NG FMS Series

Honeywell

PILOT'S GUIDE

Flight Management System (FMS) for the Embraer E-Jet E2 E190/E195-E2

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2. System Description

INTRODUCTION

The flight management system (FMS) software resides in one of many processor modules in a modular avionics unit (MAU). A diagram of the MAU is shown in Figure 2-1. The FMS provides a complete range of FMS functions including: navigation, flight planning, lateral navigation (LNAV), vertical navigation (VNAV), performance management and aero engine database (AEDB), navigation database (NDB), takeoff and landing (TOLD) function and TOLD database, Datalink and ATC database, MAGVAR database, and navigation display. The primary purpose of the FMS is to manage navigation sensors to produce a composite aircraft position. Using the composite position, along with flight planning capabilities, the FMS controls navigation, performance, and guidance work for the flight.

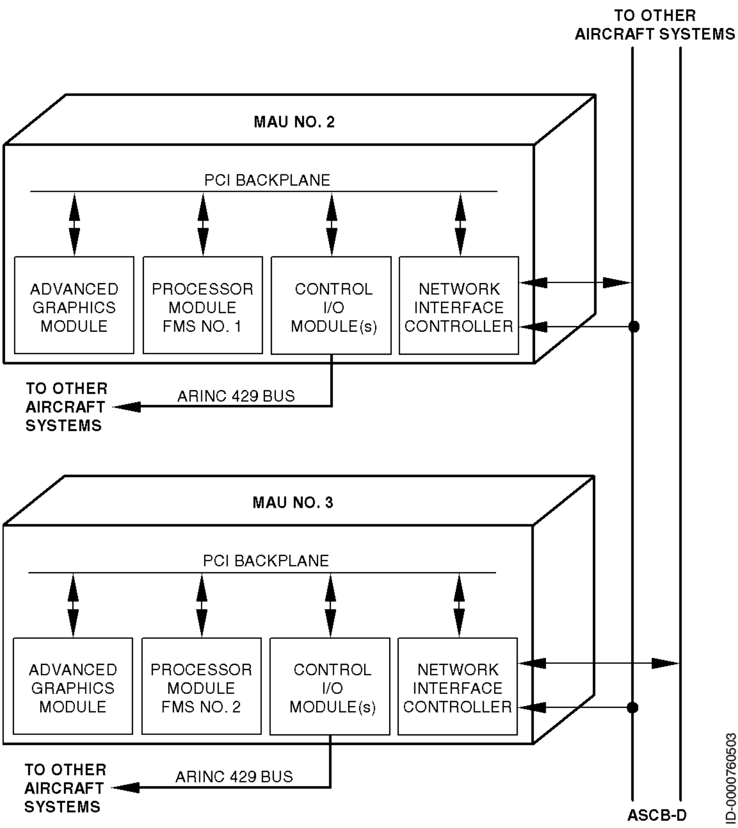

Figure 2-1
Primus Epic 2 MAU

The pilot can interface with the FMS using the multifunction control and display unit (MCDU), the cursor control devices (CCD), and the graphical flight planning (GFP) function on the interactive navigation (INAV) map. FMS tasks are accomplished using either the MCDU or the GFP function.

The FMS combines pilot inputs along with inputs of other aircraft systems to compute navigation, lateral guidance commands, vertical guidance commands, and aircraft performance predictions.

The FMS displays data to the flight crew using the MCDUs and the electronic display system (EDS). The EDS consists of the primary flight displays (PFDs) and the multifunction displays (MFDs). Data displayed on the EDS includes a map presentation indicating radio navigation aids, airports, and waypoints of the active flight plan. Data displayed on the EDS includes a map presentation of all flight plans, when selected, and map option data. Also presented on the EDS are airspeed and altitude targets and annunciation of flight management system modes.

NAVIGATION

- The navigation function computes the aircraft position and velocity for all phases of flight (oceanic, departure, en route, terminal, and approach), including polar navigation.
- The navigation function automatically blends or selects position sensors to compute an optimum position.
- The navigation function automatically selects and tunes radio navigation aids (NAVAIDs) for display and radio position calculation purposes.
- The navigation function calculates an estimated position uncertainty (EPU) as a measure of navigation performance for all phases of flight, including low RNP operations.
- The pilot has the ability to manually tune VHF NAVAIDs via MCDU entry.
- The pilot has the ability to deselect individual sensors if required.

FLIGHT PLANNING

The FMS has the ability to:

- Define an active flight plan, including origin and destination airports and runways, departures and arrivals, and airways
- Perform flight plan modifications, including inserting and deleting waypoints, holding patterns, and entering constraint data (e.g., altitude, speed, flight path angle, time, step altitudes)
- Perform secondary flight planning
- Copy and swap flight plans

- Perform lateral and vertical Direct-To operations
- Perform go-around operations
- Specify an alternate flight plan for diverting
- Perform lateral offsets
- Insert wind data for improved performance computations
- Manually enter or select speed modes for climb, cruise, and descent flight phases.

LATERAL NAVIGATION (LNAV)

- LNAV guides the aircraft along a predetermined lateral flight path.
- LNAV maintains the aircraft within an airway or protected airspace.
- LNAV automatically flies procedures, such as pilot-defined or published holds, procedure turns, offset courses, and approaches.
- The LNAV function constructs a flyable lateral path to be displayed based on predicted speeds and roll limits.

VERTICAL NAVIGATION (VNAV)

- VNAV guides the aircraft at a predetermined altitude, vertical rate, airspeed, or along a flight path. Maneuvers are acceleration-limited for increased passenger comfort.
- VNAV honors the pilot-defined or database altitude/angle constraints, speed restrictions, speed/altitude envelope, and altitude preselector.

AIRCRAFT PERFORMANCE MANAGEMENT

- Computes speed, altitude, fuel, and time estimates for the flight
- Calculates maximum and optimum altitudes
- Optimizes the flight by inserting cost-saving step climbs
- Determines the most economic speeds (when cost index option is enabled)

- Adjusts cruise speeds to achieve a required time of arrival (RTA)
- Constructs a descent that meets required speed, altitude, and FPA restrictions
- Optimizes the descent with fuel-saving optimum segments (when the optimum descent option is enabled).

DATALINK

- Airline Operational Communication (AOC): Requesting and receiving flight plans from the airline operations center
- AOC: Requesting and receiving wind data
- AOC: Requesting and receiving performance initialization data
- AOC: Requesting and receiving takeoff V_{SPEEDS}
- AOC: Reporting position and flight plan information
- Automatic Dependent Surveillance (ADS): Automated reporting to ATC centers of position and intent data
- Controller Pilot Datalink Communications (CPDLC): Two-way communication between the pilot and ATC centers.

NAVIGATION DATABASE (NDB)

- The database contains worldwide coverage of NAVAIDs, airways, standard instrument departure/standard terminal arrival route (SID/STAR) procedures, approach procedures, airports, and runways.
- NAV databases are customizable for a given operation permitting the operator to include items such as engine out SIDs (EOSIDs) and company routes.
- A required navigation performance authorization required (RNP AR) navigation database is necessary for the RNP AR option.

TAKEOFF AND LANDING FUNCTION

The Honeywell takeoff and landing data (TOLD) function calculations are limited to takeoff pitch trim and landing V_{SPEEDS} from the certified data supplied by the aircraft manufacturer. Certified data provided to Honeywell includes FAA, EASA, ANAC and TCCA certification. The TOLD system is loadable, meaning the equations and the coefficients are part of a separately loadable database. The loadable database utilizes OEM-supplied data that can be updated without modifications to the certified flight software.

AERO ENGINE DATABASE (AEDB)

The FMS is equipped with an aero engine database (AEDB) that provides information about the airframe and engine characteristics to be used when computing performance related data such as flight plan predictions. The AEDB includes the required database tables and constants required for modeling the aerodynamic and propulsion characteristics of the aircraft within the flight envelope, as well as any other tables and constants required by the FMS.

AIR TRAFFIC CONTROL (ATC) DATABASE

The FMS supports an air traffic control database (ATC DB) with ATC facility center designations that contain ground addresses used by FMS datalink to downlink data from the aircraft to specified ATC center ground stations.

CUSTOM DATABASE (CDB)

The FMS provides the capability for the flight crew to supplement the data defined by the navigation database by providing user-definition of the desired elements. The custom database (CDB) consists of pilot-defined waypoints, stored flight plans, and permanent notice to airmen (NOTAMs).

MAGNETIC VARIATION DATABASE (MAG VAR DB)

The magnetic variation (MAG VAR) database consists of tables of data representing the magnetic variation for points around the earth. The MAG VAR database is separately loadable to permit periodic updating of the model used by the FMS. This data permits the FMS to compute the magnetic variation for any point on the earth based on the data available for surrounding points.

NAVIGATION DISPLAY

- Navigation displays are shown on the electronic display system (EDS).
- Electronic maps integrate route map and vertical situational display data with auxiliary navigation data to show the situation of the aircraft at any time.
- Electronic displays integrate map data with weather radar displays that includes interactive navigation (INAV).
- The EDS also features a graphical flight planning (GFP) capability. The flight crew has the ability to make changes to the flight plan using the GFP function on the EDS.

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3. System Components

INTRODUCTION

This section describes each system component and function.

FLIGHT MANAGEMENT SYSTEM (FMS)

The function of the next generation (NG) FMS is to supply flight planning capability, navigation information, lateral and vertical guidance, performance data, and takeoff and performance uplinks to the flight crew. The FMS is capable of managing flight details from preflight to postflight. The flight plan and wind information are uplinked to the aircraft using the datalink function. The FMS supplies a worldwide navigation database with standard instrument departures (SIDs), standard terminal arrival routes (STARs), approaches with missed approaches, airways, navigation aids (NAVAIDs), and waypoints that are incorporated into the flight plan as required. The takeoff and landing data (TOLD) function supplies takeoff pitch trim computation and landing V_{SPEED} data.

The FMS is capable of providing detailed predictions regarding estimated time and fuel remaining along the entire flight plan. With this information, the FMS can perform high accuracy, long-range, lateral and vertical navigation along the flight plan. To accomplish these functions, the FMS communicates with a variety of short-range and long-range navigation sensors. The primary short-range sensors are very high frequency omni bearing range/ distance measuring equipment (VOR/DME) and DME/DME. Long-range sensors include hybrid inertial reference system (IRS) option, IRS, and global positioning system (GPS). Using the available sensors, the FMS develops a position based on a blend or mix of sensor inputs. Based on the position and the flight plan, the FMS generates information for display on the multifunction control and display unit (MCDU) and the electronic display system (EDS).

The lateral navigation function of the FMS calculates navigation information relative to selected geographical points. The pilot defines flight plan routes worldwide. The system outputs advisory information and steering signals showing the pilot or flight guidance system (FGS) how to guide the aircraft along the desired route. Routes are defined from the present position of the aircraft to a destination waypoint along a great circle route or through a series of great circle legs defined by intermediate waypoints.

The vertical navigation function of the FMS calculates navigation information relative to selected altitudes, airspeeds, or geographic/ altitude combinations. The system outputs primary information and steering signals showing the pilot or FGS how to guide the aircraft along the desired vertical profile.

MULTIFUNCTION CONTROL AND DISPLAY UNIT (MCDU)

The MCDU (MC-860), shown in Figure 3-1, is the pilot interface to the system. The function of the MCDU is described in this section. It is necessary to know the general rules and operating characteristics of the MCDU in order to understand the specific operations of the FMS.

MCDU operation is designed to be simple and to minimize crew workload in all phases of flight. The MCDU serves as the pilot interface with the navigation computer, as well as other systems that the FMS interfaces. Pilots enter data using the alphanumeric keyboard and the line select keys.

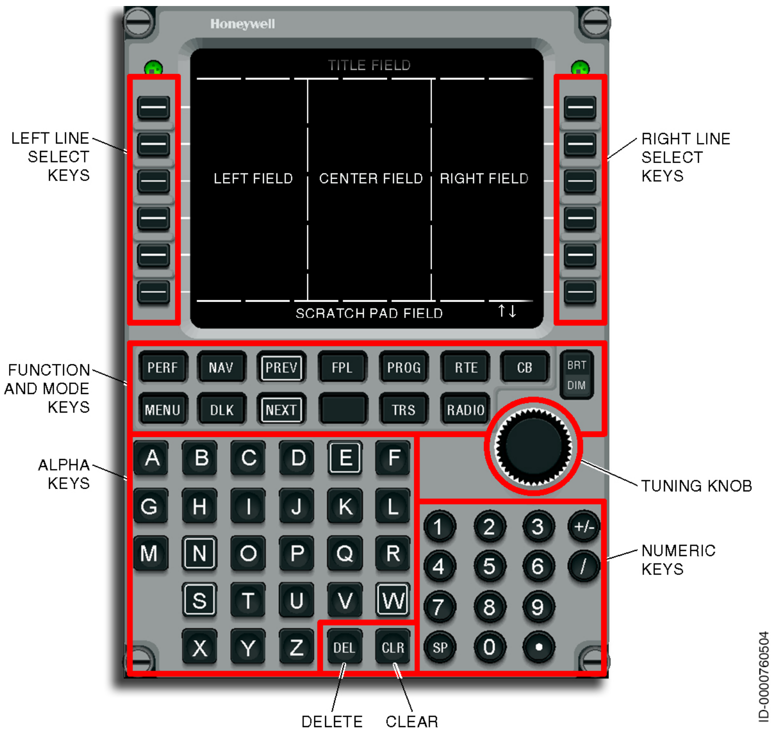

Figure 3-1
MCDU

MCDU Display

The MCDU has a full-color display and contains 14 lines. Each line contains 24 characters. The first line is a title line and line 14 is the scratchpad.

- **Color Assignments** – Color on the MCDU display page is designed to highlight important information. Color assignments are coordinated as much as possible with other displays. Table 3-1 lists definitions of color assignments.

Table 3-1
MCDU Color Coding Scheme

Assigned Color	Parameter
Cyan	Atmospheric Data, Vertical, Performance, MOD Flight Plan Waypoints
Green	Lateral, Modes, Waypoints, Course, Distance-to-Go (DTG), Estimated Time of Arrival (ETA)
Yellow	Warnings, FROM Waypoint, Flight Plan Names
Magenta	TO Waypoint, Some Active Subsystems
White	Menus and Titles
Red	Failures

- **Viewing Angle** – All symbols for the MCDU are visible at a viewing angle of 45° from the sides, 15° from the top, and 30° from the bottom. The MCDU can be adjusted for parallax, as well as view angle, based on the installed location in the cockpit. Refer to page 17-3 of this guide for details on parallax adjustment.

- **Displays** – Boxes (□□□) and dashes (**- - -**) are used to enter data. Boxes are displayed for data that is used for some form of computation while dashes are not.

NOTE: The previous is not true for Datalink display pages described in Section 13, Datalink.

Alphanumeric Keys

The MCDU alphanumeric keyboard is used by the pilot for input to the FMS. The alphanumeric keys make entries to the scratchpad only.

Each of the following are represented with a key on the MC-860. Letters are the alphabet, the numbers 0-9, the decimal, the plus/minus, the space, and the slash. See Figure 3-1 for key location. The space (SP) key is used to insert a space following a character in the scratchpad. The plus/minus (+/-) key is used to enter a - or + in the scratchpad. The initial push of the +/- key results in a - being entered. A subsequent push results in changing the - to a +. Continued pushing of this key toggles the +/- display.

Scratchpad

The bottom line on the MCDU display is the scratchpad. The scratchpad is a working area where the pilot enters data and/or verifies data before line selecting the data into the proper position. Alphanumeric entries are made to the scratchpad using the keyboard. As each key is pushed, the character is displayed in the scratchpad. Information in the scratchpad does not affect the FMS until moved to another line on the display. Data is retained in the scratchpad throughout all mode and page changes.

The scratchpad also shows advisory and alerting messages. The scratchpad shows a liquid crystal display (LCD) bright/dim control bar. See page 3-17 for additional details. The scratchpad has the following display priority:

- Bright/Dim control bar
- Alerting messages
- Advisory messages
- Delete function
- Entry and line selection.

Scratchpad Editing Mode

The scratchpad has an editing mode. While the editing mode is available all the time, it is most useful when entering messages for certain functions. Procedure 3-1 describes the procedure for using the scratchpad editing mode.

Procedure 3-1
Scratchpad Editing Mode

1. The editing mode is entered by ending the scratchpad entry to be edited with a dash (-) and pushing the previous (PREV) key.
2. The PREV and NEXT keys in the editing mode, move a reverse video cursor in the scratchpad.
3. The character in the reverse video field is removed with the clear (CLR) key or a new character is inserted before it.
4. Pushing the delete (DEL) key deletes the entire scratchpad entry.
5. The editing mode is exited when the scratchpad entry is moved to a line by pushing a line select key or by the selection of the NEXT key when the last character is highlighted/edited.

Line Select Keys (LSK)

There are six line select keys on each side of the MCDU display. Data is selected to a line from the scratchpad or vice-versa using the line select keys. These keys are identified from top to bottom as 1L through 6L on the left side and 1R through 6R on the right side. The line select keys are the most often used keys on the MCDU.

- **Direct Access Prompts/Function Selects** – In the case of an index display, the line select keys are used for selecting functions from the index. In displays other than index, the bottom line select keys (6L, 6R) are primarily used for direct access to other functions in the FMS. The functions most likely to be accessed from the present page and phase of flight are displayed as prompts. An example is the ARRIVAL prompt that is displayed on the active flight plan pages, when within 200 NM (nautical miles) of the destination. These types of prompts reduce the number of key strokes in order to minimize pilot workload. The pilot also accesses functions through the main navigation and performance indices.

- **Transfer Line Data to Scratchpad** – When the scratchpad is empty, pushing a line select key transfers the respective line data to the scratchpad. This is commonly referred to as **down selecting**.

- **Transfer Scratchpad Data to Line Fields** – Once data is entered into the scratchpad either through line selection or manual keyboard entry, the data is transferred to any of the permitted line select fields on a page. Transferring the data is done by pushing the key adjacent to the line where the scratchpad data is intended. This is commonly referred to as **up selecting**.

Clear (CLR) Key

The CLR key executes the following functions:

- When a message is displayed in the scratchpad, pushing the CLR key deletes the message.

- When a scratchpad entry begins with a pound sign (#), pushing the CLR key removes the entire entry.

- When an alphanumeric entry is made in the scratchpad, one character is cleared from the scratchpad (from right to left) each time the CLR key is pushed. When the CLR key is held down after the first character is cleared, other characters are cleared, one at a time, until the key is released. Refer to Scratchpad on page 3-5 for use of the CLR key editing feature.

Delete (DEL) Key

The DEL key is used to delete items from the FMS. When the DEL key is pushed, *DELETE* is displayed in the scratchpad. The DEL key is line selected to delete waypoints or other items displayed in the MCDU data fields. When a message is displayed, the delete operation is inhibited. Delete is also used to return default values after entries are made. Finally, as noted under Scratchpad on page 3-5, the DEL key is also used in the scratchpad edit mode. With a dash (-) at the end of the scratchpad entry, pushing the DEL key deletes the entire scratchpad entry.

NOTE: Not all entries have this capability of returning to default values using DEL. In those cases, an INVALID DELETE message is displayed.

Function Keys

The 13 function keys located directly below the screen, as shown in Figure 3-1, access primary functions, indices (menus), and page selection.

NOTE: Following power-up, the MCDU defaults to a non-FMS page. Pushing any FMS related function key, in this case, results in the MCDU showing the FMS NAV IDENT page for flight crew verification of the FMS software and database.

- **Performance (PERF) Key** – Pushing the PERF function key shows page 1 of the performance index. The pilot selects any of the index functions by pushing the respective line select key. These are shown in Figure 3-2 and Figure 3-3. Refer to Performance Index on page 5-1 for additional details.

Figure 3-2
PERF INDEX 1/2 - PERF Function Key

Figure 3-3
PERF INDEX 2/2

- **Navigation (NAV) Key** – Pushing the NAV function key displays page 1 of the navigation index. This is shown in Figure 3-4 and page 2 is shown in Figure 3-5. The pilot selects any of the index functions by pushing the respective line select key. Refer to Navigation (NAV) Index on page 6-1 for additional details.

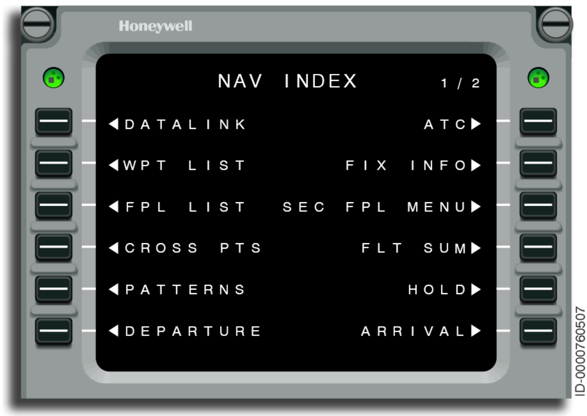

Figure 3-4
NAV INDEX 1/2 - NAV Key

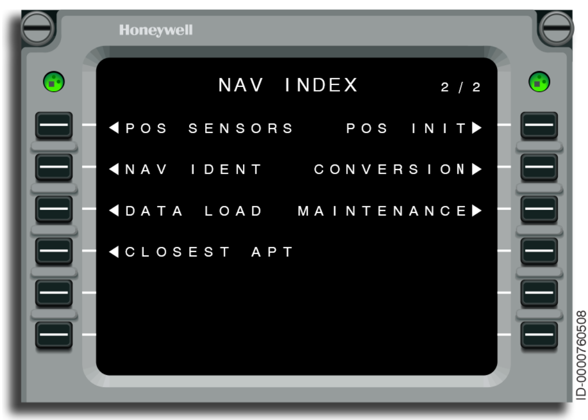

Figure 3-5
NAV INDEX 2/2 - NEXT Key

- **Paging (PREV)/(NEXT) Keys** – The specific page and number of pages in a particular function or menu are shown in the upper-right corner of the display. The page number format is AA/BB where AA is the current page and BB is the total number of pages available. Page changes are made by pushing the NEXT and PREV (previous) keys. An example is shown in Figure 3-5. The keys are held down for repeated page changing. Refer to Scratchpad on page 3-5 for use of the PREV and NEXT keys for editing.

- **Flight Plan (FPL) Key** – Pushing the FPL key shows the first page of the active flight plan. An example page is shown in Figure 3-6. When a flight plan exists with performance initialized, these pages show the FROM waypoint and all the remaining waypoints of the active flight plan along with various attribute and performance data associated with the waypoint. The first page also shows the current speed target in LSK 1R. Modifications to the flight plan are done through these pages.

  When no flight plan is entered, the pilot can perform the following:

  – Manually create a flight plan

  – Select a stored flight plan

  – Select a flight plan from the data management unit (DMU) or data LAN management unit (DLMU)

  – Insert a datalink flight plan.

Refer to Flight Plan (page 9-1) for additional details.

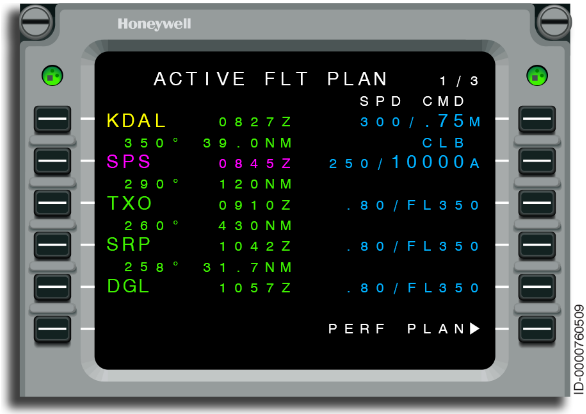

Figure 3-6
ACTIVE FLT PLAN - FPL Key

- **Progress (PROG) Key** – Pushing the PROG key shows the first progress page. This mode shows the current status of the flight. The first progress page shows the estimated time en route (ETE), distance to and fuel projection for the TO waypoint, the NEXT waypoint, and destination. It also shows the current NAV mode, the required and estimated navigation performance, and the NAVAIDs presently tuned. A typical progress page is shown in Figure 3-7. Refer to Progress (page 10-1) for additional details.

Figure 3-7
PROGRESS - PROG Key

- **Route (RTE) Key** – While on the ground, pushing the RTE function key shows the route page 1 with origin, destination, runway, and company route identifier information. The pilot selects any of the index functions by pushing the respective line select key. This is shown in Figure 3-8.

Figure 3-8
ACT RTE - RTE Key On-Ground

By pushing the PREV/NEXT keys, pages 2 through X of the remaining RTE pages are accessed while on-ground. These RTE pages show the FMS flight plan in terms of air traffic clearance references (e.g., procedures and airways). The final RTE X/X page gives the operator quick access to the ALTERNATE RTE page.

When the RTE key is pushed while in-air, the RTE page 2 through X corresponding to the aircraft position in the flight plan is displayed instead of RTE 1 page, as shown in Figure 3-9.

Figure 3-9
ACT RTE - RTE Key In-Flight

- **Radio** – Pushing the RADIO function key results in the display of the RADIO 1/2 page. From this location and also the RADIO 2/2 page, the pilot attempts to tune various radios including COM1, COM2, and NAV1, NAV2, as shown in Figure 3-10.

Figure 3-10
RADIO 1/2 - RADIO Key

- **Menu** – Pushing the MENU function key shows the MCDU MENU page that gives access to A739 subsystems (e.g., Backup Radio). This is shown in Figure 3-11.

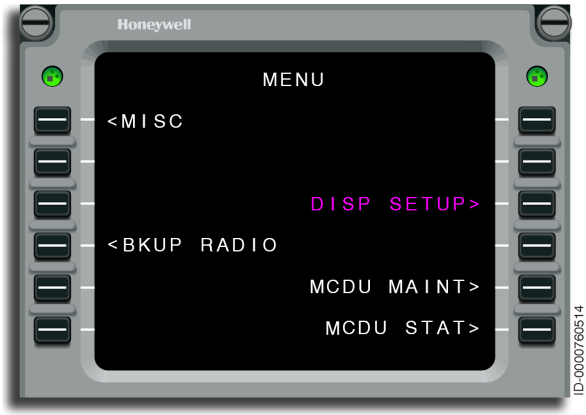

Figure 3-11
MENU - MENU Key

NOTE: Backup (BKUP) RADIO at LSK 4L is only displayed on the copilot's MCDU.

Brightness Control

Both manual and automatic (photo sensor) brightness controls are used to increase or decrease the MCDU display brightness. When manually selected, a bright/dim bar is displayed in the scratchpad, as shown in Figure 3-12. The bright/dim bar level is controlled by pushing BRT or DIM.

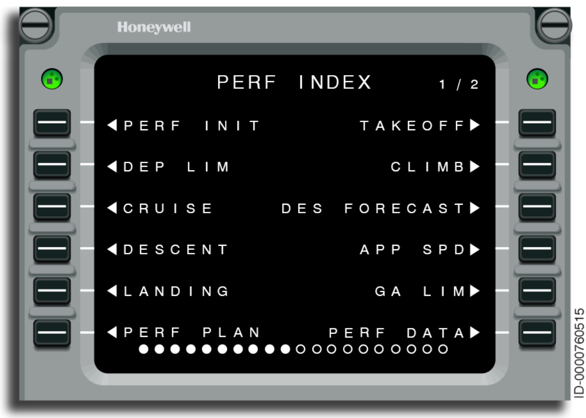

Figure 3-12
Brightness Control - BRT/DIM Keys

Following manual adjustment, the photo sensors monitor the ambient light and maintain the brightness level of the MCDU display over various lighting conditions. If there is more ambient light, such as daylight, the brightness is increased and vice-versa, so the display remains readable for very lit conditions and dimmed for night or low ambient light conditions.

Accessing any FMS Function

The FMS prompts the pilot at 6L and 6R for the most likely functions to be selected. Using these prompts, the FMS steps the pilot through procedures such as initialization. At any time, it is possible to operate out of sequence or to access other areas of the FMS. Follow Procedure 3-2 to access any function of the FMS.

Procedure 3-2
Accessing any FMS Function

1. Determine the required function. All functions are available at all times from the PERF, NAV, FPL, PROG, or RTE keys.
2. Select the correct PERF, NAV, FPL, PROG, or RTE key.
3. When PERF or NAV is selected, read the menu list for the required function or feature.
4. Select the correct function or feature.
5. The FMS displays the function or feature selected.
6. Continue working using the prompts at 6L and 6R when part of a sequence, such as initialization, is being completed.

Annunciators

Annunciators are displayed on the electronic display system (EDS), specifically the primary flight display (PFD). Magenta indicates an advisory annunciator and amber indicates an alerting annunciator.

- **Third Line FMA Information** – FMS supplies some of the third line flight mode annunciator (FMA) information for approaches as well as some engine out indications.
- **Approach** – FMS supplies the approach types of RNP, LPV, and L/VNAV for display along with the RNP value of the approach when an RNP approach type is selected.
- **Engine Out (EO)** – The FMS supplies the indicator of EO AUTO when the engine out occurs and it is automatically confirmed when the take off and go around automation APM is enabled. This automation includes engine out speed targeting, engine out bank limiting, and inclusion of an EOSID in a MOD flight plan, if available in the NDB. The FMS also supplies the indicator of DRIFT DOWN when an engine out occurs above the EO maximum altitude.

- **Dead Reckoning (DR)** – DR is an alerting (amber) annunciator. This annunciator is displayed or lit when operating in the DR mode. The FMS enters DR mode after loss of required navigation performance (see DGRAD) and loss of radio updating and all other position sensors (IRS and GPS) for greater than 2 minutes.

- **Degraded (DGRAD)** – DGRAD is an alerting (amber) annunciator. This annunciator is displayed when the FMS loses required navigation performance (RNP). This is accompanied by the UNABLE RNP scratchpad message.

  The DGRAD annunciator is displayed on the horizontal situation indicator (HSI) and LNAV display when FMS is the selected aircraft navigation source on EDS, and any of the following conditions exist:

  – FMS estimated position uncertainty (EPU) is greater than RNP

  – FMS position integrity estimate is greater than the integrity alarm limit (this occurs when EPU is slightly less than RNP)

  – GPS is not available and GPS is required for the selected flight plan procedure.

  If the DR annunciator is displayed when the DGRAD annunciator is lit, the DGRAD annunciator is removed.

- **Message (MSG)** – The MSG annunciator is an alerting (amber and reverse video) annunciator. The annunciator is displayed when there is a message on the MCDU scratchpad. The annunciator is removed or turned off after the message(s) are cleared from the scratchpad.

  Messages are displayed in the MCDU scratchpad at various times. Messages inform or alert the pilot as to the system status. Messages are divided into the following two major groups:

  – ADVISORY MESSAGES – Advisory messages contain information helpful to the pilot. Advisory messages are normally the result of a pilot action on the MCDU (e.g., making an entry with the incorrect format). These messages do not turn on the MSG annunciator.

  – ALERTING MESSAGES – Alerting messages alert the pilot to the FMS status, assuming the pilot is not looking at the MCDU (e.g., a message annunciating a sensor failure).

Messages are stacked for display in priority order on a first in, last out basis. In cases where there are multiple messages stacked, the message annunciator remains displayed or lit until all messages are cleared. Only one message is cleared per CLR key push.

- **Approach (APPR)** – APPR is an advisory (magenta) annunciator. The annunciator indicates the FMS is in the approach mode of operation. In this mode, the EDS deviation sensitivity and FMS tracking gains are increased. The approach annunciator is displayed when ALL of the following conditions are valid:
  - The FMS is the selected aircraft navigation source on EDS
  - A nonprecision instrument approach must have been activated from the navigation database. When no approach, or an instrument landing system (ILS), localizer (LOC), localizer-back course (LOC-BC), landing directional aid (LDA), or simplified directional facility (SDF) is selected, the APPR annunciator does not light.
  - The aircraft position is between 2 NM outside the final approach fix (FAF) and the missed approach point (MAP)
  - The DGRAD annunciator must not be displayed.
- **Terminal (TERM)** – TERM is an advisory (magenta) annunciator. TERM indicates the FMS is in the terminal area and required navigation accuracy has increased. The TERM annunciator is displayed on the PFD when the aircraft is within 30 NM radial distance from the origin or destination airport. Neither DGRAD or DR are displayed for this annunciator to be displayed.
- **Lateral Track Alert (WPT)** – WPT is an advisory (magenta) annunciator. The FMS gives a lateral track annunciator (WPT) 30 seconds prior to sequencing a waypoint.
- **Vertical Track Alert (VTA)** – VTA is an advisory (magenta) annunciator. A vertical track annunciator is given to warn of impending FMS vertical track command changes.

A VTA is issued for the following conditions:

- The aircraft is within 1,000 feet of capturing an altitude constraint that is not colocated with the altitude preselect
- In CRUISE, 1 minute prior to top-of-descent (TOD)
- One minute prior to resuming a climb or descent from a constrained waypoint
- Prior to resuming a vertical flight level change (VFLCH) descent due to a speed limit altitude level-off
- In CRUISE, 1 minute prior to executing a step climb.

The VTA is also issued as an audible annunciator.

- **Lateral Offset (OFFSET)** – OFFSET is an advisory (magenta) annunciator. The FMS gives the capability to define and fly a parallel offset of up to 30 NM on any track to a fix (TF) or course to a fix (CF) leg that is not included in an approach or hold. A parallel offset can also be flown to a direct to a fix (DF) leg following the final turn.
- **Required Navigation Performance (RNP)** – RNP is an advisory (magenta) annunciator. It is the RNP value for the current phase of flight.
- **Localizer Performance With Vertical Guidance (LPV)** – The GPS reference path identifier is an advisory (magenta) annunciator.

Blank Page

4. Operational Example

INTRODUCTION

This section describes the normal operational procedures of the flight management system (FMS) for a flight from Phoenix, Arizona (KPHX) to Minneapolis/St. Paul, Minnesota (KMSP). KMSP is forecast to be instrument meteorological conditions (IMC) at arrival time, therefore, Duluth, Minnesota (KDLH) is used as the alternate.

NOTE: This section describes FMS procedures using the MCDU. For directions on graphical flight planning using the INAV map, refer to Section 12, Graphical Flight Planning*.*

This section is subdivided into:

- Predeparture
- Takeoff
- Climb
- En route/Cruise
- Descent
- Arrival
- Landing
- Approach
- Missed approach
- Alternate flight plan
- Flight complete.

The flight plan is as follows: KPHX SILOW4 RSK J44 ALS DVV J114 ONL MCW KASPR6 KMSP. The departure runway is 8 in KPHX and the landing runway is 30L in KMSP. The approach is ILS 30L with the HASTI transition.

NOTE: The procedures and route used in this section are for demonstration purposes only and not to be used for navigation.

The SILOW4 departure is shown in Figure 4-1.

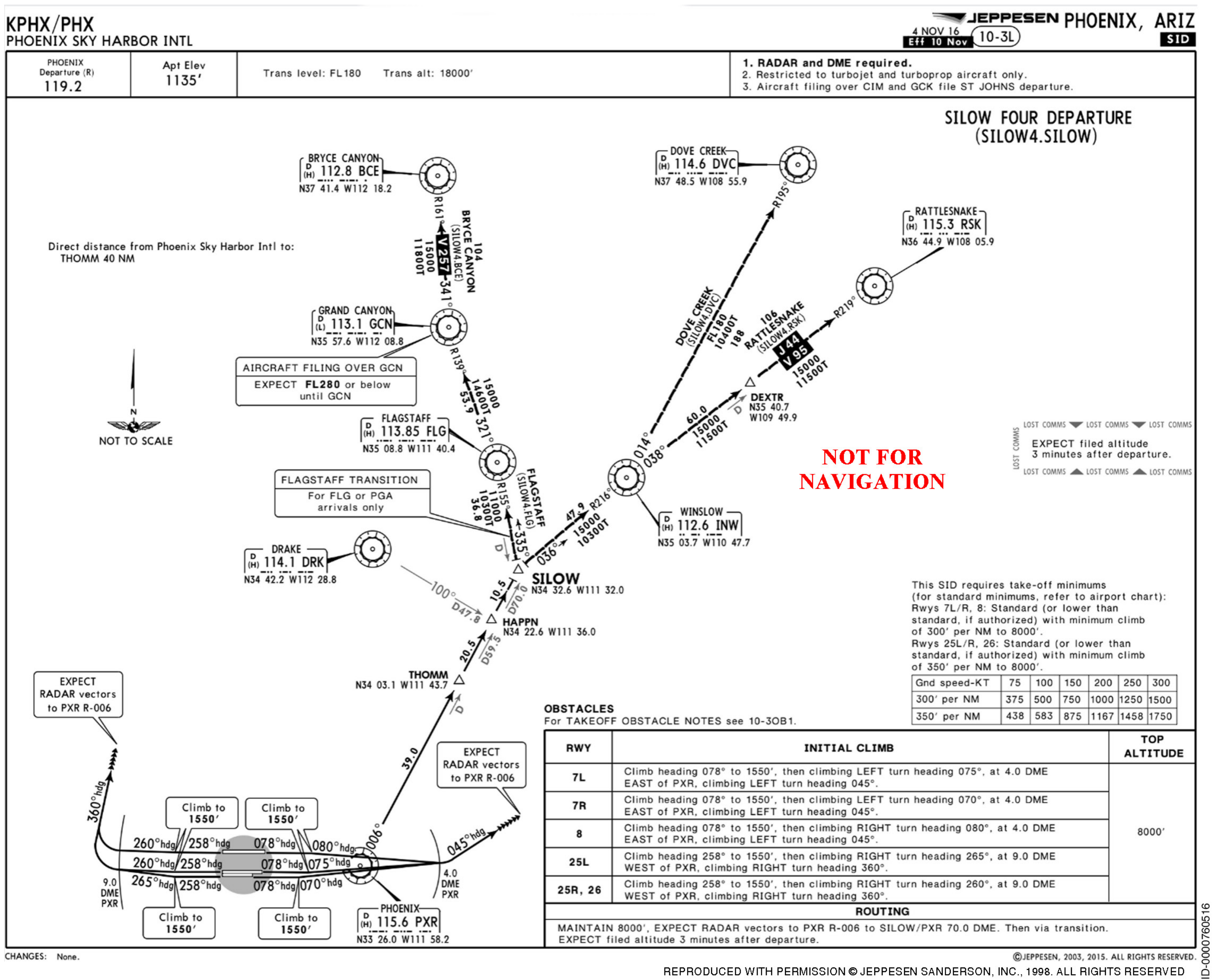

Figure 4-1
Phoenix, AZ SILOW4 Departure

The Minneapolis, MN KASPR6 Arrival is shown in Figure 4-2.

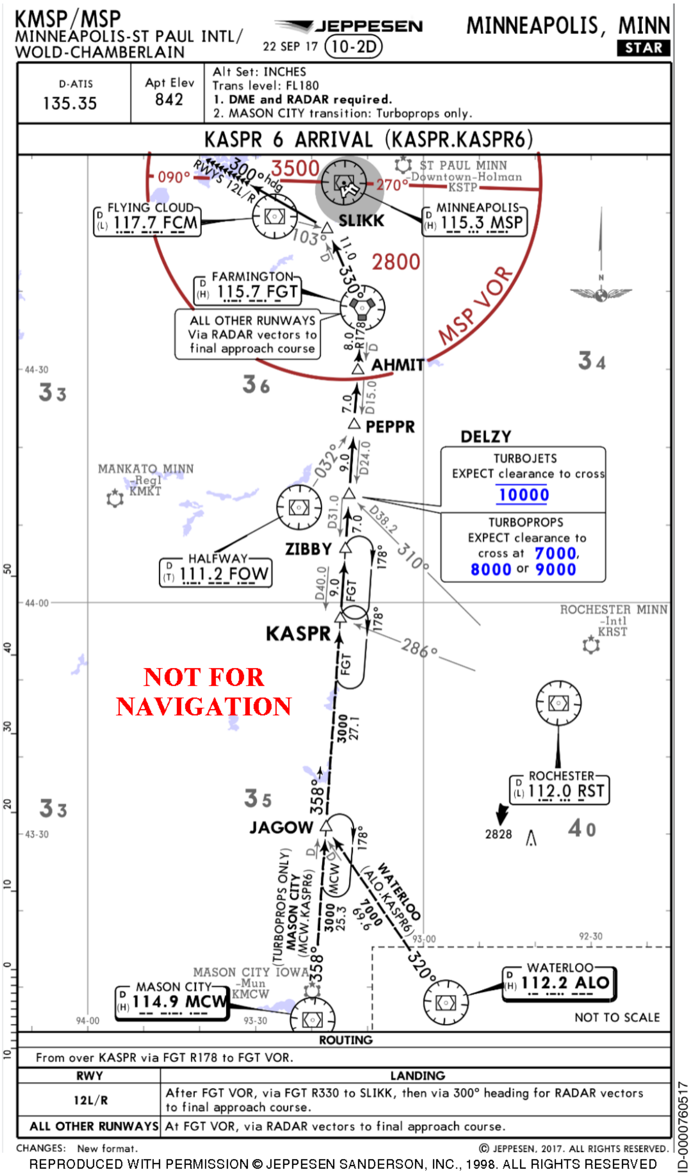

Figure 4-2
Minneapolis, MN KASPR6 Arrival

The Minneapolis, MN ILS 30L Approach is shown in Figure 4-3.

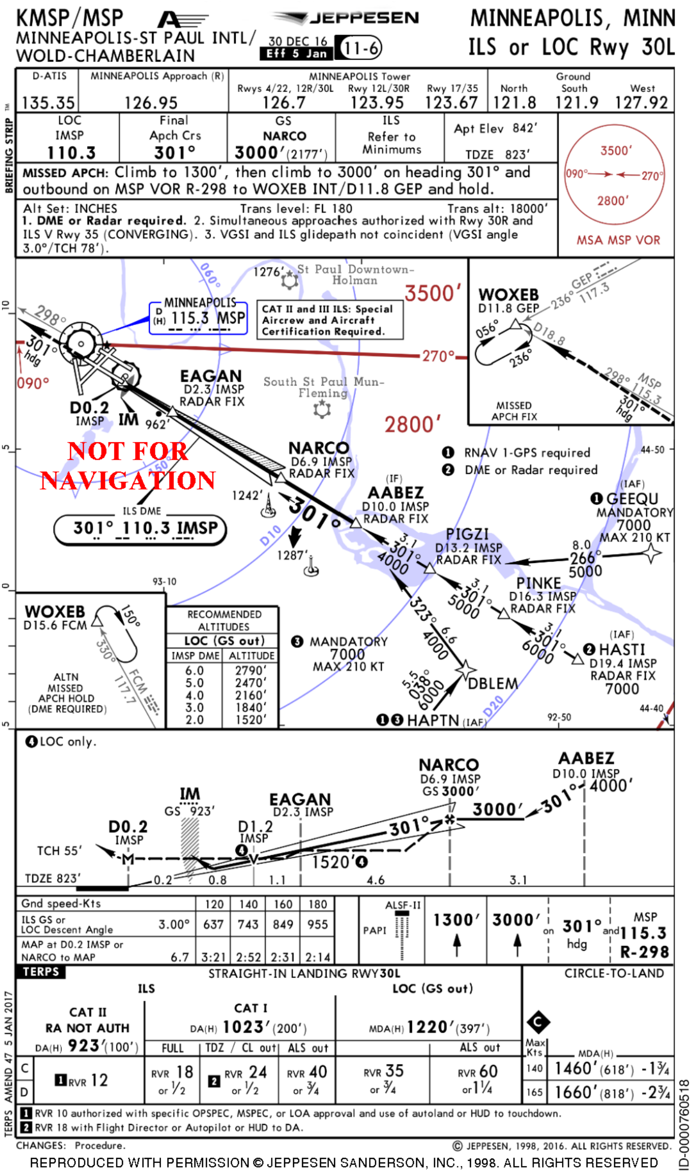

Figure 4-3
Minneapolis, MN ILS 30L Approach

PREDEPARTURE

The FMS guides the pilot through the ground initialization process using the lower-right line select key (6R). After completing the page (or pages) for each step, selecting the lower-right key (6R) moves to the next step. Figure 4-4 is a flow chart showing the preflight procedure for a normal flight.

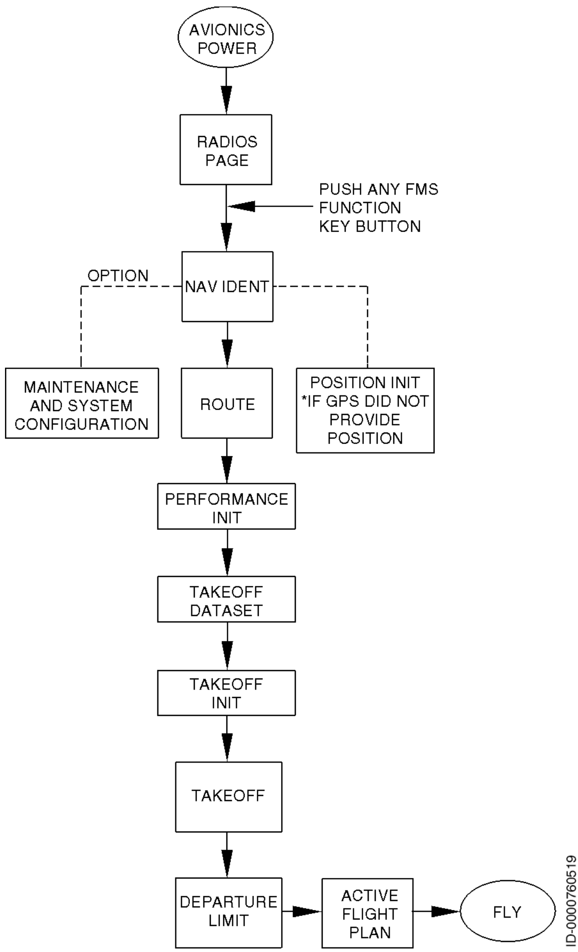

Figure 4-4
FMS Preflight Procedure Flow Chart

In any case other than a power-up condition, initialization flow is started by pushing the NAV button, then selecting NAV IDENT on the NAV INDEX 2/2 Page.

Power-Up

Once the FMS powers up and the RADIO page is displayed on the MCDU, select any FMS function key (NAV, PERF, FPL, RTE, PROG). After pushing an FMS function key on the MCDU, the NAV IDENT page is displayed, as shown in Figure 4-5.

Figure 4-5
NAV IDENT - Power-Up

The date and time shown on this page is synchronized with the global positioning system (GPS) date and time. The date and time are changed when the GPS has failed or does not have a valid date/time.

The maintenance prompt (6L) is used to verify the FMS system operating configuration. Refer to page 6-171 for additional details on the MAINTENANCE pages.

Navigation database (NDB) information is displayed on the right side of the NAV IDENT page. The active database dates are shown at 1R. The dates for the NON-ACTIVE NDB are shown at 2R. On power-up, the FMS automatically chooses the active NDB that corresponds to the current date and time based on the offset time located on the FLT CONFIG 1/2 page.

The EBA1706001, shown at 3R, indicates the version of NDB installed on the aircraft. The next step is to push the RTE prompt on 6R. The POS INIT prompt (in reverse video) is only displayed on the NAV IDENT page if the FMS present position is invalid.

POSITION INITIALIZATION

Position initialization is only necessary when FMS Present Position is not available at power-up.

The POSITION INIT page, shown in Figure 4-6, shows the LAST POS coordinates at 1L. At 2L, the airport reference point (ARP) is displayed. With no ARP available, the pilot is prompted to enter a waypoint or coordinates. In this example, the KPHX ARP is shown. At 3L, the coordinates of the highest priority valid GPS is displayed.

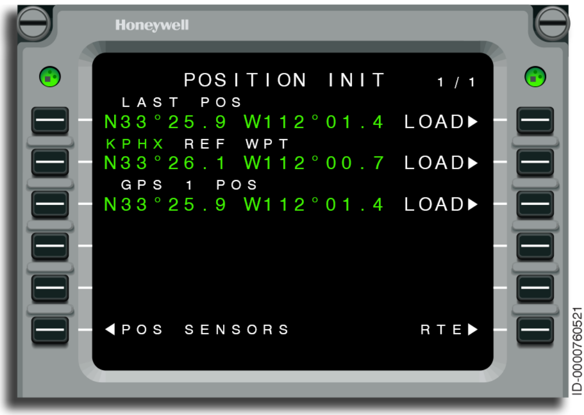

Figure 4-6
POSITION INIT - Position Initialization

Initialize FMS position by selecting the correct LOAD prompt (1R, 2R, or 3R). The selected position becomes the FMS position and is then automatically updated to the cross-side FMS. This is shown in Figure 4-7. This initializes connected sensors that receive inputs from the FMS. Refer to page 6-145 for additional details on position initialization. Typically more sensor inputs are displayed (e.g., GPS, IRS, etc.) that are not included in the figure.

After initialization, the RTE prompt is displayed in the bottom-right corner (6R) indicating the next step to be performed. Selecting this prompt continues the preflight process.

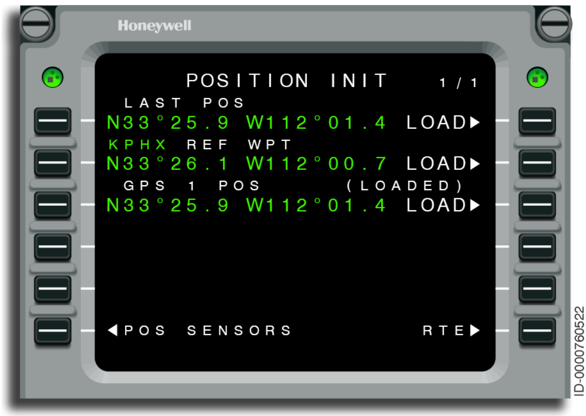

Figure 4-7
POSITION INIT - Loaded

ROUTE

Route planning is a method of flight planning used by the pilot in place of conventional flight planning using the route page features, as shown in Figure 4-8. Conventional flight planning features use the flight plan pages on the MCDU by means of individual waypoint entries and procedure selections. Route planning is performed by selecting a company route from the database or by entering flight plan waypoints and airways, which is beneficial to save time.

The route page is accessed by pushing the RTE button on the MCDU or the RTE prompt at line select key (LSK) 6R on the NAV IDENT page, as shown in Figure 4-5, or the POSITION INIT page, as shown in Figure 4-7. When the initialization coordinates are within 3 miles of an airport in the database, the airport (KPHX in this example) is already loaded in the ORIGIN line. This is shown in Figure 4-8.

Figure 4-8
ACT RTE - KPHX

The destination (KMSP) is entered in the scratchpad and line selected to the destination (DEST) prompt at 1R. This creates a MOD RTE page shown in Figure 4-9.

Figure 4-9
MOD RTE - KMSP

The alternate (KDLH) is entered into the scratchpad and line selected to the ALTN DEST prompt at 2R. The alternate can be changed but not deleted within the RTE pages. The ACTIVATE prompt is pushed at 6R creating an active route page, as shown in Figure 4-10.

NOTE: An ALTN DEST is deleted by deleting the entire active flight plan, or by deleting the ALTN origin (the active flight plan DEST) in the first page of the alternate flight plan when paging through the ACTIVE FLT PLAN pages after selecting the FPL MCDU button.

Figure 4-10
ACT RTE - KDLH (Alternate)

The next step in on-ground initialization is to select the DEPARTURE prompt at 6R.

The KPHX DEPARTURE page is then displayed, as shown in Figure 4-11.

Figure 4-11
KPHX DEPARTURE

The next step in the procedure is to enter the departure runway. The RUNWAY prompt at 1R is pushed. This displays the KPHX RUNWAYS page, as shown in Figure 4-12. Runway 08 at 3L is selected.

Figure 4-12
KPHX RUNWAYS

After the runway is selected, the SIDs page is displayed with the possible departure procedures, as shown in Figure 4-13. Select the correct procedure from the list. For this example, SILOW4 at 2L is selected.

Figure 4-13
KPHX SIDs

The next page is the SID TRANS page, shown in Figure 4-14. It lists the en route transitions for the selected departure. For this flight, the Rattlesnake (RSK) transition (4L) is selected.

Figure 4-14
KPHX SID TRANS

Once selected, the KPHX DEPARTURE page is automatically displayed, as shown in Figure 4-15.

At this point, the departure selection is complete and the flight crew can either CLEAR SEL (clear the selected departure and start over) or APPLY the selected departure, as shown in Figure 4-15.

Figure 4-15
KPHX DEPARTURE - Apply

APPLY (6R) inserts the selected departure into a MOD route, as shown in Figure 4-16. Refer to page 6-90 for additional details.

Figure 4-16
MOD RTE - SILOW4.RSK

The ACTIVATE prompt at 6R is pushed, creating an active route page, as shown in Figure 4-17.

Figure 4-17
ACT RTE - SILOW4.RSK

Airway Entry

Airways are entered on the RTE 2/3 page, as shown in Figure 4-18. Airways are entered under the line labeled VIA and en route waypoints under the line labeled TO. Begin with airway J44. The entry is made by typing the identifier in the scratchpad and using the line select key adjacent to the VIA prompt (2L). Refer to page 9-3 and page 9-17 for waypoint entry options. The AIRWAY. WAYPOINT entry format does not work on the RTE page but works on the ACTIVE FLT PLAN page.

Figure 4-18
ACT RTE - J44

When 6R is blank, use the NEXT key to advance the display pages.

Waypoint Entry

The next entry in this example is the insertion of the ALS waypoint. Waypoints are entered under the line labeled TO. Enter the identifier ALS. This is shown in the scratchpad in Figure 4-19. Insert this entry into the boxes displayed on LSK 2R below the TO.

Figure 4-19
ACT RTE - ALS

The insertion of ALS waypoint on LSK 2R creates a MOD route, as shown in Figure 4-20.

Figure 4-20
MOD RTE - ALS Loaded

The remainder of the flight plan to Mason City (DVV, J114, ONL, MCW) is entered in the same manner as previously described. Figure 4-21 through Figure 4-28 show the remainder of the RTE pages. The next entry is the DVV waypoint. DVV is entered into the scratchpad, as shown in Figure 4-21.

Figure 4-21
MOD RTE - DVV Entered in Scratchpad

Figure 4-22 shows DVV loaded at 3R.

Figure 4-22
MOD RTE - DVV Loaded

Figure 4-23 shows airway (J114) loaded in the scratchpad message section.

Figure 4-23
MOD RTE - J114

Figure 4-24 shows airway (J114) loaded at 4L.

Figure 4-24
MOD RTE - J114 Loaded

Figure 4-25 shows ONL entered in the scratchpad.

Figure 4-25
MOD RTE - ONL Scratchpad

The ONL waypoint is line selected to LSK 4R, as shown in Figure 4-26.

Figure 4-26
MOD RTE - ONL Loaded

Figure 4-27 shows MCW loaded in the scratchpad message section.

Figure 4-27
MOD RTE - MCW

MCW is line selected to LSK 5R. The MOD RTE 3/4 page is shown in Figure 4-28. The destination (KMSP) is shown at 1R.

Figure 4-28
MOD RTE - KMSP

The activate prompt at 6R is pushed to create an active route page.

The 3/4 in the upper-right corner of the RTE page indicates that the page displayed is page 3 of 4 RTE pages. Pushing the NEXT key advances to the next page of the route segment. Pushing the PREV key shows the previous route page.

Pushing the NEXT key displays the alternate route page, as shown in Figure 4-29. KDLH is displayed as the alternate since it was entered on the ACT RTE 1 page.

Figure 4-29
ALTN RTE - KDLH Alternate

The alternate route to KDLH is by way of waypoint GEP. GEP is entered at LSK 1R on the ALT RTE page the same way as entries were entered on the en route RTE pages. Figure 4-30 shows the alternate flight plan.

Figure 4-30
MOD ALTN RTE - Alternate Flight Plan

This completes the flight plan definition. Pushing the ACTIVATE prompt at 6R activates the flight plan.

The active ALTN RTE page is shown in Figure 4-31.

Figure 4-31
Active ALTN RTE Page

Flight Plan Discontinuities

If a MOD RTE contains a discontinuity, the discontinuity can be removed by either:

- Pushing the DEL function key on the MCDU and then selecting the scratchpad DELETE up to the left LSK adjacent to the discontinuity, or
- Selecting any existing waypoint up to the left LSK adjacent to the discontinuity.

The discontinuity is removed and the flight plan waypoints are connected.

PERFORMANCE INITIALIZATION

Performance initialization consists of entering data such as aircraft weight, center of gravity (CG), winds, and runway conditions. This data is then used to make FMS performance calculations.

For FMS performance computations to begin, the following data must be initialized with a flight plan entered:

- Initial cruise altitude
- Fuel (should automatically be read from the gauge)
- T/O CG (takeoff center of gravity)
- ZFW (zero fuel weight).

NOTE: The following paragraphs include an overview of performance initialization. For more details on the PERFORMANCE INIT pages, refer to the performance section of this guide.

Depending on the setting of the APM option, weights are displayed in either pounds or kilograms.

Data verified and entered under performance initialization effects several performance functions important to the completion of the flight. For example, entry of CRUISE WINDS impacts the computation of the destination fuel. A wrong entry of wind can make the destination fuel look sufficient to complete the flight, when in reality more fuel is required. A careful review of initialization data is required to make sure of accurate predicted aircraft performance.

Many values on the PERF INIT and PERF DATA pages are aircraft-dependent. Actual values can vary from those shown in the following figures in this section.

For changes to any performance initialization data modes, the OR prompt is used for the respective mode. Default values are restored by using the *DELETE* function on the correct line.

In general, entering *DELETE* on any modified performance initialization data restores them back to the power-up default conditions/values.

The PERFORMANCE INIT - 1/3 page, shown in Figure 4-32, displays the following:

- Tail number (1L)
- Performance factor (1R)
- Fuel reserve (2L)
- Takeoff/landing (TO/LDG) fuel (3L)
- Alternate (Altn) fuel (4L)
- SEND REQST (5R) (if datalink installed).

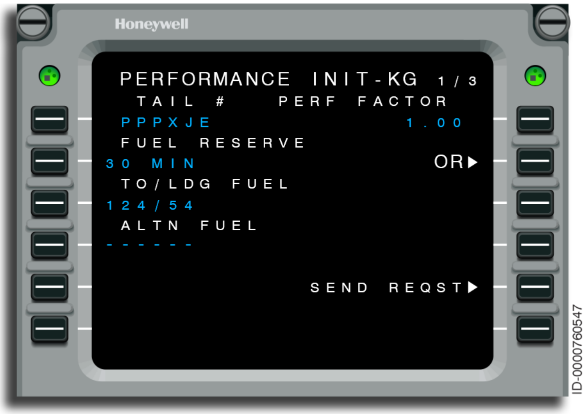

Figure 4-32
PERFORMANCE INIT - 1/3

The FUEL RESERVE value is changed by selecting OR (LSK 2R).

TO/LDG FUEL powers up with the default values from the AEDB. These values are used in the fuel prediction computations.

ALTN FUEL is entered on this page and is used for performance planning instead of predicting alternate fuel. If this field is blank, the FMS uses the computation of trip fuel from destination to alternate. If this field is filled, the FMS uses the entry value as fuel burn from destination to alternate and does not use the FMS computation.

The PERFORMANCE INIT 2/3 page, shown in Figure 4-33, displays the following:

- Cruise altitude (1L)
- Step increment (1R)
- Cruise winds (2L)
- ISA deviation (2R)
- Passenger (3L)
- Zero fuel weight (3R)
- Fuel gauge weight (4C)
- Fuel (4R)
- Takeoff CG (5L)
- Gross weight (5R) (computed).

Figure 4-33
PERFORMANCE INIT - 2/3

NOTE: PASS entry is not used for FMS performance calculations. PASS entry is only used for the cabin pressurization system.

A cruise altitude is entered and is required for performance initialization.

Optimum step climb increment is used for performance planning.

Average cruise wind and ISA Dev are entered on this page. This entry is an option. The FMS assumes zero wind and ISA Dev when no entry is made. Wind information at each waypoint is also entered on the PERF PLAN pages. Refer to Performance Plan on page 5-45 for additional details.

Gross weight is computed from the aircraft zero fuel weight and the FMS computed fuel and is required for performance initialization.

Takeoff CG is also entered and is required for performance initialization.

The PERFORMANCE INIT 3/3 page, shown in Figure 4-34, displays the following:

- Climb speed (1L)
- Cruise speed (2L)
- Descent speed (3L)
- Cost index (4L) (APM enabled).

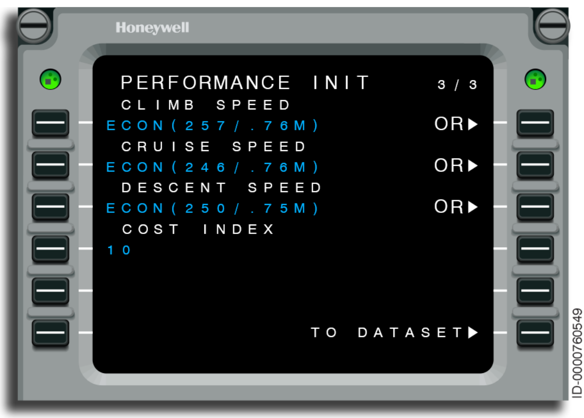

Figure 4-34
PERFORMANCE INIT - 3/3

For this example, the cost index option is enabled, therefore ECON speeds are shown. Selecting the OR prompt permits the flight crew to choose other speeds. A default cost index value is displayed and can be changed if desired.

NOTE: Selecting the TO DATASET prompt at 6R on the PERFORMANCE INIT page displays the TO DATASET page, which is not an FMS page and is not described in this guide. On the TO DATASET page, selecting the FMS TAKEOFF prompt at 6R displays the TAKEOFF INIT page, which is an FMS page that is described in this guide.

When the OR prompt for cruise is selected, the CRUISE MODES page, shown in Figure 4-35, is displayed. The cruise mode desired is selected from the available list. This action makes the selected cruise mode active and returns the display to the PERFORMANCE INIT 3/3 page. In this example, economy cruise (ECON) is the active mode.

Figure 4-35
CRUISE MODES - ECON (ACT)

Similarly, the OR prompts, shown in Figure 4-34, may be chosen for climb and descent phases to permit the selection of the desired scheduled speeds for those phases of flight.

TAKEOFF INIT

The TAKEOFF INIT page has two pages. TAKEOFF INIT 1 page displays the runway and weather information.

The TAKEOFF INIT 1 page is shown in Figure 4-36.

Figure 4-36
TAKEOFF INIT 1

Wind at LSK 3R is entered, if it is desired that the FMS compute and show the wind components. The runway heading, elevation, and runway slope are automatically entered based on selected departure. Gross weight is filled when performance initialization is complete.

It is not necessary to select a runway condition. Runway condition will be used in a possible future feature of providing takeoff speed computations.

Pushing the NEXT key accesses the TAKEOFF INIT 2 page.

The TAKEOFF INIT 2 page displays the flaps, TO CG, TO TEMP, flex takeoff mode, and dataset modes.

The TAKEOFF INIT 2 page is shown in Figure 4-37.

Figure 4-37
TAKEOFF INIT 2

The desired takeoff flap setting should be verified or the OR prompt should be selected to choose a different setting.

NOTE: This setting is used to enable the proper CHECK T.O. DATA message or NO TAKEOFF CONFIG message later if this setting does not match the actual flap setting during the takeoff procedure.

TAKEOFF

The TAKEOFF page displays the takeoff V_{SPEEDS}, flap setting, pitch trim, and computed takeoff pitch. It also gives access to LANDING, CLIMB, TO INIT, and DEP LIM pages.

The TAKEOFF page is shown in Figure 4-38.

Figure 4-38
TAKEOFF - RWY 08

On this page, the flight crew enters the desired V_{SPEEDS}. Once all speeds are entered, the takeoff pitch and trim are automatically computed.

Once the necessary data is entered on the TAKEOFF page, pushing the DEP LIM prompt at 6R displays the DEPARTURE LIMIT page.

DEPARTURE LIMIT

The DEPARTURE LIMIT page displays departure speed and altitude limits. The DEPARTURE LIMIT page also displays the VNAV capture heights and the EO bank angle limits.

The DEPARTURE LIMIT page is shown in Figure 4-39.

Figure 4-39
DEPARTURE LIMIT

The speed limit defaults to V2+10. Initially, all other values are APM default values but they can be changed by the flight crew.

Selecting FLT PLAN (LSK 6R) displays the active flight plan page.

- **AFE LIMIT** – The altitude at which the speed transitions from TO speed to departure speed (i.e., 1L speed).
- **VNAV CAP AFE** – The altitude at which VNAV engages during TO procedure. This field is only displayed if the APM, autoVNAVenable, is enabled.
- **VNAV CAP < EO** – The altitude at which VNAV engages if an engine out is active in TO.
- **EO > BANK LIM** – The maximum bank angle during TO if an engine out is active.

TAKEOFF PHASE

The next step is the takeoff phase of flight.

- **Speed Targeting** – The FMS commands the proper takeoff speeds. V2 is the initial speed targeted followed by V2+10* after V2 speed is reached. When the FD vertical mode transitions to FLCH, the departure SPEED LIMIT speed from the DEPARTURE LIMIT page is commanded. When the AFE LIMIT from the DEPARTURE LIMIT page is reached, the FMS transitions to climb speeds.

  * – Once V2 is reached, the speed target is incremented to match the current aircraft speed to the point of V2+10. This normally happens quickly, so it often seems like the speed target just transitions from V2 to V2+10.

- **Waypoint Sequencing** – On takeoff, the runway becomes the FROM waypoint and remains on the top line of the ACTIVE FLT PLAN page. The TO waypoint is shown on the second line. As the aircraft passes the TO waypoint, all waypoints scroll up one line. This is shown in Figure 4-40. This process is called waypoint sequencing.

Figure 4-40
ACTIVE FLT PLAN - THOMM Fix

Associated with the TO waypoint or a waypoint further down path there may be an altitude and/or speed constraint.

For an altitude constraint, the FMS maintains current VNAV mode as long as the aircraft is predicted to be at or below the next down path constraint. When the aircraft is predicted to pass below an AT or AT OR ABOVE constraint, the flight crew is alerted. When the aircraft is predicted to pass above an AT or AT OR BELOW constraint, the FMS changes to VASEL/VALT mode and levels off at the intermediate constraint.

After sequencing the waypoint with the associated constraint, the FMS automatically guides to the next down path speed constraint and next down path altitude constraint.

The FMS always observes the preselected altitude (PSA).

CLIMB

As the climb continues, intermediate altitude clearances are entered by using the PSA. If an altitude restriction/constraint is given for a specific waypoint, the altitude constraint is entered on the right side of the same line as the waypoint identifier on the MCDU. The 18,000 feet constraint on HAPPN was entered in this fashion and is shown in Figure 4-41. When an intermediate altitude constraint exists between the aircraft and the altitude preselect, VNAV honors that constraint.

Figure 4-41
ACTIVE FLT PLAN 1/5 - Climb Constraint

- **Speed Targeting** – When the autothrottle FMS speed mode is selected, the FMS commands a speed at or below the next down path speed constraint. If no speed constraint exists, the FMS speed commands in this phase are given by a schedule that is by default, predicted, or entered by the pilot. Speed targets are in terms of CAS, Mach, or CAS/Mach, and are limited to the aircraft defined maximum operating velocity/maximum operating Mach (V_{MO}/M_{MO}).
- **Climb Phase Constraints** – If a constraint (CAS only permitted) falls in the climb phase of flight and is less than the scheduled climb speed, the speed target is maximum limited to the constraint speed on all waypoints prior to and including the constraint, and the constraint is canceled after the constraint waypoint is transitioned.
- **Climb Phase Targets** – If a waypoint speed target (always entered in Mach) falls in the climb phase of flight, the speed target in the cruise phase of flight is the value of the waypoint speed target on reaching the top-of-climb.

EN ROUTE/CRUISE

As the flight progresses, flight plan revisions are completed using one of the two following methods:

1. When the revision is after the TO waypoint, the flight plan is modified by adding or deleting waypoints.
2. When the revision effects the TO waypoint (such as clearance direct from present position to another point), this is done by entering the Direct-To waypoint in 1L.

When the Direct-To waypoint is already in the flight plan, it is down selected to the scratchpad by pushing the line select key to the left of the waypoint. With the waypoint in the scratchpad, pushing 1L makes it the TO waypoint and a MOD flight plan page is created. Selecting 6R activates the MOD FLT PLAN and makes it the ACTIVE FLT PLAN.

When it is required to do a Direct-To a waypoint that is not in the flight plan, the Direct-To waypoint identifier is entered into the scratchpad and selected to 1L that becomes the TO waypoint and is inserted into the primary flight plan. This creates a MOD FLT PLAN page with a discontinuity added between the waypoint and the rest of the flight plan. Selecting 6R activates the MOD FLT PLAN and makes it the ACTIVE FLT PLAN.

After activation of the MOD FLT PLAN, the FMS immediately alters course to go directly to the Direct-To waypoint.

FMS speed commands in this phase are given by a schedule that is by default, predicted, or entered by the pilot. Speed targets are in terms of CAS, Mach, or CAS/Mach, and are limited to the aircraft defined V_{MO}/M_{MO}.

- **Cruise Phase Constraint Less Than Speed Target** – During the cruise phase of flight, if the constraint speed (CAS only permitted) is slower than the current anticipated speed target, the speed target is maximum limited to the constraint speed on the waypoint of entry. This goes for all waypoints after the constraint waypoint to the end of the flight plan or until the pilot deletes the speed constraint at 1R on the active flight plan page.

- **Cruise Phase Constraint Deceleration** – During cruise phase of flight, if constraint speed is less than current speed target, the speed target is set to the constraint speed prior to fix by such a distance that the aircraft can decelerate to cross the constraint at the constraint speed.

- **Cruise Phase Targets** – If a waypoint speed target (always entered in Mach) falls in the cruise phase of flight, the speed target is the value of the waypoint speed target on sequencing the waypoint and the target is carried through to the end of the cruise phase or another speed target is reached.

- **Deleting Speed Constraint Targets** – When a speed constraint is targeted for cruise phase of flight, the deletion of the speed constraint target at LSK 1R of the ACTIVE FLT PLAN page after the waypoint with the constraint speed is sequenced, deletes the current speed constraint and returns the speed targeting to the scheduled speed, otherwise the attempted deletion of a speed constraint target results in an INVALID DELETE advisory scratchpad message.

DESCENT

The FMS calculates a TOD point based on the destination elevation and any entered altitude constraints. When VNAV is engaged and the altitude selector is set to a lower altitude, the aircraft begins the descent at the TOD. When VNAV is not engaged or the altitude selector is not set lower, the aircraft remains at altitude through the TOD. In the latter case, the descent is initiated by setting a lower altitude and selecting a correct flight director mode or manually flying the descent. Once in descent, the FMS sets the target altitude to the altitude selector or the next constraint, whatever is higher.

FMS speed commands in this phase are given by a schedule that is default, predicted, or entered by the pilot. Speed targets are in terms of CAS, Mach, or CAS/Mach, and are limited to the aircraft defined V_{MO}/M_{MO}. Speed commands in descent also observe any entered speed limit altitudes.

- **Descent Phase Constraint** – During the descent phase of flight, if the constraint speed (CAS only permitted) is slower than the current anticipated speed target, the speed target is max limited to the constraint speed on the waypoint of entry. This also goes for all waypoints after the constraint waypoint to the end of the flight plan, or until the pilot deletes the speed constraint at 1R on the active flight plan page.
- **Descent Phase Constraint Anticipation** – During descent phase of flight, if constraint speed is less than the current speed target, the speed target is set to the constraint speed prior to the fix by such a distance that the aircraft can decelerate to cross the constraint at the constraint speed.
- **Deleting Speed Constraint Targets** – When a speed constraint is targeted for descent phase of flight, the deletion of the speed constraint target at LSK 1R of the ACTIVE FLT PLAN page after the waypoint with the constraint speed is sequenced, deletes the current speed constraint, and returns speed targeting to the scheduled speed. The attempted deletion of a speed constraint target can otherwise result in an INVALID DELETE advisory scratchpad message.

NOTE: In descent, the VSD shows the frozen descent path, until descent path is reconstructed due to flight plan change. An FLCH action does not cause the descent path to be reconstructed.

ARRIVAL PHASE

When within 200 flight plan miles of the destination airport, the ARRIVAL prompt is displayed at LSK 6R on both the ACTIVE FLT PLAN page and the active route (ACT RTE) page, as shown in Figure 4-42 and Figure 4-43. Selecting the ARRIVAL prompt displays the ARRIVAL page.

The ACTIVE FLT PLAN page is shown with the ARRIVAL prompt in Figure 4-42.

Figure 4-42
ACTIVE FLT PLAN - ARRIVAL Prompt

The ACT RTE page is shown with the ARRIVAL prompt in Figure 4-43.

Figure 4-43
ACT RTE - ARRIVAL Prompt

Selecting the ARRIVAL prompt displays the ARRIVAL page, shown in Figure 4-44. The destination airport is displayed in the title. Access to selecting the runway, approach, and/or STAR is on the right side of the page at 1R through 3R. While the selections are made in any order, this example selects 3R to choose a STAR. Selecting an approach automatically selects a runway.

Figure 4-44
KMSP ARRIVAL

Figure 4-45 shows the STAR page with the available standard arrival procedures. Choose the assigned or required arrival or select the ARRIVAL prompt at 6R. For this example, the KASPR6 arrival (5L) is selected.

NOTE: All STARs for the airport will be displayed on the STAR page when a runway has not been selected.

Figure 4-45
KMSP STAR

When a STAR has transition fixes, the STAR TRANS page is automatically displayed, as shown in Figure 4-46. Choose the correct transition or select the ARRIVAL prompt at 6R. For this example, the MCW transition (2L) is selected.

Figure 4-46
KMSP STAR TRANS

After the STAR TRANS is selected, the ARRIVAL page is displayed with a summary of the selected star procedure entered on 3L. This is shown in Figure 4-47.

NOTE: If a runway has not been selected, the runway transition segment of the STAR is not loaded into the flight plan. A runway must be selected to make sure that the proper STAR transition (when applicable) is entered into the active flight plan.

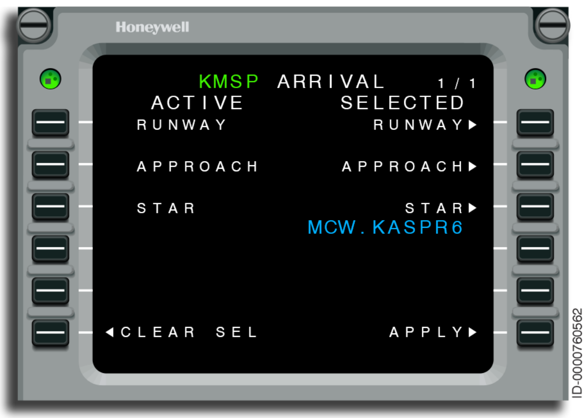

Figure 4-47
KMSP ARRIVAL - STAR Entered

The landing runway and approach are selected by pushing LSK 1R or LSK 2R.

Selecting the RUNWAY prompt displays the KMSP RUNWAYS page, as shown in Figure 4-48.

Figure 4-48
KMSP RUNWAYS

The KMSP RUNWAY page shows available runways for that airport. For this example, runway 30L is used. The 30L prompt at LSK 1R is selected.

Selecting the 1R prompt displays the KMSP APPROACH page, as shown in Figure 4-49.

Figure 4-49
KMSP APPROACH

The KMSP APPROACH page shows the available approaches for that runway. Selecting an approach also includes the missed approach procedure. In this example, ILS 30L is selected by pushing LSK 1L.

Selecting ILS 30L (1L) displays the KMSP APPROACH TRANS page, as shown in Figure 4-50.

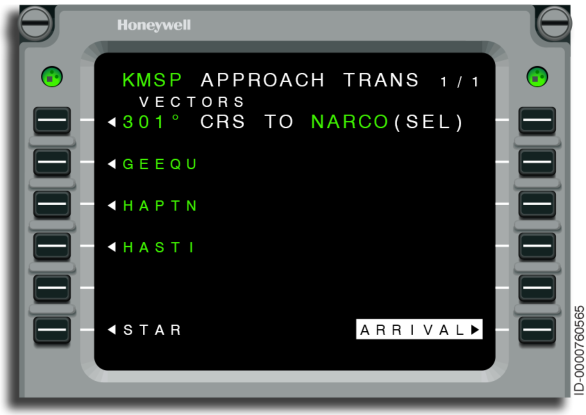

Figure 4-50
KMSP APPROACH TRANS

Once an approach is selected, the APPROACH TRANS page is displayed. The APPROACH TRANS page is used to select the approach transition for the selected approach. Selecting VECTORS (1L) inserts the FAF into the flight plan. Any applicable initial approach fixes (IAFs) are shown below the VECTORS selection.

Selecting HASTI (4L) displays the ARRIVAL page with a summary of the inserted runway, approach, and STAR, as shown in Figure 4-51.

Figure 4-51
KMSP ARRIVAL - Review

Selecting APPLY (LSK 6R) enters the selected procedures into the pending flight plan.

NOTE: Once a runway, approach, or STAR is applied on the ARRIVAL page, it cannot be deleted except through the RTE page, the ACTIVE FLT PLAN page, or through graphical flight planning. However, prior to selecting the APPLY prompt, deleting any portion of the arrival is possible.

The MOD RTE page is displayed, as shown in Figure 4-52. Remove any discontinuities as necessary.

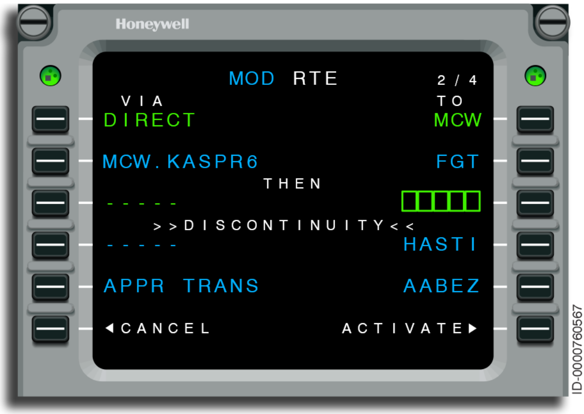

Figure 4-52
MOD RTE - Discontinuity

The procedure is then activated by pushing on the ACTIVATE prompt at LSK 6R to enter it into the active flight plan.

The ACT RTE page is then displayed, as shown in Figure 4-53.

Figure 4-53
ACT RTE - Procedure Activated

The pilot can select the FPL function key on the MCDU. The ACTIVE FLT PLAN page is displayed showing each individual waypoint defining that route segment. This is shown in Figure 4-54.

Figure 4-54
ACTIVE FLT PLAN - FPL Key

NOTE: The flight plan is displayed differently when the STAR/approach is loaded prior to and after sequencing the first fix in the STAR/approach and the final approach fix (FAF).

- *When an arrival/approach is loaded before sequencing the first arrival/approach fix or FAF, DISCON is inserted after the first arrival/approach fix or FAF, and the new arrival/approach is then inserted into the flight plan.*
- *When an arrival/approach is loaded after sequencing the first arrival/approach fix or FAF, DISCON is inserted after the next waypoint of the first arrival/approach fix or FAF, and the new arrival/approach is then inserted into the flight plan.*

Once the arrival is activated, the flight crew selects the LANDING prompt. The LANDING prompt displays the LANDING INIT page shown in Figure 4-55. The required data for landing computations should already be computed by the FMS so the flight crew should select the CONF INIT (confirm initialization) prompt at 6R. If the landing computation APM is enabled, the FMS computes the landing speeds when the CONF INIT prompt is selected. If the landing computation APM is not enabled, the LANDING prompt is displayed at 6R.

Figure 4-55
LANDING INIT - Confirm INIT

LANDING

After the CONFIRM INIT prompt is selected on the LANDING INIT page, the LANDING page is displayed, as shown in Figure 4-56. All the computed speeds are displayed in white reverse video with a header COMP to indicate the speeds have been computed but require pilot confirmation to be used.

Figure 4-56
LANDING Page - COMP

If the LANDING prompt is selected, the landing speeds are defaulted to dashes, waiting for speed entries, since no landing speeds have been entered yet, as shown in Figure 4-57.

Figure 4-57
LANDING Page - Pilot-Entry

Figure 4-58 represents what the LANDING page should look like when all the landing speeds are valid and the system is using the landing data.

Figure 4-58
LANDING - Speeds Valid

APPROACH

Once the arrival selection is activated, the FMS guides the aircraft along the STAR and approach procedure. When a localizer (LOC) approach is used, the approach must be flown using the LOC as the primary navigation source (PNS). The FMS cannot be used for navigation of any LOC-based approach. If the NAV radio is set to AUTO, the FMS automatically tunes the radios when the aircraft is 150 NM from the final approach fix. If the FMS is the NAV source for the course pointer during the arrival, the localizer preview function is displayed. When a non-LOC approach is selected, the FMS is used for both lateral guidance and vertical guidance on final approach.

The approach VNAV is executed by setting the preselect altitude down to the clearance altitude. The FMS guides the aircraft to the lateral flight plan and all VNAV altitude and speed constraints right down to the altitude preselect target and forced to level off. When the FMS speed mode is in AUTO, the FMS anticipates and commands a speed target at or less than the constraint speed by the time the FMS sequences the corresponding waypoint. A waypoint speed constraint lower than the flight phase speed schedules, including approach speeds, may result in an FMS speed command below the green dot or approach speeds, depending on aircraft configuration.

NOTE: In case the FMS target speed is lower than the green dot, it is recommended that the appropriate flap position be selected so that the green dot is lower than the speed constraint.

For an altitude constraint, the FMS maintains the current VNAV mode as long as the aircraft is predicted to be at or above the next down path constraint. When the aircraft is predicted to pass above an AT or AT OR BELOW constraint, the flight crew is alerted. When the aircraft is predicted to pass below an AT or AT OR ABOVE constraint, the FMS changes to VASEL/VALT mode and levels off at the intermediate constraint.

After sequencing the waypoint with the associated constraint, the FMS automatically guides to the next down path speed constraint and next down path altitude constraint, when the aircraft is above the PSA.

The FMS always observes the PSA. Refer to Approach on page 6-103 for additional details.

MISSED APPROACH

The missed approach pages contain waypoints for the missed approach segment. These pages follow the ACTIVE FLT PLAN pages when an approach from the navigation database has been activated. This is shown in Figure 4-59. The first waypoint on the MISSED APPROACH page 1 is the missed approach point (MAP). The MAP is also in the active flight plan. When activated, the missed approach is inserted into the active flight plan after the MAP.

Figure 4-59
MISSED APPROACH - RWY 30L

Selecting the MISSED APPR prompt or the takeoff/go-around (**TOGA**) button on the thrust lever, after the first approach waypoint is sequenced, results in the missed approach being inserted into the active flight plan.

The MISSED APPR must not be activated until the decision to miss the approach is made. When MISSED APPR is activated, any portion of the flight plan past the MAP is replaced with the missed approach procedure. Refer to Missed Approach on page 6-109 for additional details.

ALTERNATE FLIGHT PLAN

The alternate flight plan page is shown in Figure 4-60. When an alternate is entered, the pages follow the active flight plan and missed approach. If an alternate flight plan is entered with at least one VIA waypoint, the ALTERNATE prompt is displayed at 6L of the ALTERNATE FPL page. If an alternate flight plan (with at least one VIA waypoint) is not entered, the ALTERNATE prompt is displayed at 6L on the ACTIVE FLT PLAN page and on the ALTERNATE FPL page, when the aircraft is within 25 NM of the destination and the last waypoint of the primary flight plan has been sequenced. When the flight plan contains an approach, the ALTERNATE prompt is displayed only after the missed approach is activated. When an ALTERNATE is selected before the destination is reached, the FMS guides the aircraft to the original destination and then to the alternate. ALTERNATE must not be armed until a decision is made to divert to the alternate. Proceeding to the alternate without going to the original destination is accomplished by using the Direct-To feature.

NOTE: An ALTN DEST is deleted by deleting the entire active flight plan, or by deleting the ALTN origin (the active flight plan DEST) in the first page of the alternate flight plan when paging through the ACTIVE FLT PLAN pages after selecting the FPLN *MCDU button.*

Figure 4-60
ALTERNATE FPL - KDLH

FLIGHT COMPLETE

The flight is considered complete when the aircraft is on the ground for 2 minutes after landing or the cabin door is opened after landing. When flight complete occurs, the FMS data returns to original power-up condition on the ground.

CLEARING OF FLIGHT PLANS

Activating a stored flight plan clears the previous active flight plan. Activating a stored flight plan while in flight is permitted, but the pilot is required to confirm that the present active flight plan is to be replaced. Whether on the ground or in flight, a stored flight plan or portion of a flight plan is inserted into the active flight plan as a string of waypoints starting at the point of insertion. Flight plans are also cleared one waypoint at a time using the DEL key.

While on the ground, entering a new origin after some or all of the flight plan is defined, is permitted. Entering a new origin airport deletes the entire flight plan. Deleting the origin clears the entire flight plan. This applies to both active and stored flight plans.

Another action performed on the ground that results in clearing the active flight plan is to activate the previously inactive cycle database on the NAV IDENT page of the MCDU.

Blank Page

5. Performance

INTRODUCTION

The flight management system (FMS) performance computations are based on initialization data, flight plan, and input from aircraft systems. With this information, the FMS controls a variety of mission planning and speed control functions for the aircraft.

The multifunction control and display unit (MCDU) pages that control performance are similar to the navigation pages. As a general rule, when the system gives the information, items are displayed in small characters. The items are displayed in large characters when the pilot makes an entry.

Several areas of initialization are within the performance functions of the FMS. In order for the FMS to calculate performance data, the initialization pages must be reviewed, an active flight plan must exist with at least two waypoints, and the required performance initialization data must be entered.

Performance information in the FMS is based on data entered by the pilot and calculated by the FMS. Mission planning data is not evaluated by certification authorities for accuracy and is not approved by the certification authorities.

FMS fuel quantities are displayed two different ways. When showing current fuel-on-board (FOB), the quantity is in pounds or kilograms (e.g., 16,250). When showing planned fuel remaining at waypoints and fuel required, the quantity is displayed in thousands of pounds or kilograms (e.g., 12.3, meaning 12,300). The FMS fuel management data is advisory information only. The data must not be used in lieu of the primary fuel flow indicator display.

PERFORMANCE INDEX

The performance index (PERF INDEX) pages are accessed by pushing the PERF function key. When the PERF key is pushed, PERF INDEX 1/2 page is displayed, as shown in Figure 5-1. Page 2/2 is displayed by using either the PREV or NEXT paging keys, as shown in Figure 5-2. These pages show performance functions selected at any time. Push the line select key adjacent for selecting the respective function. Page numbers to the outside of each button correspond with pages in this guide that describe the button function.

Figure 5-1 shows the PERF INDEX 1/2 page.

Figure 5-1
PERF INDEX 1/2 - PERF KEY

Figure 5-2 shows the PERF INDEX 2/2 page.

Figure 5-2
PERF INDEX 2/2 - NEXT Key

The outline of this section follows the subject matter shown on the PERF INDEX pages starting from left to right (i.e., PERF INIT, TAKEOFF, DEP LIM, etc.).

PERFORMANCE INITIALIZATION

Performance initialization has three pages. Many items are set to default values to reduce the number of required inputs. The only items that are a required entry for each flight is zero fuel weight (assuming fuel quantity is supplied by the fuel gauge), cruise altitude, and takeoff CG. These items are initially displayed in boxes to indicate they are required for performance computations. An average cruise wind can be entered, when available.

The PERFORMANCE INIT page shown in Figure 5-3, is accessed from the PERF INIT prompt on the PERF INDEX page and shows tail number, performance factor, fuel reserve, takeoff and landing fuel, and alternate fuel.

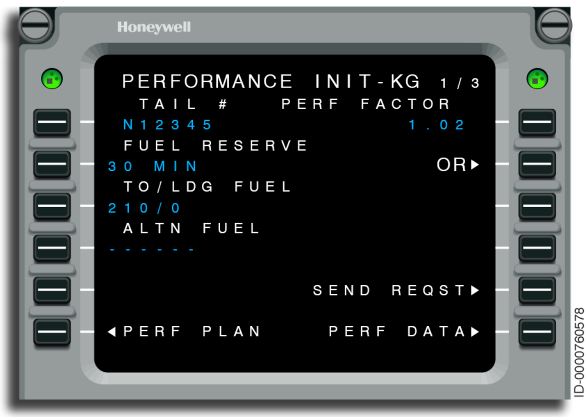

Figure 5-3
PERFORMANCE INIT 1/3 - Overview

- **1L** – The aircraft tail number (TAIL #) is displayed on this line. The tail number is configured in the aircraft personality module (APM) and cannot be changed by the crew. Once configured, it is saved. No action is required on future flights.
- **1R** – This line displays performance factor that represents the degradation of fuel flow due to aging of the aircraft from APM settings performance factor.
- **2L** – This line displays the fuel reserve. The default fuel reserve type is in minutes. Using a delete operation restores the fuel reserve back to initial power-up condition.

- **2R** – The OR prompt is displayed and when pushed, displays the FUEL RESERVE page, as shown in Figure 5-4.
- **3L** – The takeoff and landing fuel allowance is displayed in the configured weight. Entries are permitted for both takeoff and landing but must be separated by a slash (/). Any entry for landing fuel allowance only must be preceded by a slash (/). Using a delete operation restores the default values defined by the Aero Engine Database (AEDB).
- **4L** – Alternate fuel is displayed on this line. If no entry is made, then the FMS uses the performance computations to assess the fuel required for the alternate. If an entry is made, then the FMS uses this entry to assess the fuel required for the alternate in lieu of the performance computations. The default values are dashes.
- **5R** – This line is blank and nonoperational when datalink is not installed. With datalink installed, the possible displays are:
  - DLK PERF
  - SEND REQST
  - SENDING.
- **6L** – Selection of this line gives access to the PERF PLAN 1 page when airborne. It is blank when on the ground.
- **6R** – This prompt displays PERF DATA when the aircraft is airborne. This prompt is blank and nonoperational when the aircraft is on the ground.

Selecting the OR prompt at 2R, as shown in Figure 5-3, displays the FUEL RESERVE page shown in Figure 5-4. The FUEL RESERVE page is used to set the fuel reserve mode. The fuel reserve options on this page include reserve in weight and reserve in time.

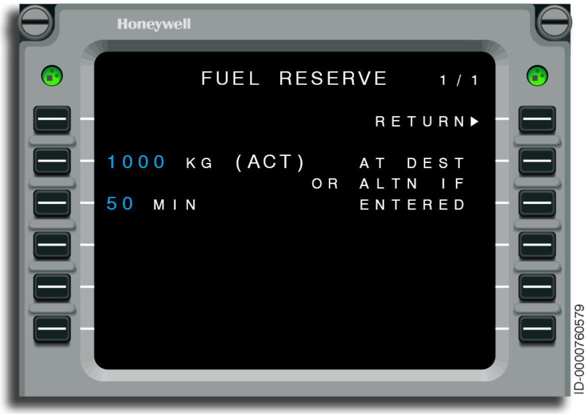

Figure 5-4
FUEL RESERVE - Overview

- **1R** – When the RETURN prompt is selected, the FMS displays the PERFORMANCE INIT 1 page.
- **2L** – A fuel reserve in lbs (pounds) or kgs (kilograms) is entered or chosen from default settings. The active fuel reserve type is indicated by the type followed by an active (ACT) prompt. Selection results in weight to become the active fuel reserve type for the active flight plan and the PERFORMANCE INIT 1 page to be displayed.
- **3L** – A fuel reserve in time is entered or chosen from default settings. If the reserve mode is time, the fuel reserve time followed by (ACT) is displayed. If a value is not available for the time mode, then dashes are displayed. If the reserve mode is time, then the fuel reserve is calculated as the fuel required to perform HOLD at an altitude of 5,000 feet over the primary destination or alternate destination (if defined).

The PERFORMANCE INIT 2 page shown in Figure 5-5, gives the capability to view and modify the following parameters: cruise altitude, step increment, average cruise winds for the route, mean ISA deviation for the route, passengers (PASS), zero fuel weight (ZFW), weight gauge fuel and current fuel-on-board, takeoff CG, and gross weight.

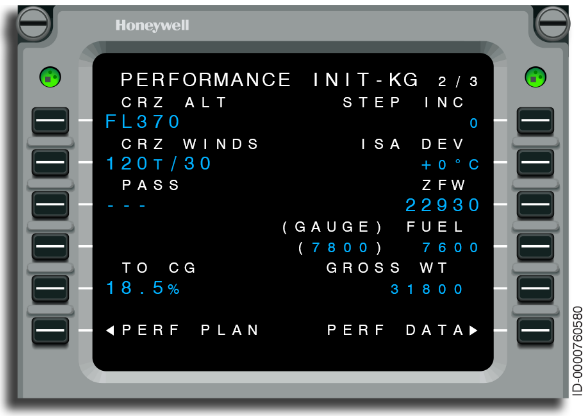

Figure 5-5
PERFORMANCE INIT 2/3 - Overview

- **1L** – The initial cruise altitude is entered at this location. The FMS uses the cruise altitude to determine the altitude where the cruise phase of flight commences. The FMS changes the speed command from climb to cruise when the aircraft levels at the cruise altitude or higher.

  An entry of cruise altitude in FL or feet is permitted. Three-digit flight level entries are permitted. Thus, an entry of 350 is interpreted as 35,000 feet or FL350.

When an entered altitude is lower than the altitude selector, the entry is rejected and the MCDU message RESET ALT SEL? is displayed. The cruise altitude (CRZ ALT) must be equal to or greater than the altitude selector.

The CRZ ALT automatically updates to the preselected value when the preselected altitude value is higher than the cruise altitude value and the aircraft is in a FLCH climb. This action also changes the cruise altitude as shown on the PERF DATA pages (refer to page 5-49). Performance data is recalculated to reflect the higher cruise altitude.

The FMS does not automatically compensate for short trip limited flight plans where the CRZ ALT is not obtainable. For short flights, the flight crew must check to determine if CRZ ALT can be reached. This is done after initializing PERF by verifying that the top-of-descent (TOD) is further out than the top-of-climb (TOC). When the TOC is at or beyond the TOD, that profile is short trip limited and a lower CRZ ALT must be requested. The FMS also gives an UNABLE CRZ ALT message when this situation occurs.

NOTES:

1. *Once in flight, if it is necessary to lower the cruise altitude from the initial cruise altitude entered on the ground, then the cruise altitude entry must be adjusted to the lower value. This is accomplished on the PERFORMANCE INIT 2 page, CRUISE page, or PERF DATA 1 page. Entry of the lower cruise altitude adjusts the performance predictions to account for the lower cruise altitude and places the FMS in the cruise mode, if the aircraft is already at that altitude.*

2. *The speed command for a lower level-off below the entered cruise altitude is the climb speed target.*

3. *The CRZ ALT automatically updates to the preselected value when the aircraft is flying at the cruise altitude, more than 50 NM prior to the TOD, the preselected value is lower then the cruise altitude value, and the pilot selects FLCH to initiate an early descent. The aircraft descends with cruise speeds to the new cruise altitude.*

4. *When leveling off, the flight crew must verify that the CRZ ALT on the PERFORMANCE INIT 2 page is displaying the correct altitude.*

- **1R** – Entries for optimum step increment are displayed on this line and must be in thousands of feet. Pilot-entries are permitted. The default step climb increment is 0.

  Optimum step climbs are used for long-range flights to optimize the aircraft performance. As the aircraft burns fuel, the optimum step altitude goes up. More than one optimum step climb can be calculated for a flight.

When a step increment is selected, time and fuel predictions assume that the step climbs are made. Therefore, an optimum step increment must only be selected when the intent is to make the optimum step climbs. When clearance is not given or the optimum step climb is not going to be made, the step increment must be set to zero in order to maintain accurate time and fuel predictions.

- **2L** – The average cruise winds are displayed on this line. An entry of wind direction and/or wind velocity is permitted and results in the update of the current value entered. Selecting DELETE results in the default value of zero to be displayed.

- **2R** – The forecast temperature deviation at the cruise altitude is entered in this field. The deviation is relative to the International Standard Atmosphere (ISA). When no entry is made, the displayed default of zero is used. Do not input the temperature deviation at the field elevation. Temperature impacts most performance predictions, such as the climb gradient, the ceiling altitude, the fuel consumption, the groundspeed predictions, and more. For additional information, refer to the explanation of the Wind and Temperature Model on page 5-48.

- **3L** – The number of passengers (PASS) is entered and displayed in this line. It is not used for FMS performance calculations. It is only output to the air management system to optimize air conditioning cabin airflow. Default values are dashes. Entering DELETE returns the number of passengers to the default value.

- **3R** – Zero fuel weight (ZFW) is displayed. Pilot-entries are permitted. Entering DELETE returns the ZFW to default boxes.

- **4R** – This line displays the fuel gauge value and fuel-on-board value.

  If the selection of TOTAL FUEL on the FUEL MGT page is COMPUTED, the pilot can enter a value on this line and it is shown in large font. The default value is taken from gauge if it is valid, shown in small font and the header is labeled (GAUGE) FUEL. If gauge is invalid, the default are boxes and the header is labeled FUEL. Entering DELETE returns the value to default (either gauge or boxes).

If the selection of TOTAL FUEL on the FUEL MGT page is GAUGE, the pilot cannot enter values on this line, the header is labeled GAUGE FUEL and the displayed values are the gauge fuel in small font. If the gauge value is invalid, the header is labeled FUEL and the line is blank.

- **5L** – Takeoff CG is displayed on this line. Valid entry of takeoff CG is permitted. If takeoff CG is invalid and the aircraft is on-ground, the takeoff CG is displayed in reverse video until the pilot enters a new value or changes the weight. A CHECK TAKEOFF CG message is displayed on the scratchpad. Entering DELETE returns the takeoff CG to default boxes.
- **5R** – This line displays gross weight in small cyan font after entry of ZFW and fuel, otherwise the display is blank. If the gross weight exceeds the maximum gross weight, then gross weight is displayed in reverse video.
- **6L** – This line accesses the PERF PLAN page.
- **6R** – This line accesses the PERF DATA page.

The PERFORMANCE INIT 3 page, shown in Figure 5-6, is used to display climb, cruise, and descent speeds as well as cost index. This page also supplies the capability to enter these speeds and optionally, the field to input the cost index value used in ECON SPEEDS calculations.

Figure 5-6
PERFORMANCE INIT 3/3 - Overview

- **1L** – The climb speed is entered here. If the APM option for cost index is enabled, the default value to be displayed is ECON climb speed schedule, otherwise the climb speed schedule (defined as a pair CAS/Mach in APM) is displayed. The displayed climb speed can be based on the selected climb speed from the CLIMB MODES page or a manually entered value.

  When the aircraft is in the climb phase of flight and the FMS is in the manual speed, MAN SPD is displayed at the header field. Selection of climb speed schedule down selects the climb speed schedule to the scratchpad. Valid entry of climb speed schedule is inserted into the active flight plan as the manual climb speed schedule. Invalid entry results in the display of the INVALID ENTRY message on the scratchpad. The title line contains SPD INTV in reverse video when speed intervention is active and the current phase of flight is climb.

- **1R** – Selection of the climb modes OR prompt at LSK 1R results in the CLIMB MODES page to be displayed.

- **2L** – The cruise speed is entered here. If the APM option for cost index is enabled then the default value to be displayed is ECON cruise speed schedule, otherwise the cruise speed schedule (defined as a pair CAS/Mach in APM) is displayed. The displayed cruise speed is based on the selected cruise speed from the CRUISE MODES page or a manually entered value. If the aircraft is in the cruise phase of flight and the FMS is in the manual speed mode, MAN SPD is displayed at 2L header field.

  If the cruise mode is not manual, then the selected cruise mode is displayed as one of following:

  - LRC if the selected cruise mode is long-range cruise
  - MAX SPD if the selected cruise mode is maximum speed
  - MAX END if the selected cruise mode is maximum endurance
  - MXR SPD if the selected cruise mode is maximum fuel reserve speed
  - RTA SPD if the selected cruise mode is required time of arrival speed.

  If the active cruise mode is not Required Time of Arrival Speed, then valid entry of cruise speed is inserted into the active flight plan as the manual cruise speed. Invalid entry of cruise speed results in the INVALID ENTRY message on the scratchpad. The title line contains SPD INTV in reverse video when speed intervention is active and the current phase of flight is cruise.

- **2R** – Selection of the cruise modes OR prompt at LSK 2R results in the CRUISE MODES page to be displayed.

- **3L** – The descent speed and angle is displayed on this line. When APM options of cost index and optimum descent are enabled, then the descent angle is not displayed. If cost index is enabled, ECON is displayed, otherwise the descent speed is displayed as a pair CAS/Mach/descent angle. The displayed descent speed is based on the selected descent speed from the DESCENT MODES page or manually entered value.

If the aircraft is in the descent phase of flight and the FMS is in the manual speed mode, MAN SPD is displayed in the header field. The descent speed schedule and descent angle (CAS/Mach/Descent Angle) are displayed when the current descent mode is not maximum operating limit (V_{MO}/M_{MO}). V_{MO}/M_{MO} is displayed along with selected V_{MO}/M_{MO} descent angle when the selected descent mode is V_{MO}/M_{MO}.

Valid entry of manual descent speed schedule is inserted into the active flight plan as the manual descent speed schedule when not in V_{MO}/M_{MO} mode. An angle entry updates the V_{MO}/M_{MO} descent angle and inserts the V_{MO}/M_{MO} mode in the active flight plan when in V_{MO}/M_{MO} mode. Entering an invalid descent speed and angle results in an INVALID ENTRY message to be displayed on the scratchpad. The title line contains SPD INTV in reverse video when speed intervention is active and the current phase of flight is descent.

- **3R** – Selection of the descent modes OR prompt at LSK 3R results in the DESCENT MODES page to be displayed.
- **4L** – This line displays the cost index when the APM is enabled and at least one speed mode is ECON. Only valid entries are accepted. Valid cost index entries are between 0 to 9999. Any invalid entry due to range or format results in display of an INVALID ENTRY message on the scratchpad. If all selected speeds are in manual mode, this field is blank.

  If cost index is displayed and the aircraft is in descent or within 10 NM of the TOD, then entries in 4L are rejected and result in the message indicating NO INPUT ALLOWED to be displayed in the scratchpad.
- **6L** – This line displays the PERF PLAN prompt when airborne, otherwise it is blank when the aircraft is on the ground. Selection of the PERF PLAN prompt displays the PERF PLAN 1 page.
- **6R** – This line displays the TO DATASET prompt when the aircraft is on the ground. Selection of the TO DATASET prompt displays the TO DATASET page for the active flight plan.

  This line displays the PERF DATA prompt when the aircraft is airborne. Selection of PERF DATA prompt displays the PERF DATA 1 page.

The CLIMB MODES page, shown in Figure 5-7, gives a list of predefined climb modes, any one of which is used during climb. It is accessed from the PERFORMANCE INIT 3 page.

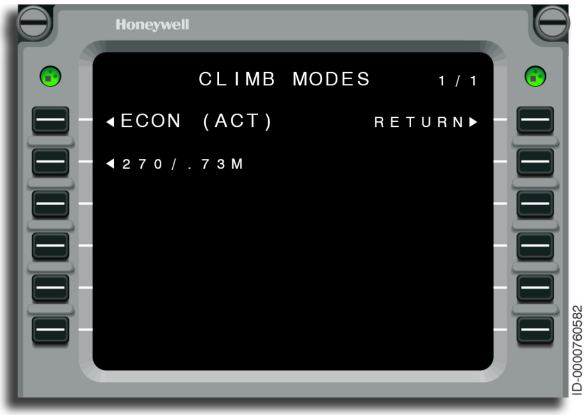

Figure 5-7
CLIMB MODES

- **1L** – This field displays the ECON speed mode prompt when the cost index option is enabled, otherwise it is blank and nonoperational.
- **1R** – The RETURN prompt is used to return to the PERFORMANCE INIT 3 page without making any selections.
- **2L** – Selecting this prompt activates the default climb schedule and returns to the PERFORMANCE INIT 1 page. The climb modes are displayed in CAS/Mach format.

The CRUISE MODES page, shown in Figure 5-8, gives a list of predefined cruise modes, any one of which may be used during cruise. It is accessed from the PERFORMANCE INIT 3 page.

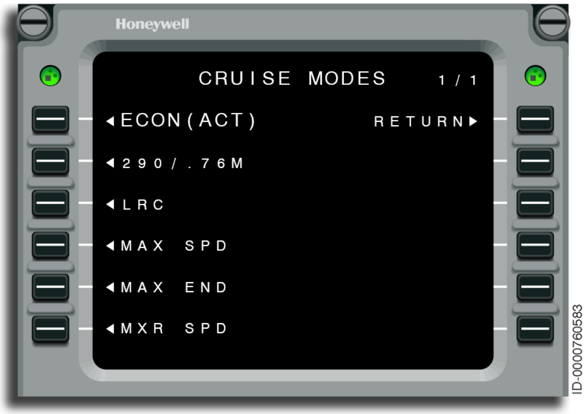

Figure 5-8
CRUISE MODES - ECON (ACT)

- **1L** – This field displays the ECON speed mode prompt when the cost index option is enabled, otherwise it is blank and nonoperational. When the active mode is ECON, then (ACT) is displayed next to ECON.
- **1R** – The RETURN prompt returns to the PERFORMANCE INIT 3 page with no action performed.
- **2L** – This field displays the manual fixed speed values from the APM displayed in CAS/Mach.
- **3L** – This field displays the long-range cruise speed.
- **4L** – This field displays the maximum speed cruise speed.
- **5L** – This field displays the maximum endurance speed.
- **6L** – This field displays the maximum reserve speed.

The DESCENT MODES page, shown in Figure 5-9, gives a list of predefined descent modes, any one of which is used during descent. It is accessed from the PERFORMANCE INIT 3 page.

Figure 5-9
DESCENT MODES - ECON (ACT)

- **1L** – This field displays the ECON speed mode prompt when the cost index option is enabled, otherwise it is blank and nonoperational. When the active mode is ECON, then (ACT) is displayed next to ECON.
- **1R** – The RETURN prompt is used to return to the PERFORMANCE INIT 3 page without making any selections.
- **2L** – This field displays CAS/Mach when the optimum descent APM is enabled. When it is disabled, the descent angle is displayed following a CAS/Mach speed entry (e.g., 280/.73M/3.5°). After an entry is made, the display returns to the PERFORMANCE INIT 3 page.
- **3L** – This field displays V_{MO}/M_{MO} when the optimum descent APM is enabled. When it is disabled, the descent angle is displayed as well. After an entry is made, the display returns to the PERFORMANCE INIT 3 page.

TAKEOFF

The takeoff pages consist of the TAKEOFF INIT and TAKEOFF pages. The TAKEOFF INIT page, displayed in Figure 5-10, is accessed from the TAKEOFF prompt on the PERF INDEX page and makes data available for takeoff speed computations. Takeoff flaps are not computed. Pitch trim and takeoff pitch are computed using entered V_{SPEED} data. Takeoff V_{SPEED} computations are not available, so entry of data in these pages are optional. The TAKEOFF pages display the takeoff data.

TAKEOFF INIT data entries are not permitted in flight.

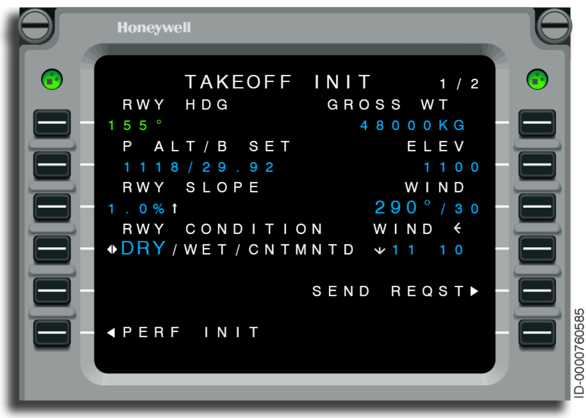

Figure 5-10
TAKEOFF INIT 1/2

- **1L** – The selected runway heading is displayed. When no runway is selected on the DEPARTURE pages, the field shows box prompts. If a departure runway is entered into the flight plan, the heading from the NAV database for selected departure runway is displayed. Entries are permitted and are made using the two-digit identification (e.g., 29 meaning 290°). Entries in degrees require a three-digit input. The runway heading is used to resolve the wind into head/tail and cross-wind components.

- **1R** – The takeoff gross weight of the aircraft is displayed. If FMS performance data has not been initialized and no gross weight is available, the field remains blank.

- **2L** – The pressure altitude and barometric (BARO) setting are displayed here. When a runway is selected, the pressure altitude is computed based on the field elevation and the ADS barometric setting. The pressure altitude is used for the density altitude computation.
- **2R** – Runway elevation is displayed here. When a departure runway is entered in the active flight plan, the runway elevation is extracted from the NAV database and that value is displayed as the runway elevation, otherwise current baro altitude is shown if there is valid air data, or box prompts if air data is invalid. Invalid entry results in the display of the INVALID ENTRY message.
- **3L** – Runway slope is displayed here. An up arrow is displayed for positive slope values and a down arrow is displayed for negative slope values. Valid entries are accepted and displayed. If no departure runway is selected in the flight plan and no runway slope entry is made, box prompts are displayed. Invalid entry results in display of the INVALID ENTRY message on the scratchpad.
- **3R** – Surface wind is displayed on this line. The default wind (direction and magnitude) is box prompts. Valid entries are accepted and displayed. Invalid entry results in the display of the INVALID ENTRY message.
- **4L** – The runway condition DRY/WET/CNTMNTD selection prompt is displayed with the default runway condition as DRY. Selection of LSK 4L toggles the selection to DRY, WET, or CNTMNTD.
- **4R** – Display wind components are shown when valid computed wind components exist. The values are rounded to the nearest knot.

- **5R** – When the aircraft is on the ground and a valid TAKEOFF UPLINK pending acceptance/rejection exists, the DLK TO prompt is displayed. Selection of the DLK TO prompt displays the DATALINK TO REQST page.

  If a valid origin and runway are defined, the SEND REQST prompt is displayed. Selection of the SEND REQST prompt initiates the datalink request. SENDING is then displayed without a prompt. Once the network acknowledge (ACK) is received, REQST SENT is displayed without a prompt.

- **6L** – This line accesses the PERFORMANCE INIT 1 page.

Pushing the NEXT key displays the TAKEOFF INIT 2 page, shown in Figure 5-11. This displays the flap, takeoff CG, runway OAT, flex TO mode, and data set modes.

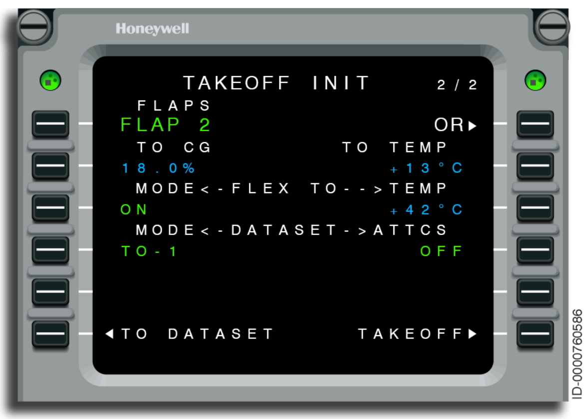

Figure 5-11
TAKEOFF INIT 2/2 - NEXT Key

- **1L** – The flap setting data is displayed when one of the flap settings is selected, otherwise FLAP 2 is displayed as the default.

- **1R** – Selection of the OR prompt at LSK 1R displays the TAKEOFF FLAPS page to make the selections of flaps setting.

- **2L** – The aircraft takeoff center of gravity (TO CG) in percentage of the calculated mean aerodynamic chord is displayed here but inserted into the PERFORMANCE INIT 2 page.

- **2R** – The default value or currently selected TO TEMP received from the Takeoff Dataset function is displayed.

- **3L** – The default value or currently selected Flex TO mode (ON or OFF) received from the Takeoff Dataset function is displayed.
- **3R** – If the Flex TO mode is ON then TEMP is displayed on the header line and the flex takeoff temperature is displayed on the data line. If the Flex TO mode is OFF, this line is blank and nonoperational.
- **4L** – The default value or currently selected dataset mode (TO-1, TO-2, or TO-3) setting value received from the Takeoff Dataset function is displayed.
- **4R** – The default value or currently selected automatic takeoff thrust control system (ATTCS) setting value received from the Takeoff Dataset function is displayed.
- **6L** – This line accesses the TO DATASET MENU page.
- **6R** – The TAKEOFF prompt is displayed. Selecting this prompt accesses the TAKEOFF page.

The TAKEOFF FLAPS page, shown in Figure 5-12, permits the pilot to select various takeoff flap speeds.

Figure 5-12
TAKEOFF FLAPS

- **1L** – The FLAP 1 prompt is displayed. If FLAP 1 is the currently active takeoff flap speed then (ACT) is displayed after the FLAP 1 prompt.

- **1R** – When the RETURN prompt is selected, the TAKEOFF INIT 2 page is displayed with no change in takeoff flap speed selection.
- **2L** – The FLAP 2 prompt is displayed. If FLAP 2 is the currently active takeoff flap speed then (ACT) is displayed after the FLAP 2 prompt.
- **3L** – The FLAP 3 prompt is displayed. If FLAP 3 is the currently active takeoff flap speed then (ACT) is displayed after the FLAP 3 prompt.
- **4L** – The FLAP 4 prompt is displayed. If FLAP 4 is the currently active takeoff flap speed then (ACT) is displayed after the FLAP 4 prompt.

The TAKEOFF page, shown in Figure 5-13, presents the computed takeoff pitch, computed takeoff pitch trim, and takeoff V_{SPEEDS}. In addition, it also gives access to Landing, Climb, Takeoff Init and Departure Speed Limit pages. No entries are permitted in flight.

Figure 5-13
TAKEOFF - Overview

- **1L** – V1 is displayed on this line. The default speed is dashes. An invalid entry results in the display of the INVALID ENTRY message on the scratchpad. An attempt to enter a V1 larger than VR results in V1 and VR being displayed in reverse video.

- **2L** – VR is displayed on this line. The default speed is dashes. An invalid entry results in the display of the INVALID ENTRY message on the scratchpad. An attempt to enter a VR smaller than V1 results in V1 and VR being displayed in reverse video. An attempt to enter a VR larger than V2 results in VR and V2 being displayed in reverse video.
- **2R** – When a valid selected takeoff flap setting exists, the selected takeoff flap setting is displayed, otherwise it is blank.
- **3L** – V2 is displayed on this line. The default speed is dashes. An invalid entry results in the display of the INVALID ENTRY message on the scratchpad. An attempt to enter a V2 smaller than VR results in V2 and VR being displayed in reverse video. An attempt to enter a VR larger than VFS/1.19 results in V2 and VFS being displayed in reverse video.
- **3R** – If TOLD computations are enabled and TOLD calculated takeoff pitch trim exists, the PITCH TRIM label and computed pitch trim data are displayed, otherwise they are blank.
- **4L** – VFS is displayed on this line. The default speed is dashes. An invalid entry results in the display of the INVALID ENTRY message on the scratchpad. An attempt to enter a VFS smaller than (1.2*V2) results in VFS and V2 being displayed in reverse video.
- **4R** – If the takeoff pitch from the automatic flight control system (AFCS) exists, it is displayed, otherwise it is blank.
- **5L** – This line accesses the LANDING INIT 1 page.
- **5R** – This line accesses the CLIMB page.
- **6L** – This line accesses the TAKEOFF INIT 1 page.
- **6R** – This line accesses the DEPARTURE LIMIT page.

DEPARTURE LIMIT

The DEPARTURE LIMIT page, shown in Figure 5-14, is accessed from the DEP LIM prompt on the PERF INDEX page and displays departure speed and altitude limits.

Figure 5-14
DEPARTURE LIMIT (T/O Auto Enabled)

- **1L** – When a valid departure speed limit exists, the departure speed limit is displayed. The default departure speed limit of V2+10 is displayed if there is no V2 available on the TAKEOFF page. If V2 is available, the V2+10 computation is displayed. Valid entry updates the departure speed limit. Entering an invalid departure speed limit results in the INVALID ENTRY message to be displayed on the scratchpad. The departure speed limit is not cleared at flight complete and is retained through power cycles.

- **2L** – This line displays the above field elevation (AFE) limit that is also known as the departure limit height. If a valid departure limit height exists, the AFE limit value is displayed. The default AFE limit is 3,000 feet. Entering an invalid AFE limit results in the INVALID ENTRY message to be displayed on the scratchpad. The departure limit is not cleared at flight complete and is retained through power cycles. Deleting the AFE limit value restores it to the default value.

- **3L** – This line displays the VNAV capture height. The departure VNAV capture height header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. Entering an invalid departure VNAV capture height results in the INVALID ENTRY message to be displayed on the scratchpad. VNAV CAP AFE values less than EO VNAV CAP are considered as an invalid entry.
- **4L** – This line displays the VNAV capture for engine out (EO) operations. The EO VNAV CAP header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. A valid entry updates the departure single engine VNAV capture height. Entering an invalid departure single engine VNAV capture height results in the INVALID ENTRY message to be displayed on the scratchpad. Default values are from the APM.
- **4R** – This line displays the bank limit for engine out (EO) operations. The bank limit for single engine header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. A valid entry updates the bank limit for single engine. Entering an invalid bank limit for single engine results in the INVALID ENTRY message to be displayed on the scratchpad.
- **6L** – This line accesses the active TAKEOFF page.
- **6R** – When the aircraft is on the ground, the FLT PLAN prompt is displayed. Selecting it displays the FLT PLAN page.

  When the aircraft is airborne, the CLIMB prompt is displayed. Selecting it displays the CLIMB page.

CLIMB

The CLIMB page, shown in Figure 5-15, is accessed from the CLIMB prompt on the PERF INDEX page and is used to view or modify parameters pertaining to the climb phase. Parameters on this page include the top-of-climb (TOC) altitude, speed command, distance-to-go to the TOC, estimated time en route (ETE) to the TOC, estimated time of arrival (ETA) at the TOC, and fuel remaining at the TOC.

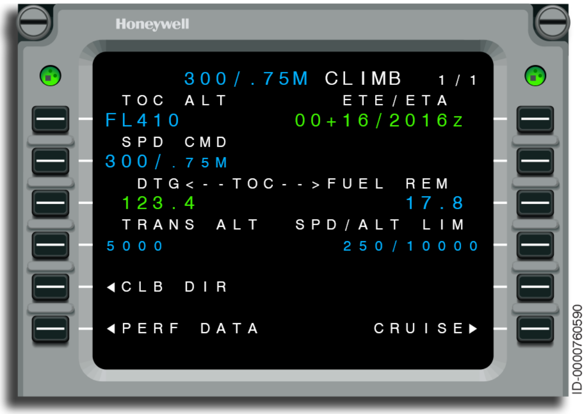

Figure 5-15
CLIMB - Overview

- **1L** – Top-of-climb altitude (TOC ALT) is displayed here and is the same altitude as the cruise altitude on the PERF DATA 2/3 page. An entry is permitted in FL or in feet. An entry changes the cruise altitude shown on all PERF pages. Entering *DELETE* results in the INVALID DELETE message to be displayed.
- **1R** – The ETE to TOC (on the ground) and the ETA at TOC (airborne or when ETD entered) are displayed. No entries are permitted.
- **2L** – The speed command shown in this field is the current climb speed command in CAS/Mach. The controlling speed (CAS or Mach) is displayed in large characters and the other in small characters. The speed command is less than or equal to the selected speed schedule (shown in the title). This is because of the speed/altitude limit or climb speed constraints.

A speed schedule is entered on this page. Either CAS, Mach, or both are entered. When a speed is entered on this line, it changes and selects the manual speed schedule on the OR page of the PERFORMANCE INIT 3/3 page. When only CAS or only Mach are entered, the manual speed retains the previous value for the unentered item. For example, when a CAS value is entered, the manual speed schedule is changed to the new CAS value and the previous Mach value. Both CAS and the corresponding Mach value are selected as the active climb speed schedule. Entering *DELETE* returns to the default speed schedule. If performance initialization has not been confirmed, NOT INITIALIZED is displayed. If it is confirmed but there is no flight plan, NO FLIGHT PLAN is displayed.

- **3L and 3R** – The distance-to-go (DTG) to TOC and the fuel remaining (FUEL REM) at TOC are displayed on this line. No entries are permitted.

- **4L** – The transition altitude is displayed on this line when an origin airport exists. Pilot-entries are accepted. The transition altitude is used to determine feet vs. flight level on altitudes associated with climb and cruise. If the origin is an airport, the default value is the transition altitude from NAV DB for the origin airport. If the origin is not an airport, a default value of 18,000 feet is displayed for the transition altitude. Deleting the transition altitude results in the default transition altitude being displayed.

NOTE: The FMS loads the transition altitude from the NAV DB if it is defined in the NAV DB for the origin airport, otherwise the default value of 18,000 feet is used.

- **4R** – The speed and altitude limit is displayed on this line. Pilot-entries are accepted. If the origin is an airport, the default value is the speed and altitude limit from NAV DB if it is available in NAV DB, or the default value is 250 knots/10,000 feet if the origin is not an airport or it is not available for the origin airport in the NAV DB. Delete results in the default values being displayed. Deleting the default value results in dashes being displayed. The speed and altitude limit restriction is reset to default values on missed approach activation.

NOTE: The FMS loads the speed and altitude limit from the NAV DB if it is defined in the NAV DB for the airport, otherwise the default value of 250 knots/10,000 feet is used.

- **5L** – The CLB DIR prompt is displayed when the current flight phase is climb, there is one or more climb waypoint altitude constraints, and the preselected altitude (PSA) is set above the first climb altitude constraint. When the CLB DIR prompt is selected, the FMS initiates a climb direct, creating an MOD flight plan with all flight plan altitude constraints cleared between the aircraft altitude and the PSA.
- **6L** – The TAKEOFF prompt is displayed on this line when the aircraft is on the ground. PERF DATA is displayed when the aircraft is airborne.

  When the TAKEOFF prompt is selected, the TAKEOFF 1 page is displayed if the takeoff speeds are valid, otherwise the TAKEOFF INIT 1 page is displayed.
- **6R** – The CRUISE prompt is displayed on this line. Selecting this line accesses the CRUISE page.

CRUISE

The CRUISE page, shown in Figure 5-16, is accessed from the CRUISE prompt on the PERF INDEX page and is used to view or modify parameters pertaining to the cruise phase. Parameters on this page include cruise altitude and speed command for the cruise phase, optimum cruise altitude, step altitude, estimated time en route (ETE) to the bottom-of-step-climb (BOSC), estimated time of arrival (ETA) to BOSC, distance and fuel remaining to step and top-of-descent (TOD), and range and time to fuel reserves. In addition, the cruise altitude and speed command are defined on the CRUISE page.

The title reflects the cruise speed mode selected during PERF INIT. In this example, the speed mode is long-range cruise.

Figure 5-16
CRUISE - Overview

- **1L** – The cruise altitude is displayed here and is the same altitude as the cruise altitude on the PERF DATA 2/3 page. Entries are made in FL or in feet.
- **1R** – The optimum altitude and step climb altitude are displayed here. No entries are permitted. The step altitude is displayed in reverse video when the step is being ignored.
- **2L** – The speed shown in this field is the current cruise speed command. Entering a CAS/Mach pair results in both values being displayed. If performance initialization has not been confirmed, NOT INITIALIZED is displayed. If it is confirmed but there is no flight plan, NO FLIGHT PLAN is displayed.

- **2R** – The ETE and ETA to the bottom-of-step-climb (BOSC) point are displayed. No entries are permitted. Data is displayed only when the performance function is planning a step climb. If a step is being ignored, the IGNORED text is displayed.
- **3L and 3R** – The DTG and the FUEL REM at the BOSC point are displayed. No entries are permitted. Data is displayed only when the performance function is planning a step climb.
- **4L and 4R** – These two lines show the distance to TOD and predicted fuel remaining at TOD. No entry is permitted.
- **5L and 5R** – This line shows the range in nautical miles where the fuel remaining equals the reserve fuel. The corresponding time to reserve fuel is also given. The predictions are based on flying the active flight plan to the destination at the given cruise speed schedule. Assuming the range to reserve goes beyond the destination, the predictions after the destination are made at the cruise altitude, but with zero winds. No entry is permitted.
- **6L** – The CLIMB prompt is displayed when the aircraft is on the ground and accesses the CLIMB page.
- **6R** – This line accesses the DESCENT page.

DESCENT FORECAST

The DESCENT FORECAST page is displayed in the format as shown in Figure 5-17. It is accessed from the DES FORECAST prompt on the PERF INDEX page. This page permits the winds aloft in the descent region to be defined or modified. Entry of winds is necessary for computation of an optimum descent path when the APM option is enabled (off-idle approach is used to provide margin for actual tailwind greater than the forecast wind). Descent forecast wind calculations are applied within 150 NM of the destination. There is the ability to uplink the forecasted winds by way of the datalink function when the optimum descent APM is enabled. See Section 13, Datalink for more information.

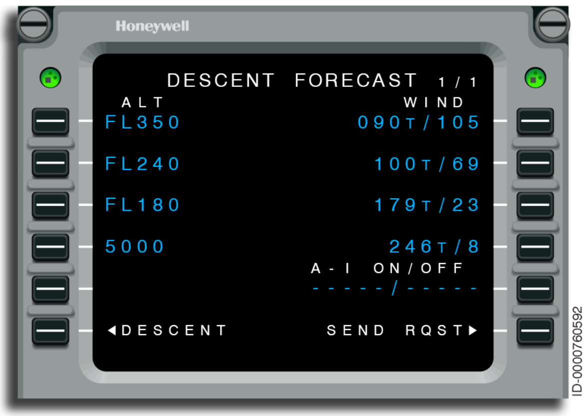

Figure 5-17
DESCENT FORECAST - Overview

- **1L through 4L** – The altitude aloft is displayed on these lines. The default altitude is dashes. Altitudes aloft are sorted from highest to lowest. If less than four altitudes aloft exist in the descent region profile, then the default altitude is displayed in LSK 1L. Pilot-entries are permitted but are ignored if four entries exist. The altitudes cannot be overridden. If four altitudes exist, then at least one must be deleted before another is added.

  Deleting an altitude aloft results in that entire line to be deleted and the altitude aloft list to be updated. Entering an invalid altitude aloft results in display of the INVALID ENTRY message on the scratchpad. Altitude entries of three digits are interpreted as flight levels.

- **1R through 4R** – Wind direction and speed are displayed on these lines. The default values are dashes. Pilot-entries are permitted. Entering wind direction and speed updates the winds aloft if no valid winds aloft exists. If valid winds aloft exist, the entry updates the winds aloft at that altitude aloft. Deleting the winds aloft at an altitude aloft results in the winds at that altitude to be set to the default winds aloft.

- **5R** – This line displays the anti-ice condition ON/OFF. The default display are dashes. Entry of both on altitude and off altitude for initial entry are considered as valid anti-ice conditions. If both on altitude and off altitude are entered, additional separate entries are permitted. Altitude entries are flight level or MSL. Entering an invalid entry results in display of the INVALID ENTRY message on the scratchpad.

- **6L** – This line accesses the DESCENT page.

- **6R** – When the SEND REQST prompt at LSK 6R is selected, the FMS results in a Descent Forecast Request downlink to occur. Other prompts that are displayed are:

  - SENDING – If a Descent Forecast Request has been sent, a network ACK for this request has not been received, and the network ACK timeout has not expired

  - REQST SENT – If a Descent Forecast Request has been sent, a network ACK for this request has been received, the uplink has not been received, and the requested data received timeout has not expired

  - DLK DES – If a valid Descent Forecast uplink is pending an accept/reject.

DESCENT

The DESCENT page, shown in Figure 5-18, is accessed from the DESCENT prompt on the PERF INDEX page and is used to view or modify parameters pertaining to the descent phase. The speed command and descent angle are defined on the DESCENT page. Parameters on this page include the bottom-of-descent (BOD) altitude, speed command for the descent phase, distance-to-go (DTG) to the BOD, estimated time en route (ETE) and estimated time of arrival (ETA) at the BOD, descent angle, and fuel remaining at the BOD.

The title line reflects the selected descent speed schedule.

Figure 5-18
DESCENT - Overview

- **1L** – Bottom-of-descent altitude (BOD ALT) is displayed. The BOD altitude is the destination elevation when no altitude constraints are in the descent. With one or more descent altitude constraints, the active BOD constraint is always displayed.
- **1R** – The ETE to BOD (on the ground) and the ETA at BOD (when airborne or when ETD is entered) are displayed. No entries are permitted.
- **2L** – The speed command shown in this field is the current descent speed command in CAS/Mach. The controlling speed (CAS or Mach) is displayed in large characters and the other in small characters. If performance initialization has not been confirmed, NOT INITIALIZED is displayed. If it is confirmed but there is no flight plan, NO FLIGHT PLAN is displayed.

A speed schedule is entered on this page. Either CAS, Mach, or both are entered. When a speed is entered on this page, it changes and selects the manual speed schedule on the OR page of the PERFORMANCE INIT 3/3 page. When only CAS or Mach are entered, the manual speed retains the previous value for the unentered item. For example, when a CAS value is entered, the manual speed schedule is changed to the new CAS value and the previous Mach value. Both CAS and the corresponding Mach value are selected as the active descent speed schedule. Entering *DELETE* returns the default speed schedule.

- **2R** – The default descent angle is displayed here. If the APM option optimum descent is enabled, the header and data field are blank. Pilot-entries are accepted. If it is not enabled, 2R displays the default descent angle or pilot-entered descent angle, not the current descent angle.

NOTE: For initial certification, Load 5, the default descent angle is fixed at 3.0 degrees.

- **3L and 3R** – The DTG to BOD and the fuel remaining at BOD are displayed on this line. No entries are permitted. When no altitude constraint is entered for the descent, the BOD coincides with the destination.
- **4L** – The transition altitude in flight level (FL) is displayed on this line when a destination airport exists. Pilot-entries are accepted. The transition altitude is used to determine feet vs. flight level on altitudes associated with descent. If the destination is not an airport, a default value of FL180 is displayed for the transition level. If the destination is an airport, the default value is the transition level from the NAV DB for the destination airport. Deleting the transition altitude results in the default transition altitude being displayed.

NOTE: The FMS loads the transition altitude from the NAV DB if it is defined in the NAV DB for the origin airport, otherwise the default value of 18,000 feet is used. The transition level is loaded from the NAV DB if it is defined in the NAV DB for the destination airport, otherwise the default value of 18,000 feet is used..

- **4R** – The speed and altitude limit is displayed on this line. Pilot-entries are accepted. If the destination is an airport, the default value is the speed and altitude limit from the NAV DB if it is available in the NAV DB, or the default value is 250/10000 if the destination is not an airport or it is not available for the destination airport in the NAV DB. Delete results in the default values being displayed. Deleting the default value results in dashes being displayed.

NOTE: The FMS loads the speed and altitude limit from the NAV DB if it is defined in the NAV DB for the airport, otherwise the default value of 250 knots/10,000 feet is used.

- **5L** – The DES NOW prompt is displayed when the active FD mode is VNAV ALT, the aircraft is 50 NM or less prior to the TOD, the aircraft is in cruise, and the descent now APM is enabled. When selected, the FMS initiates a descend now.
- **5R** – When DES FORECAST is selected, the DESCENT FORECAST page is displayed.
- **6L** – The CRUISE prompt is displayed on this line.
- **6R** – When a destination runway has not been defined, the ARRIVAL prompt is displayed. Once a destination runway is selected, the LANDING prompt is displayed.

Additional Details About Default Descent Angle

The default descent angle is used to place the TOD. When no altitude constraints are in the descent, the destination elevation is the reference point. The descent angles are also entered individually at any altitude constraints or are supplied as part of an arrival or an approach. In that case, the TOD is based on the active BOD and the entered angle. The descent angle shown on the DESCENT page is always the default descent angle from performance initialization. It could, therefore, differ from the angle flown on any individual path.

APPROACH SPEEDS

The APPROACH SPEEDS page, shown in Figure 5-19, is accessed from the APP SPD prompt on the PERF INDEX page and is used to enter speed limits for the various flap positions as well as restrictions that are used to compute speed targets during the approach phase of flight.

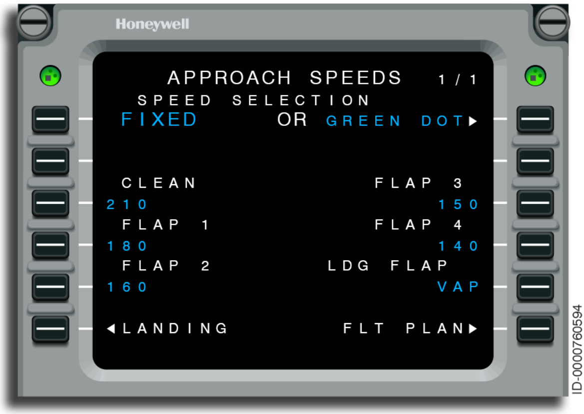

Figure 5-19
APPROACH SPEEDS - Overview

- **1L** – This field displays FIXED when fixed is selected for display or GREEN DOT when green dot is selected for display.
- **1R** – The FIXED prompt is displayed when green dot is selected for display or GREEN DOT is displayed when fixed is selected for display.
- **2L** – The title for this field is GREEN DOT ADDITIVE when green dot is selected for display. The range of the green dot additive is 0-99. The default value is 0. Deletion of the green dot additive results in the default green dot additive being displayed. Both header and the line are blank and nonoperational when FIXED is selected on 1L.
- **3L through 5L** – These lines display the speeds for various flap configurations and are only displayed when fixed is the selected speed, otherwise they are blank. Pilot-entries are accepted. Deletion results to default values.

- **5R** – The landing flap speed is displayed on this line. The default speed is displayed as VAP. Entry, deletion, or down selection of the landing flap speed is not permitted.
- **6L** – This line accesses the LANDING page.
- **6R** – Selection of the FLT PLAN prompt accesses the ACTIVE FLT PLAN page.

LANDING

The landing pages consist of the LANDING INIT and LANDING pages. The LANDING INIT page, shown in Figure 5-20, permits entry of specific information for landing and go-around calculations in addition to performance initialization.

Figure 5-20
LANDING INIT

- **1L** – The runway heading is displayed on this line if the approach runway is defined in the ARRIVAL page. The value is taken from the NAV DB and pilot-entries are accepted. The default display is dashes when the approach runway is not defined. An invalid entry results in the display of INVALID ENTRY on the scratchpad.

- **1R** – The landing weight is displayed on this line. If performance is initialized, the default landing weight is equal to predicted destination weight computed by the FMS, otherwise the default landing weight is boxes. If the landing weight is above the maximum landing weight for a certain configuration, the landing weight is displayed in reverse video. If the landing weight is below the minimum landing weight for a certain configuration, the landing weight is displayed in reverse video. An invalid entry results in the display of INVALID ENTRY on the scratchpad.

- **2L** – The landing temperature is displayed in Celsius and Fahrenheit. The pilot can enter a new temperature in either Celsius degrees or Fahrenheit, preceded by a backslash. The concurrent entry of both a Celsius and a Fahrenheit temperature is prohibited. Deletion of LDG TEMP results in the display of default value as dashes. Invalid entry results in display of the INVALID ENTRY message on the scratchpad.

- **2R** – Wind direction and speed are displayed on this line. The default wind (direction and magnitude) is dashes. Deletion of wind displays the default value as dashes. Invalid entry results in the display of the INVALID ENTRY message.

- **3L** – The landing flap setting is displayed on this line. The landing flap setting of FULL or FLAP 5 selection prompt is displayed with the default selection based on the APM landing flap selection. Selection of this prompt toggles between FULL or FLAP 5.

- **3R** – Wind components are shown when valid wind components from 2R exist. The values are rounded to the nearest knot.

- **4L** – The following approach type speeds are displayed on this line:

  – NPA & CATI

  – CATII & CATIII

  – STEEP

  – AUTOLAND.

  One of the these approach type speeds is selected from the APPR TYPE SPD page accessed through the LSK 4R prompt.

- **4R** – Selection of the OR prompt displays the APPR TYPE SPDS page to make the selections of approach type speeds.
- **5L** – The ice accretion condition NO/YES selection prompt is displayed with the default ice accretion condition as NO. Selection toggles between YES and NO.
- **5R** – This line accesses the TEMP COMP page. If the temperature compensation status from the FMS is true, the TEMP COMP prompt is displayed, otherwise this line is blank and nonoperational.
- **6L** – This line accesses the DESCENT page.
- **6R** – The CONF INIT prompt is displayed in reverse video when the weight related and database related messages are not displayed and:
  - The landing TOLD computation APM option is enabled
  - The landing initialization data required for computation of landing V_{SPEEDS} is entered
  - The current configuration is supported, or
  - When the landing V_{SPEED} values were previously computed and any initialization data is deleted and re-entered by the pilot, and when weight-related and database-related messages are not displayed.

  Selection of the CONF INIT prompt starts the calculation of the landing data and changes the display from CONF INIT to LANDING.

  When TOLD is not enabled, the LANDING prompt is displayed that gives access to the LANDING page.

The LANDING page, shown in Figure 5-21, is accessed from the LANDING prompt on the PERF INDEX page and permits the pilot to select and enter landing speeds. When TOLD is enabled, the landing speeds are automatically computed and must be confirmed by the flight crew.

Figure 5-21
LANDING - Overview

- **1L** – The reference speed is displayed on this line. Default speed is displayed in dashes. When landing speed computations are enabled, all the computed speeds are displayed in white reverse video with a header COMP to indicate the speeds have been computed, but require pilot-confirmation to be used.
- **2L** – The approach speed is displayed on this line. Default speed is displayed in dashes. When landing speed computations are enabled, all the computed speeds are displayed in white reverse video with a header COMP to indicate the speeds have been computed, but require pilot-confirmation to be used.
- **2R** – The landing flap setting is displayed when a landing flap selection exists.
- **3L** – The approach climb speed is displayed on this line. Default speed is displayed in dashes. When landing speed computations are enabled, all the computed speeds are displayed in white reverse video with a header COMP to indicate the speeds have been computed, but require pilot-confirmation to be used.

- **4L** – The final segment speed is displayed on this line. Default speed is displayed in dashes. When landing speed computations are enabled, all the computed speeds are displayed in white reverse video with a header COMP to indicate the speeds have been computed, but require pilot-confirmation to be used.

NOTE: For 1L through 4L, when the destination is within 30 NM distance, deletion of the active landing V_{SPEED} results in the deletion of all landing V_{SPEEDS}. When the destination is greater than 30 NM distance and a landing V_{SPEED} is deleted, only that landing V_{SPEED} is deleted.

- **5L** – This line accesses the DESCENT page.
- **5R** – This line accesses the APP SPD page.
- **6L** – This line accesses the LANDING INIT page.
- **6R** – This line accesses the DEPARTURE LIM page (on-ground) or the GA SPEED LIMIT page (in-air).

The APPR TYPE SPDS page, shown in Figure 5-22, permits the pilot to select various approach type speeds.

Figure 5-22
APPR TYPE SPDS

- **1L** – The NPA & CATI prompt is displayed on this line. If NPA & CATI is the currently active approach type speed then (ACT) is displayed after the NPA & CATI prompt. Selection of NPA & CATI prompt results in the display of LANDING INIT page with NPA & CATI as the current active approach type speed.
- **1R** – When the RETURN prompt is selected, the LANDING INIT page is displayed with no change in the approach type speed selection.
- **2L** – The CATII & CATIII prompt is displayed on this line. If CATII & CATIII is the currently active approach type speed then (ACT) is displayed after the CATII & CATIII prompt. Selection of CATII & CATIII prompt results in the display of the LANDING INIT page with CATII & CATIII as the current active approach type speed.
- **3L** – If the steep approach APM option is enabled, the STEEP prompt is displayed, otherwise it is blank and nonoperational. If STEEP is the currently active approach type speed, (ACT) is displayed after the STEEP prompt. Selection of the STEEP prompt results in the display of the LANDING INIT page with STEEP as the current active approach type speed.

- **4L** – If any autoland APM option is enabled, the AUTOLAND prompt is displayed, otherwise it is blank and nonoperational. If AUTOLAND is the currently active approach type speed, (ACT) is displayed after the AUTOLAND prompt. Selection of the AUTOLAND prompt results in the display of the LANDING INIT page with AUTOLAND as the current active approach type speed.

GO-AROUND LIMIT

The GO-AROUND LIMIT page, shown in Figure 5-23, is accessed from the GA LIM prompt on the PERF INDEX page and sets the VNAV capture altitudes for all engines or EO condition, bank limit for EO condition, and speed and height limits.

Figure 5-23
GO-AROUND LIMIT Page - Overview

- **1L** – This field shows the go-around speed for the clean configuration. Pilot-entry is permitted. Entering *DELETE* returns the default value. The default value is the value from the APM.

- **2L** – The go-around limit height (above field elevation) is displayed on this line as defined by the APM. Pilot-entries are permitted. Deleting the go-around limit height sets the height to the default value.

- **3L** – This line displays the go-around VNAV capture height. The go-around VNAV capture height header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. Entering an invalid go-around VNAV capture height results in the INVALID ENTRY message to be displayed on the scratchpad. VNAV CAP AFE values less than EO VNAV CAP are considered as an invalid entry.

- **4L** – This line displays the VNAV capture for engine out (EO) operations on go-around. The EO VNAV CAP header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. A valid entry updates the go-around single engine VNAV capture height. Entering an invalid go-around single engine VNAV capture height results in the INVALID ENTRY message to be displayed on the scratchpad.

- **4R** – This line displays the bank limit for engine out (EO) operations on go-around. The bank limit for single engine header and data field are displayed if the APM options for the takeoff automation are enabled, otherwise it is blank and nonoperational. A valid entry updates the bank limit for single engine during go-around. Entering an invalid bank limit for single engine results in the INVALID ENTRY message to be displayed on the scratchpad.

- **5L** – This line accesses the ARRIVAL page.

- **5R** – This line accesses the LANDING page.

- **6L** – This line accesses the DESCENT page.

- **6R** – This line accesses the APPROACH SPEEDS page.

PERFORMANCE PLAN

The PERF PLAN pages are accessed from the PERF PLAN prompt on the PERF INDEX page and show the estimated fuel remaining and ETE for each leg of the flight. This is shown in Figure 5-24. No flight plan changes are made from this page. The PREV and NEXT keys are used to review the entire flight plan. In addition to this information, this page shows a wind/temperature (W/T) prompt (right line select keys) for each waypoint.

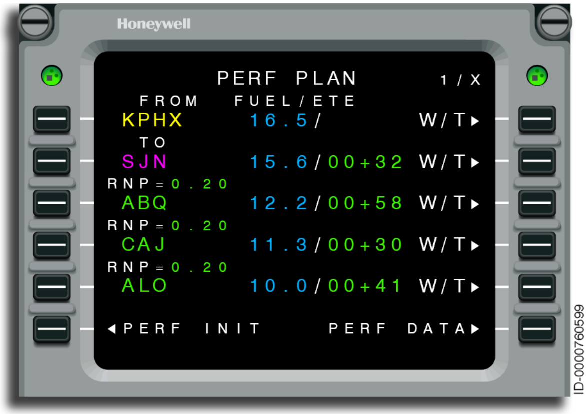

Figure 5-24
PERF PLAN

If a waypoint other than the FROM or TO waypoint is displayed, and that waypoint has an associated RNP, the RNP value is displayed.

Selecting the W/T prompt for a specific waypoint shows the WIND/TEMP page. This page is used for display and entry of wind and temperature information.

Wind and Temperature Pages

When the WIND/TEMP page is first selected, the page shows the predicted altitude, as well as the predicted wind and temperature at that altitude for the waypoint. This is shown in Figure 5-25.

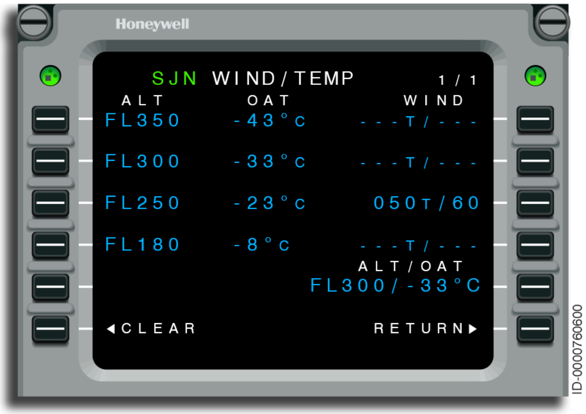

Figure 5-25
WIND/TEMP

- **1L through 4L** – The altitudes aloft are displayed on these lines. They are sorted from highest to lowest with the lowest on 4L. Unapplied altitudes are displayed in reverse video. Pilot-entries are permitted, but if four entries exist, one must be deleted in order to add another entry. Entering an invalid altitude aloft results in the INVALID ENTRY message to be displayed on the scratchpad.
- **1C through 4C** – This line displays the outside air temperature for the various altitudes. If the OAT is FMS propagated, it is displayed in small font but if it was entered at 5R, then it is displayed in large font.
- **1R through 4R** – This line displays the winds aloft at that altitude. The default winds are dashes. The wind is displayed in true reference with the corresponding speed. If the winds aloft are unapplied, the entire winds aloft data is displayed in reverse video. Winds aloft that are applied but not propagated, are displayed in large font, otherwise they are in small font. Invalid entering of winds aloft results in the INVALID ENTRY message to be displayed on the scratchpad.

- **5R** – The altitude and outside air temperature are displayed on this line. If the ALT/OAT is unapplied, then the entire ALT/ OAT data is displayed in reverse video in large font. If it is not propagated, the entire ALT/OAT is displayed in large font. If it is propagated, it is in small font. Entering an invalid ALT/ OAT results in the INVALID ENTRY message displayed on the scratchpad.

- **6L** – With entry of any data on the WIND/TEMP page, the FMS displays the CLEAR prompt at 6L. Selection of this prompt clears all entries on the page and returns to the default values shown when the page was first accessed.

- **6R** – The RETURN prompt is displayed when unapplied data exists. Selecting this prompt displays the PERF PLAN page that displays this waypoint.

  The APPLY prompt is displayed when unapplied data exists. This is shown in Figure 5-26. Selecting this prompt results in the changes to be incorporated into the flight plan. A valid wind/temperature entry requires entry of an altitude and entry of wind and/or temperature. When an entry is valid, the data is displayed in reverse video and the APPLY prompt is shown. Applying wind/temperature data creates a MOD FPL that must be activated to become effective.

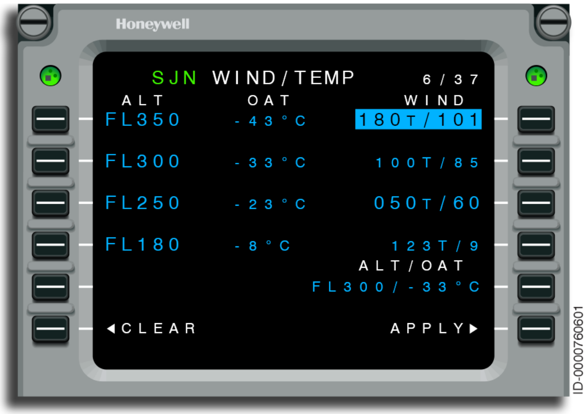

Figure 5-26
WIND/TEMP - CLEAR Prompt

Wind and Temperature Model Blending

The FMS wind and temperature model blends wind and temperature entries with the current position sensed wind and temperature. The sensed wind and temperature are blended up to 200 NM. At 200 NM and beyond, only forecast winds are used.

Wind and Temperature Model Entries

When viewing the DESCENT FORECAST or WIND/TEMP page, the forecast model is displayed. The winds displayed in small font are the propagated forecast wind model. Either a previous entry that was propagated down path to this waypoint or wind entries on a down path waypoint are propagated back to the aircraft (if initial wind entry for that altitude is down path of the aircraft). Because of this blending, the page does not necessarily reflect the exact pilot-entry. The following describes the effect of each type of entry on wind and temperature used by the FMS.

- **No Entry** – When wind or temperature is not entered on any page, a wind of zero and ISA temperature is assumed for each waypoint at every altitude. Performance planning is based on zero wind and ISA temperature, plus the blended sensed wind and temperature, as previously described.
- **Average Entry Only** – When an average wind and/or temperature (ISA DEV) is entered on the PERF INIT 2/3 page, it applies to every waypoint in the flight plan. The wind is ramped down from the entered altitude to produce a lower wind at lower altitudes. At altitudes above the tropopause, the temperature is assumed to be constant.
- **Entry at Waypoint** – Winds at four altitudes for the cruise portion of each waypoint are also entered at each waypoint on the WIND/TEMP page. When an entry is made at an individual waypoint (multiple altitudes are defined and accessed at each waypoint), any previous entry is erased. The entry is applied to each waypoint forward in the flight plan until a waypoint with another entry is encountered. Long flight plans are permitted to be subdivided into segments for the purpose of making wind/temperature entries. After an entry is made, the 6L prompt CLEAR is displayed. This prompt serves as a reminder of where entries are made and also clears those entries.

Recommended Entries

When the wind and temperature are forecast to be fairly constant over the route of flight, an average wind and temperature (ISA DEV) entered on the PERFORMANCE INIT 3/3 page is sufficient. When the flight is short, this is typically a good approximation. The ISA DEV entry must be left at zero when no forecast is available. The temperature variation at high altitudes are normally small and do not impact planning as much as wind variations.

For long flight plans, the best estimate of the average cruise wind is recommended. For shorter flight plans, entered wind matters for preflight. Once in cruise, the sensed wind takes precedence (refer to Wind and Temperature Model Blending on page 5-48).

Wind and Temperature Performance Planning

Temperature and especially wind play a significant role in performance planning. The wind can account for as much as one–third of the groundspeed. When flying a fixed Mach number, the true airspeed is roughly 5% higher when the temperature is increased by 20 °C. The increased temperature also affects the fuel flow, the MAX attainable altitude, etc. Therefore, the closer the entered winds and temperatures are to the actual encountered conditions, the better the FMS performance predictions.

PERFORMANCE DATA

Performance data is displayed when an active flight is defined and performance initialization is completed. Performance data calculations are updated when the flight plan is modified. In addition, flight factors such as unexpected winds or routing changes alter the performance predictions.

The first page of the performance data pages displays a summary of performance characteristics for the route defined in the active flight plan. This summary includes computed fuel, time, altitude data, and gross weight.

The PERF DATA page shown in Figure 5-27 is accessed from the PERF DATA prompt on the PERF INIT page and displays the overall fuel and time calculations along with the cruise altitude. When an alternate flight plan is entered, data for both the destination and the alternate destination is presented. When the aircraft is airborne and operating in an engine out condition, the title displays EO PERF DATA.

Figure 5-27
PERF DATA 1/3

- **1L** – The cruise and computed ceiling altitudes are displayed. Cruise altitude is entered in FL or feet. Pilot-entry for ceiling altitude is not permitted. An invalid entry results in the INVALID ENTRY message to display on the scratchpad. Altitude entries of three digits are interpreted as flight level therefore altitude entries less than 1,000 feet require a leading zero.

Additional Details About Cruise Altitude

When the altitude preselector is dialed to a higher altitude than the cruise altitude, the cruise altitude is automatically updated to the altitude preselect. The cruise altitude on the PERFORMANCE INIT 2/3 page is also changed. If a cruise altitude is entered that is lower than the altitude preselector, the RESET ALT SEL? message is displayed on the scratchpad. When the cruise segment is actually flown at a lower altitude than the cruise altitude, a new cruise altitude must be entered. When the new cruise altitude is not entered, a climb is predicted since the FMS is expecting a climb to the cruise altitude.

The CRZ ALT automatically updates to the preselected value when the aircraft is flying at the cruise altitude, more than 50 NM prior to the TOD, preselected value is lower than the cruise altitude value, and pilot select FLCH to initiate an early descent. The aircraft descends with cruise speeds to the new cruise altitude.

Additional Details About Ceiling Altitude

The ceiling altitude is the highest attainable altitude of the aircraft for the given cruise conditions. The ceiling altitude is limited to the certified ceiling altitude. The ceiling altitude depends on the cruise speed mode, as well as gross weight and air temperature. Prior to reaching cruise, predicted gross weight and air temperature values at TOC are used to compute ceiling altitude. Once in cruise, the current weight and outside air temperature are used.

For MAX SPEED, an altitude ceiling is computed and that supplies the maximum true airspeed (TAS) at the maximum cruise power setting.

For MAX END cruise mode, an altitude ceiling is computed and that supplies the maximum time in flight.

For LRC cruise mode, the ceiling altitude is computed and that results in the maximum range given the LRC speed schedule.

For ECON cruise mode, the ceiling altitude is computed and that results in the maximum range given the ECON speed schedule.

For manual cruise mode, the ceiling altitude is computed to be the highest altitude that the aircraft can sustain the entered CAS or Mach.

- **1R** – The step increment is entered using the same rules as during performance initialization.
- **2L and 2R** – This line shows estimated time en route (ETE) and estimated time of arrival (ETA) to the destination and the alternate destination. No entry is permitted.
- **3L and 3R** – This line shows the distance and fuel required to the destination and alternate. Fuel Required = Trip Fuel + Fuel Reserve + Landing Fuel, where Trip Fuel is the predicted fuel to reach the destination.

- **4L and 4R** – The predicted fuel quantity remaining and gross weight at the destination and the alternate destination are shown on this line. Fuel Remaining = Fuel on Board - Trip Fuel - Landing Fuel, where Trip Fuel is the predicted fuel to reach the destination.
- **6L and 6R** – The prompt at 6L on all PERF DATA pages is PERF INIT. The prompt at 6R on all PERF DATA pages is one of the following:
  - DEPARTURE – When a departure runway has not been selected
  - TAKEOFF – When a departure runway has been selected and V_{SPEEDS} are not entered
  - CLIMB – When a departure runway has been selected and V_{SPEEDS} are entered.

The PERF DATA 2/3 page, shown in Figure 5-28, displays wind information and tracks fuel prediction changes since takeoff. No entries are permitted.

Figure 5-28
PERF DATA 2/3 - NEXT Key

- **1L** – The average cruise wind for the remainder of the flight plan, as estimated by the performance mission predictions, is displayed. This wind is computed based on sensed wind and entered wind. Refer to page 5-48 for additional information on wind and temperature entries.

- **1R** – The same wind as in 1L, but resolved into average headwind or tailwind component, is displayed.
- **2L and 2R** – The preflight fuel remaining at the destination is displayed. At takeoff, this value is frozen for the remainder of the flight.
- **3L and 3R** – After takeoff, the latest estimate of fuel remaining at the destination and the difference to the preflight plan, are displayed. On the ground, these displays are blank. This enables the pilot to compare how well the flight is tracking to the preflight plan.

The PERF DATA 3/3 page, shown in Figure 5-29, displays information about fuel reserve requirements. No entries are permitted.

Figure 5-29
PERF DATA 3/3 - NEXT Key

NOTE: This is an example of when the fuel reserve mode is weight. If the fuel reserve mode is time, then it also shows the altitude and hold speed.

- **1L and 1R** – The method of fuel reserve calculation, as chosen on PERFORMANCE INIT 1/3 page, is displayed here. When the fuel reserve mode is kilograms or minutes, the fuel reserve at the destination is displayed with no alternate defined. With an alternate flight plan, these two fuel reserve modes show the fuel reserve at the alternate destination.

- **2L and 2R** – The required (REQ) fuel reserve and the predicted fuel remaining (PLAN) are displayed. When the required fuel reserves (REQ) are less than the predicted fuel remaining (PLAN), there is sufficient fuel reserve onboard. The PLAN fuel remaining is frozen at takeoff. The REQ fuel changes when the reserve mode is changed.

- **3L and 3R** – The UPDATED PLAN is displayed only while airborne and represents the most recent estimate of the fuel remaining. While in flight, this quantity must be compared to the REQ fuel. This comparison serves to verify sufficient fuel reserve is onboard. In addition, the difference between the preflight and updated plan is displayed.

FUEL MANAGEMENT

The FUEL MGT-LB 1/2 page, shown in Figure 5-30, is accessed from the FUEL MGT prompt on the PERF INDEX page and shows the current fuel quantity, fuel flow, groundspeed, true airspeed, ground-specific range, and air-specific range.

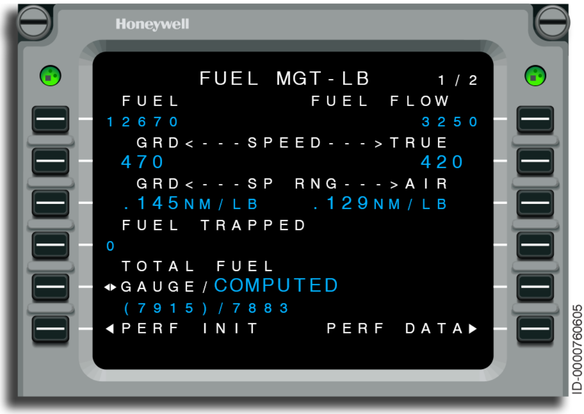

Figure 5-30
FUEL MGT 1/2

- **1L** – If 5L is selected to GAUGE, the header is GAUGE FUEL and the value from fuel gauge is shown in small font. If 5L is selected to COMPUTED, the header is FUEL and the value is shown in small font and is the same value as fuel-on-board shown in 5L and PERF INIT 2/3 page. Pilot-entries are not permitted.

- **1R** – The sensed fuel flow is displayed in small characters when received by the FMS.

Additional Explanation of Fuel Quantity and Fuel Flow

If TOTAL FUEL selection on FUEL MGT 1/2 page is GAUGE, the FMS fuel weight is always synchronized with the gauge value. If the TOTAL FUEL selection is COMPUTED, the FMS fuel weight is equal to the gauge value when the aircraft is on the ground and no engines or one engine is running. When engine start for both engines is completed, the FMS fuel weight is no longer synchronized with the gauge value. This value is then decremented by the sensed fuel flow.

This supplies a means for pilots to compare fuel quantity by two methods, measured directly and indirectly. The FMS computes fuel weight based on the sensed fuel flow to the engines. The gauges give the sensed fuel weight based on engine usage and leakage (when a leak exists).

Entering a manual value fuel can result in significant differences between the FMS fuel quantity and the actual fuel quantity. For this reason, it is recommended that no entry of fuel be made unless the sensed fuel flow is not available.

- **2L and 2R** – The current groundspeed and airspeed are displayed on this line. No entries are permitted.

- **3L and 3R** – The ground and air-specific ranges are displayed on this line. The specific ranges are based on the groundspeed, airspeed, and fuel flow shown on the page. No entries are permitted.

- **4L** – The fuel trapped is displayed on this line. It is used to adjust the threshold for display of system messages and to adjust the usable fuel-on-board (UFOB). Pilot-entries are limited to 0-999999 when the aircraft is configured to LB. If configured to KG, pilot-entries are limited to the equivalent in KG, 0-453591. Any value outside the permitted range results in the message INVALID ENTRY being displayed. The value is cleared on flight complete or a cold start. Selecting DELETE results in the default value of zero to be displayed.

Fuel trapped is fuel that cannot be accessed by the engines either automatically or manually from the center fuel tank. If fuel trapped has been entered on the FUEL MGT 1/2 page, pilots should be aware that the estimated fuel remaining at the destination, alternate, and other waypoints shown on the FMS and PFD progress box have not been reduced by the amount entered. The fuel amount depicted on the FMS and PFD progress box is the total amount of estimated fuel to be on board the aircraft at that point. To determine the amount of usable fuel on board at those waypoints, pilots must subtract the amount of fuel trapped in the center tank from the fuel numbers displayed.

- **5L** – This line permits selection of the fuel source for FMS fuel quantity. Selection of COMPUTED results in the fuel-on-board (FOB) defined by the FMS. Selection of GAUGE results in the FOB to be defined by the input gauge fuel. The selected fuel source is displayed in large cyan font and the unselected fuel source is displayed in small white font. Pilot selection is reflected on 1L and the PERFORMANCE INIT 2/3 page.

  This line also displays the gauge and FMS-computed fuel values. Pilot-entry is not permitted. Entries to the FMS computed values are performed on PERFORMANCE INIT 2/3 page.

The FUEL MGT-LB 2/2 page shown in Figure 5-31, shows the individual and total engine fuel flow, as well as fuel used.

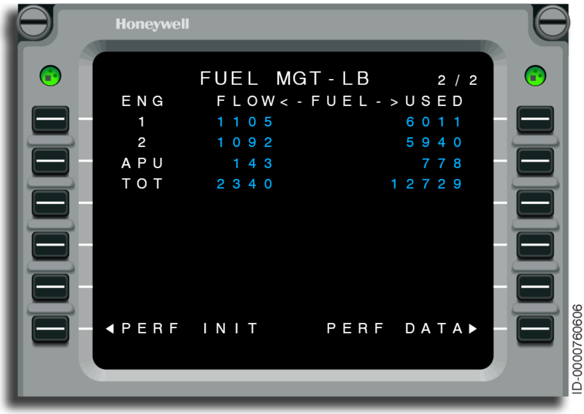

Figure 5-31
FUEL MGT 2/2 - NEXT Key

The individual engine breakdown of the total fuel flow on the FUEL MGT 2/2 page is shown on this page. The fuel used display is normally cumulative from the last power-up on the ground. The total fuel used is the same as the FLIGHT SUMMARY page shown at 4L, that is reset (see page 6-64). Resetting fuel used on the FLIGHT SUMMARY page also resets individual engine fuel used on this page.

Once the aircraft is airborne, invalid fuel flow results in Fuel Flow and Fuel Used to be shown in reverse video.

ENGINE OUT (EO) RANGE PAGE

When an engine out or an engine fire is detected, the EO RANGE page is automatically displayed on the MCDU as long as the MCDU is displaying an FMS page. If the MCDU is displaying a non-FMS page such as the RADIO page, then selecting any FMS page after the engine out/fire detection, the EO RANGE page is displayed instead of the selected page. The EO RANGE page is shown in Figure 5-32 and is also accessed from the EO RANGE prompt on the PERF INDEX page.

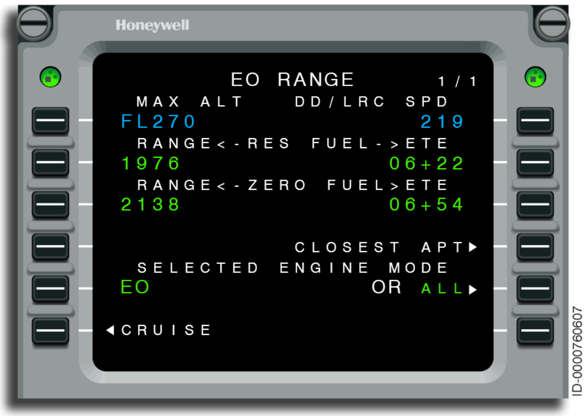

Figure 5-32
EO RANGE

- **1L** – The single engine maximum altitude is displayed, as shown, if a performance initialization has been confirmed and a valid single engine maximum altitude exists.
- **1R** – DD/LRC SPD is displayed, as shown, in the header field when performance initialization has been confirmed, a valid drift down speed exists, and the aircraft is above the engine out maximum altitude.

  LRC SPD is displayed, as shown, in the header field when performance initialization has been confirmed and a valid single engine cruise speed exists.
- **2L** – The range to fuel reserves is displayed, as shown, when performance initialization has been confirmed and a valid range to fuel reserves exists.

- **2R** – The ETE to fuel reserves is displayed, as shown, when performance initialization has been confirmed and a valid ETE to fuel reserves exists.
- **3L** – The range to zero fuel is displayed, as shown, when performance initialization has been confirmed and a valid range to zero fuel exists.
- **3R** – The ETE to zero fuel is displayed, as shown, when performance initialization has been confirmed and a valid ETE to zero fuel exists.
- **4R** – This prompt accesses the CLOSEST AIRPORT page.
- **5L** – EO is displayed when in engine out mode, otherwise ALL is displayed.
- **5R** – ALL is displayed when in EO mode, otherwise EO is displayed.
- **6L** – This prompt accesses the CRUISE page.
- **6R** – The EXIT EO AUTO prompt is displayed in reverse video when EO AUTO is active. Selecting this prompt deactivates the EO AUTO and removes the prompt.

NOTE: Engine out procedures are discussed in Section 14, Engine Out Operations.

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6. Navigation

INTRODUCTION

This section describes the navigation function of the flight management system (FMS).

NAVIGATION (NAV) INDEX

The NAV INDEX pages are accessed through the NAV function key on the multifunction control and display unit (MCDU).

When the NAV key is pushed, the NAV INDEX 1/2 page, shown in Figure 6-1, is displayed. Page 2/2 shown in Figure 6-2, is displayed by using either the PREV or NEXT paging keys. These pages show navigation functions that are available at any time. Pushing the line select key (LSK) adjacent to the respective function selects that function. Page numbers adjacent to each button correspond with page numbers in this guide describing the button function.

Figure 6-1
NAV INDEX 1/2 - Overview

NOTE: If FANS is not installed, FPL SEL is displayed on LSK 1R.

The NAV INDEX 1/2 page displays the following prompts:

- DATALINK (LSK 1L) on page 6-4
- WPT LIST (LSK 2L) on page 6-10
- FPL LIST (LSK 3L) on page 6-34
- CROSS PTS (LSK 4L) on page 6-58
- PATTERNS (LSK 5L) on page 6-65
- DEPARTURE (LSK 6L) on page 6-90
- ATC (LSK 1R) on page 6-5
- FIX INFO (LSK 2R) on page 6-32
- SEC FPL MENU (LSK 3R) on page 6-40
- FLT SUM (LSK 4R) on page 6-64
- HOLD (LSK 5R) on page 6-68
- ARRIVAL (LSK 6R) on page 6-95

The NAV INDEX 2/2 page is shown in Figure 6-2.

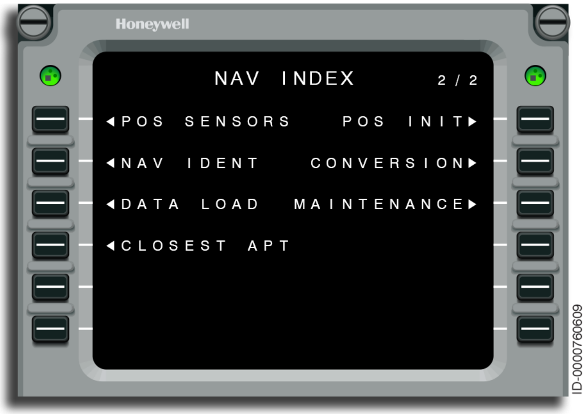


Figure 6-2
NAV INDEX 2/2 - Overview

The NAV INDEX 2/2 page displays the following prompts:

- POS SENSORS (LSK 1L) on page 6-109
- NAV IDENT (LSK 2L) on page 6-155
- DATA LOAD (LSK 3L) on page 6-166
- CLOSEST APT (LSK 4L) on page 6-181
- POS INIT (LSK 1R) on page 6-145
- CONVERSION (LSK 2R) on page 6-158
- MAINTENANCE (LSK 3R) on page 6-171

The outline of this section follows the subject matter shown on the NAV INDEX pages starting from left to right (i.e., DATALINK, ATC, WPT LIST, etc.).

DATALINK

The DATALINK INDEX page, shown in Figure 6-3, is accessed from the DATALINK prompt on the NAV INDEX page and gives access to the datalink pages available to the pilot.

Figure 6-3
DATALINK INDEX 1/1 - Overview

- **1L** – This line gives direct access to the datalink FLT PLAN page.
- **1R** – This line gives direct access to the WINDS REQ page.
- **2L** – This line gives direct access to the datalink REPORTS page.
- **2R** – This line gives direct access to the datalink WINDS REV page.
- **3L** – This line gives direct access to the datalink TAKEOFF page.
- **3R** – This line gives direct access to the datalink PERFORMANCE page.
- **4L** – This line gives direct access to the datalink ADDRESS page.
- **4R** – This line gives direct access to the datalink DESCENT FORECAST page.
- **6L** – This line gives direct access to the CMF MENU page.

AIR TRAFFIC CONTROL (ATC)

The ATC LOGON STATUS page shown in Figure 6-4, is accessed from the ATC prompt on the NAV INDEX page and permits the flight crew to view the status of and interface with the air traffic services (ATS) facilities notification (AFN) function, the automatic dependent surveillance (ADS) function, and the ATC communication application. ATC is an option and is not installed on all aircraft.

Figure 6-4
ATC LOGON STATUS 1/2

- **1L** – This line shows the AFN logon center. When no AFN logon center exists and there is a valid position, four dashes are displayed. Otherwise, the data field is blank and nonoperational. Entry of a center is permitted. A valid entry consists of four alpha characters. Entry of *DELETE* is permitted when there is no active center and results in the logon center being set to the default and the AFN logon state being set to idle. When an active center exists, entry of *DELETE* results in INVALID DELETE being shown on the scratchpad. When entry or deletion is attempted while in the process of sending the contact message, BUSY-REENTER LAST CHG is displayed on the scratchpad.
- **1R** – This line shows the logon state. When a valid entry is made and the flight number and tail number are valid, the AFN logon state is set to SEND. Valid states are SEND, SENDING, SENT, RESEND, ACCEPTED, and REJECTED. No entry is permitted.

- **2L** – When a valid flight number does not exist, eight large green font dashes are displayed in the data field left justified to column 1. When a valid flight number exists, it is displayed in large green font. Valid entries are one to eight alphanumeric characters (0-9, A-Z). Entries violating range or format requirements result in the display of the INVALID ENTRY message. When a valid flight number has not been entered and the TCAS flight number parameter produced by the modular radio cabinet is valid, the TCAS flight number parameter value is displayed. Entry of a valid flight number into the data field when dashes or a flight number is displayed results in the entered value to be shown in the data field for 7 seconds. After 7 seconds have elapsed, the data field shows the MRC TCAS flight number, if valid. Otherwise, the data field becomes dashed. If the pilot-entered flight number does not match with the flight number from the MRC TCAS after 7 seconds, the CHECK FLIGHT ID scratchpad message is annunciated. Selection of this LSK when a valid flight number is displayed and the scratchpad is blank, results in the flight number to be down-selected into the scratchpad. Otherwise, selection of the LSK is nonoperational. Selection of this LSK with *DELETE* in the scratchpad results in the INVALID DELETE message to be shown and no changes occur to the data field.
- **2R** – This line shows the active center. When there is no active center, this line is blank. No entry is permitted.
- **3L** – This line shows the aircraft tail number. No entry is permitted.
- **3R** – If CPDLC is enabled and a next ATC data authority exists, the next ATC data authority identifier is displayed.
- **4L** – This line shows the maximum uplink delay time if not logged on to ATN, otherwise it is blank.
- **4R** – The origin is displayed on this line.
- **5R** – The destination is displayed on this line.
- **6R** – The datalink message status is displayed on this line. The possible statuses are NO COMM, FAIL, VOICE, READY, and ATN READY.

The ATC LOGON STATUS 2/2 page is shown in Figure 6-5.

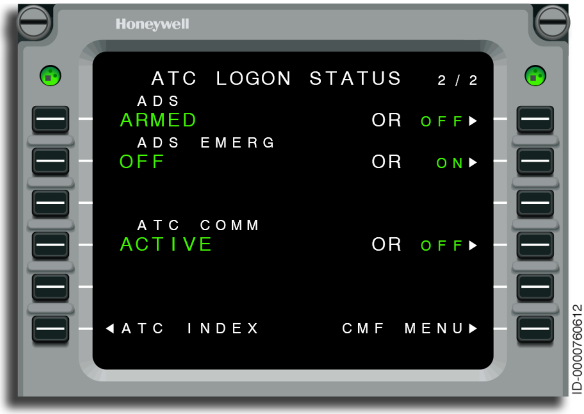


Figure 6-5
ATC LOGON STATUS 2/2

- **1L** – This line shows the current state of the ADS connection. Valid states are ACTIVE, ARMED, and OFF. No entry is permitted.
- **1R** – This line changes the state of the ADS connection. When the connection is active or armed, OFF is displayed. When the connection is off, ARM is displayed.
- **2L** – This line shows the current state of the ADS emergency connection. Valid states are ON and OFF. No entry is permitted.
- **2R** – This line changes the state of the ADS emergency mode. When the ADS connection is off, this line is blank.
- **4L** – The ATC COMM status is displayed on this line. Valid states are ACTIVE or OFF.
- **4R** – This line changes the state of the ATC COMM connection. If the ATC Comm is active, the OFF prompt is displayed, and selection of LSK 4R results in the termination of the ATC connection(s). If the ATC Comm is off, the line is blank and the OR prompt is removed.
- **6L** – This line accesses the ATC INDEX page.
- **6R** – This line accesses the CMF MENU.

FLIGHT PLAN SELECT

The FLT PLAN SELECT 1/1 page is shown in Figure 6-6, and is accessed from the FPL SEL prompt on the NAV INDEX page. This prompt is only displayed when FANS is not installed. Selecting a stored flight to be the active flight plan and also calculating performance data of the stored flight plan is shown. This page is accessed from the FLIGHT PLAN LIST page (prompt at 6R) or from the NAV INDEX page LSK 1R (when FANS is not installed).

Figure 6-6
FLT PLAN SELECT

To select and activate a stored flight plan, follow Procedure 6-1.

Procedure 6-1
Selecting and Activating a Stored Flight Plan

1. Select FPL LIST from the NAV INDEX page or the FLT PLAN SELECT page.

2. Select the desired flight plan from the list by pushing the adjacent line select key.

3. Push the line select key adjacent to the FLT PLAN prompt (1L) to insert the flight plan name. As an alternative, the flight plan name is entered directly from the keypad instead of being selected from the list. When a flight plan name is entered that has not been previously defined, the scratchpad message NO FLIGHT PLAN is displayed.

4. Choose 2L to apply to the active flight plan, 3L to apply it to the SEC1 page, or 4L to apply to the SEC2 page. This is shown in Figure 6-7.

Figure 6-7
FLT PLAN SELECT (KPHX-KMSP)

When a selected flight plan is attempted to be loaded and there is a pending flight plan, the scratchpad message MOD FPL ACTION REQ'D is displayed.

PILOT WAYPOINT LIST

The PILOT WPT LIST, shown in Figure 6-8, is accessed from the WPT LIST prompt on the NAV INDEX page and displays a list of pilot-defined waypoints stored in memory and any temporary waypoints (refer to Temporary Waypoints on page 9-3). Procedure 6-2 is used to store pilot-defined waypoints. Pilot-defined waypoints are defined using latitude/longitude (LAT/LON), place/bearing/distance (P/B/D), or place/bearing/place/bearing (P/B/P/B), as described in the procedure.

Figure 6-8
PILOT WPT LIST

Procedure 6-2 describes defining and storing waypoints.

Procedure 6-2
Defining and Storing Waypoints

1. Select WPT LIST from the NAV INDEX.

2. Enter an identifier of one to five characters and line select to the SHOW WAYPOINT line (1L). DAISO is used for this example.

3. The display changes to the definition display, as shown in Figure 6-9. Define DAISO by one of the following three ways: step 4 (LAT LON), step 5 (P/B/D), or step 7 (P/B/P/B).

Figure 6-9
PILOT WAYPOINT - Waypoint Undefined

When a previously used identifier is entered, the definition for the waypoint is displayed. This prevents the duplication of waypoint names.

A page similar to Figure 6-9 is displayed when an undefined waypoint is entered on any page that accepts waypoint entries (except the POS INIT page). For these cases, the RETURN prompt is displayed at 1R. The RETURN prompt is used before or after a waypoint is defined. The RETURN prompt is used to return to the page where the undefined waypoint was entered. When the waypoint is not defined, the waypoint entry remains in the scratchpad. When the waypoint is defined, the waypoint entry is completed.

Selection of 5R is used to load the GPS position as the Lat/Lon coordinates of the pilot-defined waypoint.

4. Enter latitude/longitude and select to 2L. N3320.77W11152.58 is used in this example. The defined waypoint is displayed and shown in Figure 6-10.

Figure 6-10
PILOT WAYPOINT - Waypoint Defined

5. **-OR-** Enter place/bearing/distance and select to 3L. Use the example, PXR/126/7, where PXR defines place, 126 defines bearing in degrees, and 7 defines distance in nautical miles. Bearing inputs are assumed to be magnetic. True bearings are designated by placing the letter **T** after the bearing.

6. The defined waypoint is displayed and shown in Figure 6-11.

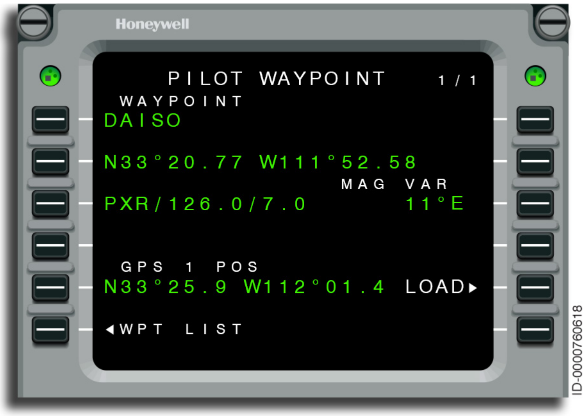


Figure 6-11
PILOT WAYPOINT - Waypoint Load

7. **-OR-** Enter P/B/P/B and select to 3L. Use the example, PXR/130/TFD/358, where PXR defines a place, 130 is the radial from PXR in degrees, TFD defines a second place, and 358 defines the radial from TFD in degrees. Bearing inputs are assumed to be magnetic. True bearings are designated by placing the letter **T** after the bearing.

8. The defined waypoint is displayed and shown in Figure 6-12. When a waypoint is defined by P/B/P/B, only the coordinates are stored and shown.

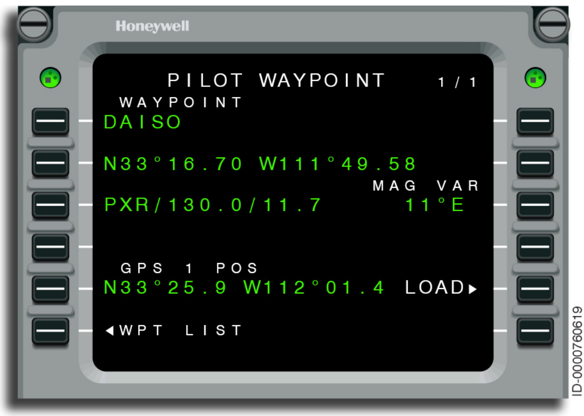


Figure 6-12
PILOT WAYPOINT - DAISO

DATABASE

The pilot interrogates the navigation database stored in the FMS by using the DATA BASE function, as shown in Figure 6-13. This page is accessed by entering a database waypoint name on the PILOT WPT LIST or PILOT WAYPOINT page. The notice to airmen (NOTAM) NAVAIDS page also shows a prompt for direct access to this page.

Figure 6-13
DATA BASE WPT

A waypoint identifier of the database is entered in the upper-left line by entering the identifier into the scratchpad and line-selecting to 1L. The following items are displayed from the navigation database:

- Airports
- Runways
- NAVAIDs
- Instrument landing systems (ILSs)
- Intersections.

The waypoint list (WPT LIST) (6L) and NOTAM (6R) pages are accessed using the prompts at the bottom of the DATA BASE WPT page.

Airports

Figure 6-14 through Figure 6-16 show the following airport data.

The DATA BASE WPT 1/3 page is shown in Figure 6-14 and contains the following:

- Identifier (1L)
- Waypoint type (1R)
- Airport name (2L)
- Country (3L).

Figure 6-14
Airport Database Waypoint 1/3

The DATA BASE WPT 2/3 page shown in Figure 6-15, displays the following:

- Identifier (1L)
- Coordinate position (2L)
- Field elevation (3L)
- Magnetic variation (3R).

Figure 6-15
Airport Database Waypoint 2/3

The DATA BASE WPT 3/3 page shown in Figure 6-16, displays the following:

- Identifier (1L)
- Access to airport runways (2L).

Figure 6-16
Airport Database Waypoint 3/3

Selection of prompt 2L displays the airport runway page, as shown in Figure 6-17.

Figure 6-17
Airport RUNWAYS

When one of the runways is selected, the runway data is displayed. This is shown in Figure 6-18. Selection of the RETURN prompt at 6R results in the display of the airport runway page shown in Figure 6-17.

Figure 6-18
DATA BASE WPT - Runway Data

Runways

Figure 6-19 through Figure 6-21 show the following information for runways.

The DATA BASE WPT 1/3 page is shown in Figure 6-19, and displays the following:

- Runway identifier (1L)
- Waypoint type (1R)
- Airport name (2L) and country (3L).

Figure 6-19
DATA BASE WPT 1/3 - Runway

The DATA BASE WPT 2/3 page shown in Figure 6-20, displays the following:

- Identifier (1L)
- Runway heading and front or back course when the runway has an associated ILS (1R)
- Coordinate position (2L)
- Elevation (3L)
- Magnetic variation (3R).

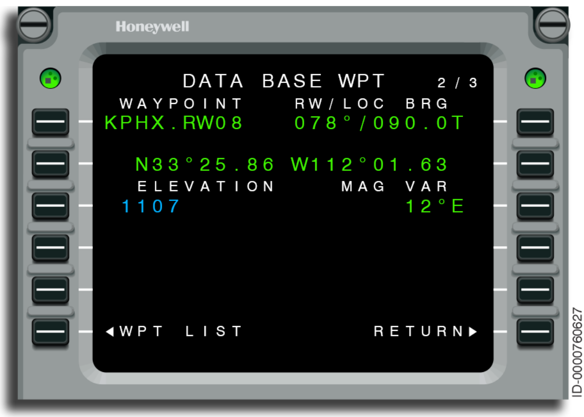


Figure 6-20
DATA BASE WPT 2/3 - Runway

The DATA BASE WPT 3/3 page shown in Figure 6-21, displays the following:

- Identifier (1L)
- Stopway (1R)
- Width (2L) – This field is blank when runway width is not available in the navigation database
- Length (2R)
- ILS glideslope when applicable (3L)
- Displaced threshold (3R).

Figure 6-21
DATA BASE WPT 3/3 - Runway

NAVAIDs

The DATA BASE WPT 1/1 page shown in Figure 6-22, displays the following information about NAVAIDs:

- Waypoint identifier (1L)
- Country (1L)
- Frequency (1R)
- Type (2L):
  - DME (distance measuring equipment)
  - N DME (noncolocated)
  - GLS (GBAS landing system)
  - TACAN (tactical air navigation)
  - N TACAN (noncolocated)
  - VORTAC (combined VOR and TACAN stations)
  - VORDME
  - VOR
  - NDB
  - N VOR (noncolocated)
- Class (2R):
  - HA (high altitude)
  - LA (low altitude)
  - T (terminal)
  - UR (unrestricted)

- Coordinate position (2L)
- Elevation (3L)
- Magnetic declination/variation (3R).

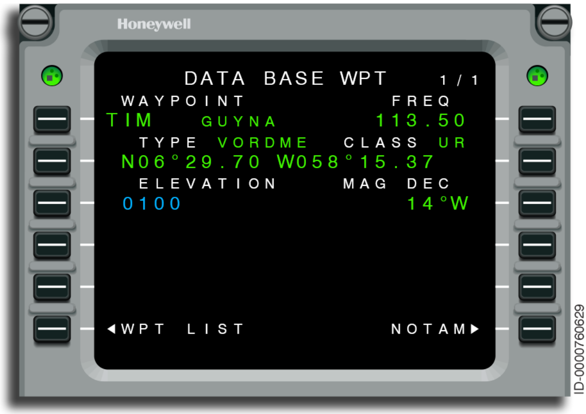


Figure 6-22
DATA BASE WPT - Guyna

Magnetic declination is defined as the difference between the 0 degree radial of the station and true north. For many NAVAIDs, this is not equal to the local magnetic variation due to the constantly changing earth magnetic field. When magnetic declination is not available, magnetic variation is displayed.

Figure 6-23 shows the DATA BASE WPT page for a nondirectional beacon.

Figure 6-23
DATA BASE WPT - NDB

Instrument Landing Systems

The DATA BASE WPT 1/1 page, shown in Figure 6-24, displays the following data for instrument landing systems:

- ILS identifier (1L)
- Country (1L)
- Front course (1R)
- Frequency (1R)
- Type (2L):
  - ILS
  - LOC (localizer)
  - LOCDME (localizer with DME)
  - ILSDME (ILS with DME)
- Category (2R):
  - I
  - II
  - III
- Localizer antenna coordinates (2L)
- Magnetic declination/variation (3R).

Figure 6-24
DATA BASE WPT - IPHX

GBAS Landing System (GLS)

The DATA BASE WPT 1/1 page shown in Figure 6-25, displays the following data for GBAS landing systems:

- GLS identifier (1L)
- Country (1L)
- Front course (1R)
- Channel (1R)
- Type (2L):
  - GLS
- Category (2R):
  - I
  - II
  - III
- Localizer antenna coordinates (2L)
- Elevation (3L)
- Magnetic declination/variation (3R)
- Glideslope (4L).

Figure 6-25
DATA BASE WPT - GLS

Intersections

The DATA BASE WPT 1/1 page shown in Figure 6-26, displays the following data for intersections:

- Intersection identifier (1L)
- Country (1L)
- Intersection coordinates (2L)
- Magnetic variation (3R).

Figure 6-26
DATA BASE WPT - Payso

Multiple Waypoints

When a waypoint identifier is entered on any page and the FMS finds more than one definition for the identifier, the WAYPOINT SELECT page is displayed. The pilot must choose what definition to use. When inserting waypoints into a stored or active flight plan, the location closest to the previous waypoint is shown at the top of the page. For all other cases, the location closest to the aircraft position is shown at the top of the page.

For example, when Thermal California (TRM) is entered on the DATA BASE WPT page, the FMS shows all the TRM waypoints found on the WAYPOINT SELECT page. This is shown in Figure 6-27.

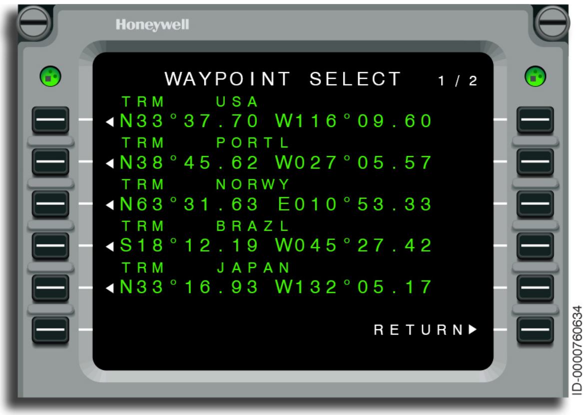


Figure 6-27
WAYPOINT SELECT

Selecting a desired waypoint is done by pushing the line select key adjacent to the desired waypoint. When RETURN (6R) is pushed, no waypoint is selected.

Pilot-Defined Waypoints

When a pilot-defined waypoint is entered on the DATA BASE WPT page, the FMS switches to the PILOT WAYPOINT page and shows the waypoint, as well as the data about the waypoint.

Undefined Waypoints

When an identifier is entered on the DATA BASE WPT page and the FMS cannot find a waypoint in the navigation database with that identifier, the FMS goes to the PILOT WAYPOINT page for waypoint definition.

FMS Database

The FMS database consists of two parts, a navigation database and a custom (or pilot-defined) database. The navigation database is loaded into the FMS and cannot be changed by the pilot. Using the custom database, the pilot customizes the FMS by defining waypoints and storing flight plans.

Navigation Database

The FMS retrieves information from the navigation database about waypoints and procedures used in flight planning and to tune NAVAIDs for position determination. The database, supplied by Honeywell, is updated every 28 days (refer to Navigation Database Updating on page 6-171).

The navigation database contains the following:

- NAVAIDs
- Airports
- Runways
- Airways (high and low)
- SIDs and STARs
- Approaches
- Named intersections
- Outer markers
- Final approach segment (FAS) datablock.

NAVAIDs include very high frequency (VHF) NAVAIDs, instrument landing system/microwave landing system (ILS/MLS), GBAS landing system (GLS), and nondirectional beacons (NDBs). VHF NAVAIDs stored in the database consist of the following types:

- VORTAC
- VOR/DME
- TACAN (tactical air navigation)
- VOR
- DME
- VOR/DME (noncolocated)
- GLS (GBAS landing system)
- TACAN (noncolocated).

NOTE: For more information on GLS operations, see publication D202012001535, Primus Epic 2 Integrated Avionics System (IAS) for the Embraer E-Jet E2 E190/E195-E2 Pilot's Guide.

Airport waypoints are the geographic reference point for the airport.

Airways contained in the database include all waypoints (some are unnamed) and only waypoints that define the airway. Some of these defining waypoints are not on paper charts. Some waypoints on the charts are shown to be on an airway, but are not defining waypoints for the airway.

The NAV database is tailored to consist of company-defined flight plans and routes. This customization is available only through a subscription service from Honeywell.

Custom Database

The custom database consists of pilot-defined waypoints and stored flight plans. Up to 1,000 pilot-defined waypoints are stored.

The pilot stores commonly flown routes using the pilot-defined flight plan procedure. The pilot activates a flight plan from the FMS custom database rather than repeat the flight plan entry procedure. The FMS custom database can have more than 100 flight plans and those stored flight plans can contain more than 100 waypoints as long as the total number of waypoints in all of the stored flight plans put together does not exceed 1,000.

Custom DBs that save flight plans also store the cruise altitude from the active flight plan but not from inactive flight plans (SEC1 and SEC2), and if multiple flight plans are loaded from the custom DB, the cruise altitude is updated only once during the first load of the flight plan. The cruise altitude is then ignored if another flight plan is loaded from the custom DB until a cycle power is performed to the FMS.

Custom DBs are downloaded and uploaded to/from Personal Computer Memory Card International Association (PCMCIA) memory cards when the DMU option is installed. This permits the pilot to save and store frequently used flight plans and pilot-defined waypoints. If DLMU is installed, the pilot can download/upload to USB device, SD Card, or LAN. With DLMU, available options are CD/DVD, PCMCIA, and LAN.

FIX INFORMATION (INFO)

FIX INFO functionality gives the means for the pilot to find intersection points on the active flight plan with selected radials or distances from database fixes. The pilot also enters radials or distances to determine positions of intersection with the flight plan and the ETA and distance of those intersections. Through selection of the abeam prompt, the point in the flight plan that is abeam of the reference fix is determined. Waypoints are then created from these intersections and the data is displayed on the multifunction display (MFD). The FIX INFO page is shown in Figure 6-28, and is accessed from the FIX INFO prompt on the NAV INDEX page.

Figure 6-28
FIX INFO - LACRE

- **1L** – Any waypoint, airport, or runway contained in the navigation database or custom database is entered here. The bearing and distance from the fix is also displayed on this line. In this example, the bearing is 126° and the great circle distance is 28 NM from the fix to the aircraft. A new fix is entered over the existing fix or the fix is copied to the scratchpad.

NOTES: 1. The fix is only erased by selecting the ERASE FIX prompt at 6L or using the MCDU DEL key.

2. A runway is displayed as a fix in 1L as AIRPORT. RUNWAY. For instance, Phoenix - Sky Harbor runway 26 is entered into the scratchpad as KPHX.RW26, then upselected to 1L.

- **2L through 4L** – Bearing and/or distance (BRG/DIS) references are entered into 2L through 4L. A bearing is entered in 2L, 3L, or 4L. Valid bearing (radial) entries are three digits ranging from 000° to 360°. The entered radial is displayed on the navigation display (ND) relative to the current map display. When the entered radial intersects the active flight plan within 999 NM of the reference fix, the intersecting distance is displayed in small font following the slash (/). When no intersection is found, the distance portion of the lines 2, 3, or 4 is blank.

  A distance is entered in 2L, 3L, or 4L preceded by a slash (/). When the distance circle intersects the active flight plan, the intersecting radial is displayed in small font before the slash. When no intersection is found within 999 NM, the bearing portion of lines 2, 3, or 4 is blank.

  When radial lines or distance circles intersect the active flight path, distance along the flight path to the intersection, ETA, and estimated altitude at the intersection are displayed.

  The ETA and DTG are displayed in lines 2 through 5 for bearing, distance, or abeam references when an intersection with the active flight plan exists.

  When an intersection with the active flight plan exists for the bearing, distance, or abeam references in 2L through 5L, the predicted altitude at that intersection is displayed in 2R through 5R. When no intersection exists, the corresponding altitude field is blank.

  Selection of a bearing entry or distance entry (2L, 3L, or 4L) from the FIX INFO page automatically creates a place/bearing/distance (PBD) waypoint and inserts it into a modified flight plan. Bearing information entered is corrected for magnetic variation. When more than one crossing point exists, the first crossing point (closest to the aircraft in distance along the flight plan) on the FIX INFO page is inserted. The pilot reviews the modified flight plan information on the MFD prior to activation.

- **5L** – Initially, an ABEAM prompt is displayed in 5L. Pushing 5L shows the bearing and distance from the fix perpendicular to the nearest intersection on the flight path. Distance along the path to the abeam point, ETA, and altitude at that point is also displayed.

  When an abeam point to the active or active offset flight path cannot be found, NO CROSSING POINT FOUND is displayed on the scratchpad.

  Pushing 5L automatically adds the temporary waypoint into the pending flight plan.

- **6L** – Pushing 6L removes all fix data from the FIX INFO page. The ERASE prompt is not displayed when a fix is not displayed in 1L.

FLIGHT PLAN LIST

The FLIGHT PLAN LIST page is accessed from the FPL LIST prompt on the NAV INDEX page and shows a list of the pilot-defined flight plans stored in the FMS memory. From this page, the pilot defines a flight plan, deletes flight plans, or selects a flight plan to activate.

When no flight plans are stored in the FMS, the FLIGHT PLAN LIST page is blank. This is shown in Figure 6-29.

Figure 6-29
FLIGHT PLAN LIST

When flight plans have been defined, the page lists the flight plans by name. This is shown in Figure 6-30.

Figure 6-30
FLIGHT PLAN LIST- Defined Flight Plans

Defining Stored Flight Plans

Stored flight plans, like active flight plans, are defined between any two nontemporary waypoints (NAVAIDs, intersections, airports, etc.). A flight plan from Phoenix to Minneapolis is used to describe how to define a flight plan in Procedure 6-3.

Procedure 6-3
Defining a Stored Flight Plan

1. Once a flight plan is created using the RTE and ACTIVE FLT PLAN pages, the flight crew can save the flight plan using the SAVE FPL AS option (5R) on the last page of the primary portion of the ACTIVE FLT PLAN page, as shown in Figure 6-31. However, the stored flight plan cannot contain the following: temporary waypoints, SIDs, STARs or approach procedures, alternate flight plans, speed, angle, altitude constraints, or another stored flight plan. These are not saved. Stored flight plans can contain patterns.

NOTE: If the cruise altitude is available, the saved flight plan on the custom DB stores the cruise altitude from the active flight plan but not from the inactive flight plans (SEC1 and SEC2). If multiple flight plans are loaded from the custom DB, the cruise altitude is updated only once during the first load of the flight plan. The cruise altitude is then ignored if another flight plan is loaded from the custom DB until a cycle power is performed to the FMS.

Figure 6-31
ACTIVE FLT PLAN - SAVE FPL AS Prompt at 5R

2. Select FLIGHT PLAN LIST from the NAV INDEX page. The FLIGHT PLAN LIST page is displayed showing all of the stored flight plans, as shown in Figure 6-32.

Figure 6-32
Stored Flight Plans

3. Entering the intended origin and/or destination at 1R of this page shows an asterisk (*) next to the stored flight plans with matching origin and/or destination, as shown in Figure 6-33. In this example, entering KPHX/KMSP at 1R shows an asterisk next to the FLTPLAN01 that has KPHX as the origin and KMSP as the destination.

Figure 6-33
FLTPLAN01

4. Similarly, entering just KPHX at 1R shows an asterisk next to both stored flight plans because both of them have KPHX as their origin, as shown in Figure 6-34.

Figure 6-34
KPHX in Both Flight Plans

Deleting Stored Flight Plans

The DEL key is used to remove stored flight plans from the FMS memory. Procedure 6-4 describes two methods for deleting a flight plan.

Procedure 6-4
Deleting a Stored Flight Plan

1. Select FPL LIST from the NAV INDEX page.
2. Push the DEL key (*DELETE* is displayed on the scratchpad). Pushing the line select key adjacent to the flight plan name erases it from the FMS memory.

SECONDARY FLIGHT PLAN

The primary purpose of the secondary flight plan is to permit the pilot to evaluate different operational scenarios, (e.g., different routes, cruise altitudes, cruise speed, winds, etc.). The secondary flight plan is used to review a datalink uplink flight plan and can also be used to define the route for the next flight plan leg. All performance functions available for the active flight plan are available for the secondary flight plan, as defined in the performance section.

When the active flight plan is copied to the secondary flight plan, the secondary flight plan defaults to a copy of the remaining active flight plan. Changes to the secondary flight plan are automatically inserted into the secondary flight plan without a MOD flight plan.

When the pilot is finished evaluating the secondary flight plan changes, the secondary flight plan can either be swapped into the active flight plan or discarded. When the secondary flight plan is swapped, the pilot must activate the resultant MOD flight plan into the active flight plan.

Access to the secondary flight plan is through the NAV INDEX page.

NOTE: *All secondary screens described in the following pages contain the same information as their active counterpart screens. The only difference is that the secondary display screens are all in white font. Therefore, no detailed explanation of each page is given in order to avoid repetition.*

ADDITIONAL RESOURCES: SECONDARY FLIGHT PLAN

Video

ID-642208

For an operational description and demonstration of using the secondary flight plan on the MCDU, select the link or scan the QR code.

http://y2u.be/ab3S1kLaEiA

Secondary Flight Plan Menu

The SEC FPL MENU page, shown in Figure 6-35, is accessed from the SEC FPL MENU prompt on the NAV INDEX page and permits selection of the desired operations/pages for each of the inactive flight plans. Access to the individual index, flight plan, and route pages associated with each of the inactive flight plans, in addition to providing the COPY and SWAP (activate) capabilities, is supplied by way of the SEC FPL MENU page. The COPY and SWAP capabilities are ONLY supplied on this page.

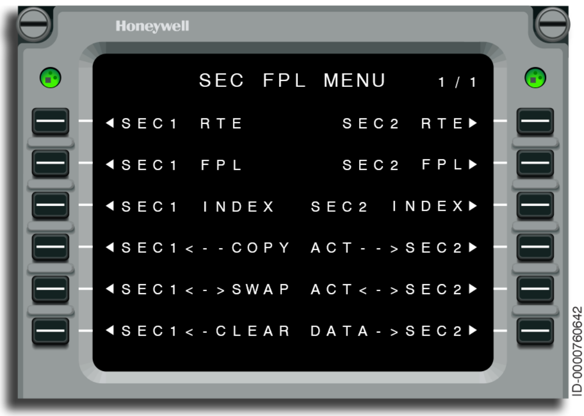


Figure 6-35
SEC FPL MENU

The SEC1 RTE 1 page gives access to the flight number, company route, departures runway, and datalink flight plan information. This page, shown in Figure 6-36, also permits entry and display of the flight plan origin and destination.

Figure 6-36
SEC1 RTE 1/3

NOTE: The OFFSET prompt is not displayed on 5L since offsets are not permitted on secondary flight plans.

The SEC1 FLT PLAN page, shown in Figure 6-37, displays a copy of the remaining active flight plan pages.

Figure 6-37
SEC1 FLT PLAN

The SEC1 INDEX page, shown in Figure 6-38, gives access to several secondary/inactive pages.

Figure 6-38
SEC1 INDEX

Secondary Performance Initialization

When PERF INIT is selected on the SEC INDEX page, the SEC PERF INIT page is displayed. There are a total of three secondary PERF INIT pages.

The SEC1 PERF INIT 1/3 page, shown in Figure 6-39, contains information about the aircraft tail number, performance factor, fuel reserve, takeoff and landing fuels, and alternate fuel information for the secondary flight plan.

Figure 6-39
SEC PERF INIT 1/3

Selecting the OR prompt at 2R, shown in Figure 6-39, displays the SEC1 FUEL RESERVE page, shown in Figure 6-40. The SEC1 FUEL RESERVE page is used to set the fuel reserve mode. The fuel reserve options on this page include reserve in weight and reserve in time.

Figure 6-40
SEC1 FUEL RESERVE

The SEC1 PERF INIT 2/3 page, shown in Figure 6-41, gives the capability to view and modify the following parameters: cruise altitude, step increment, average cruise winds for the route, mean ISA deviation for the route, number of passengers (PASS), ZFW, gauge fuel and actual fuel, takeoff CG fuel, and gross weight.

Figure 6-41
SEC1 PERF INIT 2/3

The SEC1 PERF INIT 3/3 page, shown in Figure 6-42, is used to display climb, cruise, and descent speeds. This page also supplies the capability to enter these speeds and the cost index option used in ECON SPEEDS calculations.

Figure 6-42
SEC1 PERF INIT 3/3

The SEC1 CLIMB MODES page, shown in Figure 6-43, gives a list of predefined climb modes, any one of which may be used during climb calculations. It is accessed from the SEC1 PERF INIT 3 page.

Figure 6-43
SEC1 CLIMB MODES

The SEC1 CRUISE MODES page, shown in Figure 6-44, gives a list of predefined cruise modes, any one of which is used during cruise calculations. It is accessed from the SEC1 PERF INIT 3 page.

Figure 6-44
SEC1 CRUISE MODES

The SEC1 DESCENT MODES page, shown in Figure 6-45, gives a list of predefined descent modes, any one of which is used to during descent calculations. It is accessed from the SEC1 PERF INIT 3 page.

Figure 6-45
SEC1 DESCENT MODES

Secondary Data

The SEC1 PERF DATA page, shown in Figure 6-46, displays the overall fuel and time calculations along with the cruise altitude. When an alternate flight plan is entered, data for both the destination and the alternate destination is presented.

Figure 6-46
SEC1 PERF DATA 1/3

The SEC1 PERF DATA 2 page, shown in Figure 6-47, displays wind information and tracks fuel prediction changes since takeoff. No entries are permitted.

Figure 6-47
SEC1 PERF DATA 2/3

The SEC1 PERF DATA 3 page, shown in Figure 6-48, displays information about fuel reserve requirements. No entries are permitted.

Figure 6-48
SEC1 PERF DATA 3/3

Secondary Performance Plan

The SEC1 PERF PLAN page shows the estimated fuel remaining and estimated time en route (ETE) for each leg of the flight. These pages also give access to the Wind and Temperature page by the way of a Wind/Temp (W/T) prompt for each waypoint. The SEC1 PERF PLAN page is shown in Figure 6-49.

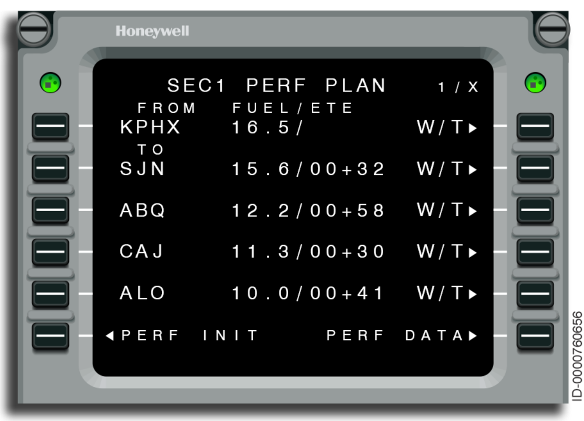


Figure 6-49
SEC1 PERF PLAN

Secondary Climb Page

The SEC1 CLIMB page is used to view or modify parameters pertaining to the climb phase. Parameters on this page include the top-of-climb (TOC) altitude, speed command, distance-to-go to the TOC, estimated time en route (ETE) to the TOC, estimated time of arrival (ETA) at the TOC, and fuel remaining at the TOC. The SEC1 CLIMB page is shown in Figure 6-50.

Figure 6-50
ECON SEC1 CLIMB

Secondary Cruise Page

The SEC1 CRUISE page, shown in Figure 6-51, is used to modify parameters pertaining to the cruise phase of flight. Parameters on this page include cruise altitude and speed command for the cruise phase, optimum cruise altitude, step altitude, estimated time en route (ETE) to the bottom-of-step-climb (BOSC), estimated time of arrival (ETA) to BOSC, distance and fuel remaining to step and top-of-descent (TOD), and range and time to fuel reserves. In addition the cruise altitude and speed command are defined on the CRUISE page.

Figure 6-51
SEC1 CRUISE

Secondary Descent Page

The SEC1 DESC page, shown in Figure 6-52, is used to modify parameters pertaining to the descent phase. The speed command and descent angle are defined on the DESCENT page. Parameters on this page include the bottom-of-descent (BOD) altitude, speed command for the descent phase, distance-to-go (DTG) to the BOD, estimated time en route (ETE) and estimated time of arrival (ETA) at the BOD, descent angle, and fuel remaining at the BOD.

Figure 6-52
SEC1 DESC

Graphical Flight Planning – Secondary Flight Plans

Graphical flight planning permits secondary flight plans to be created and displayed on the MFD. The secondary display is controlled using the dropdown menu, as shown in Figure 6-53.

Figure 6-53
Secondary Dropdown Menu

Selecting the Secondary 1 or Secondary 2 radio button shows the secondary flight plan on the MFD. Selecting Off removes the secondary flight plan from the display.

In order for a secondary flight plan to be displayed, an active flight plan must exist and the Secondary 1 or Secondary 2 radio button must be selected. Access the SEC FPL MENU, as shown in Figure 6-54.

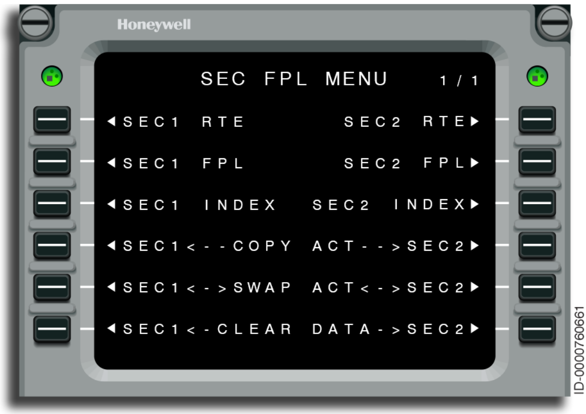


Figure 6-54
SECONDARY FPL MENU

Select LSK 4L or 4R to copy the active flight plan into the secondary flight plan. The secondary flight plan is then superimposed on the active flight plan in white dotted lines on the MFD, as shown in Figure 6-55. Using the CCD, move the cursor to the desired waypoint/destination. For this example, the destination airport is changed from KLLJ to KBYG.

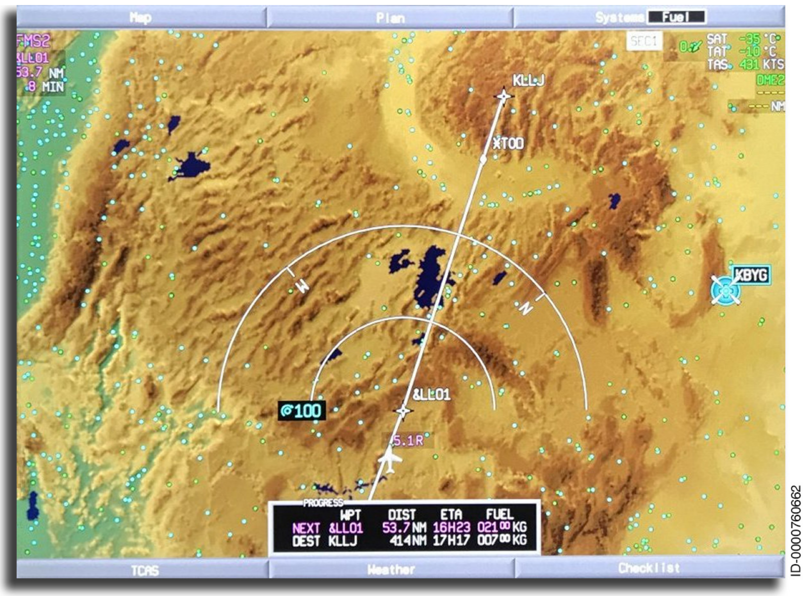
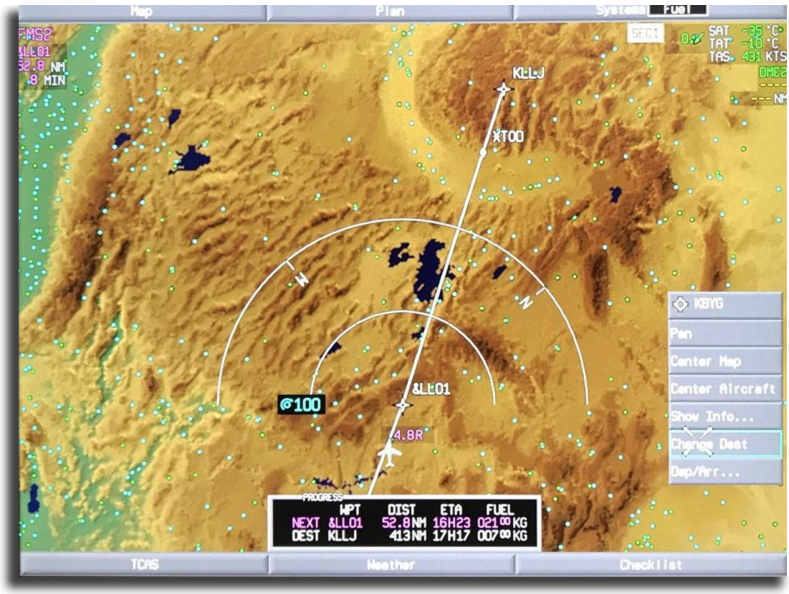


Figure 6-55
Secondary Flight Plan

Once a new destination is selected, access the airport task menu using the CCD, as shown in Figure 6-56. Select Change Dest. This changes the destination in the SECONDARY FPL page.



ID-0000760663

Figure 6-56
Airport Task Menu - Change Dest

Once the destination is changed, a white dotted line is drawn to the new destination, as shown in Figure 6-57.

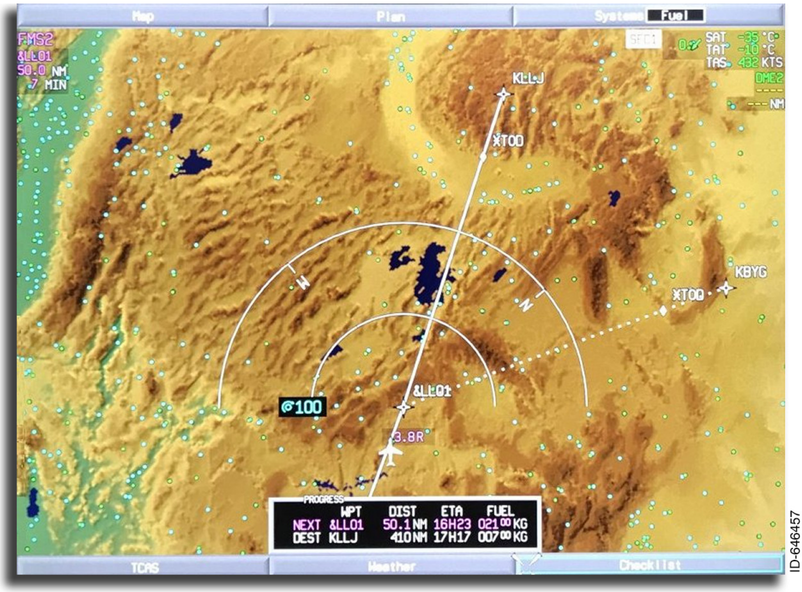


Figure 6-57
New Destination

If the secondary flight plan is desired, it must be activated by going back to the SEC FPL MENU page and selecting 5L or 5R to swap the secondary flight plan into the active flight plan. A pending flight plan is then displayed with white dashed lines. Once done, a Cancel, Undo, Activate box is displayed on the MFD, as shown in Figure 6-58.

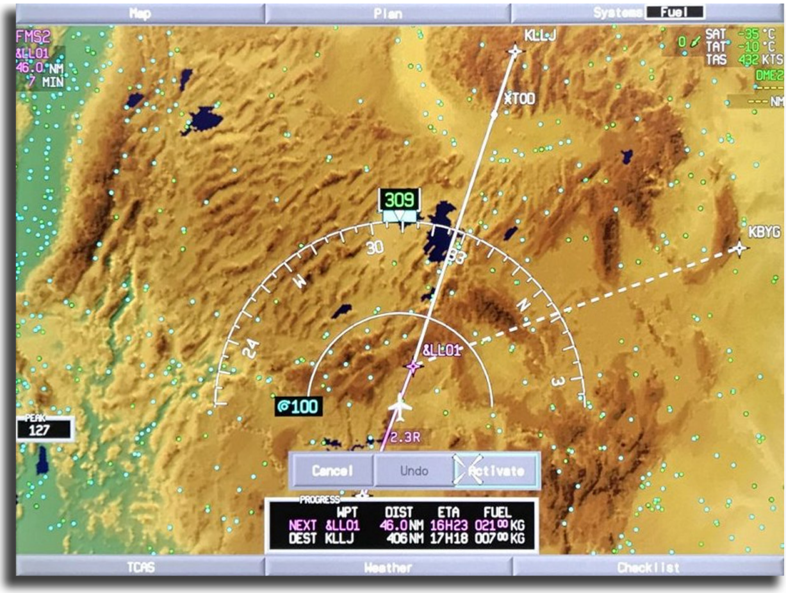
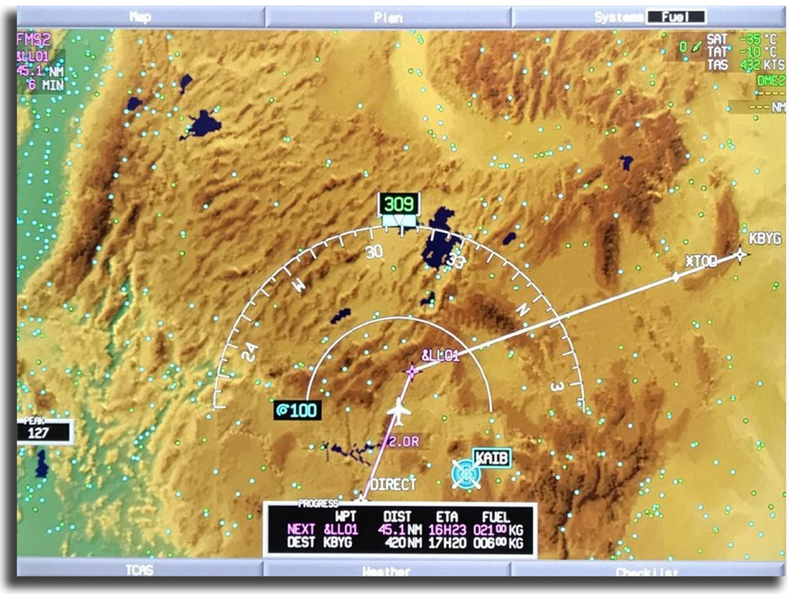


Figure 6-58
Cancel, Undo, Activate Box

Place the cursor over Activate and select using the CCD. Once activated, a solid white line is drawn directly to the new destination, as shown in Figure 6-59. All flight plan information on the ACTIVE FPLN and ACT RTE pages are automatically adjusted with the new flight plan information.



ID-0000760666

Figure 6-59
New Destination Activated

The secondary flight plan can also be modified graphically using the designator and/or waypoint stringing function. The only difference is that when using the designator and upselecting the Lat/Lon on the MCDU to the desired waypoint, a white dotted line (secondary flight plan) is displayed and not a white dashed line (pending flight plan). The same is true for waypoint stringing. See Section 12, Graphical Flight Planning, for additional information.

CROSSING POINTS

The CROSSING POINTS pages are used to determine the relationship of a waypoint relative to the current aircraft position.

The FMS computes the following types of crossing points:

1. Direct-To a waypoint from the current aircraft position.

2. Crossing latitude/longitude given latitude/longitude for the current flight plan.

3. Equal time point (ETP) between any two given waypoints.

4. Point of no return (PNR) from any given waypoint.

The CROSSING POINTS 1/1 page, shown in Figure 6-60, is displayed after selecting the CROSS PTS prompt from the NAV INDEX 1 page. This page is an index of the available crossing point options.

Figure 6-60
CROSSING POINTS

Present Position (PPOS) Direct

Select 1L from the display, shown in Figure 6-60, for Direct-To information from the present position of the aircraft to any given waypoint.

For example, to determine where DEN is relative to the current aircraft position, enter DEN into the scratchpad and push line select 1L. This is shown in Figure 6-61. At 1R, the radial and distance from DEN to the current aircraft position is displayed. The bottom half of the page shows the course, distance, ETE, and the remaining fuel when the aircraft flies direct from the current position to DEN.

The CROSS PTS prompt at (6L) returns to the CROSSING POINTS page.

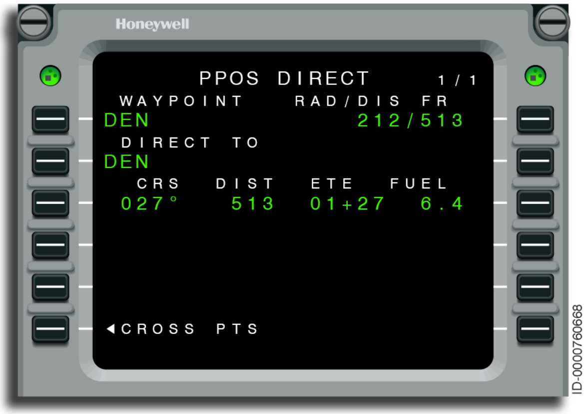


Figure 6-61
PPOS DIRECT

Latitude/Longitude Crossing

Selecting 1R from the display shown in Figure 6-60, calculates the crossing latitude or longitude when either the longitude or latitude is entered. The course, distance, ETE, and fuel remaining are displayed when the aircraft proceeds directly to the waypoint.

For example, to know where the aircraft crosses the 100° west longitude line for the current flight plan, enter W100 at 1R. This is shown in Figure 6-62. The FMS computes the latitude. The FMS also shows the course, distance, ETE, and fuel remaining to fly directly from the current aircraft position to N33°24.9 W100°00.0. The computed point is inserted into the flight plan as a temporary waypoint using the prompt at LSK 2L. When required, latitude is entered and the FMS calculates the longitude. When more than one intersection with the flight plan exists, the closest one is displayed.

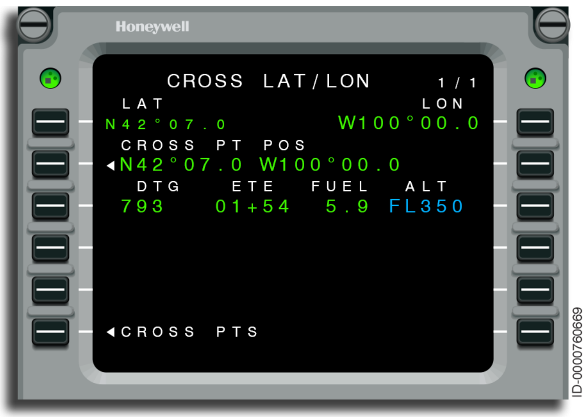


Figure 6-62
CROSS LAT/LON

When the flight plan does not cross the entered latitude/longitude, the message NO CROSSING POINT FOUND is displayed on the scratchpad.

Equal Time Point

Selecting 2L from the display, shown in Figure 6-60, calculates the equal time point (ETP) between any given waypoints. The default waypoints are the origin and destination of the active flight plan. Any waypoints are entered at 1L and 2L. This is shown in Figure 6-63.

Figure 6-63
EQUAL TIME POINT

When the WPT 1 and WPT 2 are the origin/destination, the ETP is the physical point along the flight plan where time-to-go back to the origin is the same as the time-to-continue to the destination.

When WPT 1 and/or WPT 2 are not the origin/destination, the ETP is the physical point along the flight plan between WPT 1 and WPT 2, where the time-to-go back to WPT 1 is the same as the time-to-go to WPT 2.

The D> symbol indicates Direct-To the identified waypoint. FP>ETP indicates along the active flight plan to the ETP. When the ETP location is behind the aircraft, PAST is displayed.

The FUEL digital readout is the amount of fuel remaining on arrival at the waypoint or ETP. The fuel remaining does not necessarily represent the fuel required to satisfy reserve requirements. The FUEL values shown are always fuel remaining at a given waypoint.

NOTE: When the decision is made to go to WPT 1 or WPT 2, the FMS operates under the assumption that current operating conditions continue to prevail (i.e., the same altitude, engine fuel flow, etc.).

The data on the EQUAL TIME POINT page is updated each time the page is selected or each time a new wind entry is made. When the page is left in view for an extended period of time, the data is not updated unless the page is deselected and then reselected.

The SHOW ON MAP prompt is displayed on LSK 5R. Pushing this prompt toggles between YES and NO. Selecting YES shows the equal time point on the flight plan on the MFD.

Point of No Return

Selecting 2R from the display, shown in Figure 6-60, calculates the PNR from any given waypoint. The default waypoint is the origin of the active flight plan. Any waypoint is entered at 1L. This is shown in Figure 6-64. The default wind (1R) for the waypoint is supplied from the wind model. A cruise wind is entered for the waypoint. The wind model is not changed when entries are made on this page.

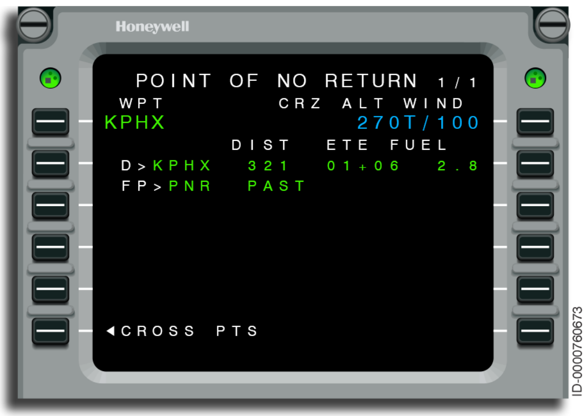


Figure 6-64
POINT OF NO RETURN

The PNR is the point along the flight plan where the fuel to reach the destination is less than the fuel to return to the WPT. The WPT is the origin (default) or any other waypoint.

D> indicates Direct-To the waypoint shown. FP> indicates the distance and fuel remaining along the flight plan to the PNR. When the PNR location is behind the aircraft, PAST is displayed. Similarly, when the PNR location is beyond the destination, BEYOND DEST is displayed.

The fuel remaining does not necessarily represent the fuel required to satisfy reserve requirements.

The data on the POINT OF NO RETURN page is updated each time the page is selected or each time a new wind entry is made. When the page is left in view for an extended period of time, the data is not updated unless the page is deselected and then reselected.

FLIGHT SUMMARY

Figure 6-65 shows the FLIGHT SUMMARY page. This page shows a summary of the flight. The FLIGHT SUMMARY page is accessed from the FLT SUM prompt on the NAV INDEX 1 page or the FLT CONFIG 2 page.

The flight summary data is automatically printed or saved at the end of a flight, as per the settings on the FLIGHT SUMMARY OUTPUT page (that is accessed from the Flight Config Page 2). The one exception is for FUEL USED. This is reset to zero. For quickturns, all the parameters except engine on/off times are reset for the new flight. The new flight is determined by closing the passenger cabin door or by starting an engine. The fuel used is manually reset at any time by selecting LSK 5R.

Fuel used is reset when a cold start of the system is performed when on the ground or when an engine is restarted after a complete engine shutdown on the ground.

Figure 6-65
FLIGHT SUMMARY

- **1L and 1R** – This line shows the engine 1 time on and off.
- **2L and 2R** – This line shows the engine 2 time on and off.
- **3L and 3R** – This line shows the takeoff, en route, and landing times.
- **4L** – The valid engine 1 and engine 2 fuel used values are displayed on this line.
- **4R** – The fuel remaining value is displayed on this line.
- **5L** – The valid auxiliary power unit (APU) fuel used is displayed on this line.
- **5R** – The RESET FUEL USED prompt is displayed on this line. This prompt resets the fuel used fields.

PATTERNS

The NAV INDEX page, shown in Figure 6-66, gives access to the PATTERNS page by selecting the PATTERNS prompt at 5L.

Figure 6-66
NAV INDEX 1/2 - PATTERNS

The PATTERNS page, shown in Figure 6-67, is accessed from the PATTERNS prompt on the NAV INDEX page and gives access to the available patterns for selecting and defining pilot-defined patterns. In addition to the pilot-defined patterns, some procedures, such as approach procedures, contain patterns. These database patterns are added to the flight plan when activating the approach procedure.

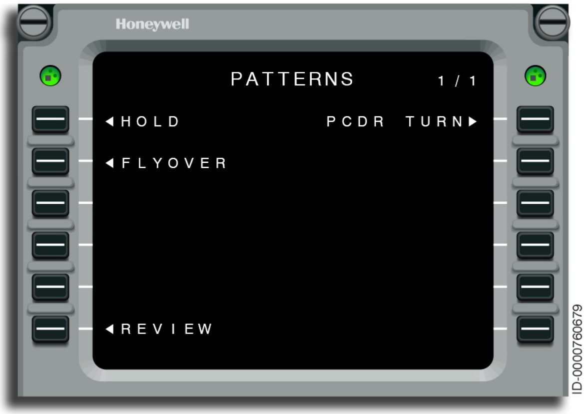


Figure 6-67
PATTERNS - Overview

- **1L** – Selecting this prompt results in *HOLD* to be displayed on the scratchpad and the parent flight plan page to be displayed as follows:
  - If accessed from the NAV INDEX or SECONDARY INDEX page, page 1 of the parent flight plan is displayed
  - If accessed from the active flight plan, the display returns to the original parent flight plan page.

  The parent is the active or temporary active for the active flight plan and is the secondary or temporary secondary for the secondary flight plan.
- **1R** – Selecting this prompt results in the FMS to display the PROCEDURE TURN page.
- **2L** – Selecting this prompt results in *FLYOVER* to be displayed on the scratchpad and the parent flight plan page to be displayed as follows:
  - If accessed from the NAV INDEX or SECONDARY INDEX page, page 1 of the parent flight plan is displayed

  – If accessed from the active or pending flight plan, the display returns to the original parent flight plan page.

- **6L** – Selecting this prompt results in one of the following to occur based on the parent flight plan:

  – If one or more patterns exist, the pattern definition page of the first pattern is displayed

  – If no patterns exist, NO PATTERN FOUND is displayed on the scratchpad.

Pattern Definition

Figure 6-68 shows each pattern type. Procedures for using each pattern type are contained in this guide. The following patterns, along with page numbers for more detailed information, are available in the FMS:

- HOLD (page 6-68)
- PROCEDURE TURN (page 6-82)
- FLYOVER (page 6-87).

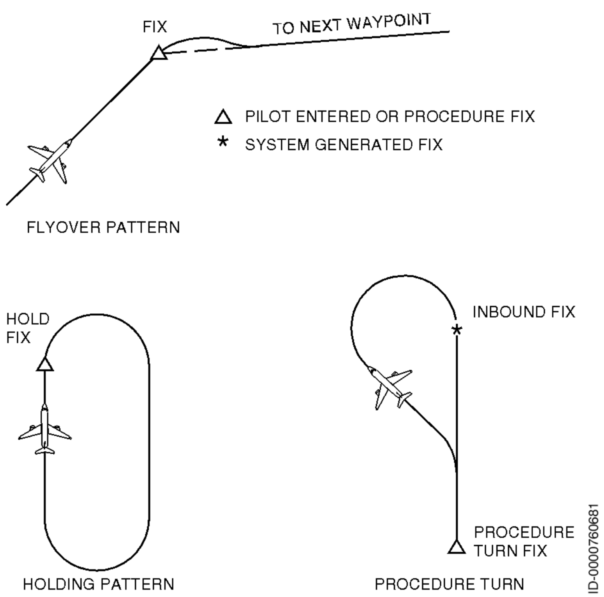


Figure 6-68
Pattern Formats

HOLD

The HOLDING PATTERN page is accessed from the HOLDING prompt on the NAV INDEX page and is used to define and review holding patterns. Holding quadrant, inbound course, turn direction, and leg length or time of the inbound leg of a holding pattern is defined on the HOLDING PATTERN page. Figure 6-69 shows a typical holding pattern.

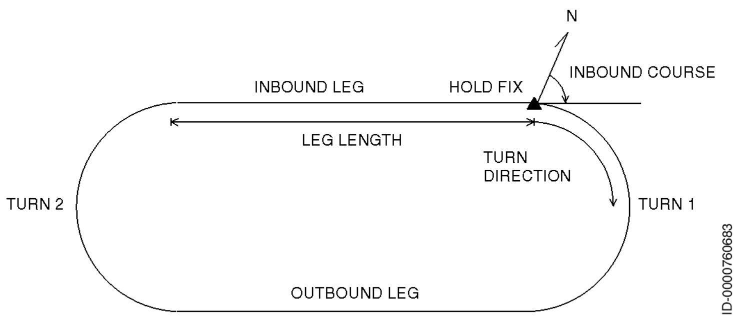


Figure 6-69
Typical Holding Pattern

The holding pattern entry type is based on the geometry shown in Figure 6-70.

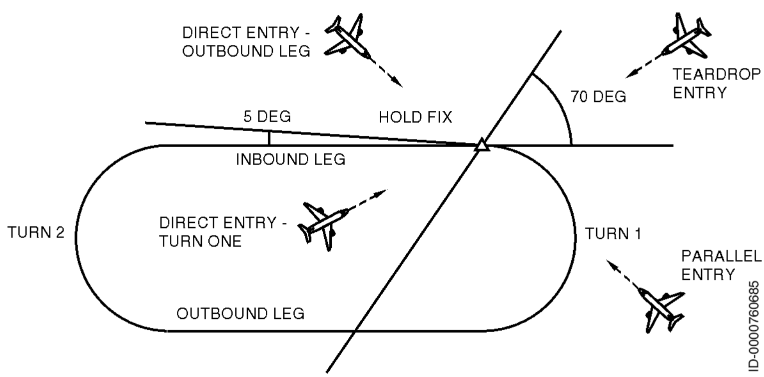


Figure 6-70
Entry Geometry

Defining a Holding Pattern

A holding pattern is defined and reviewed by following Procedure 6-5.

Procedure 6-5
Defining and Reviewing a Holding Pattern

1. Select the HOLD prompt from the NAV INDEX page. When there is no HOLD in the flight plan, *HOLD* is automatically placed on the scratchpad. Otherwise, select HOLD in 5R. This is shown in Figure 6-71. An alternative is to select PATTERNS on LSK 5L.

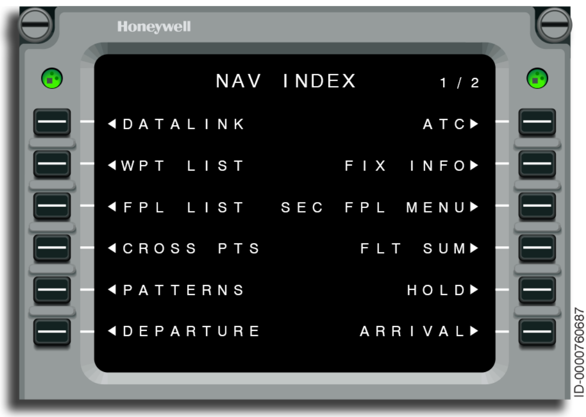


Figure 6-71
NAV INDEX - HOLD Prompt

2. Push the line select key adjacent to the desired holding fix waypoint. This is shown in Figure 6-72. In this example, MCW (2L) is selected.

Figure 6-72
ACTIVE FLT PLAN - With Hold

3. Review the default holding pattern definition. This is shown in Figure 6-73. When no changes are required, go to Step 10. Make changes, as necessary, using the required steps.

Figure 6-73
HOLDING PATTERN - MCW

DETAILS – The default holding is a standard holding pattern at the designated holding fix with the inbound course set to the flight plan course into the holding fix. Leg times are defaulted to 1 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet.

4. Enter any inbound course and/or turn direction and push line select 3L. The entry is made by entering the course followed by a slash (/) and then an **L** or **R** into the scratchpad. For changes only to the inbound course, enter the course into the scratchpad. For changes only to the turn direction, enter a slash (/) followed by an **L** or **R**.

5. Review the holding quadrant and entry procedure. Holding quadrant entry is not required or recommended. The FMS shows the holding quadrant based on the inbound course entered by the pilot. No entries are permitted for the entry procedure.

   DETAILS – Holding quadrant is entered by the pilot. When this occurs, the FMS sets the inbound course to the cardinal heading associated with the entered quadrant. This overwrites any pilot-entered inbound course. Thus, pilot-entry is not recommended for holding quadrant.

   Possible entries for the quadrant are as follows:

Quadrant	Inbound Course
N	(180°)
NE	(225°)
E	(270°)
SE	(315°)
S	(000°)
SW	(045°)
W	(090°)
NW	(135°)

6. The FMS shows a speed for holding at 1R on the HOLDING PATTERN page, as shown in Figure 6-74. The header label is indicated as SPEED. Holding speeds are shown in the following priority; a pilot-entered holding speed (displayed in large cyan font), green dot speed, or 210 KTS. When a flight plan speed is not available, a default of 210 knots is displayed.

Figure 6-74
HOLDING PATTERN - Holding Speed

7. Enter leg time (2R) or distance (3R). When a leg time is entered, the FMS computes the leg distance. When a distance is entered, time is computed. The FMS computation of leg time and distance use a groundspeed of 200 KTS for holding patterns above/ below 14,000 feet. Leg time defaults to 1.5 minutes at or above 14,000 feet and 1 minute below 14,000 feet.

   If the hold definition is based on a time-based leg length, 2R will be displayed in large font with the label LEG TIME in 2R and EST DIST in 3R. If the hold definition is based on a distance leg length, 3R will be displayed in large font with the label LEG DIST in 3R and EST TIME in 2R.

8. Enter EFC time (ZULU time) at 4R. When a valid Hold EFC time is inserted and activated, all time and fuel predictions for waypoints beyond the hold are based on remaining in the hold until the expected clearance time has elapsed. EFC is not available for entry until the hold is inserted into the active flight plan. EFC is not available in a secondary flight plan unless that plan is a copy that is currently being synched to the active flight plan. If multiple holds exist in the active flight plan, EFC will only be available on the first instance of a hold in the flight plan, which may be an active hold.

9. Select the APPLY (6R) or the CLEAR (6L) prompt.

   DETAILS – When CLEAR is selected, FLIGHT PLAN 1 page is displayed.

   When APPLY is selected, the holding pattern is inserted into the MOD flight plan and is then canceled or activated.

10. Confirm placement of holding pattern in the flight plan. This is annunciated by the reverse video letter **H** next to the holding fix on the ACTIVE FLT PLAN page. This is shown in Figure 6-75. Parallel and teardrop hold entry patterns are shown on the MFD when the next HOLD is on the active or subsequent leg in the flight plan. This feature is controlled by APM.

Figure 6-75
ACTIVE FLT PLAN - Placement of Hold

Select Hold

The SELECT HOLD page is automatically displayed when the selected waypoint to perform a hold has at least one hold definition entry in the navigation database. It permits the flight crew to choose the hold NDB values or to use the default hold values. The RNP field contains the RNP value that is used while in the hold.

The RNP value is not populated in any NDB, therefore the default RNP value is used in the hold when the NDB hold values are selected. No entries are permitted on this page.

Figure 6-76 shows the SELECT HOLD page.

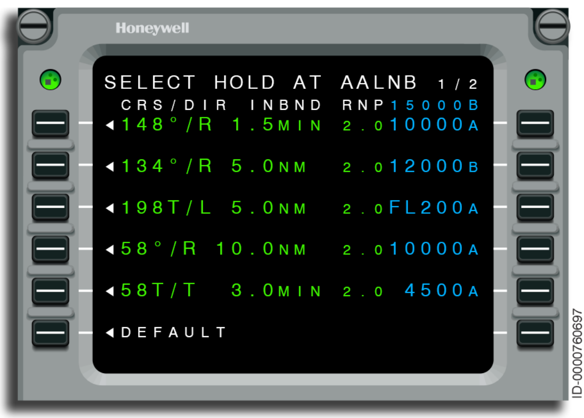


Figure 6-76
SELECT HOLD

HOLDING AT PRESENT POSITION

Procedure 6-6 describes holding at present position. Refer to Procedure 6-5 on page 6-69 for basic holding pattern definition. HOLD entry patterns are displayed for both the PFD ARC and MFD map displays when the holds are computed with a parallel entry or teardrop entry.

Procedure 6-6
Holding at Present Position

1. Select the HOLD prompt from the NAV INDEX page. *HOLD* is placed in the scratchpad. An alternative is to select PATTERNS from the NAV INDEX 1 page then select HOLD from the PATTERNS page.

2. Push the line select key (1L) of the FROM waypoint (first waypoint on the first page of the ACTIVE FLT PLAN).
3. The HOLDING PATTERN page with *PPOS (present position) as the holding fix is displayed. Make any necessary changes.

   Holding at the present position is only done when LNAV is captured and the crosstrack error is less than 0.25 NM.
4. Select APPLY (6R) or CLEAR (6L).

NOTE: Present position holding pattern insertion results in a discontinuity in the flight plan.

In the unlikely event of receiving a clearance to hold at present position while in an offset, and then being requested to continue the original offset flight plan after PPOS HOLD, the steps described in Procedure 6-7 must be followed.

Procedure 6-7
Continue Offset After Exiting PPOS HOLD

1. Copy the active flight plan to the secondary flight plan while in the offset prior to the PPOS hold entry. This is done by selecting the SEC FPL MENU (3R) from the NAV INDEX page and pushing SEC1<-COPY ACT (4L).
2. Enter and perform PPOS HOLD actions. When on the inbound leg of the hold, select EXIT HOLD.
3. While on the inbound leg of the hold, prepare to activate the secondary flight plan. This is done by selecting the SEC FPL MENU (3R) from the NAV INDEX page and pushing SEC1<-SWAP ACT (5L).
4. The secondary flight plan is now in the pending state (MOD ACTIVE FPL is displayed). Re-enter the offset value on the MOD RTE 1 page. This is done by selecting the RTE key, PREV key, and entering the offset value at 5L.
5. Activate the secondary RTE with the offset on the MOD RTE page by pushing the ACTIVATE prompt at 6R.
6. The FMS immediately captures the original offset path.

NOTE: Holds can also be done utilizing graphical flight planning. See Section 12, Graphical Flight Planning, for more information on holding procedures.

DELETING A HOLDING PATTERN

Once a holding pattern is defined and activated, deleting the holding pattern is possible before crossing the holding fix. This is performed by deleting the pattern from the ACTIVE FLIGHT PLAN page or from the HOLDING PATTERN page.

Delete the holding pattern from the ACTIVE FLT PLAN page by following Procedure 6-8.

Procedure 6-8
Deleting a Holding Pattern From the Active Flight Plan Pages

1. Display the active flight plan page showing the holding fix waypoint.
2. Push the DEL key. *DELETE* is displayed on the scratchpad.
3. Push the line select key to the left of the waypoint with reverse video of **H**. This deletes the HOLD but not the waypoint. A second *DELETE* deletes the waypoint.

Refer to Procedure 6-9 for deleting a holding pattern from the HOLDING PATTERN page.

Procedure 6-9
Deleting a Holding Pattern From the Holding Pattern Page

1. Display the HOLDING PATTERN page. Refer to Procedure 6-6 on page 6-74.

2. Select the DELETE prompt at 6R. This is shown in Figure 6-77.

Figure 6-77
HOLDING PATTERN - DELETE Prompt

The LAST EXIT (4L), EFC TIME (4R), and HOLD AVAIL (5R) prompts are shown only if the hold is part of the flight plan. They are not shown before applying and activating the hold. LAST EXIT is the time that the aircraft must exit the hold in order to meet the required fuel reserves. EFC is the expect further clearance time. HOLD AVAIL is the amount of time that is spent in the hold and arrive at the destination and alternate (if one exists) with the required fuel reserves.

3. Return to the Active Flight Plan page and activate any changes.

EXITING A HOLDING PATTERN

The EXIT prompt is used to exit the holding pattern. This prompt is displayed on the ACTIVE FLT PLAN page.

One minute before initial arrival at the holding fix, the ACTIVE FLT PLAN page shows the EXIT prompt. This is shown in Figure 6-78. When selected before the holding fix is crossed, the holding pattern is deleted from the flight plan.

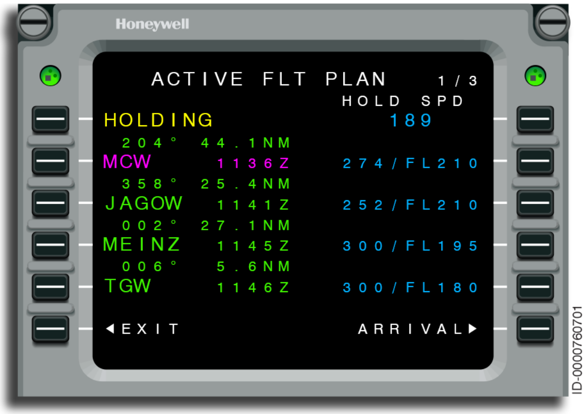


Figure 6-78
ACTIVE FLT PLAN - HOLDING

After crossing the holding fix, when the EXIT prompt is selected, the aircraft turns back to the holding fix, crosses the fix, and continues with the flight plan. Similarly, when the operator deletes the HOLD after crossing the holding fix, the aircraft exits the hold in the same manner as when the EXIT prompt had been selected.

Once the FMS starts holding at the fix and the EXIT prompt is selected, the prompt is changed to RESUME HOLD on the ACTIVE FLT PLAN. This is shown in Figure 6-79. When RESUME HOLD is selected, the FMS resumes the holding pattern.

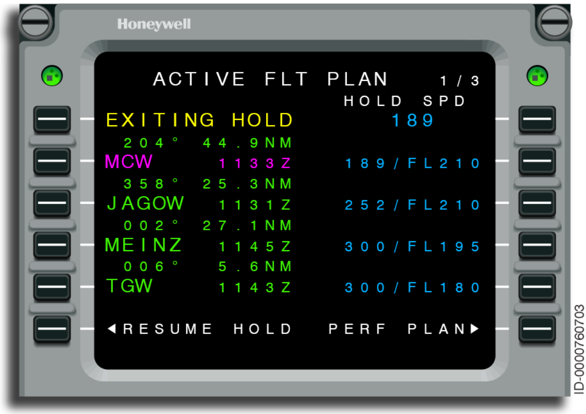


Figure 6-79
ACTIVE FLT PLAN - RESUME HOLD

HOLDING PATTERN SIZE

The FMS is designed to keep the aircraft within protected airspace during holding patterns. When the aircraft approaches a holding pattern at a groundspeed that results in the aircraft exceeding protected airspace, the scratchpad message HIGH HOLDING GRD SPD is displayed 30 seconds before the aircraft crosses the holding fix.

When this message is displayed, the groundspeed must be reduced and the aircraft position, relative to the holding pattern, must be monitored. When the high groundspeed is maintained, the aircraft can overshoot the outbound leg and possibly exceed protected airspace.

HOLDING PATTERN COURSE REVERSAL

Holding patterns that are part of the approach transition are used to reverse course and align the aircraft near the final approach course. These procedures are only available from approaches in the navigation database. This is similar to the procedure turn described on page 6-80.

The procedure is to exit after entering the holding pattern. For both teardrop and parallel entries, the FMS automatically changes to exit hold at the beginning of the entry. For direct entries, the FMS automatically changes to exit hold at the turn inbound to the hold fix. In both cases, the pilot resumes holding at any time before exiting the holding pattern. When holding is resumed, exiting the holding pattern requires pilot-action.

PROCEDURE TURN COURSE REVERSAL

Procedure turns are used to reverse course during an approach. **A procedure turn is only available from approaches in the navigation database.** Using this data, the FMS constructs the procedure turn with an outbound leg, a turn out leg, an arc leg, and an inbound leg. This is shown in Figure 6-80. Only the outbound leg and the procedure turn (PT) angle are adjustable.

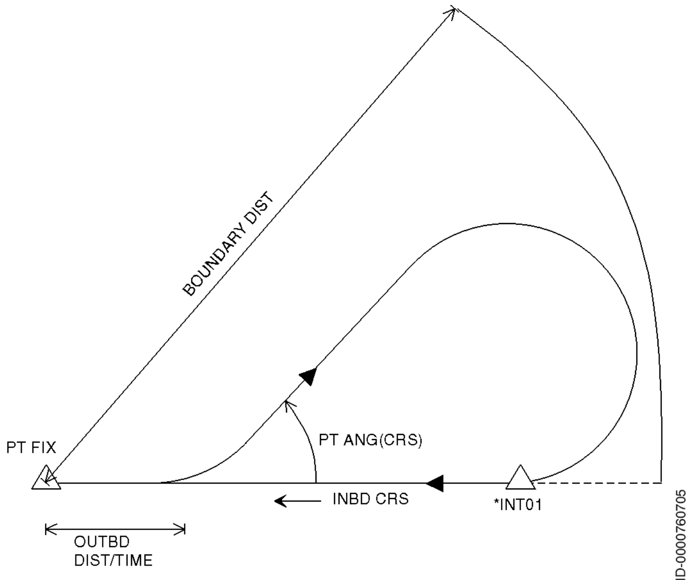
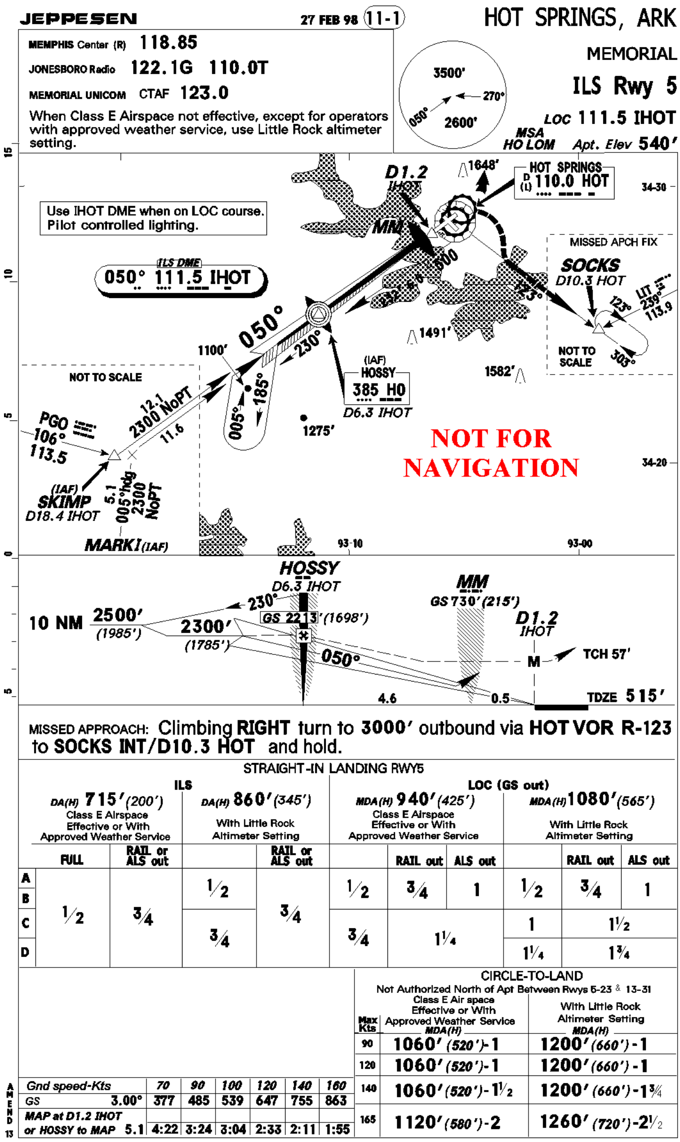


Figure 6-80
Typical Procedure Turn

In the example, shown in Figure 6-81, the ILS Runway 5 at KHOT approach transition contains a procedure turn that begins at HOT VOR. The procedure turn begins with an outbound leg starting at the initial approach fix (IAF) HOSSY.



ID-0000760707

Figure 6-81
Hot Springs, AR ILS Rwy 5

Special Considerations for Holds in Lieu of Procedure Turns

When holds in lieu of procedure turns are used, then all information shown on the HOLDING PATTERN page for that hold is for reference only. The exception is the hold speed. The pilot can enter a speed to fly the holding pattern for course reversal.

Procedure Turn

The FMS shows the ACTIVE FLT PLAN page with a **P** in reverse video next to HOSSY. This is shown in Figure 6-82. In addition, the procedure turn consists of HOSSY and the next two waypoints in the active flight plan.

Figure 6-82
ACTIVE FLT PLAN - Procedure Turn Waypoints

The FMS is designed to keep the aircraft within protected airspace during procedure turns. When the aircraft approaches the procedure turn at a groundspeed that results in the aircraft exceeding protected airspace, the scratchpad message HIGH PCDR TURN GRD SPD is displayed 1 minute before the aircraft crosses the fix.

When this message is displayed, the groundspeed must be reduced and the aircraft position, relative to the procedure turn, must be monitored. When the high groundspeed is maintained, the aircraft can overshoot the turn inbound and possibly exceed protected airspace.

While flying the procedure turn, PROCEDURE TURN is displayed at 1L on the ACTIVE FLIGHT PLAN page, as shown in Figure 6-83.

NOTE: Green dot speed is targeted as the default speed when flying a procedure turn.

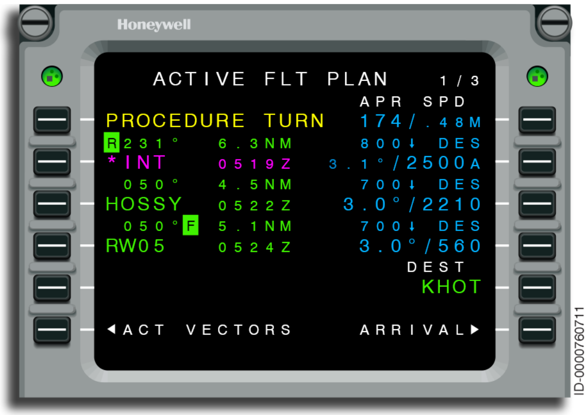


Figure 6-83
ACTIVE FLT PLAN - Flying Procedure Turn

Once the procedure turn has started, the active waypoint is *INT. This remains the active waypoint until *INT is overflown on the way back to the FAF.

DEFINING A PROCEDURE TURN

Selecting the PCDR TURN prompt on the PATTERNS page shows the PROCEDURE TURN page. This is shown in Figure 6-84. The procedure turn fix is displayed at 1L, the boundary distance at 1R, and the inbound course at 3L. No changes to this data are permitted. The outbound leg from HOSSY has a 3.5 NM default leg length while the default procedure turn angle is L45°.

Figure 6-84
PROCEDURE TURN - HOSSY

When a procedure containing a procedure turn is loaded into the flight plan, the pilot must cross verify in the navigation display to make sure that the system has constructed a continuous lateral path to perform the procedure turn, as shown in Figure 6-85.

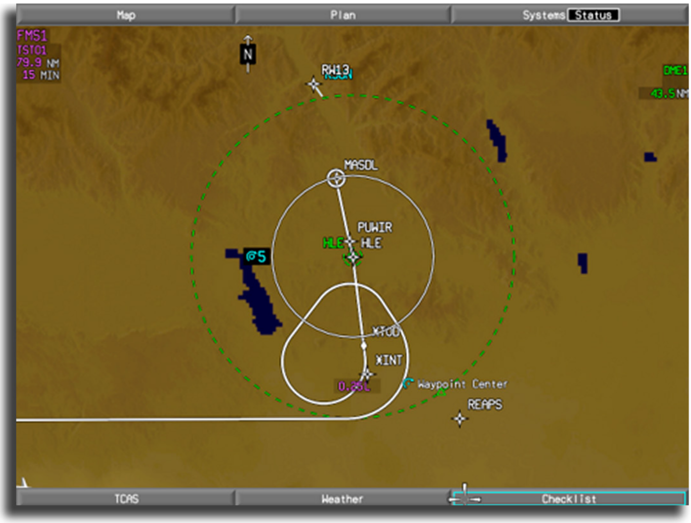


Figure 6-85
Procedure Turn on Navigation Display

If the predicted speed is high, the system is not able to construct a continuous lateral path. It constructs a path with a gap, as shown in Figure 6-86.

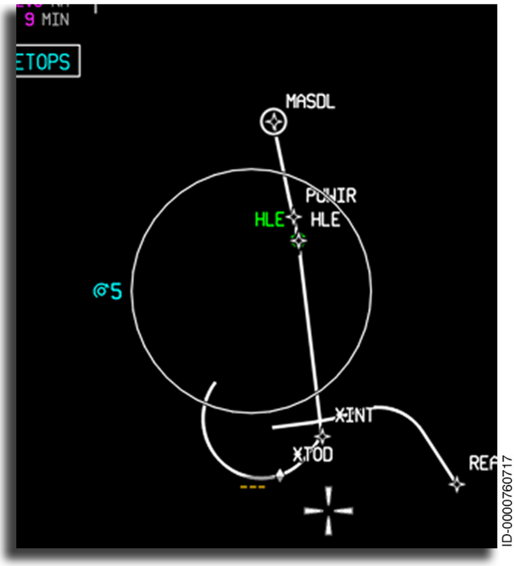


Figure 6-86
Procedure Turn With Gap

The gap in the path is an indicator that the approach geometry is not flyable for the current predicted speeds. To resolve this gap in the lateral path, the pilot must add a speed constraint at the waypoint before the procedure turn to lower the predicted speed at the transition.

DELETING A PROCEDURE TURN

Select *DELETE* from the scratchpad to the waypoint that has the reverse video **P**. The procedure turn is deleted including the following two waypoints, but not the waypoint selected. *DELETE* cannot be selected to either of the following two waypoints of a procedure turn. An INVALID DELETE message is displayed when an attempt is made to delete these waypoints.

An alternative to delete a procedure turn is to use the DELETE option at 6R of the PROCEDURE TURN page.

EXITING A PROCEDURE TURN

The procedure turn is flown automatically by the FMS and requires no manual exit. It is manually terminated while flying the procedure turn by performing a Direct-To to the procedure turn fix at the end of inbound or by using the DELETE prompt at 6R of the PROCEDURE TURN page. The inbound leg is made active and captured. The aircraft turns inbound according to the procedure turn direction. This process does not make sure of compliance with procedure turn rules, but does give a manual procedure for turning inbound when requested by ATC.

Flyover Pattern

Under normal circumstances, the FMS begins a turn before reaching the waypoint (i.e., the aircraft is turned inside the waypoint). In some cases, the requirement is to proceed to the waypoint before commencing the turn. This is done by using the flyover pattern feature of the FMS. Flyovers are entered in the flight plan automatically when required from database procedures.

DEFINING A FLYOVER

Unlike holding patterns, no pilot-entered options are required for flyovers. Therefore, FLYOVER PATTERN has no dedicated page. Follow Procedure 6-10 to define a flyover.

Procedure 6-10
Flyover Pattern Definition

1. Select PATTERNS from the NAV INDEX (page 1).
2. Select PATTERNS prompt at 5L. As an alternative, PATTERNS is selected from the NAV INDEX (page 2).
3. Select the FLYOVER prompt at 2L. This action places *FLYOVER* on the scratchpad.
4. Push the left line select key adjacent to the desired flyover pattern fix waypoint. The flyover is displayed in the modified flight plan as a reverse video **F** adjacent to the course flown to the waypoint. Activate and the aircraft flies to the waypoint before the turn is started.

DELETING A FLYOVER

Select *DELETE* from the scratchpad to delete the flyover. This creates a MOD FLT PLAN. After the changes are reviewed, select ACTIVATE at 6R to return to the ACTIVE FLT PLAN. Only the flyover is deleted, not the waypoint. A second delete is used to delete the waypoint.

EXITING A FLYOVER

There are no exit procedures. Either delete the flyover or the flight plan is changed to eliminate the flyover waypoint.

Multiple Patterns

Multiple patterns are possible in any given flight plan. Multiple patterns are also possible on a given waypoint. Table 6-1 lists the possible combinations.

Table 6-1
Multiple Patterns

Pattern Name	Additional Pattern Permitted
HOLDING	NONE
FLYOVER	NONE
PROCEDURE TURN	HOLDING, FLYOVER
ARC TURN	HOLDING, FLYOVER

When multiple patterns exist at a waypoint, the order to delete is:

- FLYOVER
- HOLD.

When a HOLD is defined on a waypoint with a FLYOVER, the FLYOVER is automatically deleted.

Pattern Review

Patterns activated into the flight plan are reviewed at any time. This is performed by selecting the PATTERNS prompt at 5L, shown in Figure 6-87, and then selecting the REVIEW (6L) prompt, as shown previously in Figure 6-67. The pilot reviews all patterns of all types in the applicable flight plan.

Figure 6-87
NAV INDEX - PATTERNS Prompt

DEPARTURE

The DEPARTURE function is used to examine and select departure runways and standard instrument departures (SIDs) stored in the navigation database.

NOTE: Some SIDs are not in the database. This is because of the way some procedures are defined by the controlling agency and the limitations of the FMS.

To illustrate the steps in the DEPARTURE function, Denver, Colorado (KDEN) is used as the origin of the active flight plan. Figure 6-88 shows the PIKES3 departure for KDEN. Refer to Procedure 6-11 for DEPARTURE selection. At any point in the departure selection process, entering a new or the same airport returns the display to the beginning of the selection process.

Following selection of a SID, the following methods must be used to modify the departure procedure in the active flight plan:

- The DEPARTURE page is used to:
  - Add a segment to the procedure already existing in the active flight plan
  - Replace a procedure segment already in the active flight plan
  - Delete a procedure segment from the active flight plan.
- Delete a portion, or all, of the activated procedure by performing a Direct-To a waypoint in the active flight plan or alternate flight plan
- Delete the procedure by activating a flight plan from the custom database
- Delete the FROM waypoint in the active flight plan (only when the aircraft is still on the ground).

The PIKES3 departure for KDEN is shown in Figure 6-88.

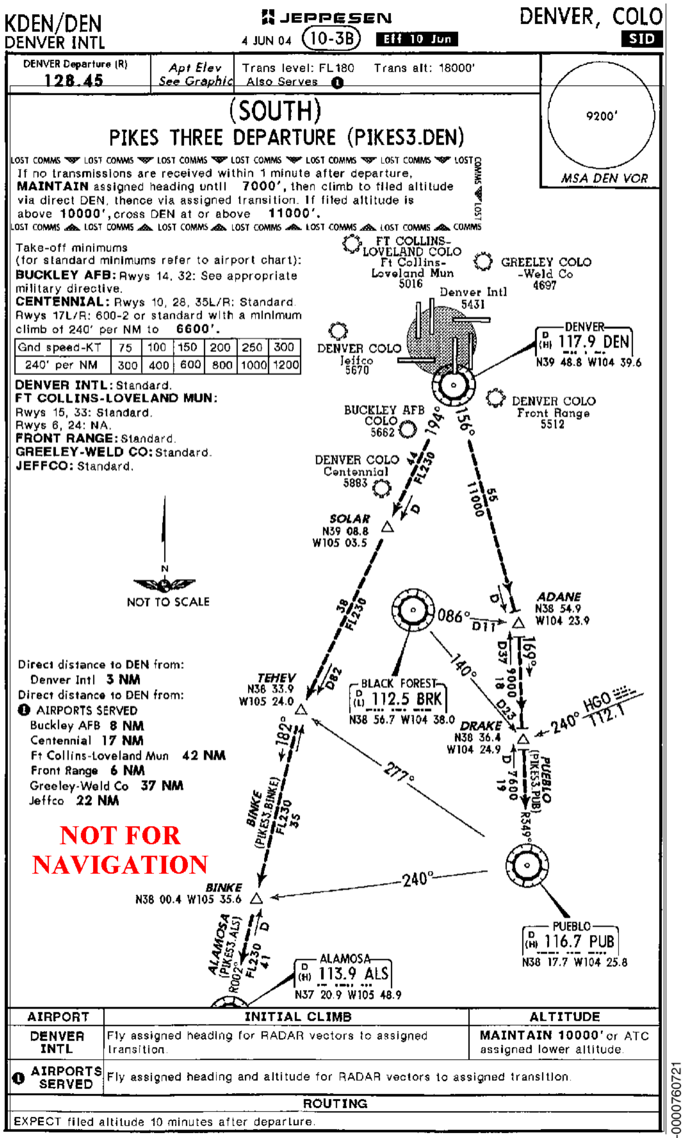


Figure 6-88
Denver, CO PIKES3 Departure

Procedure 6-11 describes the steps for the departure selection. From the departure pages, the pilot selects a departure runway, SID, and departure transition, as shown in Figure 6-89. Access to the DEPARTURE page from the ACTIVE FLT PLAN page is available only when the origin waypoint is an airport, the aircraft is within 50 NM of the origin, and a DEST is entered. Access to the DEPARTURE page is always available from the DEPARTURE prompt on the NAV INDEX.

Procedure 6-11
Departure Selection

1. Access the DEPARTURE page shown in Figure 6-89.

Figure 6-89
KDEN DEPARTURE

2. Select the desired runway from the DEPARTURE RUNWAYS page. This is shown in Figure 6-90. Runway 25 (2R) is selected in this example.

Figure 6-90
KDEN RUNWAYS

3. The SIDs page is automatically displayed when there is a published SID for that particular runway. Select the SID from the SIDs page shown in Figure 6-91. PIKES3 (2L) is selected in this example.

Figure 6-91
KDEN SIDs

4. The SID TRANS page is displayed. Select the departure transition from the SID TRANS page shown in Figure 6-92. ALS (1L) is selected in this example.

Figure 6-92
KDEN SID TRANS

5. Once a transition is selected, the DEPARTURE page, shown in Figure 6-93, is automatically displayed with the selected runway and SID. Push LSK 6R (APPLY) to add the runway and SID to the flight plan.

Figure 6-93
KDEN DEPARTURE

ARRIVAL

The ARRIVAL pages are accessed from the ARRIVAL prompt on the NAV INDEX page or from the active flight plan page and are used to examine and select runways, approaches, and standard terminal arrival routes (STARs) stored in the navigation database.

NOTE: Some approaches and STARs are not in the database. This is because of the way some procedures are defined by the controlling agency and the limitations of the FMS.

To illustrate the steps in the ARRIVAL function, Minneapolis, Minnesota (KMSP) is used as the destination of the active flight plan. This example starts with the selection of a runway. However, there is no required selection order. Also, a selection made from each page is not necessary. When a STAR has already been activated, selecting a runway is possible without affecting the previously selected procedure. At any point in the selection process, it is possible to return to the ARRIVAL page and review and/or activate the selected items.

On the ARRIVAL page, when a new runway is selected and not supported by a previously selected STAR (or approach), the previous procedures are not displayed for insertion into the MOD flight plan. In fact, only approaches to the selected runway are displayed on the APPROACH page. Changes made to the active flight plan creates a MOD flight plan. After APPLY is selected, the changed flight plan is shown as dashed lines on the MFD. Next the pilot selects ACTIVATE or CANCEL to finalize or erase the changes.

To select a new runway, return to the ARRIVAL page and select the RUNWAY prompt. Choose the desired runway, select the ARRIVAL prompt, and select the ACTIVATE prompt.

Following selection of an arrival procedure (STAR or approach), the following methods must be used to modify the arrival procedure in the active flight plan:

- The ARRIVAL page is used to:
  - Add a segment to the procedure already existing in the active flight plan

  - Replace a procedure segment already in the active flight plan
  - Delete a procedure segment from the active flight plan.
- Delete a portion, or all, of the activated procedure by performing a Direct-To a waypoint in the active flight plan or alternate flight plan
- Delete the procedure by activating a flight plan from the custom database
- Delete the FROM waypoint in the active flight plan
- Delete the procedure turn waypoint in the active flight plan
- Delete the hold attribute from the course reversal hold waypoint.

NOTE: When modifying the flight plan (i.e., changes in runway, approach, or STAR), the flight crew's responsibility is to verify the desired waypoints are inserted into the MOD RTE and/or MOD FLT PLAN pages before activating.

NOTE: When the active leg is part of an arrival or approach procedure and a new arrival or approach procedure is inserted into the active flight plan, the FMS uses the active leg to identify matching waypoints downpath in the new arrival/approach procedure. If a match is found, the matching fixes are combined together and any prior fixes in the procedure are removed from the flight plan. This can give the false impression that there are missing waypoints in the flight plan when in fact, the FMS is operating per design in melding duplicate waypoints.

If no match is found, a discontinuity is inserted between the active leg and the new arrival/approach procedure.

Figure 6-94 shows the KASPR3 STAR plate.

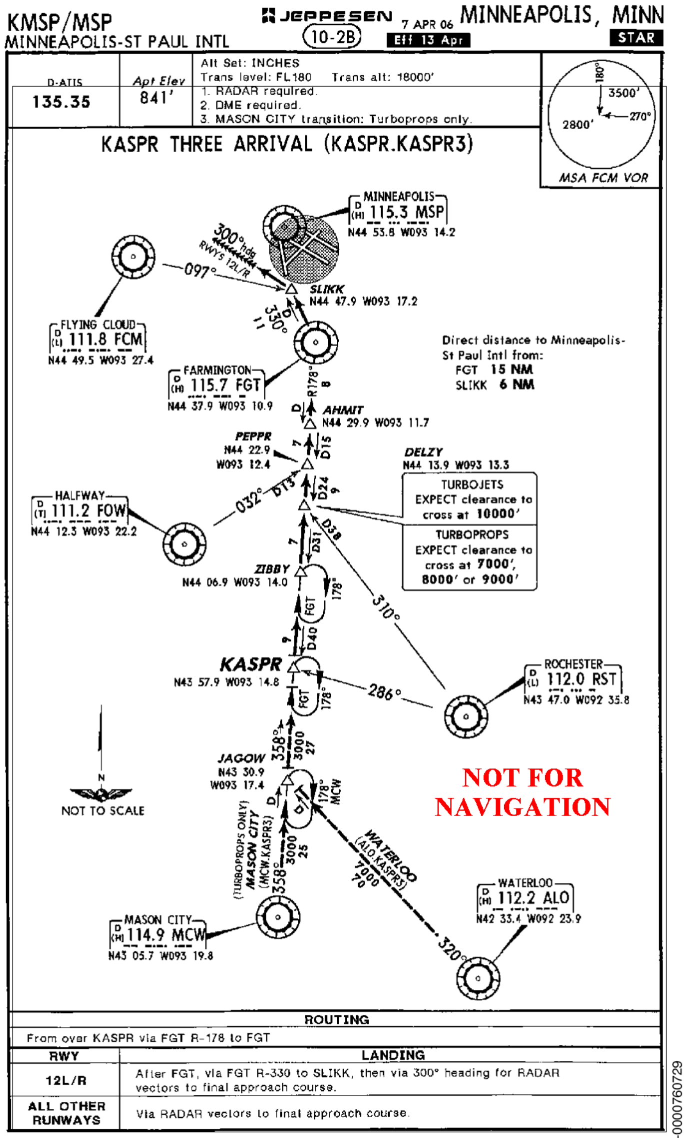


Figure 6-94
Minneapolis, MN KASPR3 Arrival

Procedure 6-12 describes the steps for an arrival selection.

Procedure 6-12
Arrival Selection

1. Select ARRIVAL from the active flight plan or NAV INDEX.
2. Select a RUNWAY, APPROACH, or STAR from the ARRIVAL page. This is shown in Figure 6-95.

Figure 6-95
KMSP ARRIVAL - Awaiting Selection

DETAILS – Figure 6-95 is displayed when the ARRIVAL function is selected. From this page, the pilot selects what element, arrival runway, approach, or STAR is to be selected. This page is also accessed from the ACTIVE FLT PLAN page when the aircraft is within 200 flight plan miles of the destination.

The destination airport is listed in the title. When the destination is not defined, it is displayed in cyan. When previous selections have been made, they are displayed on this page. Selections can also be deleted on this page.

The runway, approach, or STAR is selected (or reselected) in any order. In each case, the ARRIVAL prompt is displayed in reverse video. It is used to return to the ARRIVAL page.

When an approach is going to be selected, a step is saved by selecting APPROACH from this page. The runway is automatically selected when an approach is selected.

3. Pushing 1R selects the RUNWAYS page. Select the desired runway from the RUNWAYS page shown in Figure 6-96. In this example, runway 30L (1R) is selected.

Figure 6-96
KMSP RUNWAYS - 30L (1R)

Any previously selected runway is labeled as (ACT) or (SEL). Runways can be more than one page.

4. Once a runway is selected, the APPROACH page is automatically displayed. Select the approach from the APPROACH page. When the runway is selected first, the FMS shows only the approaches for the selected runway. This is shown in Figure 6-97. In this example, ILS 30L (2L) is selected.

Figure 6-97
KMSP APPROACH - ILS 30L (2L)

When only the straight–in portion of an approach is desired, select the approach without selecting an approach transition.

5. Once an approach is selected, the APPROACH TRANS page is displayed. Select the approach transition (includes feeder routes) from the APPROACH TRANS page shown in Figure 6-98. In this example, HASTI (2L) is selected.

Figure 6-98
KMSP APPROACH TRANS - HASTI (2L)

6. When a transition is selected, the STAR page is automatically displayed. Select the STAR from the STAR page shown in Figure 6-99. In this example, KASPR3 (3L) is selected.

Figure 6-99
KMSP STAR - KASPR3 (3L)

NOTE: All STARs for the airport will be displayed on the STAR page when a runway has not been selected.

7. When a STAR is selected, the STAR TRANS page is automatically displayed. Select the STAR transition from the STAR TRANS page shown in Figure 6-100. In this example, MCW (2L) is selected.

Figure 6-100
KMSP STAR TRANS - MCW (2L)

8. Once all selections are made, the ARRIVAL page is automatically displayed, as shown in Figure 6-101. The choices from this page are either to clear the procedure or apply the procedure. In this example, APPLY (6R) is selected.

Figure 6-101
KMSP ARRIVAL - Selected

Approach

Once an approach is selected, the pilot must check and/or monitor many things during the approach. The following is a list of those items:

- Before starting a nonprecision approach transition or approach, the crew must review the published approach procedure and verify the FMS waypoints and altitude restrictions.
- Before starting a nonprecision approach transition flown by the FMS, it is important to verify the transition is cleared by ATC. Selecting the transition fix is normally the path to selecting the actual transition.

- The APPR annunciator must turn on 2 NM before the final approach fix and remain lit for the remainder of the approach. This is a positive cue to the flight crew that the sensor configuration is correct and sensor integrity is within limits for the approach. The approach annunciator is not lit during localizer-based approaches since the FMS is not authorized to be coupled during localizer approaches. The DGRAD annunciator must be off throughout the approach. When the DGRAD annunciator turns on, the FMS must not be used for the remainder of the approach. The flight crew continues the approach using raw data or executes the missed approach procedure.

- When VNAV is used for vertical guidance on the approach, verify the approach plate waypoint altitudes are shown on the FMS MCDU. When VPATH is used, the altitude selector must be set to the minimum descent altitude (MDA) for continuous vertical navigation (VNAV) descent. When vertical glide path (VGP) is used, the altitude preselector is set to the missed approach procedure altitude once the VGP mode is engaged.

- Industry-wide standards for database information are currently inconsistent on many approaches. Some vertical paths are defined to 50 feet above the runway. Others do not arrive at MDA until at the missed approach point (MAP). Some approaches give vertical guidance below the published MDA and some vertical paths differ from the visual approach slope indicator/ precision approach path indicator (VASI/PAPI) angles.

- Since charts are continually updated, the FMS waypoint names may not exactly match the chart names. In addition, differences between courses are shown on the chart and those shown on the MCDU and electronic display system (EDS). These differences are the result of changes in magnetic variation and are normally less than 2 degrees. Verify possible changes before starting an approach.

- The navigation database does not have step-down waypoints between the final approach fix (FAF) and MAP when the VNAV path satisfies the step-down restrictions. VNAV path guidance and a cross-check with other navigation aids are the only assurance all descent path restrictions are met. Using modes other than VNAV are desirable for some approaches.

- Refer to the global positioning system (GPS), page 6-122, for information on GPS receiver autonomous integrity monitor (RAIM) for GPS only approaches.
- Approaches in the navigation database consist of localizer-based approaches and nonprecision approaches. The FMS is capable of flying all nonprecision approaches (GPS, NDB, RNP AR, LPV, VOR/DME, VOR, RNAV, NDB/DME). Use RNP APCH instead of GPS and RNAV. Approaches from the database can contain DME arcs. The FMS flies the arc as specified in the approach.

NOTE: To fly RNP AR approaches with the FMS requires operational approval.

- The FMS cannot be used to fly localizer approaches (ILS, LOC, BAC, SDF, LDA). These approaches are flown by showing the localizer data and by using the flight director/autopilot. However, these procedures are selected and activated on the FMS to enhance situational awareness. The FMS shows the approach on the EDS map displays. The FMS is used to fly the approach transition and the missed approach phases of precision approaches.
- An approach is selected with or without an approach transition. For example, when receiving vectors to the final approach course, an approach transition does not have to be selected with the approach. The pilot flies the specified vectors and arms LNAV. The FMS automatically captures the final approach course.
- Before flying the approach, the waypoints, as well as constraints in the procedure, must be verified with the approach charts. When the database contains more waypoints for the procedure than the chart actually shows, the flight plan must reflect the selected procedure. The database does not contain step-down fixes on the final approach when the constraint at the step-down fix is satisfied by the vertical descent path into the MAP.
- Following selection of an approach, the following must NOT be performed to the approach procedure:

- Adding waypoints into the middle of an approach procedure
- Relocating procedure waypoints in the flight plan
- Removing waypoints from an approach procedure (other than by deleting the FROM waypoint, performing a direct-to, activating another approach, or activating another flight plan), and then continuing to fly the procedure
- Changing an altitude or angle constraint associated with an approach waypoint
- Adding holding patterns, orbits, or radial intercepts to approach waypoints
- Changing the destination and then continuing to fly the approach procedure to the original destination.

NOTE: When an MAP is not colocated with a runway threshold position, the runway is not displayed as the last waypoint in the flight plan when performing a nonprecision approach and some ILS approaches. When this occurs, a path gap is displayed between the missed approach point (end of the runway or other point) and the first missed approach waypoint on the map and vertical situation display (VSD).

The examples, shown in Table 6-2 and Table 6-3, illustrate approach transitions and how the FMS flies the transitions.

Table 6-2
Typical FMS Pattern Displays - 1

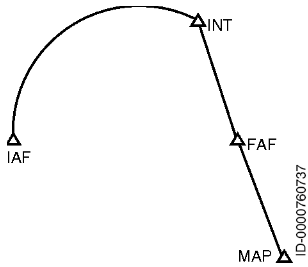
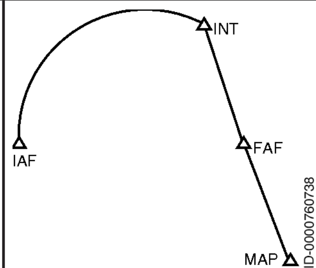
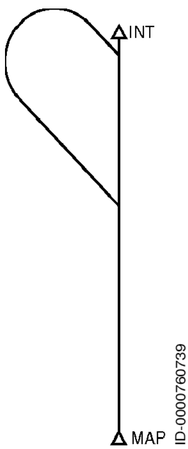
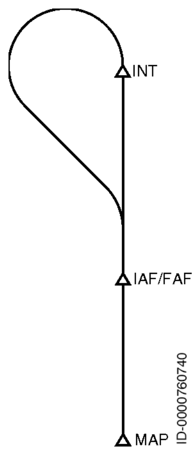
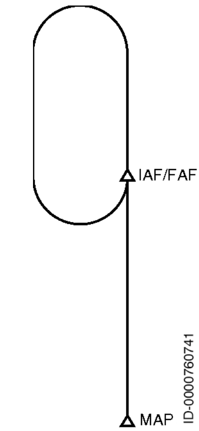
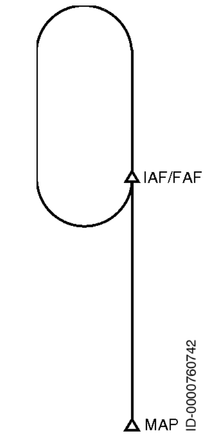
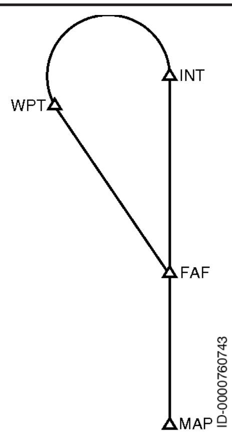
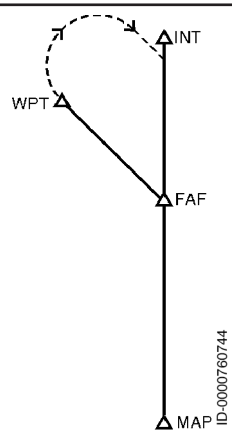
Approach Transition	Chart Depiction	FMS Ground Track
DME Arc		
Procedure Turn		

Table 6-3
Typical FMS Pattern Displays - 2

Approach Transition	Chart Depiction	FMS Ground Track
Holding Pattern Course Reversal		
Teardrop		 See NOTE
NOTE: Following sequence of WPT, the FMS turns to capture the final approach course. The FMS is not flying a defined ground track during this maneuver. Depending on speed and teardrop geometry, the FMS can roll wings level on a 45° intercept to the final approach course. Typically, the aircraft is banked until the final approach course is captured.		

Missed Approach

The missed approach is activated by pushing the **TOGA** button or MISSED APPR prompt when the first approach waypoint has been passed.

When a missed approach is initiated before the MAP, the missed approach procedure is appended to the flight plan. When a missed approach is not initiated before the MAP and the runway is not displayed in the waypoint list, the lateral and vertical modes drop to ROL and PTH. Missed approach activation past the MAP appends the missed approach to the flight plan.

FMS POSITION SENSORS

One of the primary FMS tasks is to navigate the aircraft along a predefined flight plan. To do this, the FMS receives navigation data from various sensors onboard the aircraft. From the available sensors, the FMS determines the best navigation mode and combination of sensors to give the most accurate aircraft position.

Navigation Mode

The navigation modes are as follows:

- Hybrid IRS
- GPS
- DME/DME
- VOR/DME
- IRS.

The FMS uses a performance-based sensor-selection scheme, with the estimated position uncertainty (EPU) of each sensor used to decide what sensor is performing best. The GPS sensors and the Hybrid IRS function produce a figure-of-merit (FOM) that is used to compute the EPU value for those sensors (data latency is included for EPU computation). The EPU is modeled by the FMS for the IRS, DME/DME, and VOR/DME sensors.

The FMS receives navigation data from various sensors onboard the aircraft. The selected sensor for the FMS position is chosen by comparing the EPU values of all available and not deselected sensors, and choosing the sensor with the lowest value.

Once a sensor is chosen, that sensor shall remain selected until another sensor's EPU is better than the selected sensor's EPU by 5%.

All sensor positions are continuously compared to the FMS computed position. When any sensor differs by more than 10 NM from the FMS position, a scratchpad message is displayed (example: CHECK IRS 1 POSITION).

Hybrid IRS mode uses blended GPS and IRS data produced by the IRS. The IRS outputs Hybrid IRS data and the usual Inertial data as two concurrent sets of data. The FMS treats the Hybrid data essentially as a separate sensor.

When the FMS is using Hybrid IRS, GPS, DME/DME, or VOR/DME for updating, a position error for each IRS is continuously calculated and stored within the FMS. This calculated error is called an IRS bias. When the FMS uses IRS mode for position updating, the IRS bias is held constant and the actual position used by the FMS is each IRS position plus the last calculated IRS bias. At this point, the FMS position starts to drift with the IRS position. Once Hybrid IRS, GPS, DME/DME, or VOR/DME updating is resumed, a new bias is calculated and IRS drift error has no impact on FMS position.

The following is an example of a typical transoceanic flight with an aircraft equipped with VOR/DME and IRS. The flight begins with the FMS operating in DME/DME mode. As the aircraft leaves DME coverage, the FMS transitions to IRS navigation. As the aircraft approaches radio coverage, the system returns to radio updating.

Because of limits on the use of NAVAIDs, it is possible for the aircraft to approach controlled airspace before returning to radio updating. The pilot must assess the FMS position before entering controlled airspace. This assessment is done by checking the navigation mode on the PROGRESS 1 page and cross-checking FMS position with raw VOR/DME information. The PPOS DIRECT crossing points page assists in cross-checking by giving the FMS bearing and distance to the selected station and comparing that to raw VOR/DME data.

The POS SENSORS page, shown in Figure 6-102, is accessed from the POS SENSORS prompt on the NAV INDEX page or the POSITION INIT page. Sensors are grouped by type (H-IRS followed by GPS) and listed in numerical order.

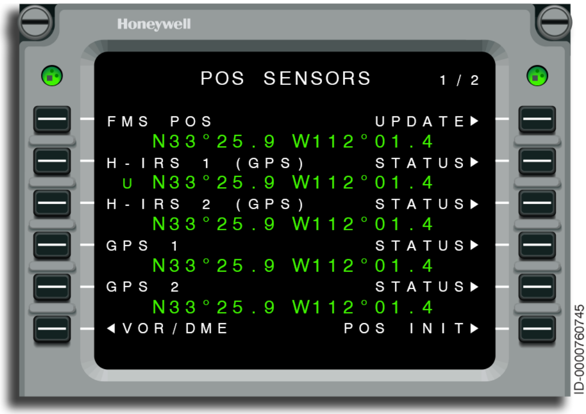


Figure 6-102
POS SENSORS

A **U** adjacent to the sensor position indicates the sensor is being used in the FMS position solution.

Using this page, it is possible to update the FMS position (UPDATE) and examine sensor positions and status (STATUS). This page is also used to determine what sensors are being used by the FMS for computing aircraft position. From this page, the pilot can remove sensors from being used for position updating (refer to Procedure 6-19 on page 6-143).

The FMS estimates the performance of the selected navigation mode and expresses this as EPU on the PROGRESS page. When EPU exceeds RNP, or when the FMS determines the integrity of the position solution exceeds the allowable limit, the UNABLE RNP message is displayed and the DEGRADE condition is annunciated.

The sensor currently selected for use is displayed on the PROGRESS 1 page (in the header for line 6), as shown in Figure 6-103, and on the PFD.

Figure 6-103
Sensor Selection Display

FMS Sensor Selection

The selected FMS sensor is displayed on the PROGRESS 1 page. The available FMS sensors for selection are as follows:

- Hybrid IRS
- GPS-D
- GPS
- IRS
- DME/DME
- VOR/DME
- DR (dead reckoning).

NOTE: GPS-D is GPS with SBAS (satellite-based augmentation system). The annunciation of GPS-D and GPS are mutually exclusive and GPS-D is dependent on the presence and reception of the SBAS signal. When the SBAS signal is present and the GPS sensor is the selected sensor for the FMS, the annunciator on the PROGRESS 1 page is GPS-D. When no SBAS signal is present, the annunciator on the PROGRESS 1 page is GPS.

FMS Sensor Deselection

The pilot has the ability to deselect FMS sensors. When the FMSs are operating in dual mode, sensor deselection is synched between the two FMSs.

SBAS GPS DESELECTION

SBAS is deselected on the FLIGHT CONFIG 2 page. The FLIGHT CONFIG 2 page is shown in Figure 6-104.

Figure 6-104
FLIGHT CONFIG 2/2 - SBAS Deselected

Procedure 6-13 describes the access to FLIGHT CONFIG 2 page.

Procedure 6-13
FLIGHT CONFIG 2 Page Access

1. Push the NAV function key on the MCDU. The NAV INDEX 1 page is displayed.
2. Push the NEXT function key on the MCDU. The NAV INDEX 2 page is displayed.
3. Select MAINTENANCE (LSK 3R). The MAINTENANCE 1 page is displayed.
4. Push the NEXT function key on the MCDU. The MAINTENANCE 2 page is displayed.
5. Select SETUP (LSK 6L). The FMS SETUP 1 page is displayed.
6. Select FLT CONFIG (LSK 1R). The FLIGHT CONFIG 1 page is displayed.
7. Push the NEXT function key on the MCDU. The FLIGHT CONFIG 2 page is displayed.

To disable SBAS on the FLIGHT CONFIG 2 page, push LSK 4R that turns the SBAS selection on or off. Turning the SBAS selection off sends a signal to the GPS receivers to stop using SBAS augmentation. SBAS augmentation for each GPS sensor cannot be individually deselected. When the SBAS switch is OFF, the GPS sensors continue to output a nonaugmented GPS position, with correspondingly larger EPU and RAIM values. SBAS augmentation is required for LPV approaches.

HYBRID IRS SENSOR DESELECTION

Deselection of individual hybrid IRS sensors is performed on the POS SENSORS pages. The POS SENSORS 1/2 page is shown in Figure 6-105.

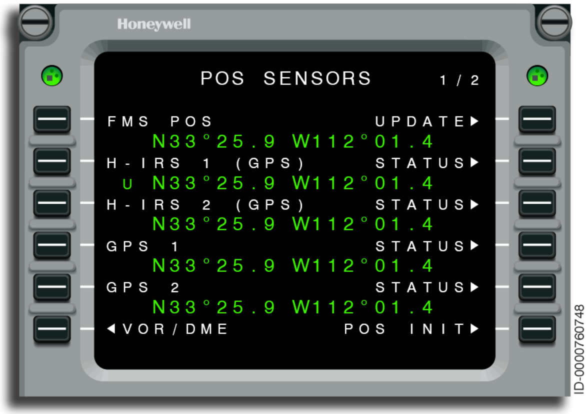


Figure 6-105
POS SENSORS 1/2 - Hybrid IRS Sensor Deselection

Procedure 6-14 describes the hybrid IRS deselection process.

Procedure 6-14
Hybrid IRS Sensor Deselection

1. Access the POS SENSORS 1 page (depending on the hybrid IRS sensor to be deselected).
2. Push the DEL key on the MCDU. *DELETE* is displayed on the scratchpad.
3. Push the left line select key corresponding to the hybrid IRS sensor to be deselected.

GPS SENSOR DESELECTION

Deselection of individual GPS sensors is performed on the POS SENSORS pages, shown in Figure 6-106. Procedure 6-15 describes the GPS deselection process.

Procedure 6-15
GPS Sensor Deselection

1. Access the POS SENSORS 1/2 page.
2. Push the DEL key on the MCDU. *DELETE* is displayed on the scratchpad.
3. Push the left line select key corresponding to the GPS sensor to be deselected.

IRS SENSOR DESELECTION

Deselection of individual IRS sensors is performed on the POS SENSORS pages. The POS SENSORS 2/2 page is shown in Figure 6-106.

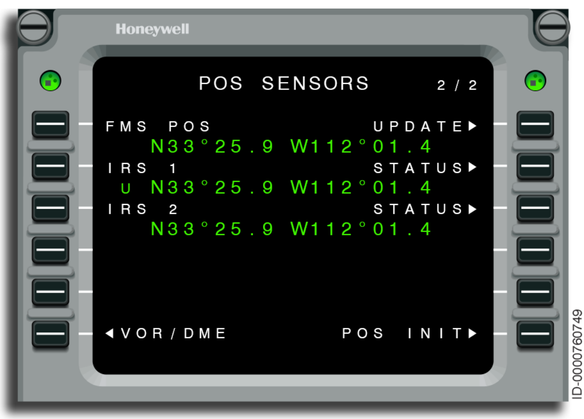


Figure 6-106
POS SENSORS 2/2 - IRS Sensor Deselection

Procedure 6-16 describes the hybrid IRS deselection process.

Procedure 6-16
IRS Sensor Deselection

1. Access the POS SENSORS 2 page (depending on the IRS sensor to be deselected).
2. Push the DEL key on the MCDU. *DELETE* is displayed on the scratchpad.
3. Push the left line select key corresponding to the IRS sensor to be deselected.

VOR/DME SENSOR DESELECTION

VOR/DME deselection is performed on the POS SENSORS page. Procedure 6-17 describes the VOR/DME deselection process.

Procedure 6-17
VOR/DME Deselection

1. Access the POS SENSORS 1/1 page.
2. Select LSK 6L. The VOR/DME page is displayed.
3. Push the DEL key on the MCDU. *DELETE* is displayed on the scratchpad.
4. Push the left line select key corresponding to the VOR to be deselected.

DESEL is displayed in reverse video above the deselected sensors, as shown in Figure 6-107.

Figure 6-107
Deselected Sensors

GPS AND SBAS INFORMATION

GPS and SBAS information is presented on the GPS 1 STATUS pages, accessed from the POS SENSORS 1/2 page pushing the STATUS prompt. The GPS 1 STATUS 1/2 page is shown in Figure 6-108.

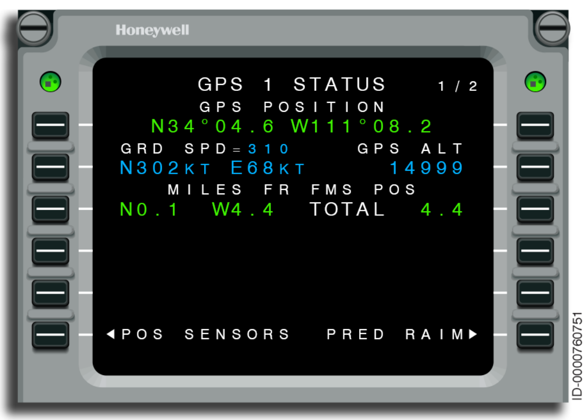


Figure 6-108
GPS 1 STATUS 1/2 - GPS and SBAS Information

The GPS 1 STATUS 2/2 page is displayed, as shown in Figure 6-109.

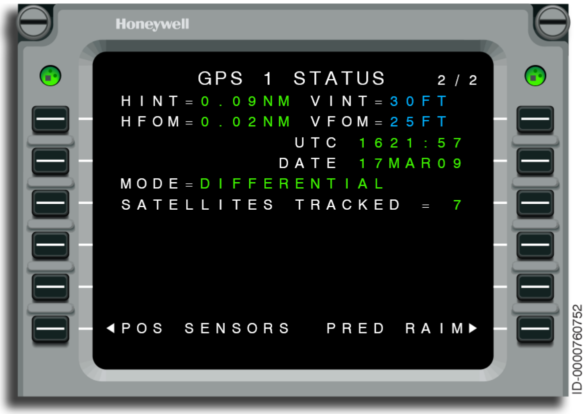


Figure 6-109
GPS 1 STATUS 2/2 - GPS and SBAS Information

With SBAS-capable GPS sensors installed, the GPS 1 STATUS 2 page, LSK 1L shows the label HINT (horizontal integrity limit). The selection of the FLIGHT CONFIG SBAS ON/OFF does not impact the label. When the GPS receiver is functioning, the information displayed in the MODE field (LSK 3L) is listed in Table 6-4.

Table 6-4
GPS Mode Descriptions

Mode	Description
ACQUISITION	Acquiring satellites. No valid position.
NAVIGATION	Receiving satellites and producing valid position. For SBAS-capable: not receiving valid SBAS signal or SBAS option deselected on FLIGHT CONFIG 2 page.
COASTING	Lost satellite reception and trying to return to NAVIGATION mode.
DIFFERENTIAL	Receiving an SBAS signal and producing an SBAS-corrected position, and SBAS not selected. This mode is not available when the SBAS option is deselected on the FLIGHT CONFIG 2 page. NOTE: Not available with non-SBAS-capable receiver.

Sensor Status Pages

To check the status of a sensor, push the line select key adjacent to the STATUS prompt, shown in Figure 6-110, for that sensor on the POS SENSORS page.

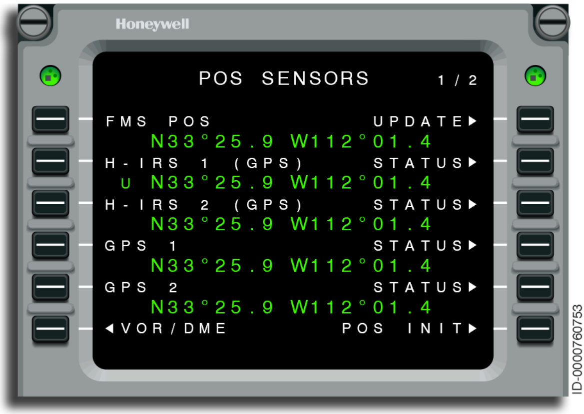


Figure 6-110
POS SENSORS 1/2 - Sensor Status

The paragraphs that follow describe the status pages used for each type of sensor (IRS, GPS). For all sensor types, selecting the POS SENSORS prompt at the bottom of any STATUS page returns the display back to the POS SENSORS page from which the sensor status was accessed. This is shown previously in Figure 6-110.

HYBRID INERTIAL REFERENCE SYSTEM (IRS) STATUS

Figure 6-111 shows the hybrid IRS STATUS 2/2 page when the hybrid IRS is operating in the NAV mode. Values shown are as follows:

- HINT (horizontal integrity limit)
- VINT (vertical integrity limit)
- HFOM (horizontal figure-of-merit)
- VFOM (vertical figure-of-merit)
- Hybrid IRS position
- Miles from FMS position.

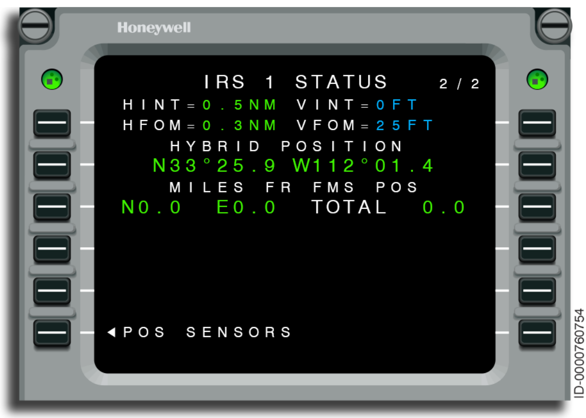


Figure 6-111
HYBRID IRS 1 STATUS 2/2

GLOBAL POSITIONING SYSTEM (GPS) STATUS

The GPS(X) STATUS 1/2 page, shown in Figure 6-112, displays the following information:

- GPS position
- Groundspeed
- Altitude (altitude above the earth)
- Miles from FMS position.

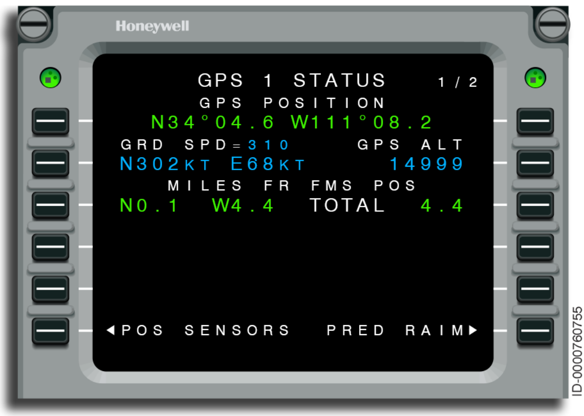


Figure 6-112
GPS 1 STATUS 1/2

GPS altitude shown is the World Geodetic System 1984 (WGS-84) height above the ellipsoid (geoid height + height above MSL). The GPS altitude is not relative to pressure altitude, but is referenced to an earth-centered earth-fixed (ECEF) coordinate system. Pressure altitude is not relative to the same reference frame, but relative to the standard pressure or local pressure settings. Therefore, significant differences are seen between GPS altitude and pressure altitude. This concept is shown in Figure 6-113.

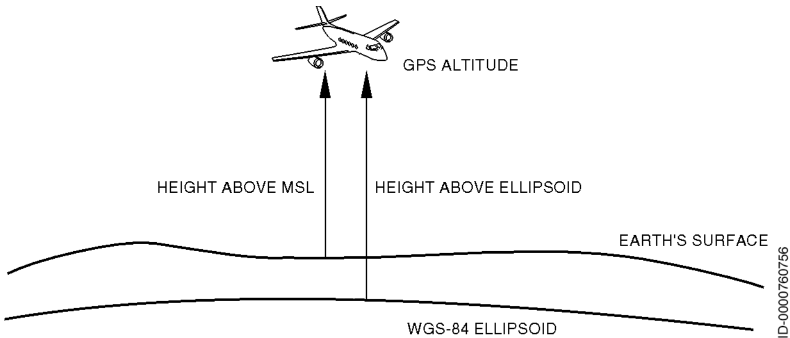


Figure 6-113
GPS ALTITUDE

The GPS(X) STATUS 2/2 page, shown in Figure 6-114, displays the following information:

- Horizontal integrity limit (HINT)
- Vertical integrity limit (VINT)
- Horizontal figure-of-merit (HFOM)
- Vertical figure-of-merit (VFOM)
- Time (UTC) and date
- Operating mode
- Satellites tracked.

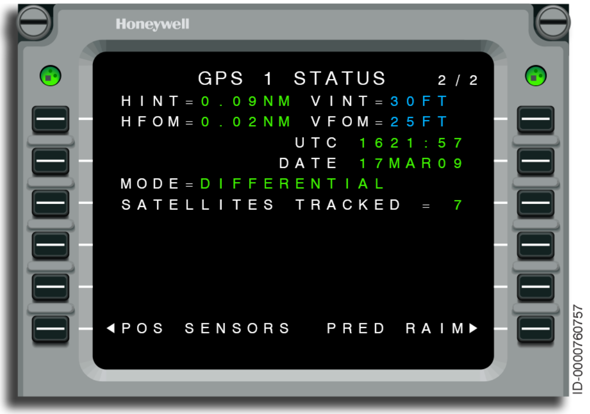


Figure 6-114
GPS 1 STATUS 2/2

The fifth line shows the operational mode of the GPS. Possible operational modes are displayed as follows:

- ACQUISITION
- NAVIGATION
- COASTING
- DIFFERENTIAL.

The acquisition mode is used to acquire satellites after power is applied. The GPS requires at least four satellites to acquire position.

After being in the navigation mode, altitude aiding is the mode entered when fewer than four satellites are being tracked. In this mode, the GPS uses altitude from the air data system (ADS) to aid in determining position.

NOTE: When the GPS is operated inside a hangar or other areas where signals cannot be received, the GPS detects this as a failure. In this case, cycling the power is necessary to restart the GPS.

The last line of the GPS STATUS page indicates the number of satellites being tracked and used by the GPS.

INERTIAL REFERENCE SYSTEM (IRS) STATUS

The IRS(X) STATUS 1/2 page, shown in Figure 6-115, displays the IRS status page when the IRS is operating in the NAV mode. Values shown are as follows:

- IRS Position
- Groundspeed
- IRS Wind
- Drift Rate
- Miles from FMS Position
- Pitch
- Roll.

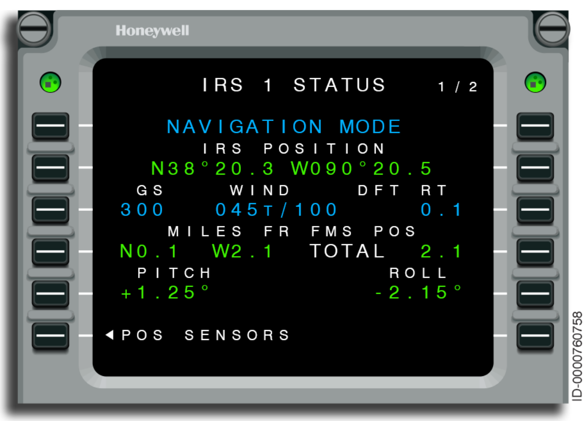


Figure 6-115
IRS 1 STATUS 1/2

The drift rate, calculated by the FMS, is the difference between the IRS and FMS position divided by the length of time the IRS has been in the NAV mode.

When the IRS is in the ALIGN mode, the time to NAV is displayed. This is shown in Figure 6-116.

Figure 6-116
IRS 1 STATUS 1/2 - ALIGN

The IRS ALIGN IN MOTION mode is shown in Figure 6-117.

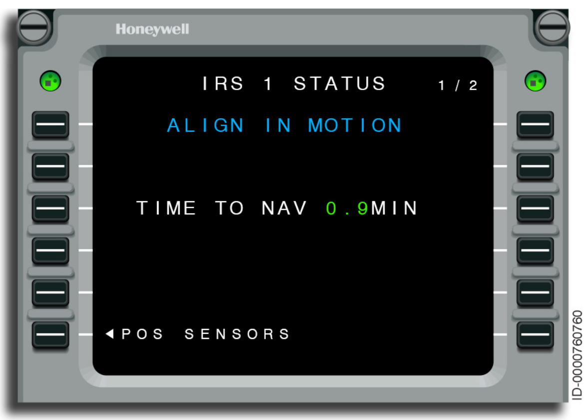


Figure 6-117
IRS 1 STATUS - ALIGN IN MOTION

The IRS ALIGN IN MOTION ATT is shown in Figure 6-118.

Figure 6-118
IRS 1 STATUS - ALIGN IN MOTION ATT

Figure 6-119 shows the information displayed when the IRS is in the ATTITUDE mode.

Figure 6-119
IRS 1 STATUS 1/2 - ATTITUDE

NOTE: When the IRS is switched to the attitude mode, on the ground or in flight, the IRS magnetic heading is set to 000°. The correct magnetic heading must be entered on the STATUS page for proper navigation and autopilot/flight director operation. Use the magnetic heading from another normally operating heading source, or the standby magnetic compass for input.

When the IRS is failed, the FAILED message is shown on the IRS 1 STATUS 1/2 page, as shown in Figure 6-120.

Figure 6-120
IRS 1 STATUS 1/2 - FAILED

The IRS 1 STATUS 2/2 page is shown in Figure 6-121.

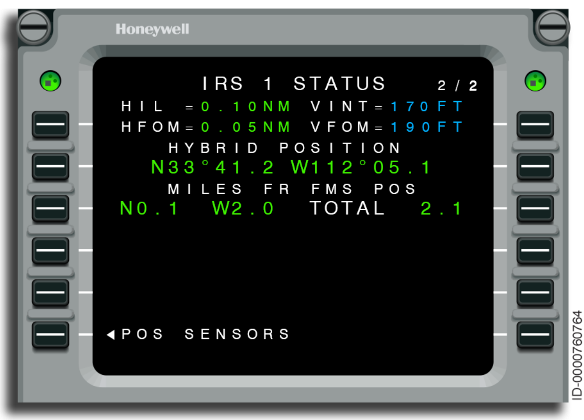


Figure 6-121
IRS 1 STATUS 2/2

World Geodetic Survey 1984 (WGS 84)

ICAO recommends all navigation position references are made using WGS 84, the standard used by the GPS system. Most countries around the world comply with this recommendation. Some countries where the conversion to WGS 84 have not been carried out lead to the possibility of navigation inaccuracies. For example, some countries may be partially compliant, not compliant, or the status of WGS 84 compliance is unknown. Crews must consult official sources (e.g., ICAO or the airport improvement program (AIP) of the country concerned) to determine the current status of airspace in which they operate.

OPERATIONS IN NON-WGS-84 AIRSPACE

Compliance with country-specific requirements relating to the use of GPS is mandatory. Check the aircraft flight manual (AFM) for any restriction and/or requirements for use of GPS in non-WGS-84 airspace. AFM requirements are controlling and supercede any conflicting guidance that may exist in this or other documentation.

RNAV approaches are prohibited in non-WGS-84 airspace. Radio-based (VOR, NDB, etc.) approaches are authorized using GPS updating provided the underlying NAVAID is tuned and monitored to make sure of aircraft position accuracy relative to the published procedure. If at anytime during the approach the GPS position does not match the raw data, the raw data will be used for navigation.

If the underlying NAVAID is out of service or the onboard radio(s) is inoperative, the use of RNAV to fly the procedure is not authorized.

Required Navigation Performance (RNP)

The RNP SETTINGS 1/1 page is shown in Figure 6-122. This page is accessed from the PROGRESS 3 page and is used for reviewing and/or manually changing the RNP value used for each of the different phases of flight or manual entry. A manual override RNP value is entered on this page. See Section 7, Required Navigation Performance (RNP), for greater detail.

Figure 6-122
RNP SETTINGS

- **1L** – This line shows the manual override RNP value. When one does not exist, entry prompts are displayed. Entry of a new RNP value is permitted. When a manual RNP is entered, it is displayed in large font, as shown in Figure 6-123. When the new RNP value is larger than the current RNP value, it is displayed in reverse video. Entry of DELETE clears the manual override RNP value.

- **2L, 3L, 1R, 2R, and 3R** – These lines show the default RNP values for each of the phases of flight in small characters. The pilot manually enters new RNP values that are displayed in large characters. Entry of DELETE returns the default value.

- **4L** – This line displays the remote RNP value. The default value is 4.00. Entered values of less than 0.10 or greater than 10.0 result in the INVALID ENTRY message to be displayed.

- **4R** – This line displays the missed approach RNP value. The default value is 1.00. Entered values of less than 0.10 or greater than 10.0 result in the INVALID ENTRY message to be displayed.
- **6R** – This line supplies access to the PROGRESS 3 page.

The RNP SETTINGS page with a manual entry is shown in Figure 6-123.

Figure 6-123
RNP SETTINGS - MANUAL

Predictive Receiver Autonomous Integrity Monitor (RAIM)

In addition to RAIM for current conditions, the GPS receiver predictive RAIM calculation gives the pilot an indicator as to whether the GPS satellite geometry is satisfactory for approach at the selected or expected arrival time. YES indicates RAIM is predicted to be within approach criteria. NO indicates RAIM is predicted to be unacceptable or unavailable.

The predictive RAIM page is accessed by selecting the PRED RAIM prompt from any GPS STATUS page. When selected, the PREDICTIVE RAIM page, shown in Figure 6-124, is displayed.

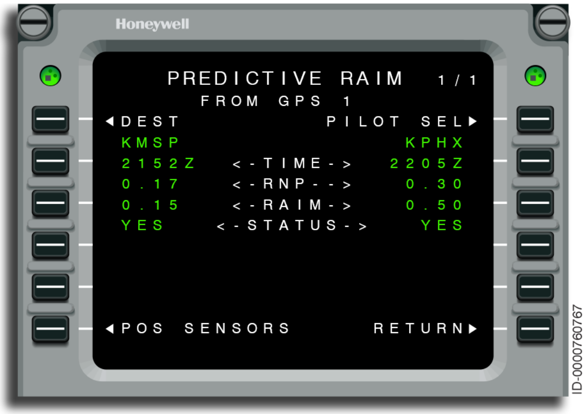


Figure 6-124
PREDICTIVE RAIM

The PREDICTIVE RAIM page includes the following information:

- Predictive RAIM source (1L)
- Destination RAIM selection (DEST) prompt (1L)
- Destination identifier - first line
- ETA at destination (2L)
- Activated approach or approach phase of flight RNP value – second line
- Predicted RAIM solution for destination (3L)
- RAIM destination status (4L)
- Pilot-selection (PILOT SEL) prompt (1R)
- Pilot-selected identifier - first line
- Pilot-entered time (2R)
- Approach phase of flight RNP value – second line
- Predicted RAIM solution for pilot-defined place (3R)
- RAIM status pilot-selected (4R)

- Access to the position sensors (POS SENSORS) prompt (6L)
- Return access to the GPS status page (RETURN) (6R).

The FMS uses the high priority GPS for predictive RAIM. The priority order for FMS 1 is GPS 1, GPS 2. The priority order for FMS 2 is GPS 2, GPS 1. When only a single GPS is available, both FMSs use it for predictive RAIM.

ETA is not enterable for destination, it is required for PREDICTIVE RAIM. ETA is updated on the PREDICTIVE RAIM page when the ETA from the active flight plan changes by more than 10 minutes.

When the GPS fails or the interface between the FMS and GPS does not work properly, the FMS shows the message PREDICTIVE RAIM UNAVAILABLE on the PREDICTIVE RAIM page.

Predictive RAIM is calculated using GPS almanac information. The almanac within the GPS is automatically updated when the GPS is on and tracking satellites. The almanac within the GPS is set invalid when older than 3.5 days. When this occurs, the message ALMANAC EXPIRED is displayed on the PREDICTIVE RAIM page. The almanac takes approximately 12-25 minutes to update once the GPS is tracking satellites. RAIM predictions are not possible with an expired almanac.

Selecting the DEST prompt from the PREDICTIVE RAIM page displays the DESTINATION RAIM 1/2 page. This is shown in Figure 6-125.

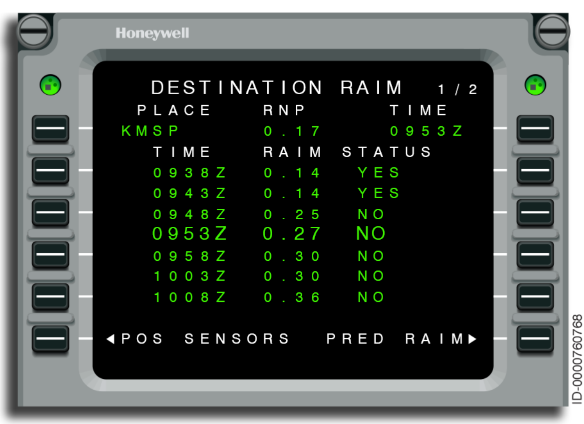


Figure 6-125
DESTINATION RAIM 1/2

DESTINATION RAIM 1/2 page includes the following information:

- Destination identifier (1L)
- Destination ETA from the active flight plan (1R)
- Destination RAIM predicted for the ETA (1R)
- Destination RAIM predicted for ETA-15 minutes (2L)
- Destination RAIM predicted for ETA-10 minutes (3L)
- Destination RAIM predicted for ETA-5 minutes (3L)
- Destination ETA (4L)
- Destination RAIM predicted for ETA+5 minutes (4L)
- Destination RAIM predicted for ETA+10 minutes (5L)
- Destination RAIM predicted for ETA+15 minutes (5L)
- Access to the position sensors (POS SENSORS) prompt (6L)
- Return access to the PREDICTIVE RAIM (PRED RAIM) page (6R).

DESTINATION RAIM 2/2 page supports satellite deselection, as shown in Figure 6-126. From this page, the pilot selects what GPS satellites are to be excluded from the DESTINATION RAIM predictions. The pilot enters the pseudo-random noise (PRN) code for the satellite scheduled to be out of service according to published GPS NOTAMs.

Figure 6-126
DESTINATION RAIM 2/2

- **2L, 2R, 3L, and 3R** – The satellite PRN is entered on these lines. Entry of *DELETE* results in the display of dashes. All PRN numbers are cleared after the aircraft has landed.

NOTE: Predictive RAIM at DEST is not available without a defined DEST and ETA for the DEST. An ETD is necessary when predictive RAIM is required before takeoff.

Selecting the PILOT SEL prompt from the PREDICTIVE RAIM page displays the PILOT SELECT RAIM 1/2 page. Pilot-selected RAIM uses the default RNP defined in the RNP SETTINGS page. This is shown in Figure 6-127.

Figure 6-127
PILOT SELECT RAIM 1/2

PILOT SELECT RAIM 1/2 page includes the following information:

- Identifier (1L)
- Time (1R)
- RAIM predicted for the ETA (1R)
- RAIM predicted for ETA-15 minutes (2L)
- RAIM predicted for ETA-10 minutes (3L)
- RAIM predicted for ETA-5 minutes (3L)
- RAIM predicted for ETA+5 minutes (4L)
- RAIM predicted for ETA+10 minutes (5L)
- RAIM predicted for ETA+15 minutes (5L)
- Access to the position sensors (POS SENSORS) prompt (6L)
- Return access to the PREDICTIVE RAIM (PRED RAIM) page (6R).

PILOT SELECT RAIM 2/2 page supports satellite deselection, as shown in Figure 6-128. From this page, the pilot selects what GPS satellites are to be excluded from the PILOT SELECT RAIM predictions. The pilot enters the PRN code for the satellite scheduled to be out of service according to published GPS NOTAMs.

Figure 6-128
PILOT SELECT RAIM 2/2

- **2L, 2R, 3L, and 3R** – The satellite PRN is entered on these lines. Entry of *DELETE* results in the display of dashes. All PRN numbers are cleared after the aircraft has landed.

While the GPS is computing, the predicted RAIM at the destination or pilot-selected waypoint, the FMS shows the message COMPUTING RAIM on the DESTINATION RAIM and PILOT SELECT RAIM pages.

Additional Details About Pseudo-Random Noise (PRN)

GPS satellites are identified by one of two unique numbers, satellite vehicle number (SVN) or PRN code. The SVN is the permanent physical identification number assigned to each satellite when launched. The SVN increments with each launch of a satellite as new satellites replace older ones. There are only 32 PRN codes available for use by the GPS satellites in the current GPS constellation.

The PRN is a complex code of 1s and 0s, transmitted by a satellite, uniquely identifying a satellite in the GPS constellation. The code is named pseudo-random because it is very long and seems to be a random sequence. The GPS system is designed for a maximum of 32 unique PRN codes transmitted by satellites within the constellation. A GPS receiver takes the satellite signal code and correlates it to one of the known stored 32 PRN codes within the receiver. By correlation with the satellite transmitted code, the receiver is able to determine what satellite it is receiving. Knowing this, the GPS receiver is able to make pseudo-range measurements in determining a given navigation solution.

VOR/DME Page

Figure 6-129 displays the VOR/DME 1 page. The VOR and DME data received from the radio is displayed. Each NAV radio received by the FMS has its own page. Access to the NOTAM page is at 6R.

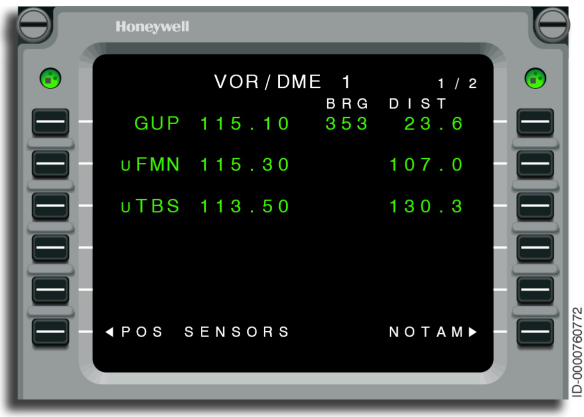


Figure 6-129
VOR/DME 1 1/2

NOTICES TO AIRMEN (NOTAM)

The pilot prevents the FMS from using a particular VOR and/or DME station for position computations by using the NOTAM page. Stations are entered as temporary or permanent. Entries in the temporary column (up to 3) are deleted after the FMS is powered down (on completion of the flight). Entries in the permanent column (up to 3) are stored in FMS memory until removed by pilot-action.

Procedure 6-18 describes how to enter and delete entries from the NOTAM page.

Procedure 6-18
NOTAM Entries

1. Select POS SENSORS from NAV INDEX 2 page. Select VOR/DME (6L) and then NOTAM (6R).

2. The NOTAM NAVAIDS page is shown in Figure 6-130. Enter the NAVAID identifier into the scratchpad. Push a line select key under either the permanent or temporary column.

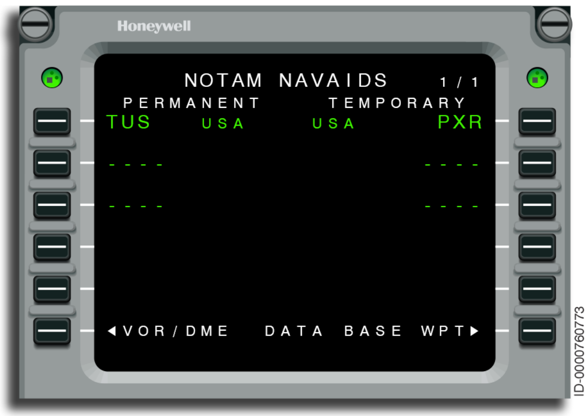


Figure 6-130
NOTAM NAVAIDS

3. Delete an entry by pushing the DEL key. *DELETE* is displayed on the scratchpad. Then push the line select key adjacent to the NAVAID identifier. An entry is replaced with another NAVAID without first being deleted.

SENSORS BEING USED BY THE FMS

Position sensors in use are indicated by the letter **U** that is shown before the latitude-longitude position on the POS SENSORS page.

Each FMS tunes the on-side radios. When the FMS is using VOR and DME data for navigation, a **U** is displayed in front of the NAVAID identifier on the VOR/DME page. In Figure 6-129, for example, the FMS is using FMN and TBS.

The class of a NAVAID and the aircraft altitude determine when the FMS tunes and uses a NAVAID for navigation. The class of a NAVAID is determined by entering the NAVAID identification on the DATA BASE WPT or PILOT WAYPOINT page. The class of the NAVAID is different in the FMS than the published class. This is because the FMS database class is adjusted to a lower class where stations on the same frequency interfere with each other at the higher class range limits. Table 6-5 lists the range and altitude limits used in selecting NAVAIDs for use.

Table 6-5
Range and Altitude Limits for VOR/DME

VOR/DME NAVAID Class	Aircraft Altitude	Lateral Distance
Terminal	≤ 12,000 feet MSL	≤ 40 NM
Low	≤ 18,000 feet MSL	≤ 70 NM
High	N/A	≤ Lesser of 130 NM or Line of Sight
Unrestricted	≤ 12,000 feet MSL	≤Lesser of 130 NM or Line of Sight
	> 12,000 feet MSL	≤Lesser of 200 NM or Line of Sight

Position Sensor Deselection

To prevent the FMS from using a sensor for position computations, use Procedure 6-19.

Procedure 6-19
Position Sensor Deselection

1. Select POS SENSORS from the NAV INDEX.
2. Push the delete key (DEL). *DELETE* is displayed on the scratchpad.
3. Push the left line select key on the SENSOR page next to the sensor that should no longer be used. DESEL is displayed adjacent to the sensor identifier and the **U** is removed adjacent to the sensor position.
4. To reselect the deleted sensor, push the DEL key and *DELETE* is displayed on the scratchpad.
5. Push the left line select key next to the sensor to be used. The DESEL adjacent to the sensor identifier is deleted and when the sensors are valid, a **U** is displayed adjacent to the sensor position when the FMS is again using the sensor.

To prevent the FMS from using a VOR/DME radio, use Procedure 6-20.

Procedure 6-20
VOR/DME Deselection

1. Select POS SENSORS from the NAV INDEX.
2. Select VOR/DME (6L).
3. Select the desired VOR/DME by using the NEXT/PREV keys.
4. Push the delete key (DEL). *DELETE* is displayed on the scratchpad.
5. Push one of the left line select keys next to one of the station identifiers. DESEL is displayed adjacent to the selected station identifiers. This action is removing the selected radio (VOR and DME channels) from being used by the FMS. Note that this deselects use of the radio, and not particular NAVAIDs.
6. To reselect the deleted radio, push the DEL key and *DELETE* is displayed on the scratchpad.
7. Push one of the left line select keys next to a station identifier. DESEL is removed from the selected station identifiers and the FMS can use the radio.

POSITION INITIALIZATION

The POSITION INIT 1/1 page, shown in Figure 6-131, is used to initialize the FMS position. This page is accessed from the NAV IDENT page when the GPS position is not available at power-up or from the POS INIT prompt on the NAV INDEX 2 page.

Figure 6-131
POSITION INIT

- **1L and 1R** – The last FMS position is displayed when the aircraft is on the ground. When the line select key adjacent to the LOAD prompt (1R) is pushed, the FMS is initialized to that position. This also serves to automatically update the cross-side FMS to the same position when the FMS is configured for DUAL. When a position is loaded, the prompt at 6R shows RTE for access to the flight planning function.

- **2L and 2R** – The reference waypoint (REF WPT) line is below the last FMS position. This line is filled automatically by the FMS or the pilot can make an entry at any time. In order of priority, the FMS fills in this line as follows:

  – RUNWAY THRESHOLD – When a departure runway is selected in the active flight plan, the coordinates of the runway threshold are displayed. Using this feature, runway position is updated when the aircraft is at the end of the runway ready for takeoff.

  – AIRPORT REFERENCE POINT (ARP) – When there is a last position available, the FMS shows the closest ARP within 3 NM.

– PROMPTS – When none of the previously discussed waypoints are displayed, the FMS shows prompts. This is shown in Figure 6-131.

- **3L and 3R** – The position of the highest priority GPS is displayed. The priority order, from highest to lowest, is GPS 1, GPS 2. This order of priority applies to all FMSs. When the line select key adjacent to the LOAD prompt (3R) is pushed, the FMS is initialized to the GPS position.

Once the correct coordinates are displayed, pushing the correct line select key (1R, 2R, or 3R) loads the position. This is shown in Figure 6-132. The position is loaded to the FMS and transmitted to any long-range sensors connected to the FMS.

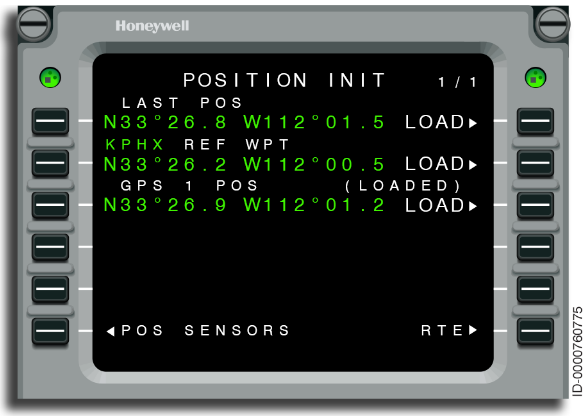


Figure 6-132
POSITION INIT - LOADED

When the aircraft is in flight and the FMS position is valid, Figure 6-133 is shown. The update feature of the FMS is used only in flight. For additional details on updating the FMS position in flight, refer to page 6-148.

Figure 6-133
POSITION INIT - UPDATE

FMS Position Update

The pilot updates the FMS to a sensor position, or known position, using POSITION UPDATE. When POSITION UPDATE is activated, the FMS position is corrected to the selected position.

Pushing the line select key adjacent to the UPDATE prompt (1R) on the POS SENSORS pages shown in Figure 6-102, displays the FMS UPDATE page, as shown in Figure 6-134. This page shows the current FMS position (1L), MANUAL prompt (2L), and a SENSOR prompt (2R).

Figure 6-134
FMS UPDATE

Procedure 6-21 uses the manual position UPDATE feature by flying over a known position. In this example, the FMS position is checked when the aircraft passes over the ZUN VORTAC.

Procedure 6-21
FMS Manual Position Update by Flyover

1. Select POS SENSORS from the NAV INDEX.

2. Before reaching ZUN, select the UPDATE prompt (1R). This is shown in Figure 6-135.

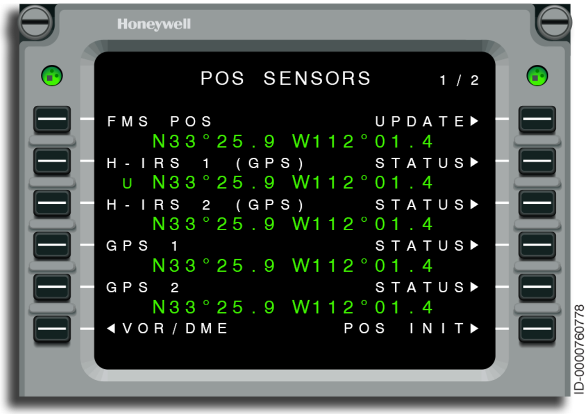


Figure 6-135
POS SENSORS 1/2

3. When the aircraft crosses over the NAVAID, select the MANUAL prompt (2L). This is shown in Figure 6-136.

Figure 6-136
FMS UPDATE – Known Position

DETAILS – The FMS position is recorded when the MANUAL prompt is pushed as the aircraft crosses over ZUN. This recorded position, labeled FREEZE POSITION, is displayed on the MCDU and shown in Figure 6-137. This is NOT the current FMS position. It is the FMS position when the manual prompt was pushed. The FMS continues to update current aircraft position.

4. Enter either an identifier or coordinates for the REF WPT. This is shown in Figure 6-137. For this example, enter ZUN as the REF WPT.

Figure 6-137
FMS UPDATE - REF WPT

5. Review the difference between the FREEZE POSITION and the reference position. Select either CLEAR (6L) or ENTER (6R), as shown in Figure 6-138.

Figure 6-138
FMS UPDATE With FREEZE POSITION

DETAILS – The FMS calculates the difference between ZUN and the FREEZE POSITION (FMS position when the aircraft overflew ZUN). Figure 6-138 shows the FMS position was 3.0 NM (1.3 NM South and 2.7 NM West) from ZUN when the aircraft flew over the navaid.

At this point, one of two selections are made. When the ENTER prompt is pushed, a 3 NM correction is added to the present FMS position (1.3 NM North and 2.7 NM East). This jumps the current FMS position (that is constantly changing) 1.3 NM North and 2.7 NM East. When the CLEAR prompt is selected, no correction is applied to the FMS position.

6. For either selection, the FMS shows the current FMS position on the FMS UPDATE page. This is shown in Figure 6-139.

Figure 6-139
FMS UPDATE - UPDATED

DETAILS – Any position sensor set to receive an update is also updated to the new position.

Updating the FMS position to one of the long-range sensors is also possible, as described in Procedure 6-22. When the FMS position is invalid, this feature cannot be used to update the FMS position.

Procedure 6-22
FMS Position Update to Long-Range Sensor

1. Select POS SENSORS from the NAV INDEX.

2. Select the UPDATE prompt (1R). This is shown in Figure 6-140.

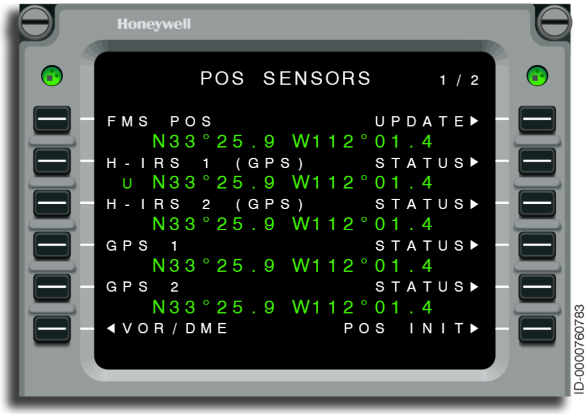


Figure 6-140
POS SENSOR 1/2 - UPDATE

3. Select the SENSOR prompt (2R). This is shown in Figure 6-141.

Figure 6-141
FMS UPDATE - SENSOR

4. Select the UPDATE prompt (right line selects), shown in Figure 6-142, for the sensor to be used for updating the FMS. In this example, IRS 1 (2R) is selected.

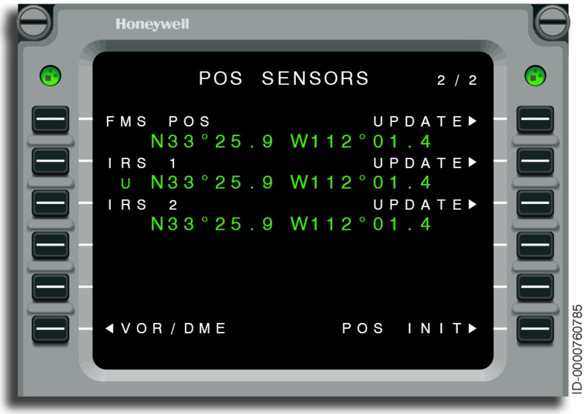


Figure 6-142
POS SENSORS 2/2 - UPDATE (2R)

5. Select ENTER at 6R to update the FMS position or CLEAR (6L) to reset the update function. This is shown in Figure 6-143. Following either selection, the FMS UPDATE page, shown earlier in Figure 6-139, is displayed with the current FMS position.

Figure 6-143
FMS UPDATE - ENTER

DETAILS – Any position sensors set to receive an update are also updated to the new position.

NAVIGATION IDENTIFICATION (NAV IDENT)

The NAV IDENT page, shown in Figure 6-144, shows information regarding the software of the FMS and the navigation database. The NAV IDENT page is the first FMS page shown on startup following selection of an FMS function key (PERF) performance, (NAV) navigation, (FPL) flight plan, (PROG) progress, or (RTE) route. This facilitates position initialization. For more information on position initialization, see page 6-145. Subsequently, this page is accessed by pushing the NAV IDENT prompt on the NAV INDEX 2 page.

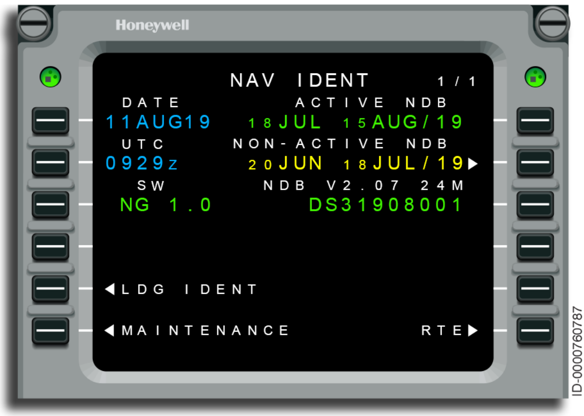


Figure 6-144
NAV IDENT

The NAV IDENT page shows the date, time, software version, and active navigation database cycle. It also shows the version, size, and region of the navigation database.

The date and time shown on this page are synchronized with the global positioning system (GPS) date and time. The date and time are changed when the GPS has failed or does not have a valid date/time. The date or time, is changed by entering the new date or time into the scratchpad. This is shown in Figure 6-145. Push the line key adjacent to the item being changed.

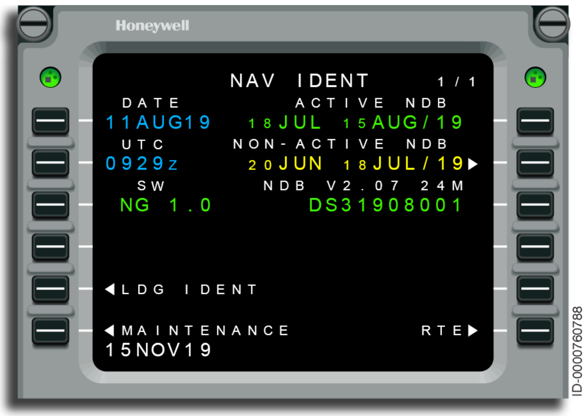


Figure 6-145
NAV IDENT - Date/Time

The navigation database contains two 28-day effective cycles. The active navigation database is changed between the two cycles by pushing the 2R line select key. This operation is only performed on-ground.

When the FMS date corresponds to a day during one of the navigation database cycles, that cycle is displayed in green. The remaining cycle is displayed in amber. When both cycles are displayed in amber, either the date is wrong or the navigation database has expired and must be updated. The database cycle is only changed while on the ground. When an active flight plan exists, it is cleared when changing database cycles.

The navigation database automatically sequences at power-up to the next cycle based on the offset time located on the FLT CONFIG 1/2 page.

LANDING IDENTIFICATION PAGE

The LDG IDENT page, shown in Figure 6-146, is accessed by pushing LSK 5L on the NAV IDENT page. It permits the flight crew to turn ON or OFF the landing V_{SPEEDS} computations if enabled on the TOLD APM function.

Figure 6-146
LDG IDENT

- **1L** – This line displays the aircraft type ID.
- **1R** – The name of the certification agency is displayed on this line.
- **2L** – The engine type is displayed on this line.
- **3L** – The QRH database effective date is displayed on this line.
- **3R** – The TOLD database version is displayed on this line.
- **4L** – The takeoff and landing V_{SPEEDS} computation database part number is displayed on this line.
- **4R** – The TOLD software version identification is displayed on this line.
- **5L** – This line displays the state of the landing speed computation.
- **5R** – This line toggles the landing speeds ON or OFF.
- **6L** – This line accesses the MAINTENANCE 1 page.
- **6R** – This line accesses the NAV IDENT page.

CONVERSION

The CONVERSION pages are accessed from the CONVERSION prompt on the NAV INDEX page and enable the pilot to convert between commonly used units. The first two pages generate conversion between English and metric units. The third page generates weight/volume conversions. The last page supports QFE/QNH conversions.

The CONVERSION 1/4 page, shown in Figure 6-147, displays conversion between English and metric units for length, weight, and volume.

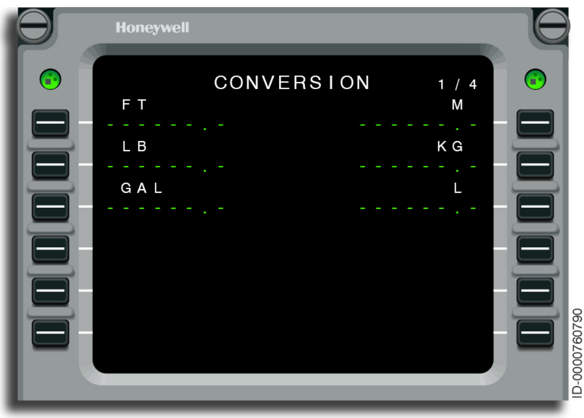


Figure 6-147
CONVERSION 1/4

- **1L** – Entry of feet on this line results in a display of the equivalent meters at 1R.

- **1R** – Entry of meters on this line results in a display of the equivalent value in flight level (FL) and feet at 1L, as shown in Figure 6-148.

Figure 6-148
CONVERSION 1/4 - METERS

- **2L and 2R** – Entry of pounds or kilograms results in a display of the equivalent weight in the opposite unit.
- **3L and 3R** – Entry of gallons or liters results in a display of the equivalent weight in the opposite unit.

The CONVERSION 2/4 page, shown in Figure 6-149, displays conversion between English and metric units for temperature, velocity, and distance.

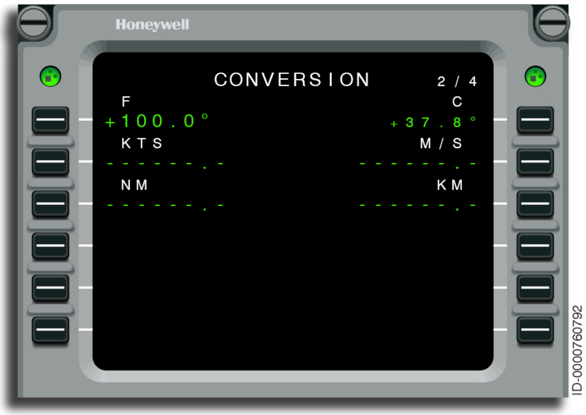


Figure 6-149
CONVERSION 2/4

- **1L and 1R** – Entry of temperature on this line results in a display of the equivalent temperature in the opposite unit.
- **2L and 2R** – Entry of knots or meters per second on this line results in a display of the equivalent velocity in the opposite unit.
- **3L and 3R** – Entry of nautical miles or kilometers on this line results in a display of the equivalent distance in the opposite unit.

The CONVERSION 3/4 page, shown in Figure 6-150, displays conversion between English and metric units for weights and volumes. The conversion is based on a specific weight shown on the page. The specific weight is changed by the pilot.

Figure 6-150
CONVERSION 3/4

Entry of pounds, kilograms, gallons, or liters results in display of the remaining parameters. Figure 6-151 is an example with an entry of 10,000 pounds.

Figure 6-151
CONVERSION 3/4 - 10,000

- **1L** – Entry of pounds on this line results in a display of the equivalent gallons (2L), kilograms (1R), and liters (2R). The conversion is based on the specific weights shown at 3L and 3R.
- **1R** – Entry of kilograms on this line results in a display of the equivalent gallons (2L), pounds (1L), and liters (2R). The conversion is based on the specific weights shown at 3L and 3R.
- **2L** – Entry of gallons on this line results in a display of the equivalent pounds (1L), kilograms (1R), and liters (2R). The conversion is based on the specific weights shown at 3L and 3R.
- **2R** – Entry of liters on this line results in a display of the equivalent pounds (1L), kilograms (1R), and gallons (2L). The conversion is based on the specific weights shown at 3L and 3R.
- **3L and 3R** – These lines show the specific weight (pounds per gallon and kilograms per liter) to be used for the conversion. Pilot-entry of specific weight is permitted. The value is retained in memory and is not lost following shut down of the FMS. See Section 15, Multifunction Control Display Unit (MCDU) Entry Format, for entry ranges and format.

Figure 6-152 shows the variation of the specific weight of fuel as temperature varies.

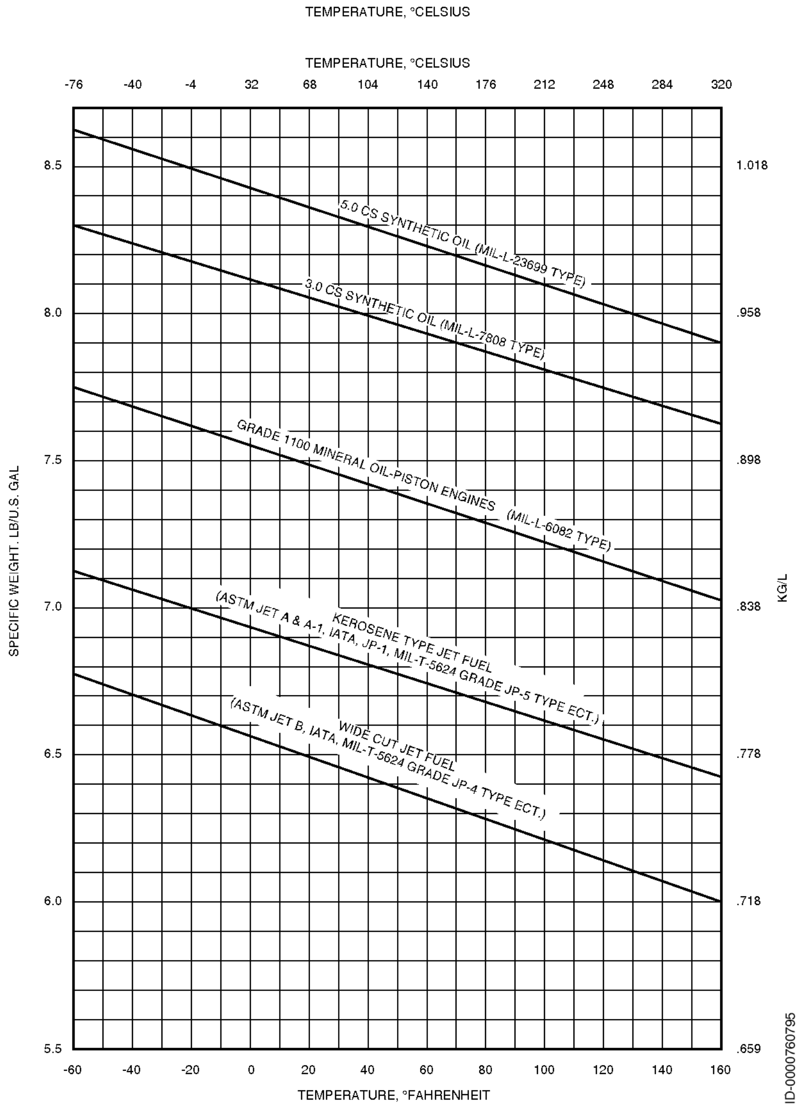


Figure 6-152
Average Specific Weight Variation of Aviation Fuels and Lubricants

The CONVERSION 4/4 page, shown in Figure 6-153, displays the QFE-QNH conversion page. This page is designed to support QFE/ QNH conversions and compute conversions between barometric altimeter units.

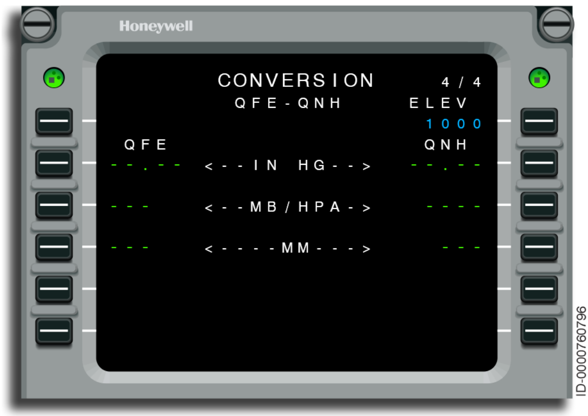


Figure 6-153
CONVERSION 4/4

QNH altimeter settings result in the altimeter showing the aircraft altitude above mean sea level based on the local station pressure. When an altimeter is set to QFE, the aircraft altitude is shown above a station. With the altimeter set to QFE and the aircraft on the ground, the altimeter shows zero (0). In-flight QFE gives height above ground level (without consideration for nonstandard temperature).

Assuming an elevation exists at 1R, entry of a QNH or QFE (in any unit) results in the display of the remaining parameters. Figure 6-154 is an example with a QNH entry of 29.92. When an elevation does not exist, the FMS is unable to convert to the QFE/QNH altimeter setting. Under this condition, the FMS computes and shows the equivalent unit(s) for the entered altimeter setting.

Figure 6-154
CONVERSION 4/4 - 29.92

- **1R** – This line is used for entering the airport elevation. The default elevation is the destination elevation in the active flight plan. When an approach is selected, the runway elevation is used as the default. Pilot-entry of elevation is permitted. Entering *DELETE* returns the default elevation. QFE/QNH conversions require an elevation. Elevation must be entered in feet.

- **2R** – Entry of QNH in IN HG (inches of mercury) on this line results in the display of the equivalent QNH in MB/HPA (millibars/hectopascals) (3R) and MM (millimeters) (4R). When an elevation exists at 1R, the FMS computes and shows the equivalent QFE in IN HG (2L), MB/HPA (3L), and MM (4L). Entering *DELETE* returns the default of dashes.

- **3R** – Entry of QNH in MB/HPA on this line results in the display of the equivalent QNH in IN HG (2R) and MM (4R). When an elevation exists at 1R, the FMS computes and shows the equivalent QFE in IN HG (2L), MB/HPA (3L), and MM (4L). Entering *DELETE* returns the default of dashes.

- **4R** – Entry of QNH in MM on this line results in the display of the equivalent QNH in IN HG (2R) and MB/HPA (3R). When an elevation exists at 1R, the FMS computes and shows the equivalent QFE in IN HG (2L), MB/HPA (3L), and MM (4L). Entering *DELETE* returns the default of dashes.
- **2L** – Entry of QFE in IN HG on this line results in the display of the equivalent QFE in MB/HPA (3L) and MM (4L). When an elevation exists at 1R, the FMS computes and shows the equivalent QNH in IN HG (2R), MB/HPA (3R), and MM (4R). Entering *DELETE* returns the default of dashes.
- **3L** – Entry of QFE in MB/HPA on this line results in the display of the equivalent QFE in IN HG (2L) and MM (4L). When an elevation exists at 1R, the FMS computes and shows the equivalent QNH in IN HG (2R), MB/HPA (3R), and MM (4R). Entering *DELETE* returns the default of dashes.
- **4L** – Entry of QFE in MM on this line results in the display of the equivalent QFE in IN HG (2L) and MB/HPA (3L). When an elevation exists at 1R, the FMS computes and shows the equivalent QNH in IN HG (2R), MB/HPA (3R), and MM (4R). Entering *DELETE* returns the default of dashes.

DATALOAD

The DATA LOAD page, shown in Figure 6-155, is accessed from the DATA LOAD prompt on the NAV INDEX page and is used to access the database crossloading function of the FMS.

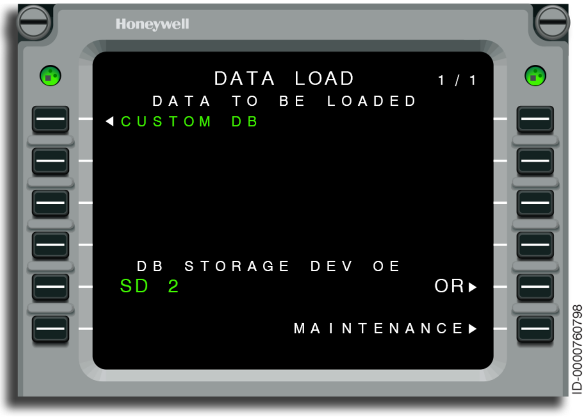


Figure 6-155
DATA LOAD

Crossloading Custom or Aircraft Database

The custom or aircraft databases are transferred from one FMS to the other. The custom or aircraft databases are transferred while the aircraft is on the ground.

In order to transfer data, the FMSs must be turned on and have compatible software versions. All steps are completed from just one of the FMSs.

Refer to Procedure 6-23 for generalized dataloading procedures.

Procedure 6-23
Database Transfer Between FMSs

1. Select the correct prompt, shown in Figure 6-156, for data to be transferred. In this example, the CUSTOM DB prompt at 1L is selected.

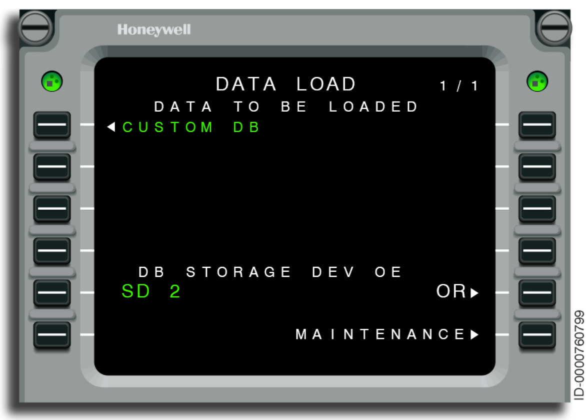


Figure 6-156
DATA LOAD - CUSTOM DB

2. Select the prompt for the source or destination of the selected data from the menu. This is shown in Figure 6-157. In this example, the FR STORAGE prompt at 3R is selected.

Figure 6-157
DATA LOAD - TO STORAGE

3. Confirm selection and select YES (6R) or NO (6L) on the display. This is shown in Figure 6-158.

Figure 6-158
DATA LOAD - CONFIRM TRANSFER

4. Progress monitoring is shown in Figure 6-159.

Figure 6-159
DATA LOAD - TRANSFER

The FMS indicates the percentage complete. When complete, the message DB TRANSFER COMPLETE is displayed and the FMS executes a restart when a navigation of aircraft database has been transferred.

When power is interrupted, ABORT is selected, or other problems that stop the loading process occur, the dataload process must be repeated from the beginning. Refer to page 17-1 for a listing of dataloader fault codes.

5. Repeat steps 1 through 4 for each FMS.

Dataloading

When the data management unit (DMU) or data LAN management unit (DLMU) is installed, the pilot has the capability to upload and download custom databases and aircraft databases. DMU supports CD/DVD, LAN, and PCMCIA. DLMU supports USB, LAN, and two SD cards. This permits the pilot to define, save, and transfer frequently used routes and pilot-defined waypoints. Refer to Procedure 6-24 for upload procedure.

Procedure 6-24
Procedure to Upload Databases to the DMU/DLMU

1. Select DATA LOAD from page 2 of NAV INDEX, as shown in Figure 6-160.

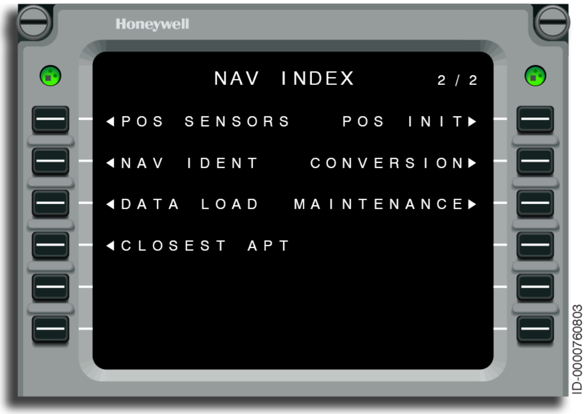


Figure 6-160
NAV INDEX - DATA LOAD

2. Select the database to be uploaded from the DMU/DLMU. For example, to upload navigation databases, select the storage device prompt at LSK 5L.

NOTE: NAV databases and tailored databases cannot be loaded directly through the DMU/DLMU using an FMS page on the MCDU. The data loading system (DLS) menu, using the MFD menu or remote personal computer (PC), must be used to load a navigation or tailored database from the compact disk.

Navigation Database Updating

Every 28 days, the navigation database in the FMS must be updated. The update is supplied by Honeywell. The navigation database is normally updated while the aircraft is on the ground. Follow Procedure 6-24 to update the navigation database using either the DL-800/900.

MAINTENANCE

The MAINTENANCE pages are accessed from the MAINTENANCE prompt on the NAV INDEX page and are used to verify the selected and active dual system modes, list failed sensors, and select true or magnetic mode for the FMS.

Operating Modes

The pilot cannot manually select the operating configuration of the FMSs, as this is automatically selected.

There are three configuration modes for those installations having two FMSs.

1. **Dual** – The active flight plan, performance entries, pilot-defined waypoints, stored flight plans, and offside radio tuning commands are transferred to the other FMSs automatically (no pilot-action required).

2. **Independent** – Only off-side radio tuning commands are transferred to the other FMSs automatically.

3. **Single** – No data is transferred between FMSs.

In all operating modes, position calculation is always independent in each FMS. Table 6-6 lists the requirements necessary for each operating mode. The FMS defaults to the SINGLE mode when the requirements for the DUAL or INDEPENDENT modes cannot be met.

Table 6-6
Operating Mode Requirements

Requirement	Dual	Independent	Single
FMS software version identical	X		
Both FMSs satisfy compatibility checks	X		
Navigation Database identical	X		
APM configuration settings identical	X		
MAG VAR Database identical	X		
ATC Database identical (if APM ATN-CPDLC option is enabled)	X		
Aero Engine Database (AEDB) identical	X		
Communication Integrity (i.e., no FM I/O failures)	X		
Active flight plans match between FMSs	X		
DUAL Inoperative, but FMSs can still communicate		X	
NO communication between FMSs			X

OPERATIONAL MODES

The FMS redundancy management software assigns the FMS operating mode as either DUAL, Independent or SINGLE. The active operating mode and resultant data transfers, including radio tuning, for the FMSs are determined using the normal operating modes.

The master/slave relationship of the FMS is determined by which side is coupled. The coupled-side is the master while the other is the slave. The new slave then synchronizes the flight plan and performance initialization with the master.

Also noted, the FMS operating in the single system mode does not receive performance initialization data from the other FMSs.

The MAINTENANCE 1/3 page, shown in Figure 6-161, is dedicated to showing the operating group. In Figure 6-161, the active mode is SINGLE, and the selected mode is DUAL.

Figure 6-161
FMS 1 MAINTENANCE 1/3

NOTE: The PROBLEMS prompt at LSK 5R is only displayed when 1L and 2L are different.

Failed Sensors

The MAINTENANCE 2/3 page, shown in Figure 6-162, displays the currently failed sensors as determined by the FMS.

Figure 6-162
FMS 1 MAINTENANCE 2/3

The SETUP prompt (6L) is used to access the setup pages. Refer to FMS Setup Pages on page 6-176, for further details on this function.

The SENSOR HISTORY prompt (6R) is used to show a list of sensors having failed sometime after takeoff during the current flight, but are not failed at the present time. Figure 6-163 shows the SENSOR HISTORY page.

Figure 6-163
SENSOR HISTORY

True/Magnetic Selection

The MAINTENANCE 3/3 page, shown in Figure 6-164, is dedicated to selecting true or magnetic headings for the FMS and HSI heading display. When TRUE is the active mode, or the selected airport/procedure is stored in the NAV DB in true, all courses and headings displayed by the FMS are followed by the letter **T**. When MAG is the active mode, all courses and headings shown by the FMS are followed by a degree symbol (°) on the FMS pages. The FMS/HSI automatically transitions from magnetic to true (and vice versa) based on crossing N82° (S82°), including keyhole regions. A scratchpad message, ACTIVE MODE IS TRUE (MAG) HDG, is displayed when the transition occurs.

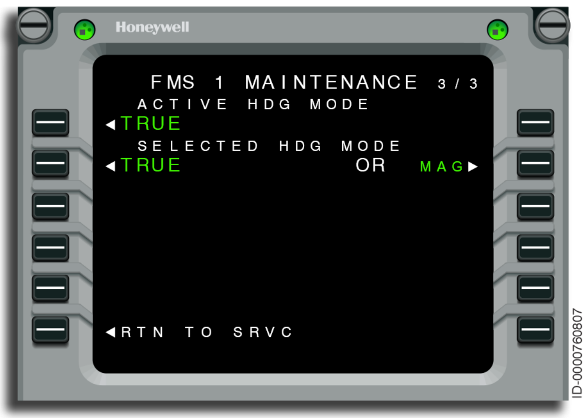


Figure 6-164
FMS 1 MAINTENANCE 3/3

The active mode also reflects how courses are displayed on the HSI. When the FMS is selected as the navigation source for the HSI, the course shown by the FMS is relative to the mode shown for the ACTIVE HDG MODE on this page.

The pilot toggles between magnetic and true by pushing the line select key at 2R.

NOTE: *The flight crew should select the proper MAG/TRUE reference as directed by ATC or as indicated in the desired procedure to be flown.*

The RETURN TO SERVICE page is directly accessed by pushing the line select key at 6L. Refer to page page 6-176 for additional details.

Return to Service

FMS software identification and configuration information is given for display only, as shown in Figure 6-165. The functional software identifier and FMS software version are displayed on this page as well as the AEDB, MAG VAR DB, and ATC DB.

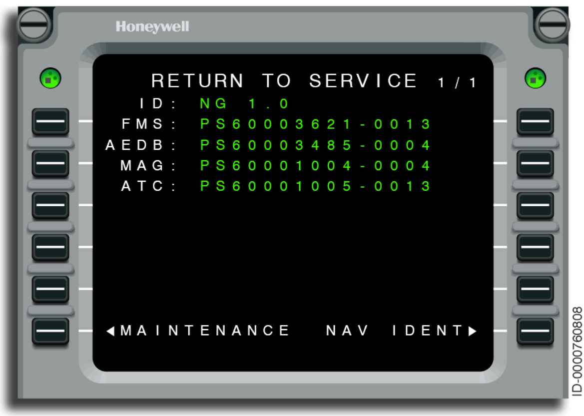


Figure 6-165
RETURN TO SERVICE

FMS Setup Pages

The FMS contains setup pages for configuring operational options. The setup pages are accessible from the MAINTENANCE 2 page using line select 6L, as described in Procedure 6-25. From this index page, the various setup pages are selected.

Procedure 6-25
FMS Setup Page Access

1. Select MAINTENANCE from the NAV INDEX (page 2).

2. Push the NEXT key to select page 2.

3. The MAINTENANCE page is shown in Figure 6-166. Select the SETUP prompt at 6L.

Figure 6-166
FMS 1 MAINTENANCE 2/3 - Setup

4. The FMS SETUP page, shown in Figure 6-167, is displayed. The selectable option is:

- **1R** – FLT CONFIG (refer to page 6-178).

Figure 6-167
FMS SETUP

FLIGHT CONFIGURATION

Flight configuration is used to set many operating conditions of the FMS. It permits the flight crew the ability to set the UTC time when the NDB cycle changes. This permits them to configure the aircraft to meet the effective time that the regulations for their area of operation require. FLIGHT CONFIG is accessed from the FMS SETUP line select 1R. For details regarding flight configuration setup, refer to Procedure 6-26.

Procedure 6-26
Flight Configuration Setup

1. Select FLT CONFIG (1R) from the FMS SETUP page. Refer to Procedure 6-25 on page 6-176.

2. Review the current configuration shown in Figure 6-168. Make changes, as necessary, using the required steps.

Figure 6-168
FLIGHT CONFIG 1/2

3. Set FPL AUTO PAGE to ON or OFF at line select 3R. The FPL AUTO PAGE feature applies when building both active and stored flight plans.

DETAILS

- FPL AUTO PAGE ON – The FMS automatically advances the flight plan page, after a slight delay, when the fifth waypoint is entered on any given page. FPL AUTO PAGE continues until the destination is entered as a waypoint on the left side of the page.

When an airway is entered, the FPL AUTO PAGE does not advance the pages.

- FPL AUTO PAGE OFF – All flight plan page changes are done using the NEXT and PREV keys.

4. Push NEXT to select page 2.

5. Review the current configuration shown in Figure 6-169. Make changes, as necessary, using the required steps.

Figure 6-169
FLIGHT CONFIG 2/2

NOTE: See page 9-70 for TEMP COMP and page 6-113 for SBAS.

6. The FLIGHT SUMMARY output selection is displayed at 3L. The FLIGHT SUMMARY output permits for the display and/or saving of the FLIGHT SUMMARY data following completion of the flight. Selection of the OR prompt at 3R displays the FLIGHT SUMMARY OUTPUT page, as shown in Figure 6-170.

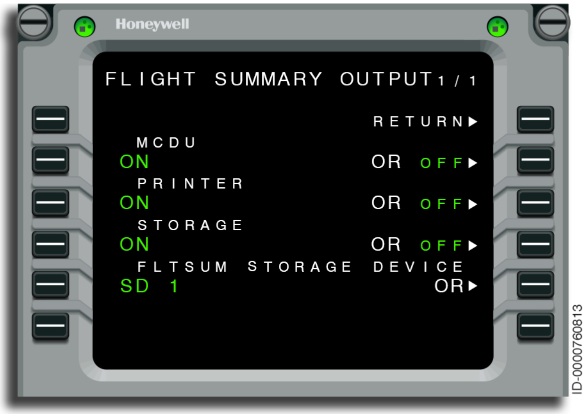


Figure 6-170
FLIGHT SUMMARY OUTPUT Page

DETAILS

- MCDU – When selected ON and the aircraft is transitioned to on-ground engines off (both) or one engine off and forward passenger door open (after landing), the FLIGHT SUMMARY page automatically is displayed.

- PRINTER – When selected ON and the MCDU is OFF and the aircraft is transitioned to on-ground engines off (both) or one engine off and forward passenger door open (after landing), the FLIGHT SUMMARY page prints automatically. When ON and the MCDU is ON, a PRINT prompt is available on the FLIGHT SUMMARY page, then giving the option to save and to print.

- STORAGE – When selected ON and the MCDU is OFF and the aircraft is transitioned to on-ground engines off (both) or one engine off and forward passenger door open (after landing), the FLIGHT SUMMARY page is automatically downloaded to database files. When ON and the MCDU is ON, a PRINT prompt is available on the FLIGHT SUMMARY page, then giving the option to save and to print.
- FLTSUM STORAGE DEVICE – Shows the various storage devices available.

CLOSEST AIRPORTS

The CLOSEST AIRPORTS page, shown in Figure 6-171, is accessed from the CLOSEST APT prompt on the NAV INDEX page and permits the user to view and select from a list of 10 airports closest to the current aircraft position. Information included on the CLOSEST AIRPORTS page includes the airport identifier, bearing, distance, and estimated fuel remaining for each airport listed.

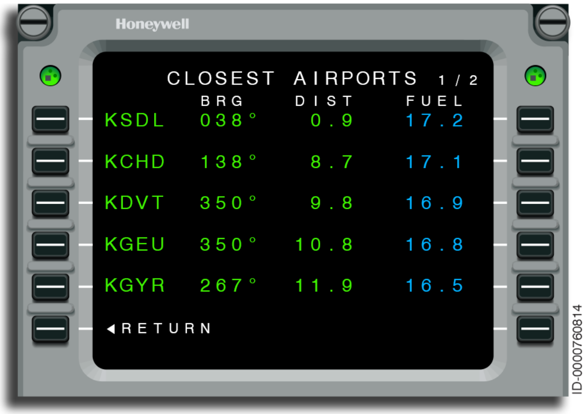


Figure 6-171
CLOSEST AIRPORTS 1/2

- **1L through 5L** – The closest airports are displayed in order of closest to furthest from the present position filling 1L through 5L. On-ground, the name of the airport, bearing to the airport from the present position in Mag or True, and distance to the airport from the present position are displayed and the fuel estimates are left blank. Once airborne, the fuel estimates are displayed.

Selecting an airport results in the airport identifier to be down selected and the last page of the primary flight plan to be displayed, which is where the destination is displayed or if no flight plan currently exists, the initial flight plan page is displayed.

TUNING NAV RADIOS

Tuning the NAV radios through the FMS is possible using the following two different methods:

1. Identifier
2. Frequency.

Tune the NAV radios using the station identifier by following Procedure 6-27.

Procedure 6-27
NAV Tuning by Identifier

1. Select PROG from the MCDU panel. When page 1 is not displayed, select NEXT until it is.
2. Enter the station identifier into the scratchpad.
3. Push the line select key 6L or 6R.
4. The FMS tunes the NAV radio and shows the identifier and frequency on the PROGRESS page.

Tune a NAV radio by frequency following Procedure 6-28.

Procedure 6-28
NAV Tuning by Frequency

1. Select PROG from the MCDU panel. When page 1 is not displayed, select NEXT until it is.
2. Enter the frequency into the scratchpad.
3. Push the line select key 6L or 6R.
4. The FMS tunes the radio to the entered frequency and searches the candidates list of local navaids. When no match is found, the FMS then searches the NAVAIDs listed in the flight plan (e.g., ILS). The frequency and identifier of the first matching NAVAID is displayed on the PROGRESS page. When no matches are identified, the identifier field remains dashed.

The FMS does not use ILS LOC/GS data for position computations. When a DME is associated with an ILS, the FMS uses it in position computation.

Autotune

The tuning mode is in autotune when the FMS is tuning the VOR. To select autotune, follow Procedure 6-29.

In autotuning, the FMS automatically selects a NAVAID, tunes it, and checks the data from the NAVAID. No pilot-interaction is required.

The FMS maintains a candidates list of up to 30 local NAVAID stations obtained from the NAV database. The candidates list contains the NAVAIDs (of type VOR/DME, VORTAC, noncolocated VOR/DME, DME, or VOR) closest to the aircraft and within a maximum range of 320 nautical miles of the aircraft. (The term noncolocated VOR/DME also includes noncolocated VORTACs. The term DME also includes TACANs.) The candidates list is sorted such that the closest NAVAID to the aircraft is first.

During autotuning, the FMS tunes the VOR the pilot would most likely tune when possible. When the VOR is required for navigation, the FMS tunes the VOR so the most optimum VOR/DME position is established.

The FMS autotunes the localizer frequency for localizer-based approaches. For localizer autotuning, frequency confirmation from the NAV receiver is performed but the data is not checked by the FMS. The pilot must rely on the primary instrument flags to determine the validity of the signals.

NOTE: During power-up and restarts, the FMS is in autotune mode.

Procedure 6-29
NAV Tuning by Selecting Autotune

1. Confirm that the VOR radio is not selected as the navigation source on either side EDS. This includes the VOR mode, ILS mode, or preview mode.

2. Confirm that the VOR radio is in the manual tune mode.

3. Select PROG from the MCDU panel.

4. Use the DEL key to enter *DELETE* into the scratchpad, as shown in Figure 6-172.

Figure 6-172
PROGRESS 1/3 - DELETE

5. Line select to LSK 6L or LSK 6R on the RADIO TUNING or PROGRESS page. The FMS switches to autotuning mode, as shown in Figure 6-173.

Figure 6-173
PROGRESS 1/3 - AUTOTUNE

NOTE: When an attempt is made to tune the radios on the PROGRESS page or on the FMS radio tuning pilot interface and the radios do not tune the frequency (even after 3 seconds) then the NAVAID identifier and frequency is displayed in reverse video on the PROGRESS 1/3 page.

NAV Tuning

Autotune is indicated by the magenta NAV active frequency on the PFD and green FMS AUTO on the adjacent field to the active NAV frequency on the MCDU RADIO page.

When VOR or LOC is selected as the navigation source on the EDS with autotuning active, autotuning ceases and manual tune is shown on the PFD active NAV frequency in green. FMS AUTO is removed from the MCDU RADIO page.

When Preview is selected (Preview mode), with autotuning active, autotuning discontinues. However the PFD and MCDU RADIO pages continue to indicate autotune. When Preview is deselected, autotuning resumes.

The FMS also has the capability to autopreview when the APM option is enabled. Autopreview distance is based on two APM parameter values. They are direct distance to destination and along track distance to destination.

In Preview mode, the FMS automatically tunes the ILS specified in the arrival procedure when either the aircraft sequences onto an active ILS approach procedure leg or the aircraft is within 150 NM of the destination runway. This is indicated by the PFD active NAV frequency shown in green and FMS AUTO removed from the MCDU RADIO page.

Manual Tuning

The tuning mode is manual when the pilot has tuned the NAV radios through the FMS or from another radio tuning source. The FMS does not make changes to the frequency the pilot has selected. Radio tune sources are the PFD, RADIO page on the MCDU, and the PROGRESS page.

- The radio tune sources on the PFD, MCDU radio page
- The on-side NAV radio, FMS PROGRESS page.

Therefore, when NOT in DUAL, the off-side NAV radio cannot be tuned by the PROGRESS page. The FMS still tunes the blind channels of the scanning DME during this mode.

HIGH LATITUDE FLYING

The following paragraphs describe flying at high latitudes.

Polar Region: IRS Equipped Aircraft

Entering the polar region (above 82° N or below 82° S and North or South keyhole) results in the message ENTERING POLAR REGION being shown. When entering the polar region, the FMS uses the highest priority sensor for navigation. Sensor blending is suspended and the FMS position is slowly ramped to the position of the highest priority sensor. Under normal circumstances, FMS 1 uses IRS 1 and FMS 2 uses IRS 2. When the highest priority sensor has failed, the next priority sensor is used. The POS SENSORS page indicates what sensor is being used.

Under normal operations, the on-side IRS is used as the heading source by the EDS (IRS 1 for the pilot and IRS 2 for the copilot). When the EDS and FMS are using the same IRS, the EDS shows a 180° reversal at the same time the FMS crosses the pole.

When leaving the region (below 82° N or above 82° S and North or South keyhole), the message EXITING POLAR REGION is displayed. The FMS resumes sensor blending and slowly ramps from the high priority sensor position to the blended sensor position.

The plan mode for the EDS map display is not useful while at or near the pole. The information presented is correct, but the presentation is not useful because the plan mode is presented north-up. When at the North Pole for example, everything is south. Therefore, the plan mode must not be used during operations at or near either pole. Instead, use the regular map mode.

While flying in the polar region, the FMS uses TRUE heading instead of MAG heading for radio navigation. For more information on switching between MAG and TRUE heading, see page 6-175.

Since the FMS uses the highest priority IRS (GPS when no IRS is available) and the IRS position cannot be updated, manual FMS position update is not permitted in the polar region.

NOTE: The flight crew must manually disable the GPS on the FMS when conducting operations in the polar region.

PREPLANNED LATERAL OFFSET

The NG FMS permits the flight crew to preplan lateral offsets. Preplanned lateral offsets are programmed in advance on the MCDU by setting start and end waypoints that exist in the active flight plan. Offsets are programmed when the aircraft is in flight or on the ground, and are accessed from the RTE page 1, as shown in Figure 6-174.

Figure 6-174
ACT RTE Page - OFFSET (5L)

Selecting the OFFSET prompt from the RTE 1 page accesses the OFFSET page, as shown in Figure 6-175. Offsets are only permitted in the active flight plan and not in secondary flight plans.

NOTE: Creation of a planned offset that passes through the polar region is permitted. PPOS offsets are also permitted in the polar region.

Figure 6-175
OFFSET

When entering the start and end fix, they must exist in the current active primary flight plan. If there is no start fix, dashes are displayed that permit pilot-entry.

When airborne, if an END waypoint and offset distance are entered, the system automatically fills the START waypoint with *PPOS in small font. This indicates that a present position offset is created if no start waypoint is entered, as shown in Figure 6-176. To create a PPOS waypoint, just delete the start waypoint if a start waypoint already exists on the OFFSET page.

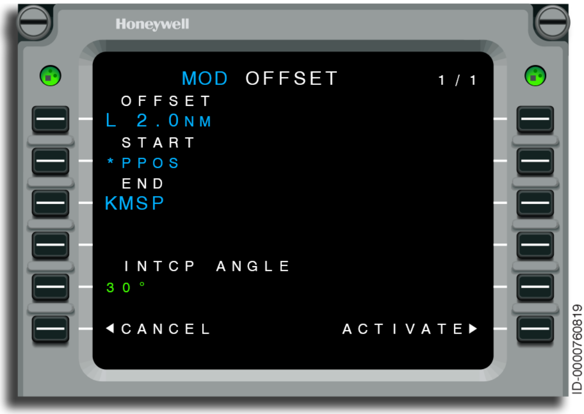


Figure 6-176
*MOD OFFSET - *PPOS Waypoint*

The desired offset is entered at LSK 1L. The offset direction (L or R) followed by the offset distance is entered in the scratchpad and then upselected to LSK 1L. Offset distances are permitted up to 99 NM. A left offset of 2 NM is displayed in Figure 6-177.

Figure 6-177
OFFSET - L 2.0 NM

The start waypoint is entered at LSK 2L and the end waypoint is entered at 3L, as shown in Figure 6-178. A MOD OFFSET page is created when the start and end waypoints are entered.

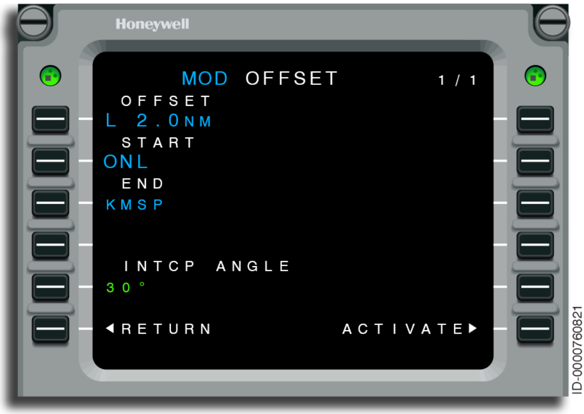


Figure 6-178
MOD OFFSET

When a start waypoint is entered, the FMS automatically enters the destination waypoint as the end waypoint in small font. To enter a different waypoint, enter the new waypoint in the scratchpad and upselect to LSK 3L. MCW is entered as the new end waypoint and is displayed in large font, as shown in Figure 6-179.

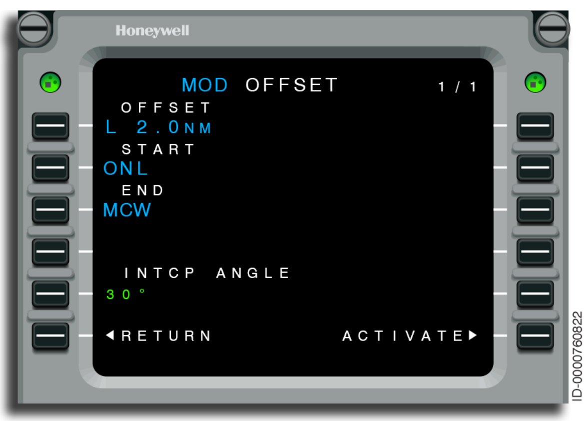


Figure 6-179
MOD OFFSET - MCW Waypoint

The intercept angle is displayed at LSK 5L. The default intercept angle is 30°. Pilot-entries are permitted. The permitted values range from 10° to 50°.

Once the desired parameters are entered, the ACTIVATE prompt at 6R is pushed, converting the MOD OFFSET page to the active OFFSET page, as shown in Figure 6-180. Pushing the RETURN prompt brings you back to the RTE page.

Figure 6-180
OFFSET - Active

Once set, the initiation of the preplanned offset begins after the identified start fix. On sequencing the start fix, the aircraft flies the intercept angle to the offset path. The offset ends when passing the identified end fix.

NOTE: Offsets can also be done utilizing graphical flight planning. See Section 12, Graphical Flight Planning, for more information on offset procedures.

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7. Required Navigation Performance (RNP)

INTRODUCTION

This section describes the concepts, functions, and operations related to required navigation performance (RNP) and RNP navigation database option.

RNP is a statement of the navigation performance, accuracy, integrity, continuity, and availability necessary for operations within a defined airspace.

RNP refers to a concept where routes and instrument procedures are not restricted to the location of ground-based navigation aids (NAVAIDs). RNP is an area navigation capability intended to enable reduced lateral separation for all phases of flight. RNP airspace includes areas, routes, and procedures designed such that the aircraft must maintain the position within the designated accuracy for that airspace (taking into account navigation accuracy and flight technical error). The aircraft is required to maintain positional accuracy to within a specified radius for the current airspace 95% of the time. RNP provides for system designed-in performance assurance in the form of two times the RNP containment limit. The RNP containment limit is intended to serve, at a minimum, the following two purposes in the development of airspace:

1. Supply a means to facilitate the safety assessments for separation and obstacle clearance in the development of routes, areas, and procedures.

2. Supply an additional boundary on error performance that enables reduction in separation buffers derived from traditional collision risk methods.

OPERATIONAL CONSIDERATIONS

Procedures having associated RNP values are:

- SIDs (standard instrument departures)
- SID transitions
- STARs (standard terminal arrival routes)
- STAR transitions

- IAP (instrument approach procedure) transition
- IAP final approach segment
- IAP missed approach segment.

NOTE: The final approach segment is defined as the flight path from the final approach fix (FAF) to the missed approach point (MAP).

RNP values are also displayed on the PERF PLAN pages only for legs as defined in the NAV DB.

RNP AR Approach Requirements – Area navigation (RNAV) RNP instrument approaches with authorization required (AR) are instrument approach procedures that require specific approval from the certification authorities prior to being flown. Prior to conducting an RNP AR approach, the aircraft must have approval, as documented in the aircraft flight manual (AFM) (supplement). In addition, the flight crew must have the required training.

PREFLIGHT CONSIDERATIONS

In addition to approaches, SIDs can require reduced RNP values. The applicable operational procedures of this section must also be followed in this situation.

In addition to the requirements of this section, the operator must comply with the general RNAV operating requirements, checking notices to airmen (NOTAM), availability of NAVAIDs, airworthiness of aircraft systems, and flight crew qualification.

Dispatch RNP Assessment – Prior to dispatch, the flight crew verifies the current receiver autonomous integrity monitor (RAIM) value on the GPS 1 STATUS 2/2 page. The flight crew also verifies the availability of global positioning system (GPS) with RAIM at the destination either by checking the DEST RAIM or pilot-selected RAIM for the selected airport and estimated time of arrival (ETA) (see Section 6, Navigation, for more details on RAIM). This information is available on the GPS STATUS PREDICTIVE RAIM page. A YES value on the page (without a specific RNP value displayed on the page) indicates RAIM is less than or equal to the selected RNP-approved minima.

NOTE: The RNP value displayed on the PILOT SELECT RAIM page (in line 1) is derived from the RNP APPR value (LSK 2R) on the RNP SETTINGS page.

NAVAID Exclusion – Applicable NAVAIDs with NOTAMs must be entered on the FMS NOTAM NAVAIDS page.

Navigation Database Currency – During system initialization, the flight crew verifies the navigation database (NDB) is current.

IN-FLIGHT CONSIDERATIONS

Modification of Flight Plan – The flight crew loads the RNP approach from the NDB using the FMS ARRIVAL selection. The lateral path cannot be modified unless accepting a clearance to go Direct-To a fix in the approach procedure prior to the FAF not immediately preceding an RF (radius to a fix) leg. The only other modification to the loaded procedure permitted is to change altitude and/or airspeed waypoint constraints on the initial, intermediate, or missed approach segments (e.g., to apply cold temperature corrections or comply with an (air traffic control) ATC clearance/instruction).

Global Navigation Sensor System (GNSS) Updating – The flight crew verifies that the FMS APPROACH (APPR) annunciator is displayed prior to the FAF. This makes sure of GPS updating. When the DEGRAD annunciator or the RNP alert (amber CDI (course deviation indicator), amber lateral or vertical deviation, UNABLE RNP scratchpad message) is displayed during the remainder of the approach, the pilot abandons the RNP AR approach unless visual conditions exist between the aircraft and runway of intended landing.

Radio Updating – Initiation of all RNP AR approaches is based on GPS or hybrid updating. Except where specifically designated on a procedure as Not Authorized, DME/DME updating is used as a reversion mode during the approach or missed approach when the system complies with the RNP value.

NOTE: The system automatically selects the best available navigation mode and supplies an RNP alert/ DEGRAD when the system estimated position uncertainty (EPU) exceeds the RNP value.

Approach Procedure Confirmation – The flight crew confirms that the correct procedure has been selected by comparison of the FMS waypoints and altitude constraints with the approach chart. The flight crew must confirm any pilot-entered changes to altitude and/ or airspeed constraints.

Estimated Position Uncertainty (EPU) – The flight management system (FMS) calculates EPU, a measure that conveys the current position estimation performance. The EPU data is supplied on the PROGRESS 1/3 page.

Active RNP Value – The active RNP value is the RNP value used by the system to determine lateral deviation scaling and to produce alerts for the loss of RNP and the FMS position disagree monitor. The FMS calculates the current RNP value every 100 milliseconds. The RNP value is determined by use of the following priority order of inputs:

- Manual entry by the flight crew
- RNP value obtained by the navigation database
- Default value based on LNAV flight phase.

The current RNP limit changes to the limit associated with the TO waypoint when the TO waypoint has a procedure specified (database) RNP limit. However, if the TO waypoint does not have a procedure specified RNP limit, then the default RNP limit applies that is based on the current flight phase.

The navigation database includes RNP values in the airway and holding pattern files, as well as procedure files. The database functions extract the specific RNP values for airways, holding patterns, and terminal area procedures from the database, when required. The default lateral RNP values based on the LNAV flight phase are:

- Departure – 1.0 NM
- En route – 2.0 NM
- Arrival – 1.0 NM
- Approach – 0.3 NM
- Radio Approach – 0.5 NM

- Missed approach (including missed approach holds) – 1.0 NM
- Remote – 4.0 NM.

NOTE: Although a manual RNP value has priority over database and default RNP limits, the manual value is reset to the default value by the FMS at flight phase changes when the manual value is greater than the default value. A scratchpad message is used to alert the crew of this change.

The FMS is capable of receiving satellite based augmentation system (SBAS) data from a global positioning system receiver. The FMS indicates when a GPS receiver is using an SBAS signal for position accuracy. On the GPS STATUS 2/2 page, DIFFERENTIAL is displayed as the operating mode. Also, GPS-D is displayed on the PROGRESS page on the same line with RNP and EPU data just above 6L and 6R, as shown in Figure 7-3.

Track Deviation Monitoring – Flight crew monitoring of the CDI and vertical deviation on the pilot's PFD (primary flight display) is required during the approach. Full-scale deflection (two dots) on the CDI corresponds to 1xRNP. The RNP value is displayed beside the CDI. Full-scale deflection (two dots) for approach on the vertical deviation scale is 150 feet. The flight crew initiates a go-around when either the lateral or the vertical deviation is too large, unless visual conditions exist between the aircraft and the runway of intended landing. The deviation limits must not exceed 2 dots laterally.

System Crosscheck – For RNP approaches, the flight crew must use the enhanced ground proximity warning system (EGPWS) as a crosscheck of the lateral and vertical guidance to make sure of terrain and obstacle clearance.

Procedures With RF Legs – The FMS has the ability to fly RF legs that can contain speed and altitude constraints, contained in an NDB procedure. When flying an RF leg, flight crew compliance with the desired path is essential to maintain the intended ground track. LNAV must be engaged to make sure of compliance with the desired ground track.

Temperature Compensation – When temperature compensation is available and configured on the FLIGHT CONFIG page and activated for the approach, the system supplies the altitude compensation at flight plan waypoint constraints. See Section 9, Flight Plan, for details on VNAV approach temperature compensation.

Altimeter Setting – Due to the reduced obstruction clearance inherent in RNP AR instrument procedures, the flight crew must verify the most current airport altimeter is set to the FAF but no earlier than the initial approach fix (IAF). Execution of an RNP AR instrument procedure requires the current altimeter setting for the airport of intended landing. Remote altimeter settings are not permitted.

Altimeter Crosscheck – The flight crew has to complete an altimetry crosscheck making sure both pilot's altimeters agree within +/- 100 feet. An ADS annunciator is displayed on the ADI should the altimeter crosscheck be greater than 100 feet.

Nonstandard Climb Gradient – When plans are to use the decision altitude (DA) associated with a nonstandard missed approach climb gradient, the operator must use the AFM, to make sure that the aircraft is able to comply with the published climb gradient for the planned aircraft loading, atmospheric conditions, and operating procedures before conducting the operation.

Engine-Out Procedures – Guidance for conducting engine-out approach procedures and engine-out extraction is supplied in the AFM.

Go-Around or Missed Approach – When flying a missed approach, flight crew compliance with the desired path is essential to maintain the intended ground track. When performing a go-around or missed approach, LNAV must be engaged. When LNAV disengages, the flight crew must re-engage LNAV by pushing the NAV button.

Contingency Procedures – System component failures are annunciated by way of the crew alerting system (CAS) messages. In addition, the flight crew can assess sensor failures on the FMS FAILED SENSORS page. The FMS POS SENSORS page indicates the long-range sensors (IRS and GPS) currently being used by the FMS. The RNP and EPU display on the MCDU indicates the RNP and EPU for the current conditions. The UNABLE RNP NEXT WPT scratchpad message indicates the current EPU does not meet the RNP requirements at the next waypoint. When the UNABLE RNP NEXT WPT message is displayed, the flight crew must monitor the RNP and EPU values.

The amber lateral deviation scale, DGRAD (degrade) annunciator and UNABLE RNP scratchpad message provide alerts when the system EPU exceeds RNP. When these alerts are displayed during the approach, the pilot must abandon the RNP AR approach unless visual conditions exist between the aircraft and runway of intended landing. When these alerts are displayed during the missed approach (or during an RNP SID), a climb must be expedited, following FD commands, to the minimum safe altitude.

RNP Approaches

RNAV RNP approaches are instrument-approach procedures having associated RNP values. Each leg of the approach procedure can have different RNP requirements, as shown in Figure 7-1. The RNP values are stored in the aircraft navigation database. The RNP values change as the aircraft is flown past the associated waypoints on the approach up to the final approach segment.

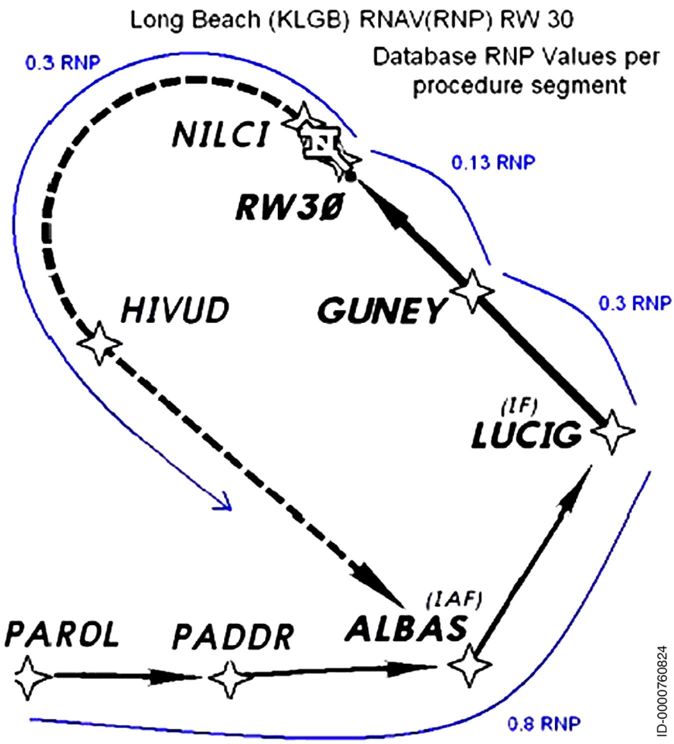

Figure 7-1
KLGB RNAV (RNP) Y RWY 30

The final approach segment can have up to three RNP values associated with different approach minimums with the RNP option. The different minimums (associated with the different RNP values) are depicted in the minimums section of the approach plate, as shown in Figure 7-2.

Figure 7-2
RNAV RNP Approach Minimums

An approach can have multiple RNP minima. Starting from the FAF and extending to the MAP, the RNP value changes to the RNP minimum value selected by the pilot when the approach is selected on the ARRIVAL page.

When the pilot does not manually select an RNP minimum value, a default RNP value is automatically selected. The default RNP value is associated with the lowest approach minimums.

When a missed approach is initiated at the MAP, the RNP value automatically changes to the RNP value associated with the missed approach course. When a missed approach is initiated prior to the MAP (e.g., between FAF and MAP), the current RNP value remains until reaching the MAP. At the MAP, the RNP value changes to the missed approach RNP.

NOTE: Do not revise the RNAV MIN shown on the ARRIVAL page (LSK 4R) after beginning an RNP approach.

RNP Displays on the FMS

The PROGRESS pages, accessed by pushing the PROG function key, displays RNP information. For more information, refer to Section 10, Progress.

Lines 6L and 6R of the PROGRESS 1/3 page, shown in Figure 7-3, displays the current FMS navigation mode, as well as active RNP limit and EPU values. In this example, the RNP value is 1.00.

Figure 7-3
PROGRESS 1/3 - RNP Limits

Selecting 6L on the PROGRESS 3/3 page, shown in Figure 7-4, navigates to the RNP SETTINGS page.

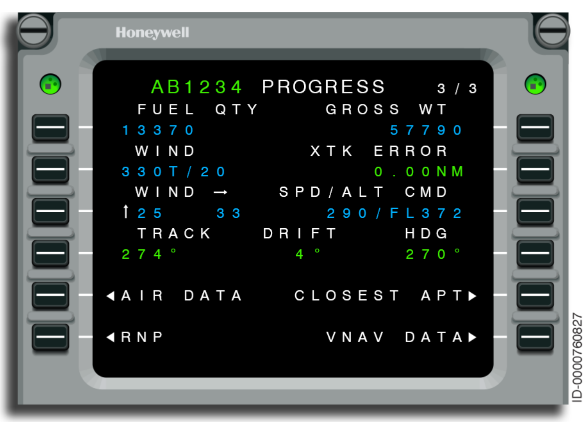

Figure 7-4
PROGRESS 3/3 - RNP (6L)

RNP Settings Page

RNP values have default values and can be manually entered and are displayed on the RNP SETTINGS page, as shown in Figure 7-5.

Figure 7-5
RNP SETTINGS

Manual lateral RNP values are entered into 1L. The page also details RNP values for the departure, en route, arrival, approach, and missed approach LNAV phases of the flight plan. These displayed values are predefined default values. Pilot-entries made on this page, with the exception of 1L, are retained in nonvolatile memory. Pushing 6R returns the display to the PROGRESS 3/3 page.

NOTE: A NO < CONFIRM ENTRY > YES prompt on line 6 is shown when an RNP value greater than the procedure-specified RNP value is manually entered by way of 1L on the RNP SETTINGS page. The purpose of the prompt is to reinforce to the flight crew that the manual entry is greater than the current RNP value for the current airspace from the navigation database.

RNP Minimums Selection

An RNAV MIN prompt is displayed in line 4R of the ARRIVAL page when an RNAV approach with multiple RNP minima values is selected. The RNAV MIN prompt on an ARRIVAL page is shown in Figure 7-6. The default RNP minimum value for the approach is also displayed in line 4R. The default RNP value for the current approach is the RNP value associated with the lowest approach minimums.

Figure 7-6
KLGB ARRIVAL - RNP

Approach Minima Type Page

Selecting the RNAV MIN prompt on the ARRIVAL page, displays the APPROACH MINIMA TYPE page. The APPROACH MINIMA TYPE page is shown in Figure 7-7.

Figure 7-7
APPROACH MINIMA TYPE - RNP

The APPROACH MINIMA TYPE page displays the RNP values associated with the different approach minimums. Pushing the LSK adjacent to a displayed RNP value selects that RNP value for the approach minimum. (SEL) is displayed adjacent to the RNP value currently selected. Selecting RETURN (LSK 1R) displays the ARRIVAL page.

The priority of the active RNP value displayed on the PFD is as follows:

- Pilot-entered manual RNP
- Navigation database procedure RNP value
- Pilot-entered flight phase RNP value
- Default flight phase RNP value.

ESTIMATED POSITION UNCERTAINTY (EPU)

The EPU is the calculated estimate of the accuracy of the navigation capability as per the active RNP value. A textual display of the EPU value is displayed on the PROGRESS 1/3 page on the MCDU, as shown in Figure 7-8.

Figure 7-8
PROGRESS Page - EPU Value Displayed

When the aircraft position is within 2 minutes of a waypoint, the FMS reviews the RNP value for the next flight plan leg and compares it with the current EPU. When the EPU is greater than the compared RNP value, the message UNABLE RNP NEXT WPT is displayed on the scratchpad. The next flight plan leg RNP value is as follows:

- The manual RNP value (when entered) or
- The database RNP value (when present) or
- The RNP value based on phase of flight.

RNP Scratchpad Messages

Table 7-1 lists RNP scratchpad messages.

Table 7-1
RNP Message

Message	Definition
CHECK RNP VALUE	The manual RNP value is greater than the applicable RNP value for the active flight leg
UNABLE RNP	The current navigation precision does not meet required navigation precision
UNABLE RNP NEXT WPT	The current EPU is greater than the RNP required at the next waypoint

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8. Localizer Performance With Vertical Guidance (LPV)

INTRODUCTION

This section describes the functions related to RNAV approaches to LPV minimums.

FMS SBAS APPROACHES

The satellite based augmentation system (SBAS) is the implementation of a ground sensor-generated correction signal transmitted to an SBAS-equipped GPS receiver by way of a geosynchronous satellite. Several countries and/or groups of countries utilize SBAS systems known by different names. The SBAS systems in use at this time are as follows:

- Wide Area Augmentation Systems (WAAS) for the United States and Canada
- European Geo-Stationary Navigation Overlay System (EGNOS) for Europe
- Multifunction Transportation Satellite-Based Augmentation System (MSAS) for Japan
- GPS Aided Geo Augmented Navigation (GAGAN) for India.

Localizer Performance With Vertical Guidance (LPV)

RNAV (GPS) approaches with LPV minimums are typically lower than LNAV or LNAV/VNAV approaches. An approach with LPV minimums is designed specifically for SBAS environments. SBAS/ LPV procedures are RNAV approaches defined as one of the RNAV approach minimums found on an RNAV approach chart. SBAS avionics equipment approved for RNAV approaches with LPV minimums is required for this type of approach.

The term LPV is used to generically describe SBAS approaches.

RNAV approaches with LPV minimums are normally conducted utilizing the LNAV and GP (glide path) flight director modes. The lateral navigation (LNAV) function is utilized by the AFCS to supply lateral guidance by way of GPS deviations to capture and maintain the lateral course by way of the LNAV flight director mode. Once captured, the AFCS guides both lateral and vertical control of the FAS, based on GPS not FMS.

NOTE: When the displayed deviations are received directly from the GPS, the horizontal situation indicator (HSI) navigation source indicators remain FMS.

A typical RNAV approach with LPV minimums is shown in Figure 8-1.

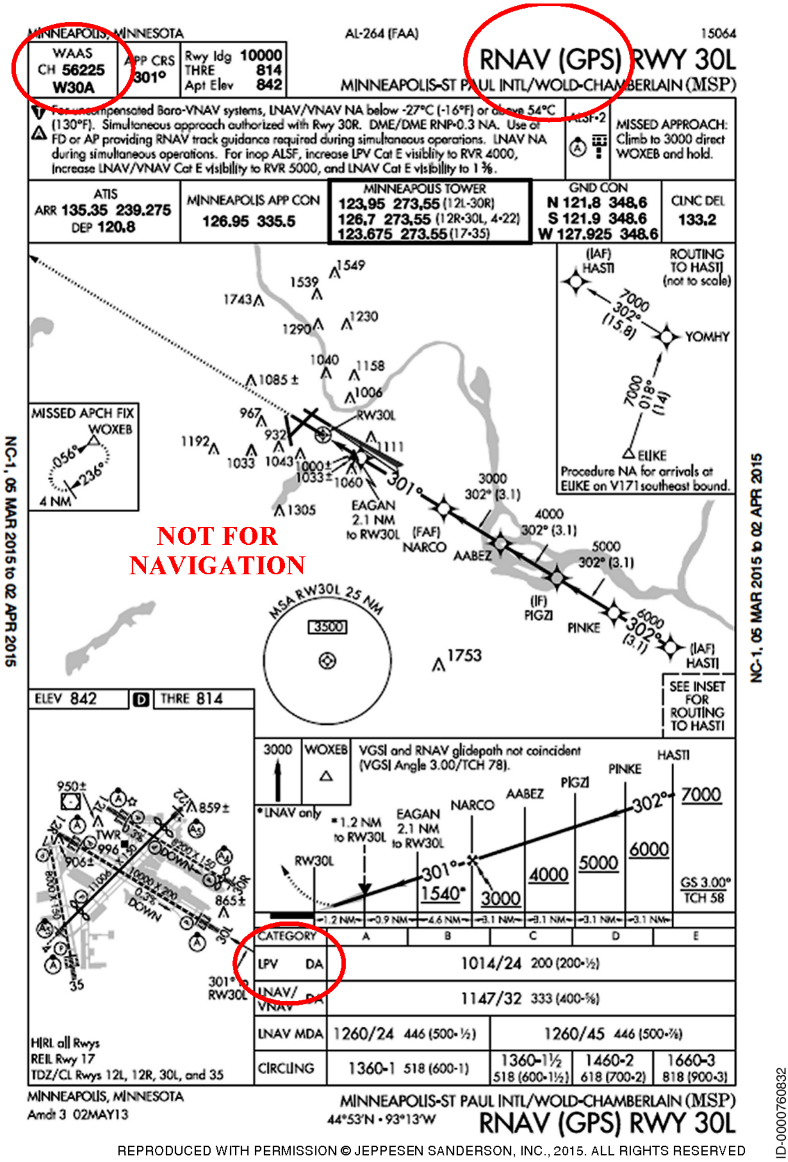

Figure 8-1
Minneapolis-St. Paul RNAV (GPS) RWY 30L Approach (With LPV Minimums)

FINAL APPROACH SEGMENT (FAS) DATA BLOCK

RNAV approaches with LPV minimums have an additional data construct stored in the navigation database called an FAS data block. The FAS data block describes the points of an approach that permit the lateral and vertical deviations to mimic the angular deviations found on an ILS. The data in the FAS data block describes where the localizer and glideslope antennas would be when installed. Selecting the LPV minimums on the APPROACH MINIMA TYPE page of the FMS loads the GPS receiver with the proper FAS data block.

NOTE: When available, LPV minimums are automatically selected by default.

LPV APPROACH SELECTION

The following section describes selecting an RNAV approach with LPV minimums using the multifunction control and display unit (MCDU). Approaches can also be selected using the graphical flight planning on the INAV map. Refer to Section 12, Graphical Flight Planning, for more information.

When an RNAV approach with LPV minimums is selected on the FMS ARRIVAL page, a prompt labeled RNAV MIN is displayed in line 4R, as shown Figure 8-2.

NOTE: *This page is used to verify that the correct channel ID and approach ID are loaded into the FMS and match the approach plate.*

Figure 8-2
KMSP ARRIVAL - LPV

Selecting the RNAV MIN prompt at 4R on the ARRIVAL page, displays the APPROACH MINIMA TYPE page, shown in Figure 8-3. The APPROACH MINIMA TYPE page is used to select the type of minimums corresponding to the selected RNAV approach.

Figure 8-3
APPROACH MINIMA TYPE - LPV

The APPROACH MINIMA TYPE page displays the available RNAV minimums for the selected approach. LPV is displayed at 1L and LNAV/VNAV is displayed at 3L. Pushing 1L selects LPV minimums for the approach. Pushing 3L selects LNAV/VNAV minimums for the approach. (SEL) is displayed in white next to the selected RNAV minimums. The default RNAV minimums selection is LPV.

SCRATCHPAD MESSAGES RELATED TO LPV APPROACHES

The system presents the following LPV alerts on the FMS MCDU scratchpad that also triggers the MSG annunciator on the PFD.

PREDICT LPV UNAVAIL – This alert message is intended to warn the crew prior to the LPV becoming active when the GPS 5-minute look-ahead horizontal integrity limit (HIL) value is greater than the FAS data block horizontal alert limit (HAL) value.

FMS/LPV MISCOMPARE – This alert message is displayed when the FMS channel ID for the approach is different from the GPS channel ID loaded for the approach. The channel ID for a WAAS approach is displayed on the approach plate.

LPV APPR LOAD FAIL – This alert message is displayed if the FAS data block fails to load successfully.

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9. Flight Plan

INTRODUCTION

This section describes how to create and modify a flight plan using the FMS. This section also covers the various elements of a flight plan including types of waypoints, routes, and LNAV/VNAV data.

A flight plan is created on the FLIGHT PLAN pages, the RTE (route) pages, or on the INAV map using the graphical flight planning (GFP) function. Any changes made using either the FLIGHT PLAN pages, the RTE pages, or the GFP function automatically transfer to the others.

NOTE: Most FMS tasks (including creating and modifying flight plans) are performed by way of the MCDUs or the GFP function. This section describes flight planning on the MCDUs. For information on creating and modifying flight plans using the GFP function, refer to Section 12 *of this guide.*

DEFINITION OF TERMS

- **VNAV Offset Waypoints** – Air traffic control (ATC) often clears an aircraft to cross a specified distance before or after a waypoint at a specified altitude. These are called VNAV offset waypoints. Refer to VNAV OFFSET on page 9-24 for additional information.

- **Flight Plan** – A flight plan is a series of waypoints that define an intended route of flight. Each waypoint in the flight plan must be defined laterally and vertically. The course between two waypoints in the flight plan is called a flight plan leg. The FMS calculates the great circle course for each leg in the flight plan. The active flight plan includes the route to a primary destination followed by the route to an alternate destination.

- **Flight Plan Capacity** – Active primary flight plans have up to 100 waypoints, including the origin and destination. Alternate flight plans can contain up to 35 waypoints. The combined waypoint capacity of the primary flight plan and the alternate flight plan cannot exceed 135 waypoints. If a flight plan is revised and as a result exceeds the maximum capacity of the primary flight plan (100 waypoints) or the alternate flight plan (35 waypoints), the revision is not be incorporated and the message FLIGHT PLAN FULL is displayed on the scratchpad. When a standard instrument departure (SID), standard terminal arrival route (STAR), airway, or stored flight plan is added and exceeds the limit, none of the inserted waypoints are added to the flight plan.

- **Modified Flight Plan** – The MOD FLT PLAN functionality gives the capability to modify the active flight plan through use of a temporary (provisional) flight plan that permits changes to be reviewed before being activated. After review, modifications to the flight plan are either cleared or activated through button selection on the multifunction control and display unit (MCDU). The MOD FLT PLAN route is displayed on the MFD with white-dashed lines and white waypoints.

  MOD FLT PLANs are synchronized between FMSs. Any change performed on one FMS is reflected on the other FMS. A MOD FLT PLAN is activated on either FMS.

- **RTE Pages** – The route (RTE) pages functionality is similar to that of the flight plan. Both give a means to modify and show the planned path for the aircraft from the departure to the destination. The difference is the RTE pages give only the lateral component of the flight plan expressed in terms of aircraft clearance language instead of each physical leg and waypoint in the flight plan. The RTE pages tie the flight plan together by identifying the means (airway, procedure, direct) to the final fix of a path segment followed by the means to the final fix for each of the following path segments in the flight plan. Any changes to the flight plan are reflected on the RTE pages and vice versa.

- **RTE Pages Capacity** – The RTE pages capacity is directly linked to the flight plan waypoint capacity as previously defined. The number of routes entered cannot contain more than 100 waypoints for the active primary flight plan and 35 waypoints for the alternate flight plan.

- **Modified RTE Pages** – A modified RTE page is created any time modifications are made to the active RTE pages. These changes are reviewed and then cleared or activated into the active RTE pages.

- **Primary/Alternate Independence** – The primary and alternate flight plans are kept independent from one another. Revisions to either the primary or alternate flight plan do not affect the other. The following exceptions apply:

  – **ALTERNATE** – The ALTERNATE prompt is the revision function that incorporates the alternate into the active flight plan. This prompt is displayed when there is an alternate flight plan, and either the distance to the destination is less than 25 NM or the last primary waypoint has been sequenced. Selection of the ALTERNATE prompt results in the alternate flight plan being inserted into a MOD flight plan.

  A Direct-To an alternate flight plan is performed at any time.

  – **ALTERNATE ORIGIN** – The alternate flight plan origin is also the primary flight plan destination.

- **Waypoint Names** – Waypoints exist in the navigation database, the custom database (pilot-defined waypoints), or as temporary waypoints. Waypoint names are used for convenience in keeping track of waypoints and recalling waypoints. Waypoint names (called waypoint IDENT or identifier) must contain at least one and as many as five alphanumeric characters. In the case of temporary waypoints, the FMS adds an asterisk (*), ampersand (&), or pound sign (#) as the first character for a total of up to six characters. Therefore, the pilot has complete freedom in naming waypoints into the FMS with no conflict. Waypoint and flight plan names are distinguished by the number of characters.

  The ampersand (&) symbol denotes waypoints with a radial pattern for the stored flight plan.

- **Temporary Waypoints** – Temporary waypoints exist only in the active flight plan and are erased when the flight plan is completed or deleted. Temporary waypoints are listed on the last WAYPOINT LIST page, when defined. Using this page, the pilot reviews the definition of the waypoint.

Temporary waypoints are used so the pilot quickly enters the waypoint definition directly into the active flight plan. Temporary waypoints are useful when cleared to a fix that is not defined in the navigation database. In this case, they have no meaning beyond the current flight. There is no reason to create a named waypoint for the clearance fix.

Temporary waypoints are defined by entering the definition of the waypoint directly into the active flight plan. Acceptable definitions are latitude/longitude, place/bearing/distance, place/bearing/place/ bearing, and along the flight plan as place//distance. When the definition is entered in the flight plan, the waypoint is assigned a name that describes how it was defined and a number (XX). Temporary waypoints are assigned a number in order of when they are created. The name is also preceded by an ampersand (&) to indicate a temporary waypoint. The assigned names are described in Procedure 9-1.

Table 9-1 lists temporary waypoints.

Table 9-1
Temporary Waypoints

Entered Definition	Waypoint Name
Lat/Lon	&LLXX
Place/Bearing/Distance	&PBDXX
Place/Bearing/Place/Bearing	&PBPBXX
Place//Distance	&PDXX

The definition is entered into the scratchpad from the keyboard or retrieved from other sources. The CROSSING POINTS pages are also sources for definition. As the name indicates, temporary waypoints are not retained in the FMS past the current flight.

Temporary waypoints are also created when a flight plan is loaded from a disk, and either the FMS database does not contain the same waypoint or the waypoint definition is different. In this case, the regular name of the waypoint is used preceded by an ampersand sign (&). For example, a flight plan is loaded containing the waypoint named CEDA. CEDA is neither in the FMS navigation database nor defined in the custom database. In this case, &CEDA is displayed and the definition, specified in the loaded flight plan, is used.

See Section 15, Multifunction Control Display Unit (MCDU) Entry Format, for additional details on entry format for temporary waypoints.

- **Runway Extension Waypoints** – The FMS creates temporary waypoints on the runway extension line. Once activated into the active flight plan, a runway is line-selected to the scratchpad. When shown on the scratchpad, the runway is in the following format: AIRPORT.RUNWAY/BEARING/. A distance is inserted to complete the definition of a waypoint on the extension line of the runway. It is also permitted to enter an altitude constraint following the distance. Insert this definition into the flight plan to create a temporary waypoint. Repeat the process with varying distances to create a number of waypoints on the extension line.

  When the runway is at the origin, the bearing brought to the scratchpad is the runway heading that permits waypoints on the departure path.

  When the runway is at the destination, the bearing brought to the scratchpad is the reciprocal of the runway heading permitting waypoints on the arrival path.

- **Origins and Destinations** – Origins and destinations are any waypoints contained in the database, including any pilot-defined waypoints. Origins and destinations of the active flight plan are temporary waypoints. Origins and destinations are normally airports. The origin or destination must be an airport defined in the navigation database to activate the respective runway, SID, STAR, or approach.

- **FROM Waypoint** – The FROM waypoint is the first waypoint on the first page of the flight plan and is displayed in amber. Before takeoff, the FROM waypoint is normally the selected origin airport or runway. Under normal flight conditions, the FROM waypoint is the last waypoint sequenced and actual time passing is displayed.

- **TO Waypoint** – The TO waypoint is the second waypoint on the first page of the flight plan and is displayed in magenta. The TO waypoint is the waypoint that the aircraft is being steered along a course defined between the FROM and TO waypoints. When the leg sequences, the TO waypoint becomes the FROM waypoint. The TO waypoint is changed.

- **Leg Sequencing** – During flight, the active flight plan automatically sequences so that the first leg of the active flight plan is the active leg referenced to the guidance parameters. Normally, the FMS sequences before the waypoint for an inside turn when the aircraft is on or close to on-course. When the aircraft is not on-course, the normal sequence occurs no later than a point abeam of the waypoint. Some waypoints have unique sequence criteria. For example, a holding fix is a flyover waypoint. The holding fix must be overflown before entering or exiting holding. Some waypoints in SID and STAR procedures also have unique sequence criteria. The FMS is programmed to comply automatically with these requirements.

  Situations occur where the sequence criteria cannot be satisfied by the FMS. Under these conditions, the pilot must perform the sequence manually to aid the FMS. The pilot is required to modify the active flight plan and consists of the following:

  – A Direct-To is performed to the desired TO waypoint. All the waypoints are deleted prior to the waypoint and the FMS creates a direct leg to the waypoint. This results in a new path to the waypoint that is different than the previous path contained in the flight plan.

  Some leg sequences indicate the direction of turn to the new leg by showing an **L** or an **R** in reverse video. This notation is used when either the direction of turn is indicated (by a SID, STAR, or approach), or the new leg requires a large turn (near 180°) to track the new course.

  When sequenced, the destination waypoint retained by the FMS is the TO waypoint. Bearing, distance, and required track to the destination waypoint continue to be computed and shown.

- **Discontinuities** – A discontinuity can exist in the flight plan. A discontinuity is a segment in the flight plan with no lateral flight plan definition. However, there must be a lateral definition before and after a discontinuity.

  When making changes, discontinuities in the flight plan are kept to the minimum. There are times when having a discontinuity is necessary. The following rules apply:

- When adding or deleting a single waypoint, no discontinuity is inserted in the flight plan. The flight plan is directly linked between the waypoints. Deleting several waypoints at a time does not result in a discontinuity.

- When linking flight plans or inserting a procedure, no discontinuity exists when a common waypoint is used. With no common waypoint, the inserted flight plan or procedure is linked at the point of insertion, but with a discontinuity at the end. For example, when the last waypoint of an SID is also a waypoint in the flight plan, the flight plan and procedure are linked at that waypoint with no discontinuity. When the last waypoint of an SID is not in the flight plan, a discontinuity exists between the SID and the flight plan. Some procedures have embedded discontinuities inserted along with the procedure.

- An SID is only replaced with another procedure and cannot be deleted. The linked portions of an arrival are deleted by the ARRIVAL page. In both cases, the discontinuity depends on the changed procedure. Linked flight plans or procedures are deleted under the same operation for deleting waypoints. This operation does not result in a discontinuity.

- Direct-To results in a discontinuity in the MOD flight plan when a Direct-To waypoint is not already in the flight plan.

- When an airway is inserted in the flight plan, there is no discontinuity since the pilot has to specify the beginning and end points.

- The INTERCEPT function does not create a discontinuity before or after the intercept point.

• **Alternate Origin** – The alternate origin is the destination of the primary flight plan. No alternate flight plan is specified until the primary destination is specified. Changing the primary destination clears the alternate flight plan because the alternate origin changes.

- **Alternate Waypoints** – Alternate waypoints apply to the alternate portion of the flight plan only. The FMS guidance is not engaged until the pilot selects the alternate destination. When the alternate portion of the flight plan is enabled, the corresponding waypoints are incorporated into the primary portion of the flight plan. At that point, all active flight plan rules apply.

- **Alternate Destination** – The alternate destination is entered when defining a flight plan to an alternate. The alternate destination is entered as the final waypoint to close out the alternate flight plan, same as the primary flight plan.

- **Climb Constraints** – Climb constraints are altitude and speed constraints associated with waypoints in the climb or cruise portion of the flight plan. Altitude constraints are AT, AT or ABOVE, AT or BELOW, or Window. For example, an entry of 10000A (A following the altitude) indicates AT or ABOVE. An entry of 10000B (B following the altitude) indicates AT or BELOW. An entry of 10000 (no letter following the altitude) indicates AT. A Window constraint is any altitude between two altitudes (e.g., 16000A17000B that is above 16,000 feet and below 17,000 feet). Climb speed constraints are observed by the FMS until the waypoint containing the constraint is passed.

- **Speed Limit** – An example of speed limits is the 250 knots below 10,000 feet limit entered during performance initialization. Other limits are imposed by the airframe such as V_{MO} or M_{MO}.

- **Speed Schedule** – Speed schedules are the default speeds used by the FMS for the departure, climb, cruise, descent, approach, and go-around phase of flight. Speed schedules are defined during performance initialization.

- **Automatic Speed Command** – The automatic speed command is the current speed being output by the FMS for control of the aircraft. It is also referred to as automatic speed target in this guide.

- **Top-of-Climb (TOC)** – A TOC waypoint is calculated and displayed on the vertical profile and shown on the VNAV DATA page. The VNAV DATA page is accessed through the PROGRESS 3/3 page. The TOC waypoint is not displayed in the active flight plan. There is only one TOC waypoint at a time. The TOC is calculated based on current aircraft altitude, climb speed, and the cruise altitude.

- **Cruise Altitude** – The cruise altitude is used by the FMS to determine the altitude where the cruise phase of flight commences. The cruise altitude is set during performance initialization on PERFORMANCE INIT 2 page. When the aircraft levels at the cruise altitude, the FMS changes to the cruise phase of flight.

- **Top-of-Descent (TOD)** – A TOD waypoint is calculated and displayed on the VNAV DATA page. The VNAV DATA page is accessed through the PROGRESS 3/3 page. The TOD waypoint is not displayed in the active flight plan. With no constraints during the descent, the TOD is calculated using the destination elevation (when available) and the descent speed schedule. With constraints during the descent, the TOD is calculated using the path mode. One minute before the TOD point is reached, a vertical track alert is given. An automatic descent is initiated at the TOD when the following is true:

  - The altitude preselector is set to a lower altitude
  - The FMS is selected as the navigation source
  - Lateral navigation (LNAV) and vertical navigation (VNAV) are engaged.

- **Descent Constraints** – Descent constraints are altitude, speed, and angle constraints associated with waypoints in the descent portion of the flight plan. Altitude constraints are AT, AT or ABOVE, AT or BELOW, or Window. For example, entering 10000A (A following the altitude) indicates AT or ABOVE. Entering 10000B (B following the altitude) indicates AT or BELOW. Entering 10000 (no letter) indicates AT. A Window constraint is any altitude between two altitudes (e.g., 17000B16000A that is below 17,000 feet and above 16,000 feet). The FMS obeys descent speed constraints at and after the waypoint containing the constraint. If an altitude constraint is entered that cannot be obtained because FMS cannot recompute a continuous descent path with the constraint, the constraint is flagged as an irrational constraint. Irrational constraints are ignored when computing the descent path and the constraints are displayed in reverse video on the ACTIVE FLT PLAN pages. They are indicated as being irrational by the altitude constraint being displayed in reverse video on the ACTIVE FLT PLAN page. In the case a vertical Direct-To is performed to an altitude constraint that would result in a violation in down path altitude constraints, the vertical Direct-To constraint takes precedence and the down path altitude constraints are flagged as irrational constraints. The FMS obeys angle constraints from the TOD to the waypoint containing the constraint. Normally, the FMS calculates the angle constraint based on performance initialization. However, a specific angle constraint can be entered at a waypoint in the flight plan.

  The descent path construction in NG FMS builds a continuously descending path with minimal maneuvers, while still meeting all restrictions.

Please refer to Figure 9-1 for a comparison of the NG FMS path (solid line) to the Legacy FMS path (dashed line) as an example to show how the descent path construction is constructed differently in NG FMS.

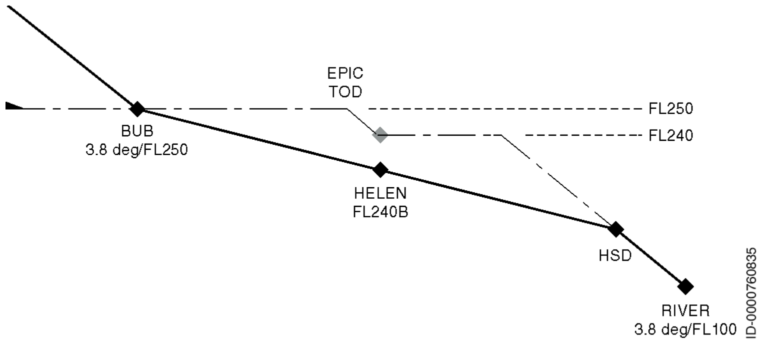

Figure 9-1
NG FMS vs. Legacy FMS Descent Constraint Profile

The following are the pilot-entered constraints for the waypoint:

– BUB 3.8 degree/FL250

– HELEN FL240B

– RIVER 3.8 degree/FL100.

In Legacy FMS, a level segment is constructed after waypoint BUB at FL250 due to the FL250 constraint. This level segment would continue until reaching the 3.8 degree path down to HELEN with FL240B constraint. This is the point where Legacy FMS would show TOD. After HELEN, Legacy FMS would continue level at FL240 until it reached the 3.8 degree path down to HSD and RIVER. This is called a “drive-and-dive” type of descent path construction.

NG FMS does not do this “drive-and-dive” type of descent path construction. Instead, it attempts to build a continuously descending path with minimal maneuvers, while still meeting all restrictions. In this case, BUB and RIVER have AT altitude constraints, so it would normally connect these together with a single descending segment. However, because RIVER has a 3.8 degree FPA constraint on it, that FPA must be respected on the RIVER leg itself. So the leg from HSD to RIVER is constructed at 3.8 degrees. Then HSD is connected straight to BUB with a continuous descending segment, with FMS computed FPA value (e.g., 1.4 degrees). This straight segment satisfies the FL240B constraint at HELEN, so no additional adjustments to the descent path are necessary.

CREATING FLIGHT PLANS

An example of the RTE page before the flight plan is entered is shown in Figure 9-2. To create a route plan, see Creating Routes on page 9-25.

This page is used to build an active flight plan by entering a destination (1R) and waypoints.

Figure 9-2
RTE - DEST

The following options are made to recall or create an active flight plan:

- Recall a previously stored flight plan or company route (3R)

- Load a flight plan from datalink (4L) (when installed, see page 13-4 for additional details).

Recall a Previously Stored Flight Plan

A known name of a previously stored flight plan is entered at 3R. This is shown in Figure 9-2. After entering, the FMS automatically recalls the flight plan and makes it the active flight plan. This is shown in Figure 9-3. The FMS takes 2 or 3 seconds to complete the recall of the flight plan.

Figure 9-3
ACTIVE FLT PLAN - Recall Previous

When the name of a previously stored flight plan is not remembered, enter the origin and destination. The FMS searches the stored flight plans for those plans with the same origin and destination. When any are found, the FLIGHT PLAN LIST page is displayed with the stored flight plan names marked with an asterisk (*). This is shown in Figure 9-4.

Figure 9-4
FLIGHT PLAN LIST - Stored Flight Plan Names

Select the required flight plan, shown in Figure 9-5. This activates the flight plan and returns the display to the ACTIVE FLT PLAN pages, shown in Figure 9-3.

Figure 9-5
FLIGHT PLAN LIST - KPHX-KMSP

Store a Flight Plan and Activate

When building a flight plan, the flight plan is retained in memory for use in the future. This is done by entering the flight plan identifier at 3R. This is shown in Figure 9-2. After entering the flight plan name at 3R, the FMS switches to the stored flight plan page to define the flight plan, as shown in Figure 9-6. After being defined, the flight plan is activated. When a flight plan name already defined is entered at 3R, the flight plan becomes active.

Figure 9-6
FLIGHT PLAN LIST - Building a Flight Plan

Build a Flight Plan by Entering Waypoints

When building a flight plan, waypoints are entered on the line showing the VIA.TO prompt (2L through 5L). This is shown in Figure 9-7. The FMS accepts a variety of inputs at the VIA.TO prompt as described in the following paragraphs.

Figure 9-7
FLT PLAN - VIA.TO

- **Waypoint** – Any waypoint contained in the navigation database or the custom database is entered. When a not-yet-defined waypoint name is entered, the FMS automatically shows a page for waypoint definition. The waypoint is defined and the RETURN prompt is used to get back to the flight plan. When the waypoint name is entered in error, the RETURN prompt is used without a definition being entered.
- **Temporary Waypoint** – Any temporary waypoint is entered.

- **Airway** – Any airway in the database is entered. When entering an airway, the waypoint in the flight plan preceding the point of entry must be a waypoint on the airway. The airway entry is made in the format of the VIA.TO prompt where VIA is the airway identifier and TO is the last waypoint used on the airway. For example, a portion of the flight plan is GUP, J102 to ALS. The first step is to insert GUP into the flight plan, followed by entering J102.ALS into the scratchpad. This is shown in Figure 9-8. The entry is completed by selecting 3L and the FMS automatically fills in all the waypoints along the airway from GUP up to and including ALS. The airway is also entered as a single input by entering GUP.J102.ALS into the scratchpad and selecting the correct line select key. Refer to Airway on page 15-3 for additional details.

Figure 9-8
FLT PLAN - GUP

- **Flight Plan Names** – Any defined flight plan name is entered. When a defined flight plan is entered, flight plans are linked together. When inserting a flight plan, the FMS searches for common points between the two flight plans being linked. When the common waypoint is found in the stored flight plan, the two flight plans are linked at that point. Any waypoints in the stored flight plan preceding the common waypoint are eliminated. When no common waypoint is found, the stored flight plan is inserted beginning at the origin. Flight plan names are also entered using the VIA.TO format. In this case, the stored flight plan is inserted up to and including the waypoint specified in the VIA.TO entry. Any waypoints in the stored flight plan after the specified waypoint are eliminated.

An alternate flight plan is entered using the same rules as a regular flight plan. After the flight plan is entered, the destination waypoint must be entered as the last waypoint to close the flight. This is accomplished by entering the destination at the VIA.TO prompt.

- **Vertical Entries** – Vertical definitions for waypoints are entered using the right hand line select keys (1R through 3R). This is shown in Figure 9-9.

Figure 9-9
ACTIVE FLT PLAN - Vertical Entries

The FMS supplies vertical predicted information for each waypoint and is displayed in small characters. Pilot-entries are used to modify and further define the vertical profile. The following information is displayed and/or entered for each waypoint in the flight plan.

– ALTITUDE – Predicted altitudes are displayed in small characters for each waypoint. Pilot-entries, shown in large characters, become altitude constraints for VNAV. Altitude constraints from procedures are also displayed in large characters.

– CONSTRAINT TYPE – Constraint type is displayed directly above altitude constraints, as shown in Figure 9-10. The constraint type shows as CLB for climb constraints and DES for descent constraints. The FMS automatically assigns constraints in the first half of the flight plan as climb (CLB), unless the entered constraint is below the current aircraft altitude, and those in the last half as descent (DES). This automatic assignment is correct for most flights. The pilot makes an overriding entry. C, CLB, D, or DES are accepted as entries. Pilot-entries are required for flights that climb, descend, and climb again.

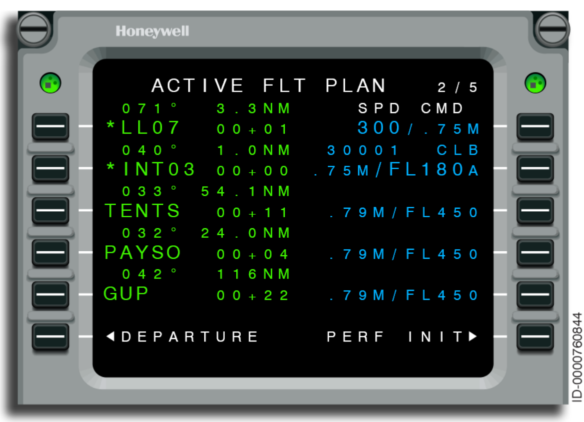

Figure 9-10
ACTIVE FLT PLAN - Constraint

Descent constraints are altitude, speed, and angle constraints associated with waypoints in the descent portion of the flight plan. Altitude constraints are AT, AT or ABOVE, AT or BELOW, or Window. For example, entering 10000A (A following the altitude) indicates AT or ABOVE. Entering 10000B (B following the altitude) indicates AT or BELOW. Entering 10000 (no letter) indicates AT. A Window constraint is any altitude between two altitudes (e.g., 17000B16000A that is below 17,000 feet and above 16,000 feet). The FMS obeys descent speed constraints at and after the waypoint containing the constraint. If an altitude constraint is entered that cannot be obtained because FMS cannot recompute a continuous descent path with the constraint, the constraint is flagged as an irrational constraint. Irrational constraints are ignored when computing the descent path. They are indicated as being irrational by the altitude constraint being displayed in reverse video on the ACTIVE FLT PLAN page. In the case a vertical Direct-To is performed to an altitude constraint that would result in a violation in down path altitude constraints, the vertical Direct-To constraint takes precedence and the down path altitude constraints are flagged as irrational constraints. The FMS obeys angle constraints from the TOD to the waypoint containing the constraint. Normally, the FMS calculates the angle constraint based on performance initialization. However, a specific angle constraint is entered at a waypoint in the flight plan.

– ANGLE – A descent vertical path is displayed when the FMS flies a vertical path to a waypoint. This is shown in Figure 9-11. An altitude constraint for the waypoint is required for the FMS to be able to fly a vertical descent path. The vertical angle is calculated based on current conditions and performance initialization. FMS computed vertical descent angles are displayed in small font while pilot-entered angles are displayed in large font.

Figure 9-11
ACTIVE FLT PLAN - Angle

  - VERTICAL SPEED – The FMS predicted vertical speed is displayed unless a higher priority item is displayed. Pilot-entry of vertical speed is not permitted.

    When vertical angle and airspeed constraints are entered, airspeed is shown above the angle and is also a constraint.

  - SPEED – Although speed is not vertical information, it is shown here as well. Speed is displayed except when an angle is entered. The FMS calculates and shows a predicted speed for each waypoint. Speed is entered in either CAS or Mach. When the waypoint is in a path descent, the angle is displayed.

- **Additions and Deletions to the Flight Plan** – Several actions result in adding and/or deleting waypoints in the flight plan. These actions create a MOD flight plan that must be activated before the changes take effect. Any entry permitted at the VIA.TO prompt can also be made onto previously entered waypoints. The rules that apply are described as follows:

  - Single waypoints, including temporary waypoints, are added to or deleted from the flight plan. To add a waypoint to the flight plan, the waypoint is line-selected from the scratchpad to the proper line. The added waypoint is displayed on the selected line. When adding a waypoint, the flight plan is searched forward of the point of insertion. When the waypoint is displayed in the flight plan, all the waypoints between the point of insertion and the first appearance of the added waypoint are deleted. When the waypoint is not displayed forward of the inserted point, the flight plan is opened and the new waypoint is inserted. Searching forward in the flight plan is restricted to the portion of the flight plan being modified (i.e., either the primary flight plan or the alternate flight plan).

  - Waypoints are deleted using the DEL key. After entering *DELETE* in the scratchpad, the line-selected waypoint is deleted. When the waypoint is deleted, the flight plan is closed and linked together. Waypoints are deleted by entering a waypoint also in the flight plan forward of the point of entry.

    The pilot deletes both TO and FROM waypoints in some combinations of flight plan changes. In such cases, the FMS shows a CHANGE ACT LEG prompt.

- The Direct-To function also adds or deletes waypoints. After selecting Direct-To, line-selecting a waypoint deletes all the waypoints before the selected waypoint. The selected waypoint then becomes the TO waypoint. A waypoint in the alternate flight plan is selected from the primary flight plan. When this is done, all the waypoints, including the original destination, are deleted and the waypoint in the alternate flight plan becomes the TO waypoint. A waypoint is entered into the scratchpad and line-selected to the prompt, making the added waypoint the TO waypoint.

- Using the INTERCEPT function gives a means for the flight crew to fly heading vectors to an automatic intercept of a desired course. No waypoints are deleted with the INTERCEPT function. Refer to Inbound Course Intercept on page 11-6.

• **VNAV OFFSET** – ATC often issues a clearance consisting of crossing a specified distance before or after a waypoint at a specific altitude. The FMS is capable of creating a temporary waypoint in the form of a &PDXX for these types of clearances. Refer to Procedure 9-1 for details.

Procedure 9-1
VNAV Offset Definition

1. Define a PLACE. Use the keyboard or line-select the place from the flight plan to the scratchpad.

2. Enter a slash (/) to indicate that the next entry is a bearing. When known, enter the bearing. When the bearing is not known, enter another slash (/) to indicate that the next entry is a distance.

3. Enter the distance to cross from the place. When DRK is the place, the entry is DRK//20.

4. Enter this information into the flight plan either before or after the place (DRK). The FMS automatically places the waypoint on the flight plan at the specified distance.

5. Enter the altitude constraint.

- **Clearing of Flight Plans** – The flight is considered complete when the aircraft is on the ground for 2 minutes. The active flight plan is automatically cleared at flight complete or when power is removed while on the ground or in flight. However, the pilot must confirm the present active flight plan is being replaced. Flight plans are also cleared one waypoint at a time using the DEL key on the MCDU.

  Deleting the origin clears the entire flight plan.

  Changing the database cycle (NAV IDENT page, line select 2R) clears all flight plans. This rules out any discrepancies between flight plan information and the new database cycle. The database cycle is changed only on the ground.

CREATING ROUTES

An example of the ACT RTE 1 page before a route is defined is shown in Figure 9-12.

Figure 9-12
ACT RTE - Creating Routes

This page is used to define a route plan by entering a destination (1R) and using any of the following options:

- Call up a stored company route (3R). This is only available when company routes have been enabled and the tailored company route database is loaded in the FMS.
- Load a route plan from datalink (3L). This is only available when the datalink functionality option is enabled.

- Manually build a route plan by entering destination (1R) and any of the following:
  - Departure procedures
  - Arrival and approach procedures
  - Missed approach procedures
  - AIRWAY segments
  - Holding patterns
  - Individual waypoints.
- Create a flight plan (see Creating Flight Plans on page 9-12).

Calling Up a Company Route

When company routes functionality is enabled and the company route tailored database is loaded, entry of a recognized company route identifier in 3R loads the origin, destination, and all associated procedures and waypoints into the modified route plan. The RTE 1 page with a company route is shown in Figure 9-13.

In order to make this company route the active flight plan, the operator must push ACTIVATE in 6R.

Figure 9-13
RTE 1/3 - CO ROUTE

If the entry in 3R does not correspond to a recognized company route, the scratchpad message NOT IN DATA BASE is displayed.

The ACT RTE 2 page is shown in Figure 9-14.

Figure 9-14
RTE 2/3 - CO ROUTE

Loading a Route From Datalink

When airline operational communication (AOC) datalink is enabled and a company route identifier is entered in 3R, the FPL REQST prompt and FPL REPORT prompt are displayed on 4L and 4R. When datalink communications are established, the pilot requests a flight plan update from the datalink source by pushing 4L. Once the flight plan is received, (FPL REQST prompt transitions from SENDING to SEND), the pilot reviews the flight plan by selecting the FPL REVIEW prompt (4R). The pilot is then sent to the DATALINK FPL REVIEW pages to review and activate the uplinked flight plan. (See page 13-11 for further details regarding review and activation of datalink flight plans).

When datalink communications are not successfully established, the message DATA LINK UNAVAILABLE is displayed in the 4L data field and the flight plan request is inhibited.

Manually Building a Route

When building a route plan, entries are made on the line showing the VIA prompt (1L through 5L). This is shown in Figure 9-15.

Figure 9-15
RTE - VIA THEN TO

The allowable entries are explained in the following paragraph.

- **Waypoint Entries** – Waypoint entries are made in the TO data field on the right side of the RTE page. Individual waypoints are entered in the route plan when the waypoint is defined in either the navigation or customer-tailored (option) database. When the waypoint is not found in either database, the scratchpad message NOT IN DATABASE is displayed. Entry format for a waypoint is the standard one-to-five-digit alphanumeric entry.

NOTES: 1. If entry of a waypoint on the TO data field has the same fix as previous waypoint, a MOD RTE is created with no flight plan change.

2. Entry of a waypoint on the TO data field on the specified terminal area procedure (except approach) results in either shortening of the procedures (when the fix exists on the strung procedure) or completely replacing the procedure (when the fix does not exist on the strung procedure). Entry on the active procedure results in rejection of the entry fix.

Entry of individual waypoints are always entered as DIRECT legs, as shown in Figure 9-16 and Figure 9-17.

Figure 9-16
RTE - ZUN

Figure 9-17
RTE - ZUN ACTIVE

- **Airway Entries** – Airways are entered into the route plan in a variety of formats. This includes airway only (AWY). Airways are entered under VIA and waypoints are entered under TO. If two consecutive airways are entered, the TO waypoint is automatically entered. Note that the entry and terminal waypoints must be existing waypoints on the airway. No modifications to the airways themselves are permitted.

Procedure 9-2 describes the airway entry steps.

Procedure 9-2
Example Procedure to Enter Airways on RTE Pages

1. Enter flight plan KPHX-KMSP-KLAX. Select the RTE mode key on the MCDU. See Figure 9-18. To activate this route, select the ACTIVATE prompt at 6R.

Figure 9-18
RTE - DIRECT

2. The active route is shown in Figure 9-19.

Figure 9-19
RTE - KLAX

3. Enter the airway information. IPL is entered in the TO column (2R), J18.J19 is entered in the VIA column (3L) and ZUN is entered in the TO column (4R). This results in a modified route page (MOD RTE), as shown in Figure 9-20. Select the ACTIVATE prompt at LSK 6R to activate this route.

Figure 9-20
MOD RTE - J18 J19

4. The MOD RTE page is now the ACT RTE page, as shown Figure 9-21.

Figure 9-21
ACT RTE - Activated

Lateral Offsets

The lateral offsets function creates an offset course at a specified direction and distance from the current offset course. Lateral offsets are defined on the OFFSET page. The OFFSET page is shown in Figure 9-22.

NOTE: For more information on lateral offsets (including waypoint offsets), refer to Section 12, Graphical Flight Planning.

Figure 9-22
OFFSET

The OFFSET page is used to define the offset. The following parameters are defined:

- **1L** – Offset distance
- **2L** – Offset course start point. Entry of the offset start point (2L) is an optional entry for a preplanned offset
- **3L** – Offset course end point
- **5L** – Intercept angle.

Flight Plan Changes to Procedures or Airways

In the flight plan, changes are permitted to be made within a procedure or airway. These changes consist of adding or deleting waypoints, changing altitude and speed constraints, entering or deleting HOLDs, adding steps, and adding RTAs on a waypoint. Once these changes are activated (or inserted into the MOD flight plan), the procedures and airways no longer represent the published segments. When this occurs, any pre-existing RTE procedure or airway is broken down and displayed into individual segments on the RTE pages.

LATERAL NAVIGATION (LNAV)

LNAV is the function in the FMS that sends commands to the flight guidance computer to laterally steer the aircraft.

General LNAV Rules

- The FMS must be selected as the navigation source.
- A minimum of one leg must be defined for LNAV calculations.
- LNAV is available for all phases of flight.
- LNAV is armed while on-ground.
- LNAV is engaged at 50 feet above field elevation (AFE) or higher.
- LNAV bank angles do not exceed 25° except in holding, procedure turns, patterns, and on arc legs. For these cases, the limit is 30°.
- LNAV roll rate is 3° per second during the RNP phase of flight and 5.5° per second on the departure and approach.
- The distance shown for each leg of the flight plan accounts for the distance traveled due to the change in course from one leg to the next.
- LNAV uses up to the limits of bank angle to stay within protected airspace.
- A lateral track alert is given for each waypoint sequence. The alert is given 30 seconds before starting a turn.

LNAV Submodes

- **LNAV ARM** – When initially selected, LNAV ARM becomes the active mode. While armed, the FMS monitors aircraft position and heading against the active leg. When within the capture zone, the FMS automatically changes from LNAV ARM to LNAV CAPTURE and guides the aircraft to capture the active leg. While in the armed mode, the FMS does not laterally control the aircraft. Normally, the HEADING lateral mode is used to control the aircraft until the FMS changes to LNAV CAPTURE.

NOTE: The aircraft must be at least 50 feet above field elevation (AFE) to capture.

- **LNAV CAPTURE** – The FMS begins lateral steering control when the mode changes from ARM to CAPTURE. The FMS uses a 3° per second roll rate during en route operations and up to 5.5° per second on the approach. Banks are planned between 0° and 23° with 25° as a maximum. In holding, procedure turns, orbit patterns, and arc legs, the maximum angle is increased up to 30°.

NOTE: When flying an LNAV approach transition to LOC, the aircraft must be within 10° of the localizer course in order to intercept and capture the course..

One of the requirements of LNAV is to keep the aircraft within protected airspace. This is done by incorporating a model of protected airspace into the FMS. From the model, the FMS determines the bank angle required to stay within the protected airspace boundaries during leg changes. The actual bank angle used is the greater of the pilot-entered bank factor or the bank angle from the protected airspace model.

VERTICAL NAVIGATION (VNAV)

VNAV is the function in the FMS that sends vertical commands to the flight guidance computer for vertical control of the aircraft. Using FMS VNAV, the pilot defines vertical profile information that is automatically flown by the aircraft when a VNAV flight director mode is selected. FMS VNAV is used for all phases of flight. In addition, descents are set up for a path mode (similar to glideslope) to cross waypoints at a specified altitude. The main area for display of VNAV information is the ACTIVE FLT PLAN page.

The FMS gives an altitude target for display on the electronic display system (EDS). This altitude target gives a reference to the flight crew regarding the next FMS altitude constraint that must be met prior to reaching the preselect altitude. This altitude target is given for display during climbs and descents, and following the VTA notifying the crew of TOD.

NOTE: This target is not displayed for the crew-entered altitude preselect, or any FMS altitude constraint colocated with the altitude preselect.

Table 9-2 lists the VNAV submodes and the abbreviations used in this guide.

Table 9-2
Mode Annunciators

Flight Director Mode	Abbreviation
VNAV Flight Level Change	VFLCH
VNAV Altitude Hold	VALT
VNAV Altitude Select	VASEL
VNAV Path	VPATH
VNAV Vertical Glide Path	VGP

General VNAV Rules

- The FMS must be the selected navigation source and LNAV must be engaged for VPATH to be operational.
- VNAV is available for all phases of flight.
- VNAV is armed while on-ground (when PERF has been initialized).
- VNAV is engaged at 400 feet above field elevation (AFE) (takeoff automation APM enabled by default).

NOTE: When takeoff automation with APM is enabled, VNAV is engaged at the value displayed on the VNAV capture AFE on the DEPARTURE LIMIT page.

- Climbs are flown using VFLCH only.
- Descents are flown using VFLCH, VPATH, or VGP.
- VNAV never supplies guidance through the altitude preselector.

NOTE: The one exception to this is in VGP that permits the pilot to set the altitude preselect to the missed approach altitude.

- VPATH angles are from 1° to 6°.
- Path guidance is always followed during VPATH descents unless the FMS transitions to speed reversion. In this condition, the FMS transitions out of VPATH to VFLCH. Refer to Speed Protection on page 9-66 for additional details.
- Speed protection is active in VFLCH. Refer to Speed Protection on page 9-66 for additional details.
- When the altitude preselector is set above (climbs) or below (descents) current altitude and VNAV is engaged, the FMS commands the autopilot to begin a climb (VFLCH) or descent (VFLCH, VPATH or VGP).

- VNAV is armed by selecting the FMS as the navigation source and selecting the **VNAV** button on the guidance panel. The electronic flight instrument system (EFIS) annunciates the submode of VNAV.
- VPATH default descent angle is part of performance initialization when the optimum descent APM option is not enabled. However, after the angle is displayed for each waypoint, the crew can make changes.
- The VPTH descent angle with the optimum descent APM option enabled, is a computed angle to permit the throttles to be idle during descent.
- When the altimeter is adjusted to show height above the ground (queens field elevation (QFE)) rather than sea level, VNAV must not be used.
- VNAV observes flight plan constraint altitudes. With the altitude preselect set to CRZ or clearance altitude, the FMS VNAV automatically levels off and then sequences all intermediate altitude constraints.
- A vertical track alert is issued anytime the FMS commands vertical track changes. The alert is issued 60 seconds before changing from level flight to either a climb or descent. When the aircraft is completing a climb or descent, the vertical alert is issued 1,000 feet before the level-off altitude. A vertical alert is not issued when the level-off altitude is set on the altitude preselector.

VNAV Submodes

- **VNAV ARM (VNAV)** – When initially selected, VNAV ARM becomes the active mode. While armed, the FMS monitors aircraft position and altitude against the altitude preselector and, if any, the next waypoint altitude constraint. From this, the FMS determines when to capture and what VNAV submode is correct.

NOTE: The aircraft must be at least 400 feet above field elevation (AFE) before VNAV is permitted to engage.

VNAV ARM remains in the ARM mode in an altitude conflict situation. For example, the altitude preselector is set above aircraft altitude and the next constraint altitude is below the aircraft altitude. In this example, VNAV cannot determine whether to climb to the altitude preselector or to descend to the constraint. The net result is that VNAV stays in the ARM mode until the conflict is resolved.

While in the ARM mode, the FMS does not vertically control the aircraft. Another vertical flight director mode is used to vertically control the aircraft until the FMS transitions out of VNAV ARM.

- **VNAV Flight Level Change (VFLCH)** – This mode is vertical flight level change. In this mode, aircraft speed is controlled by the flight guidance computer (FGC) by the pitch of the aircraft. This mode is also referred to as speed on elevator. The speed command is displayed on the ACTIVE FLIGHT PLAN 1 page. For most operations, the autothrottle is set to climb power rating for climbs and idle for descents. Exceptions are when climbing or descending only a short distance. In this case, the throttle is set to less than climb power or more than idle to avoid abrupt changes. Moving the throttle during VFLCH makes a change in pitch. This changes the vertical speed, but the aircraft speed remains the same.

  VFLCH is used during all climbs. VFLCH is used during descents unless a defined path is captured, a step descent at a waypoint is performed, or an early descent is performed. When engaging VNAV, VFLCH is set as the active mode when the altitude preselector is above or below the current aircraft altitude, and the current flight director mode is not altitude hold. When in other modes of VNAV, a transition to VFLCH is made by setting the altitude preselector to other than current altitude and pushing the **FLCH** button on the guidance panel.

- **VNAV Altitude Capture (VASEL)** – This mode is the same as altitude capture. It is used to level the aircraft at the VNAV supplied altitude target. The altitude target is either an altitude constraint or the altitude preselector setting. The FGC controls the pitch of the aircraft in order to capture the altitude. The autothrottle controls the speed command shown on the guidance panel. Moving the throttle changes speed.

- **VNAV Altitude Hold (VALT)** – This mode is the same as altitude hold. The FGC controls altitude by controlling pitch. The autothrottle controls the speed command.

  When VNAV is disengaged while in VALT, the flight director mode becomes PITCH HOLD, not altitude hold.

- **VNAV Path (VPATH)** – This mode is a vertical path. In this mode, VNAV controls the aircraft along a geometric path downward to a waypoint altitude constraint. The path angle is an FMS-computed value, procedure specified, or pilot-entered. Path descents are identical to instrument landing system (ILS) approaches where the glideslope gives a constant descent angle. VNAV gives the same constant descent angle using barometric altitude to determine the aircraft is on path. VPATH may control to variable angle if optimum descent is enabled.

  The primary objective during VPATH descents is maintaining the geometric path. To accomplish this, VNAV computes the required vertical speed to maintain the path, then sends the command to the FGC. The FGC adjusts the pitch of the aircraft to maintain the requested vertical speed. During VPATH operations, the aircraft speed is permitted to increase or decrease to maintain the path. VNAV does give speed protection, as described on page 9-66.

  During VPATH operations, the autothrottle attempts to maintain the speed command shown on ACTIVE FLT PLAN 1 page or the guidance panel. When the angle is too steep, the throttles are at idle and the aircraft speed can continue to increase. When autothrottles are not engaged, the pilot is responsible for adjusting the throttles to maintain aircraft speed. VPATH is also used during step at waypoint descents and during early descent operations.

Early Descent (DES NOW)

A VPATH early descent is available when the DES NOW prompt is displayed. The DES NOW prompt is available on the FPLN, RTE, and DESCENT pages when within 50 NM of the TOD. Figure 9-23 shows the DES NOW prompt at 6L.

Figure 9-23
ACTIVE FLT PLAN - DES NOW

Figure 9-24 shows the DES NOW prompt at 6L.

Figure 9-24
ACT RTE - DES NOW

Figure 9-25 shows the DES NOW prompt at 5L.

Figure 9-25
DESCENT - DES NOW

When an early descent is initiated by selecting the DES NOW prompt, the VPATH descent profile consists of a fixed 1,000 feet/ minute early descent path and the original predicted path. The FMS descends to a point that it intersects the original flight plan path. At this point, the FMS automatically executes a transition maneuver to capture the original path. No VTA is given for the transition maneuver. Bottom-of-descent (BOD), vertical deviation, and the FMS altitude target are all displayed with respect to the original VNAV path. All descent altitude constraints encountered prior to intercepting the original VNAV path is honored as well as the ALT SEL.

When a late descent is initiated by selecting the DES NOW prompt, the VPATH descent profile consists of a fixed-angle, late-descent path and the original predicted path. The FMS initially guides to a path 1.5° greater than the original descent path to the point that it intersects the original flight plan. At this point, the FMS automatically executes a transition maneuver to capture the original path. BOD, vertical deviation, and the FMS altitude target are all displayed with respect to the original VNAV path. All descent altitude constraints encountered prior to intercepting the original VNAV path are honored, as is the ALT SEL.

VNAV Operation in Flight

- **Climb** – All VNAV climbs are flown using VFLCH. Intermediate level offs are entered as waypoint constraints through the MCDU or are set with the altitude preselector. VNAV never flies through the altitude preselector in any VNAV mode.

  When an intermediate level off is required due to an FMS waypoint altitude constraint, VNAV automatically resumes the climb after passing the waypoint when the selector is set above the current aircraft altitude. When the selector is not set above the current altitude, VNAV maintains the intermediate altitude when passing the waypoint. In this case, the climb is resumed by setting the altitude preselector higher and pushing **VFLCH** on the guidance panel.

- **Cruise** – The cruise altitude is entered during performance initialization. When the altitude preselector is set higher than the entered cruise altitude and the aircraft is climbing in VFLCH, the cruise altitude is adjusted to match the altitude preselector. When the aircraft levels off at the cruise altitude (cruise altitude or higher when set on the selector), the FMS enters the cruise phase of flight. The speed command is adjusted to the cruise values.

  Cruise is flown by the autopilot in the altitude hold mode (VALT). From cruise, a climb or descent is executed at any time by setting the altitude preselector to the desired altitude and pushing the **FLCH** button. There is a 2 to 3 second delay before VNAV resets the altitude target to the altitude preselector or next waypoint altitude constraint (whatever is closer), and the flight director changes to VFLCH.

  When in VALT, the flight guidance system (FGS) touch control steering (TCS) function is used to maneuver the aircraft. However, when TCS is released, the aircraft returns to the original VALT altitude only when the deviation from the target altitude is less than 50 feet. When altitude deviation is 50 feet or more, the FMS does not attempt to return to the original altitude target.

Automatic changes from cruise are performed for bottom-of-step-climb (BOSC) and TOD points. In both cases, the altitude preselector must be properly set (i.e., above the current altitude for BOSC and below current altitude for TOD). When the altitude preselector remains at the current altitude, the aircraft remains in cruise as the points are passed.

- **Top-of-Descent (TOD)** – The TOD is the location that the aircraft commences a descent. The TOD is displayed on the map on the MFD and VSD. For the TOD, a vertical waypoint alert is given and an automatic descent is initiated when the altitude preselector has been selected to a lower altitude.

- **Descent** – Descents are flown as speed descents (VFLCH), path descents (VPATH), or glide path (VGP). The transition to descent is automatic, assuming the altitude preselector is set lower than the present altitude. One minute before TOD, the vertical track alert is given. On reaching the TOD, VNAV initiates either a VFLCH, VPATH, or VGP descent.

  - **Speed Descent (VFLCH)** – A speed descent is flown when no altitude constraints exist in the flight plan during the descent. Also, the TOD is based on any speed constraints in the descent such as slowing to 250 knots below 10,000 feet.

    The pilot initiates a VFLCH descent anytime by setting the altitude preselector to a lower altitude and pushing **FLCH** on the guidance panel. Following an intermediate level off at the altitude preselector value, the descent is resumed by dialing down the altitude preselector and pushing the **FLCH** button again on the guidance panel.

  - **Optimum Descent** – An optimum descent is flown to obtain an optimum descent path between the TOD and the FAF to minimize fuel consumption using the predefined FMS speeds and assuring an idle throttle setting.

  - **Path Descent (VPATH)** – A VPATH descent is flown when an altitude constraint is in the descent portion of the active flight plan. The path angle associated with the constraint is either a default angle computed by the FMS, procedure specified, or pilot-entered.

    After passing the last waypoint with an altitude constraint, VNAV changes from path descent (VPATH) to a speed descent (VFLCH).

VNAV Special Operations

- **Vertical Direct-To** – This function operates much like the lateral Direct-To. It is initiated by entering the same altitude constraint a second time on the altitude flight plan page.
- **VNAV and Holding Patterns** – The following are some special considerations for holding and orbits during VNAV operation:
  – When the holding pattern is entered while in VFLCH, the aircraft remains in VFLCH and continues the climb or descent
  – When the holding pattern is entered while in VALT, the aircraft remains in VALT
  – When a present position (PPOS) holding pattern is entered while in a path descent, the aircraft changes to VFLCH while in holding
  – Path descents are not used during holding pattern operations. When the hold is entered while in VPATH, VNAV changes to VALT. To continue the descent the pilot must manually select VFLCH.
- **VNAV (VPATH and VFLCH) and Stored Instrument Approaches**
  – All stored approach procedures have associated altitude constraints and/or vertical path angles.
  – Changing the altitude constraint and/or the path descent angle is possible once an approach procedure is activated. However, the crew must verify that all the approach procedure altitude requirements are met.
  – Industry-wide standards for database information are currently inconsistent on many approaches. Some vertical paths are defined at 50 feet above the runway. Others do not arrive at MDA until at the MAP. Some approaches give vertical guidance below the published MDA and some vertical paths differ from the VASI/PAPI angles.
  – The stored missed approach also contains altitude constraints. Some altitude constraints do not refer to any waypoint. VFLCH is used to fly the missed approach to comply with this type of altitude constraint.

- **VNAV and Alternate Activation** – If the alternate is activated during descent, the phase of flight transitions to climb.

VNAV Operational Scenarios

The operational scenarios are presented as a series of figures showing typical vertical profile segments. Certain points on the figures are labeled with numbers. These numbers are used to describe events and are enclosed in parentheses in the text. Refer to the General VNAV Rules section, page 9–36, when reviewing these scenarios.

- **VNAV Climb (VFLCH)**

  The elements of a VNAV climb profile are shown in Figure 9-26.

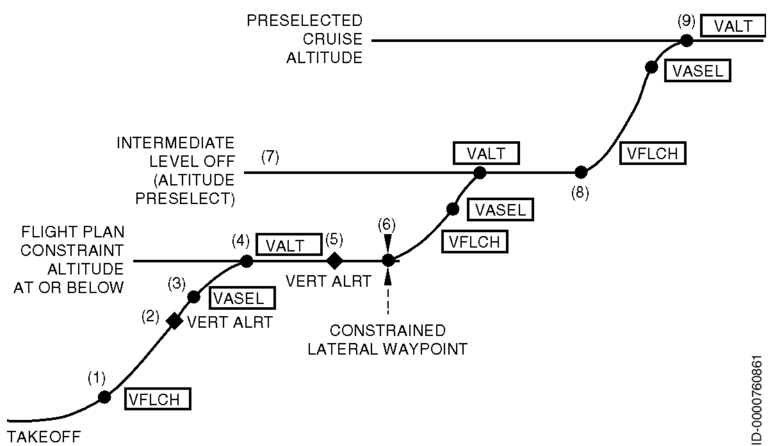

Figure 9-26
VNAV Climb Profile

A VNAV climb profile consists of the following:

- VNAV is engaged in a VFLCH airspeed climb (1) after takeoff
- One thousand feet before reaching the constraint altitude, a VTA is given (2)
- The flight guidance computer changes to VASEL to capture the altitude constraint (3)
- The flight guidance computer switches to VALT at the constraint altitude (4)

- One minute before the constrained lateral waypoint is reached, a VTA is given (5) indicating an automatic climb begins at the waypoint
- The altitude preselector is set higher than the constraint altitude (5)
- The flight guidance computer switches to VFLCH as the waypoint is passed (6)
- The flight guidance computer executes a normal level off at the intermediate altitude preselector (7) switching from VFLCH to VASEL to VALT with the normal 1,000-foot selector alert
- ATC clearance is received to the cruise altitude and the selector is dialed to the cleared altitude (8)
- The **FLCH** button is pushed to resume the climb (8)
- The flight guidance computer executes a normal level off at the cruise altitude (9) switching from VFLCH to VASEL to VALT with the normal 1,000-foot selector alert and the speed command changes to the cruise value.

- **VNAV Flight Level Change Descent (VFLCH)**

  The elements of a VNAV FLCH (IAS or Mach hold) descent profile are shown in Figure 9-27.

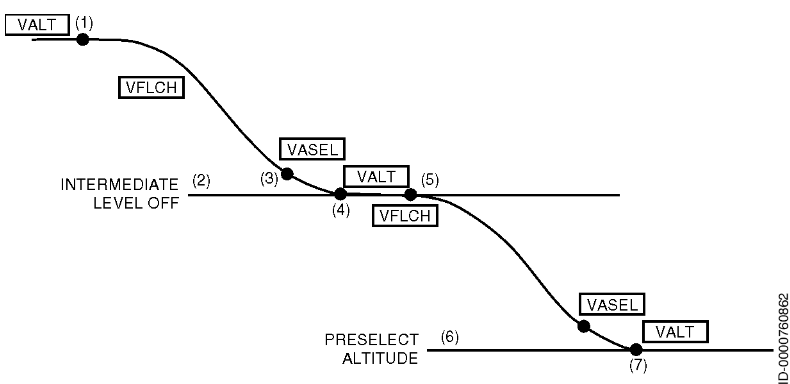

Figure 9-27
VNAV Flight Level Change Descent

A VFLCH descent is engaged at any time by using the following:

- From cruise altitude (1), dial down the altitude preselector to the ATC cleared altitude (2)
- Push **FLCH** when already engaged in a VNAV mode or **VNAV** when not already in VNAV. The flight guidance computer switches to VFLCH and begins a descent (1)
- One thousand feet before the altitude preselector (2) is reached, the normal altitude alert is given and the flight guidance computer does a normal level off switching from VFLCH to VASEL (3) to VALT (4)
- An ATC clearance (5) is received to a lower altitude and the altitude preselector is lowered (6). **FLCH** is pushed (5) and the aircraft begins a descent
- One thousand feet before the altitude preselector (6), the normal altitude alert is given and the flight guidance computer does a normal level off switching from VFLCH to VASEL to VALT (7).

- **VNAV Path Descent (VPATH)**

  The elements of a VNAV path descent profile are shown in Figure 9-28.

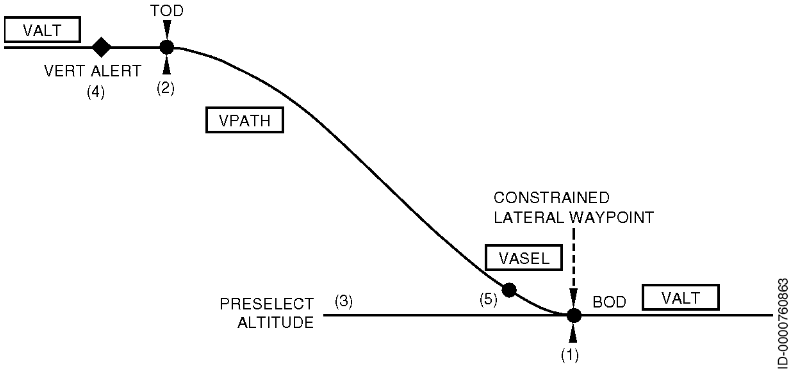

Figure 9-28
VNAV Path Descent Profile

A VNAV path descent is engaged from VALT at any time when the altitude preselector is dialed down before the TOD point is reached. The VNAV path descent mode is used to descend to a new flight level at a calculated or prescribed angle (between 1° and 6°). The following steps apply:

- An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.
- One minute before reaching the TOD, a VTA is given (4) and the vertical deviation scale is displayed on the PFD. When the altitude preselector is not at a lower altitude, the message RESET ALT SEL? is displayed.
- The altitude preselector is set to the ATC cleared altitude (3).
- At the TOD, the flight guidance computer switches from VALT to VPATH and begins a descent (2).
- The flight guidance computer does a normal level off switching from VPATH to VASEL (5) to VALT (1).

The VNAV angle is always displayed on the MCDU for path descents with exception for optimum descents. The path is always followed except when the aircraft speed approaches the following:

- V_{MO}/M_{MO}
- Landing gear or flap placard speed
- V_{REF}.

VNAV tries to satisfy both the altitude preselector and the waypoint constraint altitude. However, VNAV **never** flies through the altitude preselector.

- **VNAV Late Descent to Capture Path (VPATH)**

A VNAV late path descent is shown in Figure 9-29.

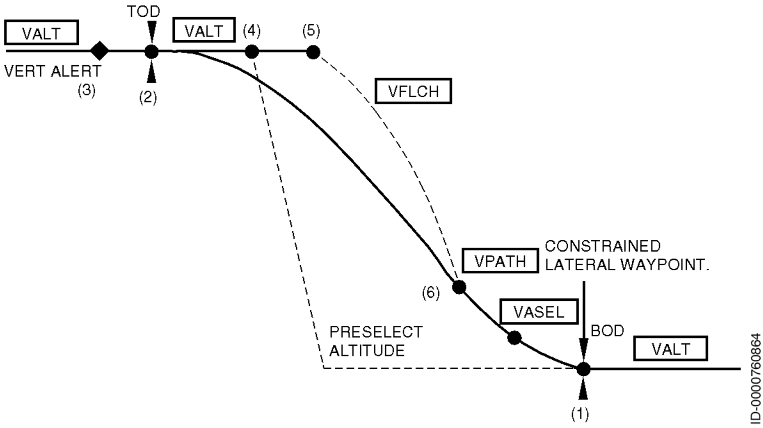

Figure 9-29
VNAV Late Path Descent

This scenario can occur when ATC has not given descent clearance by the time the TOD is reached. The steps are as follows:

– An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.

– One minute before reaching the TOD, a VTA is given (3) and the vertical deviation scale is displayed on the PFD. When the altitude preselector is not at a lower altitude, the message RESET ALT SEL? is displayed.

– When past the TOD and more than 250 feet above the path, the flight guidance computer remains in VALT.

– The altitude preselector is set (4) to the ATC cleared altitude.

– Push the **FLCH** button (5) to begin descent. The flight guidance computer transitions to VFLCH to begin the descent. When the aircraft is past the TOD but less than 500 feet from the path when the selector is set lower, the FMS switches directly to VPATH.

– When the path is intercepted, the flight guidance computer switches to VPATH (6).

– The flight guidance computer does a normal level off switching from VPATH to VASEL to VALT (1).

- **VNAV Early Descent to Capture Path (VFLCH)**

  An early descent to capture a path is shown in Figure 9-30.

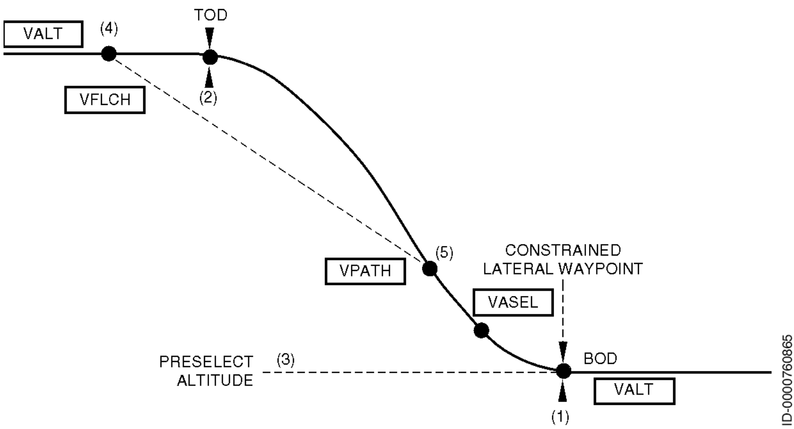

Figure 9-30
VNAV Early Descent to Capture Path

This scenario is typical should ATC instruct a descent before the established TOD point is reached. The following steps apply:

– An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.

– The altitude preselector is set to the ATC cleared altitude (3).

– Push the **FLCH** button twice (4) to begin the descent. The flight guidance computer switches to VFLCH to begin the descent.

– As the path is approached, the vertical deviation is displayed on the EFIS. When the path is intercepted, the flight guidance computer switches to VPATH (5).

– The flight guidance computer does a normal level off, switching from VPATH to VASEL to VALT (1).

- **VNAV to Capture Path (VPATH/DES NOW)**

  An early descent to capture a path is shown in Figure 9-31.

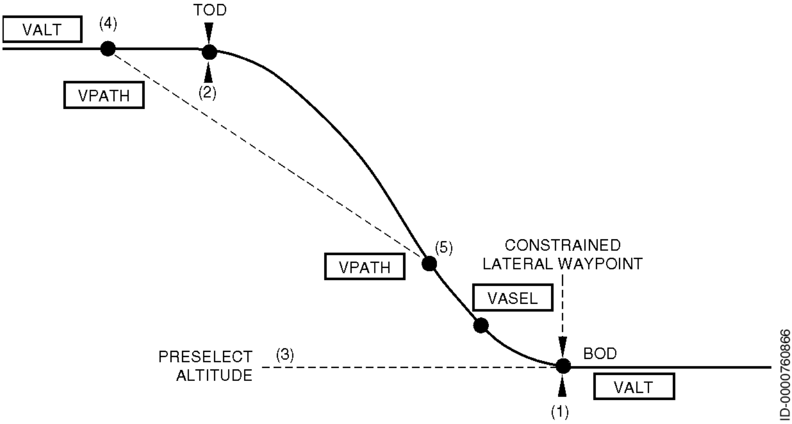

Figure 9-31
VNAV to Capture Path

This scenario is typical should ATC instruct a descent before the established TOD point is reached and DES NOW is used. The following steps apply:

– An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.

– The altitude preselector is set to the ATC cleared altitude (3).

– Push the DES NOW prompt (4) to begin the descent. The flight guidance computer switches to VPATH when descending at 1,000 feet/minute.

– As the path is approached, the vertical deviation is displayed on the EFIS. When the path is intercepted, the flight guidance computer remains in VPATH (5).

– The flight guidance computer does a normal level off, switching from VPATH to VASEL to VALT (1).

- **VNAV Early Descent Using Vertical Direct-To (VPATH)**

  The VNAV early path descent using vertical Direct-To is shown in Figure 9-32.

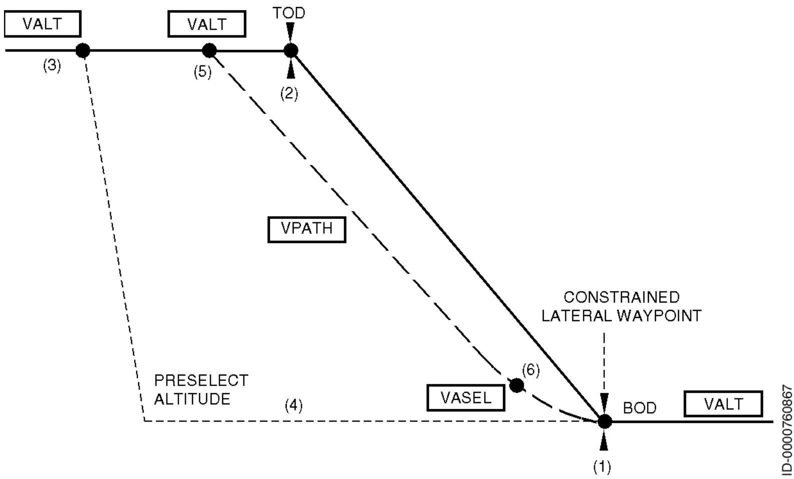

Figure 9-32
VNAV Early Path Descent Using Vertical Direct-To

The following steps apply:

- An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.
- The altitude preselector is set (3) to the ATC cleared altitude (4).
- A vertical Direct-To is performed (5) to the constrained waypoint (1) by entering the same constraint on the constraint waypoint (1). The FMS calculates the new angle in a MOD flight plan and the flight computer transitions to VPATH on activation of the MOD flight plan.
- The flight guidance computer does a normal level off, switching from VPATH to VASEL (6) to VALT (1).

- **VNAV Late Descent Using Vertical Direct-To (VPATH)**

  A VNAV late path descent using vertical Direct-To is shown in Figure 9-33.

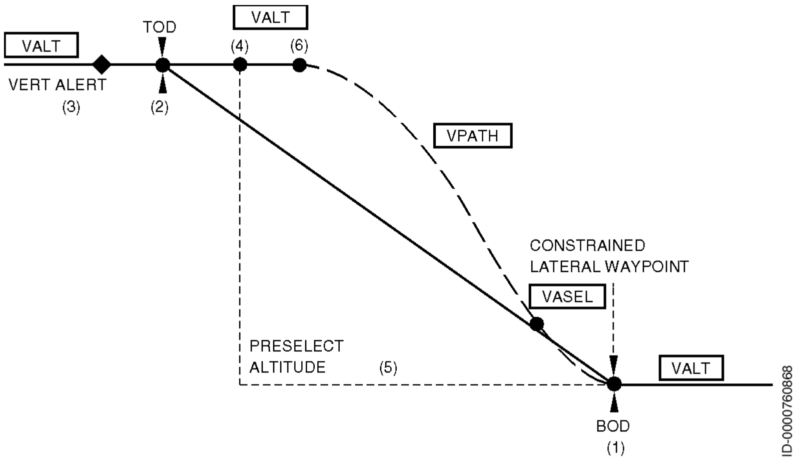

Figure 9-33
VNAV Late Path Descent Using Vertical Direct-To

In this scenario, descent clearance is not received before the TOD is reached. The following applies:

– An altitude constraint is entered at a waypoint (1). The FMS calculates an angle and TOD (2) for the path descent.

– One minute before reaching the TOD, a VTA is given (3) and the vertical deviation scale is displayed on the EFIS. When the altitude preselector is not at a lower altitude, the message RESET ALT SEL? is displayed.

– At the TOD (2), the flight guidance computer remains in VALT and remains level through the TOD.

– The altitude preselector is set (4) to the ATC cleared altitude (5).

– A vertical Direct-To is performed (6) to the constrained waypoint (1) by entering the same constraint on the constraint waypoint (1). The FMS calculates the new angle in a MOD flight plan and the flight guidance computer transitions to VPATH on activation of the MOD flight plan.

– The flight guidance computer does a normal level off, switching from VPATH to VASEL to VALT (1).

- **VNAV Optimum Descent**

A VNAV optimum descent is shown in Figure 9-34.

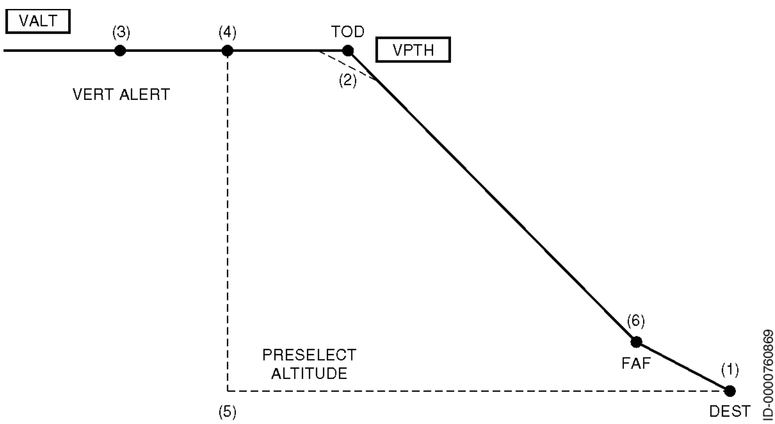

Figure 9-34
VNAV Optimum Descent

In this scenario, descent clearance is received before the TOD is reached. The following applies:

– An altitude constraint exists at the destination (1) that is the runway altitude. The FMS determines the TOD (2) based on a computed path that permits engines to remain at idle to the FAF. This assumes there are no other vertical constraints.

NOTE: The idle descent path depends on the characteristics of the aircraft and environmental conditions, therefore the path angle varies during descent.

– One minute before reaching the TOD, a VTA (3) is issued on the PFD and the vertical deviation scale is displayed on the EFIS.

– The altitude preselector is set (4) to the ATC cleared altitude (5).

– Just prior to the TOD (2), the flight guidance computer transitions to VPATH and begins an idle descent.

- **VNAV Preplanned Steps at Waypoints**

A VNAV preplanned step at a waypoint is shown in Figure 9-35.

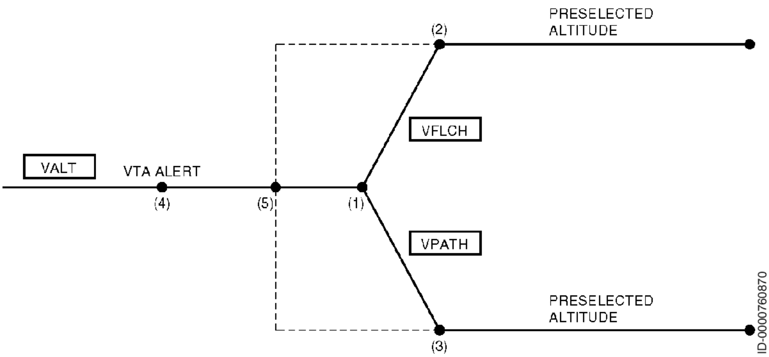

Figure 9-35
VNAV Preplanned Step at Waypoint

Steps at preplanned waypoints are done in climbs or descents. To climb, the following applies:

– A step climb is entered at the waypoint (1) by entering in the new cruise altitude followed by an S and applying that to the waypoint on the flight plan page, similar to an altitude constraint.

– One minute prior to reaching the waypoint (1), a VTA alert (4) is issued on the PFD.

– The altitude preselect (5) is set to the ATC clearance altitude (2), then the waypoint (1). The FGC transitions to VFLCH and begins to climb.

– The FGC does a normal level off at the selected altitude (2), switching from VFLCH to VASEL to VALT.

To descend, the following applies:

- A step descent is entered at the waypoint (1) by entering in the new cruise altitude followed by an S and applying that to the waypoint on the flight plan page, similar to an altitude constraint.
- One minute prior to reaching the waypoint (1), a VTA alert (4) is issued on the PFD.
- The altitude preselect (5) is set to the ATC clearance altitude (3), then the waypoint (1). The FGC transitions to VFLCH and begins to descend.
- The FGC does a normal level off at the selected altitude (3), switching from VFLCH to VASEL to VALT.

After a step is entered, the step information is found on the CRUISE page at LSK 2R.

Steps are ignored if the steps cannot be completed before 50 NM prior to the TOD. When steps are ignored, IGNORED is displayed on the CRUISE page in amber.

Vertical Glide Path Mode (VGP)

The vertical glide path (VGP) mode, shown in Figure 9-36, permits crew management of the altitude preselector during FMS managed nonprecision approaches. Using standard VNAV during nonprecision approaches, it is necessary to dial the altitude preselector to the minimum descent altitude (MDA) during the final approach segment. When a missed approach is executed, it is necessary to reset the altitude preselector to the missed approach altitude. With the VGP mode, the altitude preselector is set to the missed approach procedure altitude once the VGP mode is engaged. The FMS manages the aircraft on a vertical path to the missed approach point (MAP) regardless of the setting of the altitude preselector. This is similar in concept to glideslope capture for ILS approaches.

- **Arming of VGP Mode**: The first step toward using the VGP mode is to arm VGP. VGP is armed by selecting the approach (**APPR**) button on the guidance panel. However, the following conditions are necessary for arming the VGP mode:
  - FMS is the selected navigation source

  - Localizer (LOC) preview mode is inactive on the primary flight display (PFD)
  - A nonlocalizer-based approach is selected from the navigation database
  - The aircraft is not in dead reckoning (DR) mode
  - An NDB angle to the MAP exists
  - Altitude and angle constraint values from the NAV DB have not been changed
  - When there is an at-altitude constraint on the final approach fix (FAF), the aircraft must be in alt hold at the FAF altitude
  - No vertical Direct-To the MAP has been executed.

- **Engagement of VGP mode**: The VGP mode is engaged when the following rules are met:
  - The VGP mode is armed (by the selection of **APPR** button and meeting the conditions mentioned in the previous section)
  - LNAV is active
  - The aircraft, when holding, must be established on the inbound course to the FAF
  - The active waypoint is the FAF or along track distance to the FAF is less than 5 NM
    - When the aircraft is capture-capable and below the path, VGP is captured when VGP deviation is less than 75 feet.
  - The aircraft is able to capture the final approach slope
  - With a course reversal hold leg (HF) on the FAF, the aircraft must be established inbound to the FAF (<0.5 NM crosstrack error and <10 degrees track error on inbound leg) and be exiting the hold.

Once VGP is engaged, the crew does not have to set the preselector altitude to the MDA. The crew can dial it to the missed approach altitude. The FMS does not consider the preselector altitude in the computations while in VGP mode. This also means the message RESET ALT SEL is not displayed in VGP mode.

The vertical glide path mode (VGP) is shown in Figure 9-36.

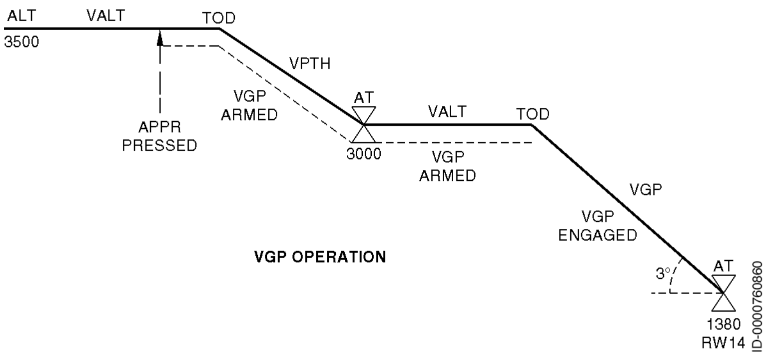

Figure 9-36
VGP Operation

– **Canceling VGP Mode**: VGP mode is canceled by the crew using any of the following methods:

- Selection of **APP**, **HDG**, **NAV**, **VNAV**, **FLCH**, **ALT**, **VS,** or **FPA** buttons on the guidance panel
- Selection of RESUME HOLD (when flying a HOLDING pattern).

VGP mode is automatically canceled when any of the VGP arming conditions (Arming of VGP Mode section) is no longer true. In this case, the aircraft transitions to flight path angle (FPA).

The VGP UNAVAILABLE message is displayed when the guidance panel approach button is pushed and the arming criteria previously mentioned is not met. The message is self-clearing when the FAF is sequenced.

SPEED COMMAND

The FMS is capable of controlling the aircraft speed during departure, climb, cruise, descent, approach, and go-around. The speed is either controlled automatically or manually. The automatic speed command (FMS) contains two submodes: automatic and waypoint constraint. In the speed command mode (MAN), the pilot enters the desired aircraft speed manually on the guidance control panel. The autothrottle then controls the aircraft to the manually entered speed. Speed intervention is permitted when FMS speeds are commanded. Approach speeds are entered and activated using the APPROACH SPEEDS page.

The FMS gives speed protection for FMS modes. This speed protection is designed to prevent the aircraft from flying too slow or too fast. Refer to Speed Protection on page 9-66 for additional information.

General Speed Command Rules

- The current speed command is displayed on page 1 of the ACTIVE FLT PLAN. This is shown in Figure 9-37.
- A CAS and Mach are both displayed when climbing or descending. Otherwise, the cruise speed command (either CAS or Mach) is displayed.
- The active speed command, whatever is the lowest value between CAS and Mach, is shown in large characters.

- The active speed command is also displayed on the PFD.

Figure 9-37
ACTIVE FLT PLAN - Speed Command

Automatic

As the name implies, the automatic speed command mode is the most automated mode. The FMS automatically changes the speed command throughout the flight to accommodate aircraft configuration and phase of flight. This automatically controlled speed command is used by the autopilot or autothrottle. The following speed schedules for the automatic speed command are configured on the PERFORMANCE INIT 3 page:

- Climb
- Cruise
- Descent.

The departure and go-around speed schedules for the automatic speed command are configured on the DEPARTURE LIMIT and the GO-AROUND pages.

The approach speed schedules for the automatic speed command are configured on the APPROACH SPEEDS page.

The automatic speed command for a typical flight changes as follows:

- When the FD is in T.O. mode, the FMS commands V2 until V2 is reached, then ramps up to V2 + 10, and then stays at V2 + 10 until the vertical mode is changed. If the FMS detects 50 feet AFE prior to reaching V2 + 10, then V2 + 10 is also commanded.

NOTE: It is possible that 50 feet AFE can be achieved without flying by setting the BAROSET in such a way that the baro altitude tape reads more than 50 feet AFE.

- When the vertical mode is changed, the FMS transitions to the departure speeds schedule defined during initialization. The departure speed is commanded until the departure area limit, defined by the AFE limit on the DEPARTURE LIMIT page.
- Once the aircraft is clear of the departure area, the speed command transitions to the climb speed schedule selected during initialization. The climb speed command is limited by the speed/altitude limit defined during initialization. Once above the speed/altitude limit, the target is the lower value of the CAS/Mach climb speed schedule. Changes to Mach are automatic.
- As the aircraft levels off at the cruise altitude, as defined in the initialization, the speed command changes to cruise. Only one value of CAS or Mach is displayed.

  The speed command transitions to cruise when the aircraft is in VALT or altitude hold, and the aircraft altitude equals the PERFORMANCE INIT cruise altitude. When the aircraft levels off at an altitude below the PERFORMANCE INIT value for cruise altitude, the speed command continues to be the climb speed command. Manually entering the lower cruise altitude is necessary to enable the FMS to transition to the cruise speed command.

  Step climbs use the cruise speed command when the altitude changes are 5,000 feet or less. Climbs greater than 5,000 feet use the climb speed commands.

- When the aircraft begins descending below the cruise altitude prior to reaching 50 NM of the TOD, the speed command remains in cruise speed schedule. When the aircraft begins descending below the cruise altitude and is within 50 NM of the TOD, the speed command changes to the descent speed schedule and the descent CAS/Mach target is displayed. The descent speed command is used during any intermediate level offs. When the aircraft nears the speed/altitude limit, the speed command anticipates the speed limit and slows the aircraft prior to reaching the altitude.

NOTE: The NG FMS uses aero/engine models to compute the required distance to decelerate to a new speed target. At times, this can result in decelerations at different altitudes than previous systems.

- When the flight director is in GA mode, the FMS commands V_{REF}+20 and for engine out operations it is Vac until the vertical mode is changed. When the vertical mode is changed, the FMS transitions to the GA speed schedule. The GA speeds are targeted in the GA area, defined by the AFE limit in the GO-AROUND LIMIT page.

Waypoint Speed Constraint

The FMS gives the ability to cross a waypoint at or below a specified speed. This is referred to as a waypoint speed constraint. A waypoint speed constraint is retrieved with a procedure (SID/STAR/approach) or is entered by the pilot.

Waypoint speed constraints are treated differently by the FMS depending on the phase of flight. Waypoint speed constraints in the climb phase of flight results in the FMS applying the speed constraint to all legs prior to the waypoint. The climb phase of flight is defined as the legs of the flight plan prior to the TOC. Climb phase constraints are entered in CAS only. If a constraint is less than the scheduled climb speed, the speed target is max limited to the climb constraint. When sequencing the waypoint, the FMS returns to the automatic speed schedules when no other waypoint speed constraint exists.

Waypoint speed constraints in the cruise or descent phase of flight results in the FMS applying the speed constraint to all legs after the waypoint to the end of the flight plan or until the pilot deletes the speed constraint at LSK 1R on the ACTIVE FLT PLAN page. Cruise and descent phase constraints are entered in CAS only. If a constraint is less than the scheduled cruise, descent, or approach speed, the speed target is max limited to the constraint speed. As the aircraft approaches the waypoint, the FMS anticipates the speed constraint so that the aircraft crosses the waypoint at the speed constraint. The cruise phase of flight is defined as the legs of the flight plan past the TOC and prior to the TOD. The descent phase of flight is defined as the legs of the flight plan past the TOD.

NOTES:

1. *All waypoint speed constraints (either by NAV DB or by pilot-entry) are treated by the FMS as AT or BELOW. If a waypoint speed constraint is greater than the scheduled speed, the FMS does not increase the scheduled speed to be AT the waypoint speed constraint value. If the waypoint speed constraint is intended to be an AT value, and the FMS scheduled speed is less than the AT value, the pilot should use speed intervention to make sure the constraint speed is followed.*

2. *Speed constraints lower than the flight phase speed schedules, including approach speeds, may result in an FMS speed command below the green dot or approach speeds depending on aircraft configuration. In this case, it is recommended to select the appropriate flap position so that the green dot is lower than the active speed constraint.*

To insert a waypoint speed constraint, follow Procedure 9-3.

Procedure 9-3
Inserting a Waypoint Speed Constraint

1. Completely initialize the PERFORMANCE INIT pages.
2. Enter the speed constraint into the scratchpad followed by a slash (/). The entered speed is either a CAS or Mach.

To remove a waypoint speed constraint, follow Procedure 9-4.

Procedure 9-4
Removing a Waypoint Speed Constraint

1. Push the DEL key on the MCDU to enter *DELETE* in the scratchpad, as shown in Figure 9-38.

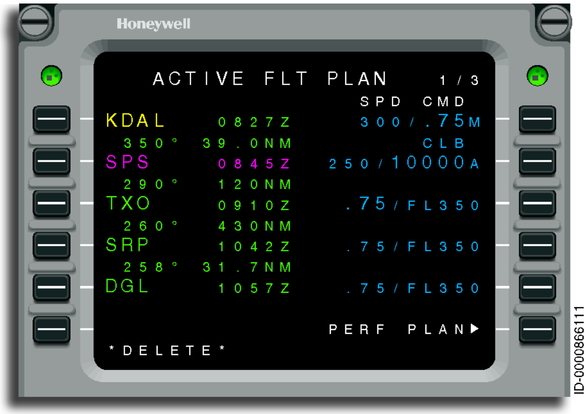

Figure 9-38
ACTIVE FLT PLAN With *DELETE* in Scratchpad

2. Push the right LSK next to the desired lateral waypoint on the ACTIVE FLT PLAN page to delete the waypoint constraint. For example, Figure 9-38 had a speed constraint of .75 Mach desired for waypoint TXO, as shown in Figure 9-39. *DELETE* was entered into the scratchpad, and then 3R was selected. The constraint was removed and replaced with a predictive constraint.

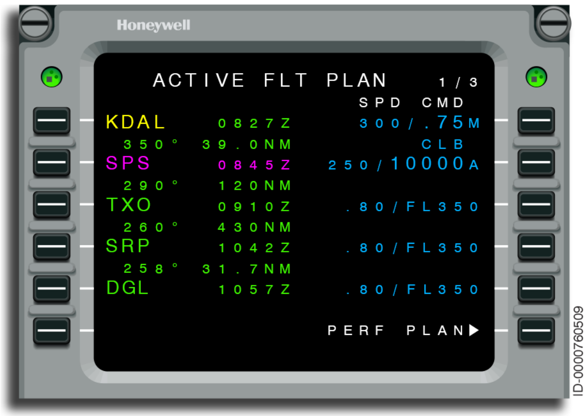

Figure 9-39
Speed Constraint Removed

Speed Intervention

Speed intervention permits the flight crew to enter a new temporary speed target in 1R on the ACTIVE FLT PLAN page. While targeting a speed intervention target, the FMS continues to monitor for speed infractions and alerts the flight crew if necessary. Speed intervention is automatically canceled when the FMS performance flight phase changes, an engine out occurs, transitioning to manual speeds, or an RTA is entered during a time when RTA speeds are commanded. SPD INTV is displayed in reverse video on the PERFORMANCE INIT 3 page when active in cruise. If it occurs in climb or descent, it is displayed on the respective title lines for CLB or DES.

NOTE: When using speed intervention, speeds can only be entered in CAS or Mach only, not both. When the flight crew enters a CAS or Mach, the FMS does not automatically transition to the corresponding CAS or Mach at the transition altitude. It is important that the flight crew cancels the speed intervention when necessary, otherwise an overspeed condition can occur.

Speed Protection

The FMS gives only one type of speed protection that automatically transitions the flight control system (FCS) vertical mode from VPATH to VFLCH (referred to as speed reversion).

The FCS vertical mode automatically transitions from VPATH to VFLCH for the following conditions:

- **V_{MO}/M_{MO}** – During a VPATH descent, when CAS becomes greater than V_{MO} + 10 knots, the transition is canceled when the airspeed decreases to LSA (low speed awareness)
- **Landing Gear or Flap Placard Speed** – During a VPATH descent, the aircraft speed exceeds the landing gear or flap placard speed by 10 knots
- **V_{REF}** – During a VPATH descent and the aircraft speed is less than V_{REF} by 10 knots.

Speed/Altitude Limit

During a VPATH descent with autothrottles engaged, the FMS outputs an altitude target equal to the speed limit altitude when the aircraft speed exceeds the speed constraint (e.g., 250 knots at 10,000 feet) by more than 9 knots. Under these conditions, the FMS levels the aircraft at the speed limit altitude until the aircraft speed is 6 knots greater than the speed limit. The FMS then requests a VFLCH descent down to the next altitude target when the aircraft is more than 250 feet off the vertical profile, otherwise VPATH is requested.

When autothrottles are not engaged or the aircraft is not equipped with autothrottles, the FMS continues the descent through the speed/altitude limit. The pilot is responsible for controlling the speed of the aircraft to meet the speed/altitude limit.

Speed/altitude limit protection is also given during VFLCH descents. Under these conditions, the FMS limits the speed target to the speed limit when approaching the altitude associated with the speed limit.

Planned Step Climbs

Planned Step Climbs are a feature implemented in the NG FMS that allow for greater versatility. Planned steps are available for both step climbs and step descents during the cruise segment of flight. The step climbs or step descents are pilot-entered and direct the FMS to perform a step climb or descent at a desired waypoint. If the aircraft is too heavy to climb to the desired altitude, the message UNABLE STEP is displayed in the scratchpad and the aircraft will remain at its current altitude. UNABLE STEP is also displayed for other reasons, e.g. the planned step waypoint is too close to the TOD, destination, or TOC. If the step altitude is higher than the max altitude, the step is deferred until the computed max altitude gets above the step altitude. The vertical situation display (VSD) depicts the planned steps as part of the vertical profile.

To perform a Planned Step Climb on the ACTIVE FLT PLAN page, follow Procedure 9-5.

Procedure 9-5
Enter a Planned Step Climb

The desired altitude (to step to) is entered into the scratchpad, followed by the letter S. In the following example, FL450S is entered in the scratchpad, as shown in Figure 9-40.

Figure 9-40
ACTIVE FLT PLAN With Step Climb of FL450S in Scratchpad

The desired altitude (to step to) in the scratchpad is then line-selected to the right-hand side of the flight plan adjacent to the desired waypoint. In this example, FL450S is entered into waypoint EGPN by pushing LSK2R, which displays STP above FL450S at 2R. This is shown in Figure 9-41. When the aircraft reaches the selected waypoint and the altitude preselect is set to a higher or lower altitude, the system will automatically begin a climb or descent.

Figure 9-41
ACTIVE FLT PLAN With Step Climb of FL450S at 2R

NOTE: The primary difference between Planned and Optimum Step Climbs is that Planned Step Climbs coincide with a specific waypoint. Optimum Step Climbs, however, will occur anytime the FMS determines the aircraft has the performance to reach the next step climb increment as is input by the crew. Optimum Step Climbs are also only available to climb the aircraft higher, while Planned Step Climbs also have the ability to facilitate descents. Additionally, multiple Planned Step Climbs/Descents can be programmed, resulting in accurate fuel/time predictions.

VNAV APPROACH TEMPERATURE COMPENSATION

VNAV approach temperature compensation is an FMS option and is not available unless enabled. The following page entries specific to the temperature compensation functionality are not displayed when the VNAV approach temperature compensation function is not enabled.

For VNAV approaches, the flight crew has the option of selecting VNAV temperature compensation to assure the FMS meets obstacle clearance standards by the published altitude constraints. The VNAV temperature compensation function adjusts all FMS waypoint altitude constraints for the defined approach, approach transitions, and missed approach segments of the flight plan to compensate for nonstandard day temperatures.

The flight crew configures the FMS for three states of VNAV approach temperature compensation:

- OFF (assumes standard day temperature)
- COLD applies temperature compensation only when approach is flown in COLD conditions (0 to -50 degrees DISA (deviation ISA))
- HOT/COLD applies temperature compensation when approach is flown in any temperature condition (limited to -50 to 70 degrees DISA). This configuration is an option and must be enabled separately from COLD.

Procedure 9-6 is an example of the steps necessary for configuring the FMS for the VNAV approach temperature compensation mode.

Procedure 9-6
FMS Temperature Compensation Configuration

1. Select MAINTENANCE from page2 of NAV INDEX.
2. Select SETUP from page 2 of FMS X MAINTENANCE.
3. Select FLT CONFIG on FMS SETUP.
4. Go to page 2 of FLIGHT CONFIG pages.
5. The FLIGHT CONFIG page layout is shown in Figure 9-42.

Figure 9-42
FLIGHT CONFIG 2/2 - Temperature Compensation

LSK 3L indicates the current temperature compensation mode is OFF and the pilot can choose changes by selecting the LSK 3R.

6. Selecting LSK 3R for changes to the temperature compensation mode shows the TEMP COMP CONFIG page, as in Figure 9-43.

Figure 9-43
TEMP COMP CONFIG

7. The following changes can be made on the TEMP COMP CONFIG page:

   - LSK 1L – Sets temperature compensation mode to OFF
   - LSK 2L – Sets temperature compensation mode to COLD
   - LSK 3L – Sets temperature compensation mode to HOT & COLD.

NOTE: The VNAV approach temperature compensation functionality, as an option, is enabled as COLD only or HOT & COLD. When enabled as COLD, only the previously discussed procedures remain the same with the exception that the HOT & COLD prompt is not available.

The FMS determines the compensated altitude constraint values automatically once an outside air temperature value is entered on the LANDING page and an arrival is inserted into the active flight plan. However, pilot confirmation by the MOD flight plan is required before the altitude compensation is applied to the active waypoints.

Procedure 9-7 is an example of the steps necessary for defining and activating the VNAV temperature compensation values in the active flight plan. (This procedure assumes an arrival has already been inserted into the active flight plan.)

Procedure 9-7
Review and Insert Temp Comp Alt Constraints Into FLT Plan

1. The LANDING INIT page, as shown in Figure 9-44, is displayed by pushing the LANDING prompt on the PERF INDEX page.

Figure 9-44
LANDING INIT - TEMP COMP

On the LANDING INIT page, enter/verify the correct landing temperature (OAT) for the destination airport.

2. The -22 °C TEMP COMP 1/3 page, shown in Figure 9-45, is displayed by pushing the TEMP COMP prompt on the LANDING INIT page.

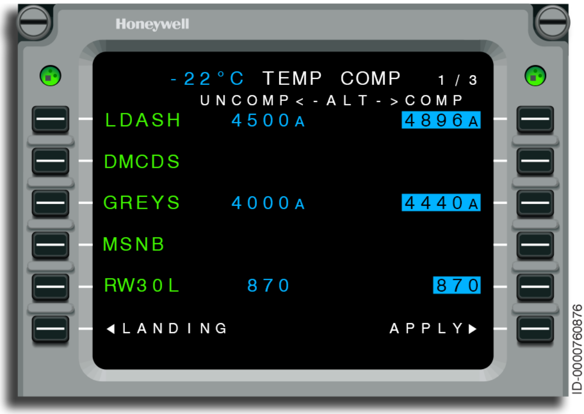

Figure 9-45
MOD TEMP COMP

The proposed altitudes for each of the arrival flight plan constraints are displayed in reverse video on the TEMP COMP page. The titles UNCOMP means uncompensated and COMP means compensated.

NOTE: The temperature compensation is applied only to the altitude constraints from the navigation database and pilot-entered constraints. Pilot-entered constraints are compensated if added prior to activation of TEMP COMP. If a pilot altitude constraint is added after TEMP COMP is activated, it is not compensated. No changes are applied to performance computed values.

3. Select the APPLY prompt to insert the temperature compensated values into the FLIGHT PLAN.

A MOD FLT PLAN page, shown in Figure 9-46, is created with database values of the arrival altitude constraints.

Figure 9-46
MOD FLT PLAN - TEMP COMP Applied

Note again that temperature compensated values are displayed in reverse video.

4. Select the ACTIVATE prompt to apply the changes in the ACTIVE FLIGHT PLAN, as shown in Figure 9-47.

Figure 9-47
ACTIVE FLT PLAN - TEMP COMP Activated

The pilot is able to calculate a temperature compensated approach MDA on the last page in the string of the TEMP COMP pages. The last page of the TEMP COMP page is accessed by pushing the NEXT function key when viewing the TEMP COMP page, shown in Figure 9-43, until the last page is displayed. The default page of the MDA TEMP COMP page is shown in Figure 9-48.

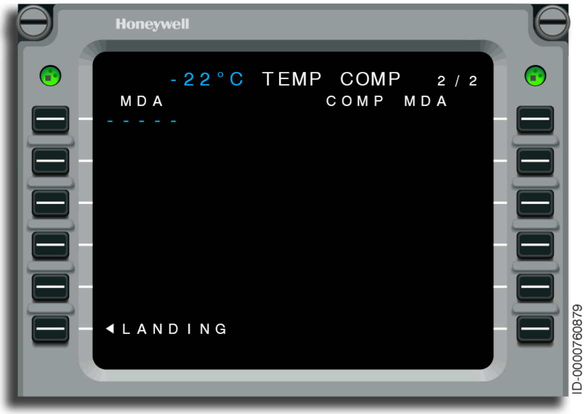

Figure 9-48
TEMP COMP - Last Page

LSK 1L is displayed with dashes. LSK 1R is blank when a published approach MDA has not been entered at LSK 1L. The published approach MDA altitude is entered in feet by the pilot at LSK 1L. When a valid entry is made at LSK 1L, an FMS-computed COMP MDA is displayed in feet at 1R, as shown in Figure 9-49. Invalid entries are not permitted and attempts to do so are annunciated to the pilot with an INVALID ENTRY scratchpad message. An entry is considered invalid when a number outside the range of 0 to 9999 is entered.

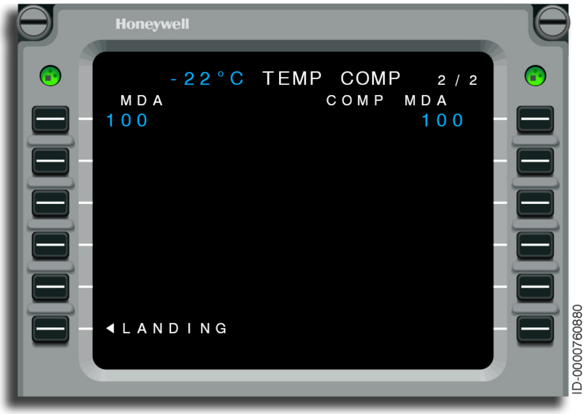

Figure 9-49
-22 °C TEMP COMP 2/2 - MDA

The compensated MDA, when it exists, is displayed opposite the uncompensated MDA at 1R. When an uncompensated MDA does not exist, the compensated MDA field is blank.

Procedure 9-8 is an example of the steps necessary for removing existing values of temperature compensated arrival altitude constraints from the active flight plan.

Procedure 9-8
Remove Temperature Compensation

1. Select the LANDING prompt from the PERF INDEX page to show the LANDING INIT page shown in Figure 9-50.

Figure 9-50
LANDING INIT - Removing Temperature Compensation

2. Select TEMP COMP on the LANDING INIT page. Select the CANCEL prompt, as shown in Figure 9-51, from the TEMP COMP review page.

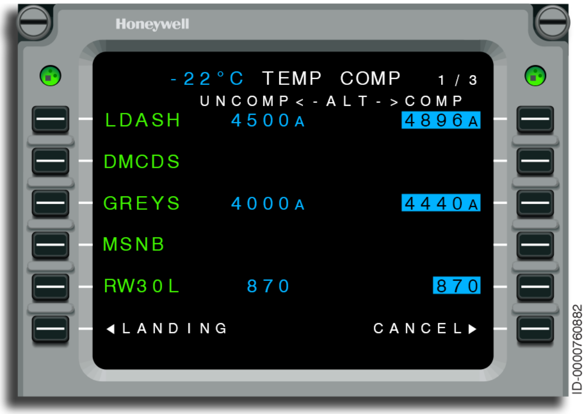

Figure 9-51
TEMP COMP - Removing TEMP COMP

3. A MOD FLT PLAN, shown in Figure 9-52, is created with the database values of the arrival altitude constraints.

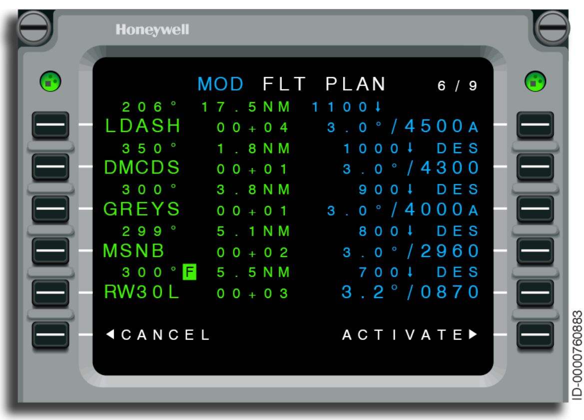

Figure 9-52
MOD FLT PLAN - Removing Temperature Compensation

4. Select ACTIVATE to apply the changes in the ACTIVE FLT PLAN page, as shown in Figure 9-53.

Figure 9-53
ACTIVE FLT PLAN - Temperature Compensation Removed

The TEMP COMP page is accessed either through the LANDING INIT page or from the FLIGHT PLAN pages. For the TEMP COMP access prompt to be available on the FLIGHT PLAN pages, the following conditions must be met:

- The active TEMP COMP CONFIG mode is COLD or HOT & COLD
- The aircraft is within 30 NM of the destination
- An approach has been activated
- Valid OAT (on the LANDING page) is entered.

10. Progress

INTRODUCTION

This section describes the progress functions of the flight management system (FMS).

The PROGRESS pages are accessed by pushing the progress (PROG) function key. These pages summarize important flight parameters and relationships to the flight plan.

PROGRESS PAGES

The PROGRESS 1/3 page, shown in Figure 10-1, displays the progress of the flight to the takeoff (TO) waypoint and the destination, as well as the current navigation status.

Figure 10-1
PROGRESS 1/3 - Overview

- **1L through 1R** – This line shows the last transitioned flight plan waypoint (FROM waypoint) and the actual time of arrival (ATA), altitude, and fuel information for the time when this waypoint was transitioned. Pilot-entry/deletion is not permitted.

- **2L through 2R** – This line shows the active waypoint (TO waypoint) and the estimated time of arrival (ETA) or estimated time en route (ETE), distance-to-go (DTG), and estimated fuel remaining. Entry of any waypoint from a valid primary or alternate portion of the active flight plan or destination or alternate destination are the only entries permitted. If DELETE is performed after any entry is done at 2L, the initial data prior to the entry is displayed.
- **3L through 3R** – This line shows the next waypoint (NEXT waypoint) and the ETA or ETE, DTG, and estimated fuel remaining. Entry of any waypoint from a valid primary or alternate portion of the active flight plan or destination or alternate destination are the only entries permitted. If DELETE is performed after any entry is done at 3L, the initial data prior to the entry is displayed.
- **4L through 4R** – This line toggles the ETA (or ETE), DTG and FUEL information, or the bearing and great circle distance (BRG/GCD) to the destination.
- **5L through 5R** – This line shows the current wind direction and velocity and temperature in degrees Celsius.
- **6L through 6R** – This line shows the display of the NAVAIDs identifier and/or frequency information. Pilot-entry is permitted. The NAVAID at 6L is for the NAV 1 radio and the information at 6R is applicable to the NAV 2 radio. The navigation mode, required navigation performance (RNP) and estimated position uncertainty (EPU) are also displayed.

The PROGRESS 2/3 page, shown in Figure 10-2, shows the RTA PROGRESS page. The required time of arrival (RTA) supplies automatic speed control in the cruise flight phase to arrive at a specified fix (RTA Fix) at a specified time. The required time of arrival (RTA) function permits the crew to enter in a required time to arrive at an RTA fix. The FMS then adjusts the cruise speed in order to meet the arrival time. The RTA PROGRESS page is used to enter and display information used by the RTA function.

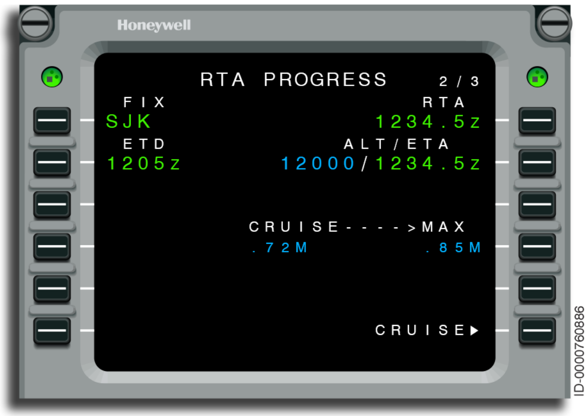

Figure 10-2
PROGRESS 2/3 - Overview

- **1L** – The RTA fix identifier is displayed on this line. If the RTA fix is the TO waypoint identifier, it is displayed in magenta. If the RTA fix was inserted in the temporary active flight plan, the waypoint identifier is displayed in cyan, otherwise it is displayed in green. The default display is dashes to indicate where operator entry is necessary.

  Entry of a valid waypoint contained in the primary portion of the active flight plan or the associated temporary is permitted.

- **1R** – The RTA is displayed on this line in Zulu time. Entry of a valid required time of arrival is permitted along with a designator option that indicates an **at or before** or **at or after** constraint. Entering an invalid RTA results in an INVALID ENTRY message to be displayed on the scratchpad. Entering DELETE results in the entered time to be cleared. The default display is dashes to indicate where operator entry is necessary.

Scratchpad entries for Zulu are entered as follows:

– Entry of 1509 is displayed as 1509.0Z

– Entry of 1509A is displayed as 1509.0ZA.

- **2L** – The estimated time of departure (ETD) is displayed on this line. Valid entries are displayed in Zulu time. The default display on-ground is dashes prior to entry of an RTA FIX and TIME, or ETD. Display and entry of the ETD is only permitted on the ground. Once airborne, the display of the header and data fields are inhibited.

- **2R** – The predicted altitude and ETA for the RTA fix are displayed if performance has been initialized and an RTA fix has been defined.

- **4R** – This line supplies a means for pilot-entry of maximum cruise speed to be commanded by the FMS in order to honor the RTA. These entries are optional. The default display of the maximum cruise speed is 320 CAS or .82 Mach. The default Mach value is displayed if performance is not initialized. Entry of maximum speed is permitted and limited by the default value. If there is no RTA cruise speed, the data under CRUISE goes blank.

NOTE: The text COMPUTING is displayed in place of the cruise speed when the cruise speed is being computed.

- **6L** – CANCEL is displayed once a MOD RTA PROGRESS is displayed due to computation of RTA data, otherwise it is blank. Selecting CANCEL cancels the MOD RTA PROGRESS and clears all entered values that define the MOD RTA.

- **6R** – This line displays the ACTIVATE or CRUISE prompts.

The PROGRESS 3/3 page is shown in Figure 10-3.

Figure 10-3
PROGRESS 3/3 - Overview

- **1L** – This line displays FUEL QTY for computed or GAUGE FUEL when GAUGE is the fuel source.
- **1R** – This line displays the gross weight.
- **2L** – The wind speed and direction is displayed on this line.
- **2R** – This line displays the crosstrack error when a valid crosstrack error exists and the active leg is not a course leg or heading leg.
- **3L** – The tailwind and headwind components are displayed on this line.
- **3R** – The command speed and altitude are displayed here.
- **4L** – The track is displayed on this line followed by a degrees designator if the heading mode is magnetic-referenced, or a **T** if the heading value is true referenced.

  If a valid drift angle exists, it is displayed as follows:

  – When not flying a heading or course leg, the drift angle is displayed, followed by a degrees designator

  – When flying heading or course legs, the drift angle is always blank, even if the track and heading are not equal.

- **4R** – The heading is displayed followed by a degrees designator if the heading mode is magnetic, or a **T** if the heading mode is true.
- **5L** – This line accesses the AIR DATA page.
- **5R** – This line accesses the CLOSEST AIRPORTS page.
- **6L** – This line accesses the RNP SETTINGS page.
- **6R** – This line accesses the VNAV DATA page.

AIR DATA

The AIR DATA page is shown in Figure 10-4. This page is accessed from the PROGRESS 3 page. The FMS shows and uses the active ADS selected for display on the EFIS. In typical operations, FMS 1 shows and uses ADS 1. FMS 2 shows and uses ADS 2. When the copilot selects ADS 1, FMS 2 shows and uses ADS 1 data. The ADS data source is displayed as part of the title.

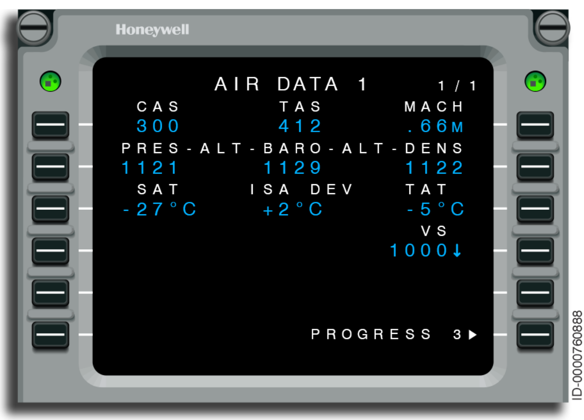

Figure 10-4
AIR DATA 1 - Overview

- **1L through 1R** – CAS, TAS, and Mach speeds are displayed on this line.
- **2L through 2R** – The pressure altitude, barometric altitude, and density altitude are displayed on this line.
- **3L through 3R** – Static air temperature, ISA deviation, and total air temperature are displayed on this line.

- **4R** – This line displays vertical speed if a valid vertical speed exists. An up arrow shows climbing and a down arrow shows descending.
- **6R** – This page accesses the PROGRESS 3 page.

VNAV DATA

The VNAV DATA page, shown in Figure 10-5, shows pertinent VNAV information. It is accessed from the PROGRESS 3 page.

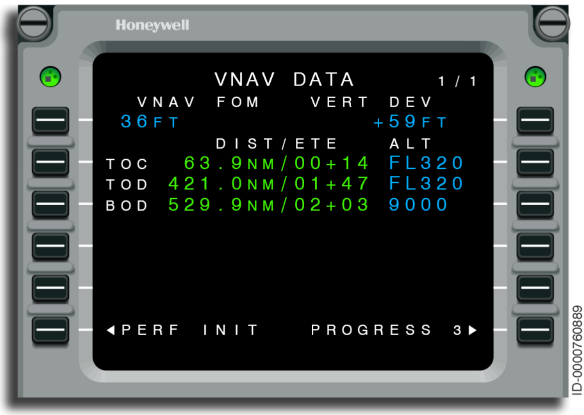

Figure 10-5
VNAV DATA - Overview

- **1L** – Shows VNAV figure-of-merit.
- **1R** – Shows deviation from the vertical path. It is not displayed until 1 minute prior to the TOD or if in the descent phase of flight.
- **2L** – Shows distance and ETE to top-of-climb.
- **2R** – Shows top-of-climb altitude.
- **3L and 3R** – Shows distance, estimated time en route, and altitude for the vertical point of interest, when they are valid. When the aircraft is descending on path, only BOD is displayed and TOD is removed, otherwise the TOD is displayed above the BOD.
- **6L** – Gives access to PERFORMANCE INIT 1 page.
- **6R** – Gives access to PROGRESS 3 page.

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11. Direct/Intercept

INTRODUCTION

This section describes the direct and intercept functions of the flight management system (FMS). There are lateral Direct-Tos, intercepts, vertical Direct-Tos, climb direct, and descent direct functions.

NOTE: Direct-To and intercepts are also available on graphical flight planning. See Section 12, Graphical Flight Planning, for more information on Direct-To and intercept procedures.

LATERAL DIRECT-TO

The lateral Direct-To function is accessed by upselecting a waypoint onto 1L on the ACTIVE FLT PLAN page. This creates a MOD flight plan with three prompts, as shown in Figure 11-1. The three prompts are:

1. CANCEL (6L)
2. ABEAM PTS (3R)
3. ACTIVATE (6R).

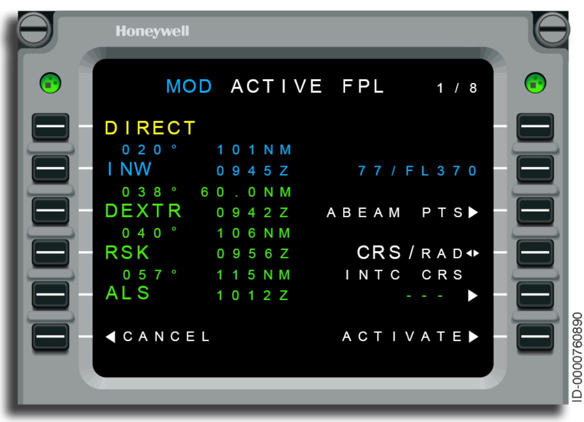

Figure 11-1
MOD ACTIVE FPL - Lateral Direct-To

Lateral Direct-To flight plan entries give the pilot the ability to fly direct to a particular fix or to intercept a course to any waypoint. The fix is part of the active route or is offpath. A lateral Direct-To is accomplished by entering a waypoint in the scratchpad of the ACTIVE FLT PLAN page and upselecting it to 1L. The lateral Direct-To operation is performed either on the ground or in the air. Deleting 1L on the active flight plan page clears the existing flight plan. The following are examples of valid, entered waypoints:

- Any waypoint, airport, navigation aid (NAVAID), or navigation database (NDB) contained in the NAV database
- Any fix defined in the active or modified flight plan, missed approach, or alternate flight plan excluding conditional legs
- A valid place/bearing/distance (PBD) waypoint
- An along-track waypoint
- A latitude/longitude (lat/lon) waypoint or lat/lon reporting point
- A course intersection waypoint.

To perform a lateral Direct-To, a Direct-To waypoint is copied to the scratchpad from the flight plan waypoints or entered manually in the scratchpad. The waypoint in the scratchpad is inserted in the flight plan as the TO waypoint on the FLT PLAN page.

Waypoints cannot be recalled when deleted by sequencing, or waypoints deleted when a lateral Direct-To was entered. These waypoints must be entered in the scratchpad and then upselected to the correct positions in the flight plan. The first waypoint must be entered in 1L and another Direct-To activated.

Direct-To Abeam Points

When a lateral Direct-To is selected, as shown in Figure 11-2, the ABEAM PTS> prompt is displayed on LSK 3R of the MOD ACTIVE FPL page. The abeam points function gives the ability for the FMS to compute and identify points abeam of the flight plan waypoints that are removed from the flight plan as a result of a Direct-To.

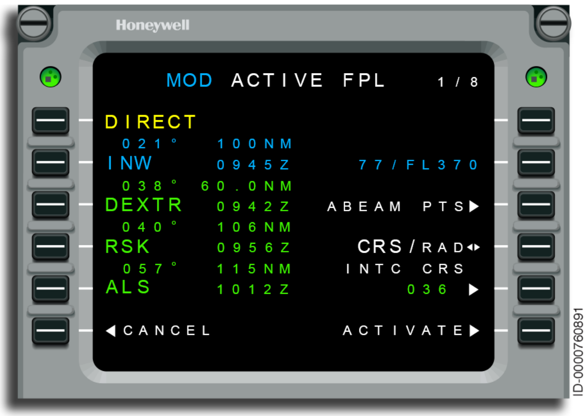

Figure 11-2
MOD ACTIVE FPL - ABEAM PTS Prompt

NOTE: Depending on the geometry and the aircraft position in which the Direct-To with abeams was performed, an abeam waypoint may or may not be created.

When the ABEAM PTS> prompt is selected, the FMS examines the active flight plan waypoints between the aircraft and the Direct-To fix. The FMS then determines the point abeam of those flight plan waypoints as projected onto the Direct-To flight plan leg, and when less than 700 NM, inserts those as PBD waypoints transferring any speed and altitude constraint from the original waypoint. A modified flight plan, shown in Figure 11-3, is created that does not show the abeam points but contains the title, DIRECT WITH ABEAMS, in line 1.

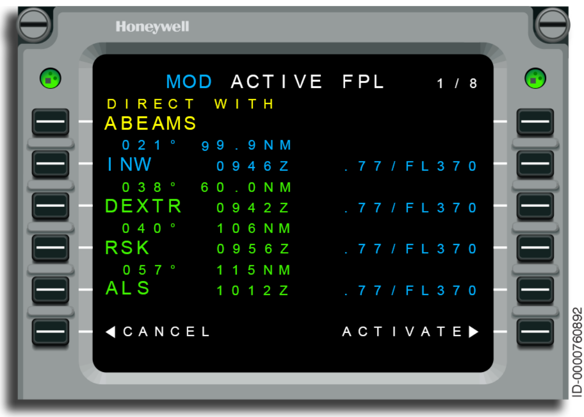

Figure 11-3
MOD ACTIVE FPL - Direct With ABEAMS

Selecting the ACTIVATE prompt at 6R creates an ACTIVE FLT PLAN, as shown in Figure 11-4, that displays the abeam points. The abeam points are displayed on the flight plan with a greater than (>) symbol located adjacent to the waypoint.

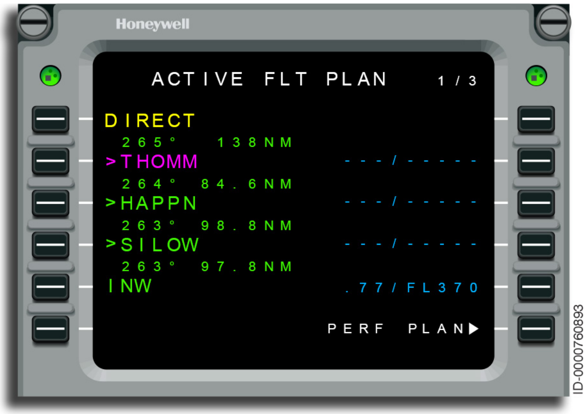

Figure 11-4
ACTIVE FLT PLAN With Abeam Points

The abeam points do not alter the path over the ground. The abeam points do have the characteristics of any flight plan waypoint. The abeam points are displayed on the map and MCDU with all the flight plan waypoint data. The FMS flies Direct-To the first abeam point.

INBOUND COURSE INTERCEPT

The intercept function consists of inbound course intercept, outbound course intercept, arc intercept, and approach intercept. Course intercepts are performed on an on-path waypoint (waypoint that already exists in the flight plan) or an off-path waypoint (waypoint that does not exist in the flight plan). The desired waypoint is upselected to 1L on the active flight plan page. This results in an MOD flight plan. When an on-path waypoint is used for a course intercept, three prompts are shown in the MOD flight plan page, as shown in Figure 11-5. The three prompts are as follows:

1. ABEAM PTS (3R)
2. Intercept course (INTC CRS) (5R)
3. ACTIVATE (6R).

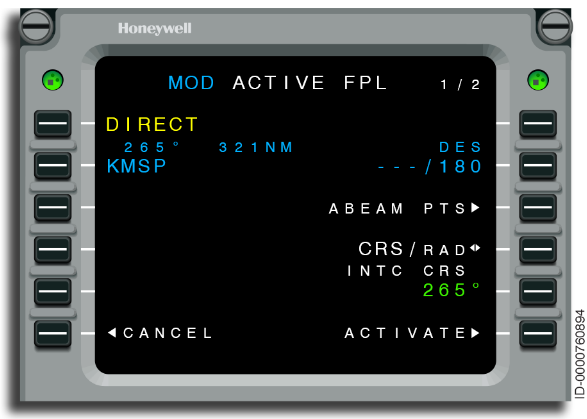

Figure 11-5
MOD FLT PLAN With INTC CRS Prompt

INBOUND RADIAL INTERCEPT

The FMS gives the ability for the pilot to fly a heading, by way of automatic flight control system (AFCS) heading select, to intercept a pilot-specified radial into the pilot-selected waypoint.

The radial intercept function inserts an extended course leg into the selected TO waypoint and disengages LNAV. Heading select mode is flown with LNAV armed until the extended course leg is intercepted. LNAV engagement onto the extended course leg is based on course capture criteria.

- When an off-path waypoint is desired, enter the desired waypoint into the scratchpad and line select the waypoint to 1L on page 1. DIRECT is displayed as the FROM waypoint in 1L. The intercept field is dashed, as shown in Figure 11-6. The crew can enter a course value (0 to 359 degrees). Selecting the ACTIVATE prompt at 6R completes the intercept.

Figure 11-6
MOD ACTIVE FPL - INTC RAD Dashes

- When an on-path waypoint is desired, enter the desired waypoint in the scratchpad or use the associated LSK to put the waypoint in the scratchpad, as shown in Figure 11-7.

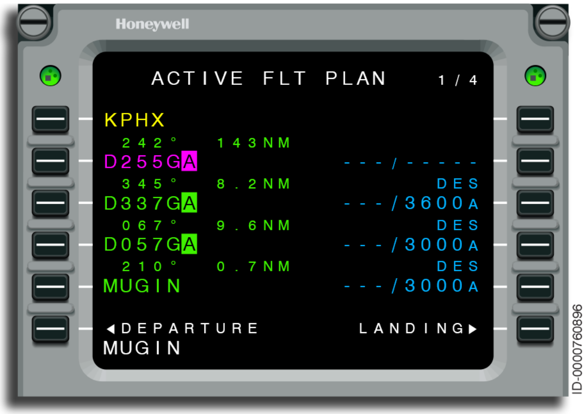

Figure 11-7
ACTIVE FLT PLAN - Waypoint in Scratchpad

The flight crew line selects the waypoint to 1L on page 1. An MOD active flight plan is created, as shown in Figure 11-8, with DIRECT displayed at 1L.

Figure 11-8
MOD FLT PLAN With DIRECT

At 5R, the FMS shows the previous inbound course to the waypoint as a default course. The flight crew can select the 5R prompt to use this course. Alternatively, the flight crew can manually enter a new course. Once the course is selected, FLY HDG SEL TO INTERCEPT is displayed at 1L, as shown in Figure 11-9.

Figure 11-9
MOD FLT PLAN – FLY HDG SEL TO INTERCEPT

Selecting the ACTIVATE prompt at 6R completes the intercept.

Figure 11-10 shows what the page would look like after the ACTIVATE prompt at 6R is selected.

Figure 11-10
FLY HDG SEL ACTIVATED

Once activation of the INTERCEPT is completed by selecting the ACTIVATE prompt at 6R, the flight director (FD) drops to basic lateral mode (ROLL). The pilot must manually select the heading mode to begin flying vectors to intercept the entered course into the FLY HDG SEL TO INTERCEPT waypoint by turning the heading select (HDG SEL) knob on the FD guidance panel. The LNAV is disengaged when armed while flying the heading selected mode. Arm LNAV for re-engagement when the engagement criteria for the course to a fixed waypoint (CF) leg into the selected waypoint is met.

Outbound Course Intercept

The FMS supplies the ability to designate an outbound course intercept from the present position or a designated waypoint. The outbound course to intercept is appended to any waypoint in the active, missed approach, or alternate flight plans. When selected, the outbound intercept creates a lateral track from the designated point along the designated course.

There are two types of outbound course intercepts. They are as follows:

- Present position outbound course intercept (PPOS)
- Down-path outbound course intercept.

PRESENT POSITION OUTBOUND COURSE INTERCEPT (PPOS)

The flight crew initiates a PPOS outbound course intercept by entering PPOS into the scratchpad and appending the desired course (i.e., PPOS/270). The flight crew then upselects the desired waypoint and course into LSK 1L. Once entered, the FMS displays a modified page with the outbound course intercept FM leg listed in 1L followed by a discontinuity.

DOWN-PATH OUTBOUND COURSE INTERCEPT

The flight crew initiates a down-path outbound course intercept to intercept from a designated fix by entering the desired waypoint into the scratchpad and appending the desired intercept course (FM leg) to the selected waypoint in the scratchpad (i.e., PSP/180). The intercept course from entry is displayed in the line following the parent waypoint. The flight crew then upselects this waypoint/course information into the LSK immediately following the selected waypoint. Once entered, the FMS displays a modified flight plan page with the desired waypoint displayed after the selected waypoint, which is followed by the correct course, then a discontinuity.

CLIMB DIRECT

The CLB DIR prompt at LSK 5L, shown in Figure 11-11, is displayed on the CLIMB page and the ACTIVE FLT PLAN page. When selected, it initiates a climb direct.

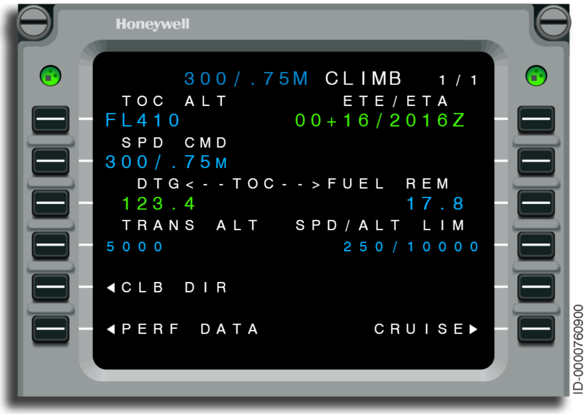

Figure 11-11
CLIMB - CLB DIR

The CLB DIR prompt is displayed when the following conditions are satisfied:

- The current phase of flight is climb
- There are one or more climb waypoint altitude constraints
- The Alt Sel altitude is set above the first climb altitude constraint.

When the CLB DIR prompt is selected, any climb altitude constraints below the selected altitude are deleted, and altitude constraints occurring at the selected altitude are retained. If the selected altitude is set between window constraints, the constraint below the selected altitude, the lower limit, is removed, but the upper limit remains. Deletion of constraints is limited to deletion of altitude constraints. All speed restraints are retained. A modified flight plan is created when a climb direct is selected. When activating this modified flight plan (created by the CLB DIR prompt), if the Alt Sel is dialed to an altitude higher than the cruise altitude, the cruise altitude is revised to the new selected altitude.

DESCENT DIRECT

The DES DIR prompt at LSK 5L, shown in Figure 11-12, is displayed on the DESCENT page and the ACTIVE FLT PLAN page. When selected, it initiates a descent direct.

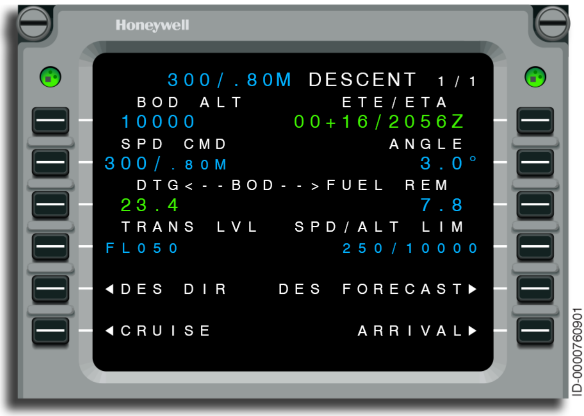

Figure 11-12
DESCENT - DES DIR

The DES DIR prompt is displayed when the following conditions are satisfied:

- The current phase of flight is descent or later
- There are one or more descent waypoint altitude constraints
- The Alt Sel altitude is set below the first altitude constraint.

When the DES DIR prompt is selected, any descent altitude constraints above the selected altitude, including any angle constraints, are deleted and altitude and angle constraints occurring at the selected altitude are retained. If the selected altitude is set between window constraints, the constraint above the selected altitude, the upper limit, is removed, but the lower limit remains. Deletion of constraints is limited to deletion of altitude constraints. Any speed constraint is retained. A modified flight plan is created when a descent direct is selected.

Approach Intercept (Vectors)

The FMS permits vectored approaches to be executed. Vectored-approach transitions permit intersection of an extended course leg into the flight plan. The extended leg is along the original inbound course to the final approach fix (FAF). When a vectored-approach transition is entered, a FLY VECTORS TO INTERCEPT is included in the flight plan. Vectored-approach transitions are incorporated into the flight plan during preflight or immediately activated during flight. Figure 11-13 shows an approach transition at LSK 3L and an ACT VECTORS selection at LSK 6L for immediate activation during flight.

Figure 11-13
ACTIVE FLT PLAN - Vector Transition

Selection of a vectored-approach transition during preflight includes a FLY VECTORS TO INTERCEPT segment into the flight plan immediately prior to the FAF. When sequencing, the fix prior to the FLY VECTORS TO INTERCEPT, LNAV disengages. Heading-select mode is flown and when LNAV is armed, the extended-approach intercept is captured.

Off-Path Approach Intercept (Vectors)

When the aircraft intercepts the approach inside the FAF, the distance-to-go to the next waypoint is computed differently based on whether the aircraft crosses the FAF wayline or not. When the aircraft does not cross the FAF wayline before the FAF sequences (aircraft #1 in Figure 11-14), the distance-to-go is the direct distance to the FAF. After the FAF sequences, the distance-to-go to the next leg (BBBB) is the along track distance, resulting in a slight drop in the distance-to-destination at the FAF sequence. The crew may observe the drop in distance in the progress data window, or observe the remaining fix(es) and destination jump slightly closer to the aircraft on the vertical situation display (VSD).

When the aircraft crosses the FAF wayline from outside the FAF (aircraft #2 in Figure 11-14), the distance-to-go is the direct distance to the FAF until the aircraft crosses the FAF wayline. After crossing the wayline (the FAF sequences when crossing the wayline), distance-to-go to BBBB is scaled to a higher value. There is not a sudden drop in distance-to-destination, but distance-to-go is higher than the actual value and continues down to zero as the aircraft reaches BBBB. The crew observes a distance-to-go value on the PFD and NAV displays higher than the actual value, and on the VSD the active fix appears farther away from the aircraft than it actually is. This distance-to-go converges to the actual value when the aircraft reaches the next fix (BBBB).

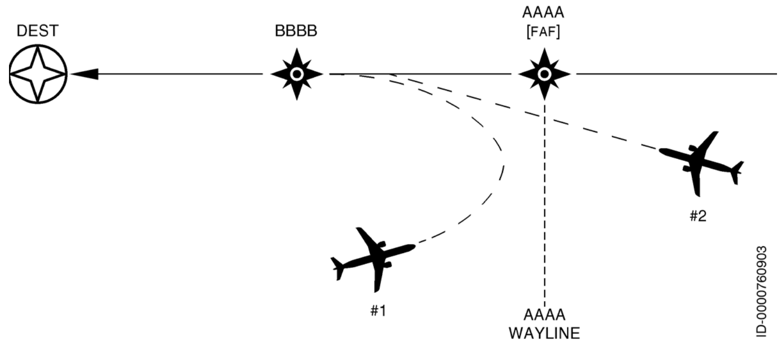

Figure 11-14
Off-Path Approach Intercept

Entering and Flying Arcs

Distance measuring equipment (DME) arcs, as shown in Figure 11-15, can be flown by adding the arc transition to the FMS flight plan, performing a Direct-To a waypoint on the arc, or using heading select to intercept the arc (i.e., vectors to join an arc).

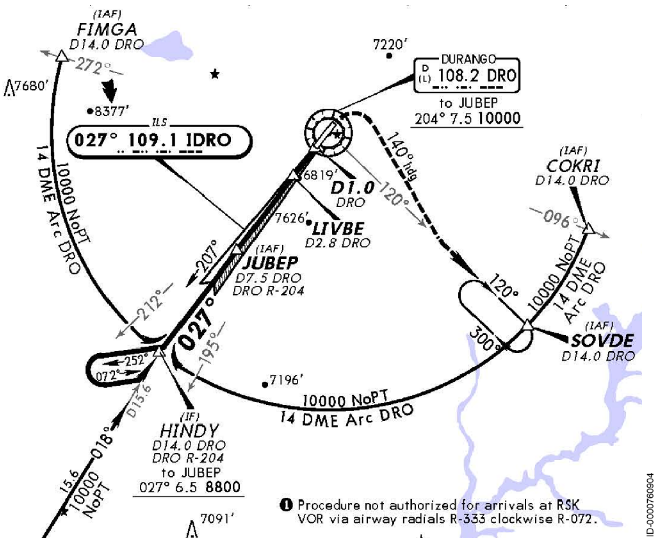

Figure 11-15
ILS Runway 03 in Durango, CO

In this example, the ILS Runway 03 in Durango, CO is selected with the SOVDE transition. The approach and arc transition is loaded into the flight plan, as shown in Figure 11-16.

Figure 11-16
KDRO (Durango, CO) Arrival Page

Once the approach and arc transition are loaded into the flight plan, arc waypoints are indicated with an **A** in reverse video, as shown in Figure 11-17.

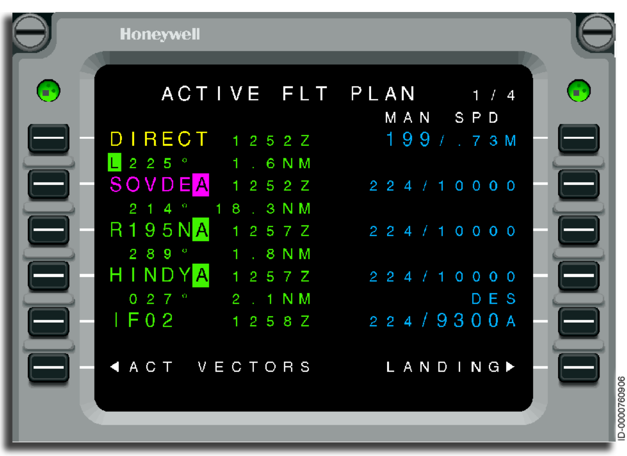

Figure 11-17
Arc Waypoints in Active Flight Plan

The ATC clearance in this example is to fly Direct-To the SOVDE waypoint, fly the 14 DME arc and intercept the localizer for Rwy 03. A Direct-To SOVDE is performed leaving LNAV engaged. The aircraft flies Direct-To SOVDE and begins a turn onto the 14 DME arc with normal course capture criteria. On completion of the arc, the aircraft begins a turn to intercept the inbound LOC course with normal turn anticipation.

Vectors to Join a DME Arc

Flying vectors to join a DME arc instead of flying direct to a waypoint on the arc is done using the HDG mode to intercept the arc. This example uses the ILS 6 approach for KGUC, as shown in Figure 11-18.

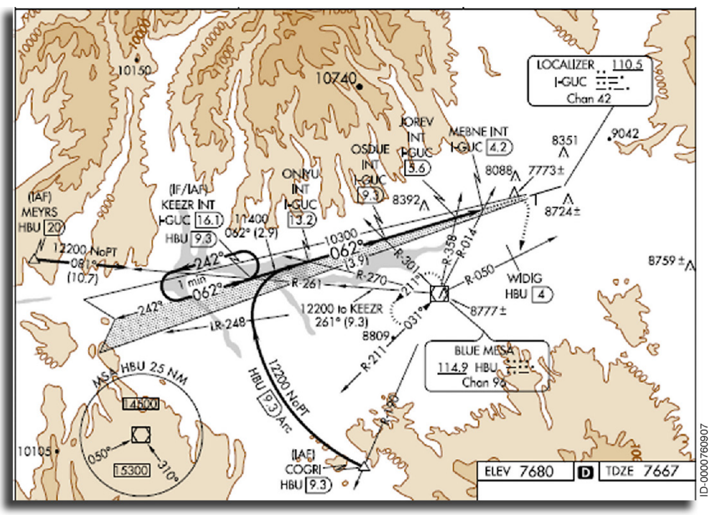

Figure 11-18
KGUC ILS 6 Approach

When being radar vectored to join the DME arc, setup the ACTIVE FLT PLAN page to proceed direct to the first fix on the DME arc, as shown in Figure 11-19. COGRI is the first fix for the DME arc.

Figure 11-19
Active Flight Plan - Direct-To First Fix on DME Arc

Push the DEL key to display *DELETE* on the scratchpad and line select *DELETE* to 1L, as shown in Figure 11-20.

Figure 11-20
Active Flight Plan Page With *DELETE* in Scratchpad

ARC TURN is displayed at 1L along with the radius of the arc that is 9.3 DME arc on HBU VOR, as shown in Figure 11-21. Push the ACTIVATE prompt to activate the mod flight plan.

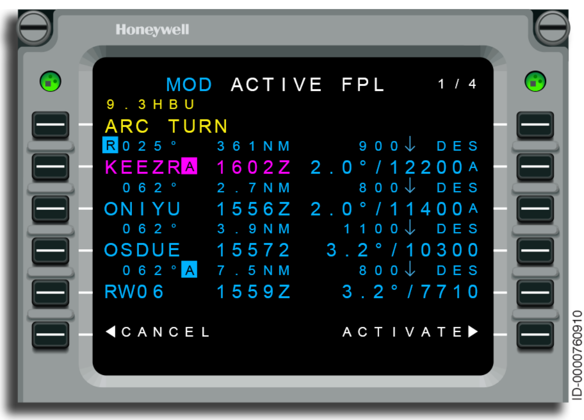

Figure 11-21
ARC TURN on MOD ACTIVE FPL Page

Push the **LNAV** button on the GP to arm the LNAV mode and join the arc. If cleared for the approach, **APPR** can be selected instead of LNAV.

VERTICAL DIRECT-TO

Vertical Direct-To flight plan entries give the pilot the ability to fly direct to a particular altitude prediction at a defined waypoint.

A vertical Direct-To is performed by down-selecting the constraint from the right side of the page into the scratchpad and re-entering the constraint (unchanged) into the same data field (line select). Figure 11-22 shows the down selection of 3R into the scratchpad.

Figure 11-22
ACTIVE FLT PLAN - Vertical Direct-To

If a vertical Direct-To is performed to an irrational constraint, the constraint is converted to a rational constraint and the vertical Direct-To is performed as explained in this section. The constraints before the selected constraint are deleted. Any down path climb constraint that is below the selected constraint is then converted as irrational. Similarly if this is done in cruise or descent phase, any down path descent constraint that is above the selected constraint is then converted as irrational.

Once an entry is made, a modified flight plan is created. This MOD flight plan removes all intermediate vertical constraints from the flight plan as the aircraft transitions to climb/descent mode toward the selected constraint.

This MOD ACTIVE FPL page, shown in Figure 11-23, permits the pilot to review changes and activate or cancel. When activated for climb phase of flight, the FMS transitions to vertical flight level change (VFLCH) for the Direct-To as long as the preselect is dialed above the current aircraft altitude. When activated for cruise/descent phase, the FMS transitions to vertical path (VPATH) as long as the preselect is dialed down below the current aircraft altitude.

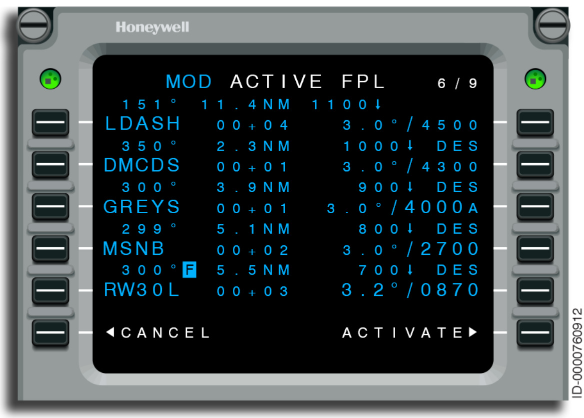

Figure 11-23
MOD FLT PLAN - Vertical Direct-To

A vertical Direct-To is only permitted when the following conditions are met:

- The entered value is an altitude constraint, not a predicted altitude or when a vertical Direct-To is enabled, the entered value is a predicted altitude
- The constraint is compatible with the phase of flight (e.g., climb constraint during CLIMB)
- The constraint is not to the missed approach
- The altitude preselect is positioned to permit the climb/descent.

If the vertical angle is less than 1 degree, the message VERT DIR UNDER MIN ANG is displayed.

If the vertical angle is greater than 6 degrees, the message VERT DIR OVER MAX ANG is displayed.

When the vertical Direct-To is not permitted for the previously discussed conditions, the scratchpad message INVALID Direct-To is displayed.

NOTE: In this case, the resultant angle of the vertical Direct-To is such that the current speed target cannot be maintained without adding drag. The scratchpad message FLT PATH ANGLE TOO STEEP is displayed.

Blank Page

14. Engine Out Operations

INTRODUCTION

This section describes engine out (EO) operations associated with the next generation (NG) flight management system (FMS). The NG FMS supplies the following features during an EO:

- Automatic display of the EO RANGE page
- Automatic EO standard instrument departure (EOSID) insertion
- EO bank angle limits
- EO takeoff/go-around vertical navigation (VNAV) capture altitudes
- EO speeds
- EO drift down.

Automatic Display of EO RANGE Page

When an engine out or an engine fire is detected, the EO RANGE page is automatically displayed on the multifunction control and display unit (MCDU) as long as the MCDU is displaying an FMS page. If the MCDU is displaying a non-FMS page such as the RADIO page, then selecting any FMS page after the engine out/fire detection, the EO RANGE page is displayed instead of the selected page. Pilot confirmation is required when the aircraft speed has reached Vfs, or FMS phase of flight is CRZ, DES, or APPR. The EO RANGE page requiring pilot confirmation is shown in Figure 14-1.

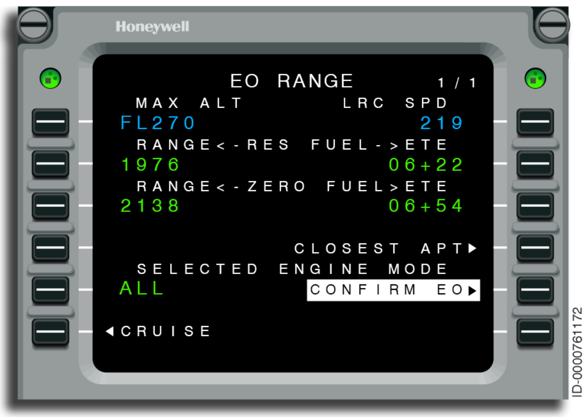

Figure 14-1
EO RANGE - Pilot Confirmation Required

The EO RANGE page with EO confirmed is shown in Figure 14-2.

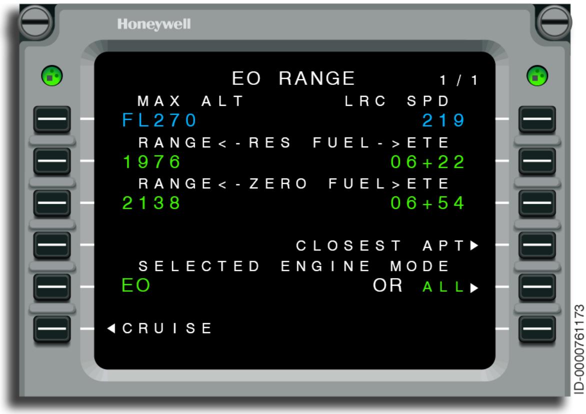

Figure 14-2
EO RANGE - EO Confirmed

EO Automatic Confirmation

The FMS automatically confirms an EO when an EO occurs at TO/GA and the current speed is less than Vfs. Otherwise, the EO condition must be confirmed by the flight crew. EO automatic confirmation is shown in Figure 14-3.

Figure 14-3
EO RANGE - Auto Confirmed With TOGA Automation APM Enabled

NOTE: When taxiing out with one engine inoperative during high winds which display 50 IAS (indicated airspeed) or greater on the primary flight display (PFD), the EO AUTO flight mode annunciator is displayed as well as the EO RANGE page. Pushing the EXIT EO AUTO prompt on the MCDU reverts back to normal indications.

EO Standard Instrument Departure (EOSID)

An EOSID is a modified departure procedure that is flown when an aircraft encounters an engine failure after departure. EOSIDs are airline specific and must be defined for each runway in the navigational database. The display of EOSID on the map and automatic insertion into the flight plan are selectable through an APM setting. If the APM is enabled, it is displayed on the map and is defaulted ON at power-up.

The pilot has the ability to preview the EOSID for a particular runway. The available runways for the departure airport are shown on the DEPARTURE RUNWAYS page, as shown in Figure 14-4. In this example, runway 08 is selected with line select key 3L.

Figure 14-4
KPHX RUNWAYS - EOSID

After the runway is selected, the standard instrument departure (SIDs) page is displayed with the possible departure procedures, as shown in Figure 14-5. An EOSID is available for runway 08, as shown on LSK 1L.

Figure 14-5
KPHX SIDs - EOSID

A discontinuity exists between the last waypoint of the EOSID and the first waypoint of the en route flight plan. When a modified flight plan exists at the time of detection, that modification is replaced with the new modified flight plan. The modified flight plan remains displayed until activated or canceled by the flight crew. The flight crew selects LSK 6R that activates the modified flight plan and creates an active flight plan, as shown in Figure 14-6.

Figure 14-6
ACTIVE FLT PLAN - EO

Since the entire EOSID is inserted into the flight plan, the responsibility of the flight crew is to make sure that any previously sequenced flight plan waypoints existing in the EOSID are cleaned up prior to activation. When a departure procedure is not included in the flight plan, the EOSID is inserted at the front of the flight plan in accordance with normal flight planning rules.

Automatic EO Standard Instrument Departure (EOSID) Insertion

The EOSID is automatically inserted in an MOD flight plan when an engine out occurs and either of the following is true:

- The entire departure procedure has not been sequenced
- The aircraft is less than 50 NM from the origin.

EO Bank Angle Limits

The FMS automatically limits the bank angle limits to an EO bank angle during an EO when the aircraft speed has not reached Vfs, and FMS phase of flight is not CRZ, DES, or APPR. This automation requires the TO/GA automation APM to be enabled. These bank limits are set independently on the DEPARTURE LIMIT and GO-AROUND LIMIT pages, shown in Figure 14-7 and Figure 14-8. These limits are in effect as long as the EO automation (EO AUTO) is annunciated on the PFD flight mode annunciator (FMA), which is until one of the following is true:

- Engine out is no longer active
- Aircraft speed is greater than Vfs+10
- The EXIT EO AUTO prompt on the EO RANGE page is selected
- The approach speeds are activated (either by prompt or by extending flaps)
- FMS phase of flight sequences to CRZ, DES, or APPR
- FMS lateral phase of flight sequences to approach (required navigation performance (RNP) value goes to the approach value).

The DEPARTURE LIMIT page is shown in Figure 14-7.

Figure 14-7
DEPARTURE LIMIT Page - EO Bank Angle Limits (4R)

The GO-AROUND LIMIT page is shown in Figure 14-8.

Figure 14-8
GO-AROUND LIMIT Page - EO Bank Angle Limits (4R)

EO Takeoff/Go-Around VNAV Capture Altitudes

The FMS automatically requests VNAV to capture during takeoffs and go-arounds at an EO capture height when an EO occurs following a go-around when the takeoff/go-around automation APM option is enabled. The VNAV capture heights are set on the DEPARTURE LIMIT and GO-AROUND LIMIT pages, as shown in Figure 14-7 and Figure 14-8.

NOTE: The FMS uses the field elevation associated with a takeoff of the selected runway (used on takeoff EO capture height in DEPARTURE LIMIT page), which may be a different value than the altitude shown on the active flight plan page associated with an approach runway (used on go-around EO capture height in GO-AROUND LIMIT page).

EO Speeds

The FMS supplies EO speeds for all phases of flights. At takeoff, EO speeds follow the normal speed schedule until VNAV is captured, when Vfs is then targeted. If the aircraft speed reaches Vfs+10, the speed target is green dot speed. The flight crew must use speed intervention or another means to speed up the aircraft to reach Vfs+10, if the climb speed of green dot is desired, otherwise the speed target remains at Vfs until a cruise altitude is reached or the aircraft goes into descent/approach. In cruise, the EO speed is EO LRC unless the aircraft is in a drift down situation. Drift down speed is green dot speed. For descent or approach there is no change in speeds during an EO, so the normal schedule speeds are targeted. In a go-around, Vac is targeted while the VNAV mode is green GA. When the FMS VNAV captures, the Vfs is targeted for the climb out. The Vfs is targeted until Vfs+10 is reached, where the EO climb speeds of green dot is targeted. All speeds are shown on the EO CLIMB (LSK 2L), EO CRUISE (LSK 2L), EO DESCENT (LSK 2L), and ACTIVE FLT PLAN (LSK 1R) pages on the MCDU. All EO speed targets are overwritten by the flight crew.

NOTE: In all cases of targeting green dot speeds, green dot is only targeted if the aircraft is in a clean configuration without flaps, otherwise Vfs+10 is targeted.

EO Drift Down

When an EO is confirmed by the flight crew when climbing or cruising above the EO MAX ALT value, shown on LSK 1L on the EO RANGE page, the aircraft goes into an EO drift down mode. The FMS lets the displays and autothrottle systems know that the aircraft is in drift down mode. Displays show this on the FMA as DRIFT DOWN and the autothrottle goes into a drift down (DD) mode that commands maximum continuous thrust.

When drift down is activated, the FMS automatically sets the cruise altitude to the EO MAX ALT. When drift down occurs while climbing, the aircraft automatically levels in the vertical mode of ALT and stays in ALT mode until the drift down speed of green dot is reached. If the aircraft is already in vertical ALT mode when drift down is activated, the vertical mode remains in ALT mode until the drift down speed of green dot is reached. Approximately 1 minute prior to the drift down speed of green dot being reached, the FMS issues a VTA. When the drift down speed is reached, the vertical mode transitions to VFLCH and the aircraft begins to descend, provided that the preselected altitude is dialed down below the current aircraft altitude. If while the aircraft is descending, the descent rate becomes less than 300 ft/min for 10 continuous seconds, the vertical mode switches to VPTH, which maintains a descent rate of 300 ft/min. The aircraft continues to descend to the EO MAX ALT or other flight crew entered altitude which is lower than EO MAX ALT, provided the PSA is dialed to those altitudes. When the aircraft levels in vertical mode of ALT, the drift down mode automatically exits. The drift down mode also automatically exits if the descent path is reached prior to reaching EO MAX ALT or the flight crew entered level off altitude is lower than EO MAX ALT.

15. Multifunction Control and Display Unit (MCDU) Entry Format

INTRODUCTION

This section describes the correct entry format used by the multifunction control and display unit (MCDU).

Each entry made to the MCDU must be checked for correct syntax or format at the time the entry is line-selected from the scratchpad.

NOTE: Leading zeros and zeros after a decimal are not required.

LIST OF ENTRIES AND DEFINITIONS

Table 15-1 lists the requirements for each type of entry.

Table 15-1
MCDU Entry Format

Entry	Format
AGL (Above Ground Level)	• Entry in feet up to five digits • Leading zeros not required • Range from 0 to 20,000

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Airport Identifiers	The flight management system (FMS) uses four-character International Civil Aviation Organization (ICAO) or ICAO-format airport identifiers. When a U.S. airport has a three-letter identifier in the Jeppesen charts, it is normally prefixed with a **K** in the database. Alaskan and Hawaiian airports with a three-letter identifier are normally prefixed with a **P**. Canadian airports with three-letter identifiers are normally prefixed with a **C**. Airports with numbers in the identifier (such as P07) are also included in the navigation database. Any other entry on an airport line is assumed to be a navigation aid (NAVAID), an intersection, or a pilot-defined waypoint. Runway data, including standard instrument departures (SIDs), standard terminal arrival routes (STARs), and approaches, are available only with an airport from the navigation database

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Airway	• Entry format is either start.airway.end or airway.end Where: Start = entry waypoint onto airway Airway = airway name End = exit waypoint of airway • When format airway.end is used, the entry waypoint onto airway must be in the active flight plan and airway must be inserted into the active flight plan following the waypoint • Airway is always followed by a decimal point • It is permitted to enter an airway into the active flight plan when the entry and exit waypoint are adjacent waypoints in the flight plan. In this case, enter the airway into the scratchpad (followed by a decimal point) and place it after the entry waypoint in the active flight plan • Airway to Airway intersections without indicating the intersecting watchpoints between two airways. The entry format is start.airway1.airway2.end Example: TCS.J65.J4.PKE
Alternate Destination	• The name is one to five alphanumeric characters • First character cannot be a dash (-)

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Altitude (Any Altitude Entry)	• Limited to certified ceiling when aircraft database (AEDB) is valid • Entry in feet up to five digits. FMS interprets entries of three digits as flight level entries in locations requiring an altitude entry • Entry in flight levels (FL) • Negative altitude permitted • Automatic display using flight levels above the transition altitude • Range from FL000 to FL600, -1,300 to 60,000 feet
Angle	• Entry in degrees and tenths of degrees. Decimal required only when entering tenths • Range from 1.0 to 6.0
Celsius (CONVERSION page format)	• Entry range is from -999.9° to 999.9° in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Company Route Identifier	• Entry is one to ten characters
Coordinated Universal Time (UTC)	• Entry is one to four digits • Range is from 0 to 2,359 • Leading zeros are not required

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Date	• Entry in day month year (no spaces) • Day is one or two digits • Month is three-letter abbreviation • Year is two digits
Destination	• The name is one to five alphanumeric characters • First character cannot be a dash (-)
Direct-To Waypoint	• The name is one to five alphanumeric characters • First character cannot be a dash (-)
Elevation	• Entry format is identical to the altitude entry format defined on page 15-4
Fahrenheit (CONVERSION page format)	• Entry range is from -999.9° to 999.9° in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Feet (CONVERSION page format)	• Entry range is from 0 to 999,999.9 feet in 0.1 increments (decimal required for tenths)
Flight ID	• Use one to eight alphanumeric characters
Flight Plan Name (Any Entry)	• Use six to ten alphanumeric characters • First character cannot be a dash (-) • When QABC-QCDF(x) format is used, QABC and QCDF are automatically used as the origin and destination of the stored flight plan

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Frequency (NAV)	• The minimum entry is two digits • A decimal is not required when tenths and hundredths are zero • Leading digit (1) is not required • Range is 108.00 to 117.95 MHz; 133.30 to 134.25 MHz; 134.40 to 135.95 MHz in 0.05 increments NOTE: Not all radios are capable of this range.
Fuel Weight	• Entry is pounds or kilograms depending on configuration • Entry is one to six digits • Range is from 0 to 999,999
Gallons	• Entry range is from 0 to 999,999.9 GAL in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Hold Inbound Course/Direction	• Entry of one to three digits is required for course • Entry of L or R is for turn direction • Slash (/) is required when making both entries or turn direction only • The range of course is 0 to 359 degrees in increments of 1
Hold Leg Distance	• The minimum entry is one digit • Range is 1.0 to 20.0 NM in 0.1 increments

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Hold Leg Time	• The minimum entry is one digit • Range is 0.5 to 3.0 minutes in 0.1 increments
Instrument Landing System (ILS) Identifier	• The minimum entry is one character • The maximum entry is four characters
Intercept Radial/ Course	• The minimum entry is one digit • Range is from 0 to 359 degrees in 1 increments
International Standard Atmosphere (ISA) Deviation	• Entry is degrees, up to two digits and negative sign when required • Range is from -80° to +50° Celsius
Kilograms (CONVERSION page format)	• Entry range is from 0 to 999,999.9 KG in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Kilometers (CONVERSION page format)	• Entry range is from 0 to 999,999.9 KM in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Knots (CONVERSION page format)	• Entry range is from 0 to 999.9 KTS in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Latitude	• The first character must be N or S • Degree range from 0 to 90 • Minutes range is from 0.0 to 59.99 in 0.01 increments • Examples of entries: **Entry** — **Display** N0 — N0000.00 N1 — N0100.00 N12 — N1200.00 N123 — N1230.00 N1234 — N1234.00 N1234.5 — N1234.50 N1234.56 — N1234.56
Latitude/Longitude	Entry of both latitude and longitude is made by combining the latitude and longitude entry with no space between (Example: N50W50)
Latitude/ Longitude/Altitude Constraint	• Similar to latitude/longitude, but with the addition of an altitude constraint • The altitude constraint entry format is identical to the altitude entry format defined on page 15-4
Liters (CONVERSION page format)	• Entry range is from 0 to 999,999.9 L in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Longitude	• The first character must be E or W • Range of degrees is from 0 to 180 • Range of minutes is from 0 to 59.99 in 0.01 increments • Example of entries: **Entry** — **Display** W0 — W00000.00 W1 — W00100.00 W12 — W01200.00 W123 — W12300.00 W1234 — W12340.00 W12345 — W12345.00 W12345.6 — W12345.60 W12345.67 — W12345.67
Meters (CONVERSION page format)	• Entry range is from 0 to 999,999.9 M in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Meters/Second	• Entry range is from 0 to 999,999.9 M/S in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Nautical Miles (CONVERSION page format)	• Entry range is from 0 to 999,999.9 NM in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Nondirectional Beacons	• All nondirectional beacons in the NAV database are accessed by using the beacon identifier NOTE: When the nondirectional beacon also has a waypoint identifier, it is in the NAV database only under the waypoint name.

Table 15-1 (cont)
MCDU Entry Format

<table>
<tr><th>Entry</th><th>Format</th></tr>
<tr><td>Oceanic Waypoints</td><td>

These waypoints are named according to ARINC 424 navigation database specification
Southern hemisphere uses the letters S or W
Northern hemisphere uses the letters N or E
Latitude always precedes longitude
Only the last two digits of longitude are used
Placement of the letter designator (N, S, E, W) in the string of five characters indicates the value of the longitude one-hundredths digit
The letter in the last position indicates longitude is less than 100
The letter in the third position indicates longitude is 100 or greater
Letters are used for position designation as follows:

<table>
<tr><th><u>Letter</u></th><th><u>Lat</u></th><th><u>Lon</u></th></tr>
<tr><td>N</td><td>North</td><td>West</td></tr>
<tr><td>E</td><td>North</td><td>East</td></tr>
<tr><td>S</td><td>South</td><td>East</td></tr>
<tr><td>W</td><td>South</td><td>West</td></tr>
</table>

Examples:
N 52 00/W 075 00 = 5275N
N 75 00/W 170 00 = 75N70
S 50 00/E 020 00 = 5020S
N 50 00/E 020 00 = 5020E
S 52 00/W 075 00 = 5275W

NOTE: All oceanic waypoints cannot be active in the navigation database.
</td></tr>
</table>

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Offset (lateral)	• The minimum entry is L or R plus one digit • Range is 0.1 to 30.0 NM in 0.1 increments
Origin	• The name is one to five alphanumeric characters • First character cannot be a dash (-)
Outside Air Temperature	• Entry is in degrees up to two digits and negative sign when required • Range is from -55° to 55° Celsius • Range is from -67° to 131° Fahrenheit
Place/Bearing/ Distance (P/B/D)	• Place is any defined waypoint name • Bearing entry minimum is one digit • Distance minimum entry is one digit • Bearing range is from 0 to 359 degrees in 0.1 increments (decimal required for tenths) • Bearing is true by placing **T** after the number (e.g., PXR/090**T**/30) • Distance range is from 0 to 9,999.9 NM in 0.1 increments (decimal required for tenths)
Place/Bearing/ Distance/Altitude Constraint (P/B/D/ ALT)	• Similar to P/B/D, but with the addition of an altitude constraint • The altitude constraint entry format is identical to the altitude entry format defined on page 15-4

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Place/Bearing/ Place/Bearing (P/B/P/B)	• Place is any defined waypoint name • Bearing entry minimum is one digit • Bearing range is from 0 to 359 degrees in 0.1 increments (decimal required for tenths) • Bearing is true by placing **T** after the number (e.g., PXR/090**T**/BXK/30)
Place/Bearing/ Place/Bearing/ Altitude Constraint (P/B/P/B/ALT)	• Similar to P/B/P/B, but with the addition of an altitude constraint • The altitude constraint entry format is identical to the altitude entry format defined on page 15-4
Place//Distance (P//D)	• Place is any defined waypoint name • Distance entry minimum is one digit • Distance range is from 0 to 9,999.9 NM in 0.1 increments (decimal required for tenths)
Place//Distance/ Altitude Constraint (P//D/ALT)	• Similar to P//D, but with the addition of an altitude constraint • The altitude constraint entry format is identical to the altitude entry format defined on page 15-4
Pounds (CONVERSION page format)	• Entry range is from 0 to 999,999.9 LB in 0.1 increments (decimal required for tenths) • A decimal is not required when tenths position is zero
Pseudo-Random Noise (PRN)	• Entry is one or two digits • Range is from 1 to 32

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
QFE/QNH	• Entry in inHg, mb/hPa, or mm • Entry range is from 16.00 to 32.00 inHg, 542 to 1083 mb, and 406 to 813 mm • A decimal is not required when all zeros follow decimal point
Quadrant	• The minimum entry is one alpha character • Possible entries are N, NE, E, SE, S, SW, W, NW
Radial	• The minimum entry is one digit • Range is from 0.0 to 359 in 0.1 increments
Radial Distance	• Minimum entry of one digit • Range from 1.0 to 999.9 NM in 0.1 increments
Radial Inbound and Outbound Radials	• Minimum entry of one digit • Range from 0.0 to 359.0 in 0.1 increments
Required Navigation Performance	• Entry in tenths. Range .01 to 10.00
Reference Waypoint	• The name is from one to five alphanumeric characters • First character cannot be a dash (-)
Reserve Fuel (Minutes)	• Entry is in minutes up to three digits • Range is from 0 to 999 minutes

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Reserve Fuel	• Entry is pounds or kilograms depending on configuration • Entry is one to six digits • Range is from 0 to 999,999
Runway Elevation	• Entry is in feet up to five digits and negative sign when required • Range is from -2,000 to 15,000 feet
Runway Heading	• Entry is in degrees or runway numbers • Range is from 0 to 360, or 00 to 36 runway number
Runway Identifier	• Entry is Airport.Runway • Range for airport name is from one to five alphanumeric characters • The runway is the runway number with a suffix option of L, R, or C • Range for runway number is from 01 to 36
Runway Length	• Entry is in feet from 2,000 to 16,000
Runway Slope	• Entry can have a minus sign (-) • Range is from -2.0% to 2.0%
Runway Stopway	• Entry is in feet up to four digits • Range is from 0 to 9,999
Runway Threshold	• Entry is in feet up to four digits • Range is from 0 to 9,999

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Specific Weight	• Entry range is from 1.000 to 9.999 LB/GAL (-.1198 to 1.1982 KG/L) in 0.001 increments (decimal required for tenths) • A decimal is not required when all numbers following are zero
Speed (any CAS/ MACH entry)	• Limited to V_{MO}/M_{MO} when aircraft database (ACDB) is valid • Minimum entry for CAS is two digits • Minimum entry for Mach is decimal plus one digit • Range of CAS is from 75 to 320 kts • Range of Mach is from .30 to .82 in 0.01 increments
Speed (any groundspeed entry)	• Minimum entry is two digits • Range from 75 to 750 kts
Step Increment	• Entry in feet up to five digits • Range is from 0 to 30,000 in increments of 1,000 • Entries from 1 to 30 are interpreted as thousands
Stopway	• Entry is in feet up to four digits • Range is from 0 to 9,999
Temperature	• Entry is in degrees and negative sign, when required • Range from -55° to 55° Celsius • Range from -67° to 131° Fahrenheit

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Temporary Waypoint	Active flight plan entries that create temporary waypoints: • Coordinates • Place/Bearing/Distance • Place/Bearing/Place/Bearing • Place//Distance • Intercept function Refer to page 9-3 for additional details about temporary waypoints.
Threshold	• Entry is in feet up to four digits • Range is from 0 to 9,999
VIA.TO	The VIA.TO prompt is used in flight planning. A variety of entries are possible with the prompt. The same entries are made to the flight plan without the prompt (such as when adding waypoints). The following is a list of possible entries: • Airway.Waypoint • Flight Plan Name.Waypoint • Flight Plan Name • Waypoint • Temporary Waypoint
VOR Identifier	• The minimum entry is one character • The maximum entry is three characters
Waypoint Name	• The name is one to five alphanumeric characters • First character cannot be a dash (-)

Table 15-1 (cont)
MCDU Entry Format

Entry	Format
Weight (any weight entry)	• Entry is pounds or kilograms depending on configuration • Entry is one to six digits • Range is from 0 to 999,999
Wind (any wind entry)	• Entry is made in the form of direction/speed • The minimum entry for direction is one digit • The minimum entry for speed is one digit • The range of direction is 0 to 360 degrees • The range of speed is 0 to 99 kts
Zero Fuel Weight (ZFW)	• Entry is pounds or kilograms depending on configuration • Entry is four to six digits • Range is from 1,000 to 999,999

16. Messages

INTRODUCTION

This section defines the scratchpad messages associated with the flight management system (FMS).

The FMS generates messages that alert the pilot to certain conditions. The messages are displayed on the scratchpad and light the message (MSG) light on the primary flight display (PFD). Any entry already in the scratchpad is placed in a stack. The CLEAR (CLR) key on the MCDU clears a message and shows the next message or entry from the stack. Correcting the cause of the message results in that message being cleared from the queue.

MESSAGE LIST AND DEFINITIONS

Table 16-1 contains an alphabetical list of all messages. The list includes the type of message and a brief explanation of the message.

Table 16-1
FMS Messages

Message	Definition
ACTIVATE APP SPEEDS?	The approach speeds have not been activated when the aircraft is within the terminal area.
ACTIVE MODE IS MAG HDG	The magnetic heading has been automatically selected.
ACTIVE MODE IS TRUE HDG	The true heading has been automatically selected.
AEDB CONFIG MISMATCH	This message is displayed if the aero engine database (AEDB) configuration check fails.
ALREADY EXISTS	A duplicate entry has been entered into a list and is not permitted.
ALT CONSTRAINT DELETED	This message indicates that an altitude constraint has been automatically deleted from a flight plan waypoint.

Table 16-1 (cont)
FMS Messages

Message	Definition
ATC COMM TERMINATED	This message is displayed when the connection with the ATC COMM active center is terminated for circumstances other than an FMS failure.
ATC NOT AVAILABLE	This message is displayed when air traffic services (ATS) future air navigation system (FANS) datalink is not configured on the aircraft.
ATC REPORT LIST FULL	This message is displayed when an uplink is received that contains a request for report and maximum number of reports already exist in the report list.
BELOW MIN LND WEIGHT	This message indicates the landing weight is below the minimum value for the current aircraft configuration.
BRG/CRS MUST BE IN TRUE	The bearing entry must be in true (entered xxxT) because the reference waypoint is outside the coverage of the magnetic variation table.
BUSY-SENDING PREV MSG	This message indicates when an attempt to create a downlink elements occurs and another crew selected downlink of the same type is in the SENDING state.
CHECK ALT CONSTRAINT	The pilot must check altitude constraints for a conflict between type of constraints (CLB or DES) and current flight mode (climbing or descending).
CHECK BAROSET	The aircraft has passed the transition altitude/level by more than 1,000 feet or is leveling at or beyond 250 feet from the transition altitude/level and the baro set has not been adjusted to the proper value. This message is shown during climbs and descents.

Table 16-1 (cont)
FMS Messages

Message	Definition
CHECK DATA LOAD (xx)	The attempted dataloader operation has failed. The failure reason is indicated by the value xx. (See Table 17-1 for failure codes.)
CHECK FLIGHT ID	The pilot activates a flight plan for the first time and the flight ID has not been changed since the last system power-up or last FMS flight complete.
CHECK GPS POSITION CHECK GPS 1 POSITION CHECK GPS 2 POSITION	The position from the identified global positioning system (GPS) sensor is more than 10 NM from the FMS position.
CHECK IRS CONFIG	More than one input port has been configured with the same IRS sensor number OR multiple inertial reference systems (IRSs) are configured and one of the sensors has an SDI of 0.
CHECK IRS POSITION CHECK IRS 1 POSITION CHECK IRS 2 POSITION	The position from the identified IRS sensor is more than 10 NM from the FMS position.
CHECK LANDING FLAP	Indicates the flap position is not the same as the flap set on the LANDING page.
CHECK LANDING INIT DATA	Indicates the landing initialization data is used but the TOLD output is invalid.

Table 16-1 (cont)
FMS Messages

Message	Definition
CHECK LANDING SPEEDS	This message is displayed when the computed landing speeds transition to a STBY state from a confirmed start, when the aircraft is 50 NM from the destination without valid landing speeds, or when approach speeds become targeted without valid landing speeds.
CHECK RNP VALUE	The manual required navigation performance (RNP) value is greater than the applicable RNP value for the active flight leg.
CHECK SPEED/ ALTITUDE LIMIT	The upcoming speed and/or altitude constraint must be checked and proper action taken in order to meet the constraints.
CHECK SPEED CONSTRAINT	In cruise or descent in vertical navigation (VNAV), the aircraft is approaching a waypoint that has a speed constraint when the FMS predicts that (based on current speed and deceleration) the constraint speed is exceeded.
CHECK TAKEOFF CG	This message indicates the computed center of gravity (CG) is not within acceptable limits according to the AEDB.
CHECK TAKEOFF INIT DATA	This message indicates the takeoff initialization data is used but the TOLD output is invalid.
CHECK TAKEOFF SPEEDS	This message indicates that the confirmed takeoff speeds are dropped due to an input monitor or computation monitor being tripped.
CHECK T.O. DATA	The Takeoff V_{SPEEDS} are not entered, there is a flap miscompare, or the takeoff configuration is not as planned by the FMS.

Table 16-1 (cont)
FMS Messages

Message	Definition
CHECK VOR/DME POSITION	The position from the identified very high frequency omni-directional range/ distance measuring equipment (VOR/ DME) is more than 10 NM from the FMS position.
CHK SPD/TURN TO WPT	The pilot should check the speed to be flown for an upcoming lateral transition to the active flight plan that may result in path overshoot or cross track error.
COMPARE FMS POSITIONS	The positions of the FMSs have a difference greater than 5 NM. The systems continue to operate normally.
DATA BASE OUT OF DATE	On power-up, or on completion of navigation (NAV) database loading, the NAV database is not current to the date entered in the FMS.
DB TRANSFER ABORTED	This message is displayed when a database (DB) transfer operation is aborted prior to completing.
DATALINK TIMEOUT	Communications management function (CMF) does not respond after a pre-determined time (100 ms).
DB TRANSFER COMPLETE	This message is displayed when a DB transfer operation is successful.
DESCENT FORECAST AVAIL	This message is displayed when a valid descent only wind uplink is received or a valid cruise and descent wind uplink is received and the cruise winds were accepted or rejected.
DRAG REQUIRED	This message is displayed when an overspeed condition exists during descent.
DUPLICATE FLT PLAN NAME	A stored flight plan already exists with the entered flight plan name.

Table 16-1 (cont)
FMS Messages

Message	Definition
END OF FLIGHT PLAN	Indicates the last defined waypoint. It does not apply to the destination waypoint.
ENDING WPT NOT FOUND	The ending waypoint of an airway or flight plan cannot be found.
ENTERING POLAR REGION	The polar region at 82° North or South and keyhole have been entered.
EXCEEDS CEILING ALTITUDE	This message is displayed when the cruise altitude exceeds the recommended performance altitude.
EXCEEDS CERT CEILING	This message is displayed when the entered altitude is above the certified ceiling for the aircraft.
EXCEEDS MAX GROSS WEIGHT	The gross weight exceeds the maximum ramp weight in the aircraft database. The maximum weight used to trigger this message is the aircraft types design maximum weight. The maximum weight can be different from the operational weight limitation of the aircraft flight manual (AFM).
EXCEEDS MAX LANDING WT	The projected landing weight exceeds the maximum landing weight. The maximum weight used to trigger this message is the aircraft types design maximum weight. The maximum weight can be different from the operational weight limitation of the AFM.
EXCEEDS MAX TAILWIND	This message is displayed when the pilot enters a wind that results in a tailwind component higher than 15 knots.

Table 16-1 (cont)
FMS Messages

Message	Definition
EXCEEDS MAX TAKEOFF WT	This message is displayed when takeoff weight exceeds the maximum allowable. In this case, takeoff data is computed at the maximum allowable takeoff weight. The maximum weight used to trigger this message is the aircraft types design maximum weight. The maximum weight can be different from the operational weight limitation of the AFM.
EXITING POLAR REGION	The aircraft is leaving the polar region at 82° North or South and also leaving the North and South keyholes.
FLT PLAN RECEIVED	A flight plan has been received.
FLIGHT PLAN FULL	The flight plan is full and is displayed when the pilot attempts to enter more than 100 waypoints in a flight plan.
FLIGHT PLAN SAVED	The flight plan has been saved to the custom database.
FLT PATH ANGLE TOO STEEP	The VNAV flight path angle exceeds an angle such that the current speed target cannot be maintained without adding drag.
FMS EXITING HOLD	The FMS is exiting a high altitude (HA) holding pattern.
FMS-LPV MISCOMPARE	This message is displayed when the satellite based augmentation system (SBAS) service provider ID in the FAS DB does not match the SBAS service provider ID from the GPS receiver, the channel ID in the FAS DB does not match the channel ID from the GPS receiver or the IO FAS DB indicator for the GPS is false.
FMS POSITIONS DIFFERENT	The FMS positions differ by 10 nautical miles or more.
FPL STORAGE FULL	The storage area for flight plans is full.

Table 16-1 (cont)
FMS Messages

Message	Definition
GPS 1 CONFIG MISCOMPARE	This message is displayed when the GPS configuration data cannot be sent to the GPS. Therefore, GLS approaches may not be available.
GPS 2 CONFIG MISCOMPARE	This message is displayed when the GPS configuration data cannot be sent to the GPS. Therefore, GLS approaches may not be available.
GPS RAIM ABOVE LIMIT	The RAIM value is above the limit for the current phase of flight.
GPS RAIM UNAVAILABLE	RAIM is not being generated by the GPS receiver.
HIGH PCDR TURN GRD SPD	The groundspeed exceeds the limit for the defined procedure turn.
HIGH HOLDING GRD SPD	The groundspeed exceeds the limits for the FAA permitted size of holding pattern.
INDEPENDENT OPERATION	The system reverted to independent operation.
INTERSECTION NOT FOUND	PD (place distance) waypoint does not intersect the active flight plan.
INVALID AERO/ ENGINE DB	This message is displayed if a valid AEDB is not available, if the installed AEDB has failed the integrity check, or if FADEC is invalid when the FMS is powered up.
INVALID ATC DB	This message is displayed if a valid ATC database is not available or if the installed ATC DB has failed the integrity check.
INVALID ATC UPLINK	This message is displayed if an uplink message is received that is determined to be invalid and not usable/displayable to the flight crew.
INVALID CUSTOM DB	The custom DB has been corrupted and has been cleared and initialized.

Table 16-1 (cont)
FMS Messages

Message	Definition
INVALID DELETE	Indicates invalid entry of the named parameter.
INVALID DIRECT TO	Indicates that a requested vertical Direct-To cannot be completed.
INVALID ENTRY	Entry is not in the correct format.
INVALID FPLN OPERATION	This message is displayed if an invalid flight plan operation is attempted.
INVALID FLPN UPLINK	Indicates an invalid flight plan uplink is received.
INVALID MAG/VAR DB	Indicates a valid magnetic variation database is not available or the installed magnetic variation database has failed the integrity check.
INVALID NAV DB	The navigation database is invalid and is not usable. Reload the database.
INVALID NOTAM LIST	Indicates that the notice to airmen (NOTAM) is invalid and has been cleared.
INVALID PERF UPLINK	Indicates when an invalid performance uplink is received.
INVALID RTA FIX ENTRY	This message is displayed when the flight crew attempts to enter a waypoint that is incorrectly formatted or not allowed to be used as the RTA.
INVALID TOLD DB	Indicates a valid TOLD database is not available or the installed TOLD database has failed the integrity or compatibility check.
INVALID TO UPLINK	Indicates when an invalid takeoff uplink is received.
INVALID WIND DATA UPLINK	Indicates when an invalid wind data uplink is received.
LAST LEG	The active leg is the last leg of the flight plan and the TO waypoint is not the destination.

Table 16-1 (cont)
FMS Messages

Message	Definition
LIST FULL	Entry into a list is not permitted because the list is full.
LPV APPR LOAD FAIL	Indicates that the FAS DB did not load successfully.
MESSAGE LIMIT EXCEEDED	Indicates when the current selection or entry would result in more than five downlink message elements to be selected for inclusion in the downlink message.
MOD FPL ACTION REQD	Indicates that when a COPY or SWAP of an existing secondary flight plan or APPLY of an existing stored flight plan is attempted, the existing MOD must be resolved.
NEW TO DATA AVAIL	This message is displayed if the flight crew changes the existing uplinked ORIGIN/RW departure information and a valid uplink exists for the new ORIGIN/ RW pair.
NEW WINDS AVAIL	This message is displayed when a valid wind uplink is received.
NO APPROACH SELECTED	This message is displayed if an approach is selected without an approach transition.
NO CROSSING POINT FOUND	No crossing points are found for the CROSSING POINTS page.
NO FLIGHT PLAN	Origin or origin/destination is entered on the FLIGHT PLAN LIST page and there is no flight plan with the same origin or origin/destination.
NO INPUT ALLOWED	No input is permitted.
NO POSITION SENSORS	The dead reckoning (DR) light is turned on.

Table 16-1 (cont)
FMS Messages

Message	Definition
NO PRESENT POSITION	An action is requested that requires present position.
NO UPLINK FPL AVAIL	A flight plan has not been received when requesting to load a flight plan.
NOT A NAVAID	An entry was made that requires a NAVAID and the entry is other than a NAVAID.
NOT ALLOWED-RTA ACTIVE	Indicates when an entry is made that is not permitted because RTA is active.
NOT AN AIRPORT	An entry was made that required an airport name and other than an airport name was entered.
NOT IN DATA BASE	The pilot requested some data not in the database and cannot be pilot-defined.
OFFSET CANCEL	The offset has been canceled.
OFFSET CANCEL NEXT WPT	The offset is canceled at the next waypoint in the flight plan. This message is cleared by pilot-action or is automatically cleared when the offset is canceled.
PARTIAL UPLINK LOADED	Displayed when only part of an AOC flight plan uplink message is loaded into the FMS.
PERF UPLINK NOT RECEIVED	Displayed when the Perf Init request response timer elapses without a valid Perf Init uplink being received from when the request button was pushed.
PERF UPLINK RECEIVED	Displayed when a valid performance uplink is received.
PERF-VNAV UNAVAILABLE	The pilot requested a performance/VNAV function before sufficient data had been entered.

Table 16-1 (cont)
FMS Messages

Message	Definition
PROCESSING INPUT	Indicates that the button push processing is taking excessively long when the FMS processing time exceeds the value in seconds specified in a configurable attribute. If the configurable attribute value is zero, the message is disabled.
RADIALS DO NOT INTERSECT	The radials defined for the intercept function do not cross.
RE-LOGON TO ATC CENTER	This message indicates that an ATC logon message was sent from the aircraft but ATC did not respond within the required time or the logon was not successful.
RESET ALT SEL?	Indicated during any of the following conditions: • Approaching climb constraint and altitude selector not set higher • Approaching descent constraint on a level segment and altitude selector not set lower • Approaching start of engine-out drift-down descent and altitude selector not set lower • Entry of cruise altitude lower than set altitude selector • Approaching planned climb • Approaching planned descent • Selection of DES NOW and altitude selector not set lower • Selection of vertical Direct-To with invalid set altitude selector (i.e. amber dashed) • Arming or selecting VNAV with invalid set altitude selector (i.e. amber dashed).

Table 16-1 (cont)
FMS Messages

Message	Definition
RESPOND TO ATC UPLINKS	Indicates when an uplink message cannot be retained and presented due to exceeding the defined available storage buffer corresponding to the received uplink message.
REQUESTED DATA NOT RCVD	Indicates when a valid uplink response to a FLIGHT PLAN or WINDS downlink request is not received within a configurable attribute timer of 10 minutes from when the request button was pushed.
RTA FIX DELETED	Indicates when a flight planning operation results in the deletion of a waypoint that has an RTA associated with it.
RUNWAY NOT FOUND	The database does not contain the entered runway at the designated airport.
SET IRS MAG HDG SET IRS 1 MAG HDG SET IRS 2 MAG HDG	Indicates that IRS (X) has to have the magnetic heading set.
SINGLE OPERATION	There is a problem between the FMS that precludes full communication between the systems.
SPEED INTV CANCELLED	This message is displayed if there is an entry of an RTA target or speed intervention, a performance flight change occurs, or an engine-out condition is detected.
SYNC IN PROGRESS	Indicates the FMS is in the process of synchronizing data.
TAKEOFF UPLINK RECEIVED	This message is displayed when a valid takeoff uplink is received.

Table 16-1 (cont)
FMS Messages

Message	Definition
TEMP COMP CANCELLED	This message is displayed when temperature compensation has been automatically canceled.
THRUST REQUIRED	This message indicates thrust is required during descent.
TO ENTRY INHIBITED	This message indicates no entries can be made to takeoff. This happens when making an entry to takeoff and power has been advanced for takeoff.
TO UPLINK NOT RECEIVED	This message indicates when the takeoff request response timer elapses without a valid takeoff uplink being received from when the request button was pushed.
TO UPLINK RECEIVED	This message indicates when a valid takeoff uplink is received.
TOLD DB CONFIG MISMATCH	This message is displayed if the TOLD database configuration check fails.
TOLD DB MISCOMPARE	This message is displayed if the TOLD database does not match between TOLD 1 and TOLD 2.
UNABLE APPROACH MOD	An attempt is made to change the lateral path between the FAF and the MAP.
UNABLE CRZ ALT	This message indicates the cruise speed cannot be reached prior to the top-of-descent (TOD) or a cruise altitude cannot be reached that has a segment long enough to be flown 1 minute prior to the TOD.
UNABLE FLXXX AT RTA FIX	This message indicates the FMS predicts that the aircraft is unable to achieve the specified altitude at an RTA fix.
UNABLE MANUAL CLOCKSET	This message indicates that the FMS time and date is being slaved to outside time and date (e.g., GPS or aircraft) and cannot be changed.

Table 16-1 (cont)
FMS Messages

Message	Definition
UNABLE NEXT ALT	The aircraft is unable to meet the altitude constraint.
UNABLE OFFSET	An attempt was made to insert an offset during a large course change.
UNABLE PCDR TURN CHANGE	Changing the procedure turn definition is inhibited after sequencing onto the procedure turn.
UNABLE PD PLACEMENT	The PD waypoint has been restricted from placement in the flight plan.
UNABLE RNP	This message is displayed when the FMS EPU is greater than RNP or HIL is greater than the integrity limit.
UNABLE RNP NEXT WPT	This message is displayed when the aircraft is within 2 minutes of the TO waypoint and the current FMS EPU is greater than the RNP required at the TO waypoint.
UNABLE RTA	This message is displayed when the FMS has calculated that the RTA cannot be met within the RTA tolerance. The initial calculation of the RTA can take up to 15 seconds.
UNABLE STEP	The aircraft is unable to climb to the next step waypoint (e.g. the aircraft is too heavy, or the planned step waypoint is too close to the TOC, TOD, or destination).
UNABLE TO LOAD CLEARANCE	Displayed when the FMS is unable to load the uplink clearance.
UNABLE TO SEND DOWNLINK	The FMS has been waiting for a network acknowledge for a linked message for 5 minutes.
UNABLE TUNE REQUEST	The pilot entered a frequency while the radios were in the manual mode.

Table 16-1 (cont)
FMS Messages

Message	Definition
USED BY FLIGHT PLAN	The pilot tried to delete a waypoint from storage that is used in the active or secondary flight plan, as a NAVAID in the computation of aircraft position, or as the displayed NAVAID.
VERT DIR OVER MAX ANG	The angle computed during a vertical Direct-To exceeds the limit. In this case, the angle is set to the maximum limit (6°).
VERT DIR UNDER MIN ANG	The angle computed during a vertical Direct-To is under the limit. In this case, the angle is set to the minimum limit (1°) and descent is started at that time.
VGP UNAVAILABLE	Vertical glide path is unavailable.
WAYPOINT NOT ON AIRWAY	The entered waypoint is not found on the airway.
WAYPOINT NOT FOUND	The entered waypoint cannot be found. This results when attempting to enter an airway into a flight plan and the waypoint is not part of the referenced airway.
WPT STORAGE FULL	The storage area for pilot-defined waypoints is full.

17. Maintenance

INTRODUCTION

This section defines the dataloader fault codes that are displayed on the multifunction control and display unit (MCDU).

DATALOADER FAULT CODES

When the MCDU shows a message of CHECK DATA LOAD (XX) after an attempted data load operation, the numeric value in the XX position is interpreted using the dataloader fault codes listed in Table 17-1.

Table 17-1
Dataloader Fault Codes

Code	Error Title	Description
02	STATUS CMD NO RESPONSE	There is a communication failure to the dataloader.
05	GET 1ST FP RECORD FAILED	The data in a flight plan file (sperry.dat) is incorrectly formatted.
10	BAD ZFW VALUE	The flight plan file contains an illegal zero fuel weight value†.
11	BAD FUEL VALUE	The flight plan file contains an illegal fuel value†.
12	BAD CARGO VALUE	The flight plan file contains an illegal cargo weight value†.
13	BAD PASSENGERS VALUE	The flight plan file contains an illegal passenger count†.
14	BAD INITIAL CRUISE	The flight plan file contains an illegal cruise altitude†.
15	BAD CRUISE SPEED	The flight plan file contains an illegal cruise speed†.
16	BAD CRUISE WIND	The flight plan file contains an illegal cruise wind†.
17	BAD CRUISE FUEL FLOW	The flight plan file contains an illegal fuel flow†.

Table 17-1 (cont)
Dataloader Fault Codes

Code	Error Title	Description
18	BAD NUM WAYPOINTS	The syntax of the waypoint count is illegal or the waypoint count does not match the actual number of waypoints†.
19	NUM WPTS OUT OF RANGE	The flight plan file contains a waypoint count less than 2 or greater than 50†.
1A	BAD NUM ALT WPTS	The flight plan file contains an illegal number of waypoints in the alternate flight plan†.
1B	NUM ALTS OUT OF RANGE	The flight plan file contains an illegal number of alternate destinations†.
1E	GET IDENT FAILED	The flight plan file contains an illegal waypoint identifier†.
1F	GET LATITUDE FAILED	The flight plan file contains an illegal waypoint latitude†.
20	GET LONGITUDE FAILED	The flight plan file contains an illegal waypoint longitude†.
21	GET SPD CONSTR FAILED	The flight plan file contains an illegal waypoint speed constraint†.
22	GET FL CONSTR FAILED	The flight plan file contains an illegal waypoint flight level constraint†.
23	GET SPOT WIND FAILED	The flight plan file contains an illegal waypoint spot wind value†.
24	GET SPOT TEMP FAILED	The flight plan file contains an illegal waypoint temperature value†.
25	GET METERO FL FAILED	The flight plan file contains an illegal meteorological flight level†.
† These codes are associated with errors in flight plan format requirements. Contact the flight plan provider for assistance.		

MCDU PARALLAX ADJUSTMENT

The MCDU is adjusted for parallax. This feature is used when the MCDU is mounted in the cockpit such that the pilot does not have a direct viewing angle to the MCDU. When this occurs, the line select prompts display out of alignment with the physical line select keys. This is called parallax. Pushing PARALLAX (5R) on the MCDU MAINTENANCE page accesses the PARALLAX ADJUST page. This is shown in Figure 17-1.

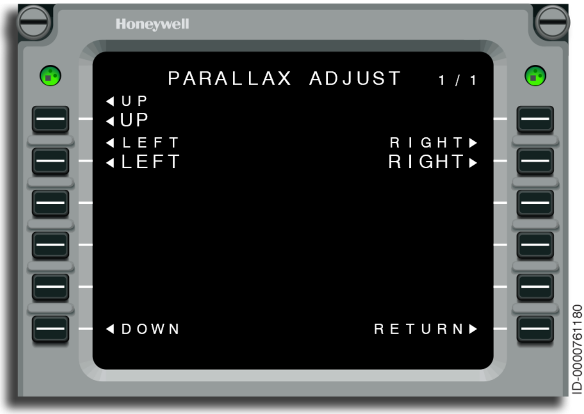

Figure 17-1
PARALLAX ADJUST 1/1

– **1L** – Push the UP prompt to vertically adjust the MCDU display upward.

– **2L** – Push the LEFT prompt to horizontally adjust the MCDU display to the left.

– **2R** – Push the RIGHT prompt to horizontally adjust the MCDU display to the right.

– **6L** – Push the DOWN prompt to vertically adjust the MCDU display downward.

– **6R** – Pushing the RETURN prompt returns the display to the SYSTEM SETUP 1/1 page or to the last page being viewed when the navigation computer (or performance computer, when installed) is operating. Pushing RETURN also saves the system status for recall on subsequent flights.

FMS OPERATION MODE PROBLEMS

The FMS is capable of three different operating modes: DUAL, INDEPENDENT, and SINGLE. The FMS attempts to operate in DUAL at all times. When the FMS is unable to operate in DUAL mode, the FMS shows either INDEPENDENT OPERATION or SINGLE OPERATION on the scratchpad. The pilot then goes to the OP MODE PROBLEMS page to view the error message. Table 17-2 lists possible error messages and descriptions.

Table 17-2
Operation Mode Problem Messages

Displayed Error	Resulting Operating Mode for the Differing FMS	Description
SW PROGRAM	SINGLE	The software version differs between the FMSs. SINGLE operation is the only operating mode available for the FMS with a different SW load.

Table 17-2 (cont)
Operation Mode Problem Messages

Displayed Error	Resulting Operating Mode for the Differing FMS	Description
APM CONFIG	SINGLE	The configuration pins (or configuration module) required for DUAL and INDEPENDENT operating modes are not identical. The following items are compared between FMSs: • SDI setting discretes • Performance computer installed discrete • Overspeed protection disabled discrete • Version B ASCB discretes • Fuel flow config. discretes • Operational mode discretes • Radio type discretes • Pounds/Kilograms discretes. Verify that the configuration settings are identical between FMSs.
NAV DB	INDEPENDENT	The navigation database is not identical between two FMSs. DUAL is not permitted unless the navigation databases are identical. To update the navigation database using either the DL-800/900, follow Procedure 6-24.
AEDB	INDEPENDENT	An Aero Engine Database is not available, or the installed AEDB has failed the AEDB integrity check.

Table 17-2 (cont)
Operation Mode Problem Messages

Displayed Error	Resulting Operating Mode for the Differing FMS	Description
MAG VAR DB	INDEPENDENT	A Magnetic Variation Database is not available, or the installed MAG VAR DB has failed the MAG VAR DB integrity check.
SYNC FAIL	SINGLE	The FMS attempted to share data with another FMS but could not. Check whether ASCB is operational. Check whether backplane connections are operational. Otherwise, it is an internal FMS software fault. When this problem is encountered, please report the problem to Honeywell.
FMS1 INOP	SINGLE	The FMS showing this message is unable to receive FMS1 transmissions on the ASCB. Verify that the ASCB is operational and properly connected to the FMS.
FMS2 INOP	SINGLE	The FMS showing this message is unable to receive FMS2 transmissions on the ASCB. Verify that the ASCB is operational and properly connected to the FMS.

Acronyms and Abbreviations

Acronyms and abbreviations used in this guide are defined as follows:

TERMS	DEFINITION
ACARS	Aircraft Communications Addressing and Reporting System
ACDB	aircraft database
ACK	acknowledge
ACT	activate, active
ADL	airborne dataloader
ADS	air data system, automatic dependent surveillance
ADS-C	automatic dependent surveillance - contract
AEDB	aero engine database
AFCS	automatic flight control system
AFE	above field elevation
AFIS	airborne flight information system
AFM	aircraft flight manual
AFN	ATS facilities notification
AGL	above ground level
AIP	airport improvement program
ALT	alternate altitude
AMI	airline modifiable information
ANG	angle
AOA	ACARS over AVLC
AOC	aeronautical operational communication, airline operational communication
AOG	aircraft-on-ground
APCH	approach
APM	aircraft personality module
APP, APPR	approach

TERMS	DEFINITION
APU	auxiliary power unit
AR	authorization required
ARP	airport reference point
ARINC	Aeronautical Radio, Inc.
ATA	actual time of arrival
ATC	air traffic control
ATIS	automatic terminal information service
ATN	Aeronautical Telecommunications Network
ATO	actual time over
ATS	Aerospace Technical Support, air traffic services
ATT	attitude
ATTCS	automatic takeoff thrust control system
AUTO	automatic
AVLC	aviation VHF link control
AWY	airway
BAC	back course
BARO	barometric
BC	back course
BKUP	backup
BOD	bottom-of-descent
BOSC	bottom-of-step-climb
BRG	bearing
BRT	bright
C	Celsius, center
CAS	calibrated airspeed, crew alerting system
CAT	category
CBM	condition-based maintenance
CCD	cursor control device
CDB	custom database
CDI	course deviation indicator
CDU	control display unit

TERMS	DEFINITION
CERT	certified
CF	course to a fixed waypoint
CG	center of gravity
CHG	change
CLB	climb
CLR	clear
CMD	command
CMF	communications management function
CNTMNTD	contaminated
COM, COMM	communication
COMP	compensation
CONFIG	configuration
CONSTR	constraint
CPDLC	controller pilot datalink communication
CRS	course
CRZ	cruise
CTR	center
D-ATIS	digital automatic terminal information system/ service
DA	decision altitude
DB	database
DCL	departure clearance
DD	drift down
dd/hhmm	day/hour/minute
DEL	delete
DEP	departure
DES	descent
DESEL	deselect
DEST	destination
DF	direct to a fix
DGRAD	degrade(d)
DIR	direct

TERMS	DEFINITION
DIS	distance
DISA	deviation ISA
DL	dataloader
DLK	datalink
DLMU	data LAN management unit
DLS	data loading system
DME	distance measuring equipment
DMT	debug maintenance terminal
DMU	data management unit
DR	dead reckoning
DTG	distance-to-go
DVDR	digital voice data recorder
E	East
eAPIS	electronic advance passenger information system
ECEF	earth-centered earth-fixed
ECON	economy
ECS	environmental control system
EDS	electronic display system
EFC	expect further clearance (ZULU time)
EFIS	electronic flight instrument system
EGNOS	European Geo-Stationary Navigation Overlay System
EGPWS	enhanced ground proximity warning system
ELEV	elevation
END	endurance
ENRT	en route
EO	engine out
EOSID	engine out standard instrument departure
EPU	estimated position uncertainty
EST	estimated
ETA	estimated time of arrival

TERMS	DEFINITION
ETD	estimated time of departure
ETE	estimated time en route
ETP	equal time point
F	Fahrenheit, flyover
FAA	Federal Aviation Administration
FAF	final approach fix
FANS	future air navigation system
FAS	final approach segment
FCRS	front course
FCS	flight control system
FCST	forecast
FD	flight director
FGC	flight guidance computer
FGS	flight guidance system
FL	flight level
FLT	flight
FMA	flight mode annunciator
FMS	flight management system
FOB	fuel-on-board
FOM	figure-of-merit
FP	flight plan
FPA	flight path angle
FPL, FPLN	flight plan
FR	from
FREQ	frequency
FTS	Flight Technical Services
GA	go-around
GAGAN	GPS Aided Geo Augmented Navigation
GAL	gallon
GCD	great circle distance
GFP	graphical flight planning
GLS	GBAS landing system

TERMS	DEFINITION
GNSS	global navigation sensor system
GP	glide path
GPS	global positioning system
GPS-D	GPS with SBAS
GRD	ground
GSP	ground service provider
GUI	graphical user interface
H	hold
HA	high altitude
HAL	horizontal alert limit
HDG	heading
HFOM	horizontal figure-of-merit
HGI	Honeywell-generated information
hhmm	hour/minute
HIL, HINT	horizontal integrity limit
hPa	hectopascals
HSI	horizontal situation indicator
I/O	input/output
IAF	initial approach fix
IAP	instrument approach procedure
IAS	indicated airspeed Integrated Avionics System
ICAO	International Civil Aviation Organization
ID	identification
IDENT	identification, identifier
ILS	instrument landing system
IMC	instrument meteorological conditions
INAV	interactive navigation
INBD	inbound
INFO	information
inHg	inches of mercury
INIT	initialization

TERMS	DEFINITION
INTC	intercept
IRS	inertial reference system
ISA	International Standard Atmosphere
KG	kilogram
kHz	kilohertz
KM	kilometer
KTS	knots
L	left, liters
LA	low altitude
LAN	local area network
LAT	latitude
LB	pound
LCD	liquid crystal display
LDA	landing directional aid
LDG	landing
LIM	limit
LNAV	lateral navigation
LND	landing
LOC	localizer
LON	longitude
LPV	localizer performance with vertical guidance
LRC	long-range cruise
LSA	low speed awareness
LSK	line select key
M	Mach, meters
M/S	meters per second
MAG	magnetic
MAG VAR	magnetic variation
Maint	maintenance
MAN	manual
MAP	missed approach point
MAU	modular avionics unit

TERMS	DEFINITION
MAX	maximum
mb	millibars
MCDU	multifunction control and display unit
MDA	minimum descent altitude
METAR	meteorological aviation report
METERO	meteorological
MFD	multifunction display
MGR	manager
MGT	management
MHz	megahertz
MIN	minimum
min	minute
MLS	microwave landing system
mm	millimeters
M_{MO}	maximum Mach operation
MSAS	Multifunction Transportation Satellite-Based Augmentation System
MSG	message
MSL	mean sea level
MXR	maximum reserve
N	North
NAT	North Atlantic
NAV	navigation
NAVAID	navigation aid
ND	navigation display
NDB	navigation database, nondirectional beacon
NE	Northeast
NG	next generation
NM	nautical miles
NO	number
NOTAM	notice to airmen

TERMS	DEFINITION
NW	Northwest
OACC	Oceanic Area Control Centre
OAT	outside air temperature
OCA	Oceanic Control Area
OEM	original equipment manufacturer
OEP	oceanic entry point
OMS	onboard maintenance system
OOOI	out-off-on-in
OP	operation
P	procedure
P//D	place//distance
P//D/ALT	place//distance/altitude
P/B	place/bearing
P/B/D	place/bearing/distance
P/B/D/ALT	place/bearing/distance/altitude
P/B/P/B	place/bearing/place/bearing
P/B/P/B/ALT	place/bearing/place/bearing/altitude
PAPI	precision approach path indicator
PASS	passengers
PBD	place/bearing/distance
PC	personal computer
PCDR	PCDR procedure
PCMCIA	Personal Computer Memory Card International Association
PD	place distance
PDC	predeparture clearance
PDL	portable dataloader
PERF	performance
PFD	primary flight display
PNR	point of no return
PNS	primary navigation source
POB	persons-on-board

TERMS	DEFINITION
POS	position
PPOS	present position
PRED	predictive
PREV	previous
PRN	pseudo-random noise
PROG	progress
PSA	preselected altitude
PT	procedure turn
PTS	points
QFE	queens field elevation
QNH	sea level standard atmosphere pressure
QUAD	quadrant
R	right
RAD	radial
RAIM	receiver autonomous integrity monitor
REF	reference
REM	remaining
REQ	request, required
REQST	request
REV	reverse
RF	radius to a fix
RNAV	area navigation
RNG	range
RNP	required navigation performance
RTA	receiver transmitter antenna, required time of arrival
RTE	route
RTN	return
RW	runway
S	South
SATCOM	satellite communication

TERMS	DEFINITION
SBAS	satellite based augmentation system
SDF	simplified directional facility
SE	Southeast
SEC	secondary
SEL	select, selector
SID	standard instrument departure
SKED	schedule
SP	space
SPD	speed
SPEX	spares exchange
SRVC	service
STAR	standard terminal arrival route
STAT	status
SVN	satellite vehicle number
SW	software, Southwest
SYS	system
T	terminal, true
T/O	takeoff
TACAN	tactical air navigation
TAF	terminal area forecast
TAS	true airspeed
TCS	touch control steering
TEMP	temperature
TERM	terminal
TF	track to a fixed waypoint
TO	takeoff
TO CG	takeoff center of gravity
TOC	top-of-climb
TOD	top-of-descent
TOGA	takeoff/go-around
TOLD	takeoff and landing data
TRM	Thermal California

TERMS	DEFINITION
TWIP	terminal weather information for pilots
UFOB	useable fuel-on-board
UNAVAIL	unavailable
UR	unrestricted
UTC	universal time coordinated
VALT	vertical altitude
VASEL	vertical altitude select
VASI	visual approach slope indicator
VDL	very high frequency datalink
VDR	very high frequency data radio
VFLC, VFLCH	vertical flight level change
VFOM	vertical figure-of-merit
VGP	vertical glide path
VHF	very high frequency
VINT	vertical integrity limit
V_{MO}	velocity maximum operating
VNAV	vertical navigation
VoIP	voice over Internet protocol
VOR	very high frequency omni-directional range
VORTAC	combined VOR and TACAN stations
VPATH	vertical path
V_{REF}	reference approach speed
VS	vertical speed
VSD	vertical situation display
VTA	vertical track alert
W	West
W/T	wind/temperature
WAAS	Wide Area Augmentation Systems
WGS	World Geodetic Survey, World Geodetic System
WPT	waypoint
WT	weight

TERMS	DEFINITION
Wt/Bal	weight and balance
Y	yes
ZFW	zero fuel weight

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