified that exceeds the database capacity.

DATABASE VAX LOADED – The database was loaded from a VAX host computer instead of a DDU.

DEAD RECKONING MODE – (DR) True air speed and heading are the only sensors being used for navigation.

DEMONSTRATION MODE – The aircraft identification is configured as “DEMO” and sensor data is simulated internally.

Do NOT use this FMS for navigation.

DISCRETE I/O FAIL – The discrete input/output self-test has failed.

DISK FORMAT FAILURE – An attempt to format a disk was unsuccessful. This message will only be displayed when not in the disk submenu.

DISK FULL - REPLACE IT – The disk in the DTU has become full while Data Recording was active and a Disk Page is not currently displayed. If a Disk Page was displayed when the disk became full, then the message is displayed on a Disk Error Page.

DISK WRITE FAILURE – An attempt to write to a disk in the DTU was unsuccessful. This message will only occur when a Disk submenu page is not being displayed.

DME TUNE FAIL – An ARINC 709 series DME has not tuned to the pilot requested frequency. The message appears regardless of the select status of the DME and is cleared when the radio successfully tunes.

DOPLR MODE CONTROL FAULT – Doppler status is a state other than that commanded for more than ten seconds.

DOPPLER ARINC FAIL – One or more specific labels from the Doppler have not been received by the FMS for ten seconds. The message will clear once the label(s) are read.

DOPPLER BASED DR – All sensors except Doppler are deselected or failed.

DOPPLER DESELECT – The specified Doppler data is questionable and has been deselected for navigation.

DOPPLER FAIL – Doppler is selected and has failed.

EFIS #1 SEL HDG FAIL – The pilot's heading bug input from the Collins EFIS has failed.

EFIS #2 SEL HDG FAIL – The copilot's heading bug input from the Collins EFIS has failed.

EMERGENCY CKLIST DB FAIL – Appears if the emergency Checklist Database has failed (only with Collins Pro Line 4 interface).

ENROUTES DATABASE FAIL – The enroute intersections section of the Navigation Database has failed.

Reload the Navigation Database.

ENROUTES COMS DATABASE FAIL – The enroute communications section of the Navigation Database has failed.

Reload the Navigation Database.

ERP # FAIL – This message will be on the #1 FMS if the #1 EFIS Radar Panel (ERP) has failed. The message will be on the #2 FMS if the #2 ERP has failed (only with Collins Pro Line 4 interface).

ETP ALERT – This message displays when the distance to go (DTG) to the equal time point (ETP) is five nm.

FMC BATTERY LOW – Self test has detected that the FMC battery is low. Navigation is still possible; however, at shutdown the position, date and time may be lost.

Return the FMS to UASC for repair.

FMC DATALINK QUEUE FULL – The FMC datalink queue is full and subsequent FMC transmission attempts may result in the loss of the datalink message.

FMS # GLS MISMATCH – GLS and FMS deviations differ by more than one dot (that is, 10°).

FMS-BC DIFFERENCE WARN – The FMS is in approach mode on a backcourse type approach and the track angle error is less than 3°, crosstrack error is less than 0.2 nm and the localizer deviation is greater than 0.039 DDM (1/2 dot).

FMS DIFFERENCE > xxNM – The sensor "watchdog" has sensed that the latitude/longitude positions of the two systems in a dual installation differ from each other by an amount that warrants pilot attention. "xx" can be six, twelve, eighteen or twenty-four nm. Since both FMSs normally use the same sensors, this should not happen. If it does:

22. Check the NAV Pages on each FMS and follow the system displaying the smallest difference between the FMS and sensor latitude/longitude positions.

23. If the FMS are using different sensor inputs, refer to Navigation Sensor Accuracy Messages in the Abnormal Procedures section.

FMS-FLOC DIFF WARN – During an FMS-ILS approach, the aircraft is inbound on the same desired track as the ILS, and FMS deviation is less than 0.2 nm while ILS localizer deviation is greater than 1/2 dot.

Select FHDG mode and manually steer the aircraft to intercept the ILS localizer.

FMS INIT NOT COMPLETE – A disallowed mode key was pressed while on the Disk Menu Page when it was accessed from the Initialization Page. Only the TUNE and MSG keys are allowed.

FMS NETWORK COMM FAIL – Indicates the FMS internally programmed Ethernet address has failed. The FMS will operate normally but cannot communicate with the DTU or other line replaceable units on the network.

FMS OVERTEMP – The internal NCU temperature rises above a preset hardware limit. This message will be inhibited while Approach is Active. This message is removed from the MSG page when the temperature falls below the hardware limit.

FMS PART NUMBER MISMATCH – The FMS installed has a different part number from that stored in the configuration module. Verify installation is correct.

FMS SYNC LOSS – FMS displays this message whenever synchronized operation has terminated without flight crew selecting INDEPENDENT on the SYNC Page. This message may occur when a manual synchronization fails, when an automatic synchronization update occurs and fails (such as initial synchronization upon power-up and the offside FMS is not yet powered-up, or any other pilot action which updates the synchronization mode).

FPL CAPACITY EXCEEDED – The pilot attempted to enter more than 98 waypoints in a flight plan.

FPL DISK MINOR ERROR – When a flight plan disk is loaded, the number of records found on the disk do not match the number of records in the header file on the disk. The flight plan should be completely reviewed for accuracy.

FUELFLOW FAIL – A fuel flow failure is detected. Manual fuel flow entries may be made.

FUEL FLOW SELFTEST FAIL – Self test of the fuel flow measurement circuitry has failed.

FUEL NOT CONFIRMED – The FMS was powered up from the Standby mode and the fuel has not been confirmed on Fuel Page 1.

GLONASS DEPENDENT NAV – The FMS is in GPS Navigation mode, the GLS/GNSS sensor is in Navigation mode and the total number of GPS satellites is less than four and at least one GLONASS satellite is in use for navigation.

GLS FACILITY INVALID – A GLS ground station failure is indicated.

GLS # CONFIG MODULE FAIL – A mismatch has occurred between data stored in the configuration module and data calculated by the GLS sensor.

GLS # DESELECT – The sensor monitor has determined that the GLS data is unreasonable and has deselected the sensor. This message will be removed after it is read.

GLS # DIFFERENCE > xxNM – The sensor “watchdog” has sensed that the latitude/longitude position as determined by GLS #1 or #2 differs from the FMS best computed position by an amount that warrants pilot attention. "xx" can be six, twelve, eighteen or twenty-four nm.

GLS # FAIL – A failed status has been determined for the indicated GLS.

24. Press [DATA], then [NEXT] to access Data Page 2.

25. Press the LSK adjacent the sensor to access the Sensor Status Page.

26. Check the sensor status.

GLS # NOT NAV – The specified GLS has changed to a non-navigational condition (that is, it is none of the following: DGPS, Navigation, Altitude-Aiding or Fault). The GLS Status Page will show the cause of the change.

GLS VDL FAIL – This message will follow an APPR FACILITY INVALID message. It informs the crew that the approach facility may be operational but the GLS VHF datalink board has failed.

GNSS # DESELECT – The sensor monitor has determined that the specified GNSS data is unreasonable and has deselected the GNSS sensor for use in navigation. The message will be removed after it is displayed once.

GNSS # DIFFERENCE > xxNM – The sensor “watchdog” has sensed that the latitude/longitude position as determined by the GNSS differs from the FMS best computed position by an amount that warrants pilot attention. "xx" can be six, twelve, eighteen or twenty-four nm.

GNSS # FAIL – A failed status has been determined for the indicated GNSS.

27. Press [DATA], then [NEXT] to access Data Page 2.

28. Press the LSK adjacent the sensor to access the Sensor Status Page.

29. Check the sensor status.

GNSS # NOT NAV – The specified GNSS has changed to a non-navigational condition (that is, it is none of the following: Navigation, Altitude-Aiding or Fault). This message will be removed after it is displayed once or when the GNSS goes into Navigation or Altitude-Aiding mode. The GNSS Status Page will show the cause of the change.

30. Press [DATA], then [NEXT] to access Data Page 2.

31. Press the LSK adjacent the sensor to access the Sensor Status Page.

32. Check the sensor status.

GPIRS # DESLECT – The sensor monitor has determined that the specified GPS data is unreasonable and has deselected the GPS portion of the sensor.

GPIRS # DIFFERENCE > xxNM – The sensor “watchdog” has sensed that the latitude/longitude position as determined by the GPS portion of the GPIR# (1, 2 or 3) differs from the FMS best computed position by an amount that warrants pilot attention. "xx" can be six, twelve, eighteen or twenty-four nm.

GPIR # FAILED – A Fail status has been determined for the GPS portion of the indicated GPIRS, because the position data is missing or invalid or the status label indicates a Fail status exists.

33. Press [DATA], then [NEXT] to access Data Page 2.
34. Press the LSK adjacent the sensor to access the Sensor Status Page.
35. Check the sensor status.

GPIR # GPS NOT NAV – The GPS portion of the specified GPIRS has changed to a non-navigational condition (that is, it is none of the following: Navigation, Altitude-Aiding or Fault). The GPS Status Page will show the cause of the change.

GPS # DESELECT – The sensor monitor has determined that the specified GPS data is unreasonable and has deselected the sensor for use in navigation. The message will be removed after it is displayed once.

GPS # DIFFERENCE > xxNM – The sensor "watchdog" has sensed that the latitude/longitude position as determined by GPS# (1, 2, or 3) differs from the FMS best computed position by an amount that warrants pilot attention. "xx" can be six, twelve, eighteen or twenty-four nm.

GPS # FAILED – A failed status has been determined for the indicated GPS either because the position data is missing, invalid or because the status label indicates that a Fail status exists.

36. Press [DATA], then [NEXT] to access Data Page 2.
37. Press the LSK adjacent the sensor to access the Sensor Status Page.
38. Check the sensor status.

GPS # NOT NAV – The specified GPS has changed to a non-navigational condition (that is, it is none of the following: Navigation, Altitude-Aiding or Fault) for at least three minutes. The GPS Status Page will show the cause of the change.

GPS ONLY NAVIGATION – Displayed if a non-RAIM GPS is the only position sensor available. This message is displayed sixty seconds after the condition appears and remains as long as the condition exists. This message is suppressed on the ground.

GPS-RADIO POS DIFFERENCE – The sensor monitor detected an exceedence in the position difference or divergence rate with only a GPS-based and radio-based position. This message is displayed when all three of the following conditions are true: (1) The positions being monitors by the Sensor Monitor consist of only a GPS-based position and radio-based position (DME or VOR). (2) The sensor monitor detected an exceedence in the position difference or divergence rate. (3) The HPL input of the GPs sensor sis invalid.

HEADING REF FAIL – The AC reference for the Analog Heading input has failed.

HIGH GROUNDSPD FOR ARC – The current leg is an AF or RF and the groundspeed is too high for the aircraft to stay within the bounds of the arc.

HIGH GNDSPD FOR HOLDING – In holding mode, the current groundspeed is excessive for holding airspace. This may be due to either high winds or high TAS. The pilot should lower airspeed if feasible.

IC600L HEADING FAIL – In the Cessna Bravo, Cessna Ultra, or Embraer 145, the heading source has failed while in use.

IC600R HEADING FAIL – In the Cessna Bravo, Cessna Ultra, or Embraer 145, the heading source has failed while in use.

IC600-L BUS FAIL – In the Cessna Bravo, Cessna Bravo II, Cessna Ultra, Cessna Excel, Cessna Ultra II or Embraer 145 configuration, label 371 has reported invalid hardware equipment condition, operational mode or data word content, or is not detected on the left-side bus.

IC600-R BUS FAIL – In the Cessna Bravo, Cessna Bravo II, Cessna Ultra, Cessna Excel, Cessna Ultra II or Embraer 145 configuration, label 371 has reported invalid hardware equipment condition, operational mode or data word content, or is not detected on the right-side bus.

ILLEGAL FACILITY TYPE – The entered facility is of an invalid type for this approach.

ILLEGAL WAYPOINT – A turn center waypoint has been entered for a Pilot Defined RF leg that defines a radius greater than 32 nm.

ILS DATABASE FAIL – An error has been detected in the ILS database and access to the ILS database is not allowed.

IMS BUS FAIL – Either invalid hardware equipment condition, operational mode or data word content is detected on the bus, or specific data word content is not detected. This applies to the Sextant IMS-01 and IMS-02 configuration used on Bombardier DHC-8 Q400.

INSIDE LOA – The aircraft is inside a defined LORAN Operating Area (LOA). This message will be removed after it is displayed.

INVALID ARINC VERSION – ARINC circuit boards are installed with software versions that are not compatible with the FMS software version.

INVALID CONFIGURATION – The FMS configuration is invalid. Further information can be found in the applicable FMS Configuration Manual.

INVALID CONFIG - TAWS – Any of several errors or mismatches made during FMS configuration for TAWS can cause this message to display.

INVALID CONFIG - VISION-1 – Vision-1 is configured as enabled but the high speed UNS-429 bus is not configured.

INVALID FUEL CONFIG – The fuel flow sensor configuration is invalid or incomplete. The fuel flow function will be disabled.

INVALID ROUTE UPLINK – UniLink has detected an error during a flight plan uplink.

IRS # ALIGN – The specified IRS is in the alignment mode. The aircraft must remain stationary at this time.

IRS # ALIGN FAULT – The entered position failed the 3+3T test or the latitude comparison test. Re-enter position.

IRS # ATTITUDE – The specified IRS is in the attitude reference mode. Navigation data is not available.

IRS # CODE 01 – (Delco only) Turn specified NAV unit off.

IRS # CODE 02 – (Delco only) Select ATT mode on specified IRS.

IRS # CODE 03 – (Delco only) Check heading output from the specified IRS.

IRS # DC FAIL – The backup battery or DC bus is below 17 VDC.

IRS # DC FAIL ON DC – The last shutdown of the system was due to a power interrupt and not because of IRS failure.

IRS # DESELECT – The sensor monitor has determined that the specified IRS data is unreasonable and has deselected the sensor for use in navigation.

IRS # DIFFERENCE WARNING – IRS position difference exceeds a rate of two knots.

IRS # FAIL – An inertial reference system failure is detected in the IRS indicated.

39. Press [DATA], then [NEXT] to access Data Page 2.
 40. Press the LSK adjacent the sensor to access the Sensor Status Page.
 41. Check the sensor status.

IRS # HEADING FAIL – The system heading source, IRS# (1, 2, or 3) has failed. Unless a NO HEADING message is also active, the system will automatically select another valid heading source. A check should be made on the appropriate DATA Page to ensure that the heading source selected is the one desired and the heading is correct.

42. Press [DATA], then [NEXT] to access Data Page 4.
 43. Press LSK [1L].
 44. Press [LIST] to access the Heading Source Page.
 45. Check the heading source and change if desired.

IRS # NAV – IRS Alignment is complete and the specified IRS is in Navigation Mode.

IRS # ON BATTERY – The specified IRS is being powered by a DC power source or standby battery.

IRS # READY NAV – In installations using Delco IRS only, the IRS align status is 5.

LAT/LONG XING WPT ALERT – This message displays fifteen seconds prior to sequencing time for latitude or longitude intersection.

LEFT IOC-OFFSIDE FAIL – This message will be displayed on the #2 FMS if the offside input/output concentrator has failed (only with Collins Pro Line 4 or Pro Line 21 configuration).

LEFT IOC-ONSIDE FAIL – This message will be displayed on the #1 FMS if the onside input/output concentrator has failed (only with Collins Pro Line 4 or Pro Line 21 configuration).

LOC STEERING ACTIVE – An LOC or BC Approach is active and the localizer signal is used in the roll steering equation. FMS XTK calculation is based on the raw localizer signal input.

LPV NOT AVAILABLE – LPV highest charted level of service and it is not available at approach arm or approach activation.

46. Press LSK [4L] to display the RNAV APPR LOS Page.
 47. Manually select an available alternative LOS for the approach.

LNAV/VNAV NOT AVAILABLE – LNAV/VNAV is the highest charted level of service and it is not available at approach arm or approach activation.

48. Press LSK [4L] to display the RNAV APPR LOS Page.
 49. Manually select an available alternative LOS for the approach.

LOW ALTITUDE ALERT – An LPV or LNAV/VNAV Approach is active and the Altitude falls below the FAF altitude by VPL.

MANUAL LEG CHANGE REQD – The aircraft is on a CA, FA, or VA leg and barometric altitude is not available to the FMS. The crew must make a manual leg change to sequence the waypoint.

MEMORY BANK # FAIL – In dual cycle memory bank FMS s, either memory bank 1 or memory bank 2 has failed and all databases in the failed bank are unusable.

Reload the Navigation Database into the other bank.

MODE KEYS INOP - DISK PAGE – A disallowed mode key was pressed while any Disk Page (except Disk Menu) is displayed. The MSG key is the only key allowed.

MOT WPT LIST FULL – For MMMSs only. The next mark-on-target (MOT) waypoint added to the list will scroll the oldest waypoint from the circular buffer.

MOT WPT MEMORY FAIL – For MMMSs only. The MOT waypoint memory section has failed during power-up self test.

NAV DATABASES FAILED – All segments of the Navigation Database failed simultaneously. This message replaces all individual segment messages.

Reload the Navigation Database.

NAV RADIO DESELECT – This message is displayed when position data is not valid and two or more radio sensors are configured. All configured radio sensors are deselected (DME, VOR).

NDB DATABASE FAIL – A problem has been found in the non-directional beacon (NDB) section of the Navigation Database. Access to this database will not be permitted.

Reload the Navigation Database.

NDB NAME DATABASE FAIL – An error was detected in the NDB plain language name database.

Reload the Navigation Database.

NEXT LEG UNDEFINED – A gap is in the next flight plan waypoint position. The flight plan must be edited by the pilot to eliminate the gap. If the gap is not eliminated, the aircraft will fly to the current TO waypoint, and after waypoint passage will continue to fly the same desired track with the TO/FROM flag now indicating FROM. The WPT annunciator will remain illuminated after waypoint passage and a **CURRENT LEG EXTENDED** message will appear on the Message Page.

NOTE: The gap placed at the end of the approach before the destination airport does not trigger this message.

50. Press [FPL] to access the Flight Plan pages.

51. Edit the flight plan to remove the gap.

NEXT VNAV LEG INVALID – The VNAV leg following the current leg is either undefined, too steep, or a climb; FMS vertical guidance will become invalid after crossing the current vertical TO waypoint in ILS advisory approaches; or the current VNAV leg is not the EOA. The pilot must take action to define a valid NEXT VNAV leg. This message will apply to procedural legs in SID, STAR and approaches which are "floating waypoints", e.g., heading to intercept a VOR radial.

This message also appears if the TO vertical waypoint is the second or subsequent approach waypoint of an ILS approach with the ILS approach configured as "advisory."

NO HEADING – No heading information is being received. This message will not be displayed while on the ground. If a valid heading source was available, it should have already been automatically selected.

52. Press [DATA], then [NEXT] to access Data Page 4.

53. Press LSK [1L] to place the cursor over the heading field.

54. Press [LIST] to access the Heading Source Page.

55. Change the heading source if desired.

56. If no other heading source is available, manually input the aircraft's heading on Data Page 4.

NO INTERCEPT – The system is in the heading intercept mode and the selected heading will not intercept the current navigation leg.

NO SATELLITE INTEG – GPS integrity monitoring is not available for twenty-seven seconds in Enroute flight phase and for seven seconds in Terminal flight phase. In Approach phase after FAF, GPS integrity monitoring is not available and HDOP is greater than 4.0 for seven seconds.

NONVOLATILE MEMORY FAIL – The non-volatile memory (NVM) has failed the power-up test. Some or all of the NVM parameters may be lost. This message can only occur following system initialization.

NORMAL CKLIST DB FAIL – Appears if the normal Checklist Database has failed (only with Collins Pro Line 4 interface).

Reload the Checklist Database.

OFFSIDE FLAP POS FAILED – No offside flap position input is detected in the Lear 45 Primus 1000 installation.

ONSIDE FLAP POS FAILED – No onside flap position input is detected in the Lear 45 Primus 1000 installation.

OTHER FMS HEADING FAILED – An FMS is using the heading source from another FMS, and that heading source has failed.

57. Press [DATA] to access Data Page 4.

58. Press LSK [1L] to place the cursor over the HDG field.

59. Press [LIST] to access the Heading Source Page and select another source if available.

OUTSIDE LOA – The aircraft is outside of a defined LORAN operating area. This message will be removed after it is displayed.

OVERSPEED INVALID – The FMS doesn't receive one or more of the following input labels required for Overspeed mode: Label 206, Indicated Airspeed, label 207, Max allowable Airspeed, label 331, Longitudinal Acceleration and Pitch Angle, label 324.

PA DATABASE FAIL – The WAAS Subsystem has rejected the FAS DB due to either an invalid CRC or unreasonable data content. This message occurs when an SBAS approach is linked to the flight plan and the CRC check has failed due to an invalid FAS DB.

If message occurs when loading an SBAS approach into a flight plan, clear the selection and reload it into the flight plan.

If this does not resolve the error, reload the Navigation Database.

PERF DATABASE FAILED – The Performance Database has failed. Advanced performance features will be disabled.

Reload the Performance Database.

PERF DB ID MISMATCH – The Performance Database identifier entered on the configuration pages does not agree with the Performance Database identifier on the disk that is loaded. Advanced performance features will be disabled.

PERF T/O GW UPDATE REQD – The current gross weight differs by more than 2.5% from the value entered in the gross weight field.

60. Press the key sequence [BACK] / [ENTER] to update, or

61. Enter a manual value in the gross weight field.

PILOT ALIGN DB UPDATED – This message appears after the Check All process. It indicates a change to the pilot alignment waypoint database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PILOT APPR DATABASE FAIL – A problem has been detected in the Pilot Defined Approach Database.

Reload data from the Pilot Data Save disk.

PILOT APPR DB UPDATED – Displayed following the Check All Process. Indicates pilot approach data has been updated by the system as a result of a navigation data update. Requires definition or confirmation by the pilot.

PILOT ARPT DATABASE FAIL – A problem has been detected in the Pilot Defined Airport Database.

Reload data from Pilot Data Save disk.

PILOT ARPT DB UPDATED – This message appears after the Check All process. It indicates a change to the pilot airport database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PILOT DATABASES FAILED – The database of all pilot defined locations has failed.

Reload data from Pilot Data Save disk.

PILOT RNWY DATABASE FAIL – A problem has been detected in the Pilot Defined Runway Database.

Reload data from Pilot Data Save disk.

PILOT ROUTE DATABASE FAIL – A problem has been detected in the Pilot Defined Route Database.

Reload data from Pilot Data Save disk.

PILOT ROUTE DB UPDATED – This message appears after the Check All process. It indicates a change to the pilot route database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PILOT SID DATABASE FAIL – A problem has been detected in the Pilot Defined Database.

Reload data from Pilot Data Save disk.

PILOT SID DB UPDATED – This message appears after the Check All process. It indicates a change to the Pilot Defined Database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PILOT STAR DATABASE FAIL – A problem has been detected in the Pilot Defined Database.

Reload data from Pilot Data Save disk.

PILOT STAR DB UPDATED – This message appears after the Check All process. It indicates a change to the Pilot Defined Database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PILOT WPT DATABASE FAIL – A problem has been detected in the Pilot Defined Database.

Reload data from Pilot Data Save disk.

PILOT WPT DB UPDATED – This message appears after the Check All process. It indicates a change to the Pilot Defined Database based on loaded or resident navigation data, and requires redefinition or confirmation by the pilot.

PNR ALERT – This message displays when the distance to go (DTG) to the point of no return (PNR) is five nm.

POSITION CORRECTING – This message normally occurs when reacquiring DMEs following an overwater or other non-DME environment flight segment. Best computed position is in the process of being corrected.

POSITION UNCERTAIN – The FMS position is uncertain (not verified).

ANP values have reached the maximum limit per phase of flight. The RNP value in use may be a manual RNP or System RNP (refer to Estimate of Position Accuracy in the Navigation Function section for more information on the RNP limits).

Refer to the Best Computed Position Update procedure. Performing this procedure will deactivate this message.

PROGRAM CHECK FAIL – A problem has been found in the program software.

62. Monitor the system closely. There is a high probability that the system will fail the initial self-tests the next time it is turned on.

63. After landing and shutdown, power down the system and then up again in order to troubleshoot.

PRO LINE 21-L BUS FAIL – In the Pro Line 21 configuration, label 360 is not detected on the left bus for two seconds.

PRO LINE 21-R BUS FAIL – In the Pro Line 21 configuration, label 360 is not detected on the right bus for two seconds.

RADIUS REQ EXCESS BANK – The orbit radius entered is less than the minimum aircraft turn radius required under current conditions. This message is presented in MMMSSs only.

RCU # FAIL – A failure has been detected in the specified radio control unit.

RESET ALT PRESELECT – The aircraft is within two minutes of a VNAV Top of Descent, and the altitude preselector has not been reset to an altitude at least 200 feet below current altitude. VNAV cannot be armed on the flight guidance system until the altitude preselector has been reset to a lower altitude.

RIGHT IOC-OFFSIDE FAIL – This message will be displayed on the #1 FMS if the offside input/output concentrator has failed (only with Collins Pro Line 4 interface).

RIGHT IOC-ONSIDE FAIL – This message will be displayed on the #2 FMS if the onside input/output concentrator has failed (only with Collins Pro Line 4 interface).

ROUTE CAPACITY EXCEEDED – An attempt has been made to create a route with over 98 waypoints or to store more than 200 routes

ROUTE DATABASE FULL – An attempt has been made to use more than 3000 waypoints in all routes.

RTU # FAIL – A failure has been detected in the specified radio tuning unit.

RUNWAY DATABASE FAIL – The runway section of the Navigation Database has failed.

Reload the Navigation Database.

RUNWAY IN USE – The specified runway is part of a SID, STAR or approach and cannot be modified or deleted.

SATELLITE POS ALARM – GPS error is any of the following:

greater than two nm for more than twenty-seven seconds in the Enroute phase of flight

greater than one nm for more than seven seconds during the Terminal phase of flight

greater than 0.3 nm for more than seven seconds during the Approach/Non-Precision phase of flight

SBAS DATABASE FAIL – A problem has been found in the SBAS (FAS DB) approach database, rendering it unusable. The FMS will limit SBAS Approach to the LNAV level of service.

Reload the Navigation Database.

SCAT-1 UNAVAILABLE – The GLS sensor has detected either an FMS or GLS failure that prevents flying the SCAT-1 approach type.

SID DATABASE FAIL – The SID section of the Navigation Database has failed.

Reload the Navigation Database.

SOFTWARE CONFIG MISMATCH – The loaded version of software does not match the version number stored in the configuration module.

SPCL MISSION MEMORY FAIL – A failure of non-volatile memory that contained search pattern or navigation data has been detected (MMMSs only).

SPEED TOO FAST FOR TURN – RF or AF leg is the current lateral guidance leg and the groundspeed is too high for the aircraft to stay within the bounds of the arc.

STAR DATABASE FAIL – The STAR section of the Navigation Database has failed.

Reload the Navigation Database.

STEERING FAIL – A continuous roll steering self-test failure has occurred. This failure can be reset as follows:

64. Press [DATA], then [NEXT] to access Data Page 4.

65. Press LSK [3L] to position the cursor over the ROLL CMD field.

66. Press [BACK] / [ENTER] to reset.

SXTK CANCEL – Selected crosstrack cancels when the current leg sequences and SXTK is not available on the next leg.

SYNC CONFIG MISMATCH – After power-up and initialization, FMS detects mismatch in one of the configuration settings (VNAV, Fuel, Temp Comp, Lateral Steering, Approach types, heading select, TGT FPA).

TACTICAL DATABASE FULL – All 100 available tactical waypoint slots have been used.

TAS INVALID – The true airspeed data from the ADC is not usable. A manual input of true airspeed may be made on the ADC Status Page.

67. Press [DATA], then [NEXT] to display Data Page 2.

68. Press the LSK adjacent ADC to access the ADC Status Page.

69. Press LSK [2L]. Enter current true airspeed. A manual TAS overrides any ADC input.

TAWS FAIL – TAWS A739 is configured and is not receiving a valid 172 label. Or, TAWS FMS fixed-pages are configured and label 123 is not valid.

TAWS FPL/TERRAIN THREAT – Label 272, bit 12 is set to 1 by the TAWS.

TCAS NOT CONFIGURED - The TFC button on the EFIS radar panel has been pressed and the FMS is not configured for Traffic Collision Avoidance System (TCAS) (only with Collins Pro Line 4 800 interface).

TERMINALS DATABASE FAIL– The terminal intersection section of the Navigation Database has failed.

Reload the Navigation Database.

TEST MODE – The FMS is in test mode.

TOP OF DESCENT ALERT– Estimated time to the top of descent point is less than two minutes. Appears two minutes prior the TOD to indicated approaching TOD.

TUNE NAV# - TO XXX ON FFF.FF – When not in approach mode, there are fewer than two DME stations available, the navigation mode is not GPS/DME, GPS or DME/DME and the current tuned VOR is greater than eighty nm away or is invalid. The XXX and FFF.FF are filled with the identifier and frequency of the nearest valid VOR.

Press the TUNE LSK to remotely tune the VOR receiver to the displayed frequency if Remote Tune is enabled (programmed into the Configuration Module at installation). Otherwise, manually tune the VOR using the control head.

UNILINK FAIL – The FMS monitoring the UniLink has determined the UniLink to be in the failed state.

UNILINK MSG RCVD – A new UniLink text message has been received.

70. Press the UNILINK LSK to access the UniLink Main Menu Page.

71. Press the NEW MSG prompt on the UniLink Main Menu Page to view message.

UNILINK RTE INVALID – An FMS uplink message containing route data that has failed error check and been rejected has been received.

UNILINK ROUTE RCVD – An FMS uplink message containing route data that has passed error check and is ready for review has been received.

UNILINK WX MAP RCVD – A new UniLink weather map has been received from Universal Weather and Aviation, Inc.

72. Press the UNILINK LSK to access the UniLink Main Menu Page.

73. Press NEW WX prompt on the UniLink Main Menu Page to view the new weather map.

UPLINK MESSAGE RCVD – A message has been received from the Global Data Center.

VARIATION WARNING – The aircraft is out of the auto-variation model range (above N72 degrees, 45 minutes and below S59 degrees, 45 minutes latitudes), there is no manual input, and the TRUE MAGNETIC switch is in the MAGNETIC position.

74. Press [DATA] to access Data Page 4.

75. Press LSK [4L] to highlight the variation field.

76. Enter a manual east or west variation.

VERIFY MANUAL RNP – A manual RNP has been entered and then a flight phase transition occurs and the new RNP limit is less than the manually entered RNP. Or, a manual RNP has been entered and a leg with a lower database RNP value is sequenced to in a linked flight plan.

VERTICAL WPT ALERT – This message appears approximately fifteen seconds prior to a VNAV mode vertical leg change. The WPT and MSG annunciators on the instrument panel flash, along with the FMS MSG light. Pressing the MSG key will change the flashing WPT to steady, turn off the MSG light, and show the VNAV WPT ALERT message.

VHF NAME DATABASE FAIL – The VHF plain language name section of the Navigation Database has failed.

Reload the Navigation Database.

VHF NAVAID DATABASE FAIL – The navaid section of the Navigation Database has failed. The backup navaid database, containing navaids and airports, will be used.

Reload the Navigation Database.

VNAV DISCONNECT – An altitude or flight level has been entered on a flight plan page that has resulted in a VNAV disconnect; Temp Comp is activated or cancelled; the current VNAV leg is undefined, too steep or a climb segment; in Cessna Primus, FMS transitions to the approach armed state before VPATH is active. Return to the VNAV Path Page to re-activate VNAV. This message will clear after it is read.

VOR TUNE FAIL – An ARINC 711 VOR has not tuned to the pilot requested frequency.

VPATH CAPTURE – This message is annunciated fifteen seconds prior to sequencing to Top of Descent or initiating the capture to vertical path from a tactical mode.

WAAS CONFIG FAILED – Communication with or data in the WAAS configuration data has failed.

WAAS CONFIG UNCONFIRMED –Critical WAAS configuration data is unconfirmed. Manually confirm the data.

WAAS# DESELECT –The sensor monitor has determined the specified WAAS data is unreasonable and has deselected the sensor for use in navigation.

WAAS# DIFFERENCE>xxnm –The sensor “watchdog” has sensed the latitude/longitude position as determined by WAAS# (1, 2 or 3) differs from the BCP by an amount that warrants pilot attention. “xx” can be 6, 12, 18 or 24 nm. For WAAS sensors, a message is displayed if the distance between sensor position and FMS position is greater than 6 nm. At 6, 12, 18, and 24 nm a new message is displayed indicating the increasing (or decreasing) amount of the discrepancy.

WAAS # FAIL – A FAIL status has been determined for the indicated WAAS. This message will be delayed for 15 seconds when the FMS is in an "On-Ground" state.

WAAS # NOT NAV –The selected WAAS status has changed to an invalid navigation condition (SBAS, Navigation, Altitude Aiding nor Fault) for three minutes. The three minute timer will be reset when the WAAS sensor enters a valid navigation condition or after a power-up.

WAAS/ANALOG FAIL – Self test for WAAS/Analog board has failed.

WAAS/ARINC FAIL – Self test for WAAS/ARINC board has failed.

WAYPOINT ALERT – The aircraft position is within fifteen seconds of a leg change while enroute, (or five seconds while using approach procedural legs) prior to the TO waypoint. The MSG light will not illuminate for this message. The instrument panel WPT alert annunciator will illuminate to alert the pilot of an impending leg change.

WAYPOINT IN USE – This message occurs when attempting to delete a waypoint from the Pilot Defined Database that is in use in the flight plan.

XFILL CONFIG MISMATCH – Crossfill data has been pushed to an FMS not configured to receive that data type. This message alerts the crew that crossfill data was sent and received but not accepted. Once read, this message is removed from the Message Page.

400 Hz REF FAIL – 400 Hz AC power has failed and there is no input to the analog roll steering. This message is suppressed if the system is installed in an "all digital" aircraft. It remains on the Message Page as long as the condition exists.

+1.5V PWR SUPPLY FAIL – Self test for power supply has failed.

+3.3V PWR SUPPLY FAIL – Self test for power supply has failed.

+5V PWR SUPPLY FAIL – Self test for power supply has failed.

+12.2V PWR SUPPLY FAIL – Self test for power supply has failed.

–12.2V PWR SUPPLY FAIL – Self test for power supply has failed.

+13V PWR SUPPLY FAIL – **Self test for power supply has failed.**

VNAV ERROR MESSAGES

ADC ALT INV – 1 Aircraft altitude is < FL 180 and only pressure altitude is available, or 2 ADC altitude is failed

APPR ALT – RESTR – An altitude entry for an approach waypoint that violates the database constraints is entered

CLEAR MAN ALT – A manual entry for altitude was made on the ADC status page

CLR SXTK – Aircraft is flying a selected crosstrack distance prior to VNAV activation

CLR XFIL ALT – A VNAV plan is defined, but crossfilled altitude is being used by the system

FPA TOO STEEP – Flight path angle is steeper than maximum FPA configured at time of installation

LEG RESTRICTION – Entry is attempted when the active vertical leg is a GAP, HA, FA, CA, VA, HM, HF, or PI leg that does not have an altitude constraint

LINK NAV/FPL – VNAV distance is invalid because the VNAV plan is not linked to the guidance legs

NO ENTRY – APPR – Entry is attempted for an approach waypoint when the approach is active

NO ENTRY – HOLD – Entry is attempted during an active vertical holding leg

NO ENTRY – VERT – Entry is attempted when the aircraft is in active VM or FM leg

NO VWPT ALT – VNAV distance is invalid because the VNAV TO waypoint is undefined

TARGET V/S HIGH – Value exceeds 6000 fpm or maximum flight path angle programmed in configuration module.

TARGET V/S LOW – Entered value is less than minimum required value

VPATH CAPTURE – Appears 15 seconds prior to TOD point or any other VNAV waypoint to indicate intersecting vertical waypoint

XTK TOO GREAT – Current crosstrack is > 12.5nm.

The following error messages will appear on the VNAV page whenever an invalid entry is made in TGT V/S or altitude data fields.

V/S TOO HIGH – Value exceeds 6000 fpm or maximum flight path angle programmed in configuration module.

V/S TOO LOW – Entered value is less than minimum required value.

ADC ALT INV – (1) Aircraft altitude is < FL180 and only pressure altitude is available, or (2) ADC altitude is failed.

CLR XFILL ALT – A VNAV plan is defined, but crossfilled altitude is being used by the system.

CLEAR MAN ALT – A manual entry for altitude was made on the ADC status page.

LEG RESTRICTION – The FMS is on a Procedure turn, VECTOR or other conditional waypoint leg type.

XTK TOO HIGH – Current crosstrack is > 12.5nm.

CLR SXTK – Aircraft is flying a selected crosstrack distance prior to VNAV activation.

FPA TOO STEEP – Flight path is steeper than maximum FPA in configuration module.

ANNUNCIATORS



In addition to the message annunciator, there are either six or seven other annunciators that may be required and are mounted on the instrument panel or are displayed through the EFIS. Many of the annunciators are incorporated into the EFIS and will not be displayed separately.

WPT – Will illuminate in conjunction with a WAYPOINT ALERT message on the FMS. Only the WPT annunciator will illuminate the MSG annunciator will not illuminate.

When on and steady, alerts the pilot to a lateral waypoint change and will occur 15 seconds prior to the changeover waypoint while enroute and 5 seconds during approach.

When on and flashing, alerts the pilot to a vertical waypoint change and will occur 15 seconds prior to the changeover waypoint while enroute and 5 seconds during approach.

SXTK – Will be illuminated during the time the FMS is in selected crosstrack mode.

FMS HDG – Will be illuminated during the time the FMS is in command or procedural heading mode.

GPS INTEG – Will illuminate if the GPS Horizontal protection levels (HPL) for the current phase of flight have been violated. During approach active, for an approach for which GPS is being used, this annunciator will illuminate if RAIM is not available.

DR – Will illuminate if the FMS is not receiving NAV sensor input from any other source and the FMS is determining its position solely from dead reckoning (DR).

FMS APPR – Will be illuminated during the time the FMS is approach active.

FMS LOS – On an RNAV SBAS approach, illuminates when an SBAS LOS is available. May be displayed as FMS1, FMS2, or FMS and may be Green, White, or Blue.

LNAV – LNAV level of service for SBAS approach is retained

LNAV/VNAV - LNAV/VNAV level of Service for SBAS is retained

LPV/LP – LPV/LP level of Service for SBAS is retained

FMS TROUBLE SHOOTING FOR PILOTS

When the FMS does not respond in the expected way, the anomalous output is often not the FMS, but an erroneous input or no input to the FMS from a related piece of equipment. When the pilot creates a squawk, maintenance may be at a loss as to whether the problem is the FMS or an interfaced system.

To assist both the pilot and maintenance personnel, the following trouble shooting guidelines were created. The following are the most common problems that are seen by pilots. For a complete list of FMS messages, refer to the FMS Message section.

Symptoms:

A/D HEADING FAIL – The present system heading source, A/D (synchro analog-to-digital), was serving as the primary heading source but has failed. This message will be removed after it is displayed. Unless a NO HEADING message is also active, the system will have automatically selected another valid heading source. This message is suppressed while the aircraft is on the ground.

Action:

No action is necessary if another valid heading was automatically selected by the FMS. A check should be made on the appropriate DATA page to ensure that the heading source selected is the one desired and the heading is correct. Check heading source on Data 4/4. Place cursor over the HDG field. Press the LIST key to access a display of alternate heading sources. Select an alternate heading source. A manual heading can be entered at the HDG field on DATA page 4/4, but once entered, all new heading changes will have to be entered manually as well.

Symptoms:

ADC INPUT FAIL – An Air Data Computer (ADC) failure is detected. TAS and altitude will not be input automatically. Altitude is used in DME positioning. TAS affects wind computations, DR capability, and VNAV will not be available.

Action:

Check circuit breaker for ADC or ACU if installed. Press the DATA key until DATA page 2 is accessed. Manual inputs should be made. If a second FMS is installed air data may be crossfilled from the other system. Check ADC data from ADC status page and record for maintenance. Note that without valid air data inputs to the FMS, VNAV is not available and any leg type terminators requiring altitudes will not be sequenced

Symptoms:

AHRS # HEADING FAIL – The AHRS heading source was serving as the primary heading source and has failed. This message is suppressed while the aircraft is on the ground.

Action:

The FMS should automatically select an alternate heading source if one is available. A manual heading may also be entered, but heading updates must be made each time the aircraft changes heading. (See DATA page section) Record information from heading source page for maintenance.

Symptoms:

ALT INVALID – The altitude portion of the Air Data Computer is not usable. If using VNAV above 18,000 feet and only non-baro-corrected altitude is available, this message will appear when descending through 18,000 feet. (If the TAS INVALID message is also active, the ADC Status page, under the DATA key, will indicate “ADC FAILED.”)

Action:

A manual input of altitude may be made on the ADC status page (under the DATA key). VNAV will not be available

Symptoms:

ANALOG BOARD FAIL – A failure is detected on the Analog Board. The outputs to the NAV may be affected, and depending upon installation, heading and fuel flow in some systems may also be affected. Verify on the DATA pages that the heading, TAS, and altitude inputs are reasonable.

Action:

On the ADC page verify TAS and altitude. On DATA page 4 verify HDG. If NAV is analog type, do not use for navigation.

Symptoms:

ANALOG INST FAIL – The Analog Waypoint Bearing or Desired Track self test has failed or the instrument reference is missing.


Action:

Check 26 VAC circuit breakers for FMC instrument reference input.

Symptoms:

CDU DATA BUS FAIL – Communication between the CDU and the NCU has failed.

Action:

If the FMS does not recover automatically, cycle power by turning the unit off using the  key. Document for maintenance whether FMS information to flight instruments remained or was lost as indicated by flags on the NAV instruments. Document whether FMS recovered automatically or recycling power was required.

Symptoms:

FMC BATTERY LOW – Self test has detected that the internal battery is low. Navigation is still allowable; however, at shutdown the position, date and time may be lost.

Action:

Advise maintenance of the message and the need to return the FMS to Universal Avionics for repair.

Failure to do so will eventually result in a loss of all pilot data

Symptoms:

FMS DIFF > xxMM – The sensor watchdog has sensed that LAT/LONG positions of two FMS in a dual installation differ by an amount that warrants crew attention. XX will equal 6, 12, 18 or 24nm.

Action:

Review DATA page 3 to determine which FMS is correct and use that FMS for navigation.

Symptoms:

FUELFLOW FAIL – A Fuel Flow failure is detected.

Action:

The FMS is not receiving fuel flow input from the aircraft engine fuel sending units. Manual fuel flow entries may be made. Also check the Fuel Flow displays for reasonableness. The Fuel Used values may be manually updated if required. To recover automatic fuel flow, position cursor over failed fuel flow field and press the B key followed by the E key.

Symptoms:

GPS# DESELECT – The sensor monitor has determined that the specified GPS data is unreasonable and has deselected the sensor for use in navigation.

Action:

Record GPS status page information for maintenance. Monitor HPL on GPS status page and when it meets phase of flight accuracy, reselect GPS. On over water legs it is possible that GPS could get deselected when, in fact, the IRS is in error. If review of the GPS status page indicates GPS to have a valid position, the pilot may choose to deselect the IRS and reselect GPS.

Symptoms:

GPS # DIFFERENCE > xxNM – The sensor “Watchdog” has sensed that the latitude/longitude position as determined by GPS# (1, 2, or 3) differs from the FMS best computed position by an amount that warrants pilot attention. “xx” can be 6, 12, 18, or 24nm.

Action:

Select Data page 2 and attempt to determine whether GPS, DME, or other NAV sensors are in error. The NAV sensor that is pulling off the best computed position must be deselected. In areas of the world where there are few DME stations or where the surveyed position of the DME stations is questionable, deselecting DME may be necessary.

Symptoms:

GPS# FAILED – A Fail status has been determined for the indicated GPS because the position data is missing or invalid or the status label indicates a FAIL status exists.

Action:

Review DATA page 2/GPS. Record GPS information for maintenance.

Symptoms:

GPS NOT NAV – GPS has changed to a not navigational condition for more than 3 minutes.

Action:

On Data page 2 select GPS. Review and record GPS information for maintenance.

Symptoms:

IRS # DESELECT – The sensor watchdog has determined that the specified IRS data is unreasonable and has deselected the sensor for use in navigation.

Action:

Review DATA page 2 and compare FMS position to IRS position.

Symptoms:

IRS # DIFF WARN – The sensor “Watchdog” has sensed that the latitude/longitude position as determined by IRS# (1, 2, or 3) differs from the UNS best computed position by an amount that warrants pilot attention.

Action:

This usually indicates an IRS drift of greater than two nautical miles per hour. Review DATA page 3 and compare FMS position to IRS position through NAV menu.

Symptoms:

IRS # HDG FAIL – The compass heading source, IRS# (1, 2, or 3), was serving as the primary heading source but has failed. This message will be removed after it is displayed. Unless a NO HEADING message is also active, the system will have automatically selected another valid heading source.

Action:

No action is necessary if another valid heading was selected. A check should be made on DATA page 4 to ensure that the heading source selected is the one you desire and the heading is correct.

Symptoms:

NO GPS INT@FAF – No response is received from the sensor or HPL exceeds 0.3nm.

Action:

Select an approach that does not require GPS. If time is available, select GPS on data page 2 and review page information.

Symptoms:

NO GPS INT@MAP – No response is received from the sensor or HPL exceeds 0.3nm.

Action:

Same as NO GPS INT@FAF

Symptoms:

NO HEADING – No heading information is being received. This message will not be displayed while on the ground. If a valid heading source was available, it should have already been automatically selected. Check the HDG SOURCE menu (DATA page 4) for a valid available heading source, or manually select either the other FMS as the heading source or manually input the aircraft’s heading.

Action:

Go to data page 4 and check heading input to FMS. Select alternate heading source, if available.

Symptoms:

POS UNCERTAIN – The FMS position is unreasonable (not verified). In the Enroute phase, an ANP of 2.8nm or greater (Q=28) triggers this message when within 300nm of DME sources. In Terminal, an ANP of 1.0nm or greater (Q=10) and during Approach active, an ANP of 0.5nm or greater (Q=5) may also trigger this message depending upon the distance from the end-of-approach point. An ANP of 6.0nm (Q=60) triggers the message outside of DME range, unless operating on valid IRS only.

Action:

Go to data page 2 and identify NAV sensors being used for computing the Best Computed Position. In some instances where DME stations are few and far between or are unreliable, deselecting DME and using GPS as the primary sensor may help restore the required quality of navigation.

Symptoms:

POS UNCERTAIN on ground – After successful initialization and the aircraft is being taxied; a position uncertain message is presented.

Action:

Check for valid heading source on DATA page 4. Heading failed message is suppressed on the ground. Record information for maintenance.

Symptoms:

STEERING FAIL – Roll steering self-test failure (continuous).

Action:

If caused by an intermittent condition, this failure may be reset by positioning the cursor over the ROLL CMD line on Data page 4, then depressing the BACK key and then the ENTER key. If the symptom persists, the autopilot will no longer respond to FMS steering commands and normal flight director modes will have to be used. Verify heading and TAS under Data section.

Symptoms:

TAS INVALID – The True Airspeed portion of the Air Data Computer is not usable.

Action:

A manual input of TAS may be made on the ADC Status page (under the DATA key). If the ALT INVALID message is also active, the ADC Status page, under the DATA key, will indicate "ADC FAILED." Crossfill heading and/or TAS from offside FMS if available.

Symptoms:

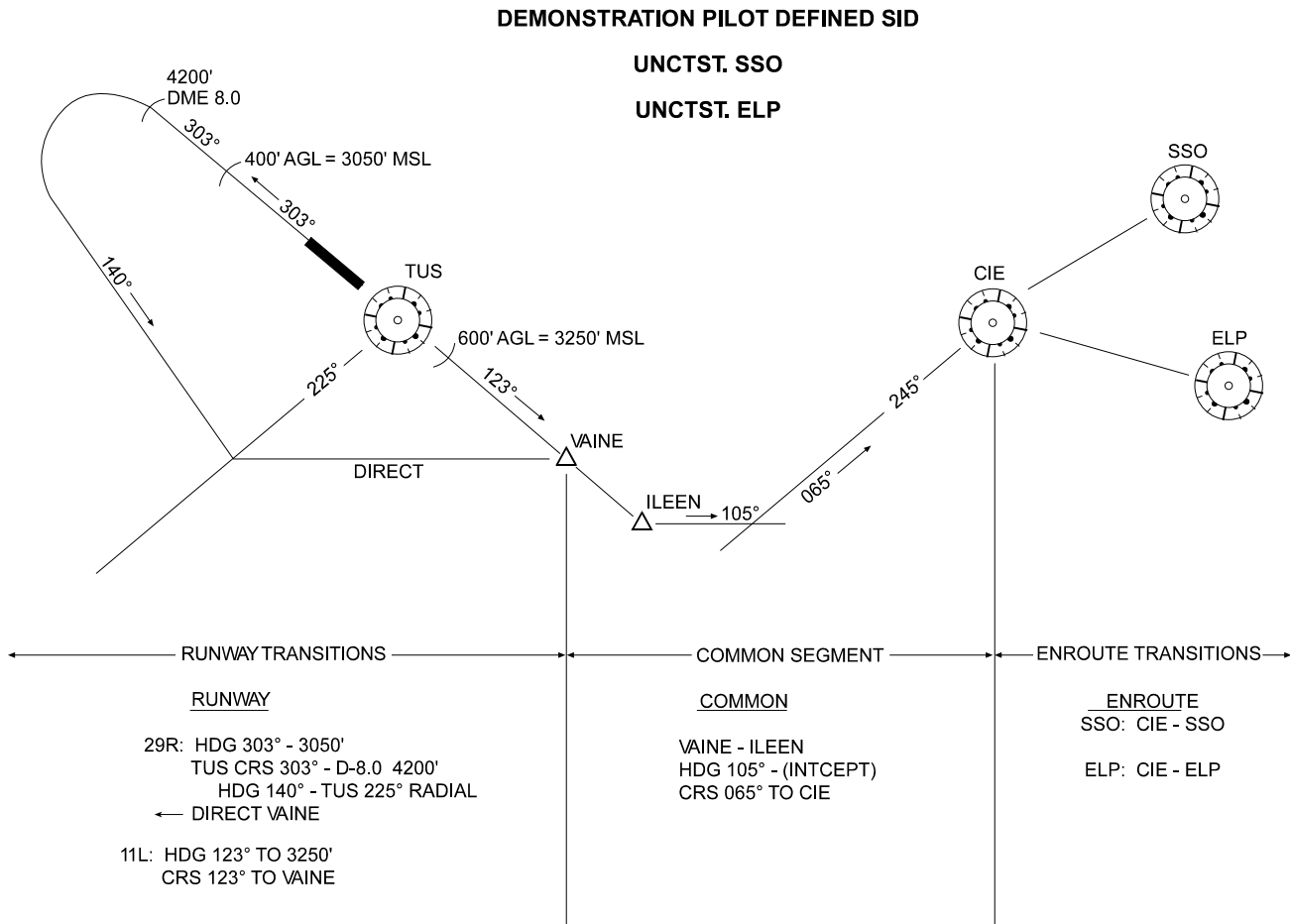
Winds differ between FMS in dual FMS installation.

Action:

Between the FMS compare heading information from DATA page 4 and TAS from the ADC page. Determine which FMS heading or TAS information is incorrect. Record this information for maintenance and use the FMS displaying correct information. (A small difference in heading can result in a remarkable difference in the winds.)

SID/STAR LEGS

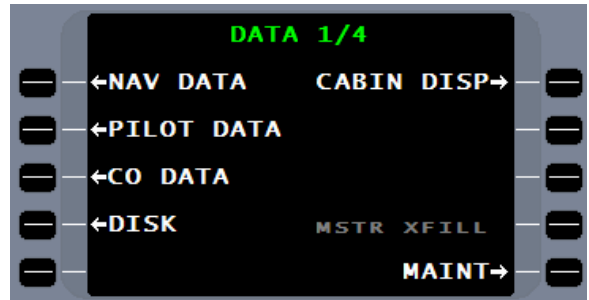
SID and STAR procedures may have as many as three segments; a runway segment, a common segment, and an enroute segment. The number and type of segments is determined during the design of the procedure. Each SID may have several runway and enroute transitions, but only one common segment.



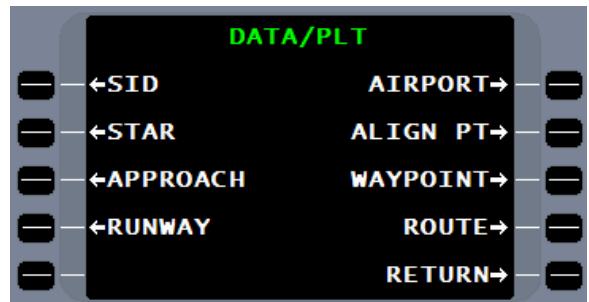
PILOT DEFINED SID

Pilot defined SID are constructed, viewed, or edited through DATA page 1.

Press the PILOT DATA line select key to display the DATA/PLT page.



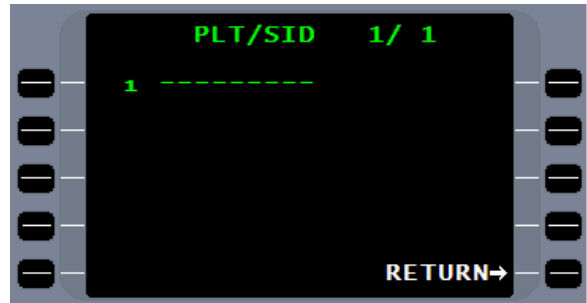
To create a SID, press the SID line select key on the DATA/PLT page.



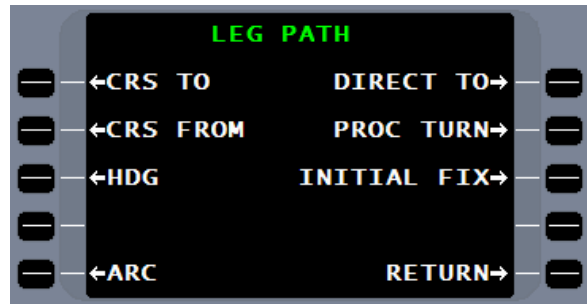
Enter the airport identifier, select the desired runway, and then create a name for the SID with 5 to 7 characters. Create and enter the identifier for the desired transition. Now press the SID LEGS line select key to define each leg of the SID.



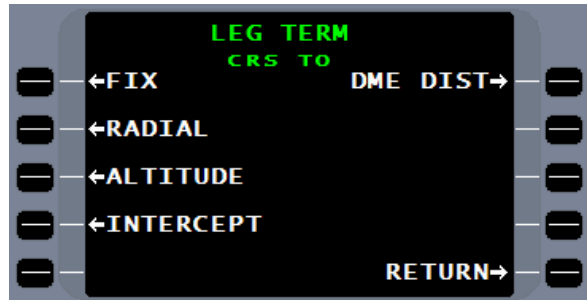
Press the 1Lw line select key to begin defining the SID. A SID should normally start with a climb on runway course to 400 feet AGL.



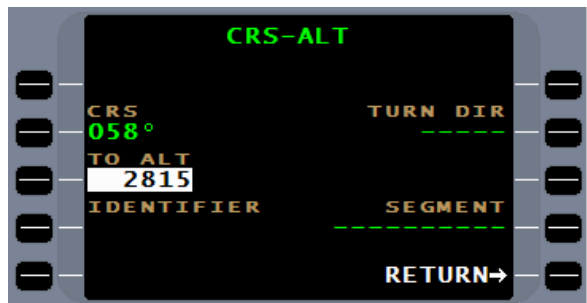
Press the CRS TO line select key to identify the initial leg.



Press the ALTITUDE line select key to terminate the leg.



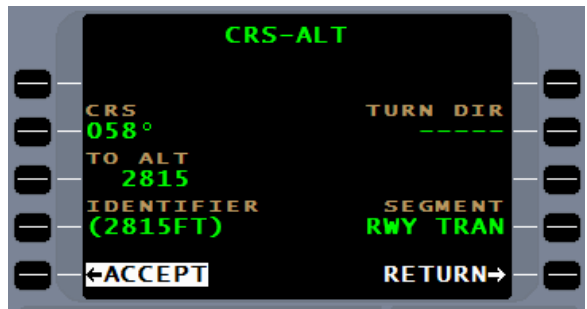
Now define the HDG and TO ALT with the runway heading and the 400 feet AGL altitude expressed in MSL numbers. Press **ENTER** to move to the SEGMENT page.



Press the RWY TRAN line select key to identify this leg with a particular runway.



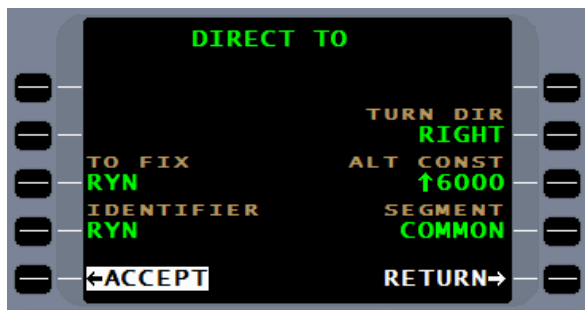
When the display returns to the **CRS-ALT** page, press **ENTER** or the ACCEPT line select key.



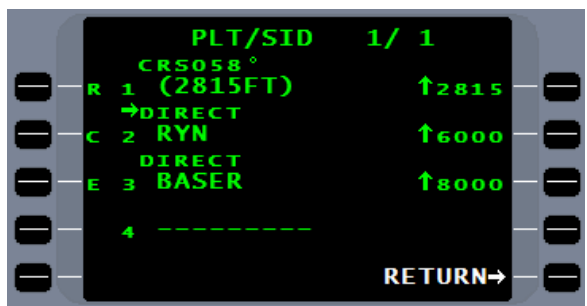
The following SID legs are constructed in the same manner, with a **LEG PATH** menu page and, when required, a LEG TERM menu page to select the definition page for each leg. Each of the leg definition pages provides an altitude constraint field. The information entered in this field will be advisory only unless altitude was selected as the leg terminator.



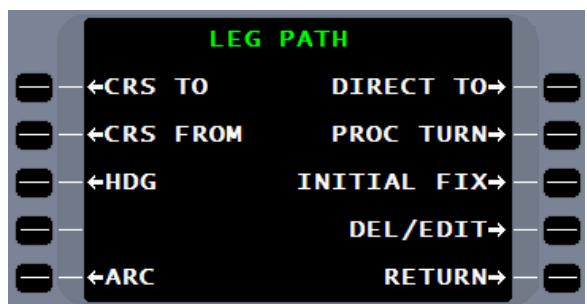
Select the next leg, use the line select keys to access and enter the required information, then press the **ENTER** key to confirm the required information.



To edit a SID leg already that is already created, press the appropriate line select key to the left of the leg to be edited.



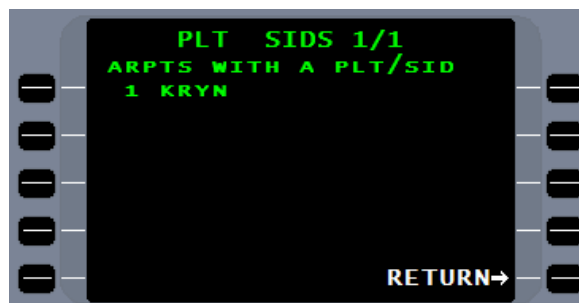
Pressing the line select key next to any of the SID legs on the **LEG PATH** menu page will now contain a DEL/EDIT line select key.



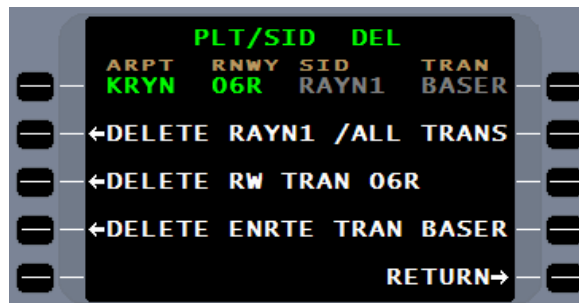
Press RETURN twice to return to the PLT/SID page. Press the **MENU** key to display the **PLT/SID MENU** page. This page will offer a COPY line select key to provide for the copying of the previously displayed SID in order to add other transitions, a DELETE line select key for the deletion of the SID or transitions, and a DIRECTORY line select key for selection of a directory.



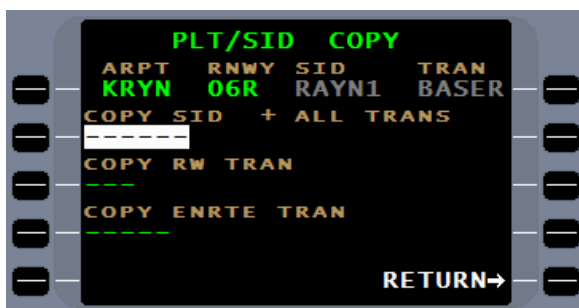
This directory page lists all airports with a pilot defined SID stored in the pilot database.



To delete a pilot created SID, press the DELETE line select key under the PLT/SID MENU page. A PLT/SID DEL menu will provide options for deleting all or part of the SID.



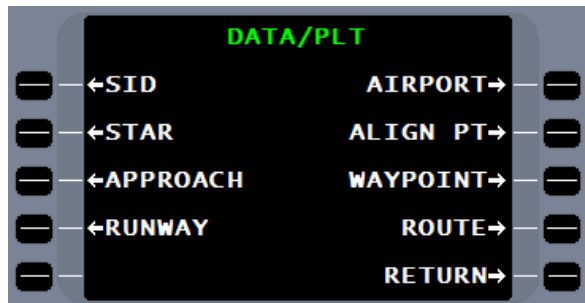
The PLT/SID COPY function allows for making a copy of the SID or portions of it for creating new SID or transitions. Enter the new name in the appropriate field and then edit the newly created copy to make a new SID or transition.



PILOT DEFINED STAR

The same procedures and editing conventions that were used to construct, view, and edit pilot defined SID is used in a pilot defined STAR.

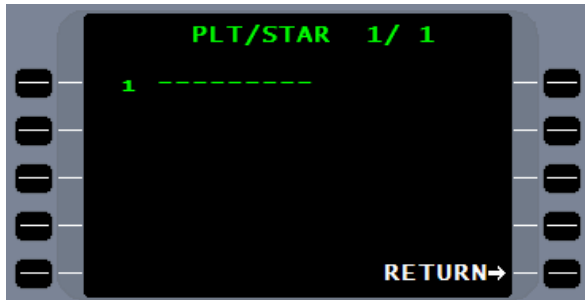
From the **DATA/PLT** page, select the STAR line select key.



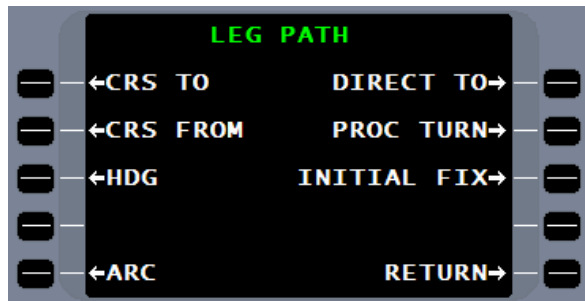
On the **PLT/STAR** definition page follow the prompts to enter airport, runway, name the STAR, and the transition. Press the STAR LEGS line select key.



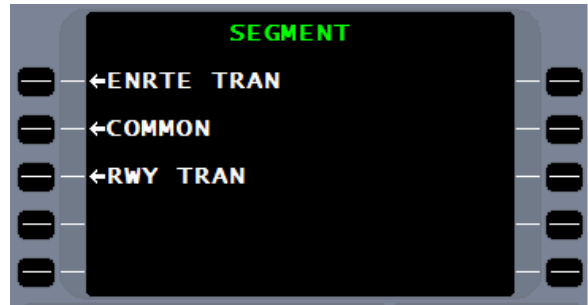
Press the 1Lw line select key to define the beginning point of the STAR.



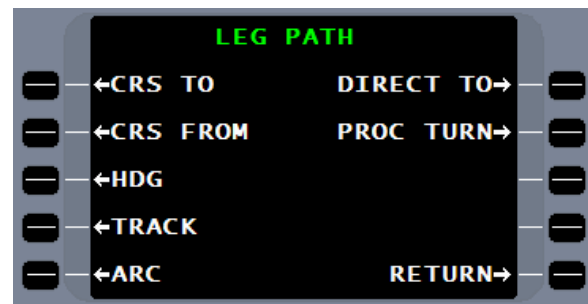
Press INITIAL FIX line select key.



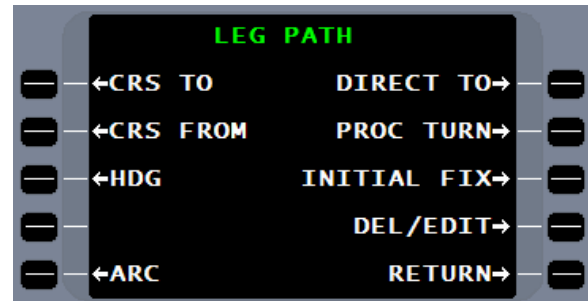
Enter the identifier and select the ENRTE TRAN line select key.



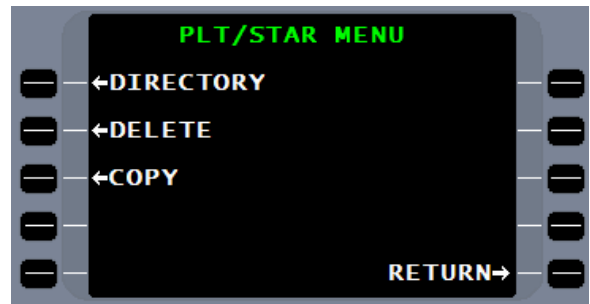
The following STAR legs are constructed in the same manner with the **LEG PATH** menu page and, where required, the LEG TERM menu page leading to definition pages for each leg. As with SID, the altitude entered is advisory only, unless altitude is selected as the leg terminator.



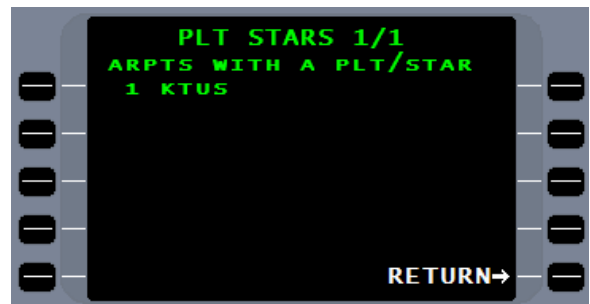
To edit a STAR leg already entered, press the appropriate line select key to the left of the leg to be edited, and the **LEG PATH** menu page will now contain a DEL/EDIT line select key option.



Press RETURN twice to return to the PLT/STAR page. Press the **MENU** key to display the PLT/STAR MENU page. This page will display a copy of the previously displayed STAR to add other transitions, deletion of the STAR or transitions, and selection of a directory. Press the DIRECTORY line select key.



This directory page lists all airports with a pilot defined STAR stored in the pilot database.



The DELETE and COPY line select key options provide for the same features, as did their counter parts in the pilot SID function.

PILOT DEFINED APPROACHES

The FMS is approved for a variety of pilot defined approaches. Many of the approach types are restricted to special mission aircraft. It is strongly recommended that general aviation aircraft use only the VFR pilot defined approach. The approach capabilities of a specific installation depend on the installed sensor suite and the interfaced aircraft flight guidance system. Pilot defined approaches include the following:

ILS	FMS Defined – ILS Guided – requires NAV to NAV EFIS
LOC	must be WGS-84 surveyed – TSO 129 EFIS or analog
LOC-BC	must be WGS-84 surveyed – TSO 129 EFIS or analog
VOR/VOR DME	Requires VHF NAV input to FMS
RNAV VOR DME	Requires VHF NAV input to FMS
TACAN	Requires TACAN input to FMS
VFR	Pilot Defined, used only in VFR conditions
GWS	Used by CAA airspace approach designers

The creation of a Pilot defined VFR approach will be discussed in this section. Pilot defined database approaches can be created through the aircraft's FMS CDU or the Universal Flight Planning Program 24.0 and later.

NOTE: The creation of other than VFR approaches is reserved for special mission aircraft and is not covered in this document. Federal Air Regulations prevent the creation of RNP, RNAV, or GPS approaches other than by an authorized database manufacturer.

HELICOPTER POINT-IN-SPACE APPROACH

Building a helicopter Point-in-Space approach may be accomplished through the FMS pilot defined approach tool. The procedure describing how to create a pilot defined VFR approach and may also be used to create a helicopter Point-in-Space approach. This tool can create a final approach fix with altitude, a flightpath angle, and a missed approach point with altitude which is the point in space. The point in space can be 20ft above the heliport or 200ft above the heliport or any altitude as desired by the creator. Additional waypoints may be entered as an approach transition or missed approach.

The lateral definition of the final approach course is composed of three components:

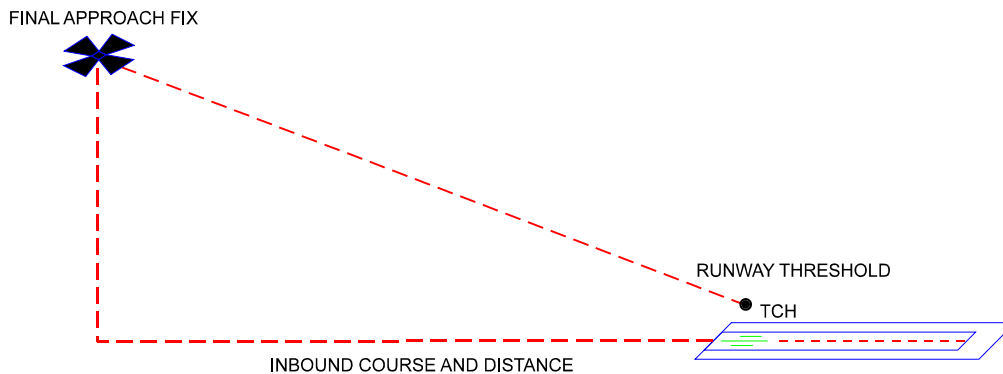
1. Final Approach Fix Location
2. Inbound course and distance
3. Runway threshold location

When any two of these components are defined, the third will be calculated by the FMS.

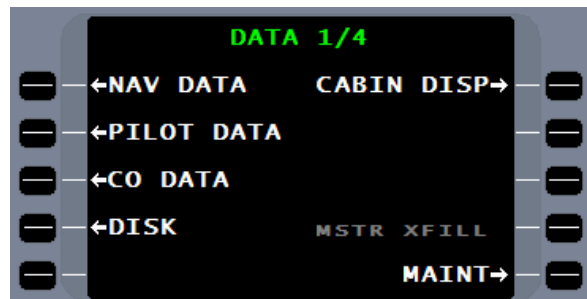
NOTE:

If the runway location and FAF are defined, the FMS will calculate the inbound course/distance. This will be displayed as “From FAF to RUNWAY”. If the FAF and inbound course/distance are defined, the FMS will calculate a Missed Approach Point (MAP) for the runway. This will be displayed as “FROM FAF TO MAP”.

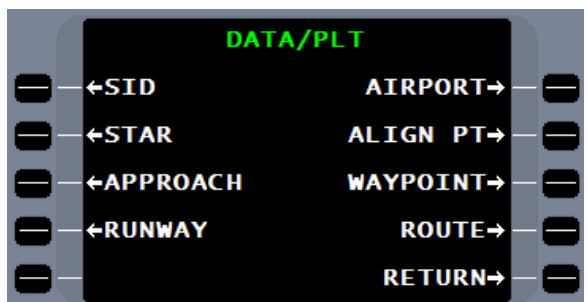
If the runway location and the inbound course/distance are defined, the FMS will calculate the FAF. This will be identified as FFXX, where XX is the runway number.



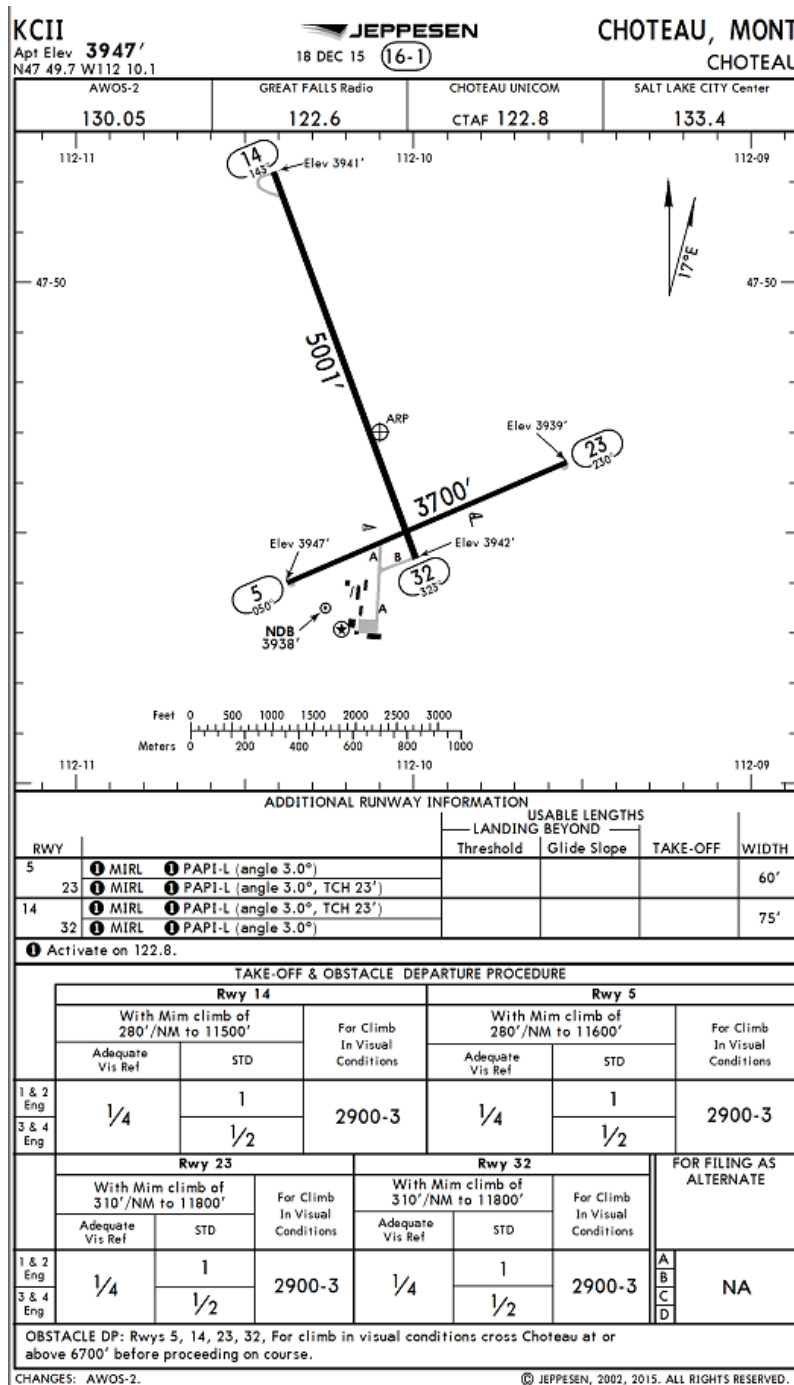
Pilot defined approaches are created, viewed, or edited through the data function. From DATA page 1, press the PILOT DATA line select key.



On the DATA/PLT page, press the APPROACH line select key.



The airfield at Choteau Montana has a NDB approach only to runway 23. When conditions allow for landings on runway 14, a VFR approach would significantly improve the safety of a night landing.



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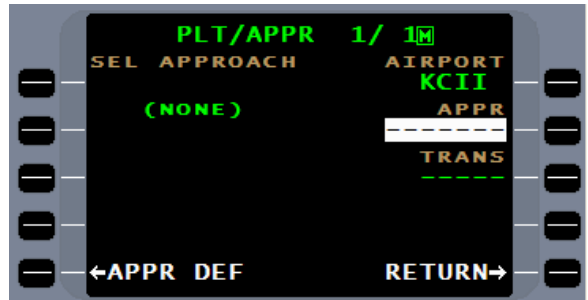
With pilot approach selected, the **PLT/APPR** directory page is displayed, listing all airports with pilot defined approaches stored in the database or none. Enter the identifier into the airport field.



After entry of the airport identifier, all pilot defined approaches for that airport will be listed or none and the APPR DEF line select key will allow creation of a pilot defined approach.

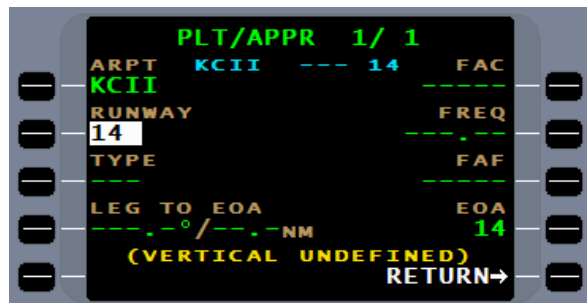


Press the APPR DEF line select key to create an approach.

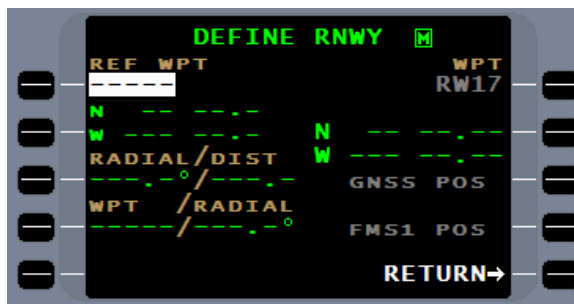


The **PLT APPR** page prompts you to enter the Runway Number. If the runway is in the NAV database, the **LIST** function may be used to find the runway.

Typically the entry will be a one or two digit number (1-36) which may be followed by the letter L, C, or R. A single letter (A-Z) may be used to designate an approach that is not associated with a runway. This may be used for a helicopter point-in-space approach.



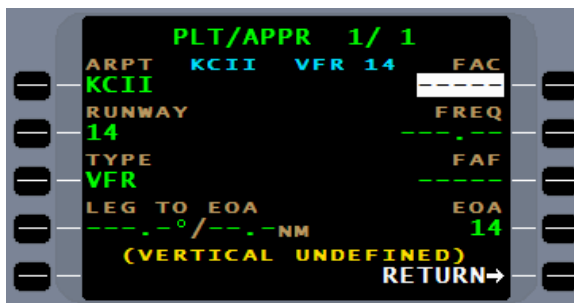
If the runway entered is not stored in the Navigation or Pilot database, the **DEFINE RNWY** page will be displayed for input of the runway threshold coordinates and elevation.



The page will now display approach types from which VFR will be selected. (For flight departments requiring other than VFR for their special mission requirements, contact UASC training for a custom training class.)

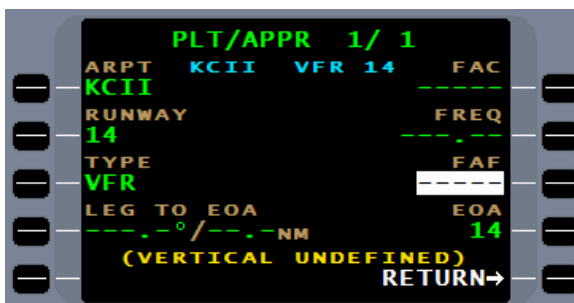


At the cursor, a reference VOR navigation facility for the approach may be added, if available. The **LIST** function may be used. It is recommended that the VOR be on or within 10nm of the airport.

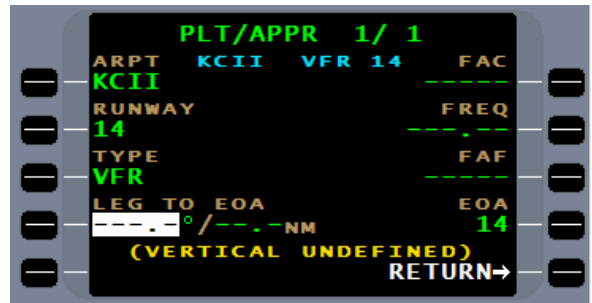


NOTE: When entering navigation data, always verify that you are using the correct facility, as there may be several facilities with the same identifier. If the list feature is used, only facilities in the area will be chosen, when entering facility by ID, all facilities with that identifier will be accessed from the database.

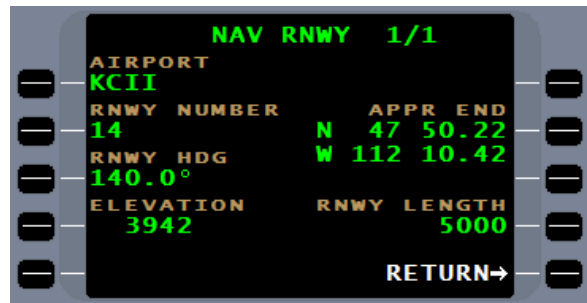
If a waypoint is available for the FAF, entering it will result in the automatic calculation and entry of course and distance to the threshold of the runway.



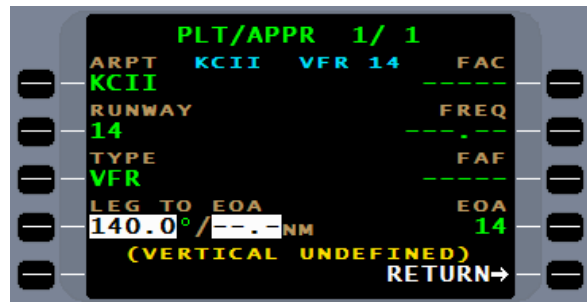
The method for this example will be to enter the course and distance and allow the FMS to calculate the FAF location. Normally, 5nm is use for distance.



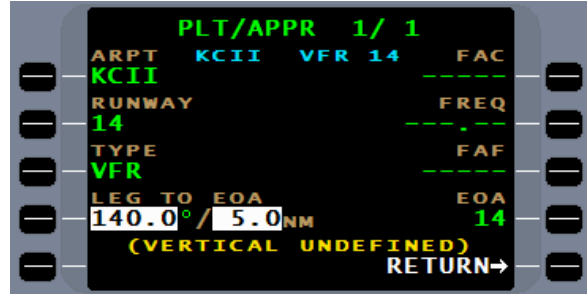
For more exact determination of the runway alignment, through the DATA/NAV page, the runway information may be obtained.



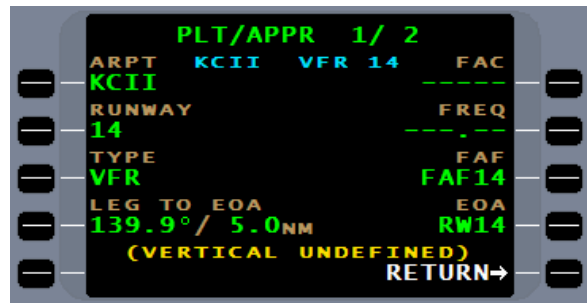
With the course data entered, press the **ENTER** key.



Enter the distance from the runway threshold to the FAF and the FMS will calculate the FAF point.



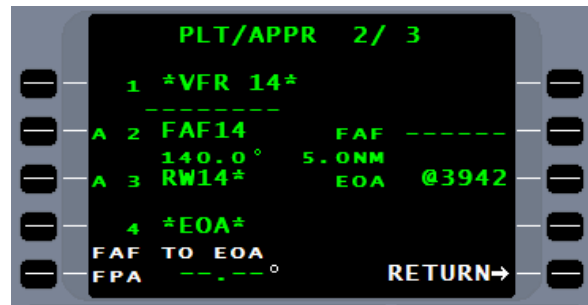
Very slight variations to the inbound course may be calculated by the FMS but, the consequence will be negligible. The footnote on page 1 of (VERTICAL UNDEFINED), will prompt to move to page 2.



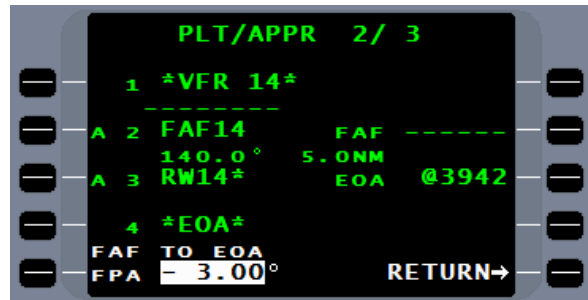
If an approach to a Missed Approach Point (MAP) in lieu of an approach to the RUNWAY coordinates is desired, the calculated INBD CRS and DIST may be changed to manual entries. If manual entries are made for CRS/DIST, the FMS will calculate a Missed Approach Point (based on the specified CRS/DIST from the FAF). The FMS will show MAXX in place of the runway waypoint.

The lateral definition of the approach is now complete and (VERTICAL UNDEFINED) is displayed indicating that the optional vertical parameters have not been defined. To define the vertical parameters for Pseudo- Glidepath steering information, press the **NEXT** key to display PLT APPR page 2.

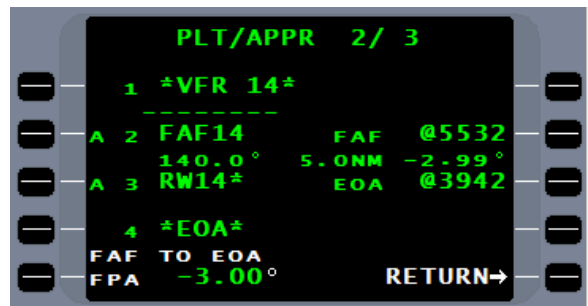
To define the vertical flightpath for the approach, the angle must be entered next to the FPA. The displayed runway altitude will be from the runway database and is not the threshold crossing altitude. Adjustments to the threshold altitude will be made later.



The standard for an approach glidepath is -3.00°, but may be up to 9° or that angle limitation entered into the FMS configuration.

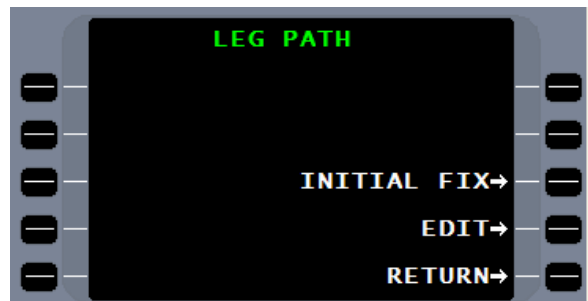


With the FPA entered, pressing the **ENTER** key will result in the FMS calculating the altitude at the FAF.

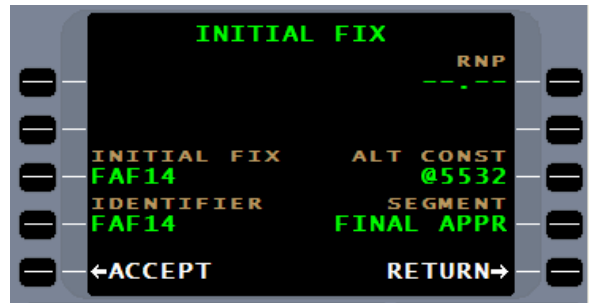


To add a FACF or edit the current leg, press the line select key adjacent to the location where the waypoint will be entered. If a new waypoint is entered, the FAF14 will move down allowing for the new waypoint.

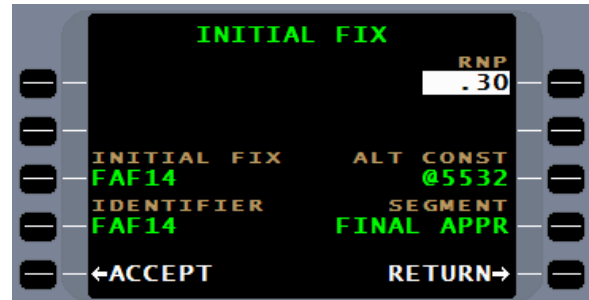
Upon pressing the line select key, the **LEG PATH** page will be displayed. To edit the current leg, press the EDIT line select key.



Selecting the EDIT line select key will allow for the changing of previous entered data or the entering of new data.



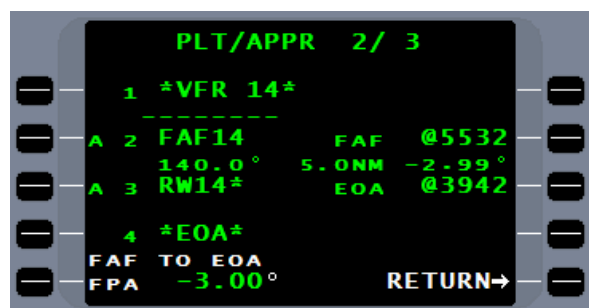
An RNP to monitor FMS navigation accuracy may be entered.



Pressing ACCEPT will save the new data.



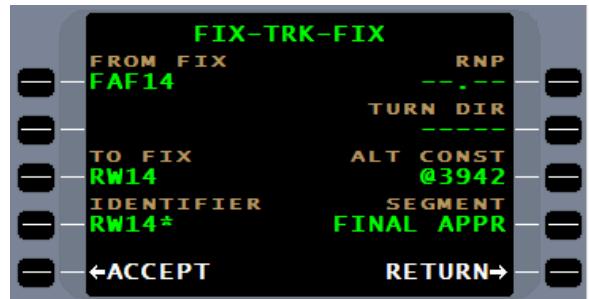
To correct the altitude at RW14 to reflect the threshold crossing altitude, press line select key 3L next to RW14 and...



...select EDIT.



Select 3R to change the altitude to the correct crossing altitude.



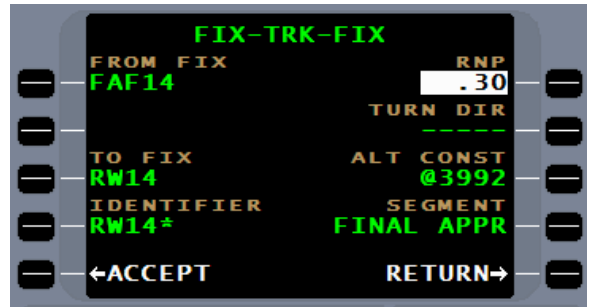
Select 1L to change the “@” altitude.



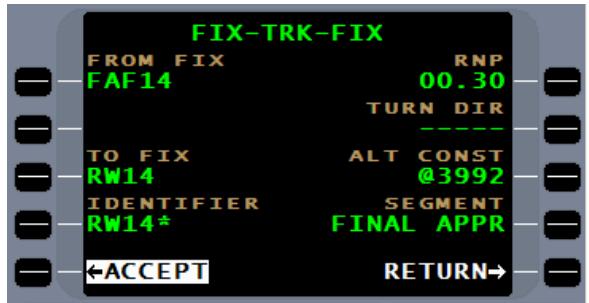
Adding 50' will correctly reflect the EOA altitude for crossing the threshold.



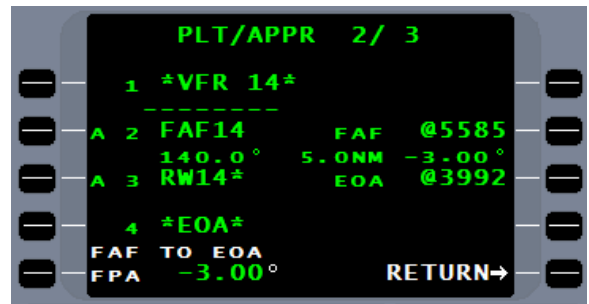
Entering RNP for this leg may, also, be done.



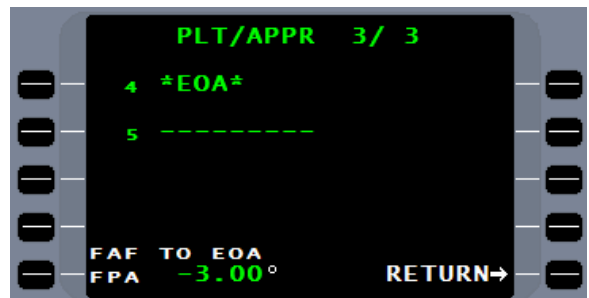
Press ACCEPT to save the additions



The FAF14 to RW14 leg now reflects correct course and altitude parameters.



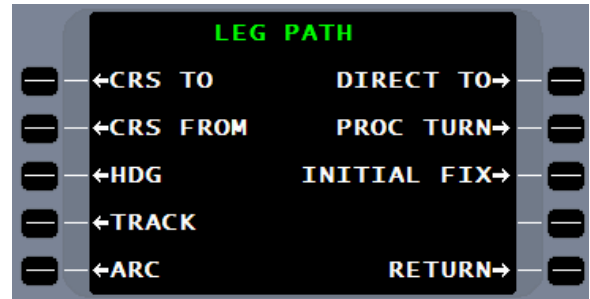
To add a missed approach, move to page 3 and select waypoint 5 line.



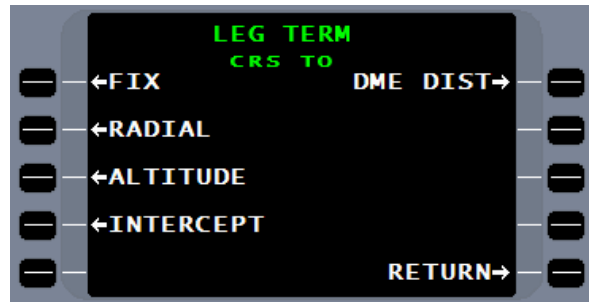
If desired, a missed approach procedure may be added to the approach. PLT Approach page 3 is used to define Missed Approach legs. To define a missed approach leg, select the leg type and press the appropriate line select key. The system will prompt the operator for entry of a LEG PATH and LEG TERMINATOR for each leg of the defined procedure. Menu pages for each LEG PATH and LEG TERMINATOR will retrieve input pages for entry of the appropriate data. Optional inputs for these legs will be the turn direction and the advisory altitude constraints.

The LEG PATH MENU page will be displayed to choose the path of the first leg.

Typically the first leg will be a climb on runway heading or course to 400 AGL. Press the CRS TO line select key to begin the missed approach definition.



Press the ALTITUDE line select key to terminate the leg.

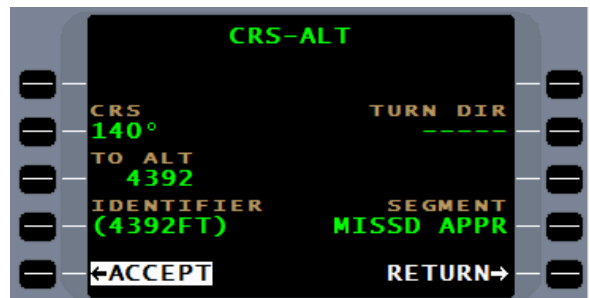


Enter the course 140° at the cursor and press

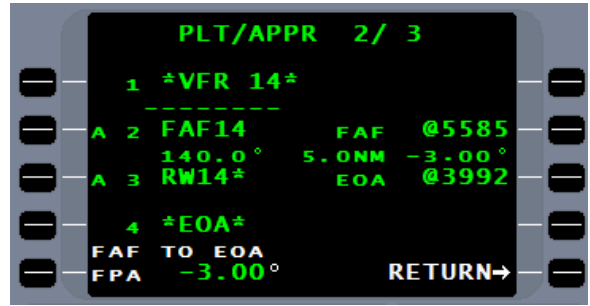


Since there is no TURN DIR to be entered, accept this leg.

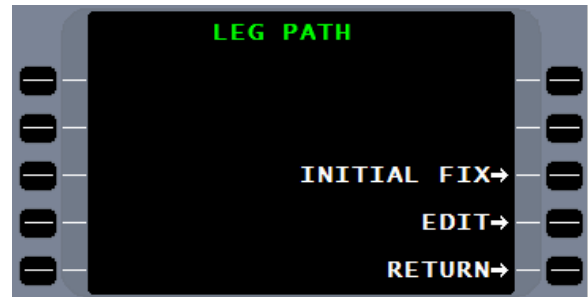
Additional legs may be entered as necessary. A turn to crosswind and again to downwind can be added.



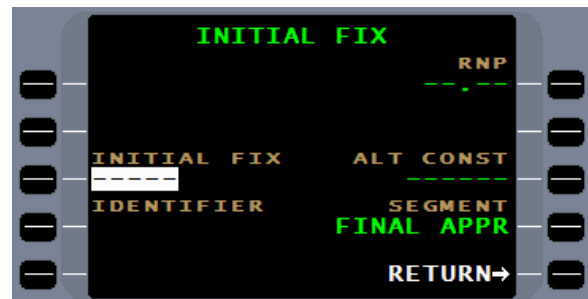
To add a FACF, from **PLT/APPR 2/3**, press 2L.



Select INITIAL FIX.



Enter the waypoint to be the FACF. If the NAV database does not contain a waypoint, use the "pilot waypoint creation method", and create one.



The "pilot created waypoint", CFVFR, is entered.



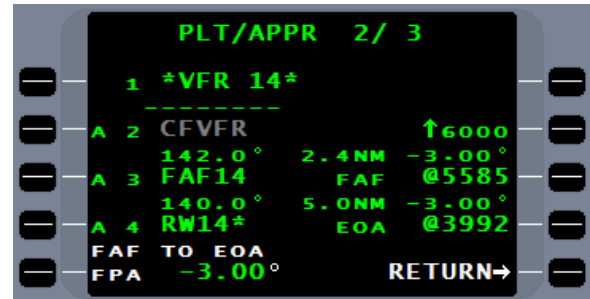
The approach segment is now complete and can be flown as is.



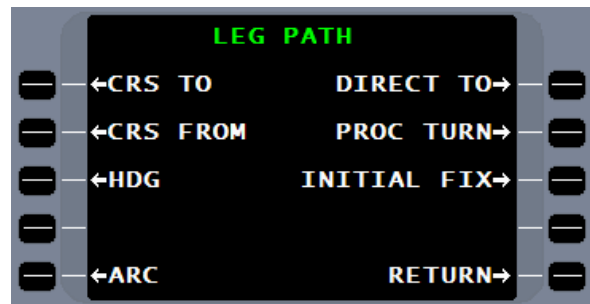
To add an approach transition, return to pilot approach page and enter the name for the transition. More than one transition can be created for each approach. With the name entered, press the **ENTER** key and then go to pilot approach page 2.



Select line select key 1L.



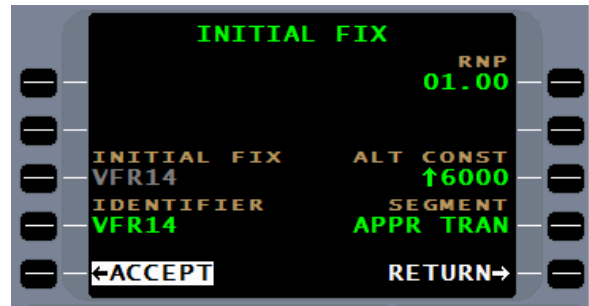
To begin the transition, select INITIAL FIX.



Enter the desired waypoint, either from the NAV database or pilot created.



With the optional altitude constraint entered, accept the initial fix to the approach transition.



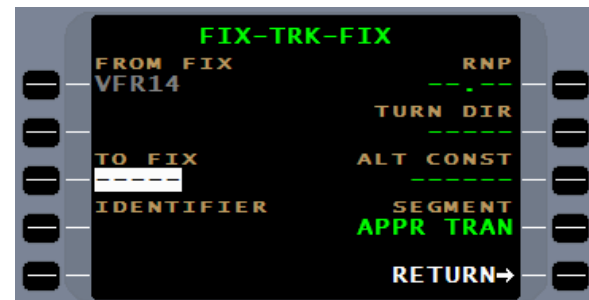
To link the approach transition to the approach segment, the fix CFVFR should be entered a second time, following the waypoint VFR14. To do this, press the line select key below the VFR14 waypoint. The FAF entered outside the approach label will produce a TF leg may be used for auto activation. The FAF inside the approach label will be used for manual activation and produce a CF leg.



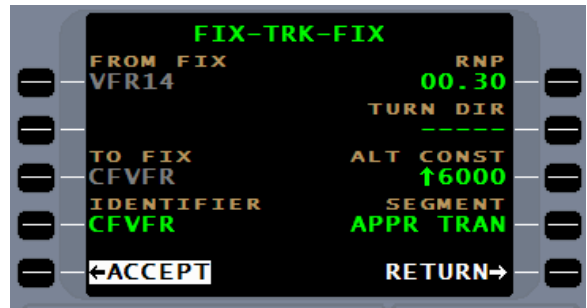
For this leg, TRACK will be selected.



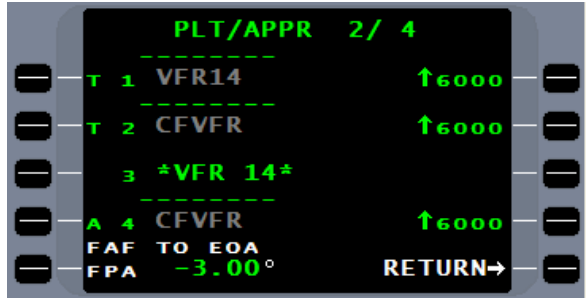
Enter CFVFR as the “TO” fix.



With the optional altitude constraint entered, accept the entered data.



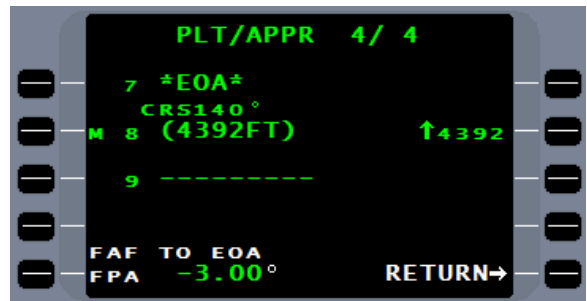
The approach transition is now complete and...



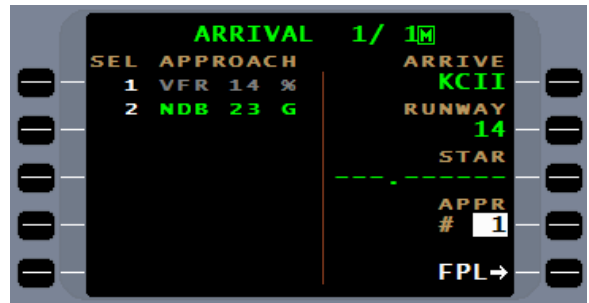
...will transition automatically into the approach segment. The FMS will go approach active upon crossing CFVFR.



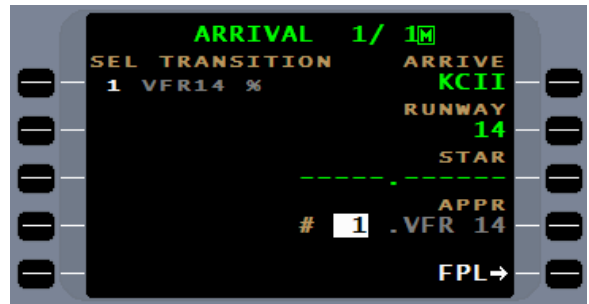
If a missed approach is required, the FMS will guide the pilot on the runway course until reaching 400' AGL, at which time the pilots VFR navigation will take over. Additional missed approach legs may be constructed to navigate the aircraft to downwind.



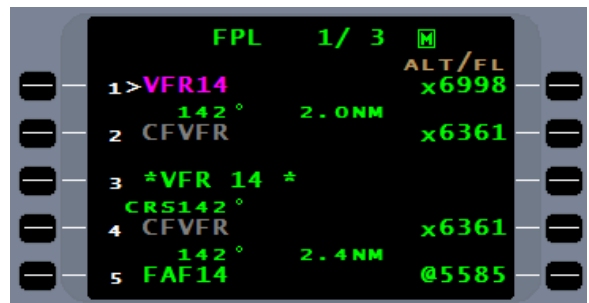
Pilot created data, including SID, STAR approaches, airports, and runways, will be displayed in a subdued color and be followed by a “%” symbol, denoting that it is pilot created.



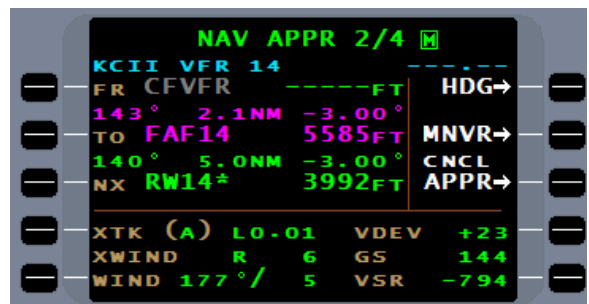
Entering a pilot approach to the flight plan is accomplished the same way any NAV data approach would be entered.



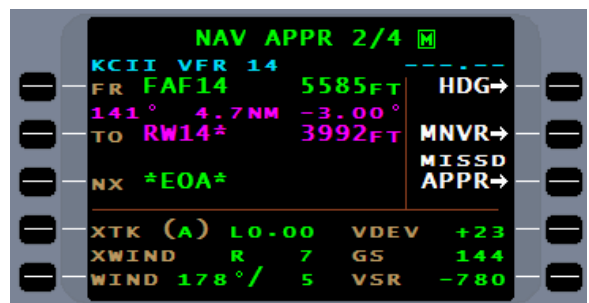
Except for the color of the waypoints, the pilot approach will be displayed in the flightplan as any waypoint would be displayed.



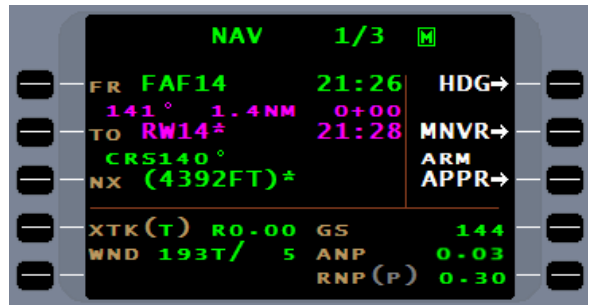
The active pilot approach will be displayed the same as a NAV database enabled approach.



When crossing the final approach fix, the MISSD APPR option will be presented.



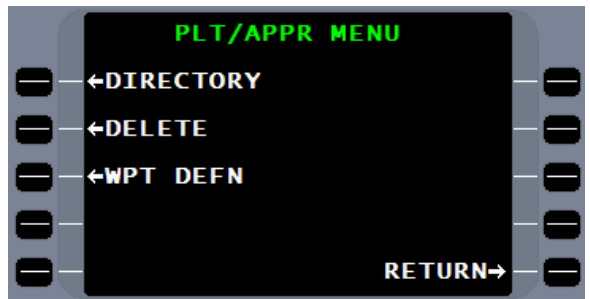
The selected missed approach, again, will respond the same as a NAV database enabled approaches missed approach segment.



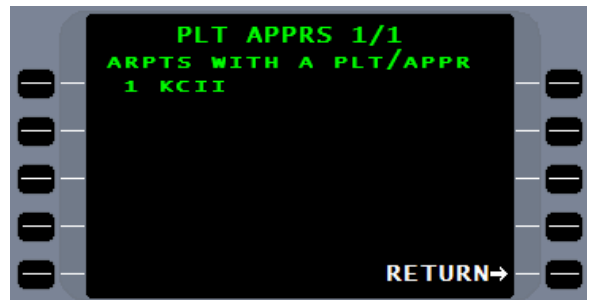
The [MENU] option available and represented by the [M] symbol supports several options.



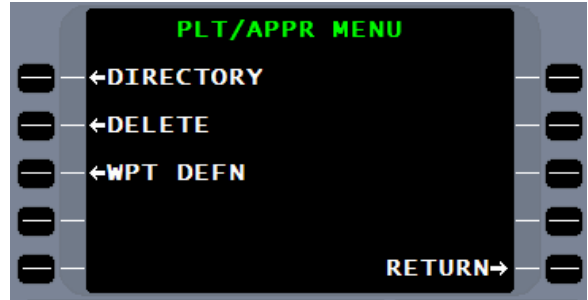
Select the **DIRECTORY** option to...



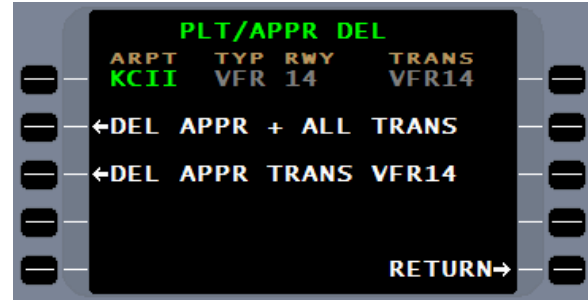
...display a list of airports for which pilot approaches are created.



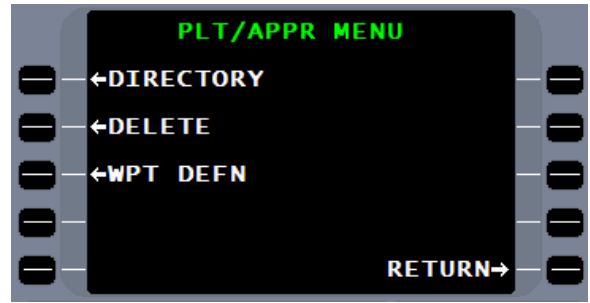
Select **DELETE** to...



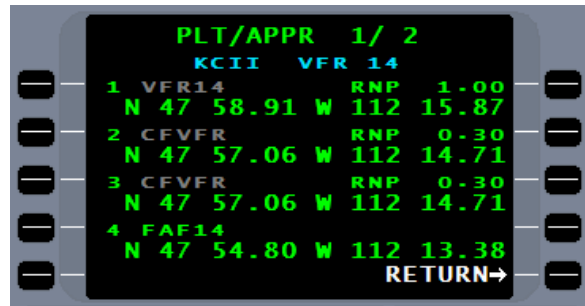
...present options to delete the entire approach and transitions or just a specific transition.



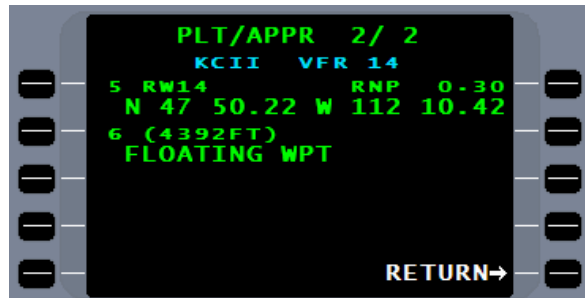
The waypoint definition option will...



...display the approach latitude and longitude with RNP or...



...the definition of a conditional or floating waypoint.



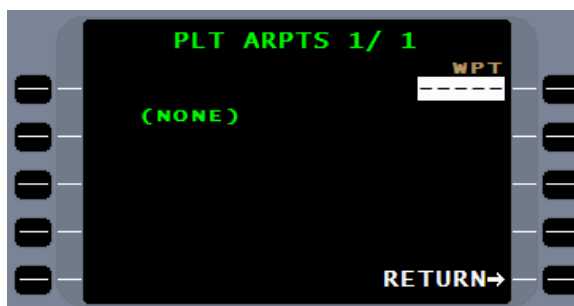
NOTE: Training for the creation of approaches by pilots other than VFR is covered in a customized class by contacting the UASC Training Department.

PILOT DEFINED AIRPORT

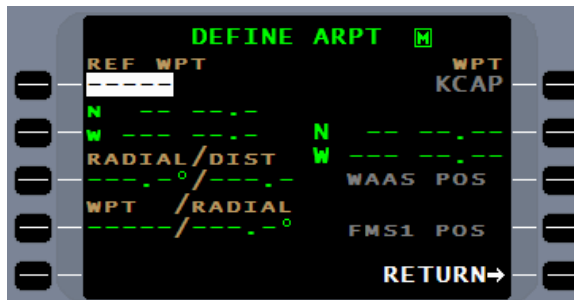
For private airports and other airports not included in the NAV database, the FMS offers the pilot the capability to define an airport. From the DATA/PLT page select AIRPORT.



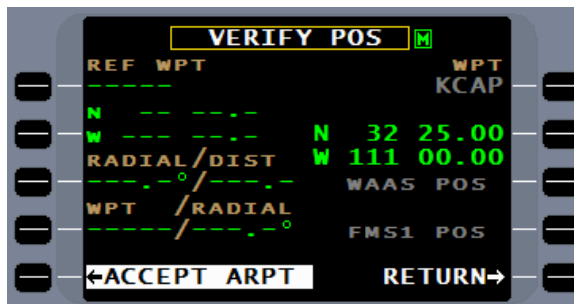
The **PLT ARPTS** page will list all the pilot created airports and offer the ability to create a new airport. First select an identifier that is not already being used in the NAV or pilot database. If the identifier selected is already in use, when the **ENTER** key is pressed the identifier will flash and not move to the DEFINE ARPT page.



Once the identifier is accepted, the **DEFINE ARPT** page will allow for defining the airports geographic reference point, usually the center of the airfield. The coordinates can be entered in the same manner as defining a pilot created waypoint. Use either radial-and-distance from a known fix, or the crossing radials of two know fixes, or directly enter the latitude and longitude.



After entering the Airport reference point by one of the above methods, press either the **ENTER** key or the ACCEPT ARPT line select key.



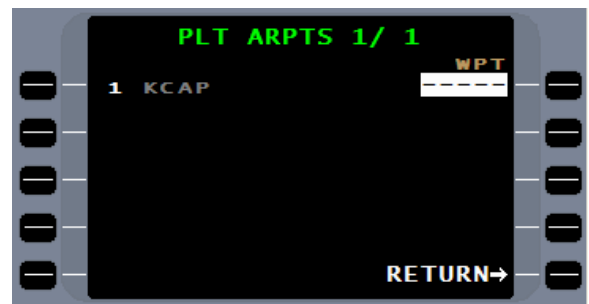
The next page allows for entering the airport altitude.



Accept the altitude and the airport is defined.

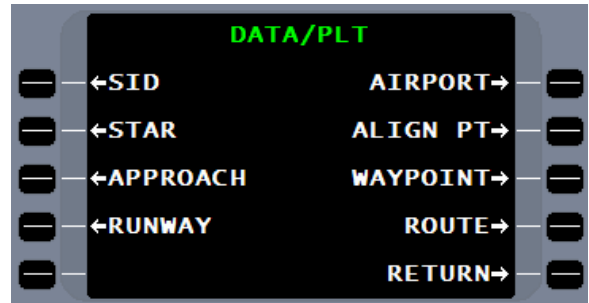


The **PLT ARPTS** page now reflects the created airport.

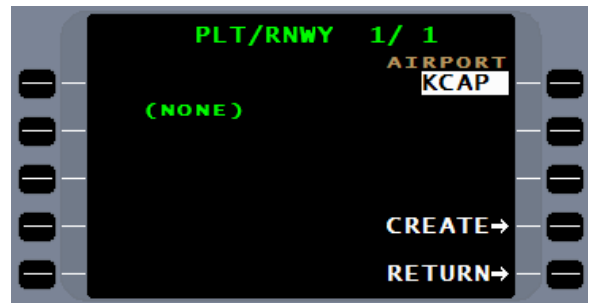


PILOT DEFINED RUNWAY

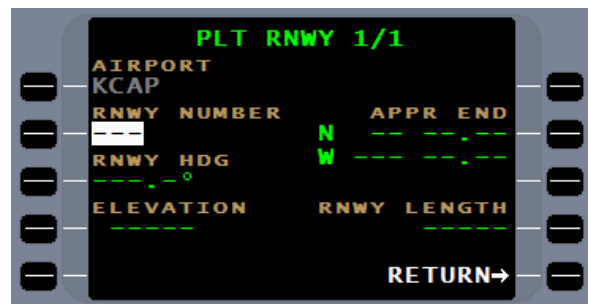
For the pilot defined airport a runway can be defined. Through the DATA/PLT page select **RUNWAY**.



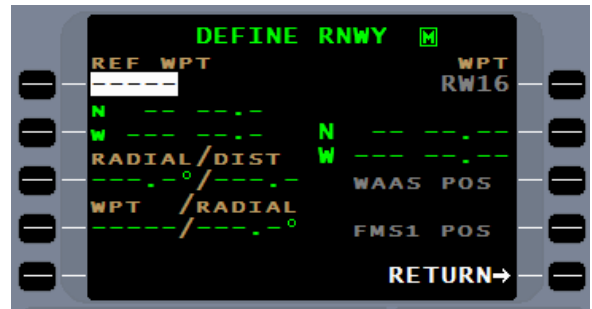
After entering the airport identifier, press **ENTER** and the CREATE line select key becomes available.



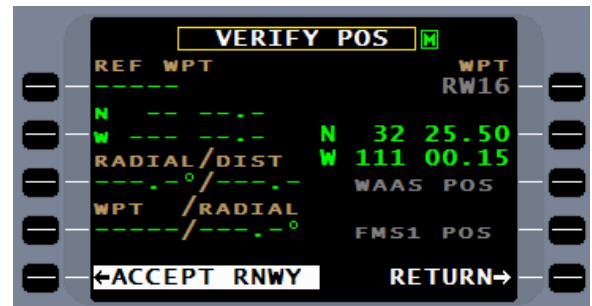
Pressing the CREATE line select key brings up the PLT RNWX page. Enter the runway identifier and press the **ENTER** key. A [L], [C], or [R] may be added for left, center, or right.



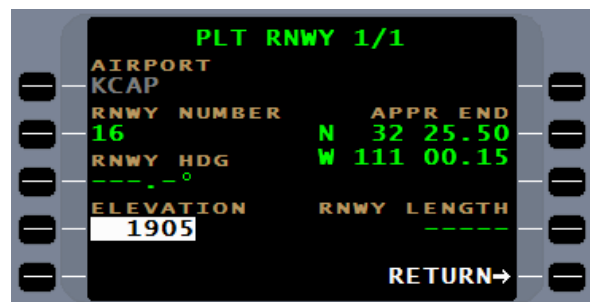
The runway end or threshold coordinates must now be entered. Use the same procedures as with the DEFINE AIRPORT page.



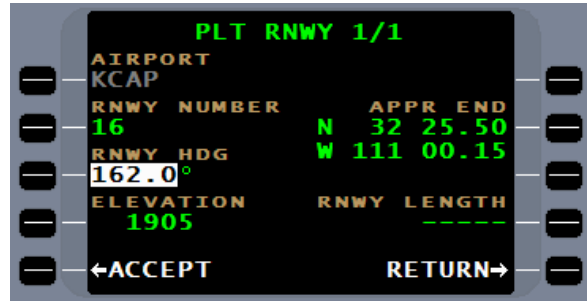
Accept these runway end coordinates and move to the next page.



Enter the runway end altitude, which may or may not be the same as the airport geographic reference point.



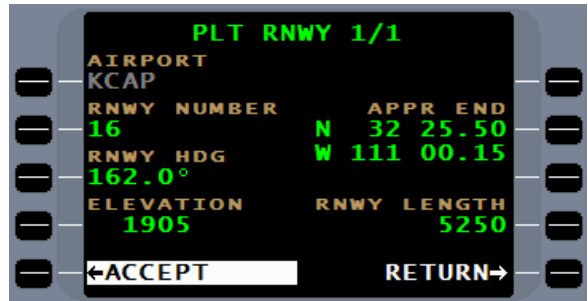
Enter the runway heading. It can be defined to the tenth of a degree.



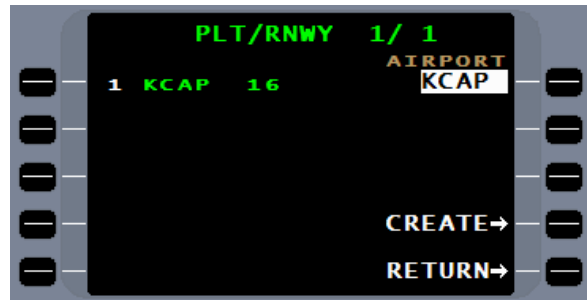
Finally, define the Runway length.



Accept the defined runway.

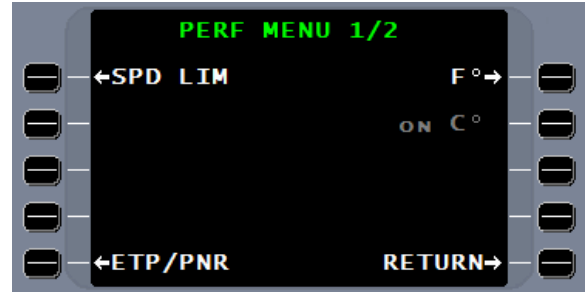


Review the newly created pilot runway.

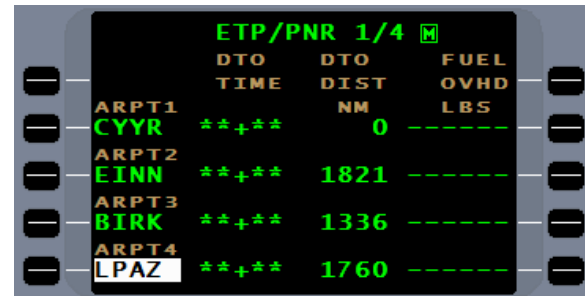


EQUAL TIME POINT (ETP) & POINT OF NO RETURN (PNR)

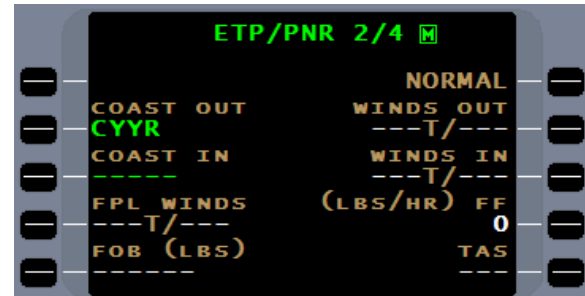
Equal Time Point and Point of No Return is accessed through the performance page menu by selecting ETP/PNR line select key.



Begin on **ETP/PNR 1/4** by entering divert airports to include departure and arrival airports.



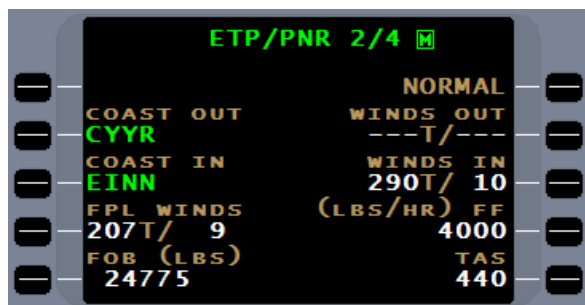
To calculate ETP and PNR, on page 2 enter the COAST OUT and COAST IN airports from a list compiled from page 1.



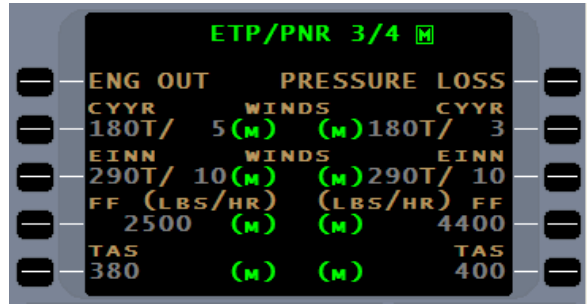
Pressing line select key 1 or 2 will bring up the list of airports from page 1.



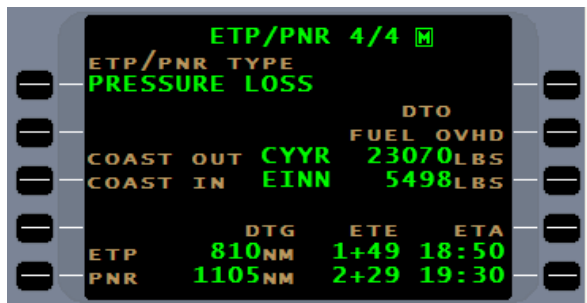
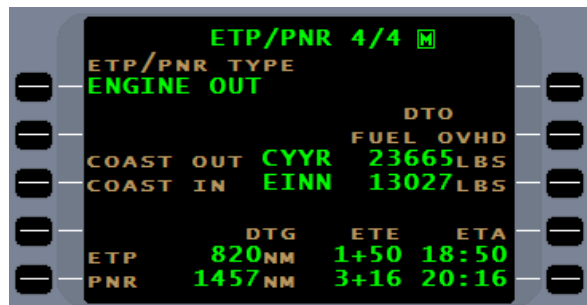
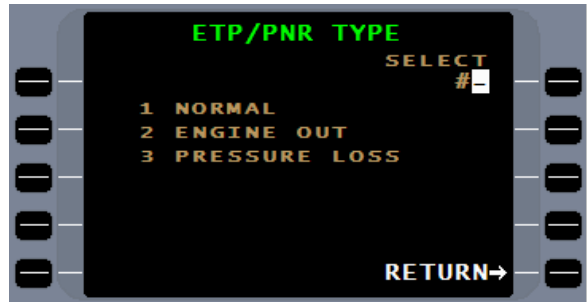
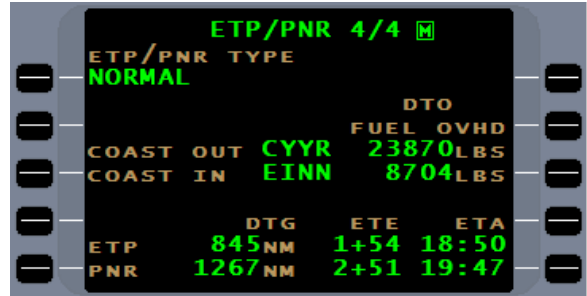
Information for FPL WINDS, FOB, FF, and TAS will be pre filled by the FMS if available. WINDS OUT and WINDS IN will be filled from forecast flightplan winds if available or can be manually entered by the pilot.



For ENG OUT and PRESSURE LOSS ETP/PNR calculations, required information must be entered manually.



Display of ETP/PNR information for NORMAL, ENGINE OUT, and PRESSURE LOSS is selectable by pressing 1Lw line select key.



PROCEDURAL LEG TYPES

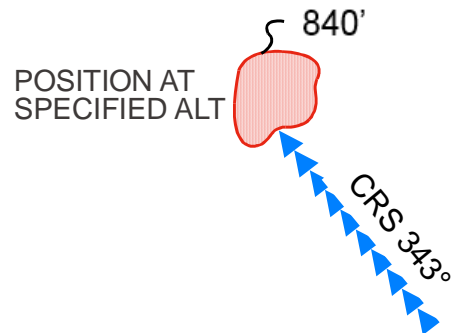
SIDS, STARS, APPROACH TRANSITIONS, MISSED APPROACHES

Standard Instrument Departures (SID) and Standard Terminal Arrival Routes (STAR) consist of procedural legs that begin and end at prescribed locations or conditions. A procedural leg has two parts: a leg path and a leg terminator. The path of these legs can be flown along a heading, a course, a great circle path, or even a constant arc. The termination of a leg can occur at a specific geographic fix, at a VOR radial crossing, or when the aircraft attains a certain altitude. The FMS with SCN 100X will fly the different procedural leg types as defined in ARINC 424, of which airport departures and arrivals are comprised.

The following make up the twenty-three leg types that are currently in use:

Heading to Altitude	VA..... 329
Heading to a DME Distance	VD 333
Heading to a Next Leg Intercept	VI..... 310
Heading to a Manual Termination	VM..... 335
Heading to a Radial Termination	VR 308
Course to an Altitude	CA 308
Course to a DME Distance	CD 319
Course to a Next Leg Intercept	CI..... 321
Course to a Radial Termination	CR 319
Course to a Fix	CF..... 310
Tracking Between Two Fixes	TF 311
Direct to a Fix	DF..... 295
Course from a Fix to an Altitude	FA..... 331
Course from a Fix to an Along Track Distance	FC..... 325
Course form a Fix to a DME Distance	FD..... 313
Course from a Fix to a Manual Termination	FM 323
Constant DME Arc to a Fix	AF..... 313
Constant Arc Radius to a Fix	RF..... 337
Hold to a Fix	HF..... 338
Hold to an Altitude	HA 338
Hold to a Manual Termination	HM..... 338
Initial Fix	IF 317
Procedure Turn to Intercept	PI..... 315

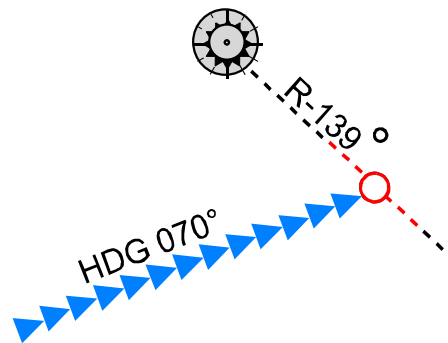
The following illustrates the Seattle airport (KSEA), Runway 34L, using the SUMMA Nine departure with the Lakeview (LKV) transition as shown in the Flight and Departure section of this manual. Listed with each screen is the exact procedural leg type used to navigate this departure. Remaining procedural leg types not used in this departure follow with an appropriate example of each.



COURSE TO ALTITUDE (CA)

The aircraft will fly runway course 343° until reaching 840 feet.

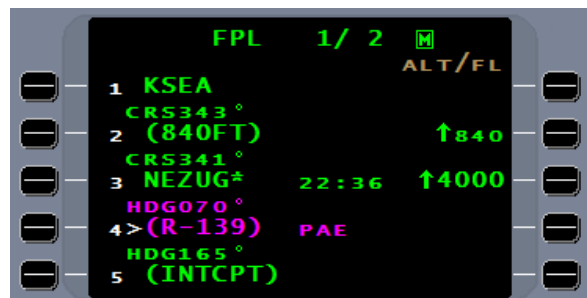
Course to Altitude



HEADING TO RADIAL (VR)

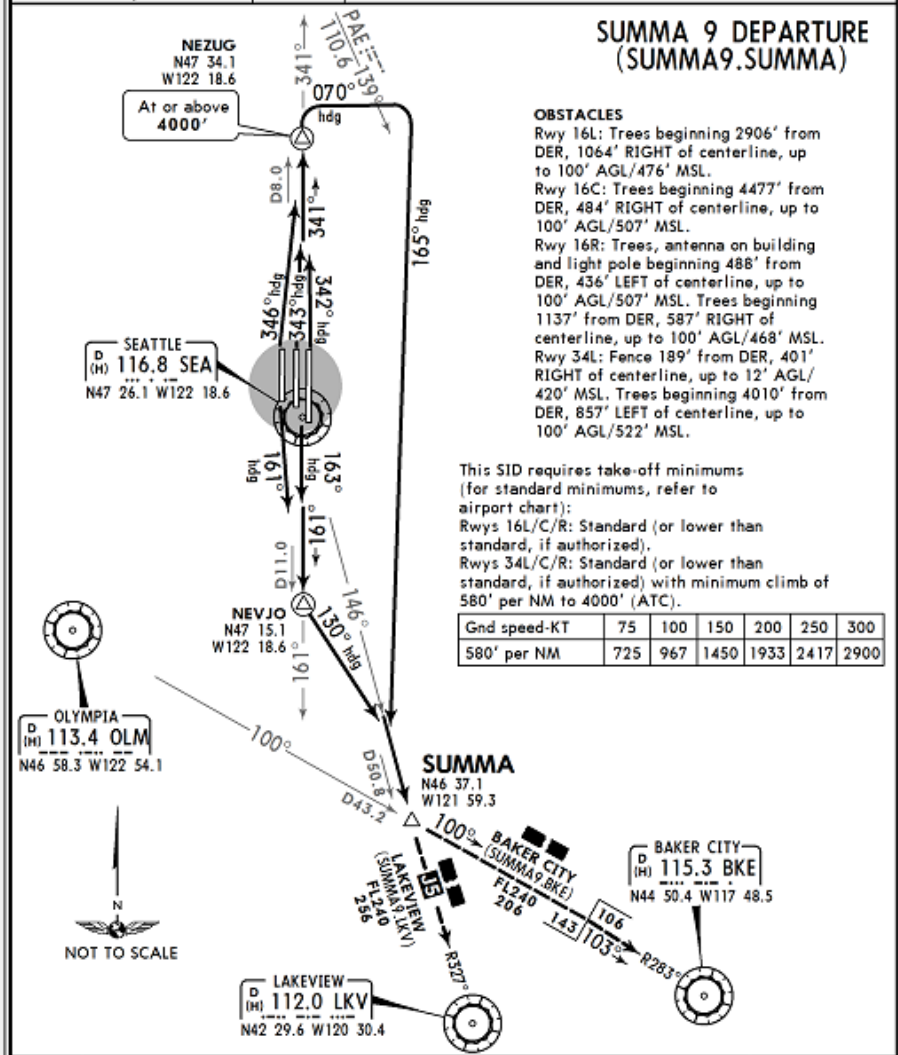
The aircraft will turn right to a heading of 70° until crossing the PAE 139° radial.

Heading to Radial



KSEA/SEA -TACOMA INTL **JEPPESEN** **SEATTLE, WASH**
4 NOV 16 **20-3G** Eff 10 Nov **SID**

SEATTLE Departure (R)
Rwys 16L/C/R 120.4 | Rwys 34L/C/R 119.2 | Apt Elev 433' | Trans level: FL180 | Trans alt: 18000' | **RADAR and DME required.**



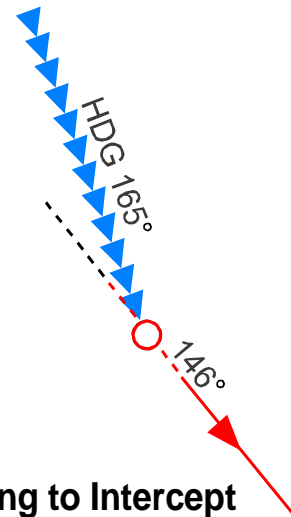
RWY	INITIAL CLIMB	TOP ALTITUDE
16L/C	Climb heading 163° and SEA R-161 to NEVJO, then LEFT turn heading 130° to intercept the SEA R-146 to SUMMA.	Assigned by ATC
16R	Climb heading 161° and SEA R-161 to NEVJO, then LEFT turn heading 130° to intercept the SEA R-146 to SUMMA.	
34L	Climb heading 346° and SEA R-341 to cross NEZUG at or above 4000', then RIGHT turn heading 070° to cross PAE R-139. Then RIGHT turn heading 165° to intercept the SEA R-146 to SUMMA.	
34C	Climb heading 343° and SEA R-341 to cross NEZUG at or above 4000', then RIGHT turn heading 070° to cross PAE R-139. Then RIGHT turn heading 165° to intercept the SEA R-146 to SUMMA.	
34R	Climb heading 342° and SEA R-341 to cross NEZUG at or above 4000', then RIGHT turn heading 070° to cross PAE R-139. Then RIGHT turn heading 165° to intercept the SEA R-146 to SUMMA.	
ROUTING		
From SUMMA, then via assigned transition.		

CHANGES: None. © JEPPESEN, 2005, 2016. ALL RIGHTS RESERVED.

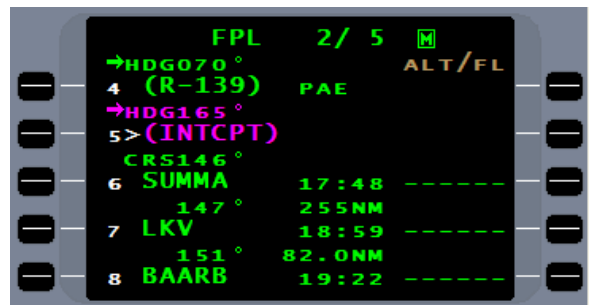
Copyright 2016 Jeppesen Sanderson, Inc.
Reproduced with permission from Jeppesen Sanderson, Inc.
FOR ILLUSTRATION PURPOSES ONLY; MAY NOT BE USED FOR NAVIGATION

HEADING TO INTERCEPT (VI)

The aircraft will turn right to 165° HDG until intercepting course 146° inbound to SUMMA.

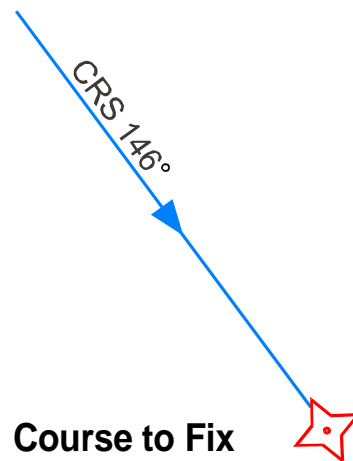


Heading to Intercept

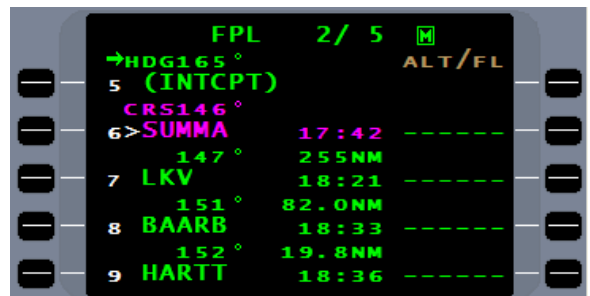


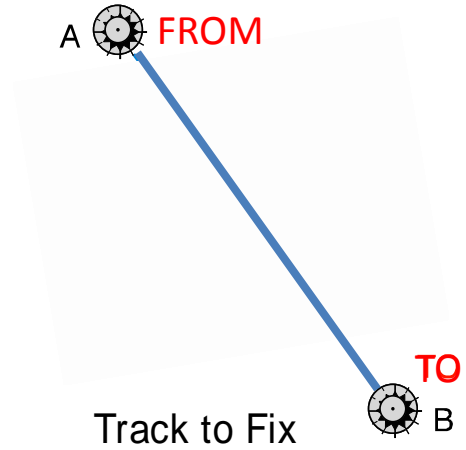
COURSE TO FIX (CF)

The aircraft will turn left, intercept, and fly 146° course to SUMMA intersection.



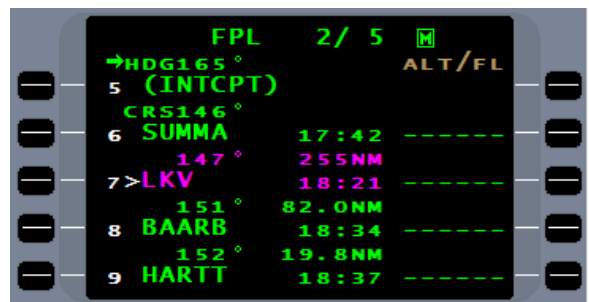
Course to Fix

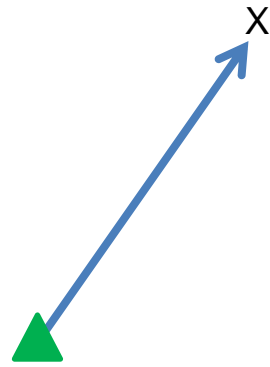




TRACK TO FIX (TF)

After SUMMA, the aircraft will fly a TRACK to FIX LEG of 147° initially from SUMMA to LKV VOR.

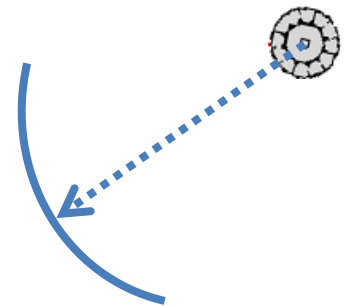
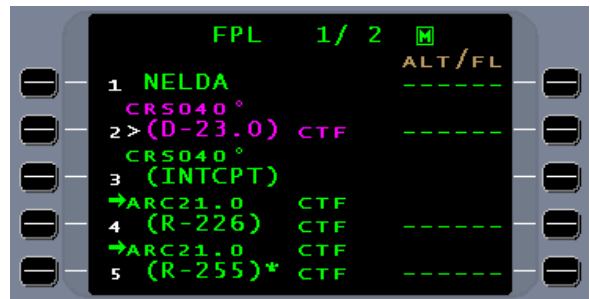




FIX TO DME DISTANCE (FD)

From NELDA the FMS will track the course 040° to 23.0 DME of CTF.

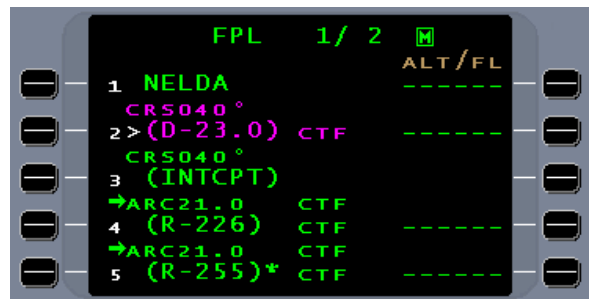
Course from Fix to DME Distance

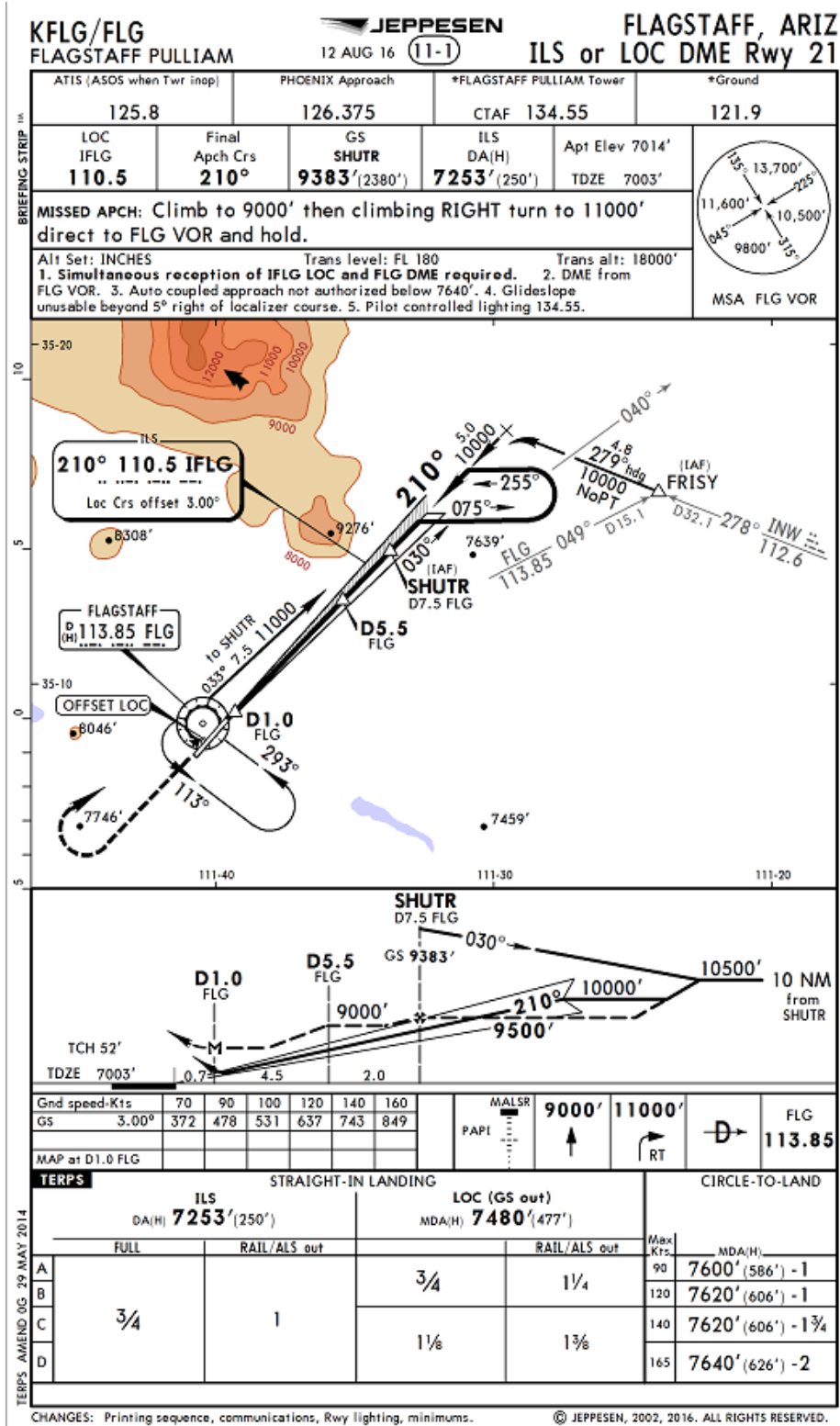


ARC TO FIX (AF)

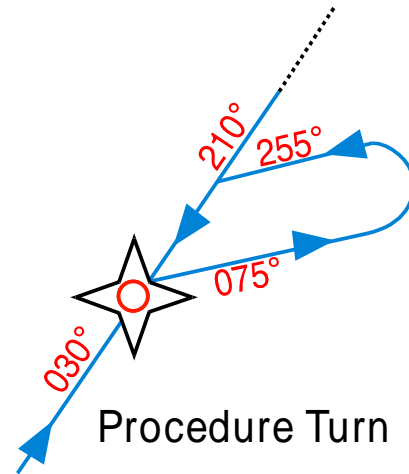
The FMS will turn to intercept and follow the 21nm DME ARC to the intersection of the 226 radial of CTF, then sequence to the next arc segment.

DME ARC





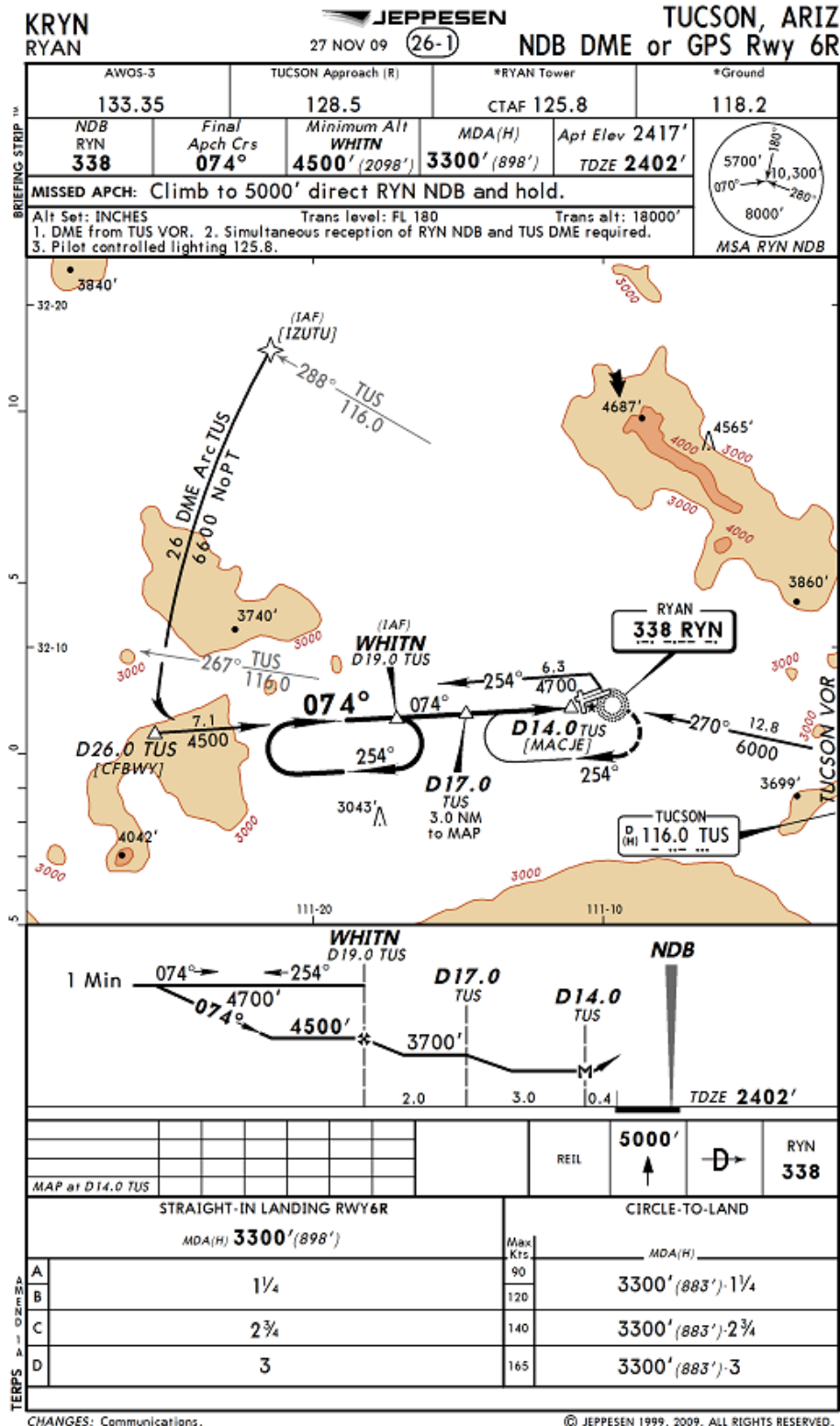
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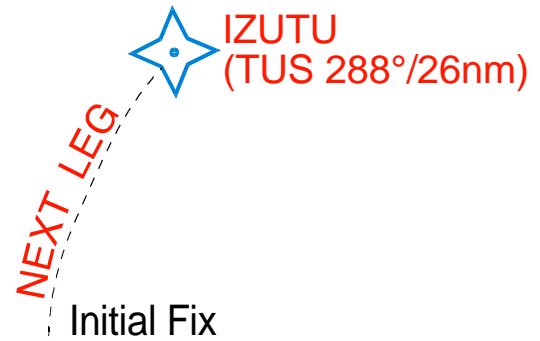
PROCEDURE TURN TO INTERCEPT (PI)

After arriving at SHUTR, the aircraft will turn to 030° then to 075° followed by a turn left to 255° at the correct time/distance interval to intercept 210° course inbound.



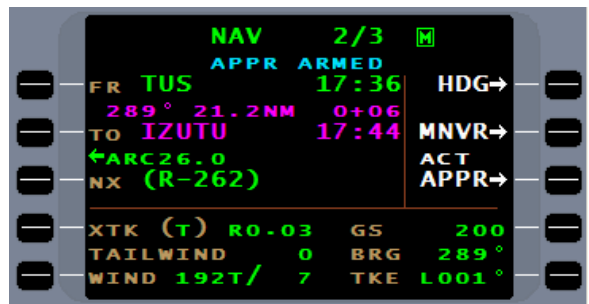


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INITIAL FIX (IF)

IZUTU, defined by the TUS 288° radial at 26nm, is designated “Initial Fix” for NDB DME or GPS Rwy 6R approach at KRYN. The aircraft will fly direct from TUS VOR to IZUTU. The difference between the FMS course of 289° and the TUS VOR radial of 288° is attributed to the VOR declination of 12°E and the FMS magnetic variation of 11°E.



JEPPESEN

24 AUG 07 **(10-3A)**

HOBART, TAS, AUSTRALIA

SID

YMHB HOBART

TRANS LEVEL: FL 110
TRANS ALT: 10000'

NORTH

**KAREN FOUR DEPARTURE
LIFFY THREE DEPARTURE
ST HELENS (STH) FOUR DEPARTURE
TEA TREE (TTR) ONE DEPARTURE**

Minimum required climb gradients:

Gnd speed-Kts	75	100	150	200	250	300
Rwy 12 3.3% V/V (fpm)	251	334	501	668	835	1003
Rwy 30 3.5% V/V (fpm)	266	354	532	709	886	1063

RWY 12: Track 120°. At or above 1000' turn LEFT.

For TTR, LIFFY: Track direct to HB VOR. Intercept cleared route.

Requirement: Reach 1500' by over or abeam HB VOR.

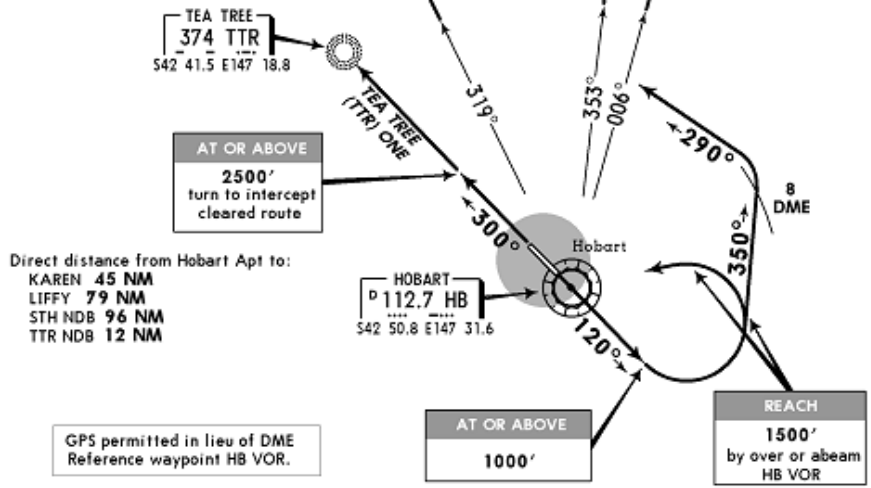
For KAREN, STH: Track 350°. At HB 8 DME turn LEFT, track 290°. Intercept cleared route by no later than 15 DME NORTH of HB VOR.

Requirement: Reach 1500' by over or abeam HB VOR.

RWY 30: Track HB R-300. At or above 2500' turn to intercept cleared route by no later than 15 DME NORTH of HB VOR.



MSA HB VOR
Within 25 NM
5600' within 10 NM

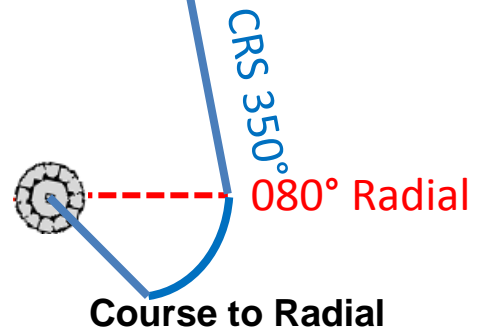


Direct distance from Hobart Apt to:
KAREN 45 NM
LIFFY 79 NM
STH NDB 96 NM
TTR NDB 12 NM

CHANGES: MSA.

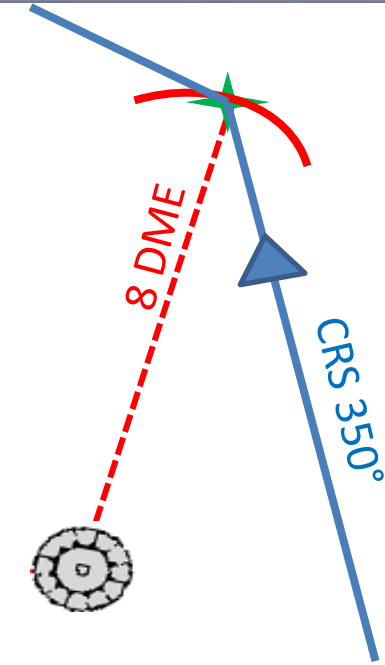
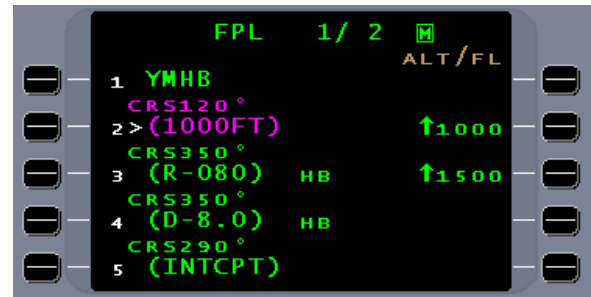
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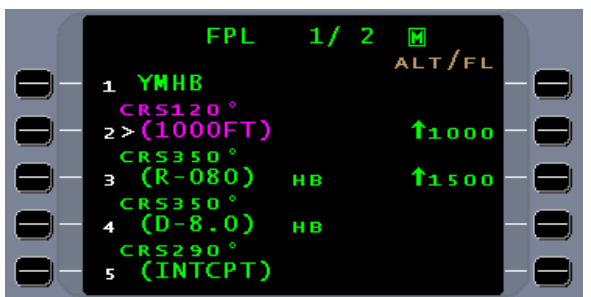
COURSE TO RADIAL (CR)

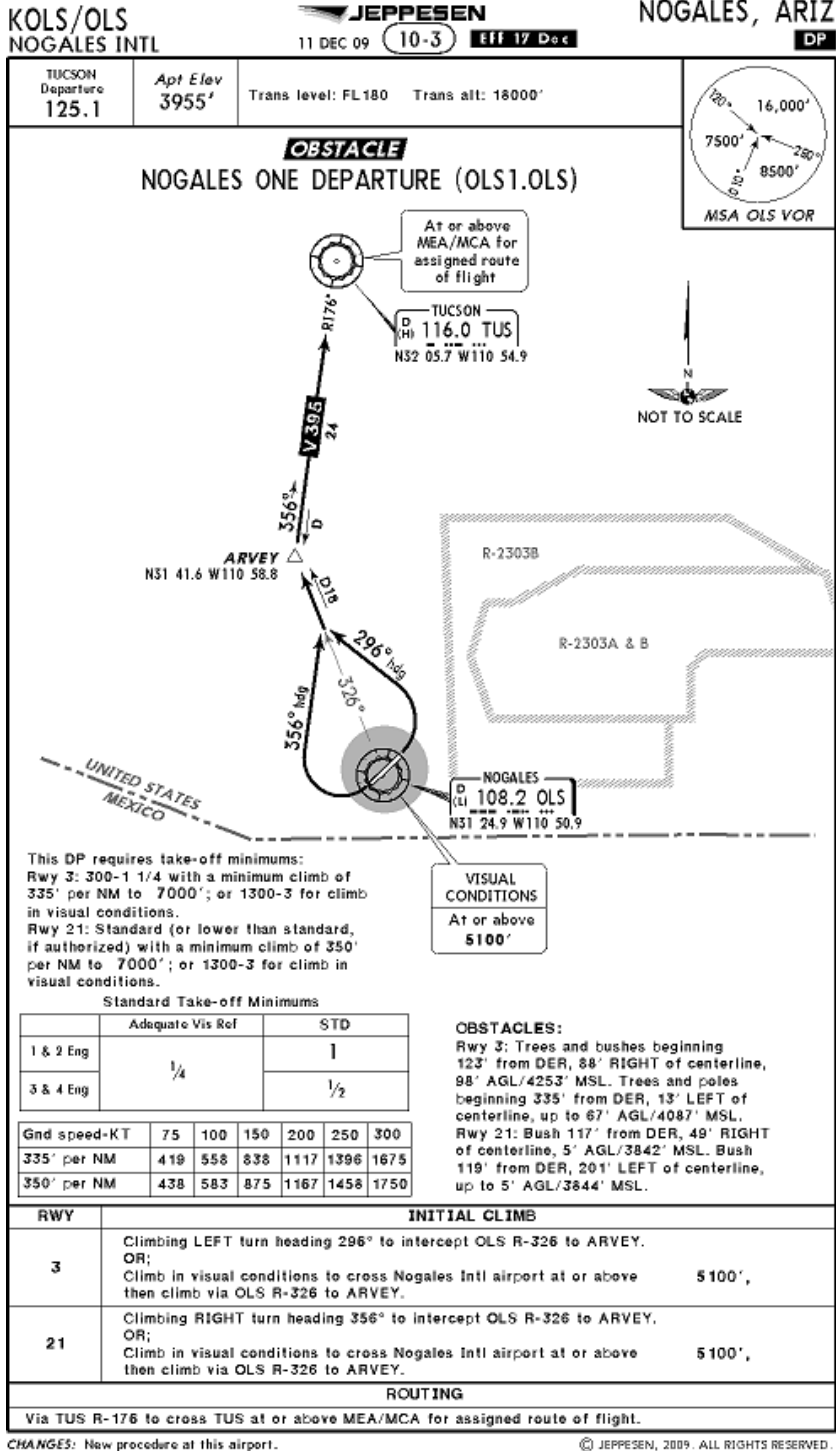
On the KAREN FOUR departure, after takeoff on runway 12 upon reaching 1000' turn left to cross at or above 1500' abeam HB VOR (080° radial).



COURSE TO DME DISTANCE (CD)

On the KAREN FOUR departure track (fly a course) to 8 DME



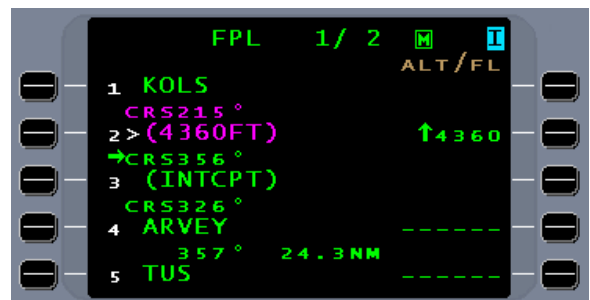


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COURSE TO INTERCEPT (CI)

After reaching initial takeoff altitude, the FMS will command a right turn to a course of 356° to intercept the course of 326° inbound to ARVEY intersection.

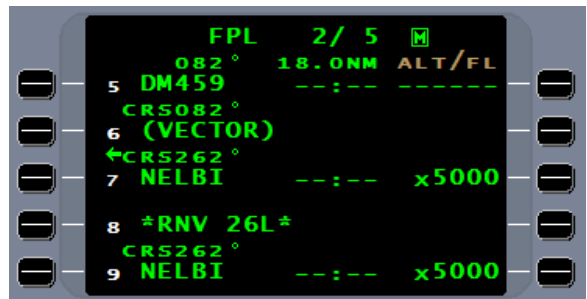


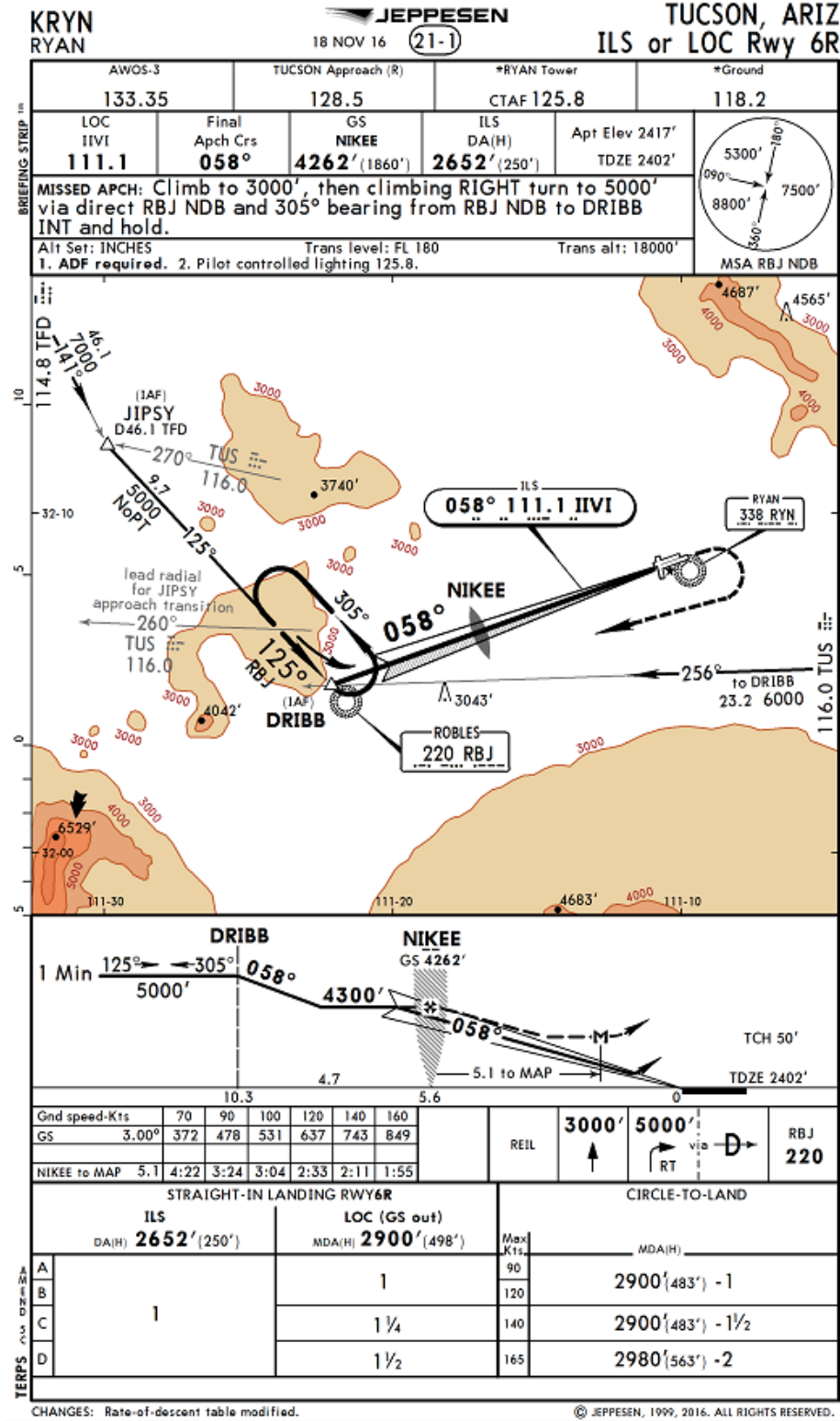


FIX TO MANUAL TERMINATION (FM)

FMS arrival guidance to aircraft on the EDDM BETOS26 RNAV Transition will maintain the current track with course of 082° and the leg will terminate with (VECTOR). After entering this leg the pilot will expect ATC vectors.

FIX TO MANUAL TERMINATION

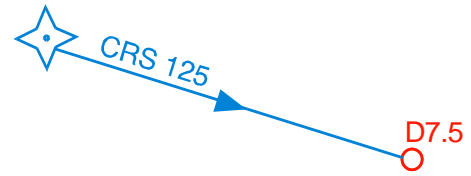




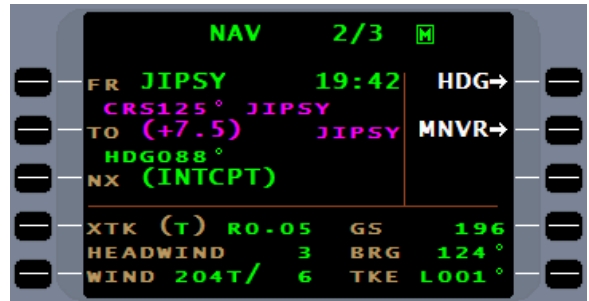
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FIX TO A DISTANCE ON COURSE (FC)

The aircraft will fly a course of 125° from JIPSY to (+7.5) along track distance that is the lead-in RADIAL for the ILS intercept. The aircraft will then turn left to 88° HDG at (+7.5).

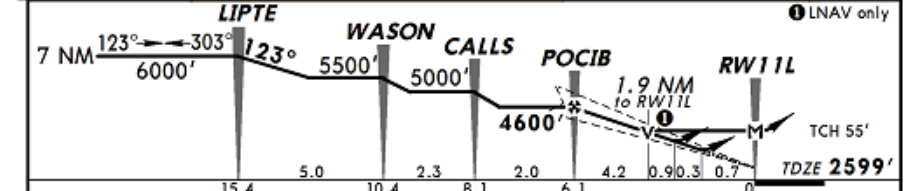
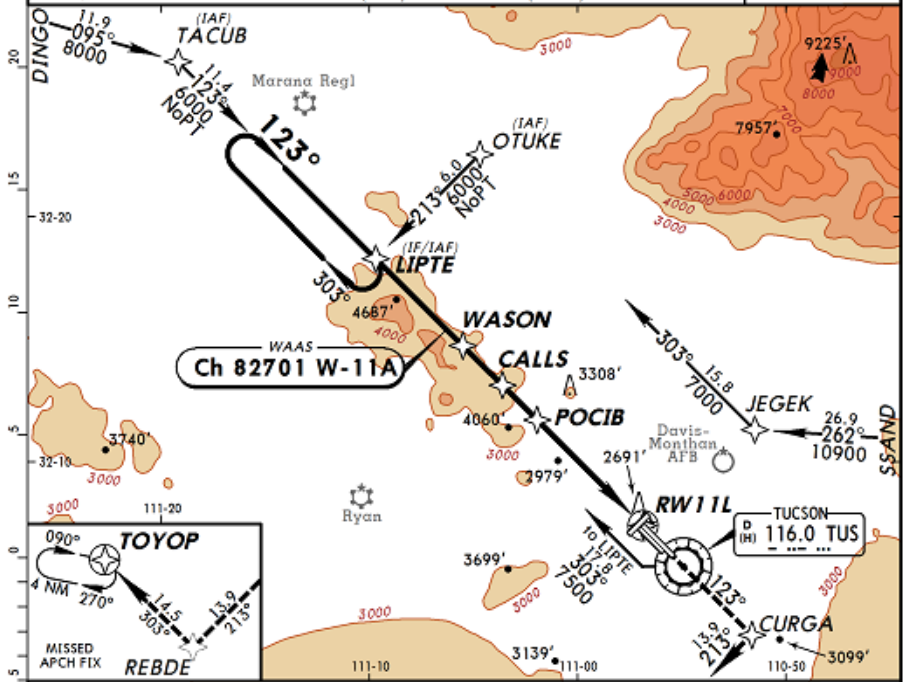


Course from Fix to Along Track Distance



KTUS/TUS TUCSON INTL **JEPPESEN** **TUCSON, ARIZ**
29 AUG 14 (12-2) **RNAV (GPS) Z Rwy 11L**

ATIS 123.8	TUCSON Approach (R) 119.4	TUCSON INTL Tower 118.3	Ground 124.4
WAAS Ch 82701 W-11A	Final Apch Crs 123°	Minimum Alt POCIB 4600' (2001')	LPV DA(H) 2849' (250')
Apt Elev 2643'			TDZE 2599'
MISSED APCH: Climb to 6000' via direct CURGA and via 213° track to REBDE and via 303° track to TOYOP and hold.			
Alt Set: INCHES Trans level: FL 180 Trans alt: 18000' 1. DME/DME RNP-0.30 not authorized. 2. For uncompensated Baro-VNAV systems, LNAV/VNAV not authorized below -20°C (-4°F) or above 43°C (111°F).			
			MSA RW11L 10,700'

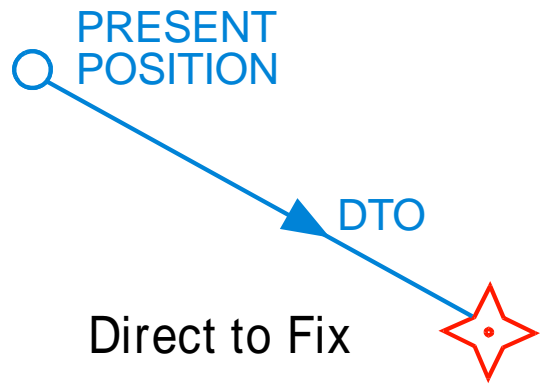


Grnd speed-Kts	70	90	100	120	140	160	MALS R 6000'		CURGA
Glide Path Angle 3.00°	372	478	531	637	743	849	PAPI		

LPV DA(H) 2849' (250')		LNAV/VNAV DA(H) 2956' (357')		LNAV MDA(H) 3240' (641')		CIRCLE-TO-LAND	
RAIL or ALS out		RAIL out ALS out		RAIL out ALS out		Max Kts MDA(H)	
A				RVR 24 or 1/2	RVR 40 or 3/4	RVR 50 or 1	90 3240' (597')-1
B				RVR 60 or 1 1/4	1 3/4		120 3240' (597')-1 3/4
C	RVR 24 or 1/2	RVR 50 or 1	RVR 40 or 3/4	RVR 60 or 1 1/4	1 1/2	2	140 3240' (597')-2
D							165 3240' (597')-2

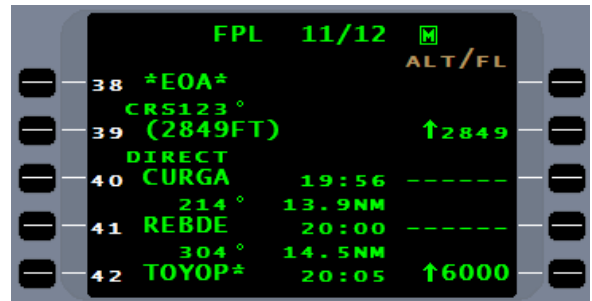
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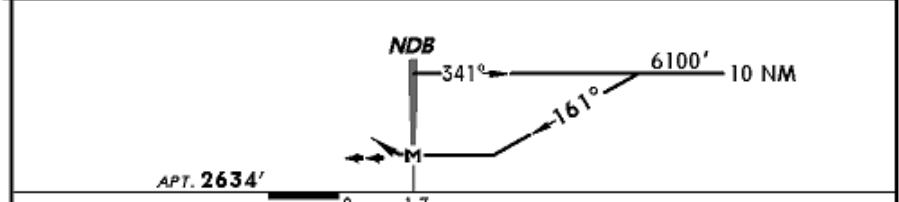
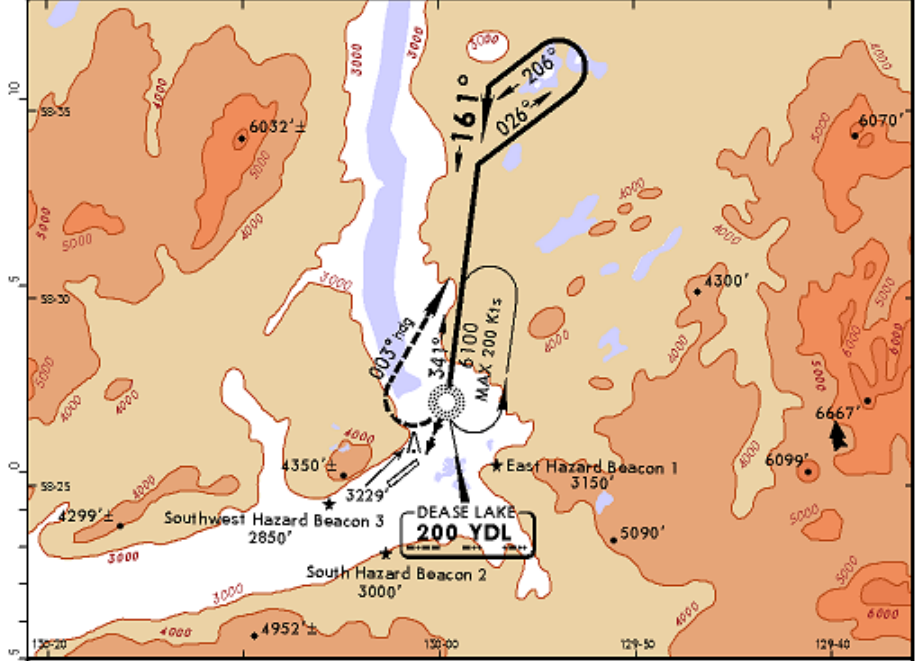
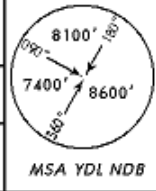
DIRECT TO FIX (DF)

During the missed approach when the FMS reaches 2849FT, the FMS will proceed direct to CURGA.



CYDL/YDL DEASE LAKE **JEPPESEN** **DEASE LAKE, BC NDB-A**
18 MAR 11 (16-1)

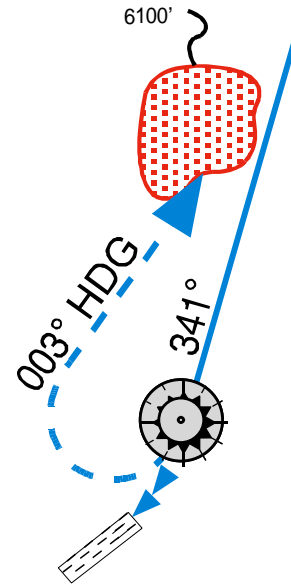
LWIS 128.7	EDMONTON Center 134.05	WHITEHORSE Rad o 126.7	DEASE LAKE Traffic ATF 123.2
NDB YDL 200	Final Apch Crs 161°	No FAF	MDA(H) Refer to Minimums Apt Elev 2634'
MISSED APCH: RIGHT climbing turn to 6100' on heading 003°. RIGHT turn direct YDL NDB.			
All Set: INCHES Trans level: FL 180 Trans alt: 18000' 1. SAFE ALTITUDE WITHIN 100 NM 12,300'. 2. Terrain rises abruptly to 4400' 1 NM west of airport. 3. Aerodrome assessed for aircraft wingspans less than 79'. 4. Pilot controlled lighting 123.2.			



Lighting - Refer to Airport Chart	6100' on	003° hdg	YDL 200
MAP at NDB			
CIRCLE-TO-LAND		NO CIRCLING	
Max Kts	MDA(H)		
A 90	4660' (2026')-3		
B 120			
C 140			
D 165			

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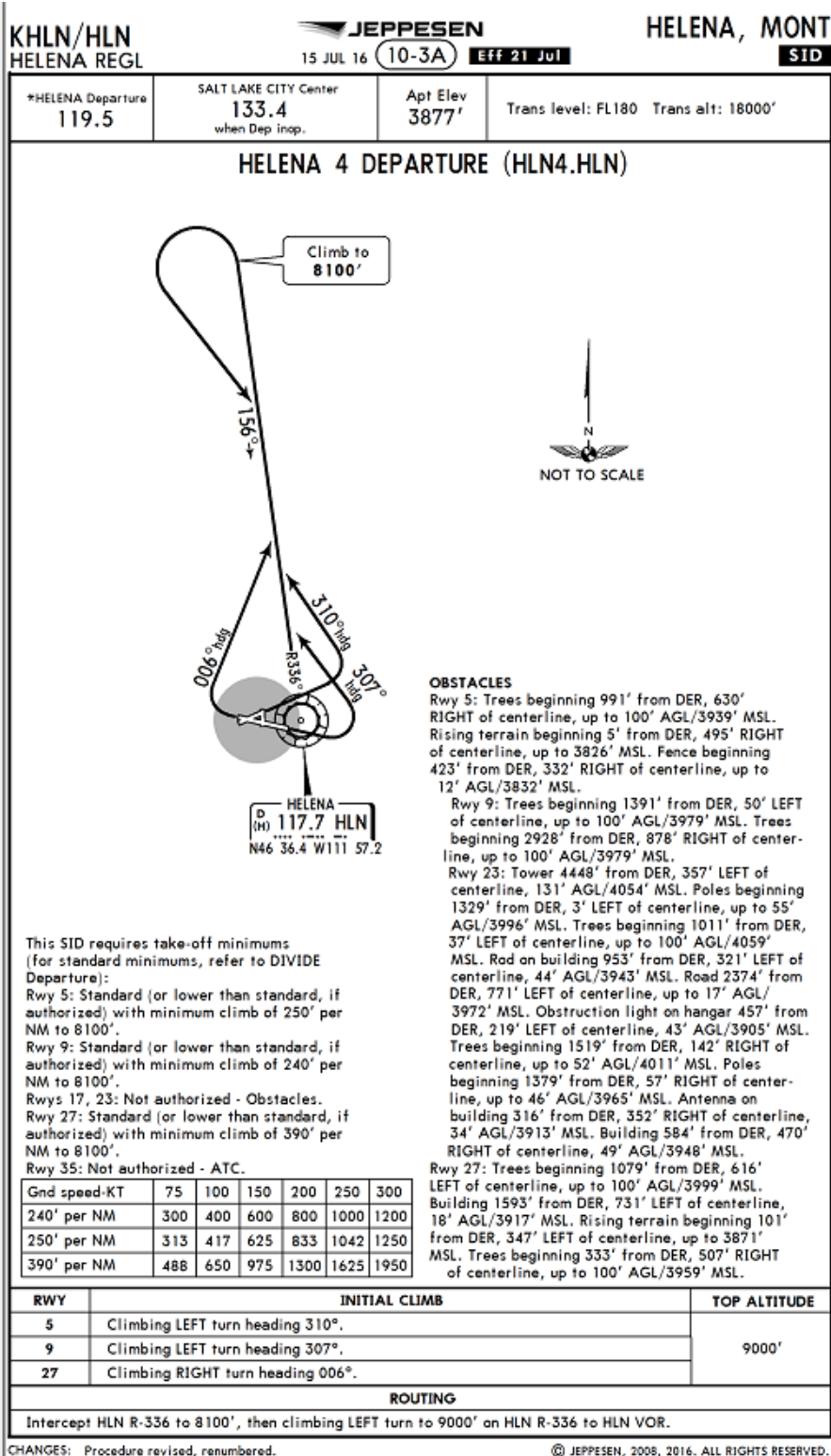


Heading to Altitude

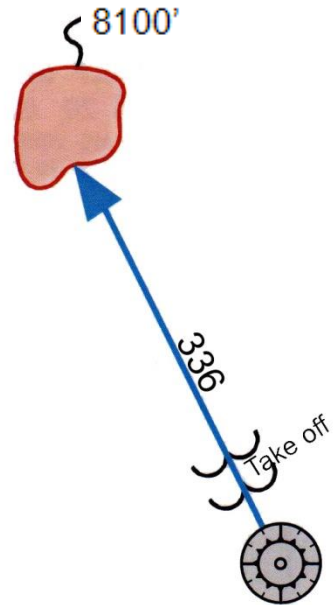
HEADING TO ALTITUDE (VA)

On the missed approach, the FMS will command a right climbing turn on a heading of 003 to an altitude of 6100' and then direct YDL. The difference in heading is due to the FMS magnetic variation model.





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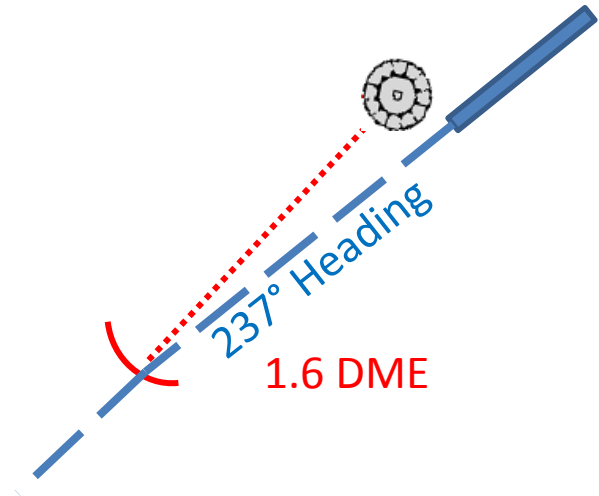


COURSE FROM FIX TO ALTITUDE (FA)

Following takeoff and intercept of the 336 course from HLN, the aircraft will follow the 336° course from the HLN VOR to 8100'.

Course from Fix to Altitude

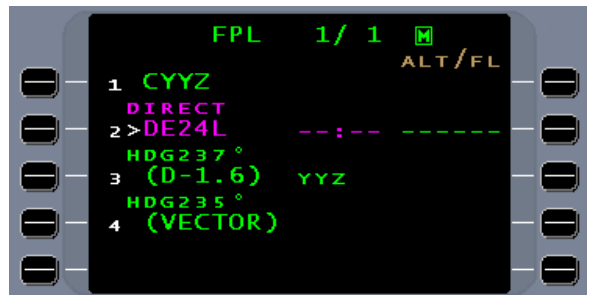




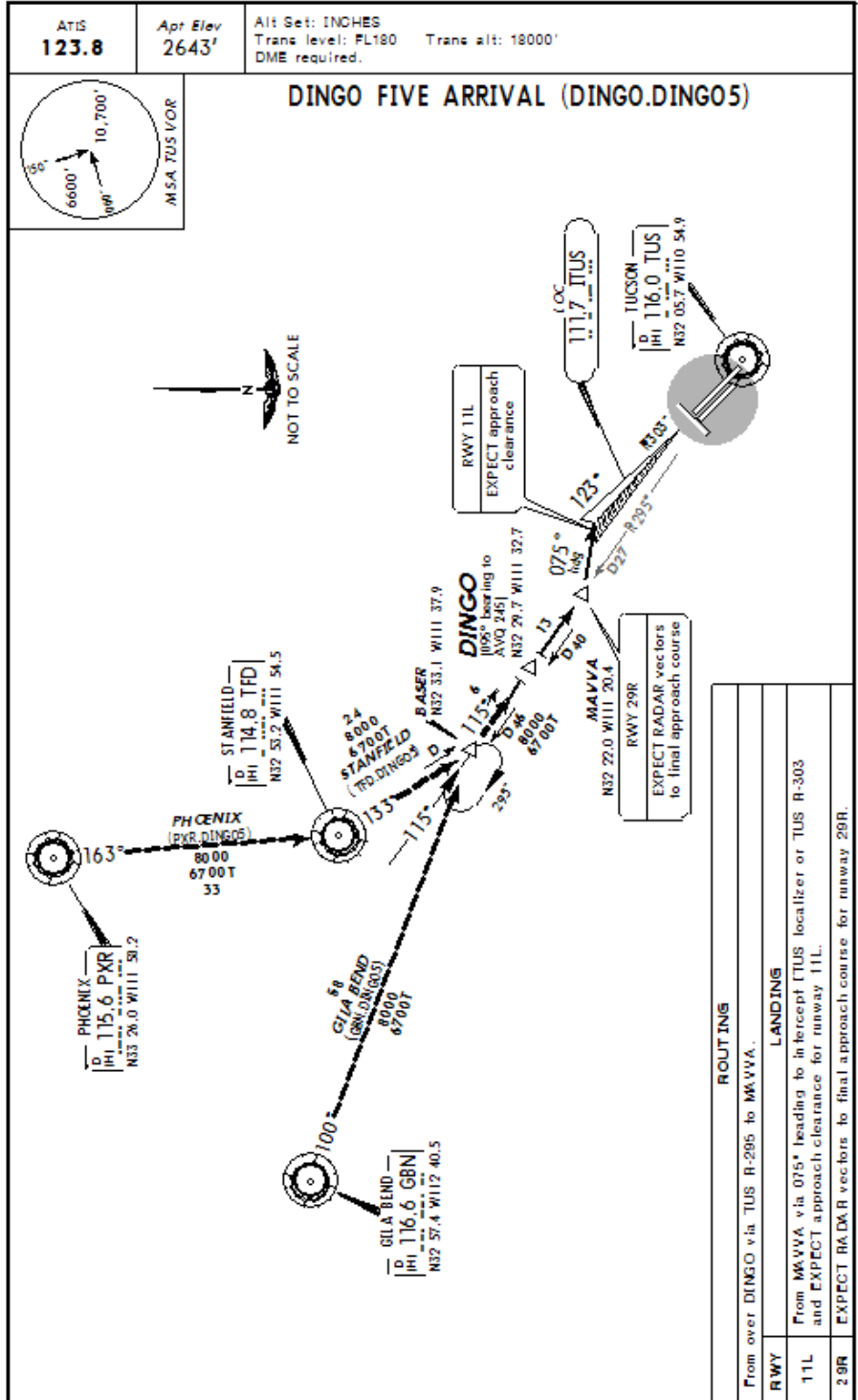
HEADING TO DME DISTANCE (VD)

After takeoff from runway 24, the aircraft will follow a heading of 237° until crossing 1.6 DME of YYZ VOR then the FMS will command a turn

Heading to DME Distance



KTUS/TUS TUCSON INTL **JEPPESEN** TUCSON, ARIZ **STAR**
24 AUG 07 **10-2** Eff 30 Aug



CHANGES: DINGO formation, new format.

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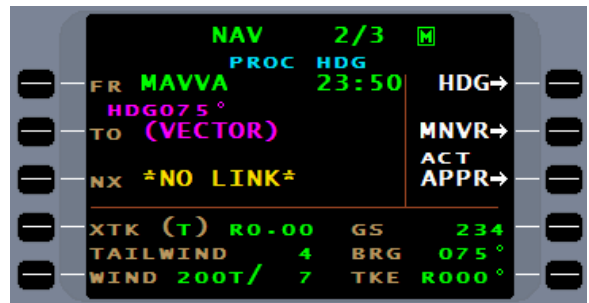
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HEADING TO MANUAL TERMINATION (VM)

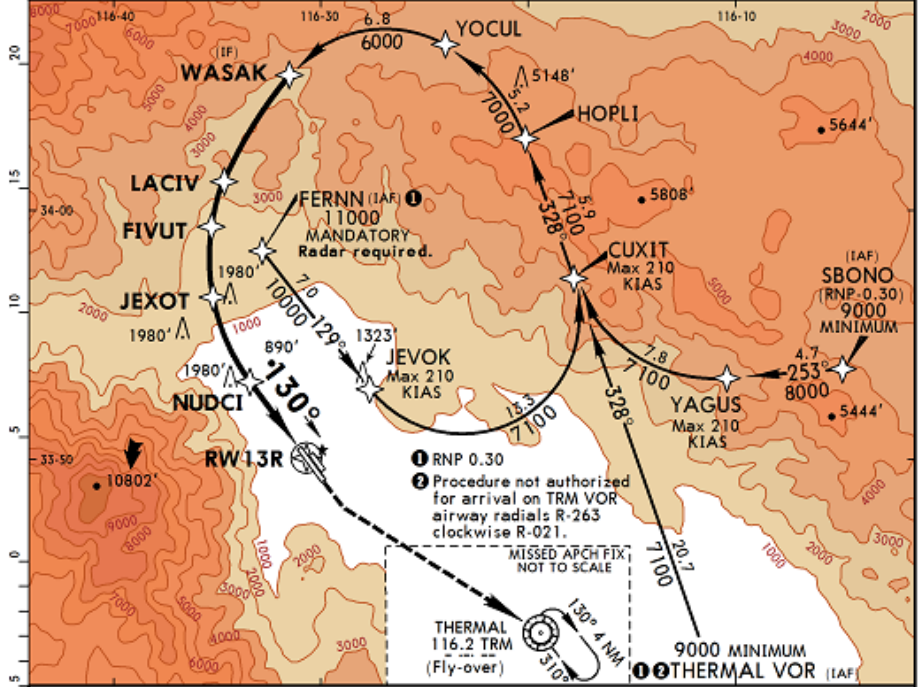
Upon crossing MAVVA intersection, the aircraft will turn to a heading of 075° until manually terminated.

Heading to Manual Termination



KPSP/PSP PALM SPRINGS INTL **JEPPESEN** **PALM SPRINGS, CALIF**
 4 NOV 16 **Eff 10 Nov 12-20** **RNAV (RNP) Z Rwy 13R**

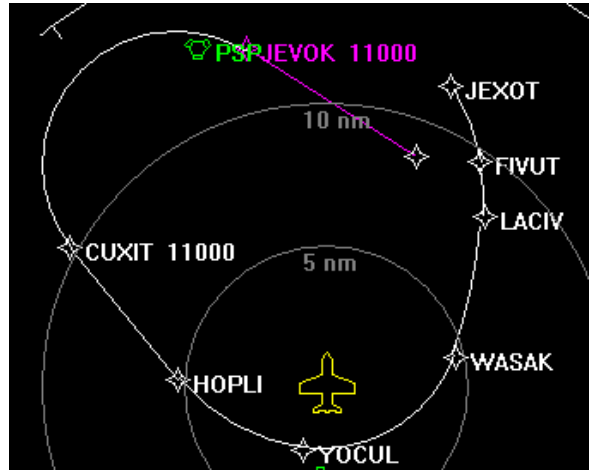
ATIS (ASOS when Twr inop) 118.25		SOCAL Approach (R) 8000' and below 135.275 9000'-13000' 126.7		*PALM SPRINGS Tower CTAF 119.7	*Ground 121.9
RNAV	Final Aph Crs 130°	Minimum Alt JEXOT 2900' (2449')	RNP 0.17 DA(H) 812' (361')	Apt Elev 476' TDZE 451'	12,700' MSA RW13R
MISSED APCH: Climb to 900' then climbing LEFT turn to 4000' direct TRM VOR and hold. Alt Set: INCHES Trans level: FL 180 Trans alt: 18000' 1. AUTHORIZATION REQUIRED. 2. RF required. 3. GPS required. 4. Procedure not authorized when control tower closed. 5. For uncompensated Baro-VNAV systems, procedure not authorized below 1°C (34°F) or above 54°C (130°F). 6. VGSI and descent angles not coincident (VGSI angle 3.25°/3.00°- TCH 69°/41'). 7. Pilot controlled lighting 119.7.					



WASAK	LACIV	FIVUT	(FAP) JEXOT	NUDCI	RW13R	TCH 45'
6000'	4400'	3800'	2900'			TDZE 451'
17.4	5.0	12.4	1.9	10.5	2.9	7.6
			3.00°		1713'	3.7
			130°		2.8	0
Gnd speed-Kts	70	90	100	120	140	160
Glide Path Angle 3.00°	372	478	531	637	743	849
MAP at DA						
TERPS			STRAIGHT-IN LANDING RWY 13R			
RNP 0.17			RNP 0.30			
DA(H) 812' (361')			DA(H) 882' (431')			
A						
B						
C	1/4		1/2			
D						

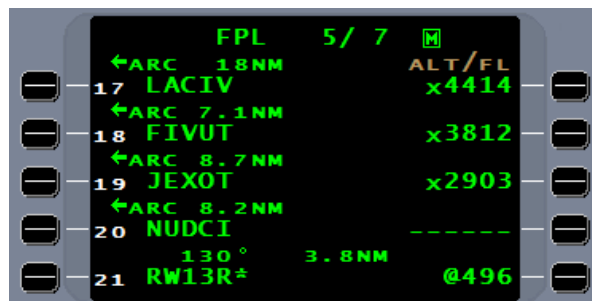
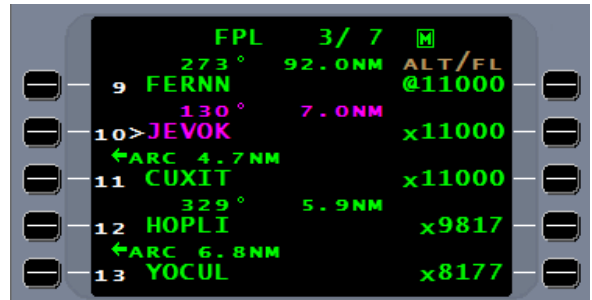
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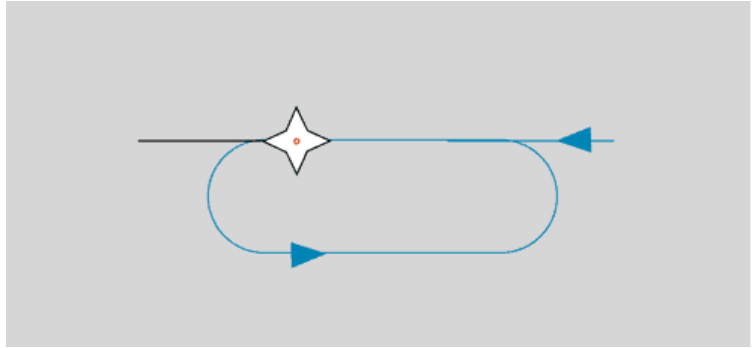


RADIUS TO FIX (RF)

On this RNAV (RNP) approach, the FMS must navigate on a series of radius to fix or precision arcs until reaching minimums. These arcs are not based on a ground based navaid.



HF HA and HM LEGS
HOLD TO FIX
HOLD TO ALTITUDE
HOLD TO MANUAL TERMINATION



The HF leg – Hold to a fix – will result in one orbit of the hold. It will sequence legs and exit after one circuit. This type of hold is frequently used in an approach where a holding pattern is used in lieu of a procedure turn.

	FPL	8/12	M	
	115°	13.0NM		ALT/FL
26	MAVVA	---		-----
	115°	27.0NM		
27	>TUS	21:35		-----
	304°	17.8NM		
28	LIPTE*	21:43		x7500
	→HLD123°	LIPTE		
29	LIPTE	21:43		x6781
	124°	5.0NM		
30	WASON	21:46		x5729

The HA leg – Hold to Altitude – is provided for a climb in the holding pattern. On reaching the terminating altitude, the system will cross the holding fix then sequence legs to proceed on course to the next waypoint in the flightplan.

	FPL	2/ 3	M	
	CRS221°			ALT/FL
5	SIMCO*	13:46		-----
	→HLD221°	SIMCO		
6	(12000FT)	13:46		↑12000
	175°	43.1NM		
7	LTJ	14:09		-----
	206°	131NM		
8	EUG	15:20		-----
	168°	56.6NM		
9	RBG	15:50		-----

The HM leg – Hold to a manual termination does exactly as the name implies. Leg sequencing requires pilot's intervention.

	FPL	7/12	M	
	119°	45.6NM		ALT/FL
22	GBN	19:00		-----
	103°	58.0NM		
23	>BASER*	19:16		-----
	→HLD115°	BASER		
24	(HOLD)	19:16		-----
	115°	5.5NM		
25	DINGO	19:17		-----
	115°	13.0NM		
26	MAVVA	19:21		-----

FMS APPROACH OPERATIONS

Except for a few minor differences SCN 1000/1100, SCN 1001/1101, and 1002/1102 fly approaches in the same way.

The FMS is approved for a variety of approaches. The approach capabilities of a specific installation depend on the installed sensor suite and the interfaced aircraft flight guidance system. The approved approaches include the following:

GLS	Global Navigation Satellite Landing System – requires GLS 1250
ILS	FMS Defined – ILS Guided – requires NAV to NAV Avionics
LOC/LOC-BC	Requires LOC input to FMS – must be WGS-84 surveyed
RNAV (GPS)	Requires SBAS, GPS 1000/1000a, GNSS, or GLS 1250
RNAV (RNP)	Requires compliance with AC 90-101() or AC 90-105()
RNAV - LPV	Requires SBAS
RNAV - LP	Requires SBAS and SCN 1002 or subsequent
RNP	Performance Based Navigation approach, flown as RNAV in FMS
VOR/VOR DME	Requires VOR and DME sensor input to FMS or GPS approval
NDB	WGS 84 and GPS
TACAN	Requires TACAN sensor input to FMS or GPS approval
VFR	Pilot Defined, used only in VFR conditions

APPROACH DATABASE

FMS approaches can only be executed when the approach is defined in the FMS navigation database. The approach can be either a published approach, which is included in the Navigation database, or an approach entered by the operator in the Pilot database. Pilot database approaches can be created through the Aircraft's FMS CDU or in the Universal Flight Planning Program, UFP 25.0 or subsequent.

The approach database includes navigation-sourced approaches for all runways, including circling approaches. These include ILS, LOC, BC, RNAV (GPS/GNSS), RNP (listed as RNAV) VOR, VOR/DME, NDB, and TACAN approaches. An RNAV RNP AR approach database requires an LOA.

TERMINAL WAYPOINTS

Translating terminal waypoints from approach chart to database can be sometimes confusing for the pilot. When the charted waypoint identification cannot be directly entered into the FMS approach database, Jeppesen, with the guidance of ARINC 424, will translate the waypoint identification into names the FMS can use. The information on the next page provides for a better understanding of the ARINC 424 terminal waypoint naming convention.

TERMINAL WAYPOINT NAMING CONVENTION

IAW ARINC Specification 424 (An Abbreviated List)

Initial Approach Fix (IAF)	AX__
Intermediate Approach Fix (IF)	IX__
Final Approach Course Fix (FACF)	CX__ frequently called Capture Fix
Final Approach Fix	FX__
Missed Approach Point (MAP)	RW__ at threshold
	MX__ not at threshold
Touchdown Point (TDP)	TX__
Step Down Fix (SX)	SX__
Where “__” equals runway	

Where “X” above equals:

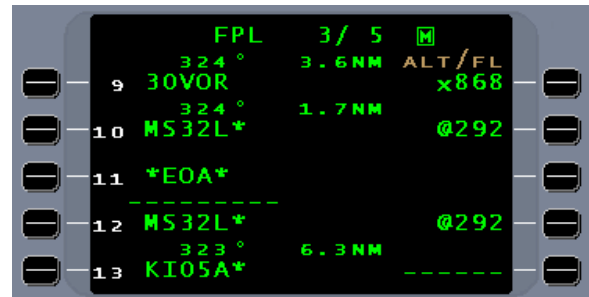
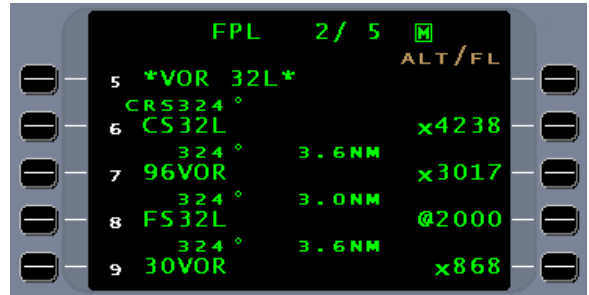
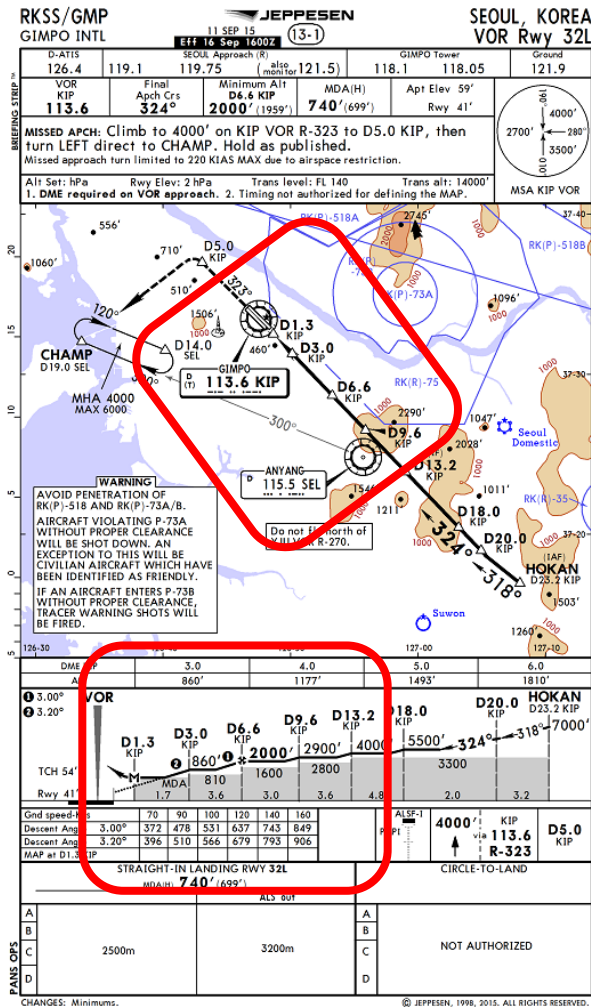
Approach Transition	=	A
Localizer Backcourse	=	B
VOR/DME	=	D
Flight Management System Approach	=	F
RNAV (RNP) Approach	=	H
Instrument Landing System (ILS)	=	I
GNSS Landing System Approach (GLS)	=	J
Localizer Only Approach (LOC)	=	L
NDB Approach	=	N
GPS Approach	=	P
NDB/DME Approach	=	Q
Area Navigation Approach (RNAV)	=	R
VOR DME Approach using VORDME/VORTAC	=	S
TACAN Approach	=	T
VOR Approach	=	V

The “X” in the first section is replaced by a letter in the second section and, with the addition of the runway identification, constitutes the waypoint name.

For unnamed intermediate waypoints, the distance and related navaid will be used.

Less than 10nm; example: 96VOR = 9.6nm from the VOR

Equal to or Greater than 10nm; example: VOR11 = 11nm from the VOR

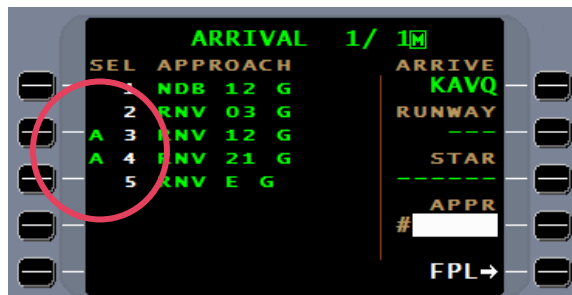


The above shows that the charted waypoint identifiers were changed in the database to names in accordance with the ARINC 424 Terminal Waypoint Naming Convention.

- D1.3 = MS32L = Missed Approach Point not at the Runway Threshold
- D3.0 = 30VOR = 3.0nm from the VOR
- D6.6 = FS32L = Final Approach Fix for a VORTAC approach
- D9.6 = 96VOR = 9.6nm from the VOR
- D13.2 = CS32L = Final Approach Course Fix (or Capture Fix) for a VORTAC approach

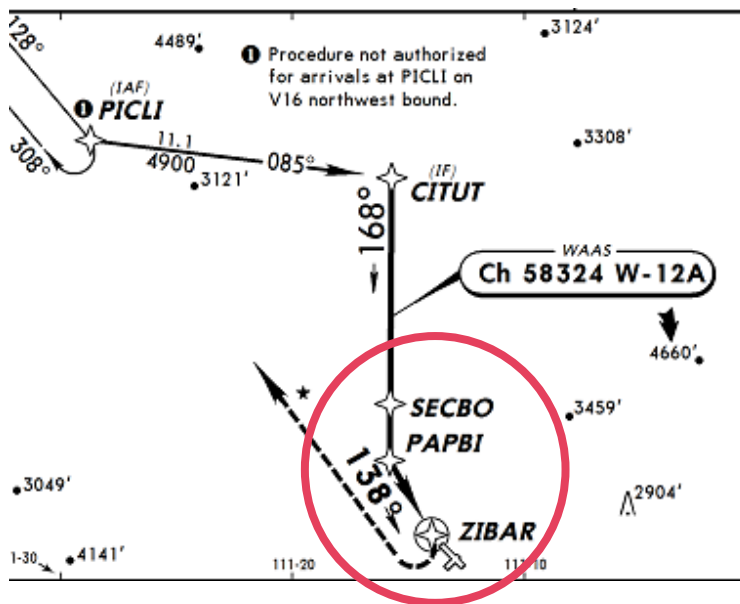
ADVANCED (Avionics) APPROACHES

An “A” preceding an approach on the arrival page indicates the approach requires advanced avionics equipment in order to fly the procedure.



One reason for an approach to be classified as advanced is that the turn at the final approach fix (FAF) exceeds 6°. A second reason for the advanced classification of an approach is the use of a radius to fix (RF) leg. Roll steering is required for an autopilot, receiving navigational guidance from an FMS, to fly an approach active advanced FMS approach. Older, analog based autopilots flew the final approach segment in deviation steering. This resulted in “S”ing down final and is considered unsafe. Current designed digital autopilots can make the turn in roll steering and, therefore, will allow for the flying of these approaches. During FMS installation, the autopilot capabilities are selected determining whether advanced approaches can be flown by the aircraft.

A turn of 6° or more can be part of a VOR approach, a NDB approach, as well as a RNAV approach.



Track to Fix (TF), Course to Fix (CF), and Radius to Fix (RF) legs can be used in advanced approach types. Currently, RF legs are used only in RNAV (RNP) advanced approach types, but potentially could be used in RNAV (GPS) approach types.

Older Aircraft with analog autopilots together with the UNS EFI 890R and SCN 100X can now fly advanced avionics approach types. When approach active, the EFI 890R and SCN 100X/110X will keep the analog autopilot in roll steering until crossing the FAF at which time they will transition to deviation steering. By keeping the autopilot in roll steering until crossing the FAF, turns greater than 6° can be made allowing for the flying of advanced approaches. When past the FAF deviation steering is used by the autopilot.



FMS APPROACH TYPES

ILS APPROACHES

NAV-TO-NAV ILS approaches can be flown with the use of the FMS and a NAV to NAV compatible EFIS, flight guidance system, and autopilot. With the approach active and upon localizer intercept, the FMS will direct the ILS navigation from VHF straight to the EFIS for navigation during the approach segment. During the approach transition or ATC vectoring, the FMS is the source for aircraft navigation. If the pilot goes missed approach, the FMS will reassume aircraft navigation.

Selection of flight director approach mode is required for the FMS to hand off navigation to the EFIS. This must be accomplished prior to localizer intercept for both auto activation when flying an approach transition or when flying vectors with FMS heading to localizer intercept. **On vectors to intercept the localizer, select flight director approach mode then press FMS heading INTERCEPT.** This will result in the NAV-TO-NAV transfer taking place and the aircraft intercepting the localizer and turning to final.

Where the approach is surveyed IAW WGS-84, GPS will be used to assist the FMS in navigating the aircraft during vectors or on the approach transition. At non WGS-84 surveyed airports, GPS will be deselected upon approach arming and approach transition navigation for the ILS must come from other NAV sensors such as DME-DME and IRS or the FMS will be DR.

For aircraft without NAV-TO-NAV capability, the ILS will be coded as advisory. The approach transition and missed approach can be flown with the FMS, but VHF/ILS guidance must be selected by the pilot to fly the approach segment.

LOCALIZER AND BACKCOURSE APPROACHES

On aircraft with VHF localizer input to the FMS, localizer and localizer backcourse approaches can be flown. The FMS uses the localizer to calculate and track the final approach course. Since the localizer is only one dimensional, to determine the location of the final approach fix and missed approach point, the FMS will retain the GPS. Using the GPS requires the approach be surveyed IAW WGS-84.

The backcourse approach flown with conventional navigation would require selecting the localizer front course on the course arrow and selecting B/C on the flight director. When flying a backcourse approach with the FMS, the course arrow will reflect the landing runway inbound course and, on most aircraft, selection of B/C on the flight director is not required. In addition, on most backcourse approaches, a barometric glidepath is available. This will make the approach similar to an ILS; MDA minima must still be observed.

RNAV AND RNP APPROACHES

RNAV approach denotes the ability to fly a final approach course that is either not using a ground base navaid or is not directly in line with a ground base navaid. The three types of RNAV approaches are identified by the parentheses following RNAV and are GPS, GNSS, VOR DME, and RNP.

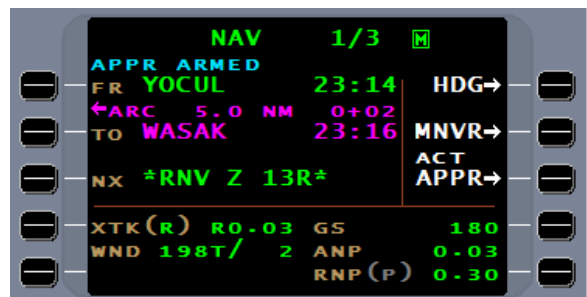
Under the category of Performance Based Navigation (PBN) RNP approaches have been introduced. RNP approaches are listed on the arrival page as RNAV approaches. Provisions for listing RNP approaches as RNP on the arrival page will be included in a future FMS software.

RNAV (GPS) AND GPS APPROACHES

Aircraft using SCN 100X/110X are certified to fly RNAV (GPS) approaches under TSO C-146C; Titled: *Stand-Alone Airborne Navigation Equipment using the Global Positioning System Augmented By The Satellite Based Augmentation System*. Although GPS standalone approaches are slowly being phased out, those that are still in existence are listed separately in the database from RNAV (GPS) approaches. The approach transitions throughout the world can vary significantly and regulations for flying these transitions are country specific. Using SBAS/GPS requires the approach surveying to be IAW WGS-84. RNAV (GPS) approaches may have as many as three sets of minima that may be flown by the 1000 series software. LNAV only requires lateral navigation and all GPS approach certified aircraft may use the LNAV MDA (Minimum Descent Altitude). LNAV/VNAV will be flown to a DA (Decision Altitude). The SCN 100X FMS may use either an SBAS glidepath or a barometric glidepath. To fly to a DA with a barometric glideslope requires compliance with AC 90-105 or equivalent. LPV (Localizer Precision with Vertical Guidance) requires a SBAS (Satellite Based Augmentation System), and example being WAAS which covers North America, Hawaii, and the Caribbean. The few standalone GPS approaches that remain are flown the same way a non-SBAS RNAV (GPS) is flown.

RNAV (RNP) APPROACHES

These approaches have multiple legs in the final segment; using radius to fix, course to fix, and track to fix legs. The quality of navigation is based on RNP and approaches may have multiple sets of minima based on the ANP capabilities of the aircraft. When the CDI scaling and RNP values are taken from the NAV database they will be displayed as (R) for the scaling and (P) for RNP value. Most of these approaches are Authorization Required (AR); requiring FAA approval under AC 90-101a or other CAA and will be titled RNAV (RNP) with "AUTHORIZATION REQUIRED" under notes. Many areas of the world list approaches as RNAV (RNP) instead of RNAV (GPS) and do not require AR approval. These will be titled RNAV (RNP). If the RNP value for the approach is coded in the database for each leg, this value will be used to set CDI scaling. Only in this case will CDI scaling be linear instead of angular.



NOTE: Global Navigation Satellite Landing System (GLS) approaches are covered in a supplement given to those operators authorized to fly this approach.

VOR AND VOR/DME APPROACHES

VOR and VOR/DME approaches can be flown as a SBAS overlay approach if the words “or GPS” are in the title of the approach. VOR and DME are required if the approach is non overlay, GPS is unavailable, or the approach is not surveyed IAW WGS-84; making GPS unusable. In SCN 100X/110X GPS will be retained on all FMS approaches. If the country of origin does not authorize the use of SBAS or GPS with the statement “or GPS”, (GPS), or request the use of GPS as does Canada and the USA, the pilot must manually deselect the GPS/SBAS at time of approach arming. Transport Canada and the FAA request that the GPS will be retained for FMS navigation for all VOR or VOR/DME approaches. In these two countries, to make a non-overlay approach legal, the VOR must be monitored either internally within the FMS or externally by, at a minimum, the VOR RMI needle. Most VOR approaches will have a baro constructed glidepath.

NDB APPROACHES

Through the FMS, NDB (Non Directional Beacon) approaches can only be flown with the use of SBAS or GPS. All worldwide WGS-84 surveyed NDB approaches will be available in the SCN 100X NAV database with SBAS or GPS retained. To make a non-overlay NDB approach legal, the NDB must be tuned and identified and the NDB RMI needle must be selected. Most NDB approaches will have a baro constructed glidepath.

VFR APPROACHES

Created through the FMS as a pilot approach, the FMS will fly VFR approaches. VFR approaches will use all usable NAV sensors to fly the approach to include DME, VOR, and GPS. Where the pilot has created the definition for a baro glidepath, the FMS will present it.

WGS-84 SURVEYING

For the purpose of explaining WGS-84, it needs to be presented in the context of how it affects the flying of FMS approaches. First of all, WGS-84 is the World Geodetic System of 1984. Technically, it defines the shape and size of the ellipsoid of revolution (an oblate spheroid) that is considered to be the best mathematical model of the Earth. From a pilot's perspective, it's the mathematical calculation of the shape of the Earth. This mathematical model is used to calculate latitude and longitude and is the system used by GPS to calculate latitude and longitude.

When navigating, it is important to agree on exactly where the latitude/longitude coordinates are located. Those agreeing to use WGS-84 to define the shape of the world and, therefore, to calculate latitude/longitude coordinates, will know exactly where that point is on the surface of the Earth.

Countries using WGS-84 to survey airports will provide more precise navigation for those aircraft navigating with FMS and GPS navigational tools. GPS cannot be used to fly approaches where WGS-84 surveying is not in use.

On the Jeppesen Corporation web site is a list of WGS-84 compliant countries.

<http://www.jeppesen.com/company/publications/wgs-84.jsp>

FMS APPROACH CONFIGURATION

THE ENABLED APPROACH

During the installation of the FMS, the engineer will determine which approaches are flyable through the FMS and which are not. Those that are flyable are enabled in the FMS configuration. The criteria for enabled includes available NAV sensors, type and model of primary flight display, and type of autopilot. The exception is the ILS NAV-to-NAV which is FMS enabled, but ILS navigated.

With an enabled approach, the FMS will be the source for navigation throughout the entire approach; from transition through final segment through missed approach. It will be the source of presentation for the primary flight display.

THE ADVISORY APPROACH

When the FMS installation does not meet the criteria for a specific approach type, it is configured as advisory. The advisory configuration applies only to the approach final segment; that part of the approach that guides the aircraft to the runway. The FMS can still navigate the approach transition and missed approach. The pilot can select this approach to assist in flying the approach transition and missed approach, but must use navigation other than the FMS to fly the final segment to the runway. With the approach entered into the FMS flightplan, the aircraft ND will present a map of the approach providing increased situational awareness.

An example would be an ILS with a procedure turn. The FMS will guide the aircraft through the procedure turn; the pilot will then select the VHF ILS as the source of guidance and fly the final segment towards the runway. If a missed approach is required, the pilot may reselect the FMS for missed approach guidance.

APPROACH SEGMENTS

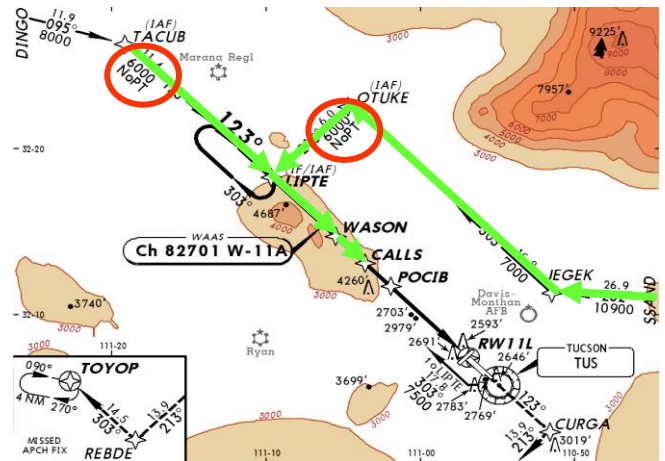
For the purpose of FMS operations, Jeppesen will take a normal approach chart and identify three segments; the transition, the approach, and the missed approach. These three segments make up a complete approach.

TRANSITION SEGMENT

The transition segment is the maneuvering segment. It allows the FMS to navigate the aircraft through a series of legs or procedures to align it with the final approach. The transition segment may be edited as necessary and the remainder will be unaffected. Transitions consist of the following:

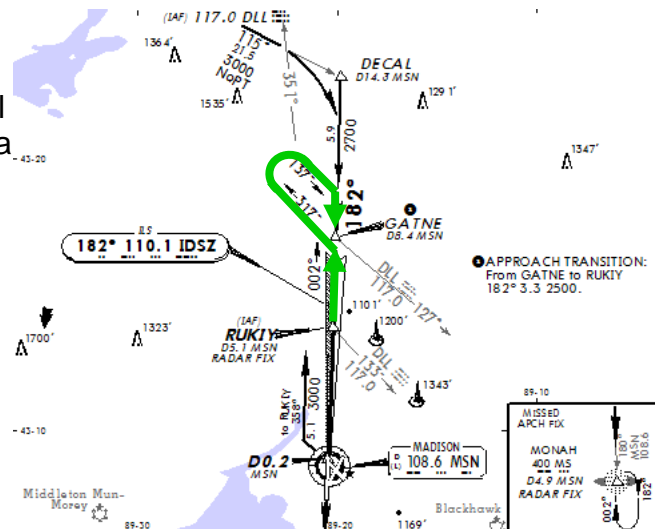
No Procedure Turn (No-PT)

A series of navigational legs designed to align the aircraft with the final segment without entering a procedure turn or holding pattern



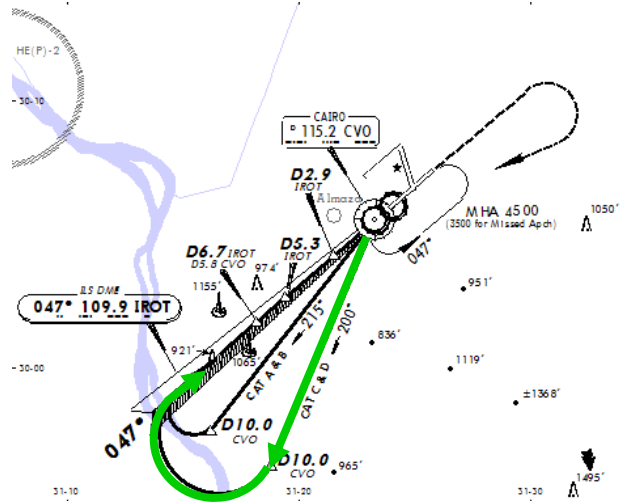
Procedure Turn

A procedure to allow the pilot to reverse the course of the aircraft and align it with the final approach course; a holding pattern in lieu of a procedure turn is being used on RNAV approaches for course reversal in lieu of this procedure.

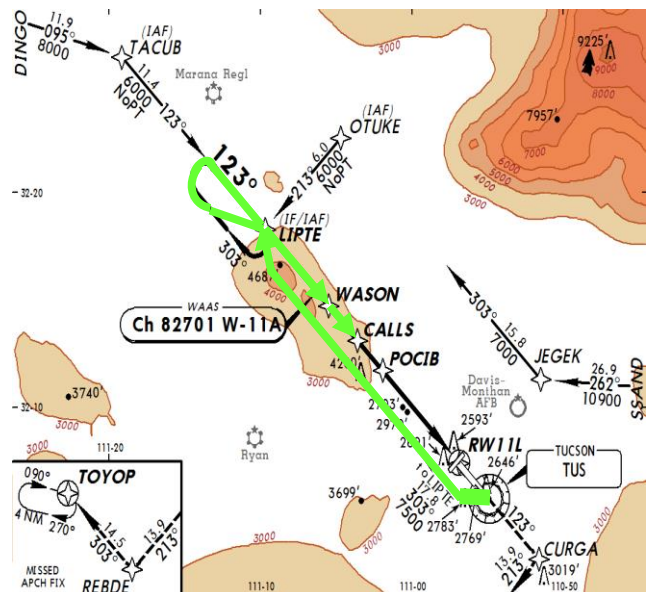


Teardrop

After crossing a designated fix, proceed outbound on a specific course for a specific distance. Turn inbound to intercept the final approach course back towards the designated approach fix. The procedure resembles the shape of an ice cream cone. When a Category A & B and a Category C & D procedure are presented on the chart, only the Cat C & D will be in the database.

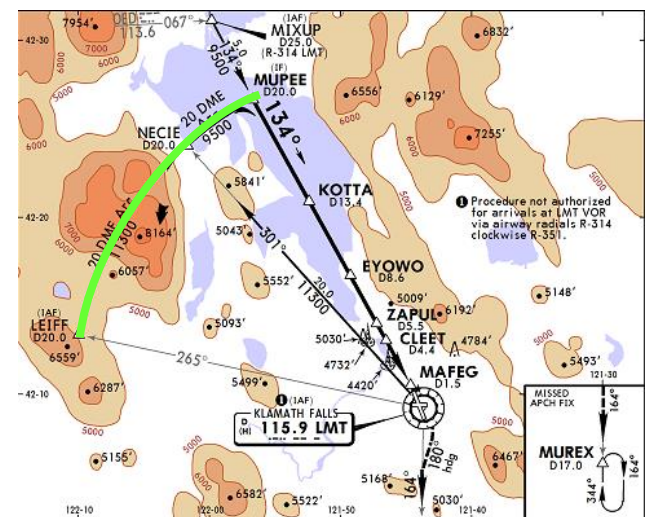


Holding Pattern In Lieu Of A Procedure Turn
A holding pattern is used to reverse course when the aircraft's position is not conveniently aligned to turn directly to final. Occasionally used to descend to an altitude more in line with the final approach fix altitude or as a delay by ATC



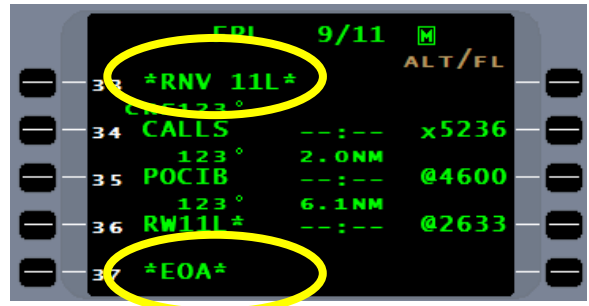
Arcs

Designed to fly a constant distance path relative to a DME until turning to the final approach segment



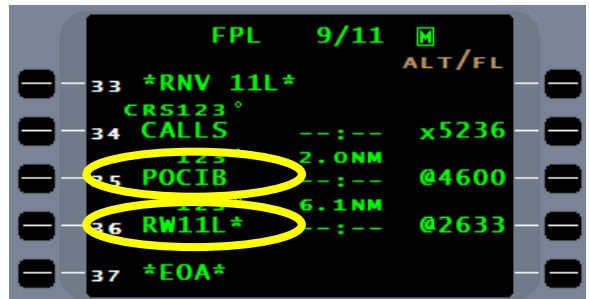
THE APPROACH SEGMENT

The approach segment is the FMS navigation that takes the aircraft to the runway. It is identified as those waypoints that follow the approach label and are terminated by the *EOA* or End Of Approach label.



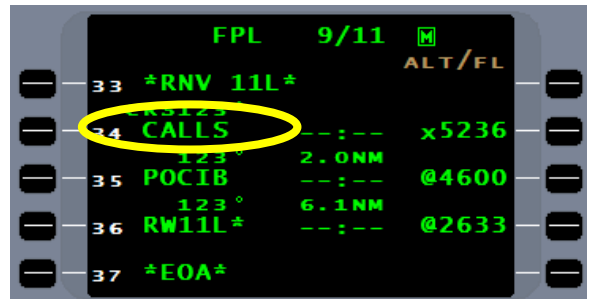
A final approach fix (FAF) is required for all FMS approaches and where the approach design does not call for one, Jeppesen will add one to the approach database per ARINC 424 guidance.

A missed approach point (MAP) is required and is normally identified by “RW” or “MX”, which are ARINC 424 recommended names for this point. RW is defined as being co-located with the runway threshold and MX is a missed approach point not at the runway threshold. Although these identifiers are used a great deal, they are not required and other names may be used to identify the missed approach point.



SCN 100X/110X allows for step down fixes or intermediate waypoints to be used between the FAF and the MAP and will be presented when in the NAV database.

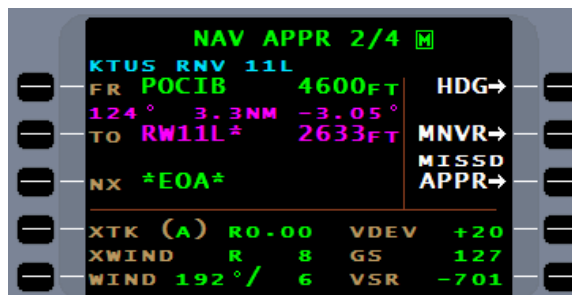
If a waypoint is found prior to the FAF in the approach segment of the FMS database, it is a final approach course fix “FACF”; often called a final approach capture fix. This waypoint is used by the FMS during an automatic activation of an approach. As the FMS sequences this waypoint and meets other requirements, it will go approach active. Since the FMS needs a buffer zone for approach activation of at least 2nm prior to the FAF, the FACF is used as the activation point. No FACF will be any closer than 2nm, but may be as far as 10nm with an average distance of 5nm. All RNAV approaches will contain waypoints that are usable as a FACF and most of other types of approaches will also contain FACF waypoints. When an approach design does not present a waypoint that can be used as a FACF, no FACF will be presented in the FMS approach segment. When this happens, the FMS will create an activation point that is 2nm from the FAF. This waypoint is transparent to the pilot, but is necessary for FMS automatic activation. A FACF waypoint may be the same waypoint as the last waypoint in the approach transition and, therefore will be listed twice in the flightplan. This is correct for the UASC FMS systems; do not delete one of these waypoints.



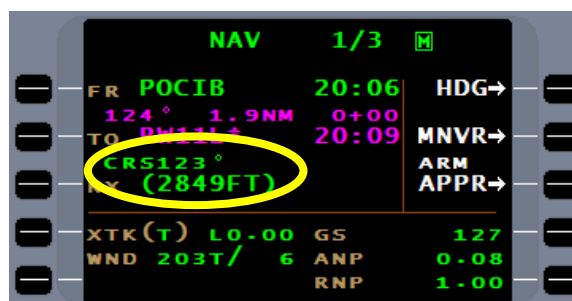
The approach segment must **NOT** be edited or it will void the approach. An edited approach, including approach label and *EOA*, will violate the integrity of the approach segment and these waypoints can no longer be flown as an FMS approach.

THE MISSED APPROACH SEGMENT

When approach active for SCN 1001/1101 and subsequent, and sequenced past the FAF for SCN 1000/1100, the FMS will present a MISSED APPR line select key. By pressing the MISSED APPR line select key, the FMS will be placed in the missed approach mode of flight. The FMS will continue to navigate the aircraft to the MAP and, when crossing that point, the FMS will enter the missed approach segment. On most FMS installations, the aircraft takeoff go-around system (TOGA) is interfaced with the FMS. If the TOGA is selected when the FMS MISSED APPR line select key is present, the FMS will receive this input and automatically select the MISSED APPR line select key for the pilot.



One of the functions of the missed approach line select key is to sequence the ***EOA*** on the NAV page allowing the FMS to move into the missed approach segment. The ***EOA*** will act as a GAP and prevent sequencing. By removing it during ***EOA*** sequencing, the FMS will sequence to the first navigation leg of the missed approach segment. This leg is often times a course to altitude (CA) leg. This leg, when not part of the charted procedure, is created by either Jeppesen per ARINC 424 guidance or required by the state of origin of the procedure, i.e. FAA. This leg is often a database entry only and not found in the published missed approach procedure. It is intended to insure the aircraft is at a safe altitude before sequencing to the first charted leg of the missed approach. The ***EOA*** will not be removed from the flightplan, only from the NAV page. This will insure the integrity of the approach is maintained to ensure the approach is available if needed again.

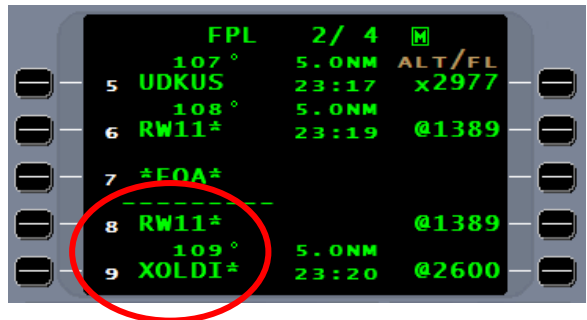


The missed approach line select key can be remotely pressed through the go-around system of the aircraft flight director. The missed approach line select key is only available upon crossing the Final Approach Fix (FAF), thus the selection of the aircraft go-around system or takeoff/go-around system (TOGA), other than after crossing the FAF on an active FMS approach, will have no effect on the FMS.

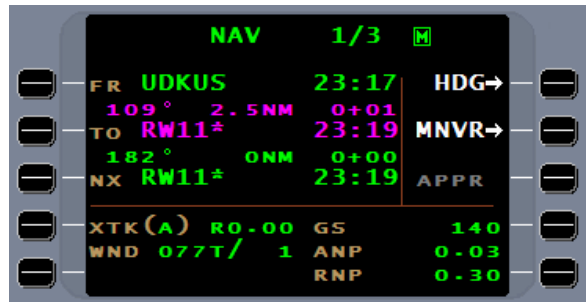
When the MISSED APPR line select key is pressed, the FMS will maintain approach scaling and alerting until crossing the missed approach point (MAP).



If the first NAV leg following the *EOA* is a Track to Fix (TF) leg aligned within 3° of the inbound course, the FMS will maintain approach scaling until the termination of that leg.



If the first leg following the end of approach waypoint is a TF leg, the flightplan will repeat the end of approach waypoint after the *EOA*.



This allows the FMS to calculate the course information from the missed approach point to the end of that leg.



As with all missed approaches, if the pilot uses the aircraft go-around system, the aircraft pitch up, wings level command will come from the aircraft flight director. The FMS will not provide any vertical guidance during missed approach. To reconnect the flight director to the FMS, flight director NAV mode must be selected.

APPROACH ARMING

The purpose of arming the approach is to prepare the FMS to fly the selected approach. At 50nm from the arrival airport, with an FMS approach in the flightplan, the FMS will present an arm approach line select key which will allow for manual arming of the approach. Between 50nm and 30nm from the airport the primary reason for manual arming is to place the FMS into terminal phase of flight early. Automatic approach arming occurs when the aircraft enters the terminal area at 30nm from the airport. Some approaches have the initial approach fix (IAF) more than 30nm from the arrival airport. Crossing the IAF requires the FMS to be in the terminal phase of flight and arming the approach manually will do this. In SCN 100X series manual arming is only necessary when flying radar vectors to an approach following a missed approach. This is because this software will automatically enter the terminal phase of flight anytime the aircraft enters a STAR or approach transition even if the IAF is more than 30nm from the airport.

What does arming the approach do?

It sets the phase of flight to terminal if more than 30nm from the airport and not on a STAR or approach transition.

It analyzes the NAV sensor requirements to fly the approach. NAV sensors are categorized as required, approved, and not approved to navigate for the approach. A required NAV sensor example is the GPS for a RNAV (GPS) approach or a localizer for a localizer based approach. An approved NAV sensor would be the use of GPS on a VOR approach. A not approved sensor would be GPS on a VOR approach in a non WGS-84 country.

If a ground based navaid is required or approved for the approach, the FMS will check to see if it is tuned. If not tuned and if the FMS is capable of tuning the NAV radio, the FMS will offer a tune approach line select key. The FMS will not tune a VHF NAV radio without first asking permission by use of the tune approach line select key. Pressing the line select key will request the tune head to tune the VHF radio to the required frequency. If the required VHF NAV radio is not tuned, prior to approach activation the FMS will push a message alerting the pilot to the need to tune the radio. Without a required NAV sensor the FMS cannot fly the selected approach and when the FMS attempts to activate the approach, red flags will appear for navigation on the primary flight display.

If the approach is an RNAV (GPS) and the database contains information for the SBAS to predict a level of service, it will occur at this time.

APPROACH DESIGN LOGIC TF & CF LEGS

It has often times been asked why the FACF waypoint is located on both sides of the approach label. The following few pages will explain that logic.

When following FMS guidance to the activation point of the approach at the approach label, one will notice that the first navigation leg of the approach is a Course to Fix (CF) leg. A CF leg will draw a navigation line through the waypoint in the direction so indicated. If the termination point of the aircraft navigation is an airway directly in line with the course, upon sequencing that waypoint the FMS will join the CF leg and fly final approach course.

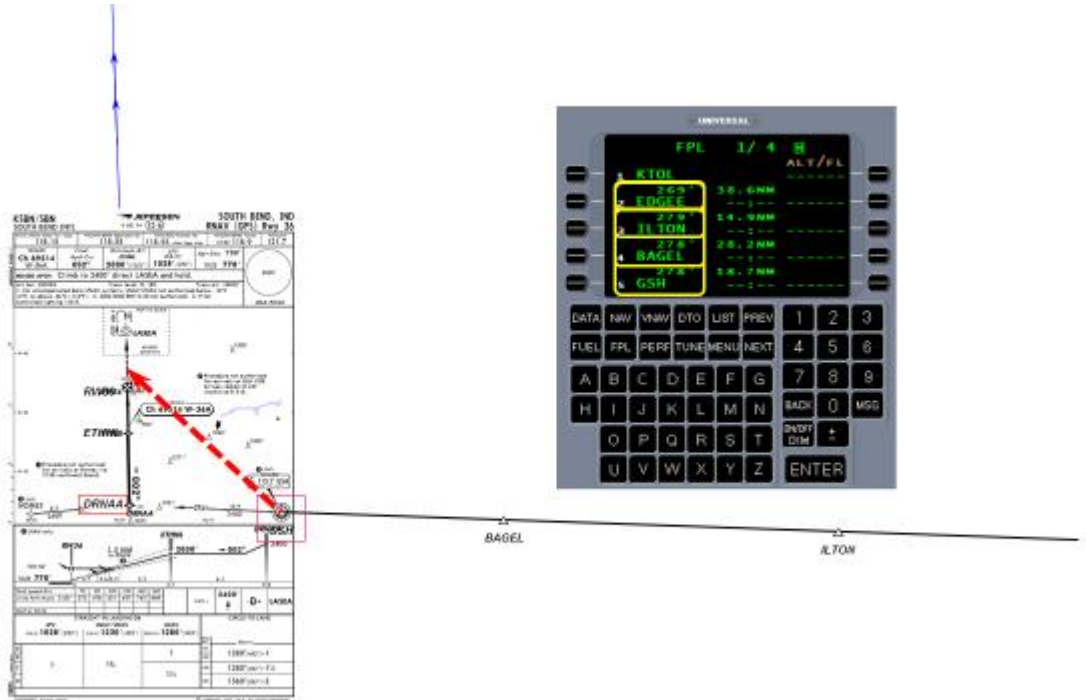
Approach Design Logic TF and CF Legs



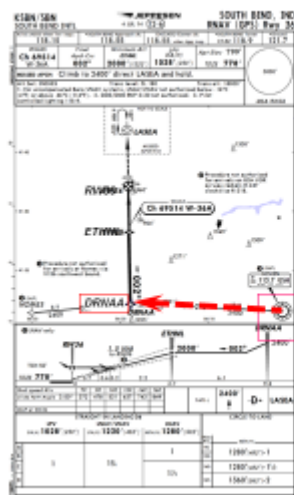
OSN

ILCW

In most cases the airway will not place the aircraft directly in line with the final approach course and upon sequencing that waypoint the FMS will join the CF leg. This will result in the FMS turning to intercept with up to a 45° angle.



By selecting an approach transition the FMS places a TF leg into the flightplan. A TF leg will allow the FMS to fly point to point navigation. Since the FMS can't have both a CF leg and a TF leg to the same waypoint the FMS must duplicate the waypoint outside the approach label. The TF leg will navigate the aircraft directly to the FACF to join the final approach course. As the FMS sequences the FACF the FMS will go approach active.



To fly vectors to final, one would want the FMS to extend the final approach, a pseudo localizer. When placed on vectors, the pilot would activate the approach. This brings the CF leg to the "TO" position on the NAV page extending the final approach course for intercept by the aircraft. Since the navigation to the final approach course is by heading, the pilot can control when the aircraft will join the FMS final approach course.



AUTO APPROACH ACTIVATION VS MANUAL APPROACH ACTIVATION

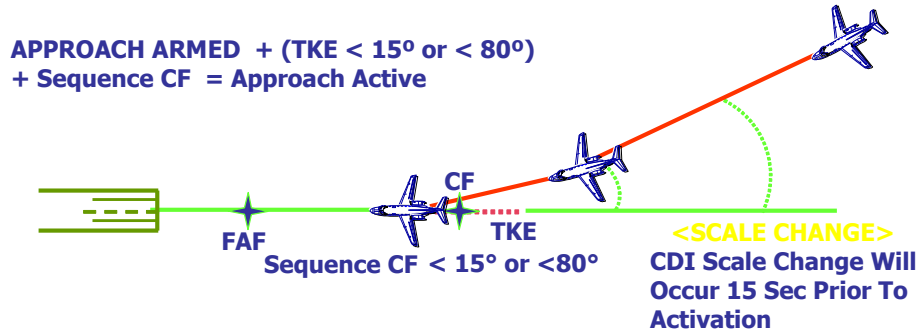
There are two ways to activate an approach, automatically and manually. Which one to use is dependent upon how the aircraft will navigate to the beginning of the final approach segment.

AUTO ACTIVATION

Auto activation is used when flying an approach transition. The FMS will remain in the terminal phase of flight until reaching the activation point and then automatically activate the approach. Fifteen seconds prior to activation, the FMS will present a “<SCALE CHANGE>” banner that announces the CDI scale change from terminal to approach. The activation point is defined by a set of criteria that is somewhat based on the makeup of the approach. The criteria are as follows:

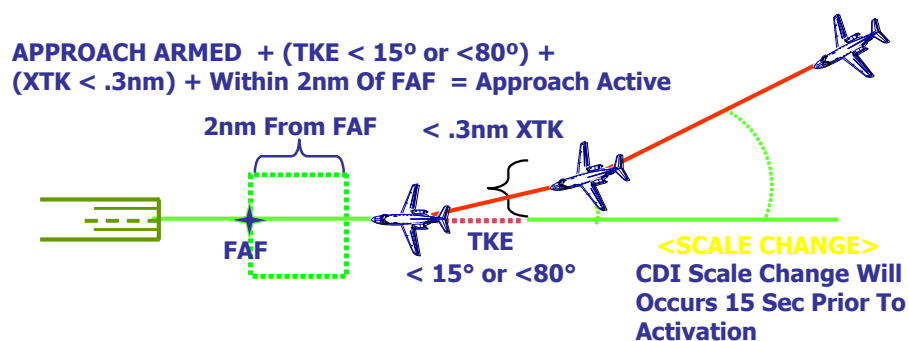
- The approach must be armed. This is accomplished automatically at 30nm from the airport and can be manually armed up to 50nm from the airport. If on missed approach, the FMS will not automatically arm until placed on a navigational path to a point in the flightplan ahead of the approach. It will then automatically arm.
- The angle of intercept or track error must be within less than either 15° or 80° of the final approach course. If the FMS is installed in an aircraft of older design that uses an analog autopilot with deviation steering, when approach active, the angle of intercept will be set to 15° through configuration in the FMS. If the FMS is installed in an aircraft of a newer design that uses a digital autopilot, the angle of intercept will be set to 80° of the final approach course. The setting of 80° will also allow for the flying of advanced approaches. If an EFI 890r is installed on an older designed aircraft with an analog autopilot, new technology allows for the intercept angle to be 80°.
- If the approach design incorporates a final approach course (FACF) in the approach segment, that waypoint must sequence from the “TO” waypoint to the “FR” waypoint. With the other two criteria complete, the FMS will go approach active. There is no requirement that the criteria be completed in a specific order. Depending upon the transition, either the angle of the intercept or FACF sequencing will activate the approach.
- If the approach design does not incorporate a FACF, another criterion is added and that is a crosstrack of 0.3nm to ensure on CDI approach scale. Without a FACF, the FMS must designate a point prior to the FAF of 2nm. This point will not be visible on the FMS or NAV display, but is required to allow time for the FMS to activate the approach prior to the FAF. The “<SCALE CHANGE>” banner will precede the activation point by 15 seconds.

AUTOMATIC ACTIVATION WITH APPROACH FACF



With a designated waypoint as the approach FACF, the FMS will begin automatic approach activation with a **<SCALE CHANGE>** banner at the top of the NAV page that will occur 15 seconds prior to activation. The approach should already be armed due to automatic arming at the 30nm point; as a result the FMS is now concerned with angle of intercept and FACF sequencing. If the leg prior to the FACF is directly in line with the final approach course, angle of intercept is not a factor and as the FMS sequences the FACF the FMS will go approach active. If the leg prior to the FACF is an arc or a 90° turn to final, the FMS will sequence and begin the turn to final. As the angle decreases past 80° or 15° degrees, depending on FMS configuration, the FMS will go approach active.

AUTOMATIC ACTIVATION WITHOUT APPROACH FACF



Without a designated waypoint as the approach FACF, the FMS will, again, begin automatic approach activation with a **<SCALE CHANGE>** banner at the top of the NAV page that will occur 15 seconds prior to activation. The angle of intercept of either 80° or 15° degrees will be a factor. To the above, the FMS will add a criterion of crosstrack of less than 0.3nm from the final approach course to ensure the aircraft is within the CDI approach scale. Without a designated FACF the FMS will go approach active 2nm prior to the final approach fix. This will give the FMS its required buffer allowing time for the FMS to activate all approach components.

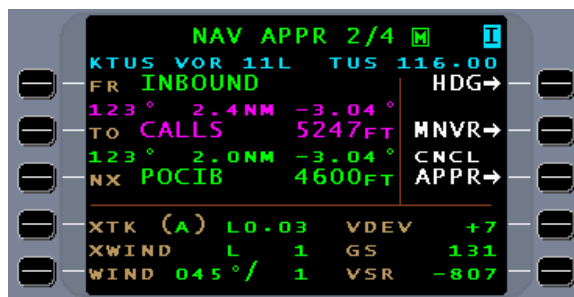
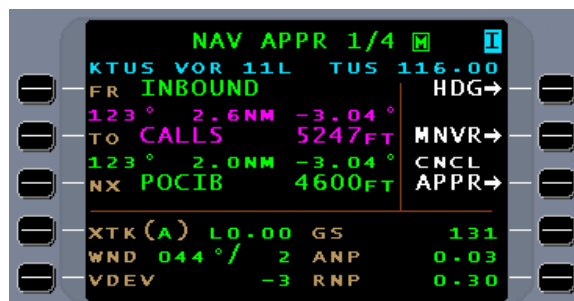
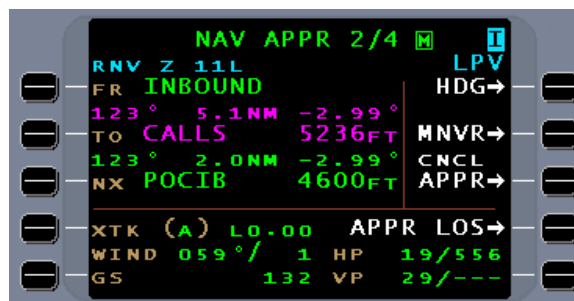
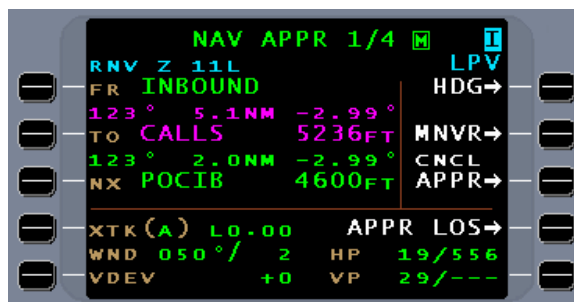
APPROACH ACTIVE NAVIGATION PAGES

When the FMS is approach active, the FMS will present four NAV pages. The first two NAV pages are different when flying an RNAV SBAS approach than when flying any other approach. For all approaches both pages 1 and 2 will provide the approach type, from (FR), to (TO) and next (NX) lines with waypoints, vertical information, and, for an RNAV approach, level of service (LOS) is added. Below the division line, for an RNAV approach, crosstrack (XTK), wind direction in magnetic degrees and velocity (WND), and horizontal, approach LOS line select key, (HP) and vertical (VP) protection and alert levels are provided. Page one will provide vertical deviation (VDEV).

Page 2 will replace the VDEV line with ground speed (GS).

For non SBAS approaches, on page 1 level of service information is replaced with GS, actual (ANP) and required (RNP) navigational performance

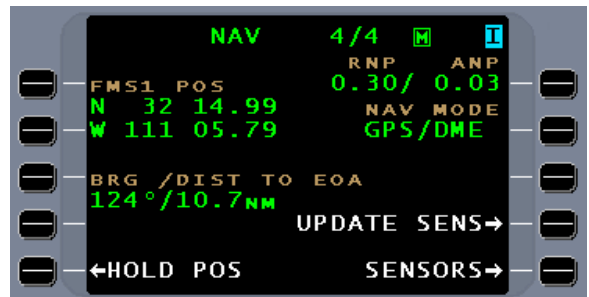
Page 2 will add a crosswind component and replace ANP and RNP with ground speed, and vertical speed required (VSR).



Following the FMS going approach active, NAV pages 2 and 3 are renumbered and become NAV pages 3 and 4. NAV page 3 shows a subheading or mode indication of **APPR ACTIVE**.



Approach active page 4 displays the same information as normal navigation page 3.



MANUAL APPROACH ACTIVATION

“Radar vectors to final”, are the words that will result in the need to manually activate the approach. All the criteria required to automatically activate the approach will be eliminated with the exception of approach arming. Manually activating the approach will immediately present the final approach segment in an approach active condition and extend the final approach course to 50nm from the airport. The first waypoint inside the approach label will become the “TO” waypoint. This will either be the FACP or the final approach fix depending upon the design of the approach. This will be the Course to Fix (CF) leg. The heading control of the aircraft will now be dependent upon a configuration option. Most aircraft use command heading enabled as their configuration option. Unless command heading is in use when activating the approach, upon activation, the FMS will present the command heading function with the aircraft heading being the active command heading. As discussed later, normal procedure will place the aircraft on the ATC heading first then activate the approach. Any mapping display will present final approach course and waypoints.

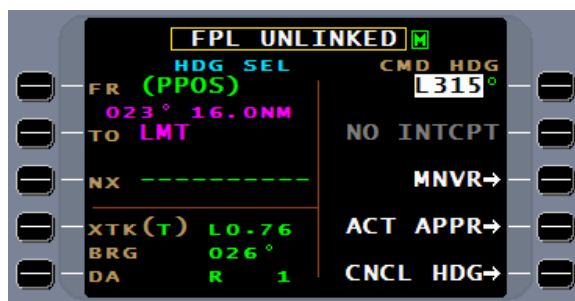
Procedures for flying and manually activating an approach are as follows:

Upon ATC placing the aircraft on radar vectors to final; first activate command heading (if interactive heading) and turn the heading bug to the ATC assigned heading



...or enter the ATC heading through the **CMD HDG** field.

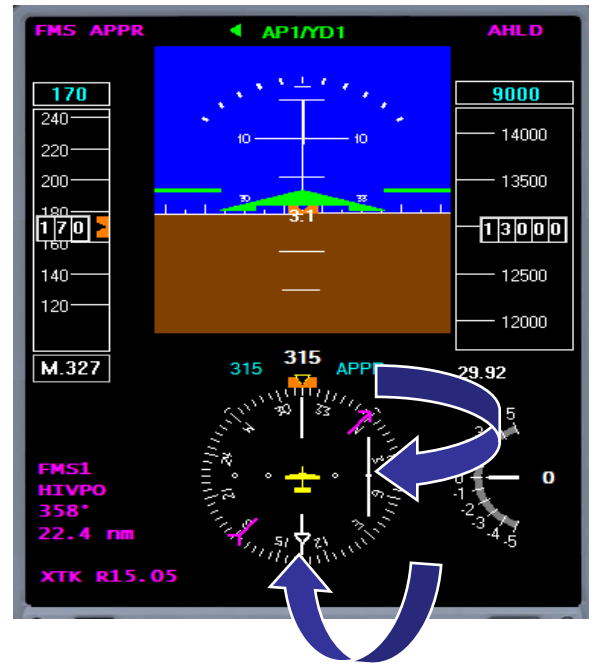
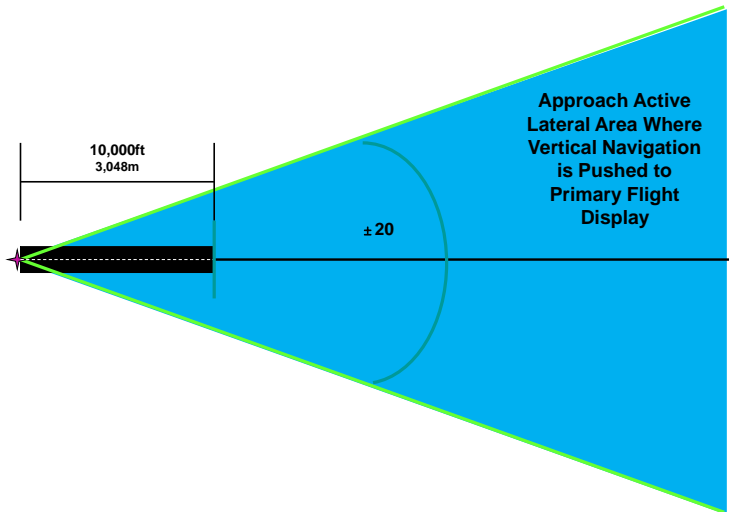
If currently using flight director heading mode, to transfer to FMS heading mode, a technique is to allow the aircraft to complete the turn with flight director heading, then activate the approach. Now the two headings will be the same. Select flight director NAV mode and the FMS command heading will be navigating the aircraft.



While in the turn or after completing the turn, press the ACT APPR line select key to manually activate the approach.

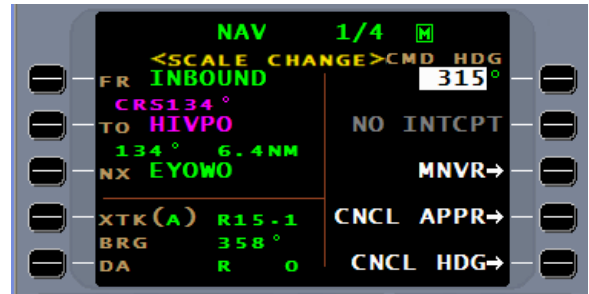
NOTE: If on radar vectors following a missed approach, wait until the aircraft is on downwind before activating the approach to avoid inadvertent sequencing of the approach.

With activation, the course arrow will align itself with the final approach course and the CDI will display the aircraft offset from the final approach course. Glidepath will become active when within the lateral cone of 20° of the final approach course (See diagram

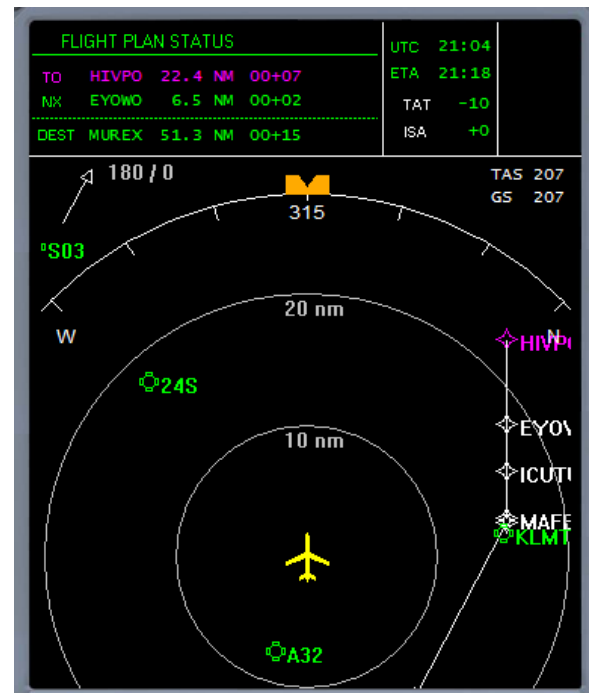


below).

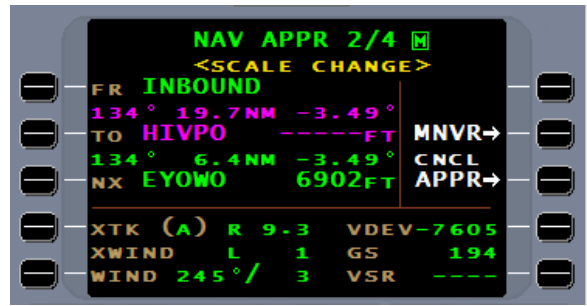
The FMS NAV page will show the **TO** waypoint as the first waypoint on the approach segment and the **FR** waypoint as **INBOUND**, which is the extension of the final approach course. **<SCALE CHANGE>** takes place now since the FMS could not anticipate activation. Depending on FMS configuration, the **CMD HDG** function will automatically activate with the aircraft heading as the command heading. If **CMD HDG** is in use before approach activation, following approach activation, the heading in use will remain the active heading.



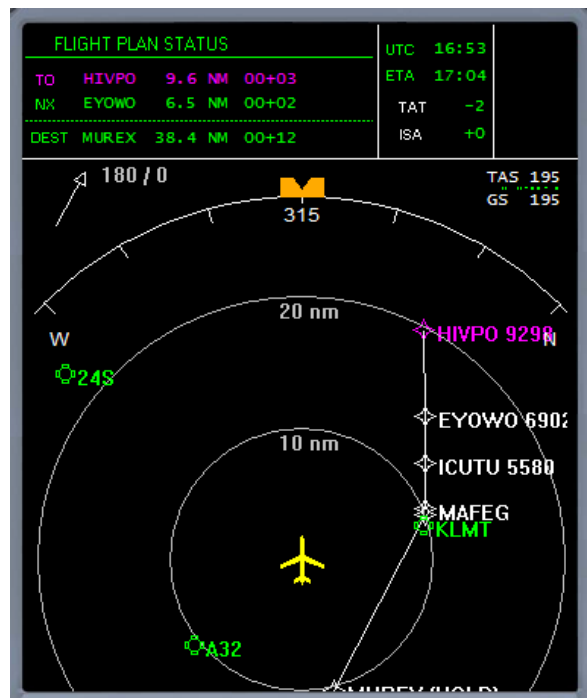
If a map display is available, the approach course and waypoints will be displayed providing enhanced situational awareness.



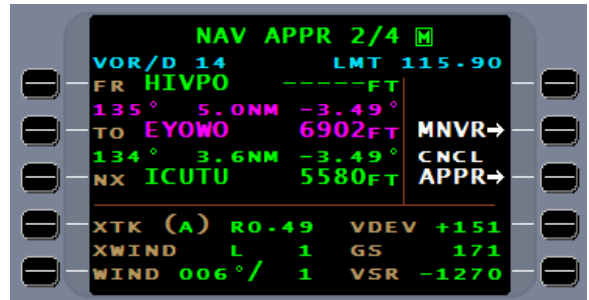
If the FMS configuration is command enroute only or none, following activation, the **CMD HDG** function will not be accessible. Heading control for vectoring is assumed to be by flight director heading mode.



The map display and HSI will still present the approach inbound course information.



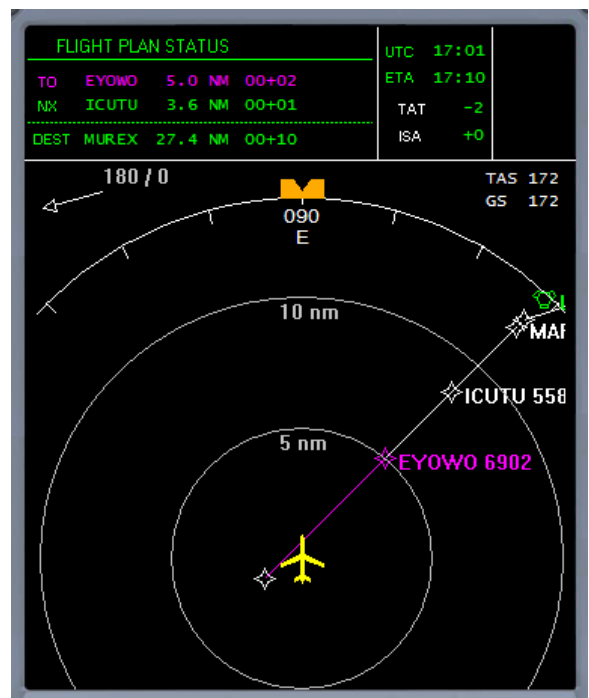
When cleared approach, the pilot must determine when to transition from flight director heading mode to flight director NAV mode.



Once in flight director NAV mode, the FMS will control navigation. It will automatically compute an intercept not to exceed 45° to the approach course.



The pilot may choose to turn the aircraft on to the inbound course with the flight director heading mode or allow the FMS to turn on course by the pilot selecting flight director NAV mode. If selecting flight director NAV mode when on the approach intercept leg, the FMS crosstrack should be less than 0.7nm to prevent an early turn to final.



RULES FOR APPROACH ACTIVATION

It is critical to know when to allow automatic activation of the approach and when to manually activate the approach. The following rules will provide guidance regarding the choice of the activation method.

- 1. When flying an approach transition, allow the FMS to automatically activate the approach.**

(This will insure that approach transition guidance is not lost before the final approach segment is reached.)

(Determine the point of activation, the FACF, to ensure the aircraft flight guidance is set for the approach at or prior to crossing the FACF or point of activation.)

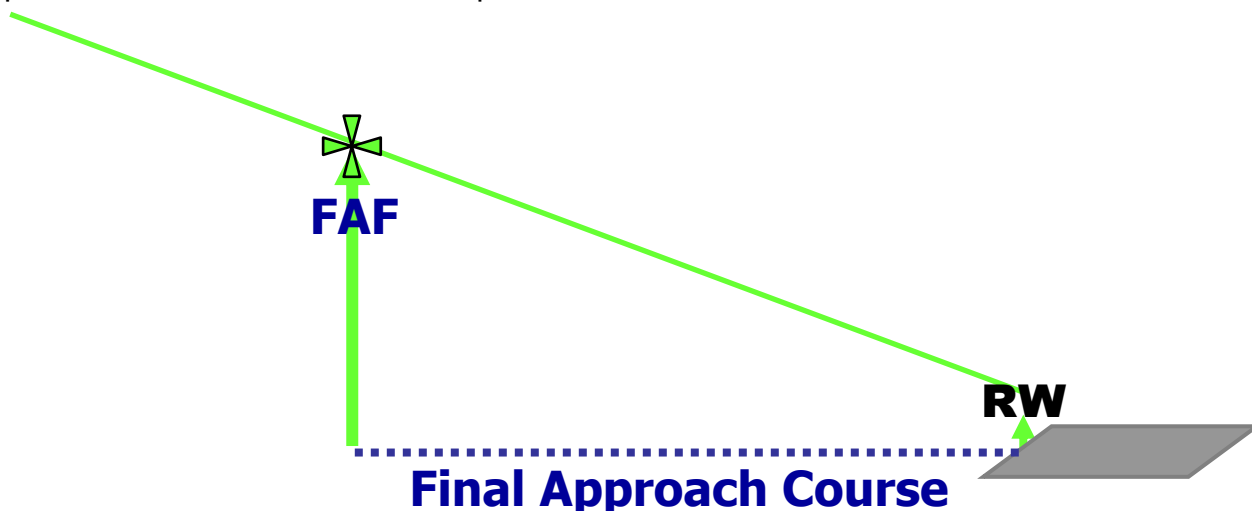
- 2. When on vectors to the final approach course and after placing the aircraft on the assigned heading, manually activate the approach.**

NOTE: When on vectors following a missed approach, wait until downwind before activating the approach to avoid inadvertent leg sequencing.

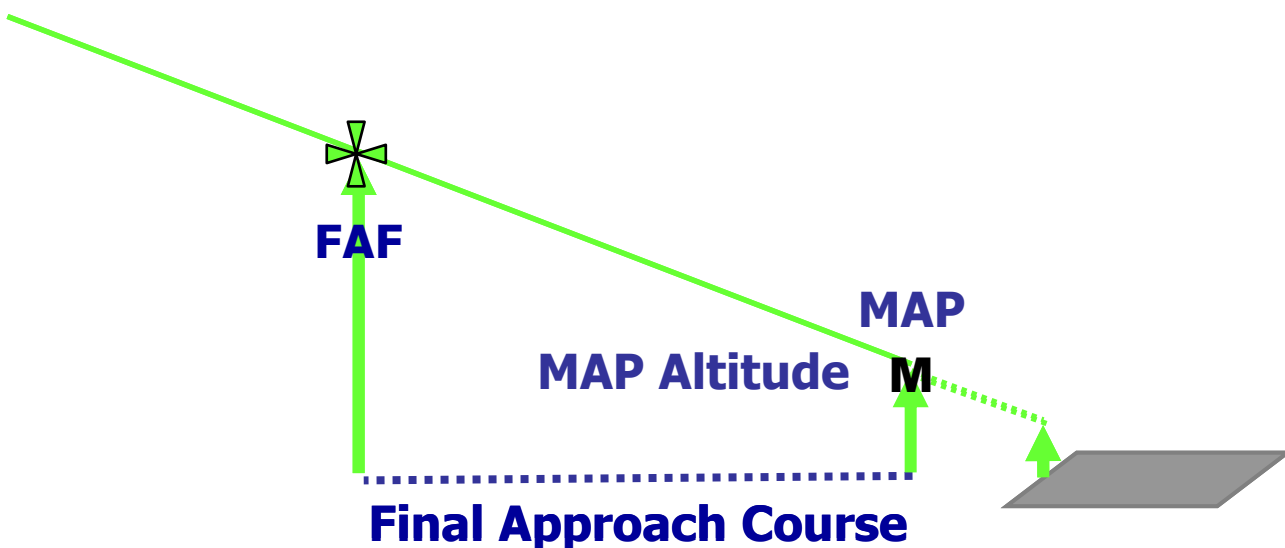
NOTE: Placing the aircraft on the assigned heading first will insure the FMS will not capture an incorrect heading when the approach is activated.

VERTICAL APPROACH NAVIGATION

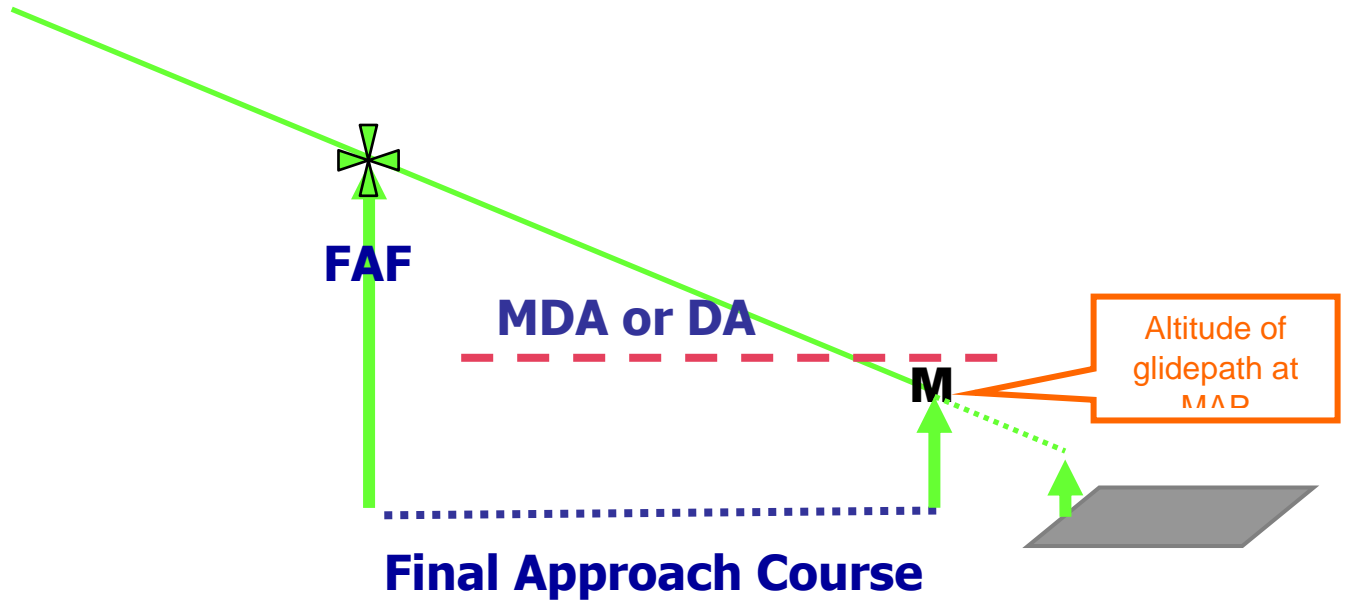
From the navigation database as part of the approach definition is vertical navigation. With SCN 100X series using the Satellite Based Augmentation System (SBAS), the FMS can use either a GPS calculated glidepath or it can use barometric altimeter inputs through the air data computer to monitor the altitude of the aircraft relative to the defined approach glidepath or glideslope. Which one of the methods of calculating a glideslope will be used depends on the approach type and the availability of the SBAS. The definition for the approach vertical navigation is computed by first starting at the runway threshold crossing altitude, then computing an angle that will pass through the final approach fix database altitude. This angle is used to project a glidepath over the approach final approach course. The intent of this glidepath is to guide the aircraft towards the runway threshold to cross at the threshold crossing altitude. For any approach with the final approach course in line with the runway, an attempt will be made to code a vertical path.



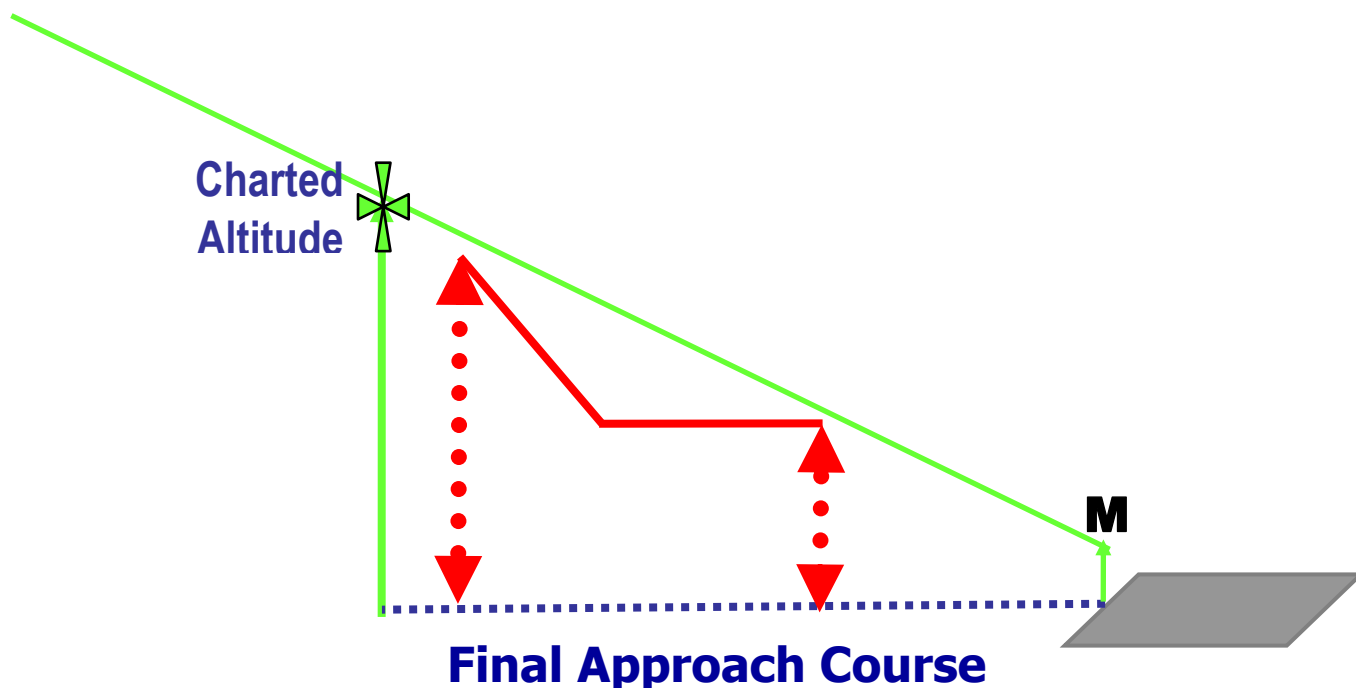
If the missed approach point is prior to the runway threshold, the database altitude at the missed approach point is that which is computed from where the glidepath crosses the missed approach point on the way to threshold. Although the intent of the glidepath is to guide the aircraft to the threshold at the threshold crossing height, the threshold and crossing altitude is not part of the approach definition. The altitude at which the glidepath crosses the missed approach point is in the approach definition and is used to calculate the glidepath angle.



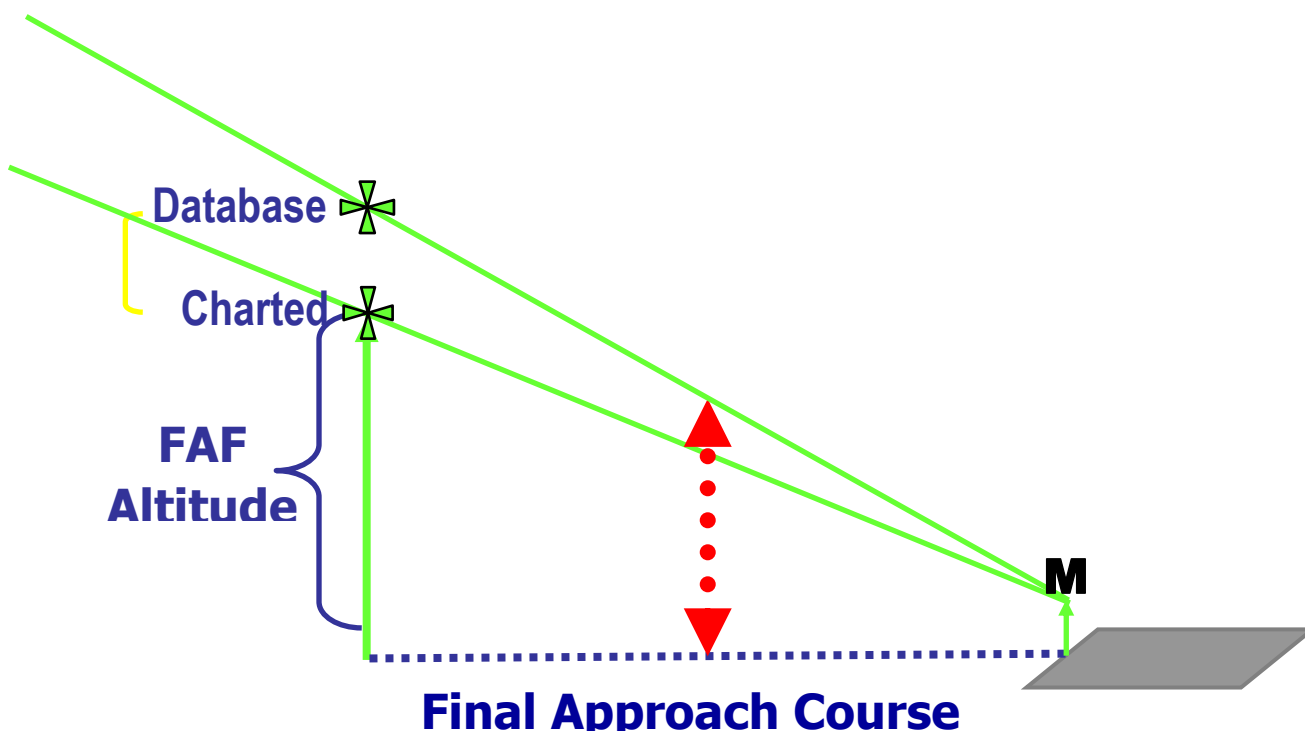
The minimum descent altitude and decision altitude are not in the FMS database and is the responsibility of the pilot. The FMS glidepath will terminate at the missed approach point and the aircraft glidepath indicator will bias out of view. The altitude of glidepath termination will normally be lower than the MDA or DA. A decision to continue below the MDA or DA is the responsibility of the pilot even though the FMS glidepath may continue below that altitude.



If step down fixes are part of the charted approach, they are figured into the glidepath calculation to ensure the glidepath will clear the step down altitudes. If the glidepath is above the step down altitudes, there is no problem.

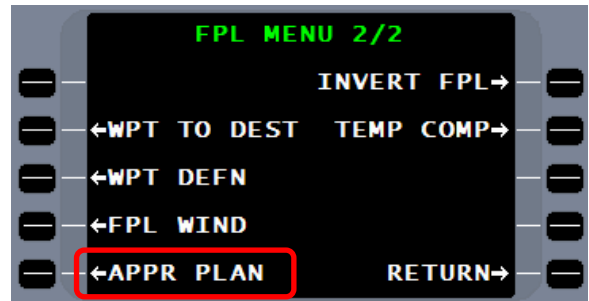


If the step down fix altitude is higher than the calculated glidepath, the glidepath is recalculated to an angle that will clear the highest step down fix. The altitude at the final approach fix in the FMS database will be higher than the charted final approach fix altitude.

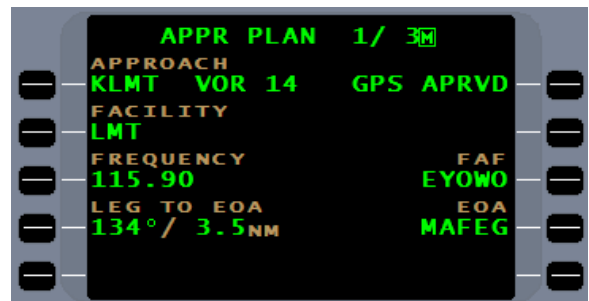


FMS APPROACH PLAN

Located on **FPL MENU 2/2** is the approach plan (APPR PLAN). This FMS tool is an important part of planning the FMS approach.

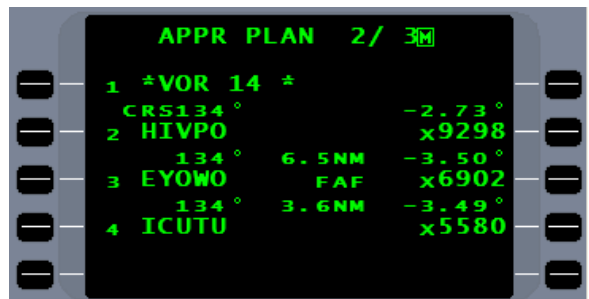


Page 1 of the **APPR PLAN 1/3** will provide a basic definition of the approach selected to include type of approach, NAV facility, if any, the status of GPS for the approach, final approach information.

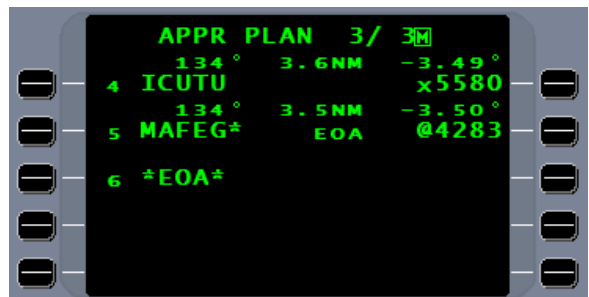


Page 2 and 3 and any pages to follow will present final segment waypoints, course, distance, glidepath angle, and altitudes.

This information can be used to help determine where to configure the aircraft, to determine glidepath intercept altitudes, and to determine approach power settings based on vertical flight path angle.



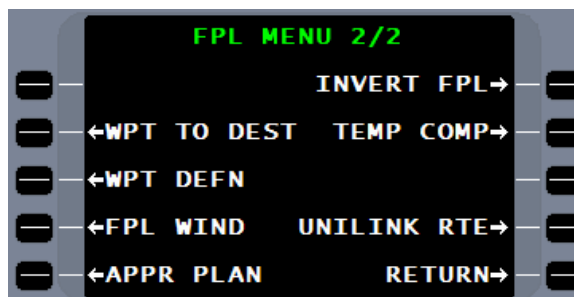
For approaches with multiple step-down fixes such as RNAV (RNP) approaches, several pages may be needed to display all the approach segment waypoints.



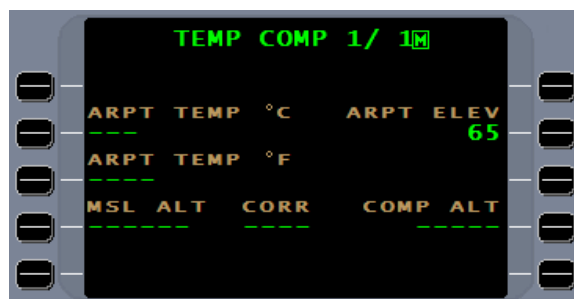
TEMPERATURE COMPENSATION

The accuracy of a barometric altimeter is affected by non-standard temperature. A colder than standard temperature (International Standard Altitude, ISA) will result in the true MSL altitude being lower than the indicated altitude and hotter than standard temperature will result in the MSL altitude being higher than indicated. When the FMS created glidepath uses barometric altimeter inputs to monitor the aircraft's altitude relative to the VNAV path, non-standard temperature will result in a slight error between the actual and indicated position on the glidepath. Many countries have created standard correction table for very cold conditions. This correction table has been incorporated in a TEMP COMP feature in the FMS.

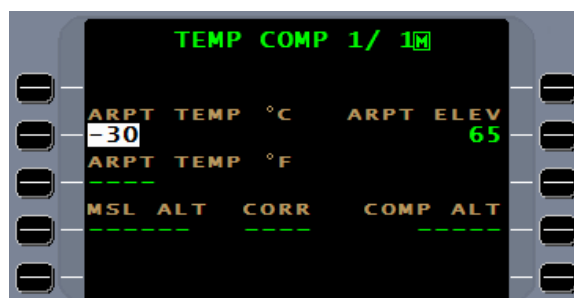
TEMP COMP, when activated by a technician in the FMS configuration section, is available on **FPL MENU 2/2**.



Selection of the TEMP COMP line select key will present the **TEMP COMP** page.



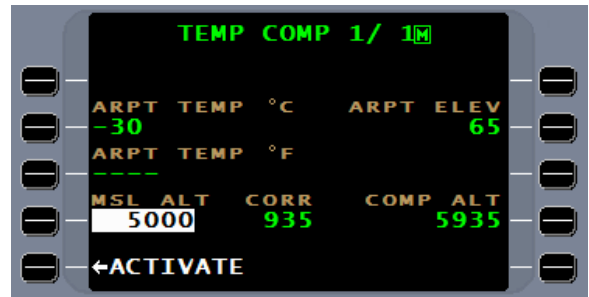
By entering a temperature, either Celsius or Fahrenheit, into the **ARPT TEMP** line, altitude adjustments can be made.



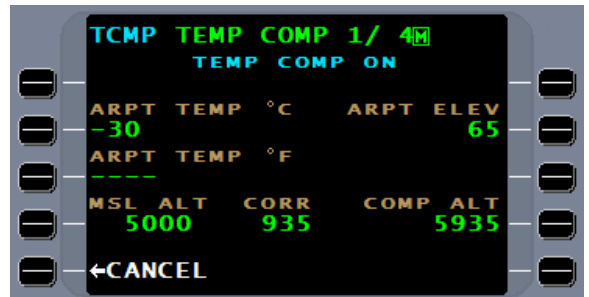
NOTE: The temperature entered can only be at or below freezing. The \pm key need not be pushed for a Celsius entry. The temperature range that can be entered is 0°C to -70°C and +32°F to 94°F.

By entering an **MSL ALT**, the amount of compensation and the compensated altitude are calculated and presented.

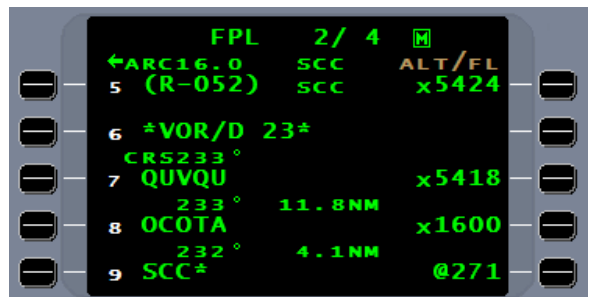
Activating line select key 5L will apply the temperature compensation to the selected FMS approach or VNAV plan.



The subheading **TEMP COMP ON** signifies that temperature compensation is active. Temp comp will stay active for any approach selected at the current airport listed on the flightplan. Using the CANCEL option or deleting the current airport from the flightplan, deleting the flightplan, or cycling FMS power will cancel temp comp.

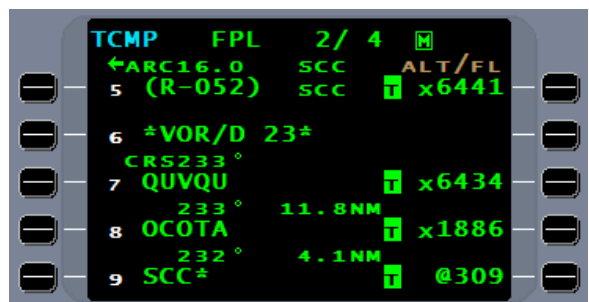


To the right are the altitudes before applying the temperature compensation.

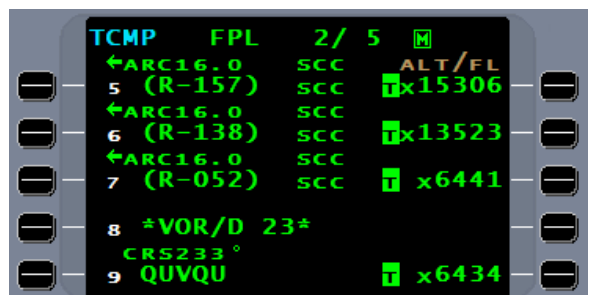


With temperature compensation on and a **-30°C** temperature entered, the altitudes are adjusted.

TCMP on the flightplan and NAV page will indicate the temperature compensation feature is active and the **T** prior to the altitude indicates a temperature corrected altitude.



Temperature compensation will be projected throughout the approach transition VNAV waypoints. Temperature correction will not be placed in STAR waypoints.



COLD TEMPERATURE AIRPORTS

In the United States a list of cold temperature airports have been created by the FAA where temperature compensation must be applied if below a designated temperature. Specific procedures are also implemented.

Terminal Charts - RNAV (GPS) Y RWY 2L					PASC/SCC DEADHORSE	JEPPESEN 5 JUN 15 (10-1W)	DEADHORSE, ALASKA COLD TEMPERATURE TABLE
BRIEFING STRIP™	ATIS		FAIRBANKS Approach (R)		FAIRBANKS Tower		
	124.4		360°-179° 126.5 180°-359° 125.35		118.3		
	WAAS Ch 57915 W-02B	Final Apch Crs 017°	Minimum Alt BOSGE 2100' (1661')	LPV DA(H) 642' (203')	A		
	MISSED APCH: Climb to 4900' direct ELACA and hold, or climb-in-hold to 4900'.						
Alt Set: INCHES					Trans level: FL 180		
1. DME/DME RNP-0.30 not authorized. 2. For uncompensated Baro-VNAV system RNAV/VNAV not authorized below -25°C (-13°F) or above 48°C (118°F)							
3. Cold temperature altitude correction required at or below -20°C (-4°F).							
4. VGSI and RNAV glidepath not coincident.							

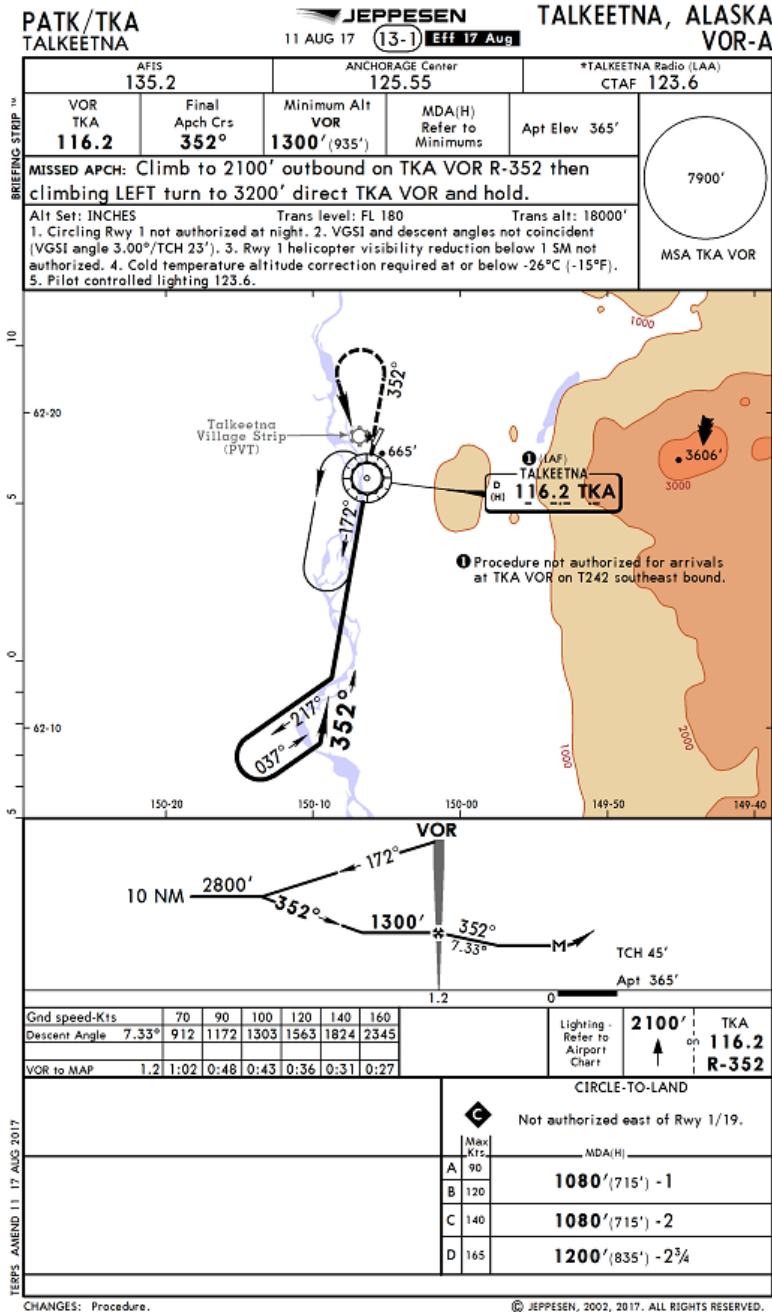
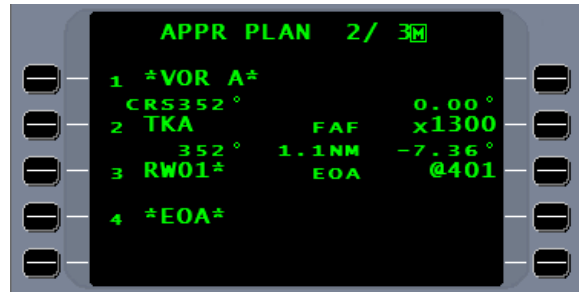
COLD TEMPERATURE CORRECTION TABLE														
HEIGHT ABOVE AIRPORT (FEET)														
REPORTED TEMP.	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
+10°C (+50°F)	10	10	10	10	20	20	20	20	20	30	40	60	80	90
0°C (+32°F)	20	20	30	30	40	40	50	50	60	90	120	170	230	280
-10°C (+14°F)	30	30	40	50	60	70	80	90	100	150	200	290	390	490
-20°C (-4°F)	40	50	60	70	90	100	120	130	140	210	280	420	570	710
-30°C (-22°F)	40	60	80	100	120	140	150	170	190	280	380	570	760	950
-40°C (-40°F)	50	80	100	120	150	170	190	220	240	360	480	720	970	1210
-50°C (-58°F)	60	90	120	150	180	210	240	270	300	450	590	890	1190	1500

The use of the FAA charted temperature correction table or the FMS TEMP COMP will meet the requirement.

For further guidance, see: FAA updated list of "Cold Temperature Restricted Airports" found in Notice to Airmen Publication (NTAP) and InFO 15002, dated 2/10/15 or AIM 7-2-3c-e.

For Canadian Cold Temperature guidance, see: Transport Canada AC 500-020, Issue 03.

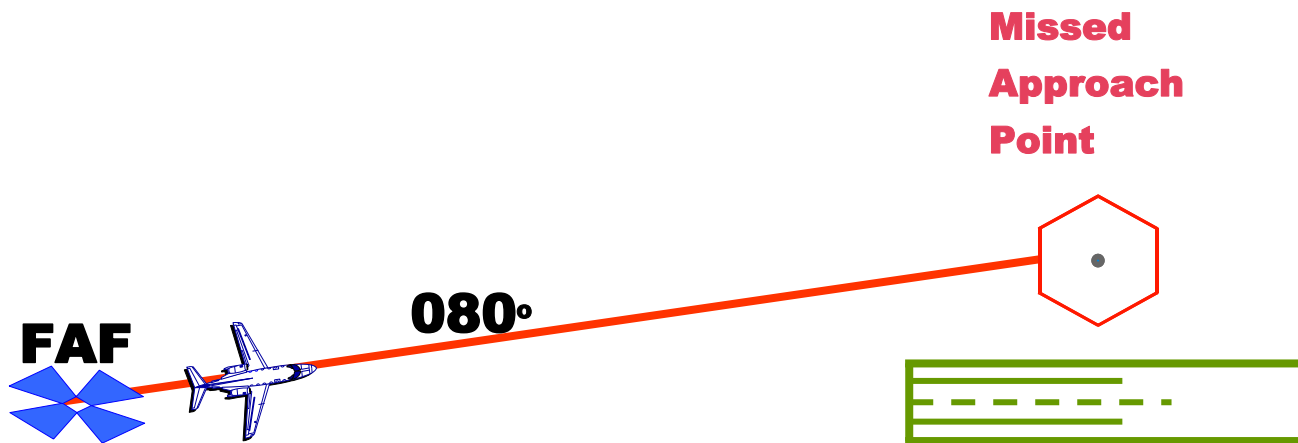
In some situations, if the inbound approach course is in line with the runway, a vertical flight path may be available.



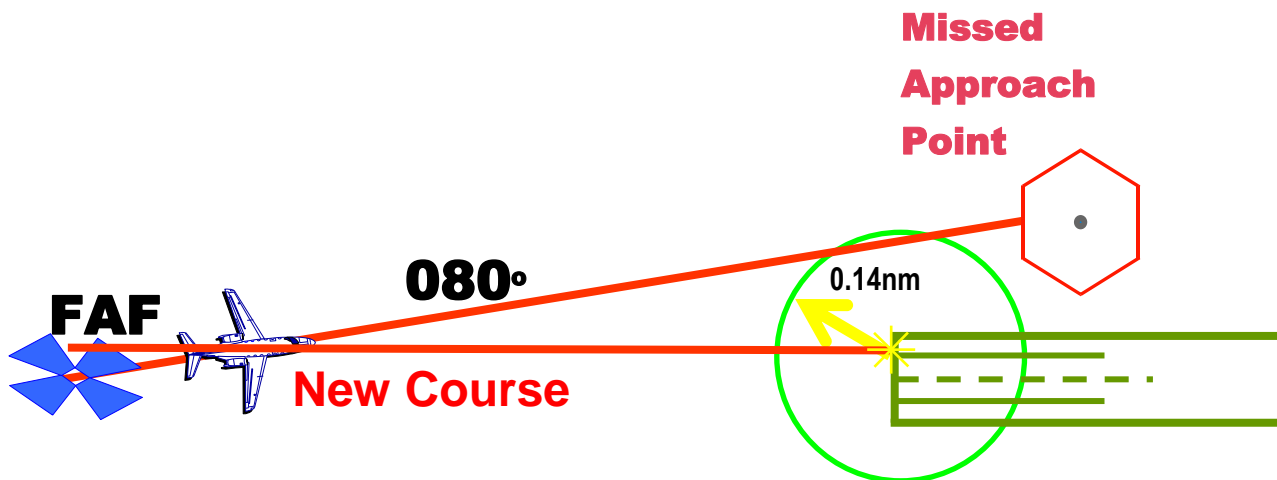
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MISSED APPROACH POINT IS AFTER THE RUNWAY THRESHOLD

If the missed approach point is beyond the runway threshold such as in the case where the navaid is the missed approach point, for the glidepath to cross the threshold at threshold crossing height (TCH) would require an altitude tag on the missed approach point (MAP) that would be lower than the runway elevation. That would not be permitted, so no glidepath is created.



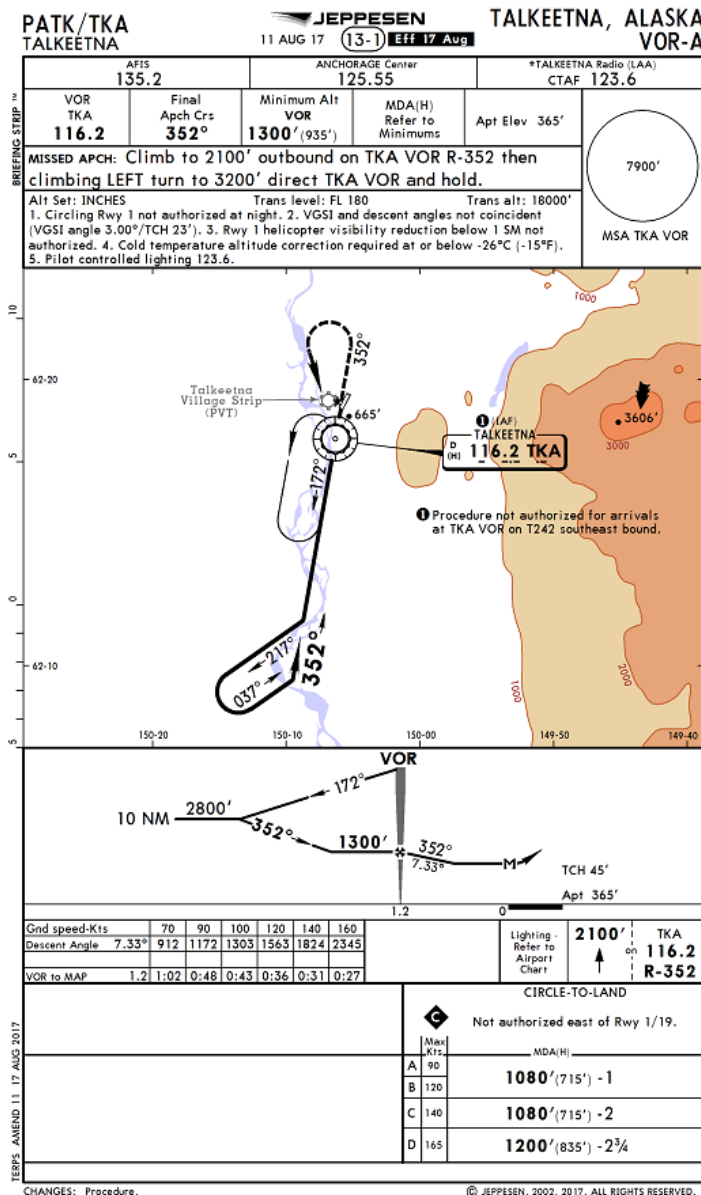
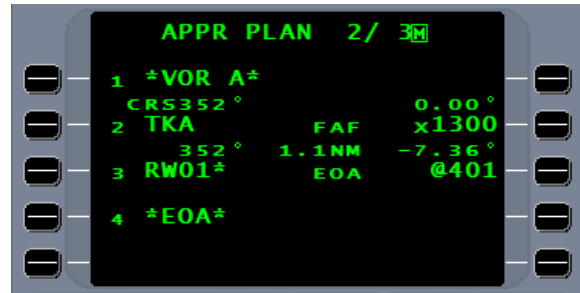
With ARINC 424 guidance, however, if the inbound course is considered to be in line with the runway, but the missed approach point (MAP) lays more than 0.14nm from the threshold of the runway, the inbound course may be redirected to the threshold. With the threshold as the missed approach point, a glidepath can now be created. In effect, there are now two approaches, one for conventional navigation and one for FMS/RNAV navigation.



If the Missed Approach Point is within 0.14nm of the threshold, vertical navigation will be directed to that point to cross the threshold at the threshold crossing height.

GLIDEPATH ANGLE TOO STEEP

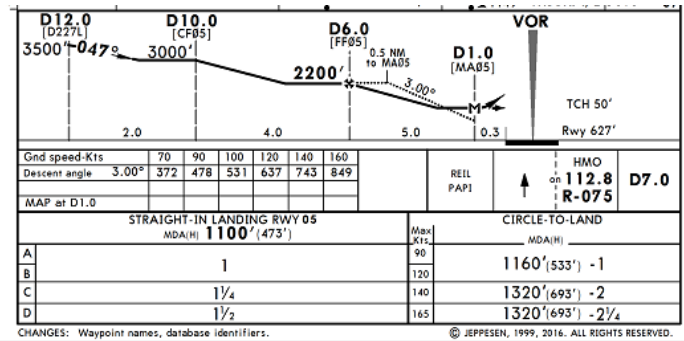
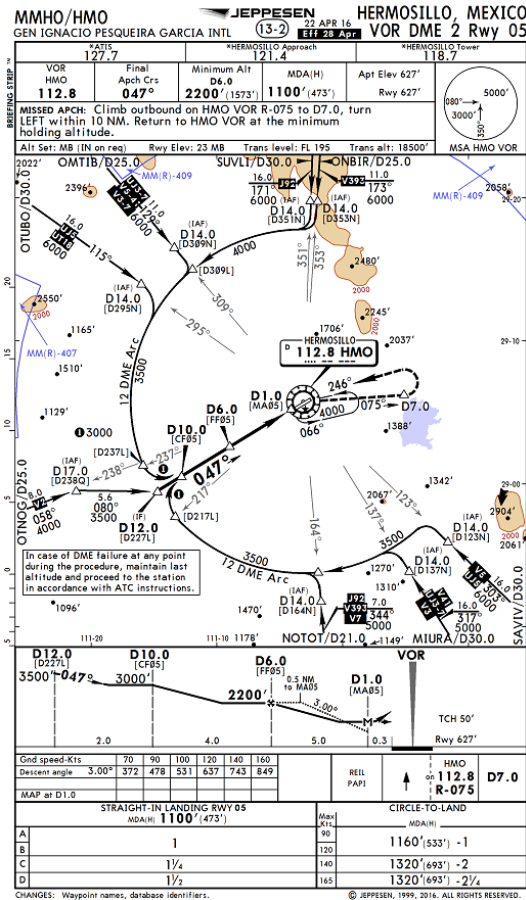
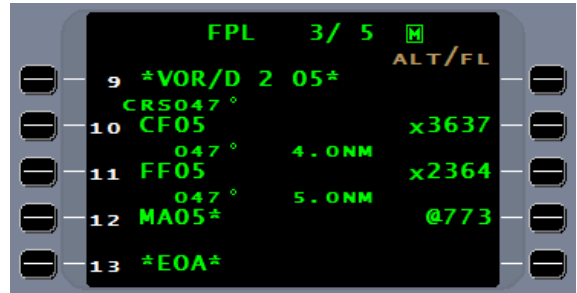
If the charting source (country of origin) designates a vertical flight path angle, it is published in the database. If the glidepath is created by Jeppesen, there is no maximum angle. Decision to fly an advisory glidepath is that of the pilot's.



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GLIDEPATH ANGLE TOO SHALLOW

If the country of origin designates a vertical flight path angle, it is published in the database. If the glidepath is created by Jeppesen and their calculation is less than 3°, the angle on most approaches is raised to 3°.



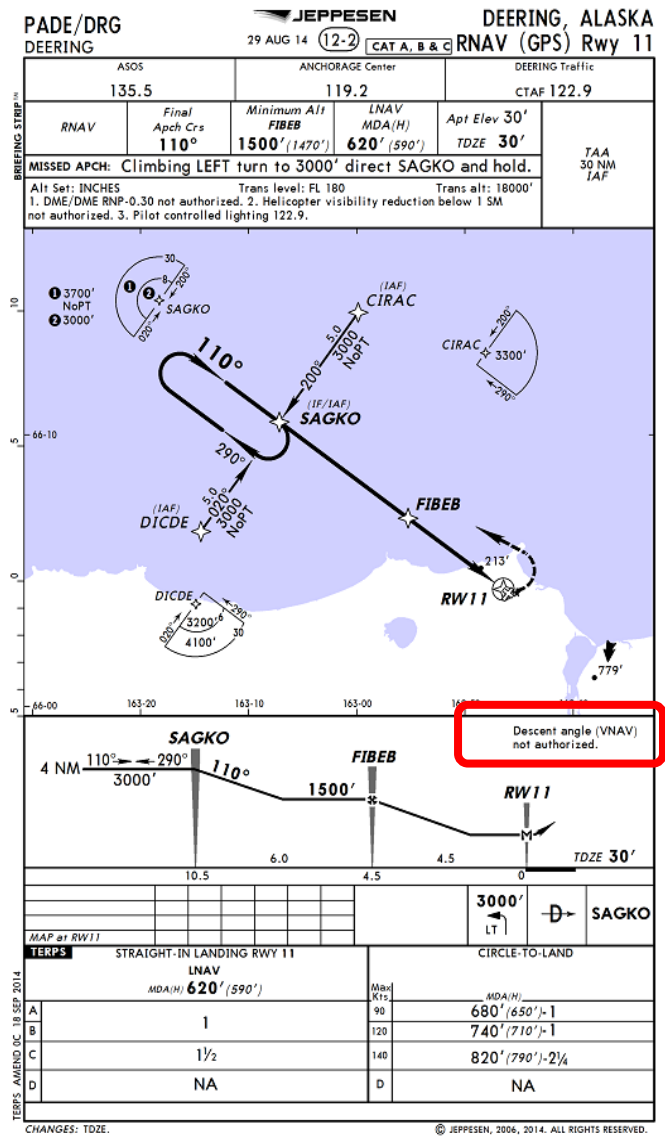
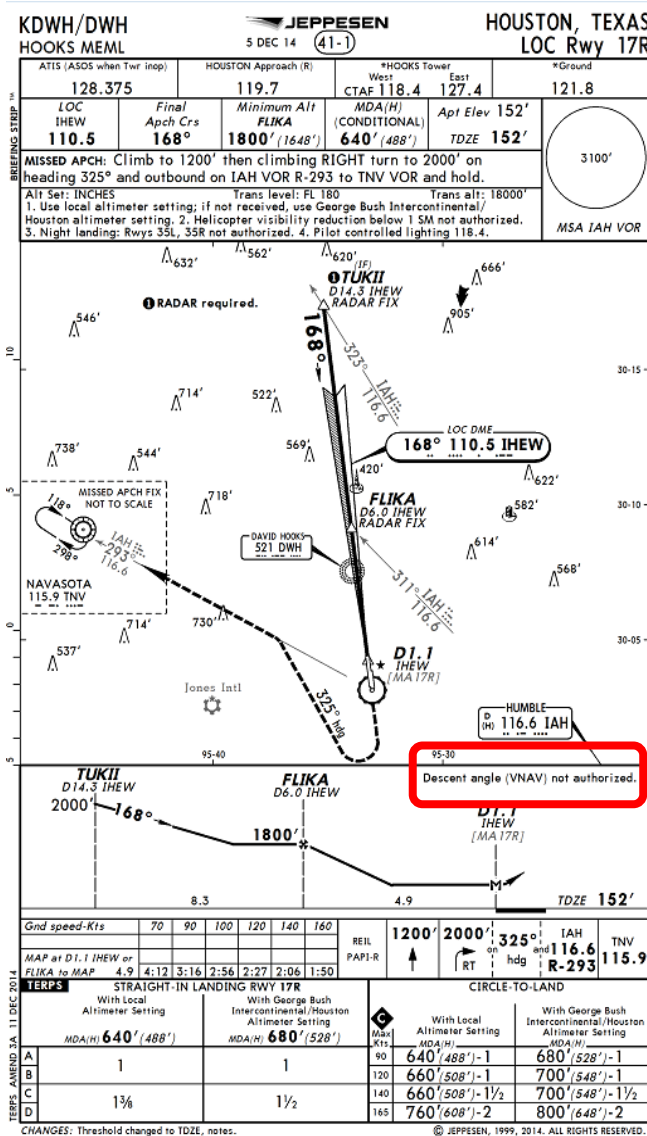
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NOTE: Rules for glidepath creation IAW ARINC are ever changing. The approach definition is only changed when the approach is reviewed or changed by the source (state of origin).

VERTICAL GLIDEPATH NOT AUTHORIZED

Where following a vertical glidepath is considered unsafe, the approach chart will contain the statement. Vertical navigation will not be provided.

Descent angle (VNAV) not authorized



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VERTICAL APPROACH SYMBOLS

Just prior to the release of SCN 1000.6, the FAA issued guidance on vertical glideslope calculation for RNAV approaches and it was incorporated in the release of this point change and subsequent software. If the RNAV approach has either an LNAV/VNAV DA or LPV DA, the glideslope must be computed from the FAF to the MAP and not include crossing altitudes for intermediate stepdown fixes. The below RNAV approach has a “@” altitude at the FAF (CUTOK) and at the MAP (RW14). The vertical glideslope is drawn between these two points. The “X” altitude at PIKYI, the FAF, is an extension of the vertical glideslope angle. The “↑” or “|” are advisory information for operators flying this approach as a two dimensional procedure.

Step	Altitude	Symbol
5	8910	X
6	7000	@
7	6480	↑
8	6000	↑
9	5680	↑
9	4141	@

The “X” Symbol is used for FMS computed crossing altitude.

The “@” Symbol is used for a required crossing altitude.

The “↑” or “|” Symbol is used for above altitude constraint; used as advisory information when flying a two dimensional approach without FMS vertical guidance.

These symbols also apply to enroute vertical navigation on SIDs and STARs.

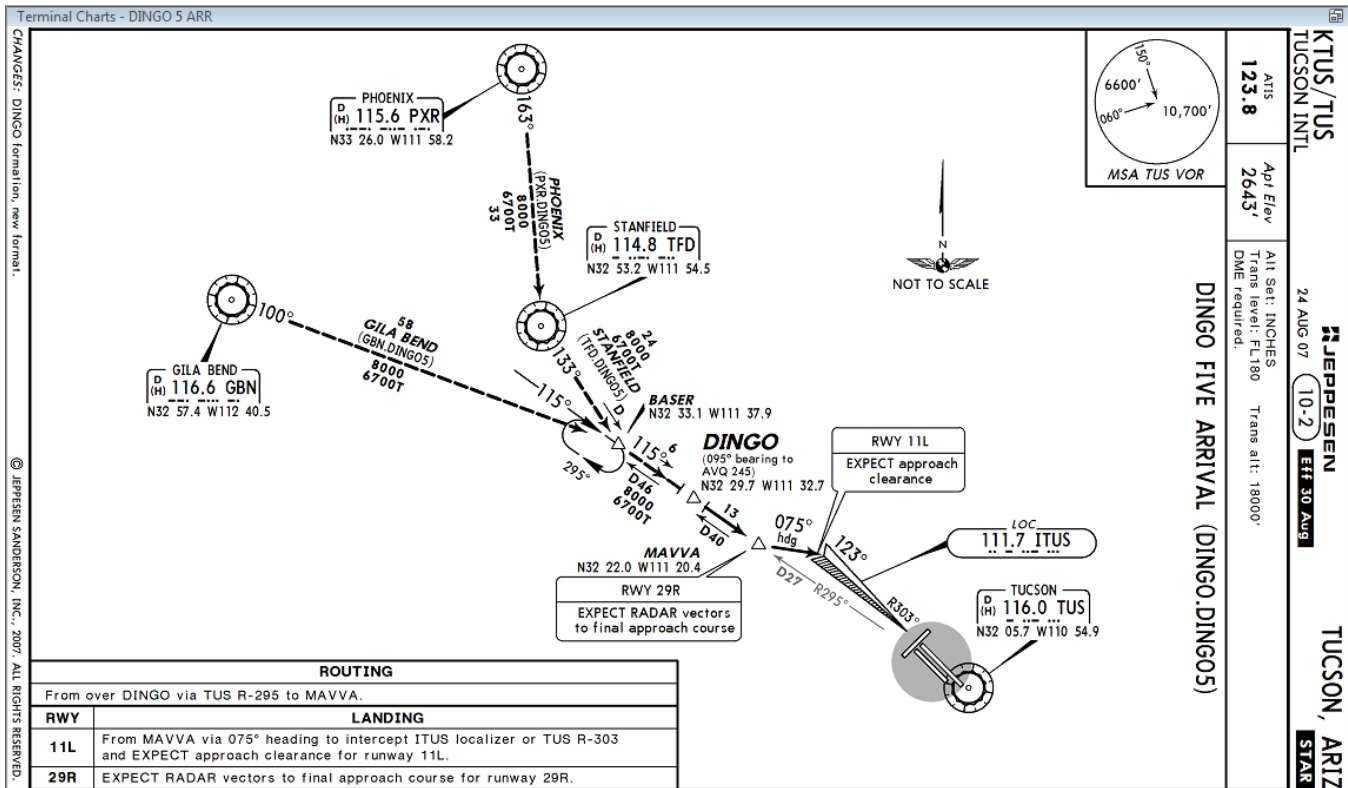
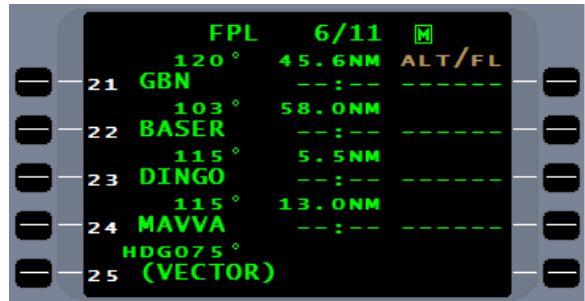
VERTICAL DEFINITIONS

Glideslope: A required vertical path to a Decision Altitude (DA). Following this vertical path is mandatory when on a three dimensional approach procedure.

Glidepath: An advisory vertical path to a Minimum Decent Altitude (MDA). Following this vertical path is optional. Used when flying a two dimensional approach procedure.

FLYING THE APPROACH TRANSITION

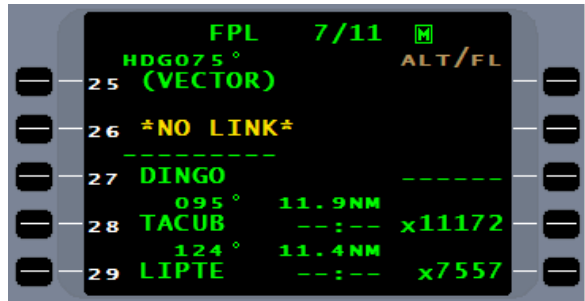
Often times when flying an arrival to an airport, the STAR and the approach will not smoothly interface with each other. An example is the arrival into Tucson International (KTUS). The DINGO5 STAR terminates at MAVVA intersection with a heading to vector leg of 075°. This procedure will take the aircraft to an intercept heading for final approach segment. It will require manual activation of the approach and pressing of the FMS heading intercept line select key.



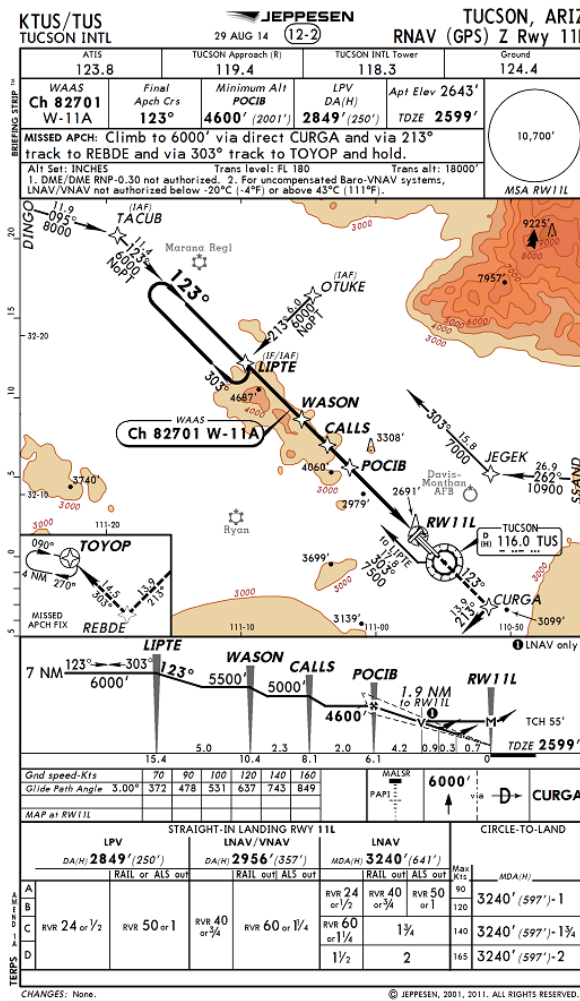
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For the RNAV (GPS) Z 11L approach, selecting the DINGO transition will result in the aircraft leaving the STAR at DINGO intersection for automatic approach activation at CALLS intersection.

Unless the pilot is familiar with ATC procedures at this airport and can, therefore, modify the flightplan for the arrival, the decision to choose either the STAR or the approach transition would be totally arbitrary. Keeping both procedures available may be the best decision.



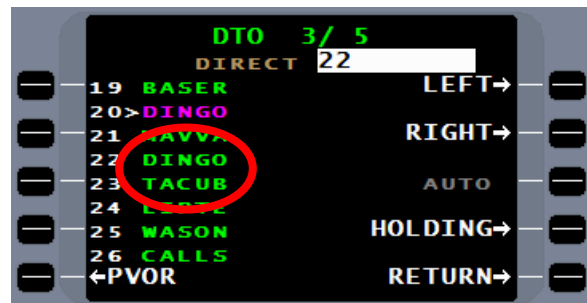
The choice will be made when inbound to DINGO intersection. Simply doing nothing will continue the aircraft on the STAR.



To choose the DINGO approach transition, when inbound to **DINGO**...



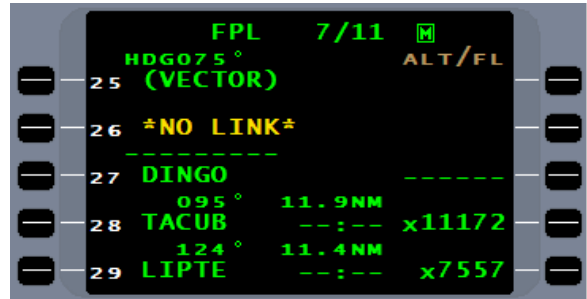
...press DTO and select the **DINGO** that begins the approach transition.



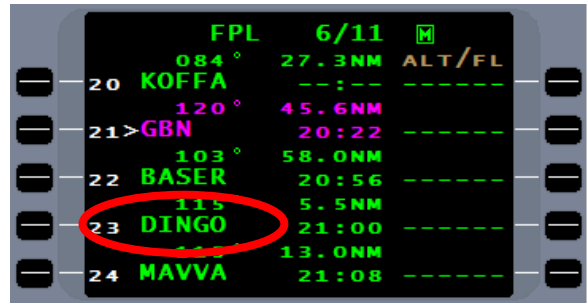
The aircraft will continue to **DINGO**, but will then turn to **TACUB**.



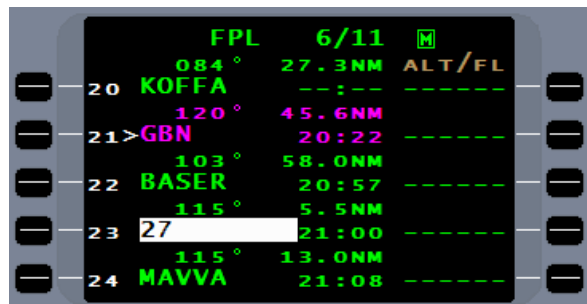
If knowledge of the ATC procedures at Tucson International Airport allows for editing of the flightplan to fly the DINGO approach transition, the technique of moving **DINGO** of the approach transition (#27) up to...



...replace **DINGO** of the STAR (#22) will be the easiest way.



Enter the number 27 into the cursor field of waypoint number 23...



...and press the **ENTER** key. The FMS will guide the aircraft to leave the DINGO5 STAR at **DINGO** intersection and fly the DINGO transition for the approach.

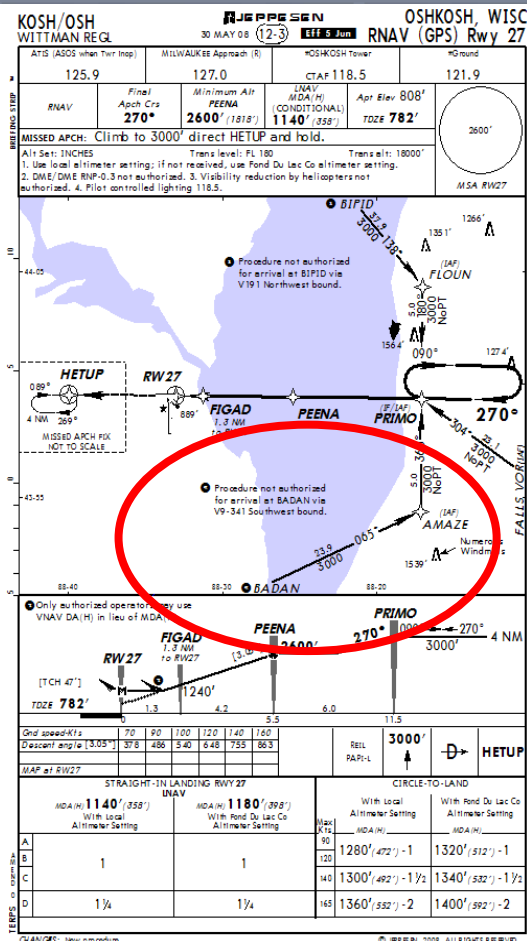


SELECTING THE APPROACH TRANSITION

On many occasions ATC may give a clearance direct to a waypoint in the terminal area, but when selecting the approach transition, this waypoint is not listed. Such is the case when cleared direct to the waypoint AMAZE on the approach chart of the RNAV (GPS) Rwy 27. To select the appropriate transition that will include AMAZE, find the waypoint that feeds into amaze and is also on the list of approach transitions. In this case, the choice is the **BADAN** approach transition.

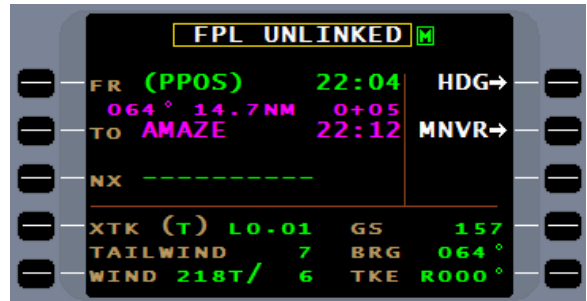
It can be difficult some times to identify the correct approach transition. If the wrong transition is selected, simply go back to the approach transition selection field and choose a different one.

Many countries will use a waypoint on the enroute chart as the beginning of the approach transition. In this case the approach chart may not contain the waypoint on the approach transition list.



LINKING THE NAV LEG TO THE FLIGHTPLAN

There are two techniques to link the current NAV leg to the flightplan. One way is to press the **NX** line select key.



This will allow for selection of the follow on way point from the flightplan.



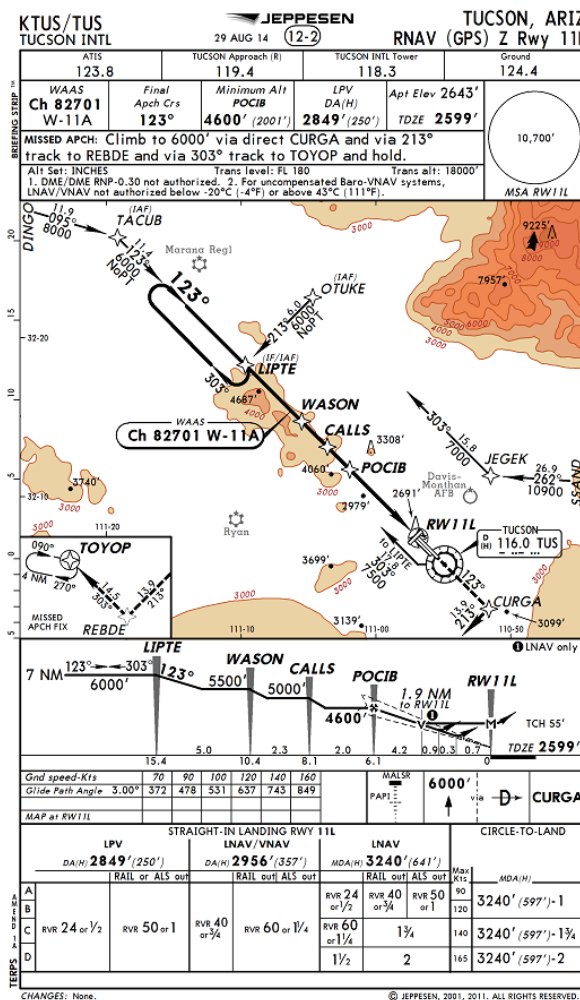
Once the waypoint is selected, the **NAV** page is now linked to the flightplan.



Another way to connect the NAV leg to the flightplan is to use the **DTO** key. While in holding at the waypoint TOYOP, the missed approach holding waypoint on the RNAV (GPS) Z Rwy 11L at Tucson International (KTUS), the clearance is direct to LIPTTE for the course reversal; cleared approach. The previous approach was the RNAV (GPS) Z Rwy 11L with the DINGO transition. This approach transition is a “No PT” and, therefore, does not contain the holding pattern.

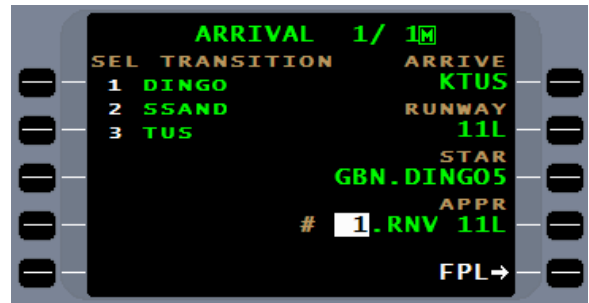


The first step is to go direct to **LIPTTE**.



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While the aircraft is enroute to LIPTE intersection, the pilot must change the approach transition...



...to the TUS approach transition which contains the holding pattern for course reversal.



The flightplan may become unlinked from the NAV page because original waypoint in the DINGO transition was removed during the approach transition change. SCN 100X will attempt to reconnect to the flightplan. If it reconnects, check to insure the correct waypoint was used.



A second technique to re-link the NAV page to the flightplan is to use the DTO function. Select the desired waypoint, in this case LIPTE* with the asterisk, which is the entry point for the holding pattern. Being that this is a hold to fix (HF) pattern, selection of the second LIPTE (LIPTE/H) will result in the FMS not entering the holding pattern.



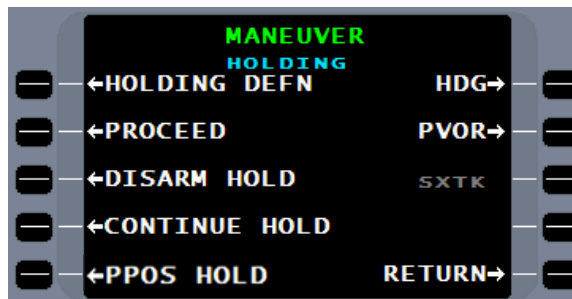
CAUTION: If it automatically links to the flightplan, confirm the FMS has selected the correct waypoint for holding pattern entry. Being that this is a hold to fix (HF) pattern, selection of the second LIPTE (LIPTE/H) will result in the FMS not entering the holding pattern.

The FMS NAV page is now linked to the flightplan and will enter the holding pattern for the course reversal and the approach transition.

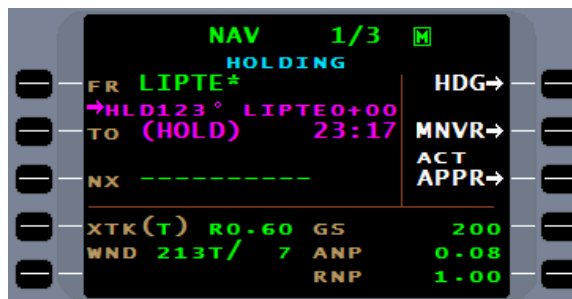


HOLDING DURING THE APPROACH TRANSITION

Once the aircraft has entered the holding pattern and if there is a requirement to continue holding, an option to continue the hold is provided.



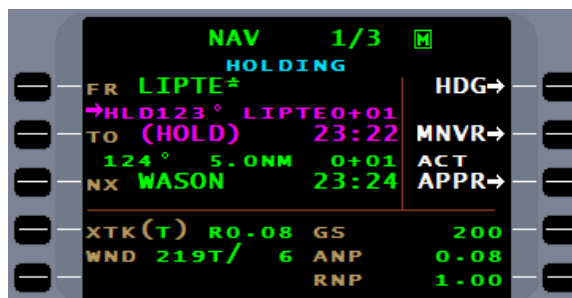
If the option “CONTINUE HOLD” is used, the holding pattern will be converted to hold until manually terminated (HM). This will require pilot action to exit the holding pattern.



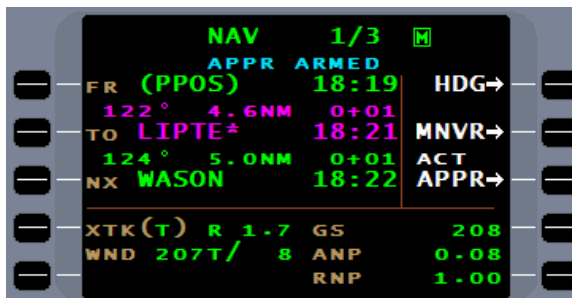
When it is time to exit the holding pattern and fly the approach, select “PROCEED”.



The “PROCEED” option will convert the holding pattern into a HF pattern and the aircraft will now exit holding upon crossing the holding waypoint.

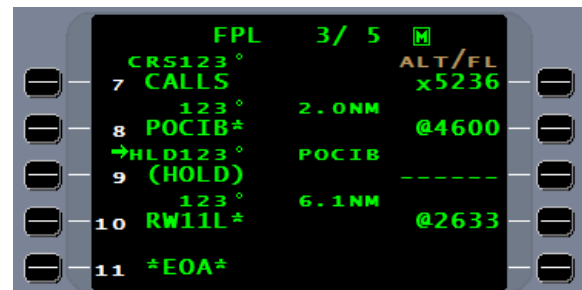


While on the outbound leg, to terminate a holding pattern and proceed direct to exit before completion of the holding pattern, first press “PROCEED”. This will clear the holding pattern from the flightplan. Then, use the DTP function to proceed direct to the holding fix.



HOLDING IN THE APPROACH SEGMENT

The ATC clearance following a missed approach is to proceed to the FAF and hold. SCN 1000/1100 will allow the pilot to select the FAF from the flightplan list on the holding definition page and build a holding pattern. The negative side of this is it will corrupt the flightplan making it unflyable. To fly the approach it must be reentered into the flightplan through the ARRIVAL page.



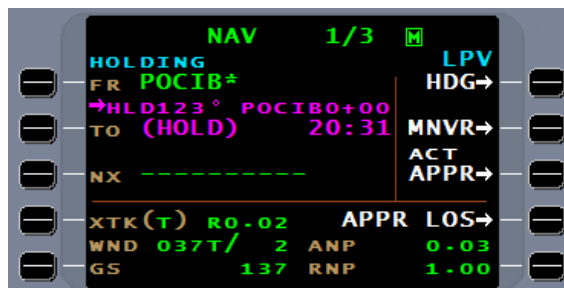
The solution, don't connect the FAF waypoint to the flightplan. By selecting the waypoint used as the FAF from the LIST function or manually typing in the name...



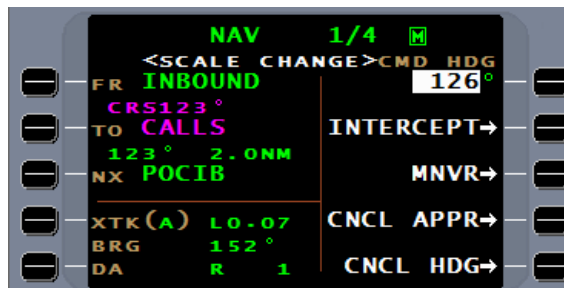
...the FMS will consider it an off the flightplan waypoint. Upon completing the holding definition, select DTO hold.



When ready to fly the approach, manually activate the approach when inbound to the FAF.



Then cancel heading mode if so configured



With SCN 1001/1101 and subsequent the FMS is programmed that when creating a holding pattern at an approach segment waypoint the FMS will only create an off the flightplan holding pattern. Even when selecting the waypoint from the flightplan list an ARM HOLD option is not presented and...



...the holding pattern will not be in the flightplan.



When ready to fly the approach, as above, manually activate the approach when inbound to the FAF, then cancel heading mode if so configured

FLYING A PROCEDURE TURN

Although the classic procedure turn is not being used on the new generation approaches, it is still used in a large number of conventional approaches.

The selection of the transition will bring the procedure turn definition into the flightplan. This will also arm the procedure turn program that will create the procedure turn as this procedure is needed.

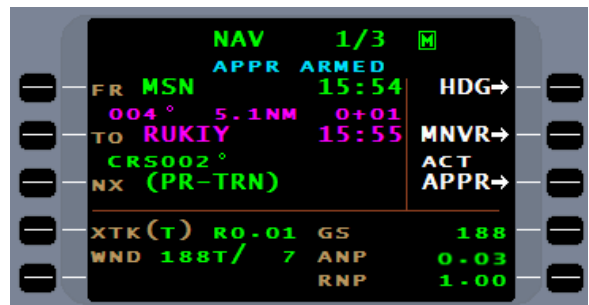


For the procedure turn program to calculate the procedure turn, it requires the definition of the procedure turn which it obtains from the flightplan, the winds, and groundspeed. With this information the FMS will create the two turn points for the procedure turn.

The procedure turn program will calculate the procedure to ensure the minimum amount of airspace is use, but yet completing the turn far enough out to allow for safe approach activation.



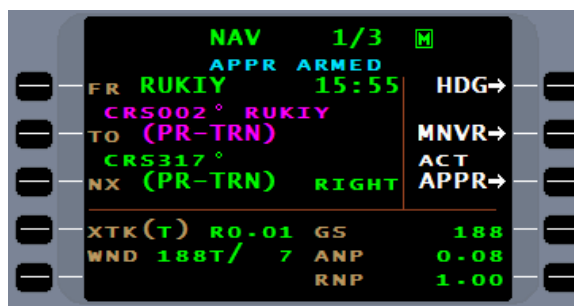
When the FMS sequences for presentation of the (PR-TRN) as the NX waypoint, the FMS will capture wind and groundspeed and calculate the lat/long of the two procedure turn waypoints. Since they are lat/long points, the FMS will navigate to them and calculate mileage for presentation on the primary flight display. If this procedure is flown again, the FMS will capture new winds and ground speed for the calculation of the waypoint lat/long.



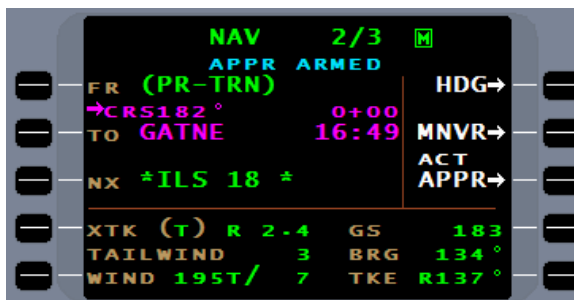
If the aircraft has a map display, the procedure turn waypoints will be presented. Later generation map displays will draw the complete procedure.



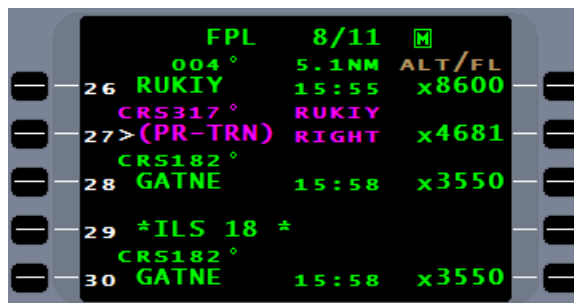
Since the FMS navigates to a specific waypoint, the pilot can more easily maintain situational awareness. The “**RIGHT**” following the second (**PR-TRN**) will force the FMS to make a right turn when sequencing.



Upon sequencing the second (**PR-TRN**) waypoint, the inbound course and the follow on waypoint will become the **TO** waypoint. The “**→**” next to the course leg indicates a mandatory right turn.

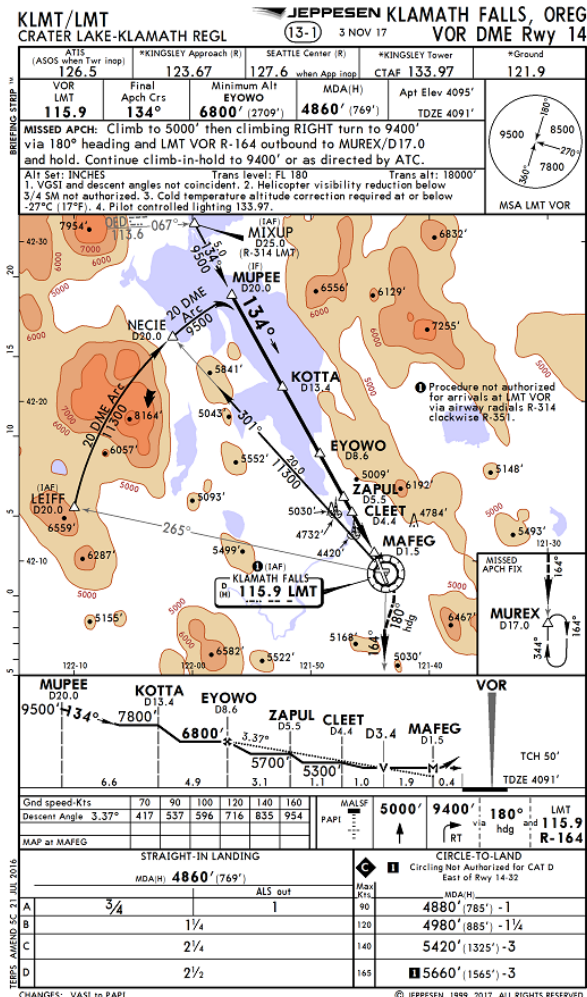


Although the procedure turn waypoints are presented on the FMS and map display, the flightplan will not display these waypoint.



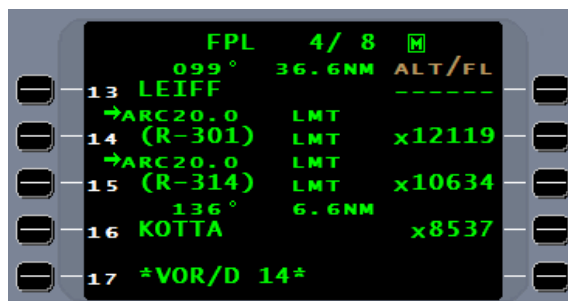
FLYING AND INTERCEPTING ARCS

An arc leg (AF) is a procedural leg that cannot be created in the flightplan and must come from the database.

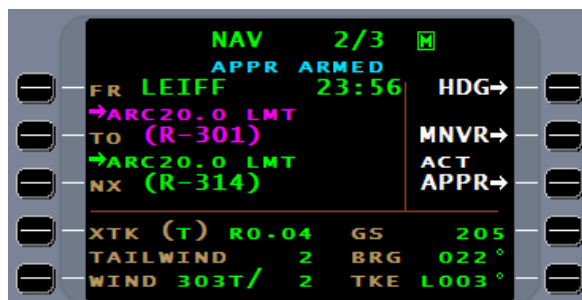


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The leg definition of the arc leg on the LEIFF transition to the KLMT VOR DME Rwy 14 approach is as follows. The arrow indicates the direction of arc, in this case a right arc. The distance of 20.0 is the arc distance from the LMT VOR.

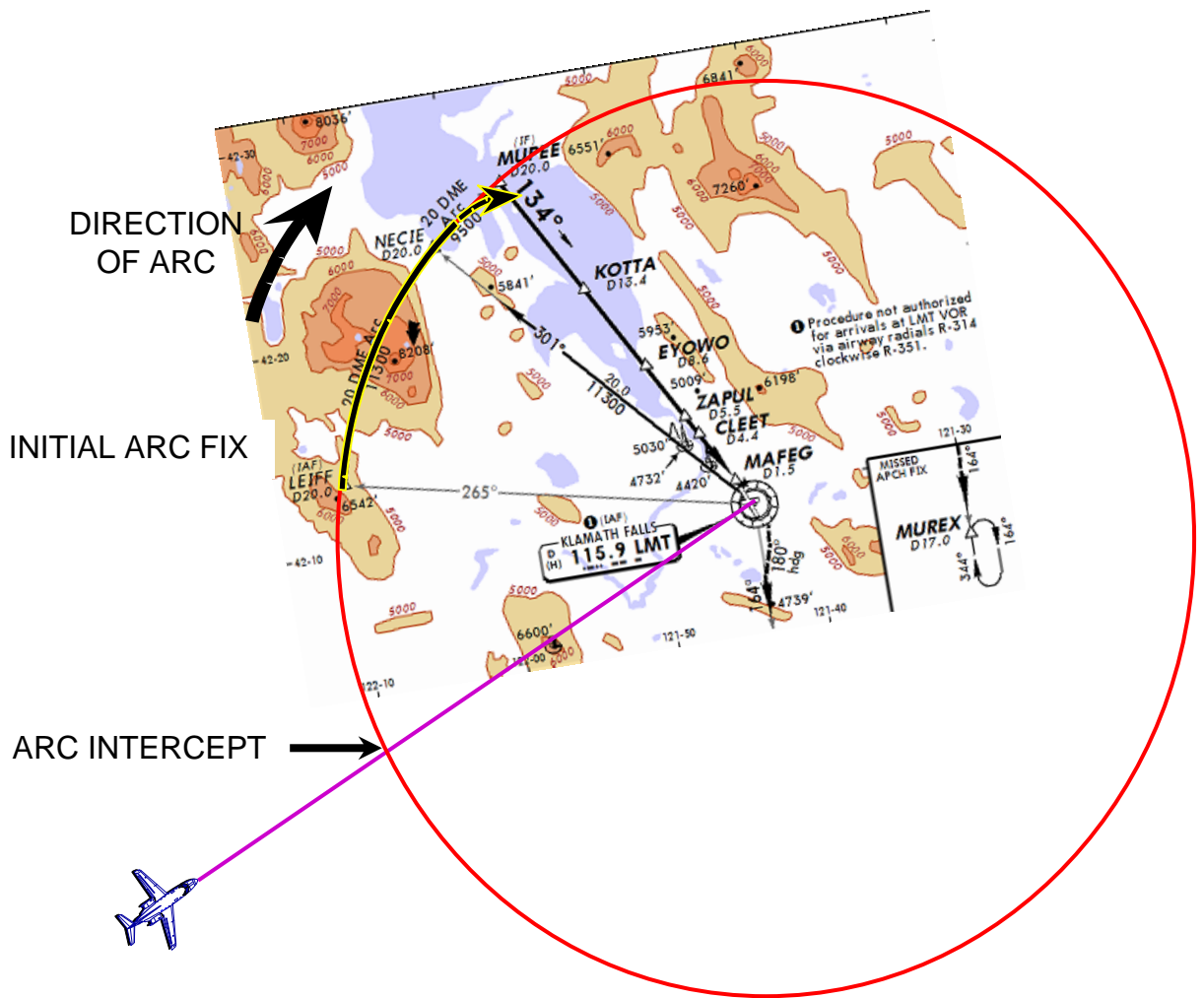


Sequencing onto an arc leg is no different than sequencing onto any other FMS leg. Once established on the arc leg the presentation on the HSI may be different than the conventional method of flying an arc.



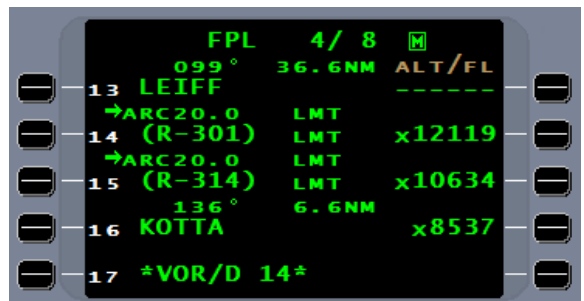
The course arrow will indicate a tangent to the arc and when established will be at the top of the HSI. The CDI will indicate the distance left or right of the arc as it does with a TF or CF leg. As the aircraft flies the arc, the compass rose will rotate indicating a changing aircraft heading. If an FMS bearing pointer is available and selected, it will point to the leg terminator to the arc.



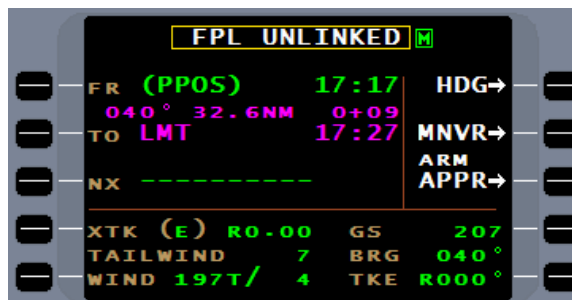


On occasion when flying inbound to a VOR DME a clearance is given to intercept the arc rather than proceeding direct to the initial fix of the arc; then join the approach. By implementing a special procedure, the FMS can intercept an arc while on course to the VOR DME.

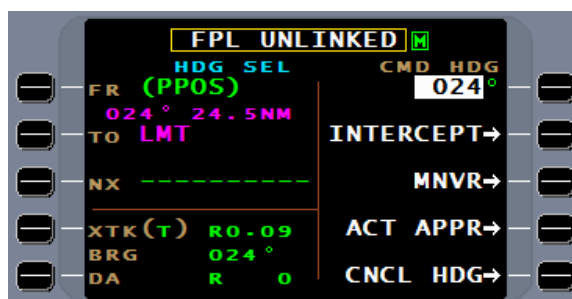
When the approach is identified, insure it's in the flightplan with the arc transition selected.



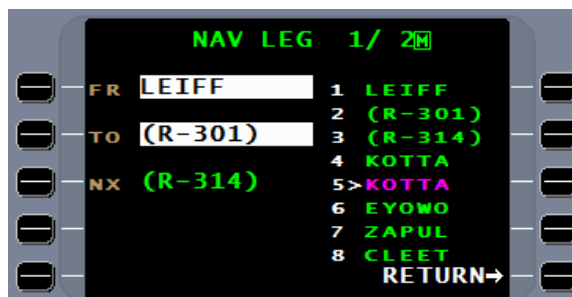
Whether on an airway or direct to the VOR DME, allow the FMS time to zero the crosstrack (**XTK**) and track error (**TKE**). With this accomplished, the FMS heading has compensated for winds and will track to the VOR DME.



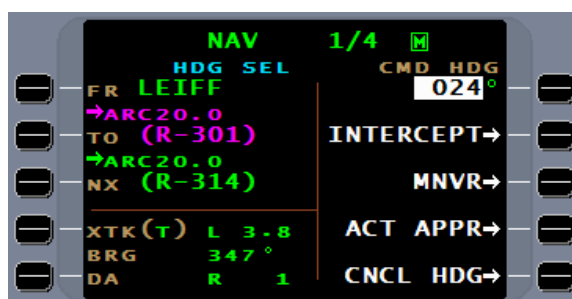
The next step requires understanding that the difference between tracking to the VOR and heading to the VOR is the effect of wind. Now that the FMS has compensated for wind, the FMS can be placed in command heading on the current heading of the aircraft. Select the heading line select key followed by the **ENTER** key. For the short time needed, the FMS will continue towards the VOR DME.



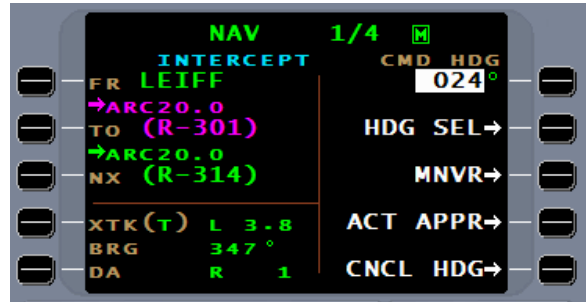
To continue with the procedure requires a manual leg change with the initial arc fix entered as the from (**FR**) waypoint. The sequential waypoint will automatically be entered into the **TO** waypoint. Press **ENTER** to accept this new leg.



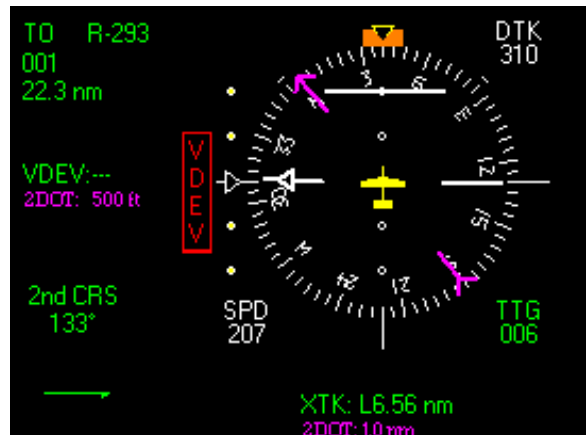
Since the FMS projects the active NAV leg behind the **FR** waypoint and, being that this is an arc leg, the FMS heading function will see an intercept at the point where the projected course to the VOR crosses the projected arc leg.



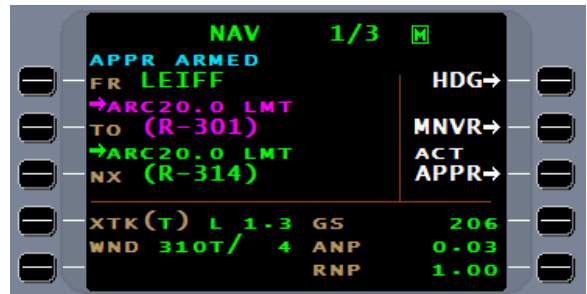
With intercept selected, the FMS will guide the aircraft towards the arc and with a smart turn will intercept the arc. The crosstrack will indicate the aircraft distance from the arc.



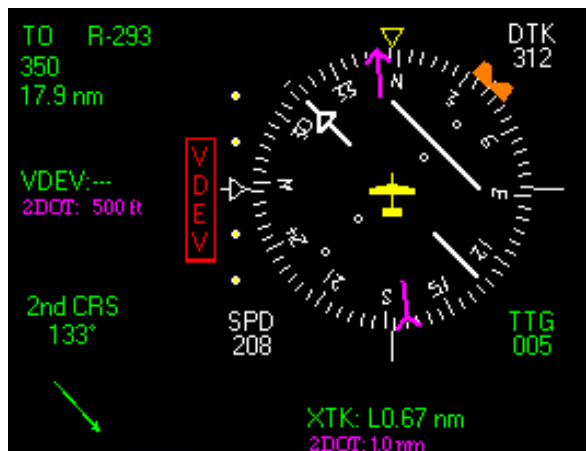
The HSI will present a tangent to the arc. The FMS bearing pointer will point to the waypoint at the end of the arc segment. Distance is line-of-sight to the **TO** waypoint



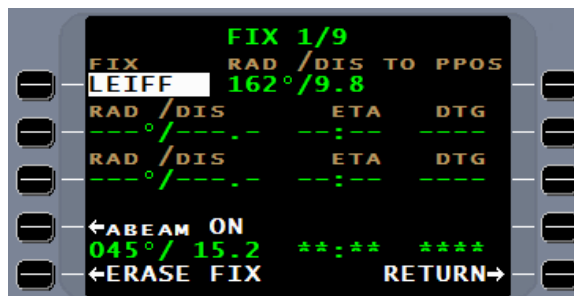
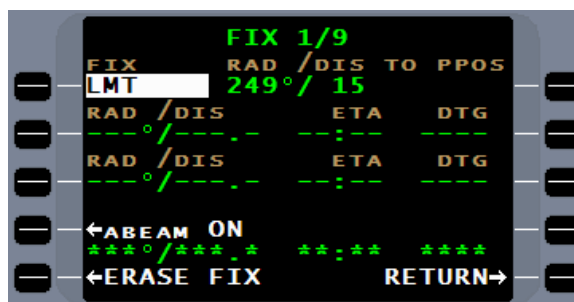
When the FMS captures the arc leg the heading mode will cancel.



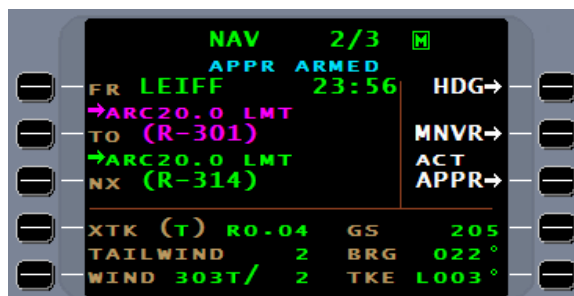
The HSI will turn to orient the course arrow with the direction of flight.



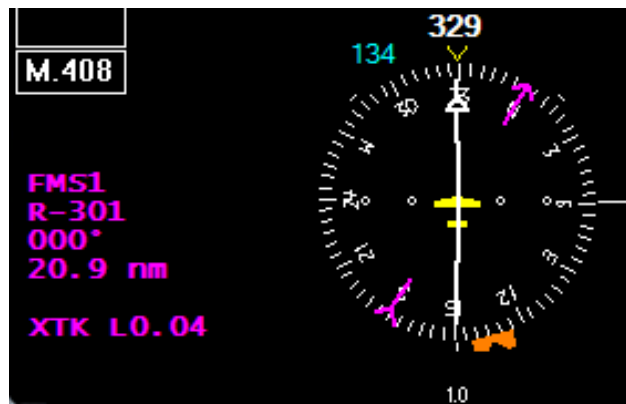
The aircraft cannot leave the last assigned altitude until on a published segment of the arc. For the example approach, this will be when crossing LEIFF, which is on the 265° radial of the LMT VOR. There are three ways to identify when crossing LEIFF. One, and probably the best way, is to use the VOR bearing pointer and when it indicates the 265° radial, the aircraft is at LEIFF. The second way is to use the PFD or MFD map display to identify LEIFF. The third way is to use the FIX tool under the NAV menu. Enter LMT and the dynamically calculated radial of the aircraft relative to LMT will be presented or LIEFF and the distance to LIEFF will be presented.



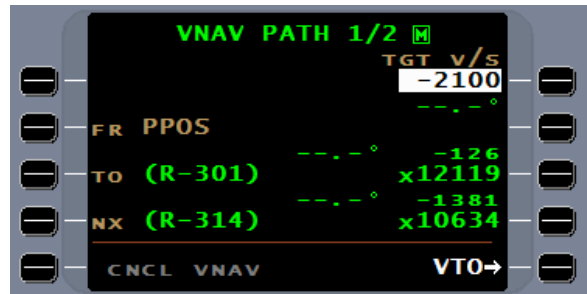
When established on the arc, **XTK** and **TKE** will be close to zero.



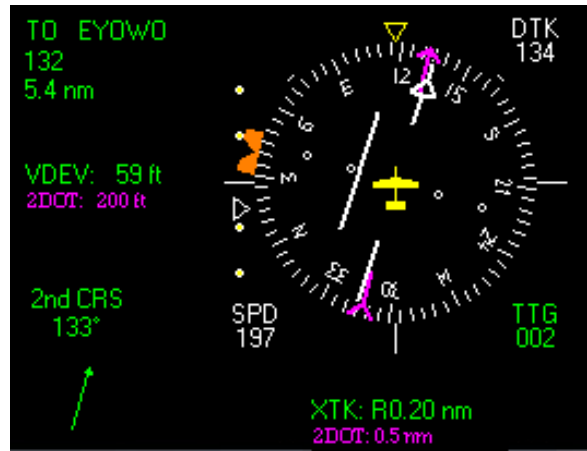
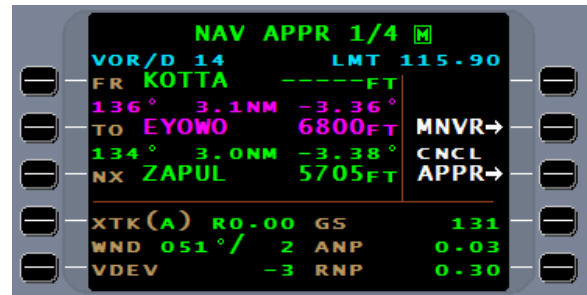
The course arrow will be at the top of the display and the CDI will be centered. Mileage will be line-of-sight to the intersection of the LMT 20DME/301 RADIAL.



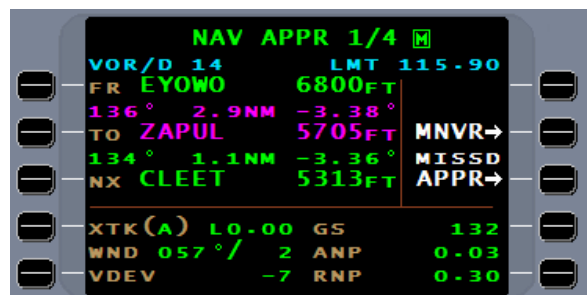
If enroute VNAV is used to descend in the arc, VTO must not be activated until established on a published segment of the approach procedure which will occur upon passing LEIFF intersection.



As the FMS intercepts the inbound course and meets the criteria for approach activation, enroute VNAV will cancel and the FMS will automatically transition into approach VNAV.



The FMS will guide the aircraft towards the runway threshold both laterally and vertically.

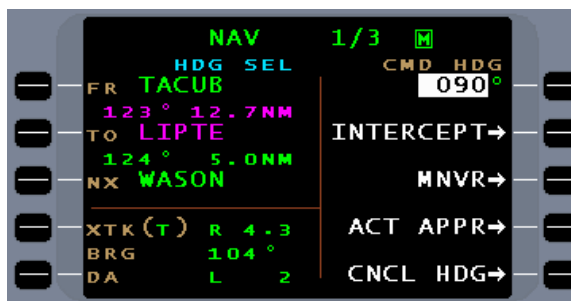


VECTORS TO AN APPROACH TRANSITION LEG

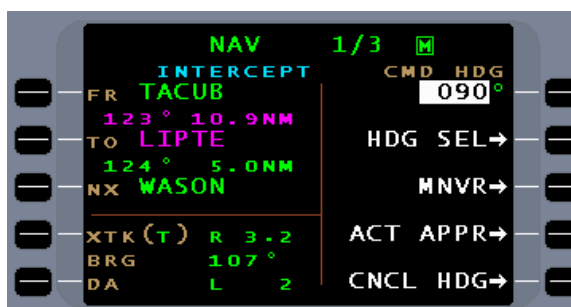
If vectors are given to intercept an approach transition leg, first insure the desired leg is displayed as the "FR" and "TO" waypoints. If necessary, do a manual leg change.



If the heading direction in the CMD HDG field will intercept this leg, an INTERCEPT line select key will be presented.



Press this line select key and the aircraft will intercept this leg and proceed to the TO fix. Remember, even though this is vectors, this is not vectors to the final approach course and automatic approach activation applies. If the given vectors are to intercept the inbound course and the intercept will take place before the course fix associated with the approach label, manually activating the approach is an option. Understand the clearance before activating the approach.

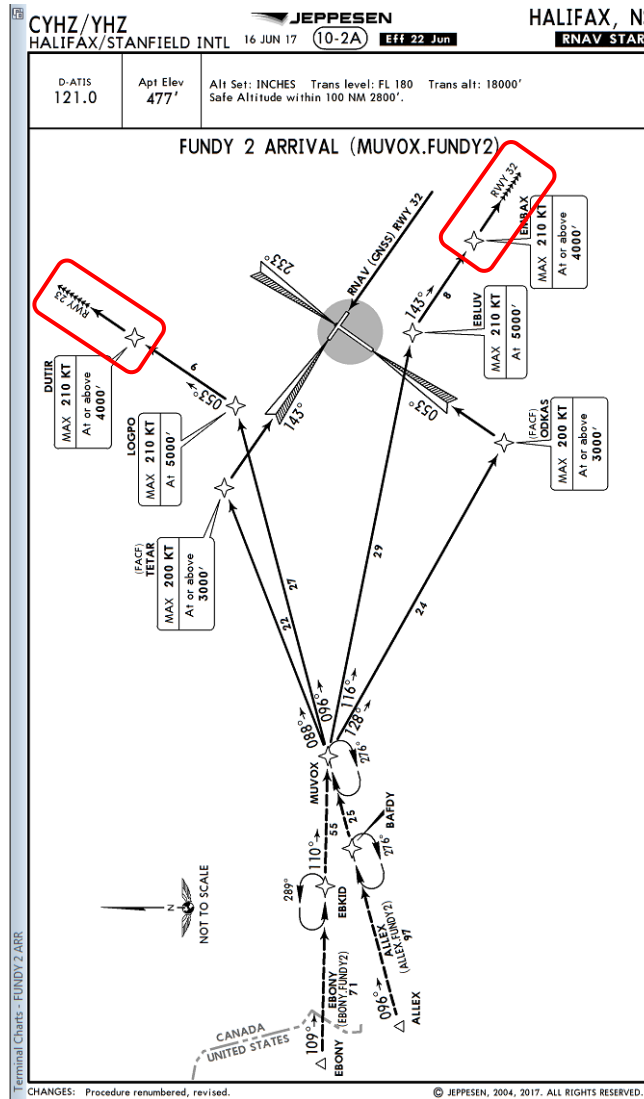


ARRIVALS WITH A VECTOR LEG

ENABLED APPROACHES

Flying arrivals with a vector to manually terminated leg (VM) may require a variation to normal procedures.

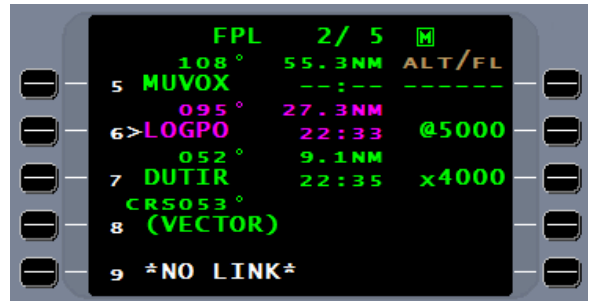
The following arrival is typical of those having a VM leg prior to the final approach course which is usually a course to fix leg (CF). The rectangles identify the VM legs on the chart.



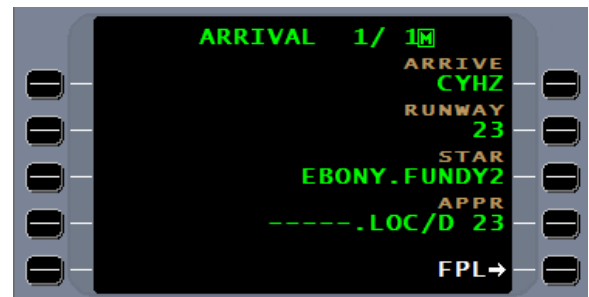
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There several ways to fly this arrival depending on the ATC clearance. The scenario is to an enabled approach, which is flown differently than for an advisory approach.

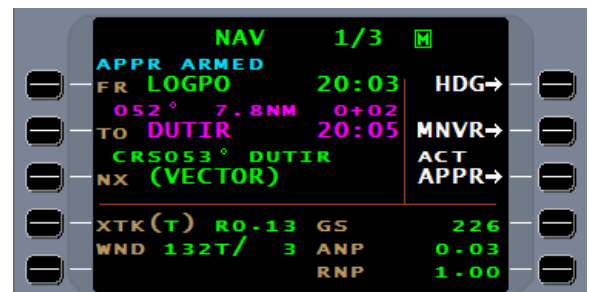
The first arrival scenario is vectors to join the final approach course. The flightplan shows a track to fix leg (TF) preceding the course to manually terminated leg (CM). The NO LINK was created because the FMS is unable to connect this CM leg to the approach.



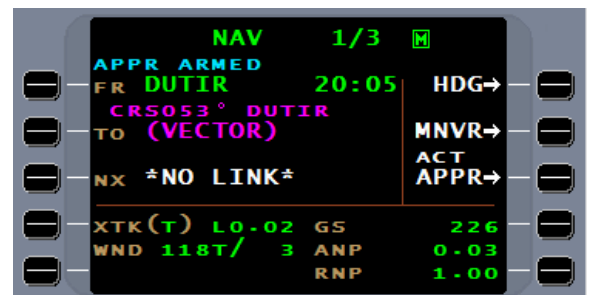
The approach is loaded without a transition.



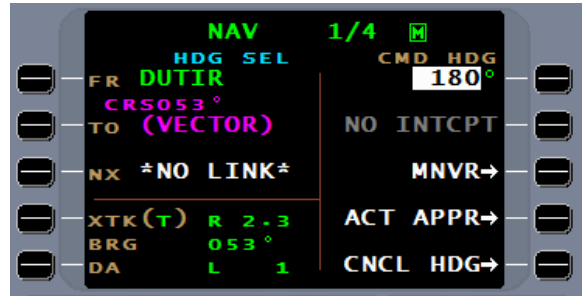
Fly the TF leg as depicted until crossing the TF leg terminator; in this case, **DUTIR**.



Upon sequencing to the CM leg, the FMS will enter a vector leg which will continue the aircraft on a downwind leg.

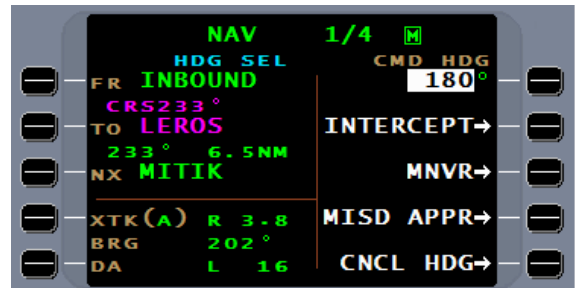


Upon ATC will providing a heading to intercept the final approach course, the Rules of Activation states, when on vectors to the final approach course, activate the approach.

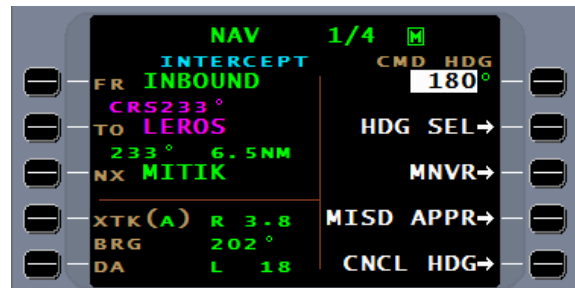


Upon approach activation CMD HDG will provide an INTERCEPT. Set the flight guidance to approach mode and select INTERCEPT.

If using flight guidance heading mode

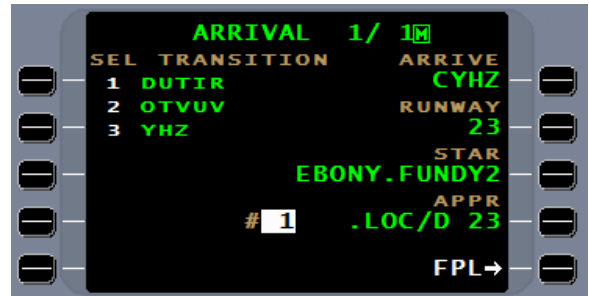


The aircraft will now be in a position to fly the approach.

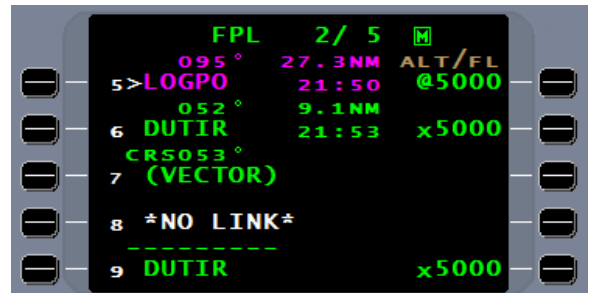


NOTE: It is important that the heading function of the FMS or aircraft be used when on vectors to intercept a course to fix (CF) leg. Allowing the FMS to navigate to a CF leg with its own calculation will result in a turn to intercept of up to 45°.

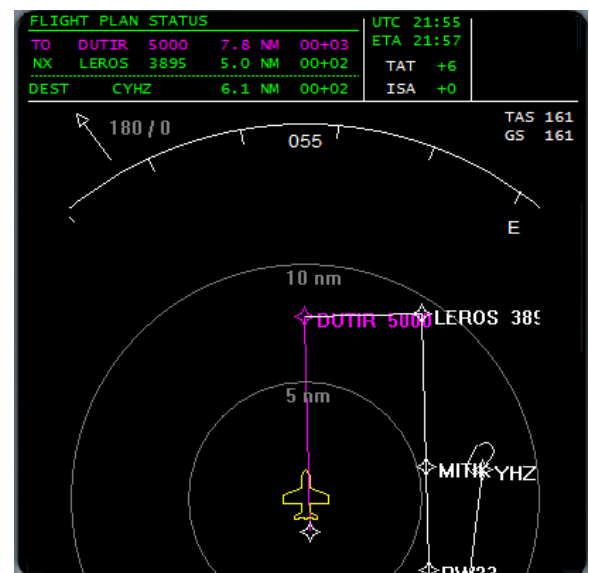
Another way that ATC may give a clearance is to close the approach. To do this will require using the approach transition to link the STAR and the approach.



In most cases this will present a common point to link the two procedures together. In this case, DUTIR.

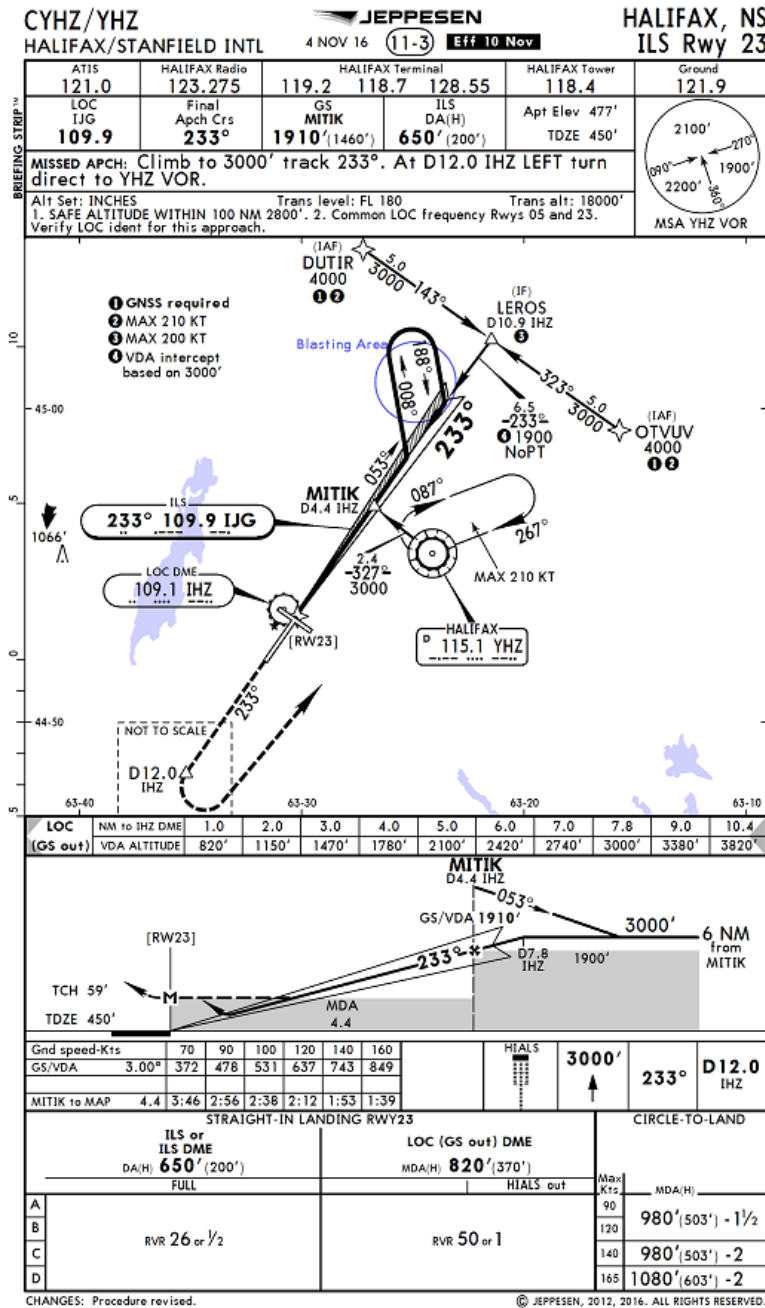


This will provide FMS guidance to the approach segment.



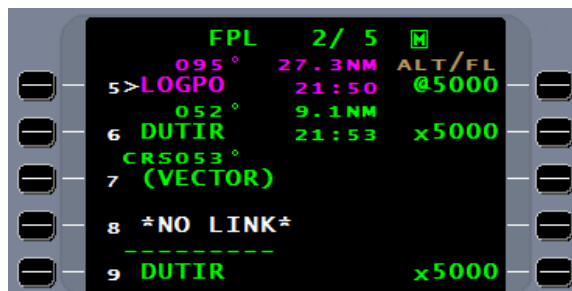
ADVISORY APPROACHES

For navigation to an ILS advisory approach from a STAR with a vector leg may require one of two methods depending on the ATC clearance.



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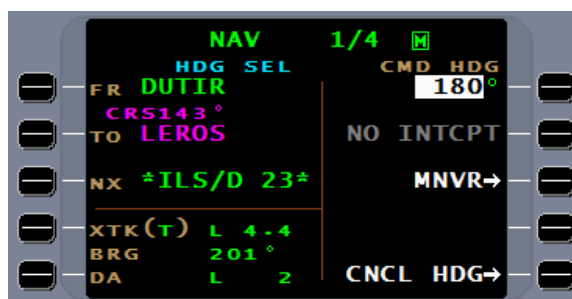
If the approach has a design that would permit closing the approach, linking the STAR to the approach transition as with an enabled approach is the best plan. When established on the inbound course, select VHF navigation for the ILS.



If expecting vectors on an advisory ILS, the pilot already knows that transitioning from FMS navigation to VHF navigation will be required. To allow the FMS to sequence thus providing mapping information and missed approach guidance if needed, the *NO LINK* and the CF leg will need to be deleted.

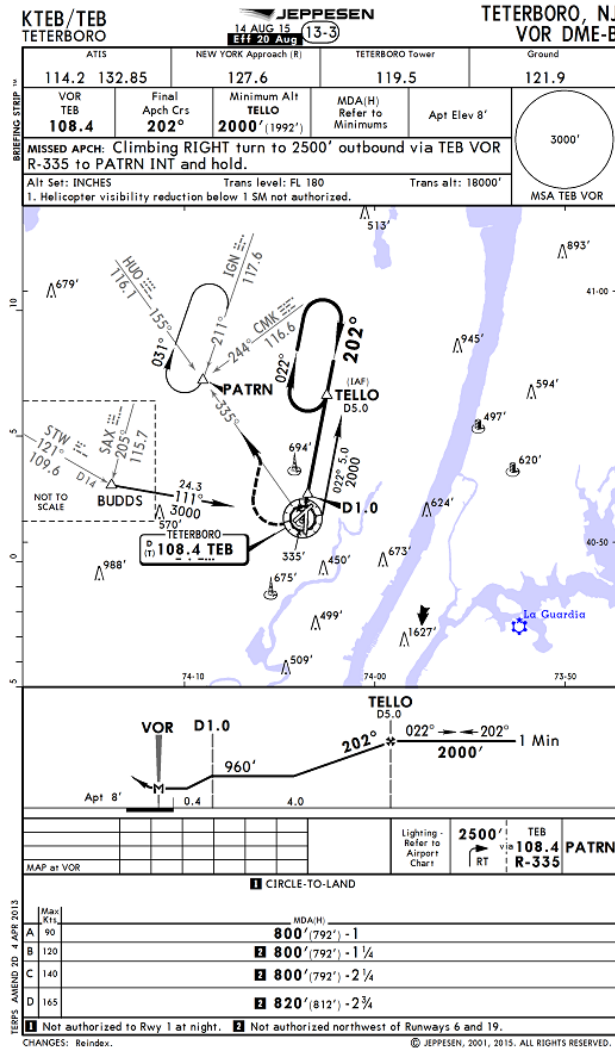


When placed on ATC vector to intercept, at pilots discretion, exiting the FMS and selecting the VHF ILS will be required. The FMS will continue sequencing to provide mapping and missed approach guidance.

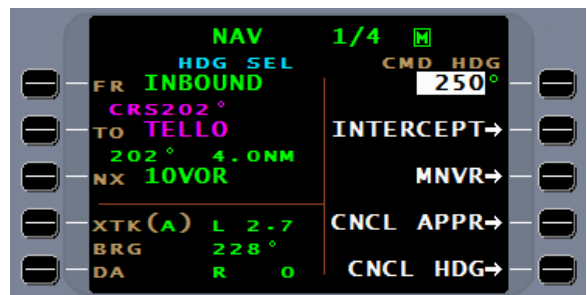


PVOR TO EXTEND AN APPROACH CENTERLINE

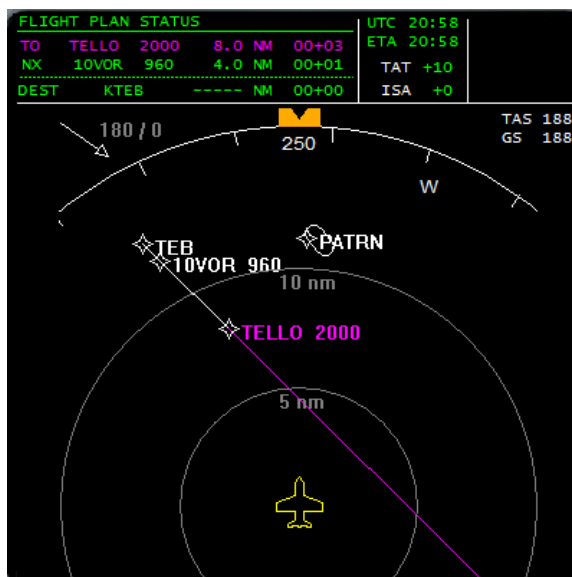
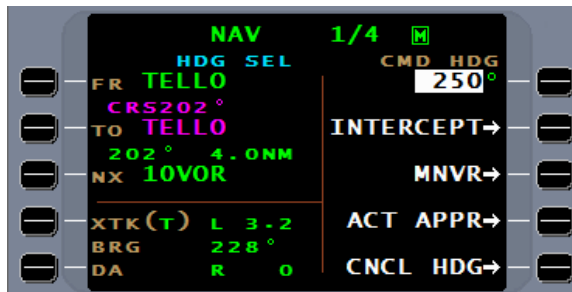
The clearance is to fly the assigned heading and intercept the VOR DME-A final approach course outside WANES intersection. There are three ways to extend this approach inbound course.



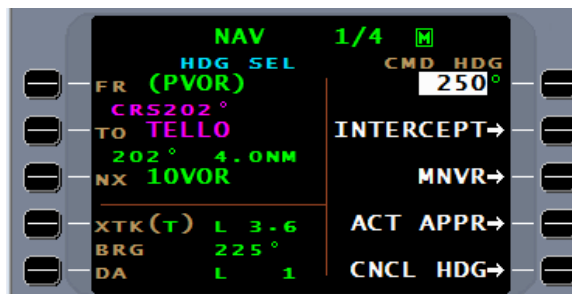
One way is to manually activate the approach. This will extend the inbound course for intercept, but, review of the approach will show a problem in manually activating this approach. The flightplan shows that **TELLO** is associated with the approach label and with manual approach activation, the holding pattern will be eliminated from the NAV page.



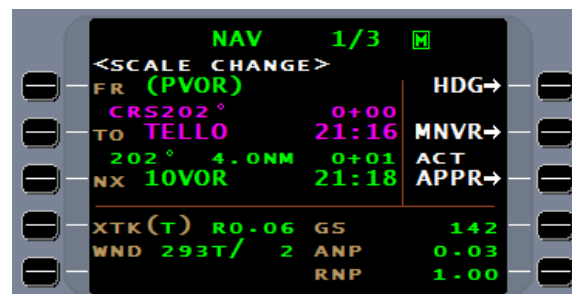
A second method is to do a manual leg change, but this presents a dilemma. There is only TELLO, but TELLO is both the FAF and in the transition, the holding waypoint. The FAF TELLO must be the **TO** waypoint for auto activation to occur, so the answer is to select TELLO the holding waypoint at the **FR** waypoint. The course will now extent behind **TELLO** for intercept.



A different solution is to make **TELLO** a pseudo VOR (PVOR). Entering a track of 202° will result in a radial being extended from **TELLO**. A heading of 250° will intercept the PVOR radial and, by pressing the INTERCEPT line select key, the aircraft will intercept, capture this radial, and fly inbound to **TELLO**.



Since **TELLO** is the FAF approach activation will occur 2nm prior to **TELLO**.



PVOR & THE RUNWAY LIST OPTION

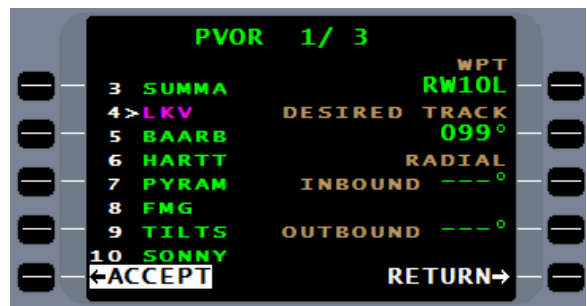
When doing tactical operations such as PVOR, DTO, and HOLD, the LIST function will provide a RWY option.



The RWY option will present the airport identifier and runway. The runway coordinates are that of the runway threshold.

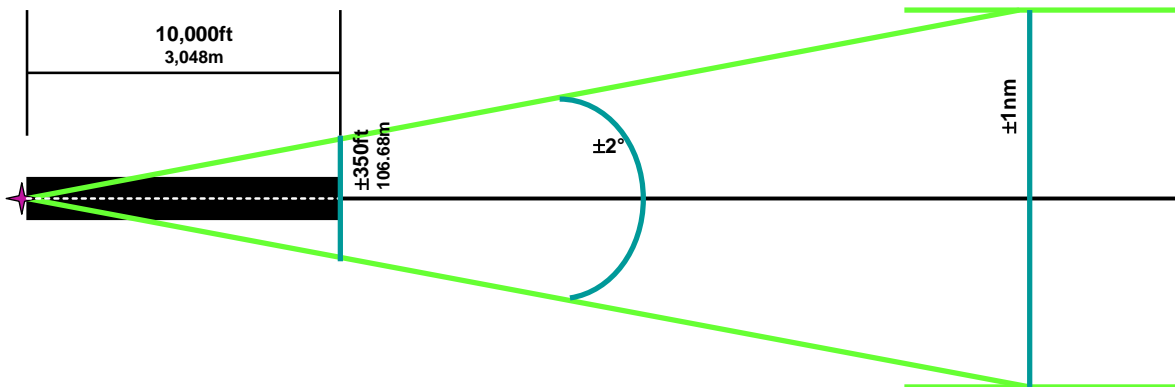


When the RWY option is used with PVOR, the runway heading is automatically entered as the DESIRED TRACK. Accepting this will present, on the NAV page, a PVOR with runway course information.

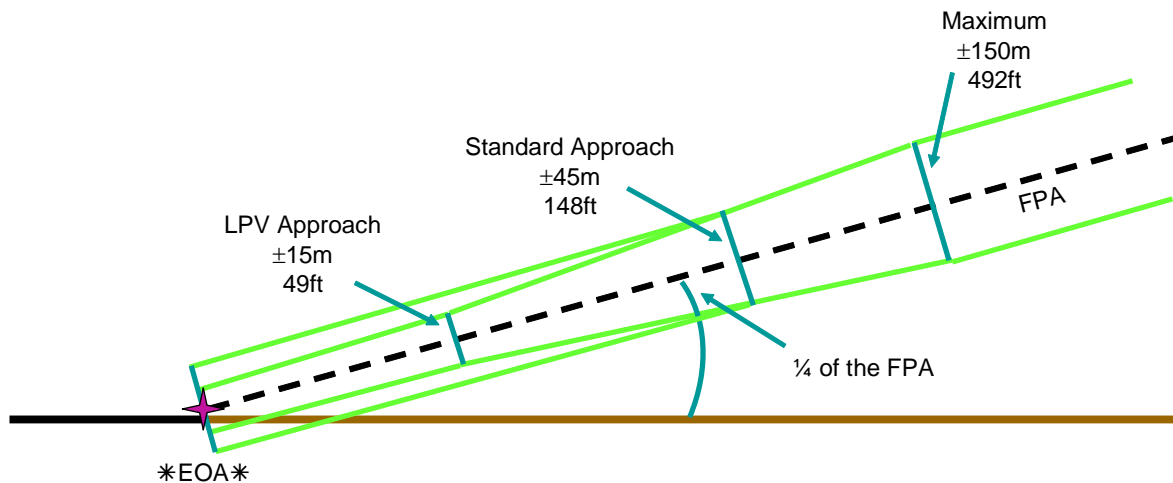


APPROACH LATERAL AND VERTICAL SCALING

Transitioning for lateral scaling occurs when the approach is activated. CDI two dot displacement is based on a $\pm 2^\circ$ angle which at the threshold is ± 350 feet and extends to a maximum of ± 1 nm. When the NAV database contains an RNP value for a specific leg, the FMS will scale the CDI (two dots) to equal the RNP value. If the NAV database contains an RNP for the legs of the final approach segment, the CDI will fly this segment linier rather than angular.



Transition for vertical scaling occurs when approach is activated. VSI two dot displacement will begin at ± 150 m (492ft) and stay linear until reaching an FMS calculated point where the scale changes to angular. On a non-LPV or standard approach the angular scale will decrease to ± 45 m (148ft) then continue linear to the *EOA*. On an LPV approach the angular scale will continue to ± 15 m (49ft) then continue linear to the *EOA*.



FLYING THE ILS APPROACH

The flying of a NAV-to-NAV ILS approach requires advanced avionics to include EFIS, flight director, and autopilot. There are both procedures and techniques to flying the NAV-to-NAV ILS approach.

The FMS is not certified to fly the ILS approach, to do so requires a higher level of certification. It is not permitted to process both the localizer and glideslope to create the three dimensional path, and then send the navigation to the aircraft flight guidance system. In cooperation with some EFIS and autopilots, the FMS will allow for the automatic transfer of navigation control to the aircraft flight guidance for the flying of the ILS final approach segment. To do this requires an advanced autopilot, flight director, and Electronic Flight Instrument Systems (EFIS). Check the aircraft flight manual supplement to determine if your FMS integration is NAV-to-NAV capable.

From a pilot's perspective, the flying of an ILS NAV-to-NAV approach is the same as any other FMS approach with one exception. The exception is the required signal the EFIS gives to the FMS that indicates it's ready to receive the NAV-to-NAV transfer. The signal occurs when the pilot selects approach mode on the flight director. The EFIS will then send communication to the FMS that it is ready for the transfer. When the FMS detects the ILS localizer and has received the transfer ready notification from the EFIS, it will notify the EFIS to assume navigation control of the aircraft. The EFIS will now present navigation commands to the flight director and autopilot.

Following the arming of the approach, the FMS will require that the ILS frequency be tuned and will prompt with the TUNE APPR line select key. If this is not accomplished, further prompting by FMS message will occur.



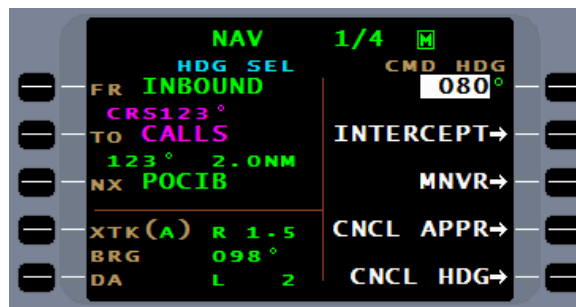
For automatic activation when flying an approach transition, arm the aircraft flight director approach mode prior to the FACF.

As the FMS becomes approach active, it will transfer navigation control to the EFIS.



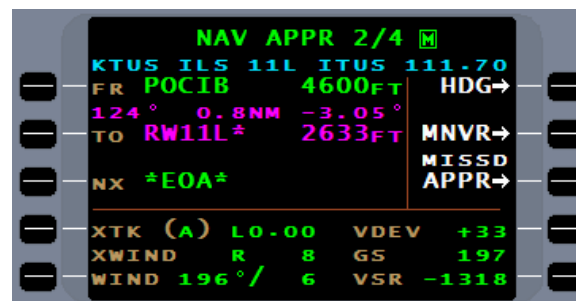
NOTE: Follow automatic approach activation, if the FMS has a slight position error that causes the aircraft to fly parallel to the ILS inbound course without VHF LOC capture, the FMS will advise the pilot with the message "FMS-FLOC DIFF WARN". The pilot should use FMS HDG mode to steer the aircraft to intercept the ILS.

When on vectors to the final approach course, manual activation of the approach is required. Follow the rule that first requires using the FMS heading mode to place the aircraft on the assigned heading, and then activate the approach. Follow ATC vectors to the intercept leg. When the FMS presents a heading intercept line select key, first arm the aircraft flight director approach mode, then press the FMS intercept line select key.



NOTE: It is extremely important that flight director approach mode be armed before pressing the FMS intercept line select key. On some configurations the navigation transfer may not take place if this sequence is not followed and the aircraft will fly through the ILS final approach course.

The ILS missed approach will operate the same as any other FMS approach. Selecting the FMS MISSED APPR line select key either directly or remotely through the aircraft go-around system will result in the FMS regaining navigational control of the aircraft and following the missed approach procedure.



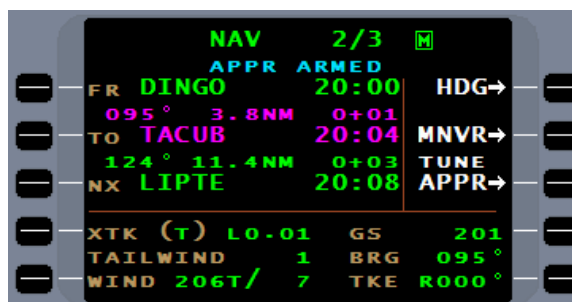
As with all missed approaches, if the pilot uses the aircraft go-around system, the aircraft pitch up, wings level command will come from the aircraft flight director. The FMS will not provide any vertical guidance during missed approach. To reconnect the flight director to the FMS, flight director NAV mode must be selected.

At some airports ATC guidance will direct the aircraft to intercept and proceed inbound on the localizer without clearance to fly the approach. Retaining the aircraft flight director approach mode will result in capture of the glideslope when clearance to do so was not given. A technique to accomplish this is as follows. Select the aircraft flight director approach mode to transfer navigational control to the EFIS. Once the transfer is complete, reselect NAV mode on the aircraft flight director. Once transfer to the EFIS is made, the FMS will not retake navigational control until a missed approach is executed. The aircraft will now follow the localizer without capturing the glideslope. When cleared for the approach, select aircraft flight director approach mode to capture the glideslope upon intercept.

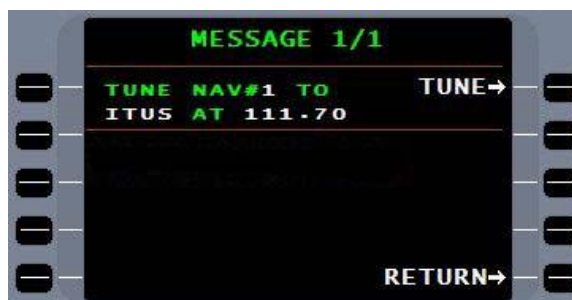
FLYING THE LOCALIZER AND BACKCOURSE APPROACH

Both the localizer and back course approaches are flown with the FMS providing navigational control throughout the entire approach. The FMS must have VHF NAV radio input for reception of the localizer. The FMS will identify the line over the ground created by the localizer and be able to follow it. This, however, will not allow the FMS to identify the final approach fix and missed approach point. The FMS will use GNSS/GPS to identify the Lat/Long of the FAF and MAP, therefore, the approach must be surveyed IAW WGS-84. This is also the reason the LOC and BC approaches will be followed on the arrival page with a “G”.

Following the arming of the approach, the FMS will require that the ILS frequency be tuned and will prompt with the TUNE APPR line select key.



If this is not accomplished, further prompting by FMS message will occur. Failure to tune the VHF radio to the required frequency will result in the FMS being unable to fly the approach with flagging of the NAV display on the Primary Flight Display (PFD).

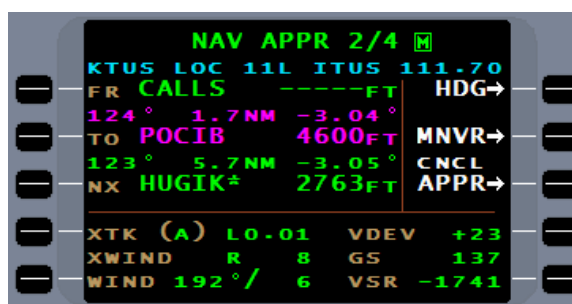


Upon going approach active and the VHF localizer acquired, the FMS will push a message “LOC STEERING ACTIVE” to verify the localizer is the guidance for course steering. NAV mapping will change to display VHF course guidance.

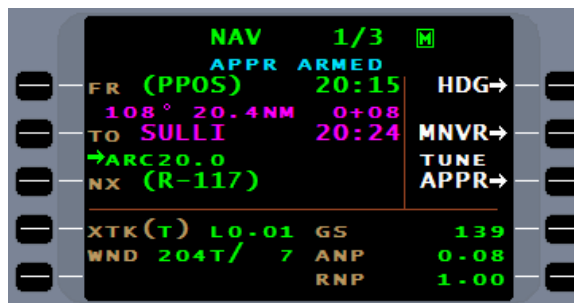


In addition to lateral navigation with the use of the localizer, vertical navigation is available with a barometric glidepath for a three dimensional approach.

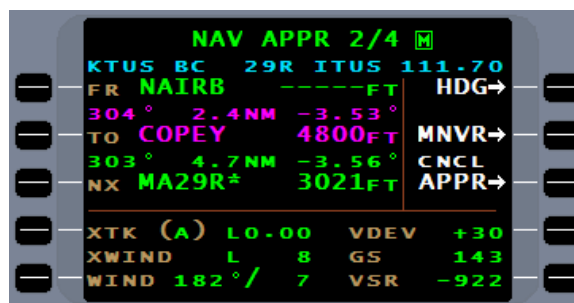
If the localizer approach meets the criteria for a glidepath, the approach will contain a baro VNAV glidepath. Check the approach plan on flightplan menu page 2 for glidepath availability.



Following the arming of the backcourse approach, the FMS will require that the localizer frequency for the back course approach be tuned and will prompt with the TUNE APPR line select key. If this is not accomplished, further prompting by FMS message will occur.



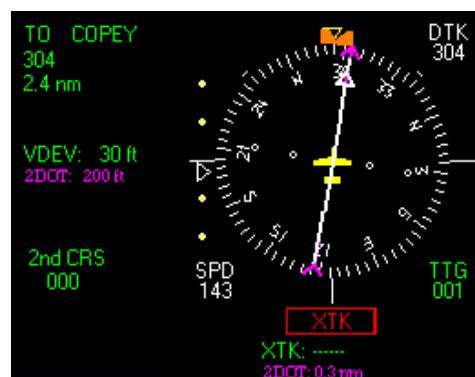
The FMS will present both lateral and vertical guidance for the backcourse approach the same as a localizer approach.



Upon going approach active and the VHF localizer acquired, the FMS will push a message “LOC STEERING ACTIVE” to verify the localizer is the guidance for course steering. NAV mapping will change to display VHF course guidance



The difference between a conventional back course approach and an FMS flown back course approach is the course arrow will point to the landing runway of the back course approach and the pressing of the aircraft flight director BC switch for most aircraft is not required.



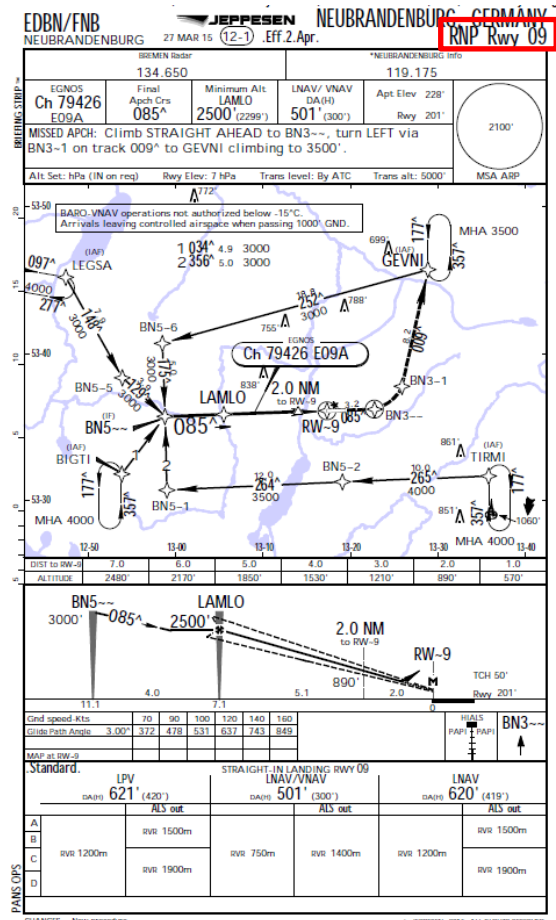
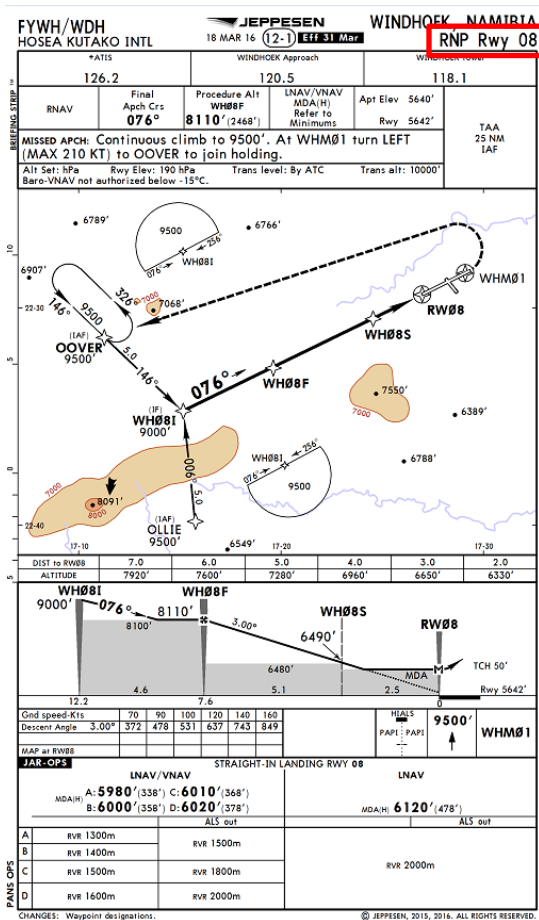
If the backcourse approach meets the criteria for a glidepath, the approach will contain a baro VNAV glidepath. Check the approach plan on flightplan menu page 2 for glidepath availability.

PERFORMANCE BASED NAVIGATION

REQUIRED NAVIGATION PERFORMANCE (RNP) APPROACHES

ICAO has proposed implementation of Performance Based Navigation (PBN) IAW ICAO DOC 9613. This document defines Performance Based Navigation, Area Navigation (RNAV), and Required Navigation Performance (RNP). As a result of decisions made in the industry in the 1990s, most modern RNAV systems provide on-board performance **monitoring and alerting**, therefore, by ICAO definition, the navigation specifications developed for use by these systems can be designated as RNP. ICAO proposes that the current RNAV procedures be re-designated RNP.

Many countries have started replacing RNAV procedure names with RNP. Currently UASC FMS software does not recognize this procedure name. To continue to fly these procedures the name RNP will be replaced with RNAV as the database goes through NAV database processing. Use of the name RNP will be addressed in future FMS software.

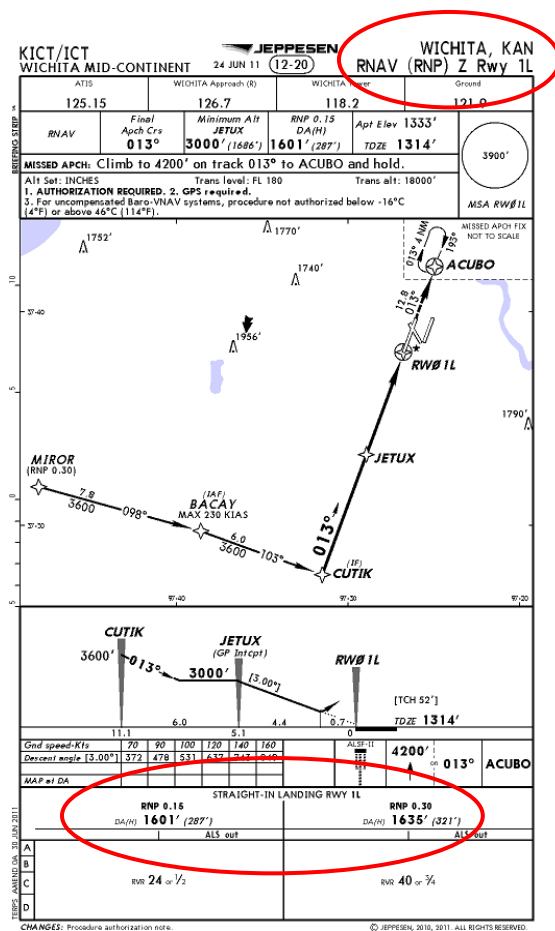
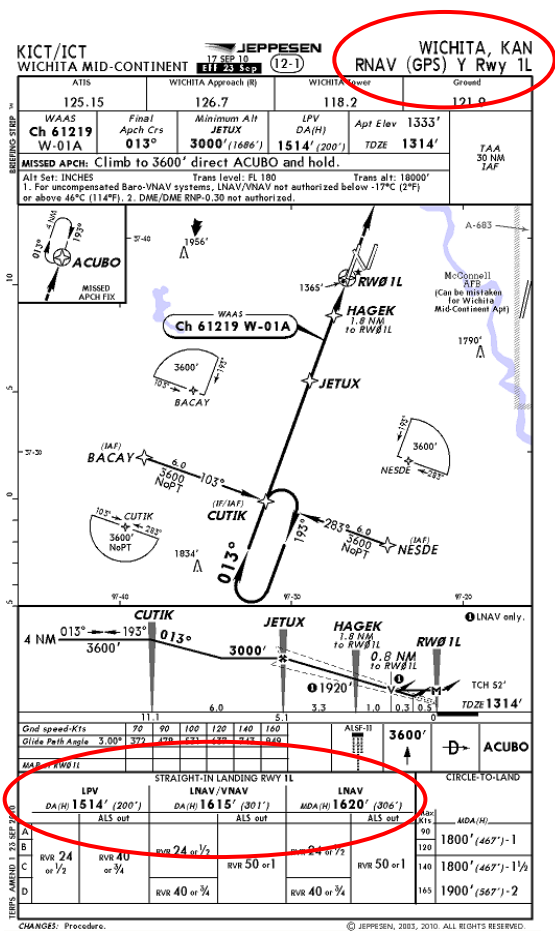


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FLYING THE RNAV APPROACH

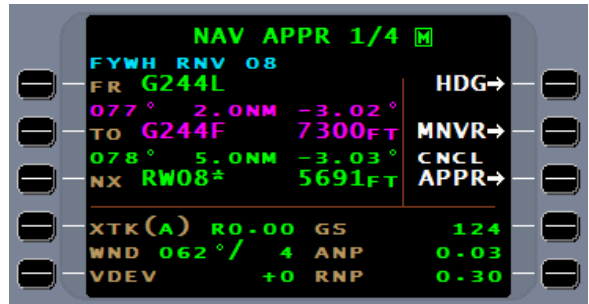
RNAV (GPS)

RNAV (GPS) approaches, originally named RNAV, were created in February 2000 to allow a multi sensor FMS the ability to fly approaches using GPS, DME-DME, or any NAV sensor or combination of NAV sensors capable of meeting RNP 0.3 to fly to LNAV/VNAV or LNAV minima. Due to a problem with implementation, the use of these approaches were withdrawn and re-released in February of 2001 as RNAV (GPS). RNAV (GPS) can be flown under GPS/SBAS approach certification or RNP certification IAW AC 90-101(). RNAV (RNP) approaches came later with the release of AC 90-101(). Most aircraft fall under the GPS or SBAS certification. Notes on the approach plate such as "DME/DME RNP 0.3 not authorized" do not apply to aircraft flying under GPS/SBAS approach certification. DME/DME is retained by the FMS, but GNSS/GPS/SBAS is required for the approach. Since the release of RNAV (GPS) approaches and RNAV (RNP) approach types are gathered under the RNAV umbrella. RNAV approaches are further being separated by the use of the letters "Y" and "Z". These letters are used to differentiate between two RNAV approaches that go to the same runway. RNAV (RNP) approaches are covered later.

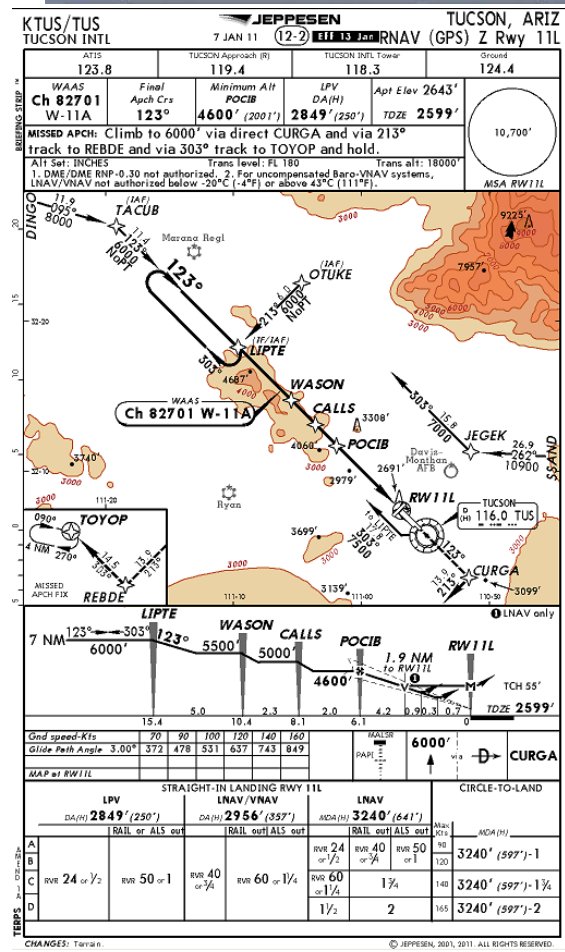
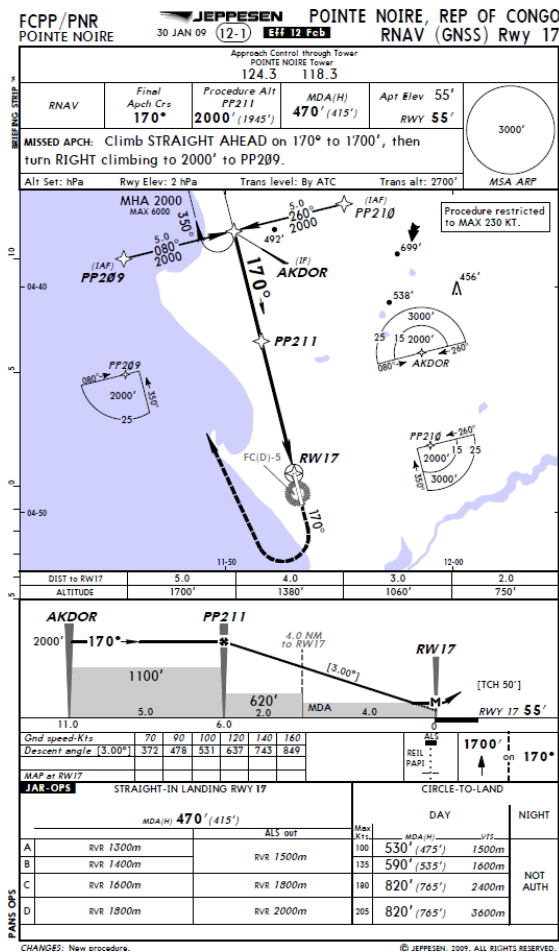


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When approach active, SCN 100X, will state either RNP 0.3 on NAV page 1 for non-Level of Service (LOS) approaches or...

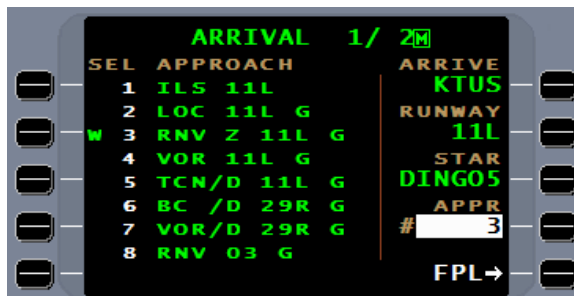


...HP/VP for Level of Service approaches.



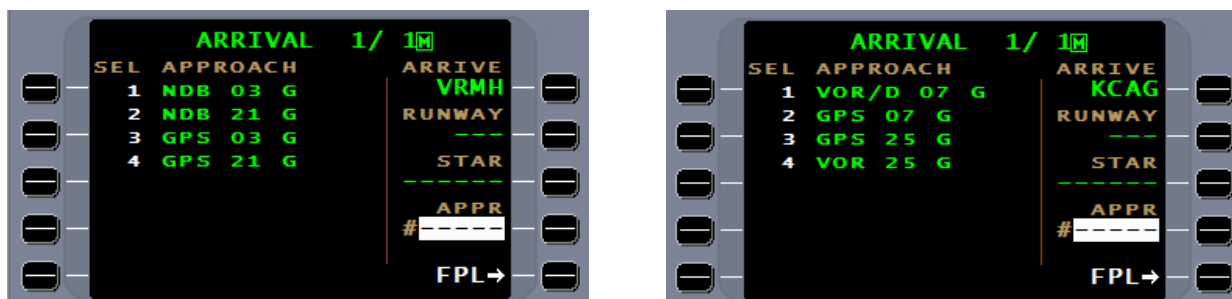
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RNAV approaches are separated from standalone GPS approaches and are listed as “RNV” on the arrival page.



KCAG/CIG -MOFFAT	JEPPESSEN 8 MAY 15 (18-2)	CRAIG, COLO GPS Rwy 25
VRMH/HAQ HANIMAADHOO	JEPPESSEN HANIMAADHOO ISLAND, MALDIVES 2 JUL 10 (18-1) CAT A & B	GPS Rwy 03

Whereas, standalone GPS approaches are listed as “GPS” on the arrival page.



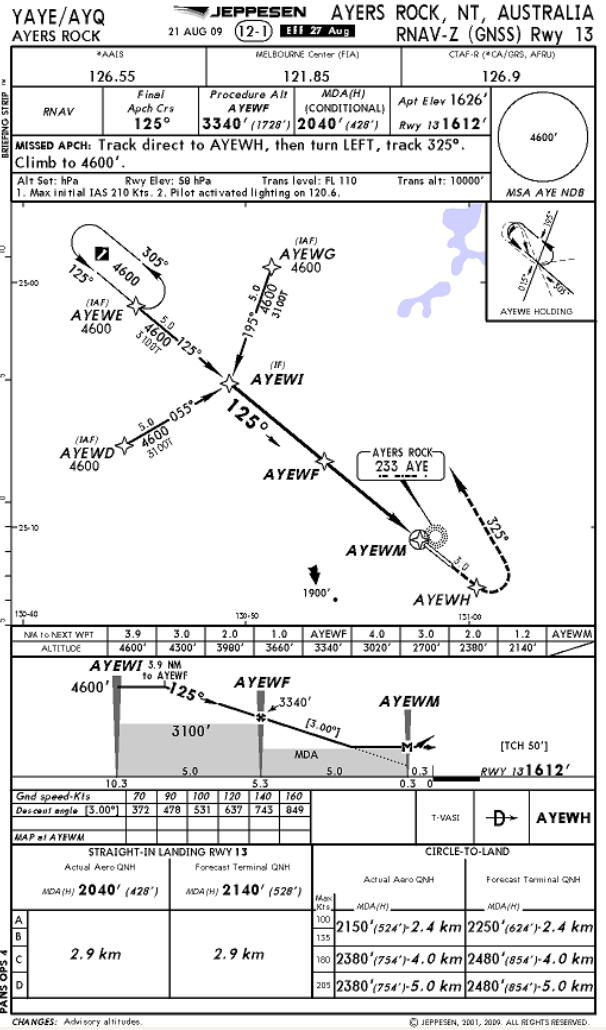
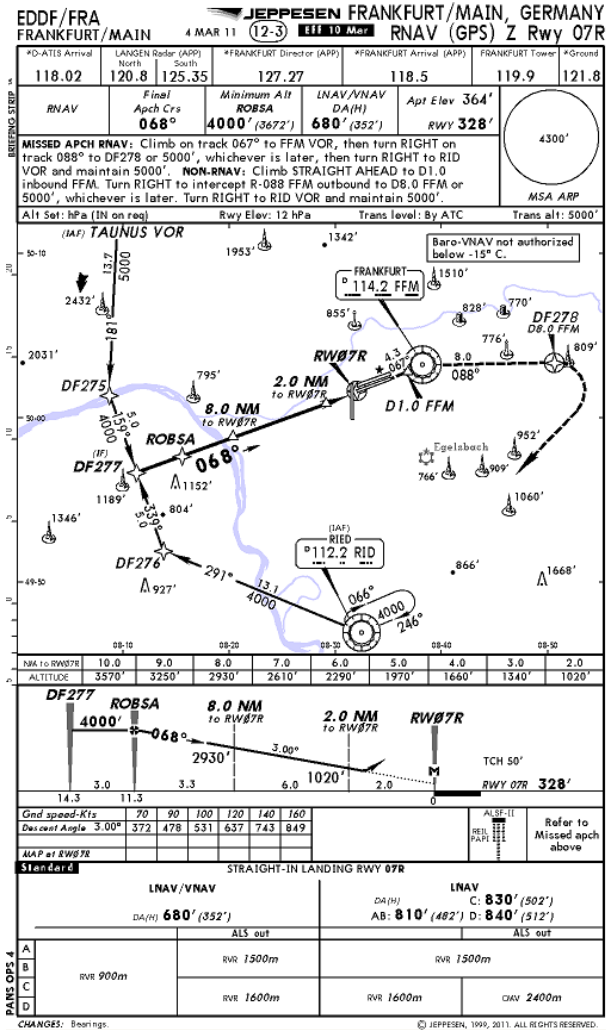
The approach minimums are in three categories LPV (Localizer Precision with Vertical Guidance, LNAV/VNAV (Lateral Navigation/Vertical Navigation), and LNAV (Lateral Navigation only). The LPV approach minima require Satellite Based Augmentation System (SBAS).

The LPV and LNAV/VNAV minimums use a DA (Decision Altitude) for vertical navigation approved FMS installations. In other non-precision approaches, where vertical navigation is available through the FMS, the pilot must still observe the MDA (Minimum Descent Altitude).

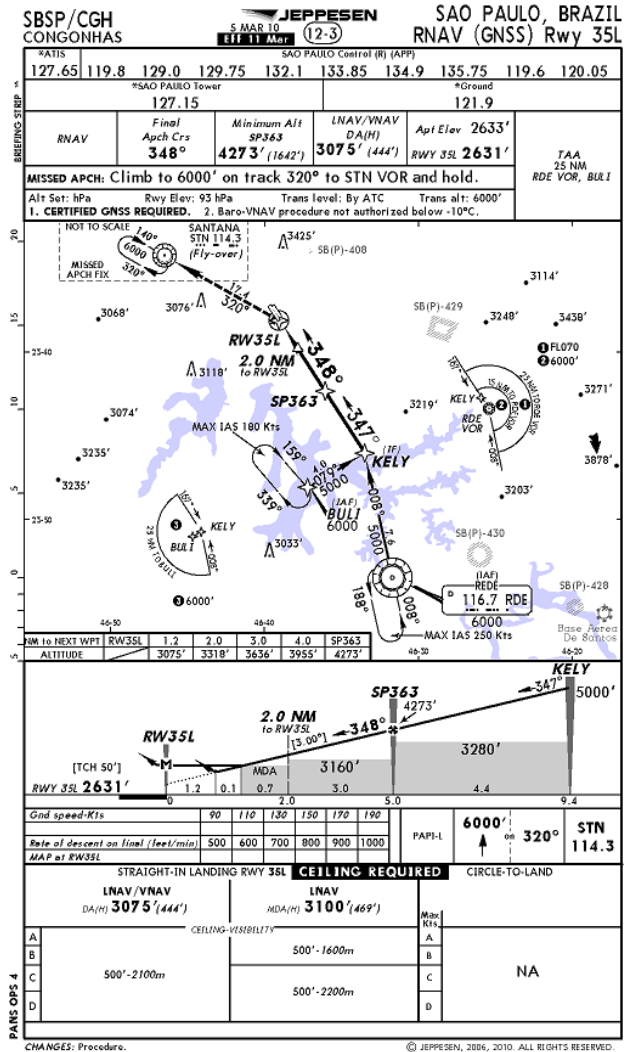
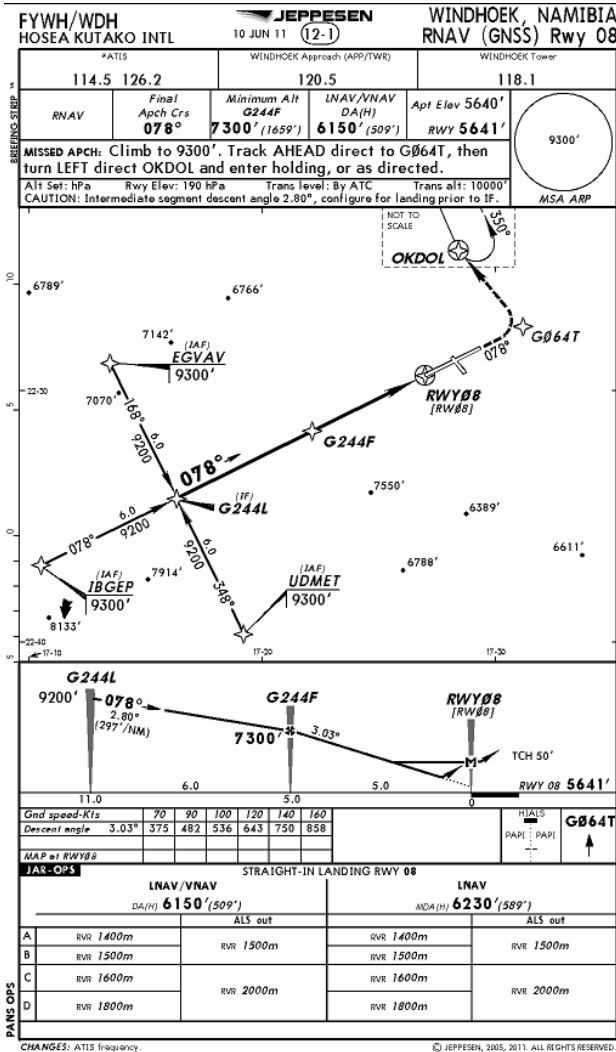
LNAV minimums are based on no vertical navigation being available or noncompliance with AC 90-105. This approach will be flown as any non-precision approach where the pilot controls the vertical descent. Where advisory glidepath information is available, the pilot may follow it to the LNAV MDA.

		STRAIGHT-IN LANDING RWY 17L						CIRCLE-TO-LAND	
		LPV DA(H) 1486' (200')		LNAV/VNAV DA(H) 1610' (324')			LNAV MDA(H) 1800' (514')		Max Kts
		RAIL or ALS out	RAIL out	ALS out	RAIL out	ALS out			
TERMS	A				RVR 24	RVR 40	RVR 50	90	1800' (505')-1
	B				or 1/2	or 3/4	or 1	120	
	C	RVR 24 or 1/2	RVR 40 or 3/4		RVR 50 or 1		1 1/2	140	1800' (505')-1 1/2
	D			RVR 40 or 3/4	RVR 50 or 1	RVR 60 or 1 1/4	1 3/4	165	1860' (565')-2

The RNAV (GPS) approach format is used internationally and examples are provided below. Some charts use (GPS) and some use (GNSS), but the formats are all very similar.



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NOTE: In SCN 100X, standalone GPS approaches, although slowly being phased out, are flown in the same manner as non-SBAS RNAV (GPS) approach.

If the RNAV (GPS) approach meets the criteria for a glidepath, the approach will contain a VNAV glidepath. Check the approach plan on flightplan menu page 2 for glidepath availability.

FLYING AN RNAV (GPS) APPROACH WITH SBAS

The North American version of the Satellite Based Augmentation System (SBAS) is the Wide Area Augmentation System (WAAS). RNAV (GPS) approaches in the approach database contain the required information to provide the FMS with the necessary lateral and vertical navigational accuracy to allow the aircraft to fly to Localizer Performance with Vertical Guidance (LPV) minima. This requires SBAS. To achieve SBAS accuracy the aircraft must be within an SBAS coverage area and receive a geo satellite which provides the SBAS data.

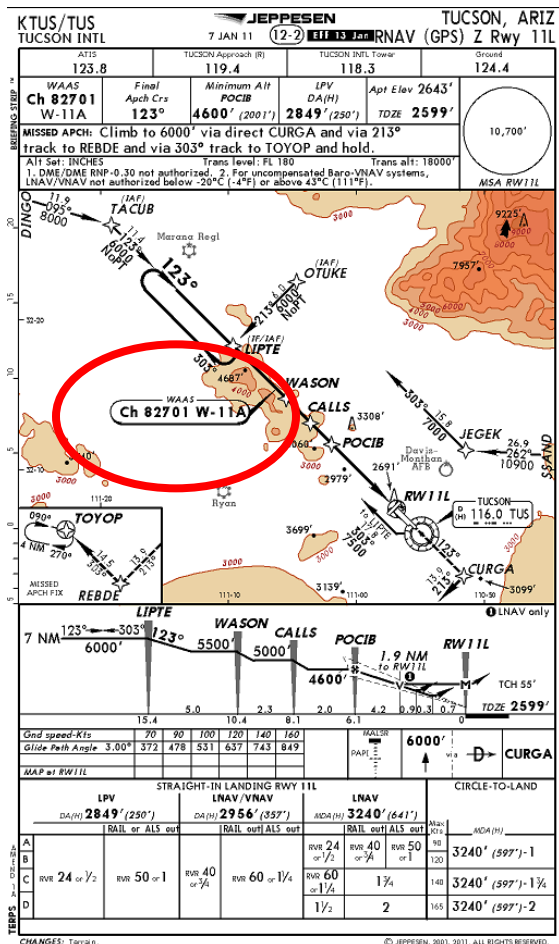
The specific information in the database is the Final Approach Segment Data Block (FAS DB). The FAS DB contains approach specific information that allows the FMS to meet the requirements necessary to fly to the LPV minima. Presentation of the channel ID is an indication that a FAS DB is in the FMS database.

Without the FAS DB, flying to the LPV minima is not permitted, but if the RNAV (GPS) approach contains ellipsoid altitude information, the FMS can still use SBAS navigation for lateral and vertical navigation. This will allow the aircraft to descend to LNAV/VNAV minima. The glideslope provided by the FMS will still be based on SBAS.

The SBAS glideslope begins at the FAF and continues to the runway threshold at the threshold crossing height. Baro-VNAV is used prior to the FAF. Just prior to the FAF the final Level Of Service (LOS) is determined with approach LOS being set. If SBAS does not meet the required tolerances for VNAV at the FAF, the LOS will be downgraded to LNAV and VNAV will be flagged.

When the approach database does not contain the required data for LPV or LNAV/VNAV, but the aircraft is still in the SBAS coverage area, the FMS will use SBAS for lateral guidance and baro-VNAV for vertical guidance. The pilot may still descend to LNAV/VNAV minima if the aircraft meets the criteria of AC 90-105 for the use of baro-VNAV to fly to a decision altitude (DA).

Where SBAS is unavailable for approach navigation the SBAS/GPS sensor will revert to basic GPS. Baro-VNAV will be used for vertical navigation. No level of service will be presented if the approach does not lie within an SBAS coverage area or a geo satellite is not received.



RELIABILITY REQUIREMENTS FOR APPROACHES TO LPV AND LP MINIMA

To meet the FAA's requirements for reliability when flying an SBAS approach to LPV minima requires either a dual FMS installation or a single FMS and a second SBAS monitor.



Single FMS and Monitor



A Dual 1Ew/1Espw or 1Fw

Although it is preferable in a dual FMS installation that both FMS indicate the same LOS, it is acceptable to use LPV minima if one FMS indicates LPV and the other indicates LNAV/VNAV. The FMS with the higher LOS must be used for navigating the approach.

FAA OPERATIONAL CHANGES

Unlike TSO-C129 avionics, which were certified as a supplement to other means of navigation, SBAS avionics are evaluated without reliance on other navigation systems. As such, installation of SBAS avionics does not require the aircraft to have other equipment appropriate to the route to be flown [IAW AIM 1-1-20c7]. In addition, the FAA allows for a WAAS/GPS based approach to be used to meet alternate airport requirements [IAW AIM 1-1-20c7(a)].

If on the **ARRIVAL** page approach list the approach is preceded with the letter “W”, SCN 1000/1100 the approach database will contain the required information to fly to LPV minima. In SCN 1001/1101 and subsequent the “W” was removed from the arrival page.



When the approach is armed, the predicted Level Of Service (LOS) is presented in the upper right corner of **NAV** pages 1 & 2 and on annunciator panel. If the LOS changes prior to approach activation, at activation the FMS will change the LOS and push a message indicating change of LOS. The pilot may manually downgrade the LOS on the RNAV APPR LOS page by way of the APPR LOS line select key. A selection of a new LOS must be accomplished prior to the FAF. After sequencing of the FAF, LOS cannot be changed.



When the SBAS approach is active, the NAV page displays the Horizontal Protection Level (HPL or HP) and Vertical Protection Level (VPL or VP) in place of ANP/RNP. These are analogous to the Actual Navigation Performance (ANP). The HPL and VPL are compared to the Horizontal Alert Level and Vertical Alert Level (displayed after the slash) which is analogous to the Required Navigation Performance (RNP). Although the Vertical Protection Level (VPL or VP) is displayed after approach activation, the Vertical Alert Level is not displayed until sequencing the FAF.



When crossing the FAF, if all requirements remain satisfactory the approach continues with both LNAV and VNAV provided by SBAS. If SBAS requirements for VNAV fail at the FAF, the FMS will flag VNAV. In this case no FMS vertical navigation will be supplied and LNAV will be the only choice on the Level Of Service (LOS) page.



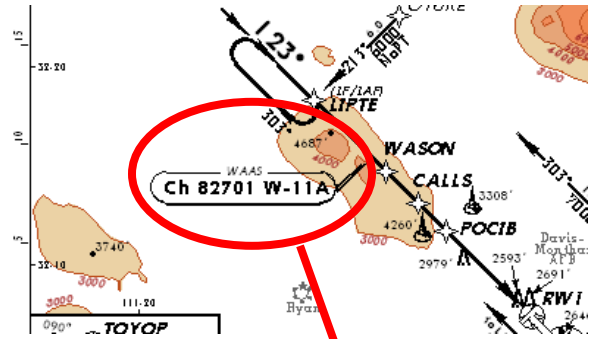
Pressing the APPR LOS line select key on the NAV APPR page accesses the RNAV APPR LOS page. When the approach is armed, the FMS automatically predicts and selects the highest LOS for the selected approach. The pilot can select a lower level of LOS if desired. Only during approach arming and activation does the FMS automatically select LOS; the LOS is not dynamically updated during the approach. Final LOS determination is accomplished at FAF sequencing. In SCN 1000.5 a REFRESH option was added enabling the pilot to have the FMS run a new prediction if the first was less than desired.



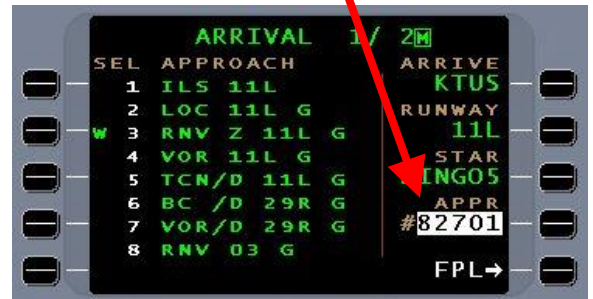
Levels of Service annunciators are added to the aircraft instrument panel or in the EFIS display if supported.



There are provisions for entering the channel ID directly in the FMS

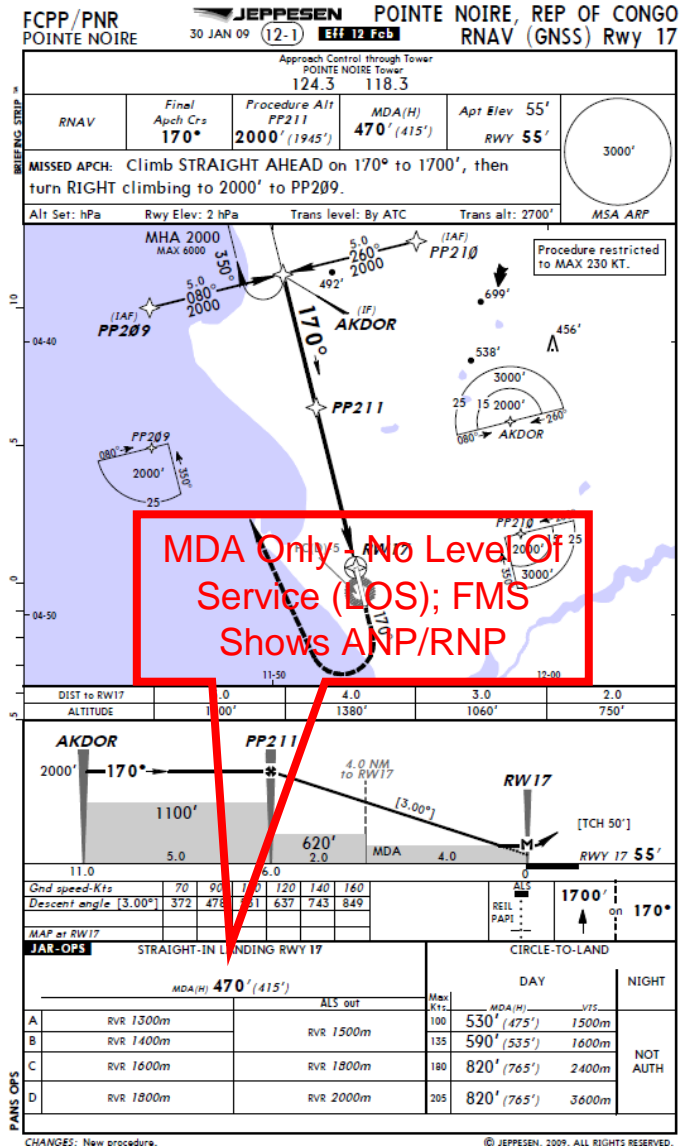
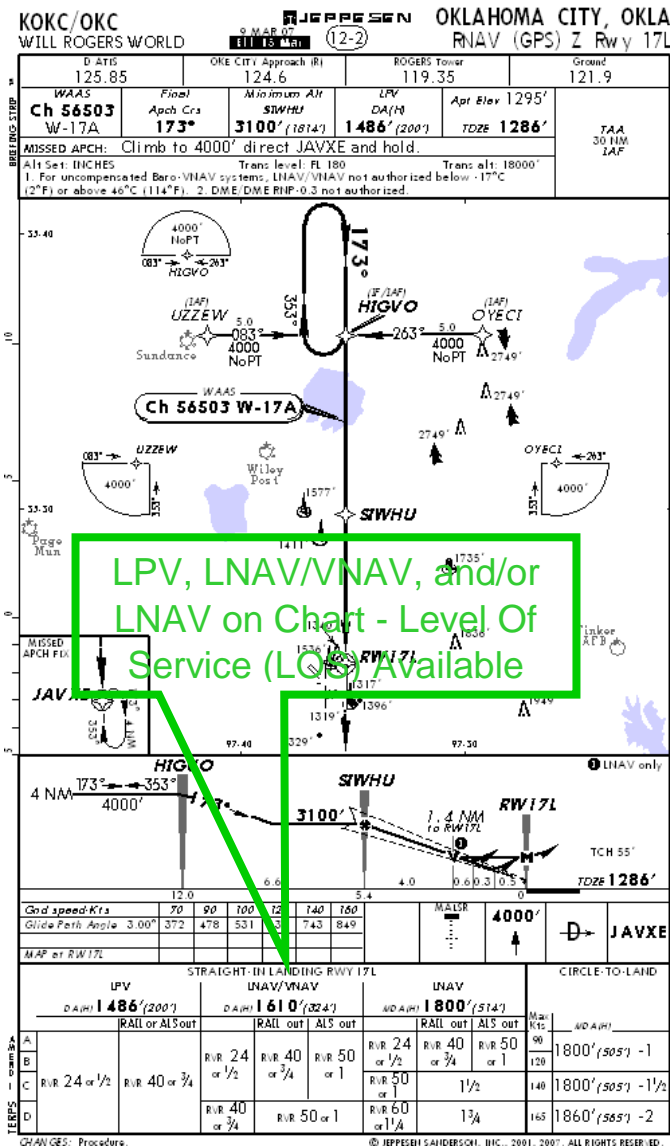


Per the example, by entering the RNAV (GPS) channel ID of 82701, the FMS will find the approach in the database and select it.



ON WHAT RNAV APPROACHES WILL “LOS” BE AVAILABLE?

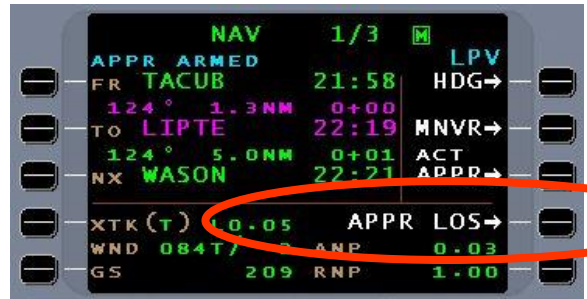
To determine whether the RNAV approach will contain a level of service the chart must display LPV, LNAV/VNAV and/or LNAV. Only in an SBAS coverage area will LPV be available. Outside of SBAS coverage area LNAV LOS will be provided indicating that only a baro-glideslope is available. Even with LNAV LOS, a baro-glideslope may be used for LNAV/VNAV minima. If the chart shows MDA only, the FMS will show ANP/RNP.



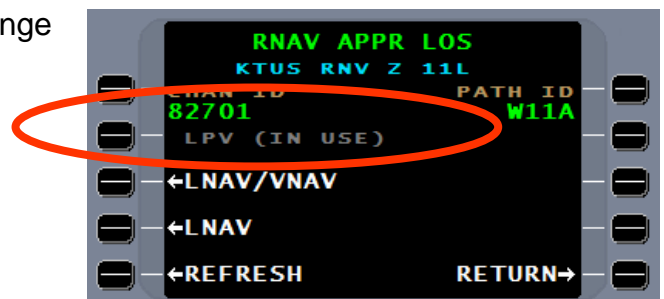
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LEVEL OF SERVICE (LOS)

At FMS approach arming, the Level Of Service (LOS) is predicted with the LOS presented in the upper right corner of NAV pages 1 & 2. To further view or change the LOS, press the APPR LOS line select key to present the RNAV APPR LOS page.

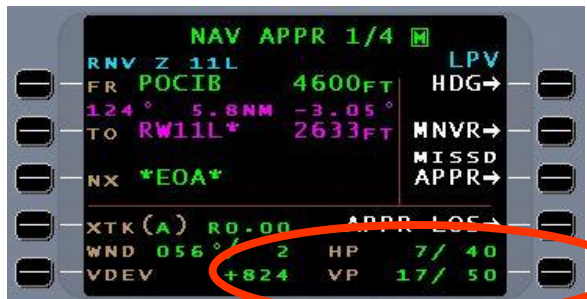


The predicted LOS is listed as (IN USE). To change the LOS, select the appropriate line select key.



The protection level is analogous to ANP in that it is computed dynamically by the FMS, but in the case of SBAS, there is a horizontal (HP) and a vertical (VP) protection level. The number before the “/” is the protection level

The number after the “/” is the alert level; analogous to RNP, but again with a horizontal (HA) and vertical (VA) component.



For an LPV approach the alert levels come from the FAS DB and are unique for each approach.

For an LNAV/VNAV approach the alert levels are 556m (0.3nm) laterally and 50m vertically.

For an LNAV approach the alert level is 556m (0.3nm) laterally with no vertical component.

For non SBAS approach ANP/RNP is used with RNP set to 556m (0.3nm).

FLYING THE RNAV APPROACH WITH LPV LOS

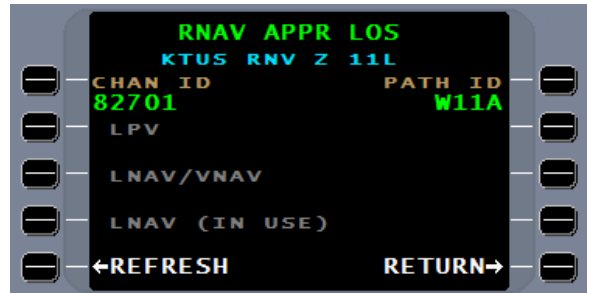
At approach arming the LOS is predicted. To fly to LPV minima the FMS can only use the SBAS NAV sensor. No other NAV sensors will be used during the approach final segment.



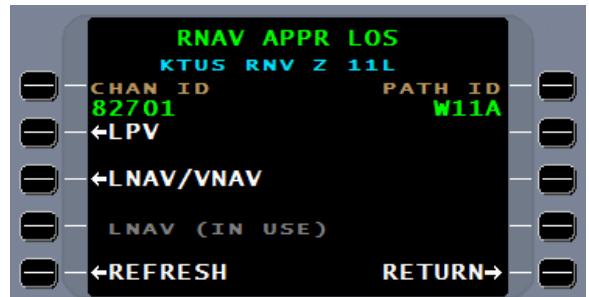
If the FMS predicts a lower LOS, a re-request can be made through the LOS page by selecting REFRESH.



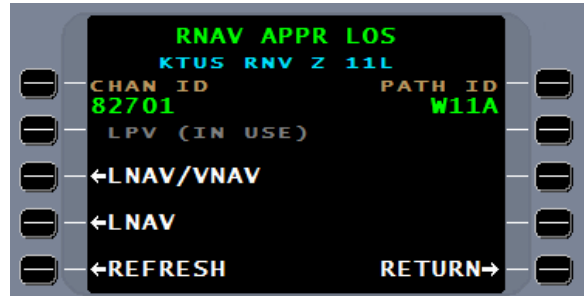
REFRESH will cause the FMS to take another look at the LOS.



If the FMS determines that a higher LOS is available, the pilot may reselect the higher option.



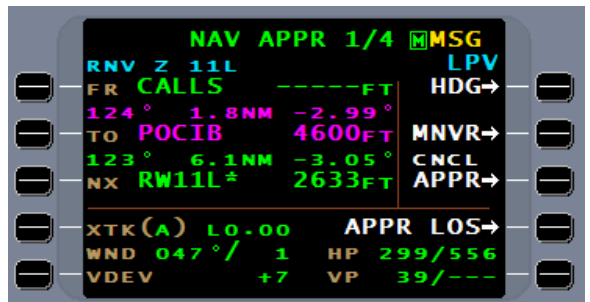
The higher LOS must be manually selected.



At approach activation the LOS is confirmed. If there is no change between the prediction and the LOS at activation, the approach proceeds.



If the predicted LOS is unavailable at approach activation, the pilot must select a lower LOS. This must be accomplished prior to crossing the FAF. A message at approach activation will alert the pilot to this issue.



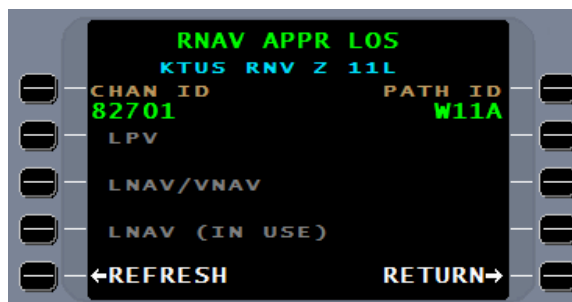
In addition to alerting the pilot that the predicted LOS is not available, the message will provide access to the LOS page.



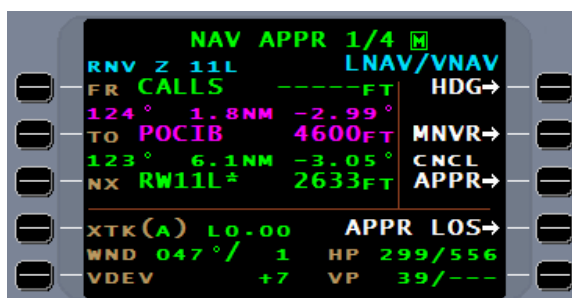
Although the **RNAV APPR LOS** page may show that LPV is in use, the message warned that it will be unavailable after crossing the FAF.



Selection of a lower LOS is required to continue any vertical guidance past the FAF. With selection of a lower LOS it becomes obvious that LPV is unavailable.



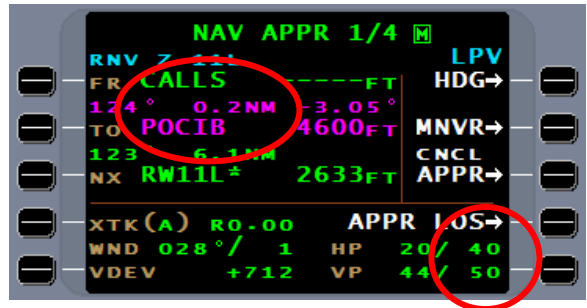
Selection of LNAV/VNAV will allow the FMS to continue with SBAS vertical navigation, but the integrity of LPV cannot be maintained, therefore, the pilot is restricted to LNAV/VNAV minima.



Until reaching the FAF the vertical guidance is provided by baro-VNAV and the vertical alert limit (VL) for SBAS is not presented.

In lieu of VDEV, NAV APPR 2/4 will present ground speed (GS).

At the sequencing of the FAF the VA (VERTICAL ALERT LEVEL) will be presented



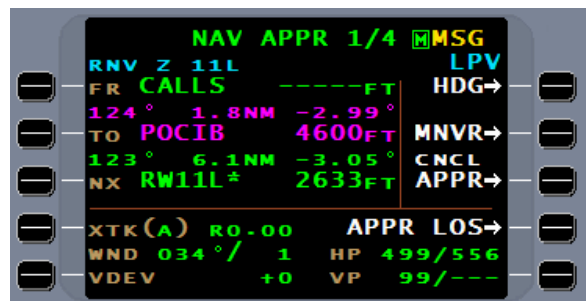
With both LPV and LNAV/VNAV the vertical navigation after crossing the FAF will be provided by SBAS. The difference between LPV and LNAV/VNAV is the HA and VA requirements which restrict the approach minima.



On the NAV with LPV LOS, after crossing the FAF and the FMS LPV components have full control of the navigation, the LPV color will change.



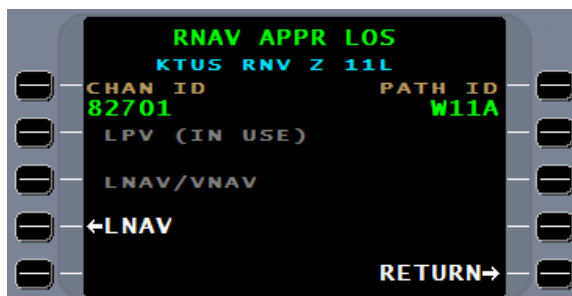
If the FMS estimates LPV or LNAV/VNAV, but at activation determines that only lower LOS is available, a message will appear requiring a change to the LOS.



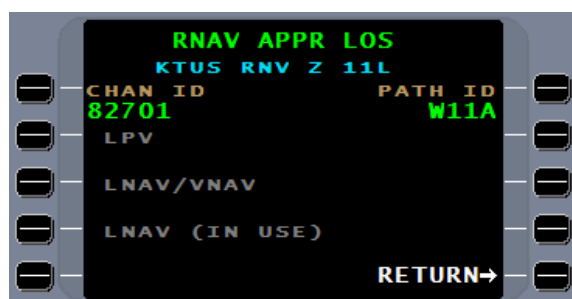
The message will state that LPV or LNAV/VNAV is not available and will provide a line select key to access the LOS page.



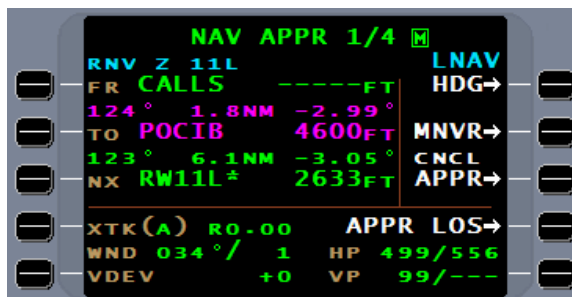
The lower LOS will be the only option.



With the lower LOS selected, RETURN to the NAV APPR page.



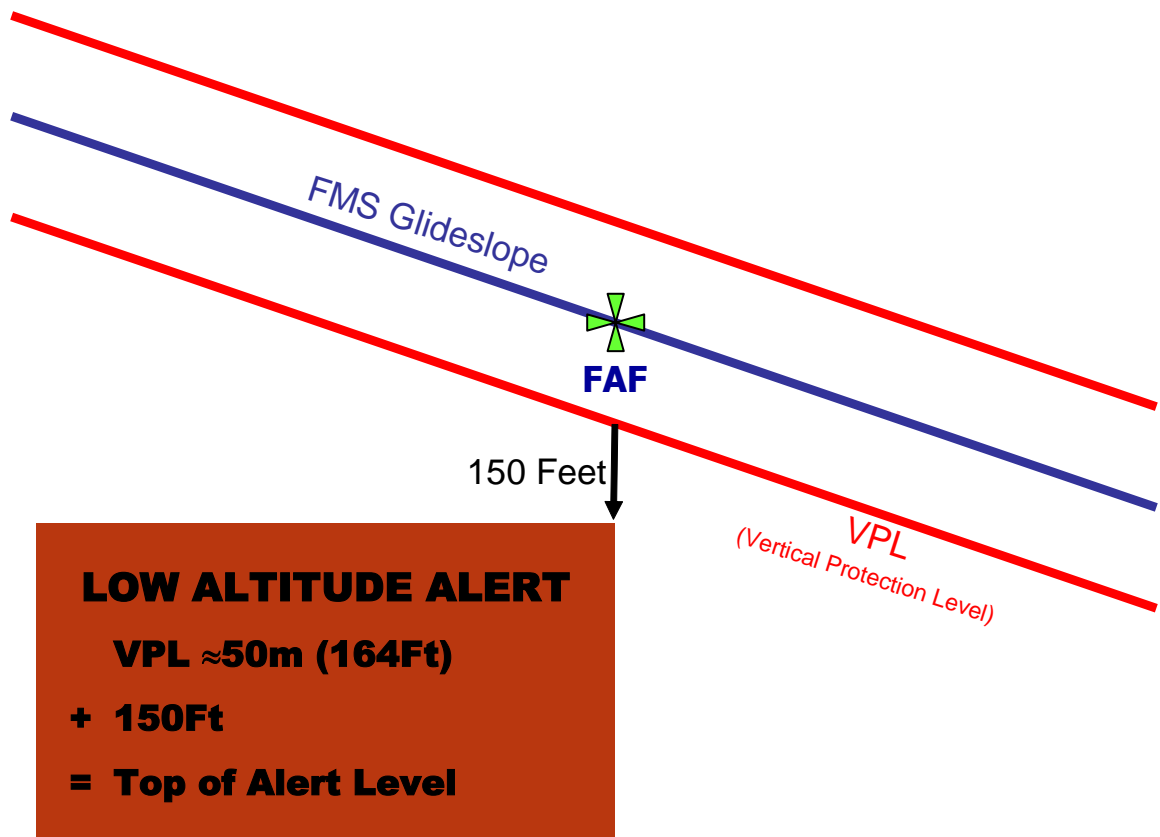
LNAV LOS will require an HA of 556 (0.30nm) and will not provide a VA. Although SBAS, if available, will be used for LNAV, baro-VNAV must be used. If the aircraft meets the requirements of AC 90-105, Use of Barometric Vertical Navigation (VNAV) for Instrument Approach Operations Using Decision Altitude, the pilot may fly to LNAV/VNAV minima.



NOTE: When by message the pilot is notified that the current LOS is not available, failure to select a lower LOS prior to crossing the FAF will result in **NO** vertical navigation being provided. The approach must be continued with lateral navigation only to LNAV minima.

LOW ALTITUDE ALERT

When approach active and flying an SBAS approach with LPV level of service and outside the Final Approach Fix (FAF), the FMS will monitor the vertical relationship of the aircraft to the glideslope crossing altitude at the FAF. If the aircraft is at or below the Vertical Protection Level (VPL) (approximately 50m or 164 feet) plus 150 feet, the FMS will push a “LOW ALTITUDE ALERT” message.



USING SBAS TO FLY A NON LPV LOS APPROACH

Many RNAV approaches have not yet been surveyed for LPV and contain only LNAV/VNAV minima. If the approach database contains an ellipsoid altitude, the FMS can use both SBAS lateral and vertical navigation to fly to LNAV/VNAV minima. Channel ID and PATH ID are only provided in the FAS DB of an LPV approach and are absent when the approach provides a LOS that is less than LPV.



LNAV/VNAV is estimated at approach arming and at activation the LOS is determined.

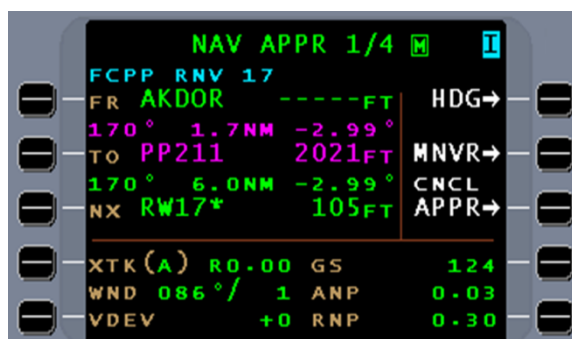


If LNAV/VNAV is determined at activation, the pilot will use SBAS vertical navigation. In other words, the glideslope is based on GPS not baro-VNAV.



If LNAV/VNAV is not available, LNAV will use baro-VNAV. Aircraft meeting the requirements of AC 90-105 may fly to LNAV/VNAV minima with the use of baro-VNAV.

RNAV approaches displaying an MDA only will not have a LOS. Lateral navigation will be based on GPS and vertical navigation will be based on baro-VNAV.



MISSED APPROACH FROM A SBAS APPROACH

If a missed approach is initiated, ANP/RNP will replace HP/VP. Until the end of the final segment, the RNP will remain 0.30nm with approach scaling of 0.30nm. After crossing the missed approach point, the FMS will return to terminal scaling (1nm) and alerting (1nm).



On the rare occasion that a TF (Track to Fix) leg follows the approach final segment, the FMS RNP will remain at 0.30 with approach scaling remaining in effect.



A TF leg can be identified in the flightplan by the missed approach waypoint (RW11*) being displayed twice. A TF leg must begin and end with a lat/long waypoint. The FMS cannot create a TF leg through the *EOA*, thus the second missed approach point will begin the TF leg.



Following a missed approach, the NAV page will display the missed approach point twice. Upon sequencing the missed approach point the FMS will present the second missed approach point as the from (FR) waypoint.



GPS PREDICTIVE RAIM (RECEIVER AUTONOMOUS INTEGRITY MONITORING)

RAIM prediction for approaches is **NOT** required for SBAS FMS certified under TSO C-146C. This applies to both SBAS areas of coverage and non-SBAS areas of coverage. Therefore the automatic RAIM prediction function of earlier generation FMS is removed in SCN 100X/110X.

GPS satellite geometry changes with position and time. RAIM prediction will estimate the satellite availability and the geometry to determine GPS accuracy. The manual prediction program will calculate predictive RAIM for the lat/long of the arrival airport or the manually entered waypoint.

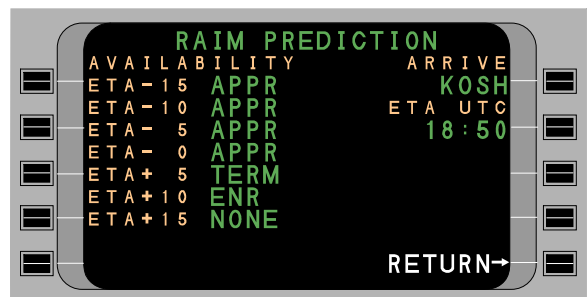
Prior to take off and during the enroute phase of flight the pilot may review the RAIM available accuracy at the destination for the period of time 15 minutes before to 15 minutes after ETA. The manual RAIM prediction program is available under the flightplan menu. This program may be used if a standalone or overlay GPS non-precision approach is planned.

To access RAIM prediction press **FPL** key then **MENU** key. **FPL MENU 1/2** will be displayed.

Press the line select key for “RAIM PRED” and the **RAIM PREDICTION** page will be displayed.



If any RAIM availability is shown to be other than **APPR** for the 30 minute window, then the pilot should plan for a non GPS approach and not plan to rely on GPS for aircraft position during the non-precision approach. However, the RAIM prediction program only predicts RAIM; it will not prevent the pilot from attempting a GPS approach. The real time integrity and accuracy of GPS will be the only criteria that will prevent a GPS approach from being flown.



The display presented, APPR, TERM, ENR, or NONE is determined by the length of the radius of Horizontal protection level as determined from the number of satellites and their geometry.

These labels meet the GPS Horizontal Protection Level (HPL) for that phase of flight.

Guidelines are:

Enroute	ENR	< 2.0NM
Terminal	TERM	< 1.0NM
Non-Precision Approach	APPR	< 0.3NM
RAIM not available	NONE	

PROBLEMS WITH RAIM PREDICTION

The GPS almanac is released every seven days and is automatically down loaded by the GPS in the FMS. During the power up of the GPS the almanac date is compared to that transmitted by the GPS satellites. If the residing almanac is out of date a new one is down loaded.

The problem occurs in that real world satellite changes may not be reflected in almanac data currently in the receiver. In other words, when on day five a RAIM prediction is made the satellites used may not reflect the real world.

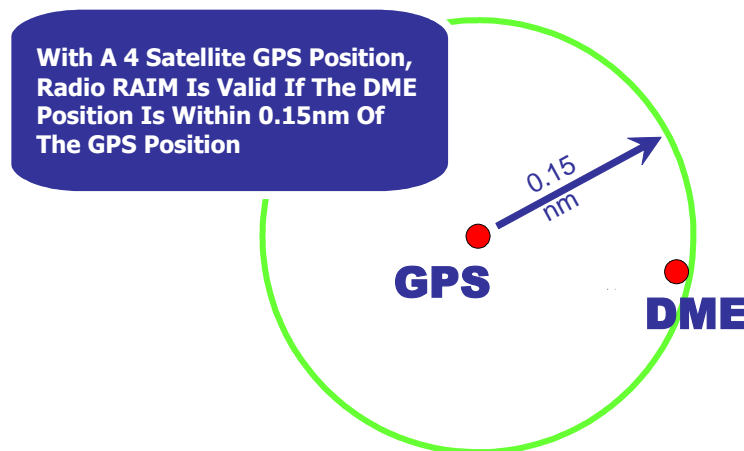
Another problem occurs when a RAIM prediction is made in that the program assumes an almost level horizon. If the GPS based approach is in mountainous terrain, satellites used during the prediction program may be masked by the mountainous terrain.

To sum it up, RAIM prediction is not perfect and with SCN 1000 and subsequent it is not required to fly a GPS approach.

RAIM DURING THE APPROACH

For a GPS based approach to become active, real time RAIM must be available or SBAS integrity must be established. GPS RAIM for non SBAS coverage can be accomplished by receiver RAIM, the reception of five or more satellites, or radio RAIM. To verify the accuracy of a non RAIM GPS position, it is permitted to use a scanning DME position. If the non RAIM GPS position is within 0.15nm of the scanning DME position, the FMS will accept this in lieu of a five satellite RAIM calculation.

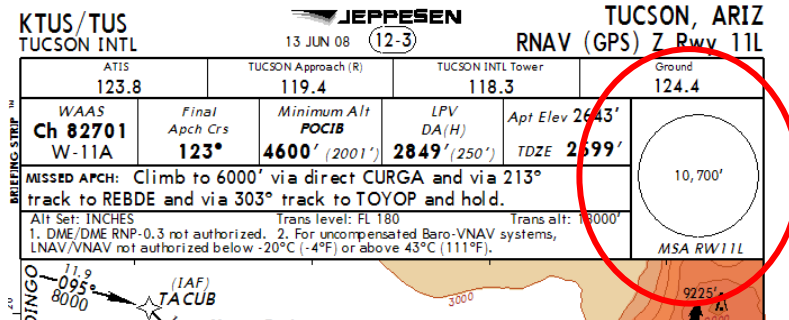
Radio RAIM Operation



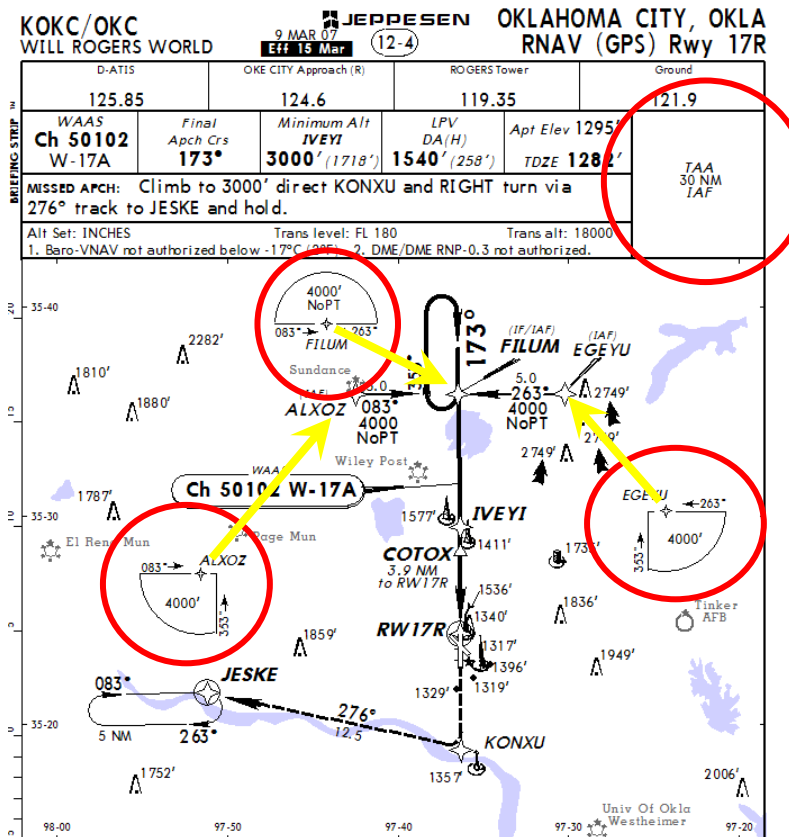
For all practical purposes, the use of radio RAIM will be transparent to the pilot. It can be observed on the WAAS/SBAS page on DATA page 2 by the INTEG line reading RADIO, but this seldom monitored by the pilot.

RNAV (GPS) APPROACH CHARTING

Jeppesen charts will provide on RNAV approaches either a MSA (minimum safe altitude) or, a TAA (Terminal Arrival Area) which is discussed in the FAA Aeronautical Information Manual. If TAA is presented, the 30nm distance for calculating the sectors is taken from the associated IAF.



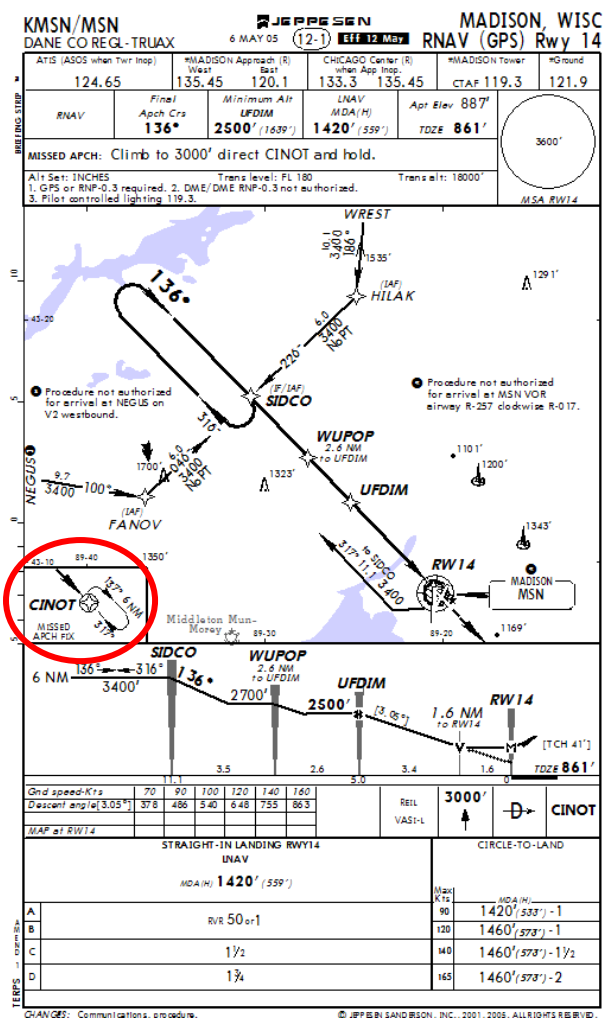
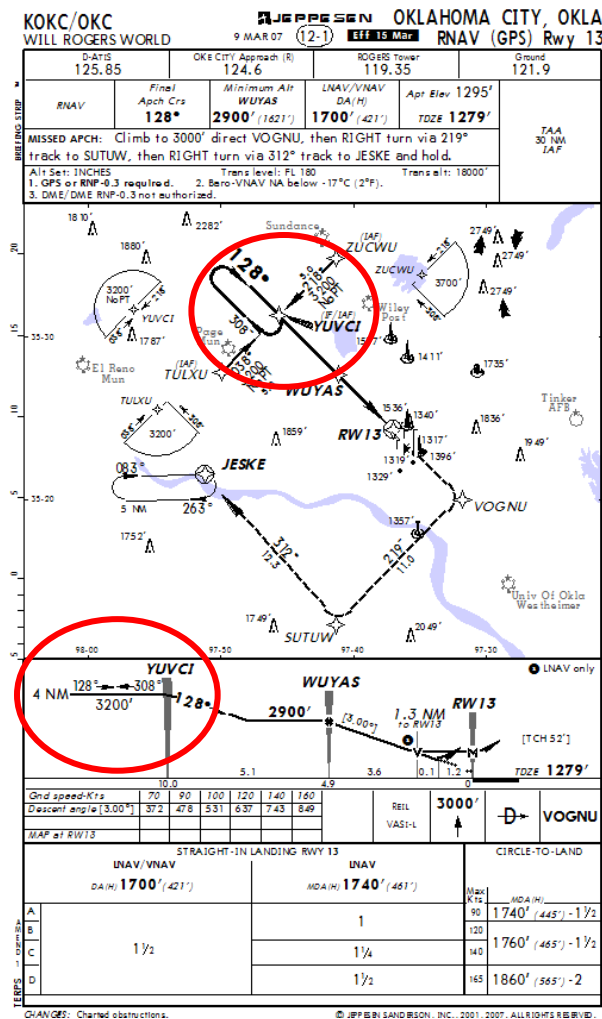
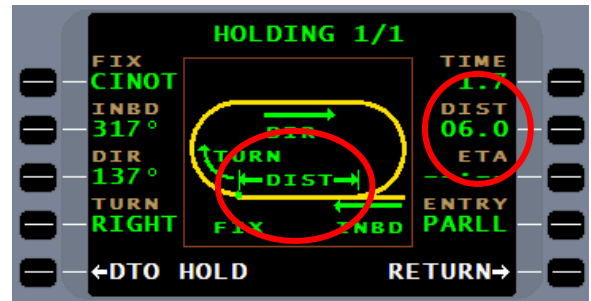
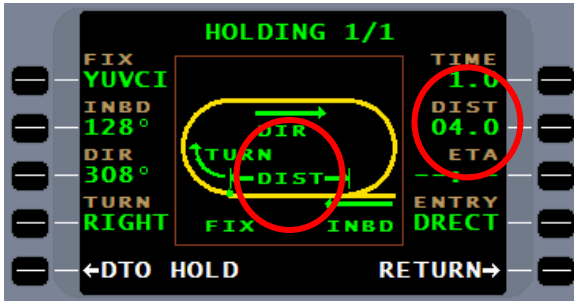
Minimum Safe Altitude (MSA)



Terminal Arrival Area (TAA)

NOTE: Many countries use the Terminal Arrival Area on RNAV charts. The distance from the IAF or the TAA may vary.

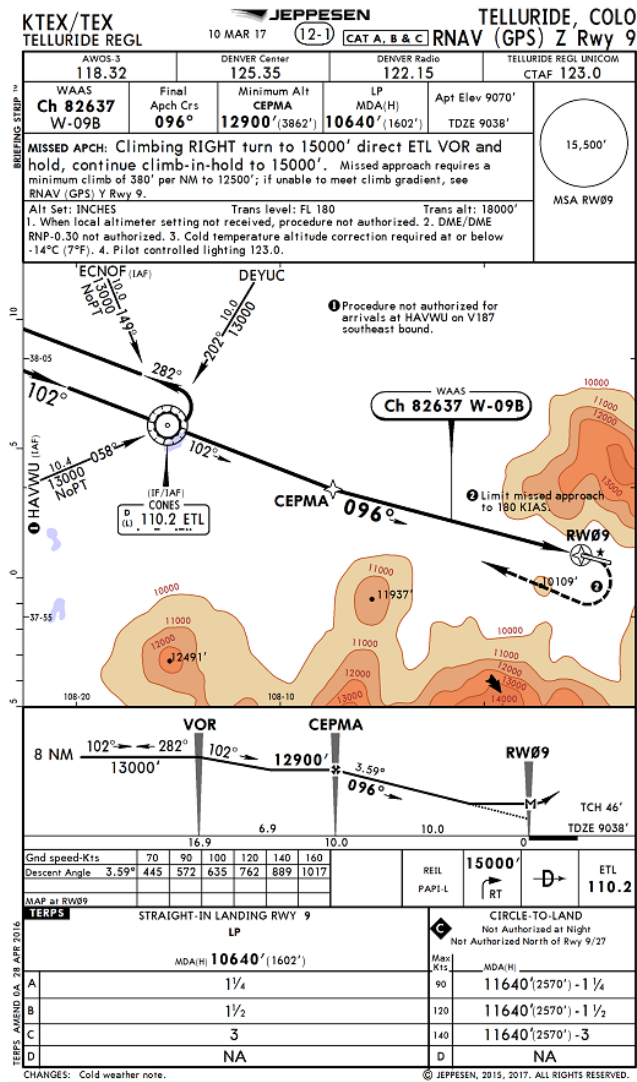
For most countries, RNAV approach charting for holding pattern leg length is based on distance not time. The NAV approach database will reflect distance for the inbound leg and can be seen on the holding definition page under MNVR. Some countries still use time; check the holding definition page to determine holding definition for the approach selected.



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RNAV (GPS) APPROACHES TO LP MINIMA

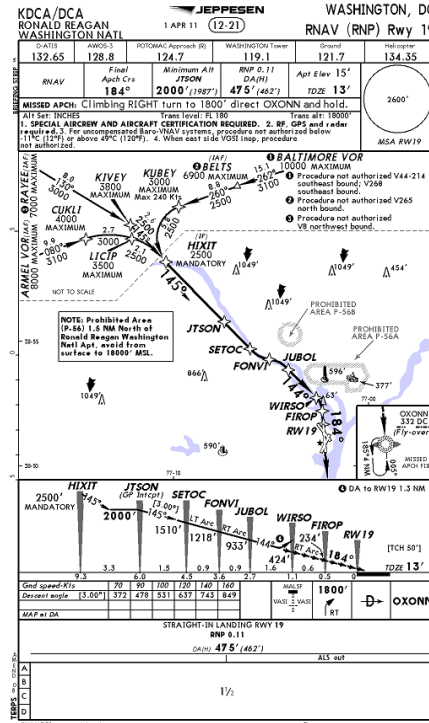
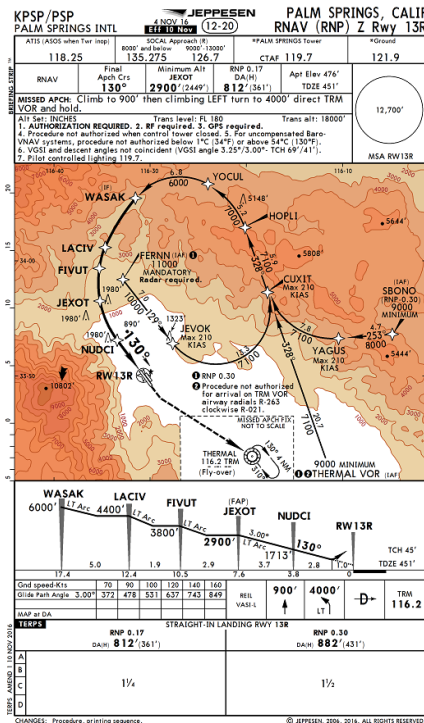
Available in SCN 1002/1102 and subsequent are RNAV (GPS) Approaches to LP minima. Localizer Performance (LP) approaches are a GNSS replacement for localizer only approach procedures. These approaches will have a channel ID like LPV approaches, but will not have a GNSS glideslope. Most of these procedures will, instead, have a baro glidepath for advisory vertical navigation to an MDA.



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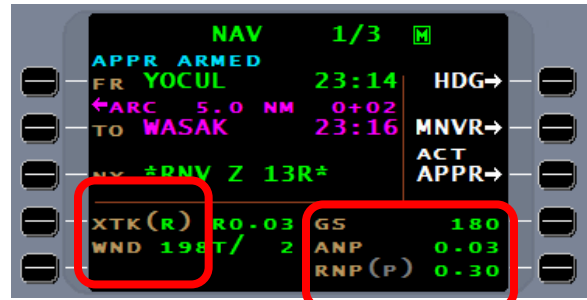
RNAV (RNP)

RNAV (RNP) approaches are covered under advisory circular AC 90-101 which requires special aircraft and aircrew certification. Newer charts will say **AUTHORIZATION REQUIRED**. FAA requirements dictate that unless the FAA issues a letter of authorization under AC 90-101(), the FMS NAV database may not contain these approaches. A special NAV VOR database is available from UASC for qualified operators. For qualified clients customized training is available.



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These procedures normally have the CDI scaling and RNP values in the NAV database and will display symbology showing an (R) and (P).



In some parts of the world, RNAV (GPS) is replaced with RNAV (RNP). These approaches do not require authorization, but only that the avionics equipment is able to fly the procedure. If the RNP is identified in the NAV database for a specific leg, the CDI (two dots) will equal the RNP value. If the approach leg is coded to 0.10, upon entering that leg the CDI full scale deflection will equal 0.10nm and retain linier scaling.

FLYING VOR AND VOR/DME APPROACHES

VOR and VOR DME approaches may be flown with the use of GNSS/GPS if the approach is designated as an overlay approach and the words “or GPS” are in the title of the approach. In this case the reception of the VOR is not required, in fact, the VOR may be listed in the current NOTAMS as unusable for navigation and the approach could still be flown using GPS.

Reception of VOR and DME may be required where the approach is a non-overlay. In this case the FMS may deselect GPS during the approach arming process and must have VOR and DME to continue the procedure. If the FMS is configured where only GPS is available to the FMS for navigation, the FMS will be unable to fly the VOR approach and an attempt to do so will result in the FMS failing to go approach active with navigation being red flagged on the primary flight display.

Where both the GPS and VOR DME are available to the FMS and the approach permits the use of both, the FMS will use both and if one fails, the FMS will continue on the remaining NAV sensors. A message stating loss of the NAV sensor has occurred, but no flagging of the navigation display will occur. This may be the case in the rare occasion where GPS satellite reception is lost or VOR reception is lost.

Some countries such as the United States and Canada allow VOR approaches to retain the use of GNSS/GPS when flying the approach. This may give the impression that all VOR approaches are overlay when, in fact that is not the case. For the approach to be an overlay it must contain the words “or GPS” in the title of the approach. To make a non-overlay approach legal the reception of VOR is required. This can be accomplished by the reception of the VOR by the FMS. For those aircraft without reception of VOR by the FMS, the pilot may use the FMS, but must have in view by another source the VOR for navigation. In most cases, the use of the VOR bearing pointer may suffice. Where the approach is a VOR DME approach, FMS distance may substitute for DME. On the arrival page if the approach name is followed by a “G”, the approach will retain the GPS for navigation even if it is not an overlay approach.

If the approach meets the criteria for a glidepath, the approach will contain a baro-VNAV glidepath. Check the approach plan on flightplan menu page 2 for glidepath availability.

FLYING THE NDB APPROACH

Since the FMS does not use the NDB as a NAV sensor, the use of GPS is required. It, therefore, should go without saying that the approach surveying must be IAW WGS-84 for the FMS to fly the approach. If the approach is designate as an overlay approach and the words “or GPS” are in the title of the approach, the reception and viewing of the NDB is not required to fly the approach. If the NDB approach is not surveyed IAW WGS-84, the FMS approach database will not contain the approach.

Recent changes to international procedures allow for the use of GPS to aide in the approach navigation of NDB approaches that are surveyed IAW WGS-84. SCN 100X approach database will contain all NDB approaches surveyed IAW WGS-84 and the GPS will be retained to assist with navigation. If the words “or GPS” are not in the approach title, the NDB must be used, but the FMS may be used to supplement NDB navigation.

If the NDB approach meets the criteria for a glidepath, the approach will contain a baro-VNAV glidepath. Check the approach plan on flightplan menu page 2 for glidepath availability.

FLYING THE VFR APPROACH

VFR approaches are created by the pilot in the FMS pilot database. Once created the approach is entered into the flightplan in the same way any approach is entered into the flightplan. The approach can be automatically or manually activated and, if a glidepath was defined as part of the approach, it will be presented. This approach is only legally flown in VMC conditions.

ARRIVAL AND APPROACH

ARRIVAL

Outside of a 50nm radius of the *EOA*, with an approach entered in the flightplan, a diminished APPR will appear at line select key 3R. Arming the approach cannot be accomplished at this time. The diminished APPR is merely to show that an FMS flyable approach is in the flightplan.



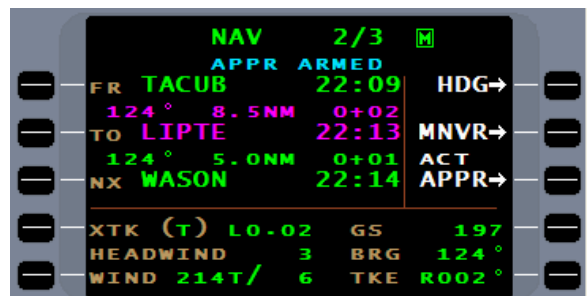
Within 50nm radius of the *EOA*, the ARM APPR line select key will become available. The approach may be armed manually, but will automatically ARM when within a 30nm radius of the *EOA*. Arming manually may be required if on vectors to final following a missed approach.



If the approach uses a ground base navaid, the FMS will request that the navaid be tuned to that frequency. If FMS tune capabilities exist, a TUNE APPR line select key will be presented. Pressing this key will tune the VHF radio to the required frequency.

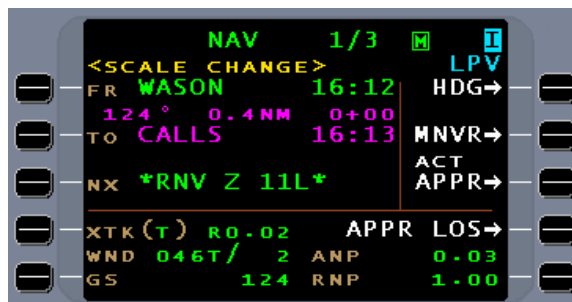


Note that XTK (E) Enroute automatically changes to displays XTK (T) Terminal when within 30nm or if the ARM APPR line select key is pressed prior to 30nm. With either manual or automatic approach arming, the ARM APPR line select key will change to ACT APPR.

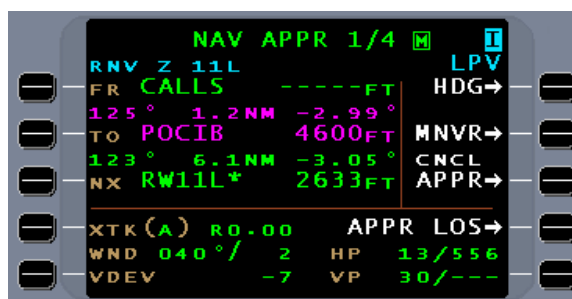


AUTOMATIC APPROACH ACTIVATION

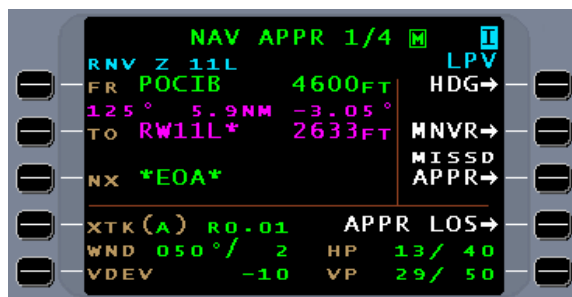
For automatic approach activation, a **<SCALE CHANGE>** banner will precede activation by 15 seconds announcing terminal to approach CDI scale change.



Whether by manual or automatic approach activation, when activated, the FMS will present the **NAV APPR** pages 1 and 2. Line select key 3R will display CNCL APPR. Selecting this line select key will take the FMS out of approach mode and back to terminal; the waypoints will not change, but vertical navigation will be discontinued.



When past the Final Approach Fix (FAF), a **MISSD APPR** line select key will be presented. Selecting this directly or remotely through the aircraft go-around system will place the aircraft in the missed approach mode. All FMS supplied vertical navigation is terminated. Lateral navigation only will take the aircraft to the missed approach point.

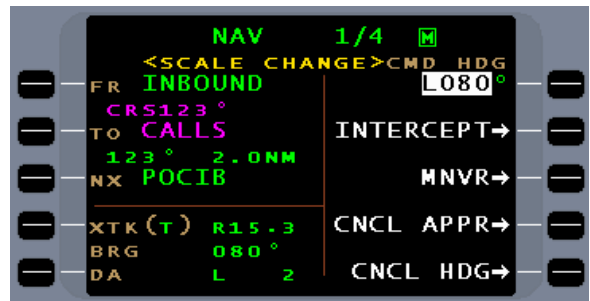


Following the pressing of missed approach, the FMS will guide the aircraft to the missed approach point. The missed approach point is always a flyover waypoint. On most NAV data missed approach procedures, a safety leg is included to insure the aircraft is above a safe altitude before entering the first published missed approach leg. Since this is a conditional waypoint, when entered the FMS will determine if the aircraft meets the condition and, if so, will immediately sequence.

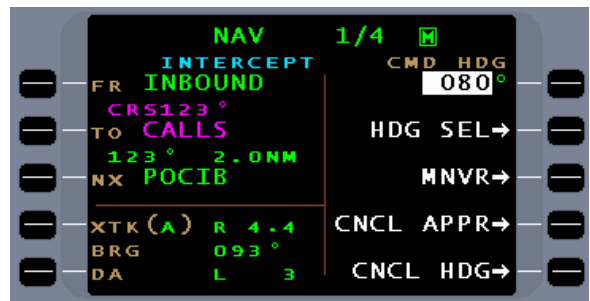


MANUAL APPROACH ACTIVATION

When radar vectors to the final approach course are given by ATC, once in the turn or on the ATC heading, manually activate the approach.



Press the INTERCEPT line select key to arm the capture of the inbound approach course.

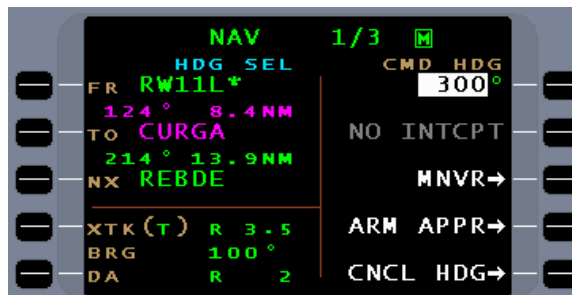


When the inbound course is captured, the heading mode will cancel. The approach has been activated manually, so over flying CALLS intersection, the FACP, will not affect the FMS.

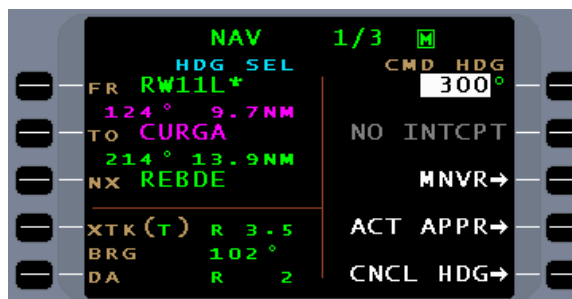


VECTORS FROM A MISSED APPROACH

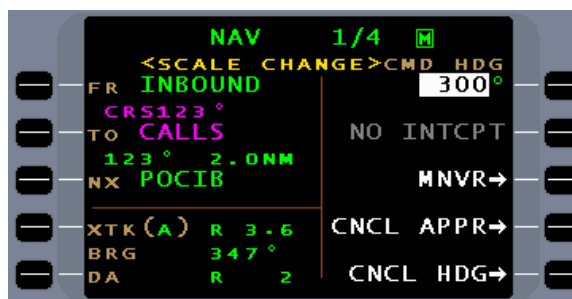
If on vectors from the missed approach, to avoid inadvertent sequencing of the FMS, wait until downwind before manually activating the approach. Because the approach will not automatically arm following a missed approach, first arm the approach.



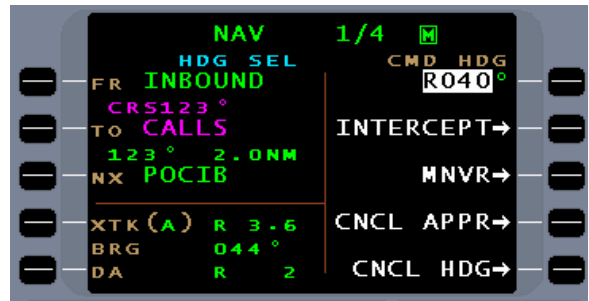
The ACT APPR line select key will now be presented for activation of the approach.



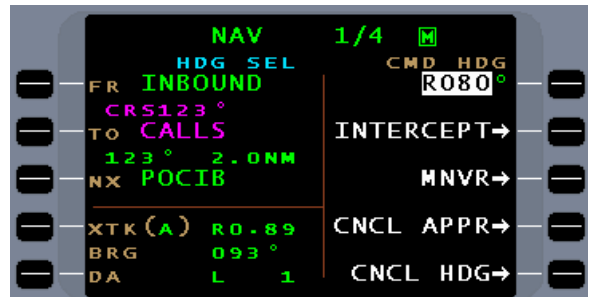
When downwind, activate the approach. With activation of the approach, the FMS NAV page will be presented with crosstrack indicating the distance offset from the final approach course. The HSI course arrow will align with the inbound course. If a map display is available, final segment waypoints will appear.



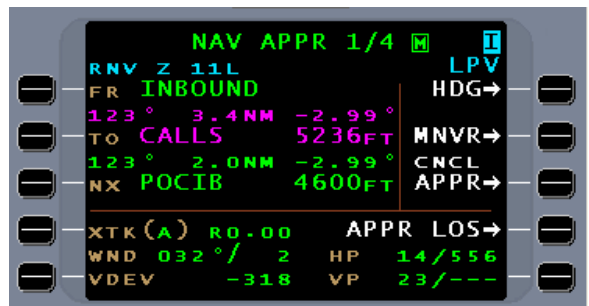
If a turn to base leg is given before the turn to intercept final, an intercept option may be presented. Until cleared for approach, intercept should not be pressed. This will avoid an inadvertent turn to final when not cleared to do so.



When the turn to intercept is given and the words “cleared approach” are spoken by ATC, pressing the INTERCEPT line select key will arm the FMS to capture the inbound course.

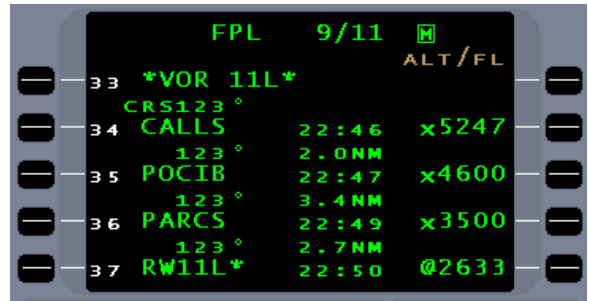


Once the approach course is captured, normal approach procedures apply.

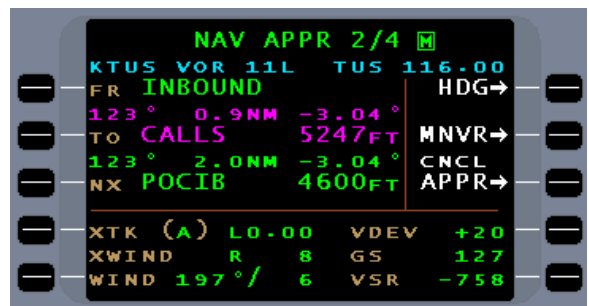


APPROACH WITH AN INTERMEDIATE OR STEPDOWN FIX

For approaches with stepdown fixes between the final approach fix and missed approach point, these fixes will be presented in SCN 100X. Crossing altitude at the FAF may be preceded by either a “@” or “X”.



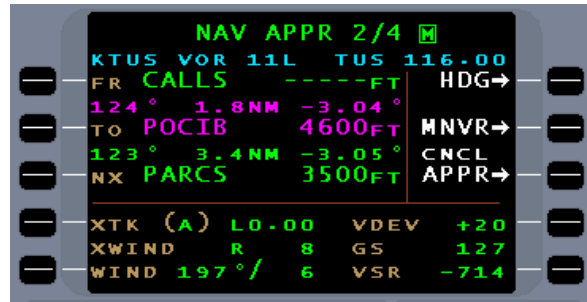
When approach active, the FMS approach will be flown as normal.



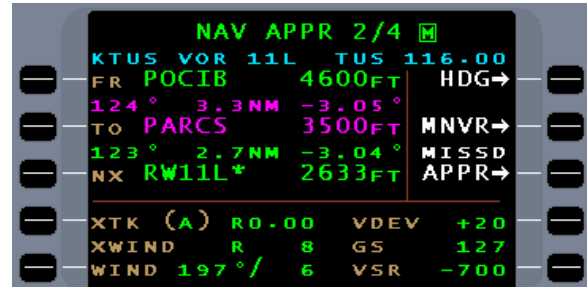
Map display of approach segment waypoints include the stepdown fix.



Normal sequencing will occur to include the stepdown fix.



Upon crossing the FAF, distance information will be to the stepdown fix. If the FMS glidepath is used, the glidepath calculation will clear the stepdown fix altitude. For lateral only navigation, stepdown will occur when crossing the stepdown fix.



NOTE: If deviation from the final approach course leg is made prior to activating the missed approach segment as in a circling approach, the FMS might command an unwanted turn to the missed approach point or runway threshold when FMS missed approach is activated. It is recommend when deviation from the final approach course is necessary, the first leg of the missed approach should be made with pilot navigation until a DTO with the FMS to the appropriate missed approach waypoint can be made.

ADVISORY APPROACHES

Advisory approaches are identified at time of FMS installation and are so labeled in the FMS configuration. If the installation of the FMS will not allow for the required NAV sensor to be available during the final approach segment, that part of the approach cannot be flown by the FMS; thus, the classification of advisory.

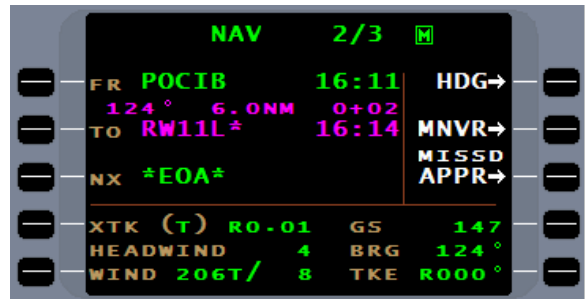
Advisory approaches can be selected and entered into the flightplan, but the approach segment cannot be flown through the FMS to other than terminal tolerances. Advisory approaches can, however, be used for the transition and missed approach portion of the approach. Procedural turns, arcs, holding patterns in lieu of procedural turns, vectors, and straight in approaches to the FAF can be flown. Sometime before the FAF, select the VHF radio as the source to fly the approach segment.

Most aircraft installations do not allow for the ILS to be an enabled approach. If an approach transition is to be flown, the FMS can be used to do this. Where to leave the FMS and select VHF navigation is technique, and may vary by transition type.

With an advisory approach in the flightplan, the NAV page will present navigation, but the line select key 3R will not present the ARM, ACCT APPR, CNCL APPR options that are required of an enabled approach. SCN 1000 will present a MISSD APPR line select key when crossing the FAF to facilitate the execution of a missed approach. SCN 1001.1 and subsequent will provide automatic sequencing past the missed approach point by automatically removing the ***EOA***. No MISSD APPR line select key will be presented on an advisory approach.

MISSED APPROACH FROM AN ADVISORY APPROACH

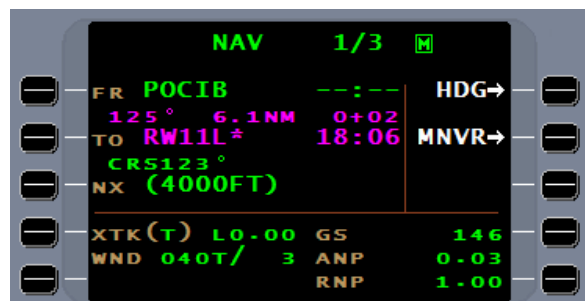
With SCN 100X, to facilitate the use of the missed approach segment when flying an advisory approach in terminal (T), a MISSD APPR option is presented when crossing the final approach fix.



Pressing the MISSD APPR line select key directly or electronically through the aircraft go around system, will sequence *EOA* on the NAV page and allow for the FMS to move into the missed approach segment upon crossing the missed approach point. Because the FMS is flying an advisory approach, XTK scale will remain in terminal (T) throughout the approach. Once stabilized on the missed approach, the pilot must select FMS as the source of guidance.



For SCN 1001.1/1101.1 and subsequent, the EOA on the advisory approach is automatically deleted from the NAV page. No MISSD APPR line select key will be presented. Upon executing a go-around the pilot must reselect the FMS as the source of navigation if FMS navigation is desired.



NOTE: With the use of the aircraft go-around or TO/GA system, most aircraft will require reselecting the NAV mode on the NAV selector panel.

MULTI MISSION MANAGEMENT SYSTEM (MMMS)

The Multi-Mission Management System (SCN 1100, SCN 1101, and 1102) has the ability to fly any one of six predefined search patterns along with drifting target navigation for maritime search and rescue operations. In addition, SCN 1102 includes a transition to hover capability. It can also integrate the use of Doppler for navigation. The six search patterns are:

- 1) **Rising Ladder**, consists of a series of parallel legs that resemble the rungs of a ladder
- 2) **Sector**, in which a center point is overflowed on selected tracks resulting in a pie-shaped ground track
- 3) **Expanding Square**, a series of legs which together resemble a squared-off spiral
- 4) **Orbit**, which consists of flying a constant radius circle
- 5) **Race Track**, a pair of parallel legs
- 6) **Border Patrol**, in which a route segment is flown and reversed until canceled

NOTE: SCN 1101.XM and 1102.XM are special mission software design for specific users and is not available to the general public.

From NAV page 1 or 2, press the **MENU** key. The **NAV MENU** page is displayed. Press the line select key for PATTERNS.



A **SEARCH PATTERNS** page is displayed.



Upon selection of one of these patterns, the FMS will display a page where the crew will be prompted to "fill in the blanks". Once this has been done the ACTIVATE option will be presented. Selection of this will cause the FMS to output steering commands to intercept the initial leg. Selection of the SEARCH option will then provide steering commands to fly each succeeding leg.

NOTE: In MMMS the dual FMS SYNC mode is not operational.

BORDER PATROL

For our demonstration, we will depart KDGL, in Douglas, Arizona and patrol the southwestern border of New Mexico.

First create a pilot route using the following pilot waypoints:

NM1	-	N	31	14.30	W	109	21.20
NM2	-	N	31	12.40	W	109	09.80
NM3	-	N	31	22.20	W	109	07.50
ES4	-	N	31	20.20	W	108	56.10

From the search patterns page, press line select key 3R for Border Patrol.

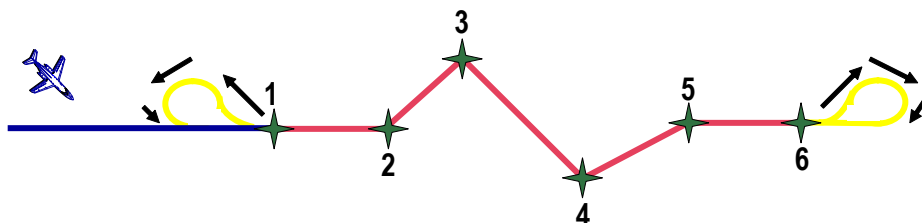
From the **BORDER** page, press the line select key for COPY ROUTE. The route we just created is now displayed on the list. Select the number for NM1 - ES4. The display will return to the **BORDER** page. Turn direction can also be set at this time by pressing 3L or 3R line select key. When selecting the turn direction, it is important to note the method the FMS uses for reversing course.



Press the ACTIVATE line select key to activate the pattern. The display will change to **NAV SRCH 1/3** page. In the Activate mode, the FMS will provide steering at up to a 45-degree intercept angle or by FMS CMD HDG to intercept the initial leg or an extension of that leg. Leg changes will be inhibited to allow maneuvering of the aircraft to intercept this leg.



In the ACTIVATE mode the initial leg will continue in both directions. Once intercepted, SEARCH will need to be selected for the FMS to navigate the search pattern. If the aircraft intercepts the pattern beyond the first waypoint and SEARCH is pressed, the FMS will navigate on the nearest pattern leg.



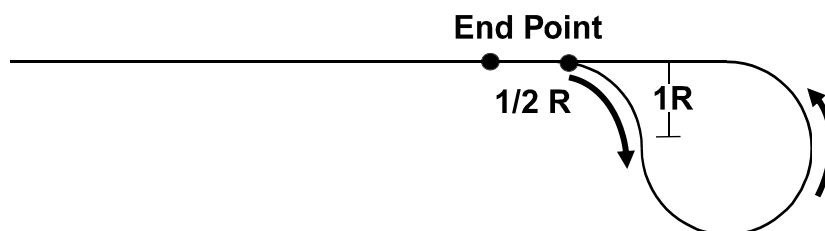
During flight, active information to the initial waypoint is displayed. Press line select key 5R to activate the **SEARCH** mode. Note that an icon of a circle is displayed on the pattern. This denotes the aircraft is in-bound to the next leg. As the aircraft passes the initial waypoint, the icon changes to a triangle, indicating the aircraft is presently bound for the end point of that leg.



As the end of the pattern is reached, the FMS will reverse the pattern. As ES4 is crossed, the icon changes to a circle and all information is referenced to ES4 as viewed on NAV SRCH 1/3.



The aircraft will continue on the present desired track for a distance equal to 1/2 the minimum turn radius (R) under present conditions (altitude, groundspeed and steering limits). The FMS will then command a right turn until crosstrack is equal to 1R. Now the FMS will command a turn in the reverse direction and fly on a circular arc to intercept the new leg.



Minimum turn radius may be calculated using the following formula.

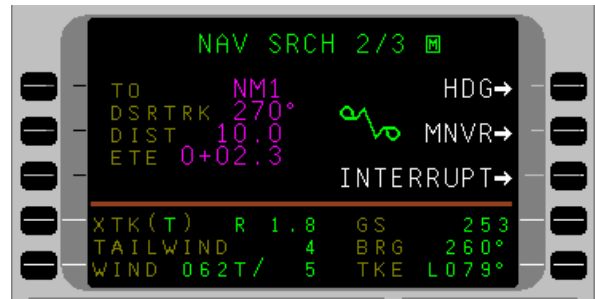
$$R = v^2/g \tan\Phi$$

Where: V = ground speed (Knots)
G = a gravitational constant equal to 68682
 Φ = degrees of bank

In this case, at 250 kts, steering limits are 24.5 degrees; therefore, the turn radius will be 2.0nm.

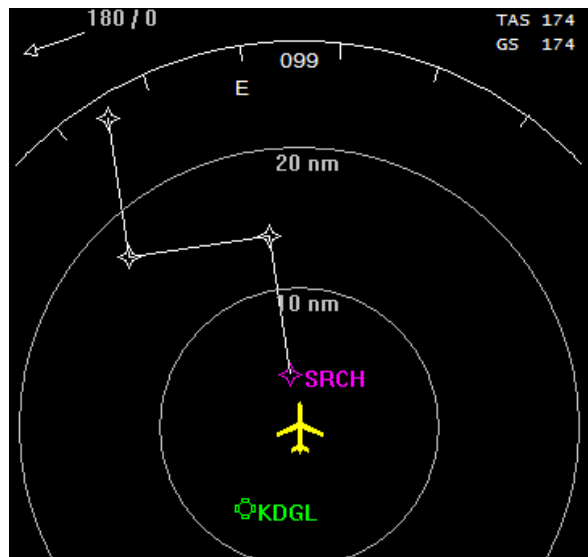
Following the course reversal will result in the aircraft intercepting the leg before the next waypoint and fly the pattern in reverse order.

HSI information is displayed on **NAV SRCH 2/3** along with wind direction and velocity, groundspeed, distance, and estimated time enroute.

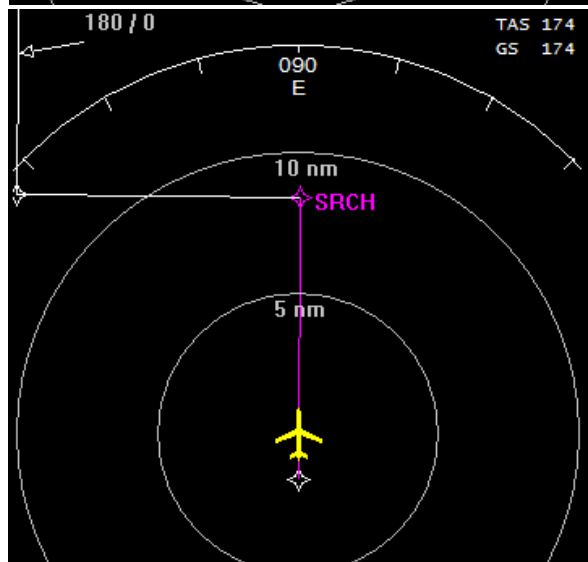


- DSRTRK Desired track
- BRG Bearing to start or "TO" waypoint
- XTK Cross track in (100thnm) when crosstrack less that 10nm
- TKE Track angle error

The FMS will display on an MFD map several of the pattern legs. The FMS is currently in ACTIVE mode proceeding to the active waypoint which the FMS named SRCH.



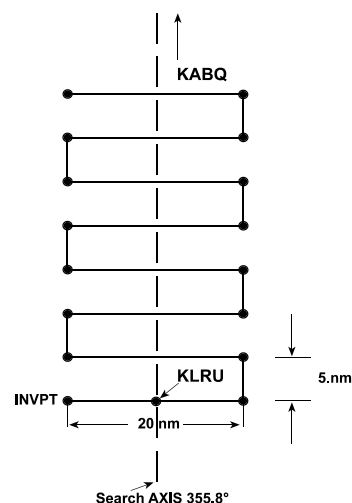
The FMS is now in SEARCH mode with the first leg displayed as the active leg. The SRCH waypoint will always be displayed as the waypoint to which the FMS is navigating.



RISING LADDER PATTERN

There is an aircraft flying from Las Cruces, New Mexico to Albuquerque that is overdue. Since there are no specifics on where the aircraft may have gone down, the decision is made to search the route between KLRU and KABQ using the Rising Ladder Pattern. Heading direct to KLRU, a search pattern is constructed that will allow searching the area ten miles on either side of the direct route between Las Cruces and Albuquerque. The parameters of the search pattern to fit these requirements are defined.

From the SEARCH PATTERNS page, select the Rising Ladder pattern. The course from KLRU to KABQ is 360° and that will define the search axis. With this data one can make the following entries on the RISING LADDER page:



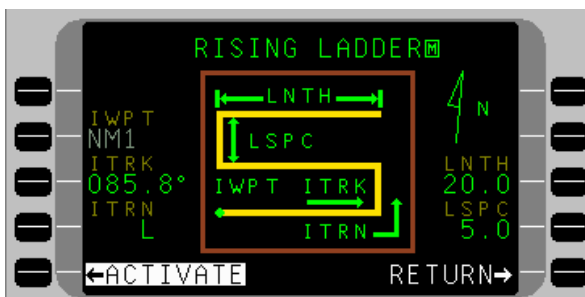
IWPT - The **Initial Waypoint** can be input using the list or direct entry process. Since the pattern is to start 10nm from the search axis, a pilot defined waypoint 10nm on the 270° bearing from KLRU is created. Press line select key 2L to place the cursor at the IWPT field and enter NM1 as the name for this waypoint. This brings up the DEFINE WPT page to define “IWPT”.



ITRK - The **Initial Track** is 90° to the search axis, so 085.8 is entered in the ITRK field.

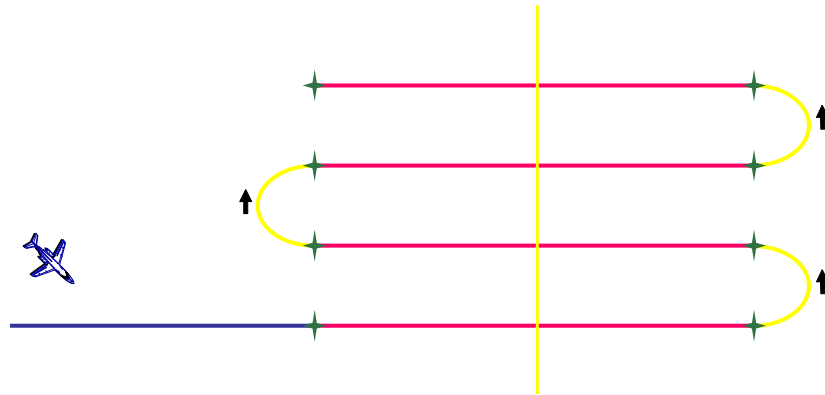
ITRN - The **Initial Turn** direction will be to the North, so L is entered in this field.

LNTH - To look 10nm on either side of the search axis 20.0 entered for the leg **Length**.

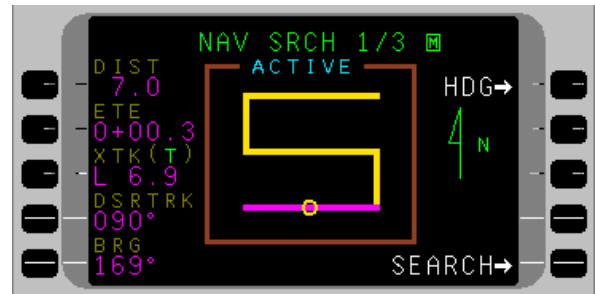


LSPC - 5.0 is chosen for the **Leg Spacing** to enable a scan of 2.5nm on each side of the aircraft.

The cursor now highlights the ACTIVATE line select key. Press this key to activate the pattern.

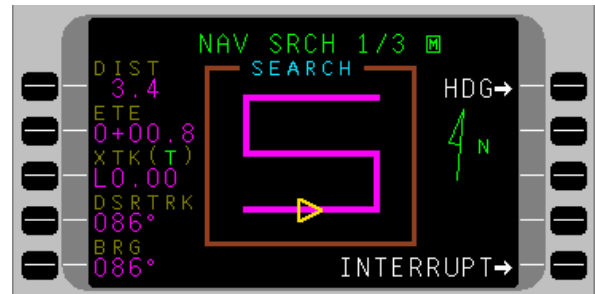


The display will change to **NAV SRCH 1/3** page. The FMS will provide steering to the initial leg or an extension of the initial leg at up to a 45° intercept angle or may be navigated by FMS CMD HDG. Leg changes are inhibited to allow maneuvering of the aircraft as necessary. The Circle on the search pattern icon indicates the search pattern is active. The SEARCH mode must be selected before reaching the first turn point for the FMS to follow the search pattern.

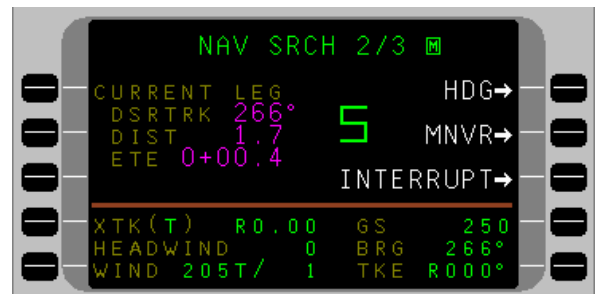


To activate the search mode, press the SEARCH line select key.

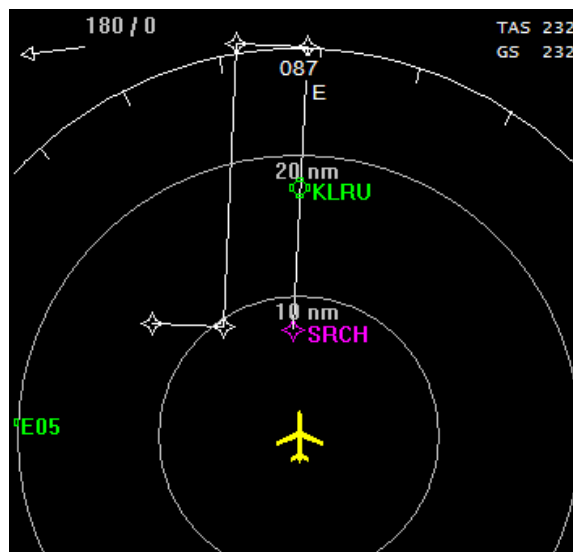
The circle changes to a yellow triangle to indicate the search leg is active. Progress of the search pattern can be followed on **NAV SRCH 1/3**. The triangle indicates what search leg is active, and the circle shows what transition to the next search leg is active.



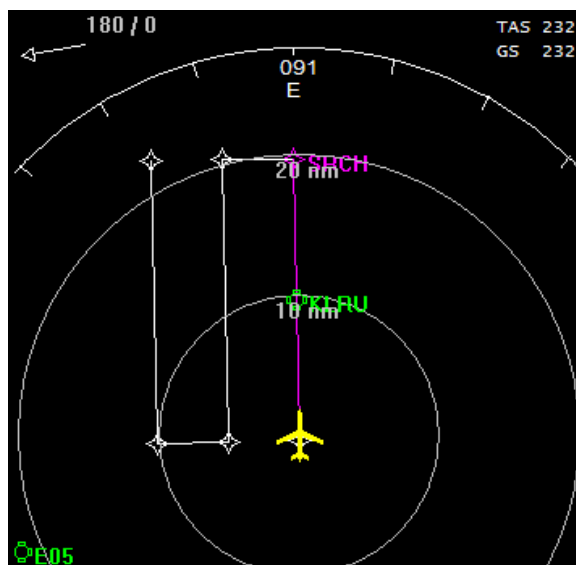
The **NAV SRCH 2/3** page adds additional information.



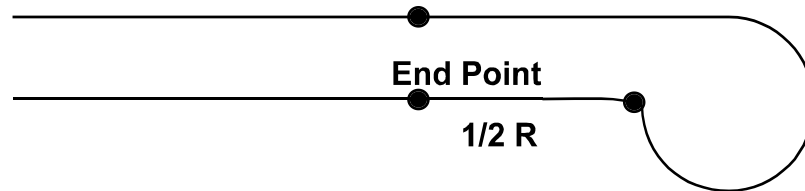
The FMS will display on an MFD map several of the pattern legs. The FMS is currently in ACTIVE mode proceeding to the active waypoint which the FMS named SRCH.



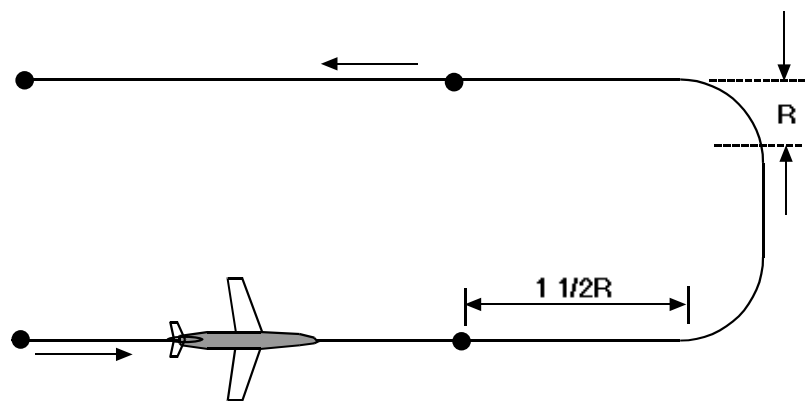
The FMS is now in SEARCH mode with the first leg displayed as the active leg. The SRCH waypoint will always be displayed as the waypoint to which the FMS is navigating.



The Rising Ladder search pattern, as well as the Race Track, presents the problem of connecting the alternate straight legs with varying separation distances. The FMS will approach the problem by flying to a point one half of the minimum turn radius (R) past the end waypoint of the leg and then steer to the new leg. If the separation between legs is less than $2R$, the FMS will turn in a direction to increase crosstrack to the new leg. At a crosstrack distance equal to the midpoint between the leg separation and the $2R$ separation, the FMS will reverse its turn direction and fly on a circular arc to intercept the new leg.

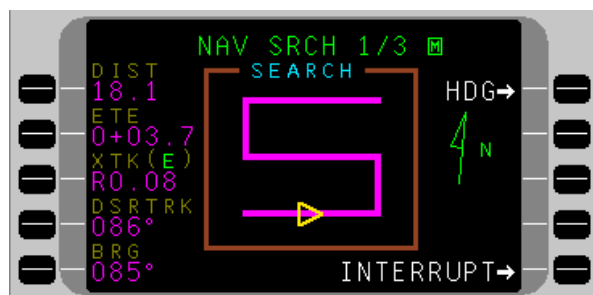


If the separation between legs is greater than or equal to $2R$, the FMS will continue on the straight path to a point $1 \frac{1}{2}R$ beyond the end point. It will then command a turn onto a track perpendicular to the new desired track. At a crosstrack of $2R$, the FMS will command steering on a circular arc to intercept the new leg. It will intercept the new leg before the end point and then fly the great circle path to the next end point.



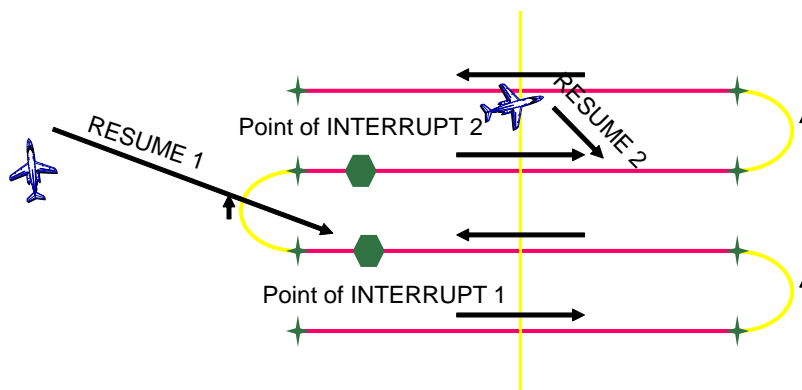
INTERRUPT AND RESUME

While in the search pattern, smoke is spotted off to the west. On **NAV SRCH 1/3** page, press the INTERRUPT line select key. This will allow for maneuvering of the aircraft to investigate the smoke, but resume search on the same leg on the pattern. Press the HDG line select key and enter 286 degrees.



After investigating this, it turns out to be a small brush fire. Maneuver the aircraft back to the INTERRUPT point either manually or with the heading mode to be on course in the correct direction, and then press RESUME. The aircraft will now resume the search pattern.

The rising ladder pattern will not sequence to the next leg until the current leg is complete. When resume is selected, the FMS will calculate an intercept to the active pattern leg with up to a 45° intercept angle. In example RESUME 1, the FMS will proceed to the point of interrupt and then turn to pick up pattern navigation. In RESUME 2, the FMS will turn the aircraft in the navigational direction of the active leg to intercept a point along that leg.



To search a rising ladder leg that is currently not active, the FMS must first complete the current leg or, to immediately go to a new leg, the pilot must redefine a new starting point.

CANCELLATION

A search pattern that is active at the time of cancellation will be reset to its initial condition. If selected again, the flight guidance will be to the initial leg of the search pattern and the search pattern commenced from there.

If INTERRUPT is selected prior to cancellation, the search pattern will *not* be reset, it will be flown from the interrupt point if selected again.

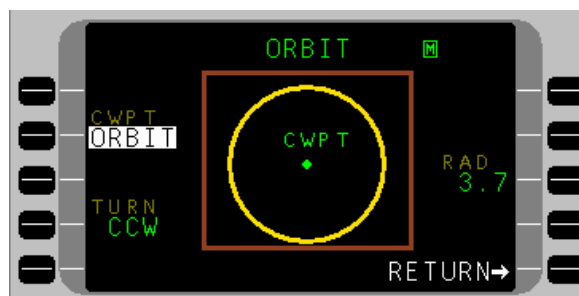
Press the DTO function key to conduct a direct-to operation, or from NAV SRCH 2/3 page, select the MNVR option then PVOR. The search pattern will be canceled and removed from the NAV display.

ORBIT

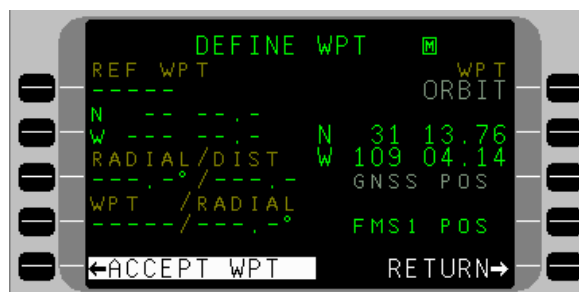
When the crash site is located, to orbit the site an orbit pattern may be used. Press **MENU** from the NAV pages, select PATTERNS and from the **SEARCH PATTERNS** page press the ORBIT line select key.



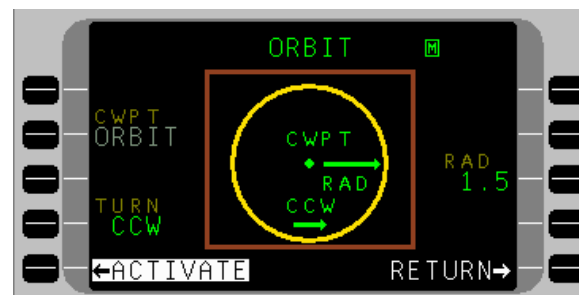
First create a pilot waypoint that will be the center of the orbit pattern. Enter the pilot waypoint name at the cursor and press **ENTER**.



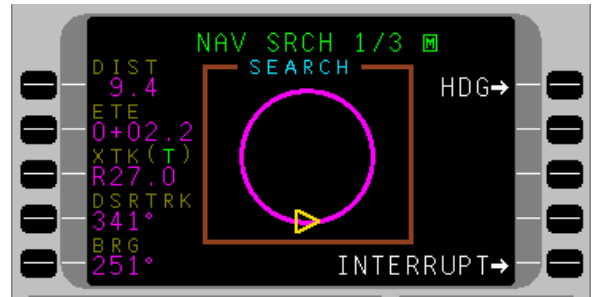
This will bring up the **DEFINE WPT** page. Prior to crossing over the crash site, press line select key 2R. Then press 4R to define the waypoint as the FMS present position.



Press **ENTER** to accept this position and the display returns to the **ORBIT** page.



Select the turn direction and radius. With the cursor over the turn direction field, press **ENTER** to accept the CCW default. If a CW turn were desired, the **±** will toggle the field. The cursor will advance to the RAD field. Enter 1.5 for the radius. Press the ACTIVATE line select key.



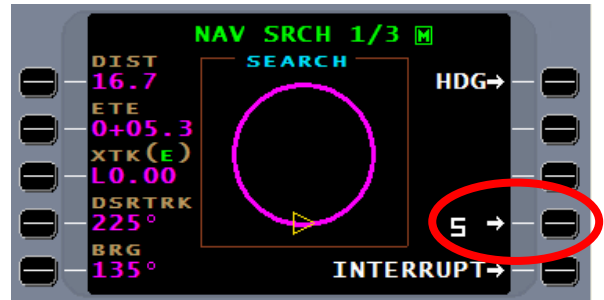
If the aircraft speed is too high to maintain the orbit at maximum bank, a message "RADIUS REQ EXCESS BANK" is displayed.



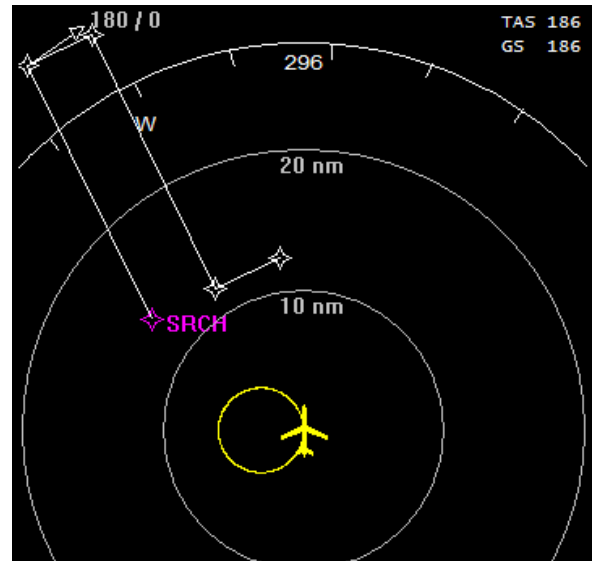
On **NAV SRCH 1/3**, select the SEARCH option. The distance and ETE are reference to the initial entry point on the circle. This waypoint is generated as the closest point on the circle from the aircraft at the time activate is selected. Since the aircraft is flying a circular arc, desired track will be constantly changing. Bearing will be to the center waypoint.

NOTE: While inbound to the orbit, distance displayed will be the circumference of the circle regardless of the actual distance from the OWPT.

The crash site was found while on the rising ladder pattern. Interrupt was initiated from the rising ladder pattern and the aircraft flew to the orbit site. If a requirement exists to rejoin the rising ladder pattern, selection of the line select key with the rising ladder symbol will result in the termination of the orbit pattern and the return to the rising ladder pattern.



With the rising ladder pattern in interrupt status, the MFD map will continue to display the rising ladder legs while flying the orbit pattern.

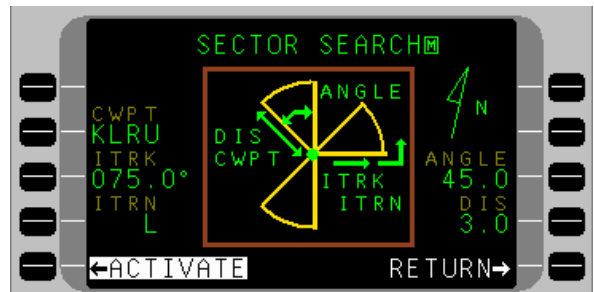


SECTOR

The sector search pattern consists of a series of legs that all overfly the center of a circular search area. The crew will define the center waypoint, the leg lengths, angle between legs, and direction of turn.

A search will be conducted around KLRU.

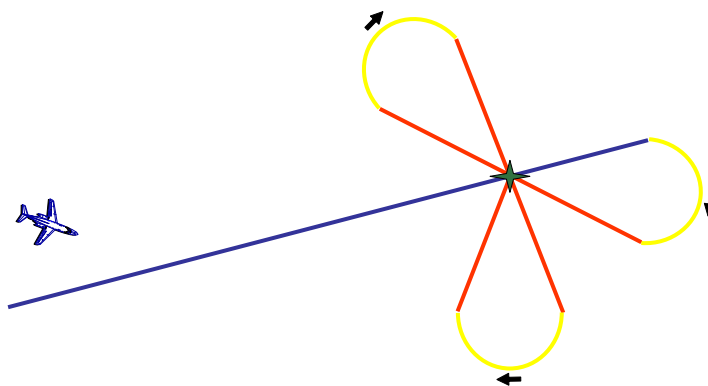
From the PATTERNS page, press the Sector line select key. Our center waypoint (CWPT) will be KLRU. Enter this in the cursor field. Since we are already southwest of this point, we will make our initial track (ITRK) 075.0 degrees. In the ITRK field, line select key 3L, enter 750 and press **ENTER**. We wish to make left turns at the end of each leg. In the ITRN field, line select key 4L, "L" will be prefilled,



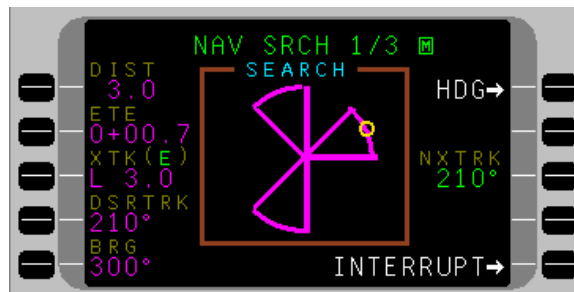
just press **ENTER**. If right turns are desired just press **±** key for "R" and then press **ENTER**. For an angle between legs we will enter 45.0 degrees. In the ANGLE field, line select key 3R, enter 450 and press **ENTER**. Finally, our leg distances will be 3.0nm. In the DIS field, line select key 4R, enter 30 and press **ENTER**. Note that the distance is TO and FROM the CWPT. Each track is made of one 3nm leg to the CWPT and one 3nm leg from the CWPT.

ACTIVATE the sector search.

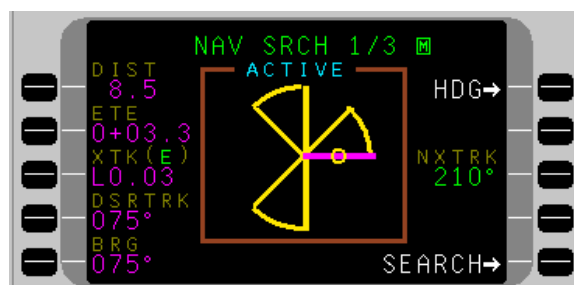
The FMS will create the initial leg for intercept and pressing SEARCH the FMS will fly the pattern.



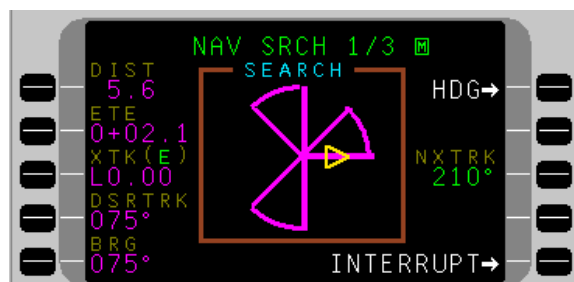
Press the SEARCH line select key to select SEARCH.



The FMS will steer the aircraft to cross the CWPT on the desired course (075). The circle icon will change to a triangle.

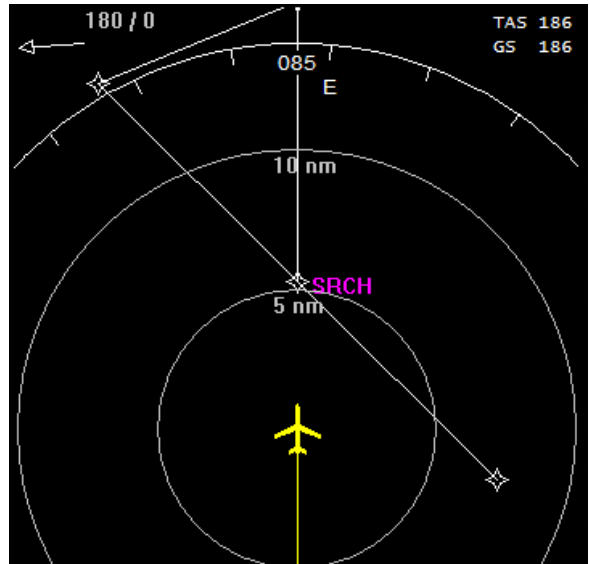


The next track leg (NXTRK) is displayed on the right side 210°. At the end of the FROM leg, the icon will again change to a circle and move to the curved line connecting the two legs, indicating the aircraft is maneuvering to intercept the next leg.



NOTE: Keep in mind that each leg in the sector search sequences is as follows: Initial first leg STARTS from CWPT center waypoint. The first leg ENDS at the selected distance. The second leg STARTS at the same selected distance on the next track and ENDS at the CWPT center waypoint. During the turn between legs all DIST, ETE, XTK (E), BRG references the NEXT leg START point. The search pattern shown on the CDU screen is "pictorial only". The arrow - circle icon will move only on the right side of the pattern.

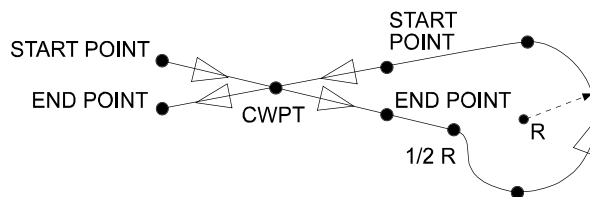
The FMS will display on an MFD map several of the pattern legs. The FMS is currently in ACTIVE mode proceeding to the active waypoint which the FMS named SRCH.



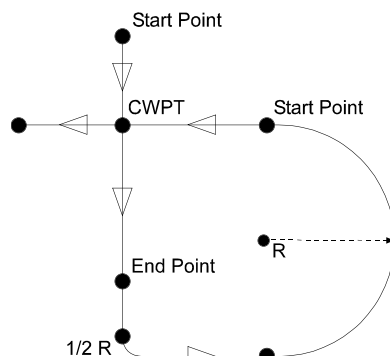
The FMS is now in SEARCH mode with the first leg displayed as the active leg. The SRCH waypoint will always be displayed as the waypoint to which the FMS is navigating.



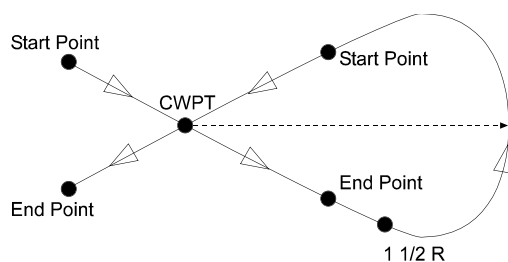
The FMS will fly on the same track for a distance of one half the minimum turn radius (R) of the aircraft under present ground speed plus steering limits. It will then maneuver the aircraft to intercept the new leg in one of three ways.



If the distance between the end point of a leg and the start point of the next leg is less than $2R$ and the aircraft is in a TO position relative to the new leg, the FMS will turn in the direction to increase crosstrack to the new leg. At a crosstrack distance equal to the midpoint between the leg separation and the $2R$ separation, the FMS will reverse its turn direction and fly on a circular arc to intercept the new leg before the endpoint.



If the distance between the end point of a leg and the start point of the next leg is less than $2R$ and the aircraft is in a FROM position relative to the new leg, the FMS will turn to intercept a leg outbound parallel at a spacing of $2R$ to the new leg. At a point on this parallel leg, the FMS shall fly on a circular arc to intercept the new leg before the endpoint.

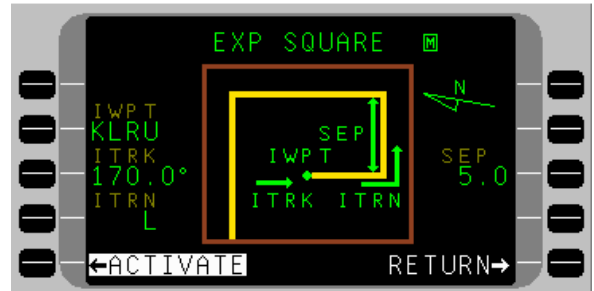


If the distance between the end point of a leg and the start point of the next leg is greater than or equal to $2R$, the FMS will continue on a straight path to a point $1\frac{1}{2}R$ beyond the end point. It will then command a turn onto an orbit segment. At a crosstrack of $2R$ relative to the new leg, the FMS will command steering on a circular arc to intercept the new leg before the end point.

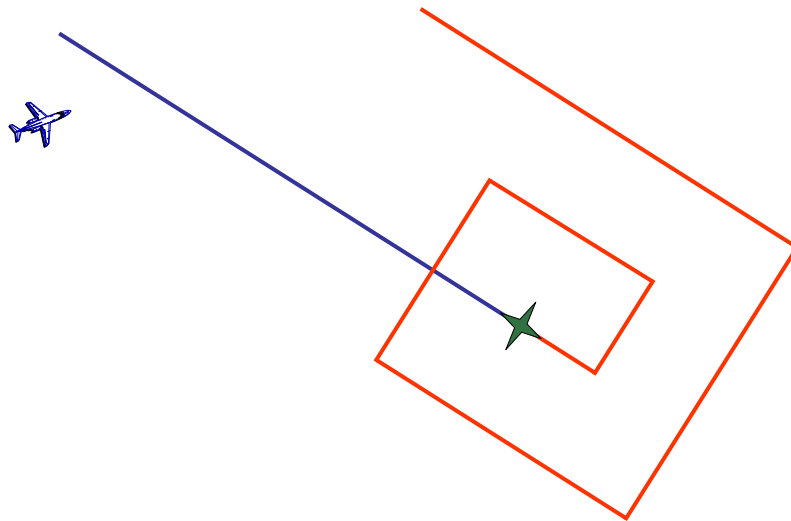
EXPANDING SQUARE

The expanding square pattern consists of a series of legs flown with conventional turn anticipation, where the leg length will be incremented by the leg separation distance after every other leg is flown.

The expanding square is defined by entering the initial waypoint (IWPT), initial track (ITRK), initial turn (ITRN), and leg separation distance (SEP). The pattern is activated the same as the other patterns.



The initial leg will be the greater of the specified separation or twice the minimum aircraft turn radius. This leg length will be established when the expanding square is selected.



RACE TRACK

The race track pattern consists of a pair of parallel legs connecting fly-over waypoints that are connected by special turn sequences. These turn sequences use the same rules as the rising ladder.

The racetrack is defined by entering the IWPT, ITRK, ITRN, leg length (LNTH), and leg spacing (LSPC). The pattern is activated and SEARCH is initiated in the same manner as the other patterns.



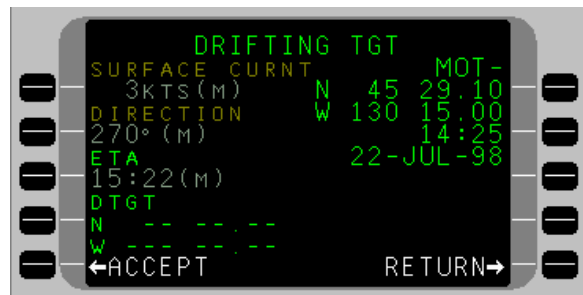
DRIFTING TARGET

Drifting target (DTGT) information, surface current speed, and direction of drifting target are derived from the calculated difference between MMMS velocities and DATA from an external Doppler Sensor. Manual entries may also be entered. MMMS calculates a delta position using current speed, direction, and ETA, then compares the Delta position to the original position to generate the estimated DTGT location.

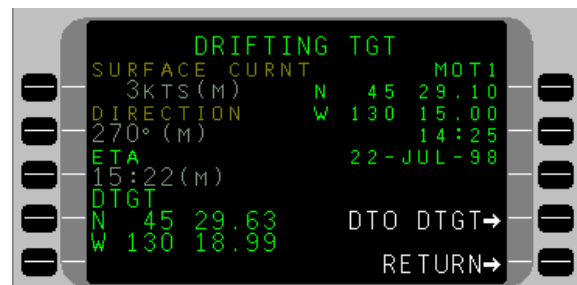
Press the **NAV** key then the **MENU** key to display the NAV MENU. Press DRIFT TGT line select key. For aircraft equipped with Doppler navigation equipment, the surface current and direction is calculated by the FMS and displayed.



For aircraft not equipped with Doppler, manual entries can be made. In the SURFACE CURNT field, line select key 1Lw, manually enter the surface current speed in knots. In the DIRECTION field, line select key 2L; manually enter the direction of surface current. Activating the Mark On Target switch mounted in the cockpit will enter the coordinates of a drifting target by sending a discrete input to the FMS. This will cause the FMS present position, normally overhead the target, to be entered with UTC. Manual entry of the drifting waypoint location may be made by pressing 1R line select key to enter coordinates, 2R line select key to enter time of the fix, and 3R line select key to enter the date. (DD-MM-YY format)



Once these entries are made, press the ACCEPT line select key. The present location of the drifting target will be displayed at the lower left display field and the DTO DTGT line select will be available. Selecting DTO DTGT will cause the FMS to proceed to the calculated coordinates.



Pressing line select key 4R, DTO DTGT, will exit the drifting target page and display the NAV 1/3 or 2/3 page while turning the aircraft to fly direct to the DTGT co-ordinates.

It will then be necessary to return to the DTGT page, press line select key 3L and input the ETA manually. This will add the time to waypoint and recalculate the DTGT position.



Mark On Target (MOT) waypoint list page is accessed from the DRIFTING TGT page by pressing line select key 1R, (cursor over Latitude Field) then press the list key. Up to nine targets (MOT Co-ordinates) may be stored by Number, Date, and Time. Pressing line select key 5L twice deletes all of the waypoints on the page. Use line select key 5R to return to the NAV page.



FLIGHTPLAN ERASE

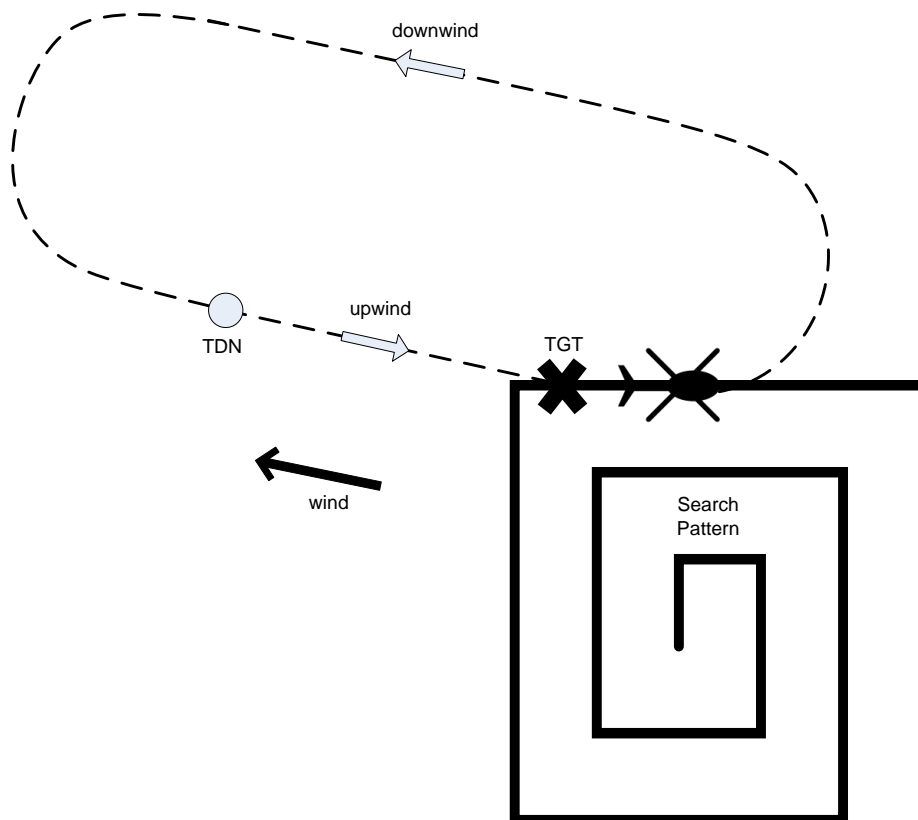
An installation and configuration option is a flight plan Erase discrete that, together with a switch in the aircraft cockpit will erase the current flight plan, pilot routes, and pilot defined waypoints. This process is nonreversible and does not affect the NAV database.

MONOCHROME

A special part number CDU has faceplate lighting compatible with NVG (Night Vision Goggles). The UNS-1 MMMS has the option to display monochrome instead of color. This is selected on the NAV MENU page.

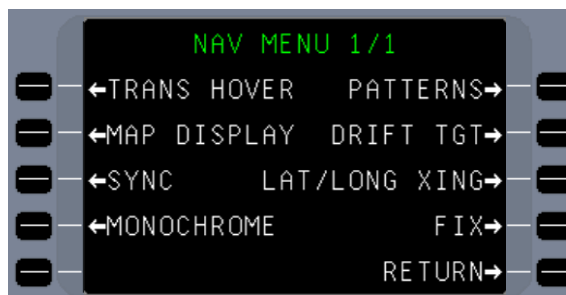
TRANSITION TO HOVER

Available in SCN 1102 MMMS when integrated into the AS332L/L1 Super Puma helicopter. Transition to Hover (TTH) is a feature that allows the pilot to mark a target, and the FMS provides an automatic downwind leg and course reversal to a top of descent point downwind of the target. The FMS will continue lateral guidance while the Puma's CDV-155 performs the vertical transition down and deceleration to a stable hover. A generic configuration is available for other helicopter makes and models to provide lateral guidance via the pattern to the target.



From a search pattern the target is found and marked. The FMS will then calculate the transition to hover pattern from the entries on the TRANS TO HOVER page.

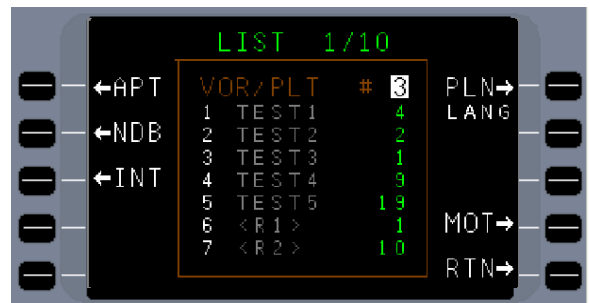
From the NAV MENU page select TRANS HOVER. If page jump is enabled from any page except drifting target a MOT button push will also bring up the TTH page.



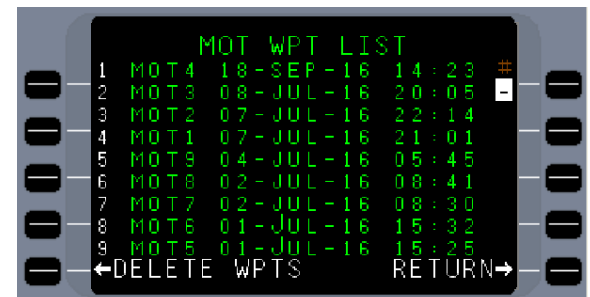
The target waypoint can be based on a Mark on Target (MOT) or the entry of a NAV waypoint, pilot waypoint, or radar waypoint. Date/time stamp is only for MOT.



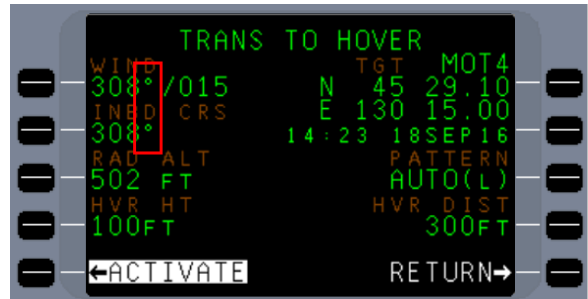
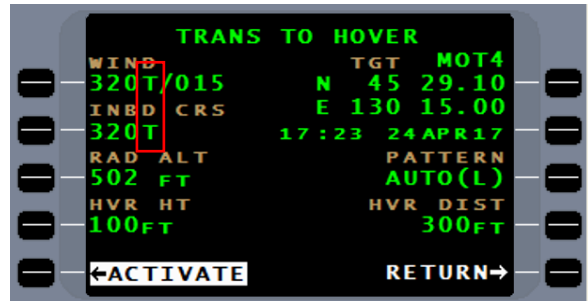
By pressing the lat/long line select key 1R and pressing the **LIST** key, available waypoints will be displayed.



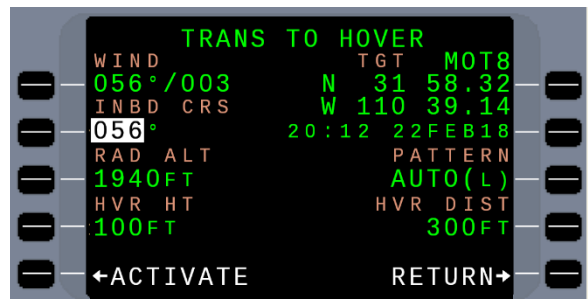
By selecting the MOT line select key, a list of available MOT waypoints will be displayed. The DELETE WPTS line select key will delete all MOT waypoints.



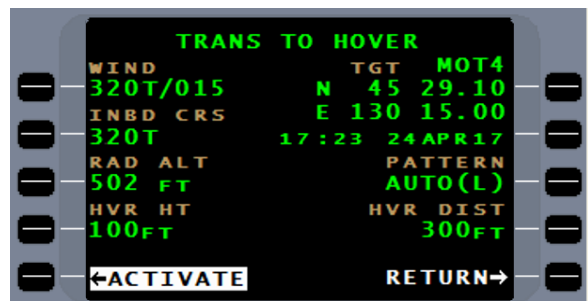
In 1102.0, winds are calculated and displayed on the FMS TRANS TO HOVER page. The presentation will be in either true or magnetic to match the course guidance. On the NAV page the winds will be displayed in true.



The inbound course can be accepted as calculated by the FMS or by pressing INBD CRS line select key 2L, the pilot can enter a manual inbound course. The FMS will adjust the downwind to correspond with this manually entered inbound course.



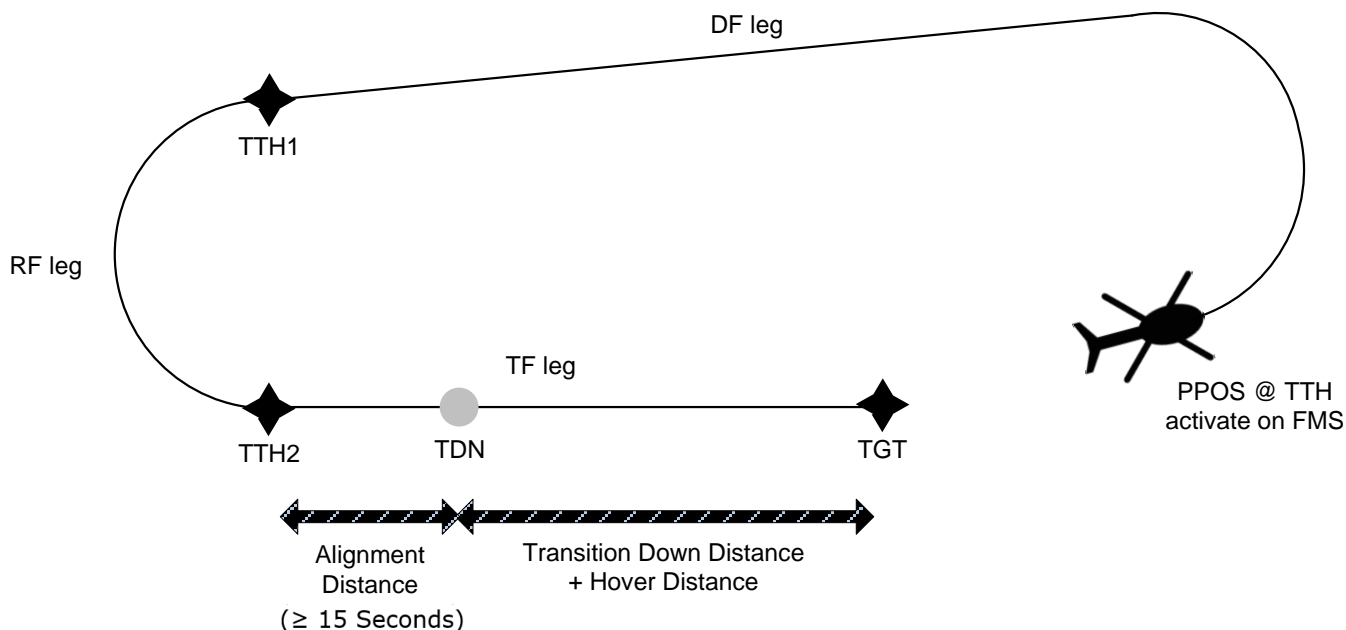
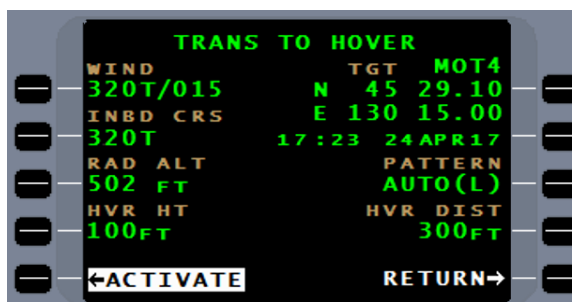
The RAD ALT is the input from the aircraft radar altimeter or manual entry, HVR HT is the altitude received from the Puma's CDV-155 unit or set manually, and HVR DIST is calculated by the FMS based on FMS configuration settings or can be manually set.



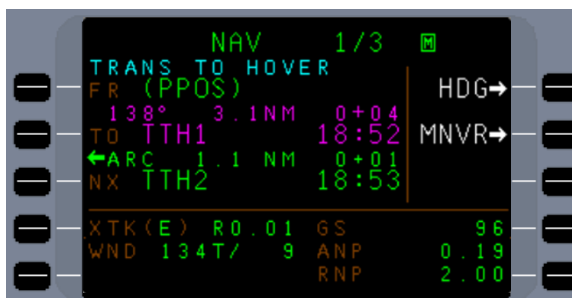
By selecting line select key 3R, PATTERN, the pilot can manually direct the turn to the upwind leg or accept AUTO which provides the shortest path to the upwind leg.



With the TRANS TO HOVER setting complete, the pilot will select the ACTIVATE line select key.



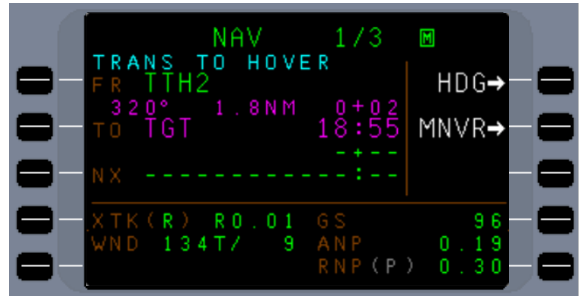
The FMS will switch to NAV page 1 with a TRANS TO HOVER mode displayed. The downwind leg is a direct to fix leg to the first waypoint listed as TTH1.



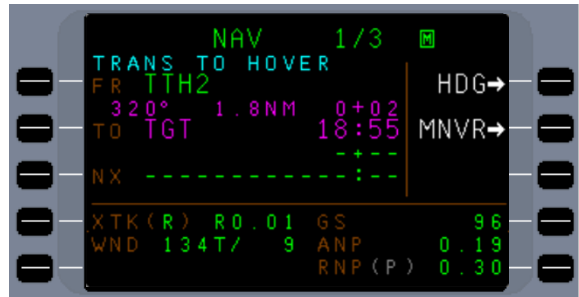
From TTH1 to TTH2 the FMS will calculate a radius to fix (ARC) that, when completed, will be closely aligned to the inbound course to the target. The scaling and alerting will use program embedded (R) for XTK of 0.3nm and (P) for RNP of 0.3nm.



TTH2 to the Transition Down (TDN) point, will be a minimum of 15 seconds. The transition down point is not displayed on 1102.0, but the CDV-155 alerts the pilot as the aircraft approaches the TDN point.



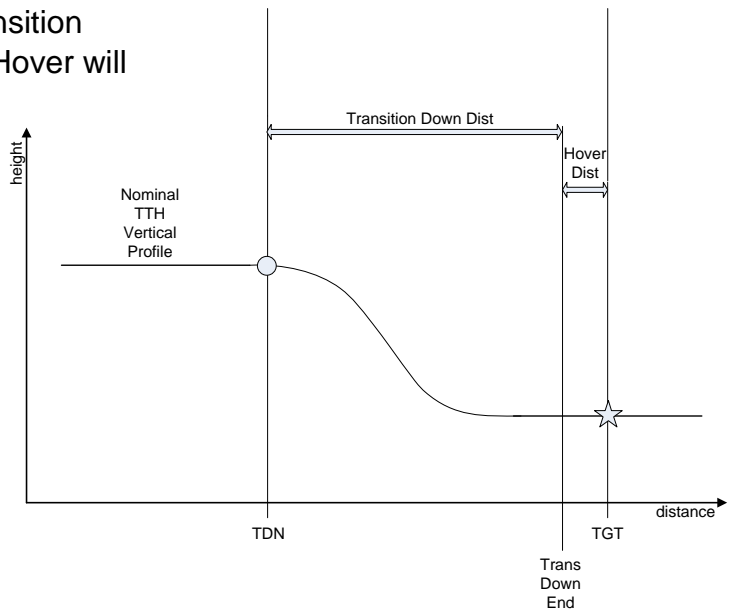
From transition down to the target, TGT, the FMS will provide the lateral guidance and the Puma's CDV-155 unit or pilot will provide the vertical guidance.



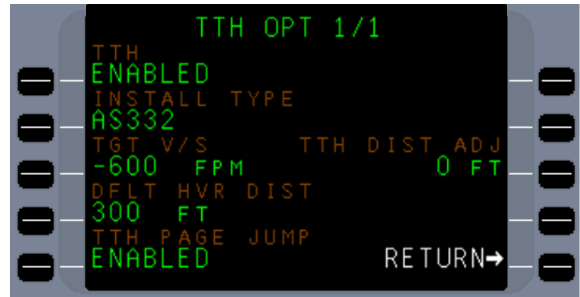
To cancel TTH do any of the following procedures: Direct To (DTO), create a PVOR, do a manual leg change, create a holding pattern, or fly a search pattern.

As with other MMMS tools, the SYNC function is not operational.

The diagram starts with TTH2 to TDN (Transition Down Point). At the TND the Transition to Hover will commence. At the end on the transition down, the aircraft will maneuver to the target (TGT) and hover.



TTH configuration is done through the maintenance pages. On FMS CONFIG page 4 the TTH Options page is selected where TTH may be enabled. When enabled, the Super Puma AS332 or generic may be selected; generic is default. If generic is selected the TGT V/S may be set; -600 is default. The default hover distance may be set; 300ft is default, and the TTH distance adjustment may be set. This tool is for



doing fine adjustments to the top of descent location if the aircraft continually overshoots the target. The page jump tool works with the MOT discrete to jump between the current FMS page and the TTH page when a MOT is detected; default is disabled.

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