Honeywell

Boeing 777
Flight Management System
Pilot's Guide

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TO: HOLDERS OF THE BOEING 777 FLIGHT MANAGEMENT SYSTEM FOR THE PILOT'S GUIDE PILOT'S MANUAL, HONEYWELL PUB. NO. C28-3641-022

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HIGHLIGHTS

This manual has been extensively revised to reflect changes and added information. The List of Effective Pages (LEP) identifies the current revision to each page in this manual.

Because of the extensive changes and additions throughout the manual, revision bars have been omitted and the entire manual has been reprinted.

Please replace your copy of this manual with the attached complete revision. The Record of Revisions page shows Honeywell has already put Revision No. 1 dated Oct 2001 in the manual.

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Boeing 777 Flight Management System

Pilot's Guide

This Honeywell FMS Pilot's Guide was written as a training aid to the operation of the Flight Management System in the Boeing 777 aircraft. In no case will this guide be used as an authorized check list or procedural aid replacing FAA or other certifying authority approved flight manuals or check lists. Contact the pilots at Honeywell Flight Technical Services at (602) 436-1446 with any aircrew related questions, problems, or comments.

Pilots using the avionics system described in this document are required to maintain Lateral and Vertical Situational Awareness at all times through the use of current and approved en route, sectional, and other navigational charts. The avionics system herein described is designed to provide pilots with a TSO C-129 (A1) navigation capability. However, pilots are advised to use all available flight-following techniques appropriate for the phase of flight, to insure that a valid mental picture of the desired route is maintained at all times.

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List of Tables

1. Pilot Overview

The Honeywell Boeing 777 Flight Management System (FMS) Pilot's Guide describes the operation of the Honeywell Flight Management System installed on the Boeing 777 aircraft.

This automated system integrates sensors, systems, and displays to give economy with a minimum workload. The FMS gives the pilot substantial assistance in creating the flight plan. The FMS software was developed by Honeywell to meet the unique systems design specifications of Boeing. While optimizing the flight plan for winds and operating costs, it fills in the details, suggesting the most economical climb profile, cruise altitude, airspeed, step climb, and descent. If the pilot selects the automatic flight mode, the FMS guides the aircraft throughout the entire flight plan, from takeoff through landing. Also, the FMS tries to provide the lowest possible cost for the flight while attempting to satisfy all operational constraints that are imposed on it. The key roles of the system are performance and arrival predictions.

While fuel consumption is a major component of cost, other factors are taken into account. These include flight and ground crew wages, costs of late arrival, and other factors determined by the operator. A cost index (CI) is determined by the operator, and the flight management computer function (FMCF) uses this cost index to develop an optimized flight plan.

The Honeywell flight management (FM) functions include: navigation, performance optimization, flight planning management, managed guidance calculations, and information display management.

This guide is organized to:

- Give a general flight management computer system (FMCS) overview
- Step through FMS operation as it could be used in airline operations
- Give in-depth information about system functions.

The Pilot's Guide gives the information necessary to operate the FMS in most operational modes. When used with a training device, the pilot gains sufficient knowledge for in-flight system use. The guide contains sufficient details to answer most of the questions generated through system use.

Every effort has been made to ensure the accuracy of published information. Questions about current system operation and configurations should be directed to the pilots at Honeywell Flight Technical Services or Honeywell Boeing 777 Engineering.

This manual is intended as a guide and does not supersede any Boeing, certifying authority, or airline approved procedures. It is written for system familiarization only.

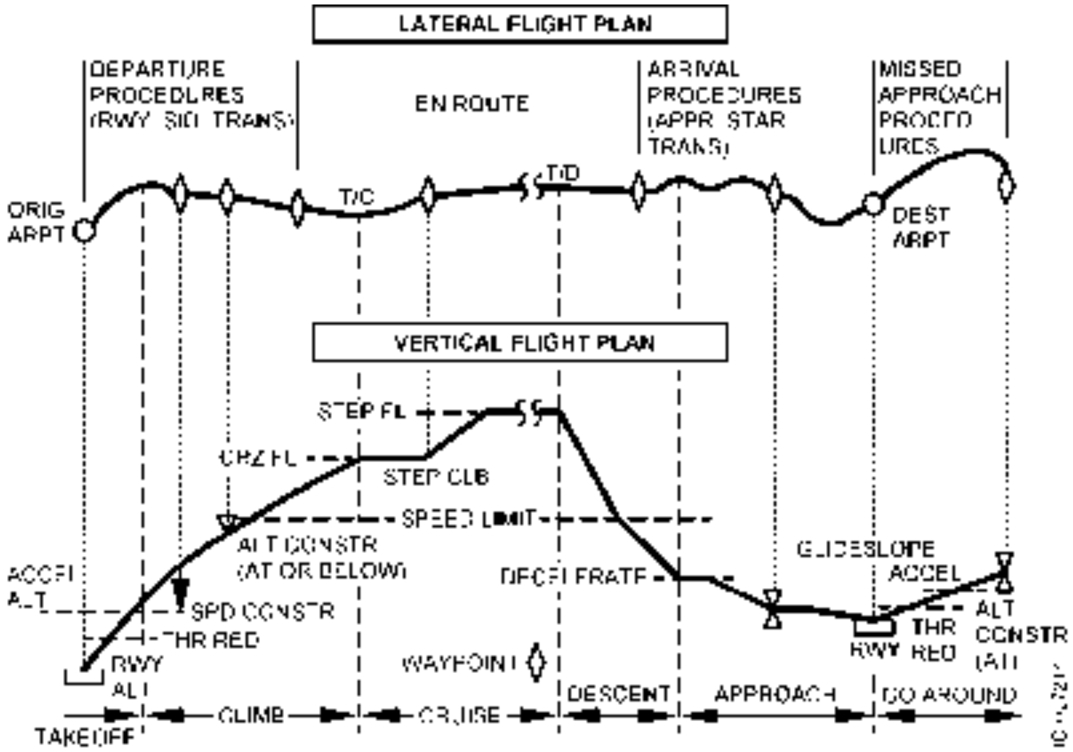
This manual describes all software enhancements made to the system. All or some of these enhancements may or may not be available in any particular aircraft.

2. Flight Management

GENERAL OVERVIEW

The pilot can enter a flight plan, select various flight control modes, and enter other necessary flight data into the FMS with the mode control panel (MCP) on the glareshield panel and the control display unit (CDU) in the forward pedestal. Flight progress is monitored on the CDU and the primary display system (PDS).

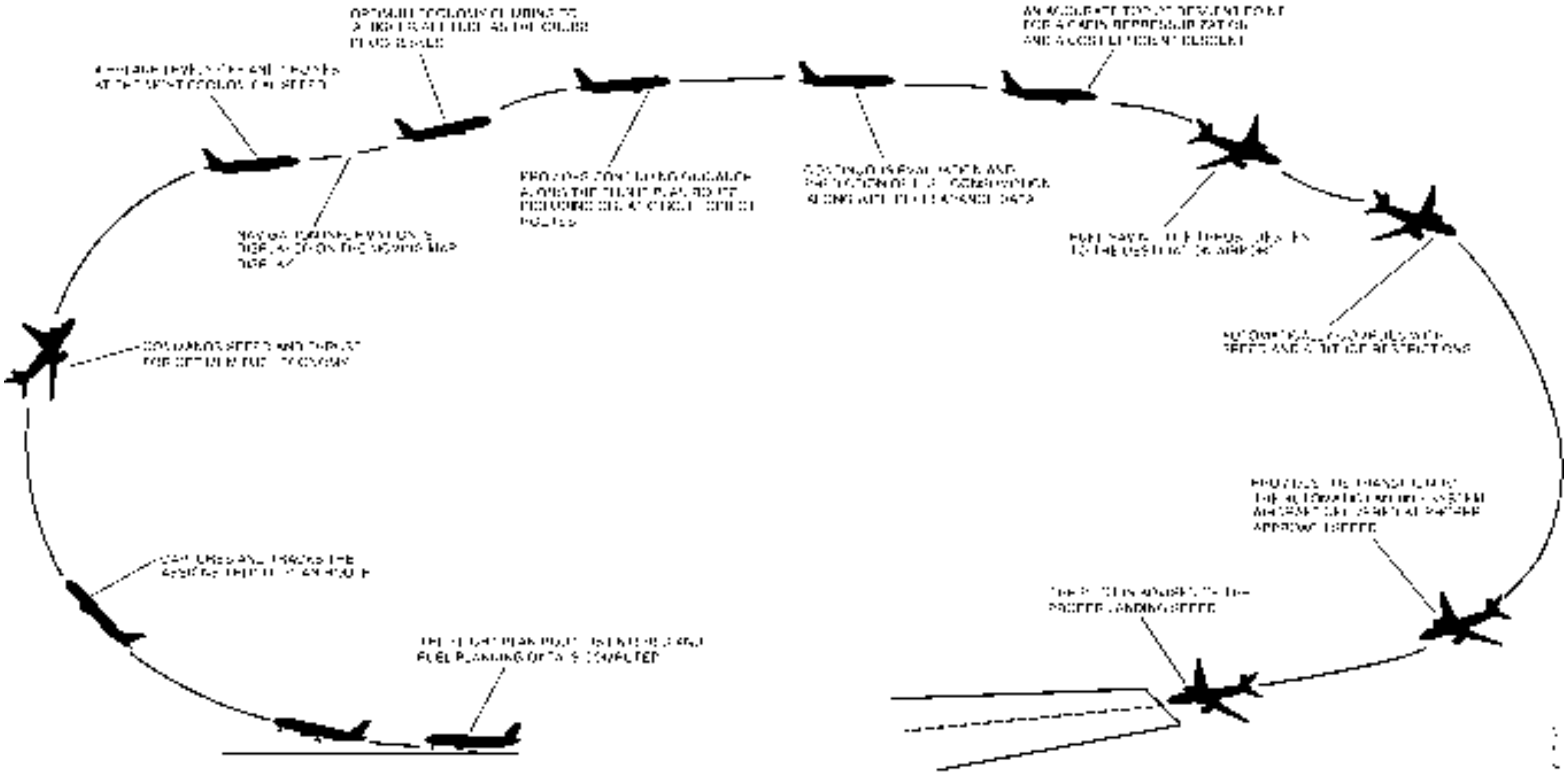
After data entry, the FMS generates the optimum flight profile from the origin to the destination airport. The system gives automatic aircraft guidance along the defined flight path while computing and displaying current and predicted progress along the flight plan (see Figure 2–1).



Flight Management System Profiles
Figure 2–1

After data entry, the FMS helps the pilot by reducing the workload in flight planning, navigation, performance management, aircraft guidance, and monitoring the flight progress to ensure optimum efficiency and effectiveness (see Figure 2-2).

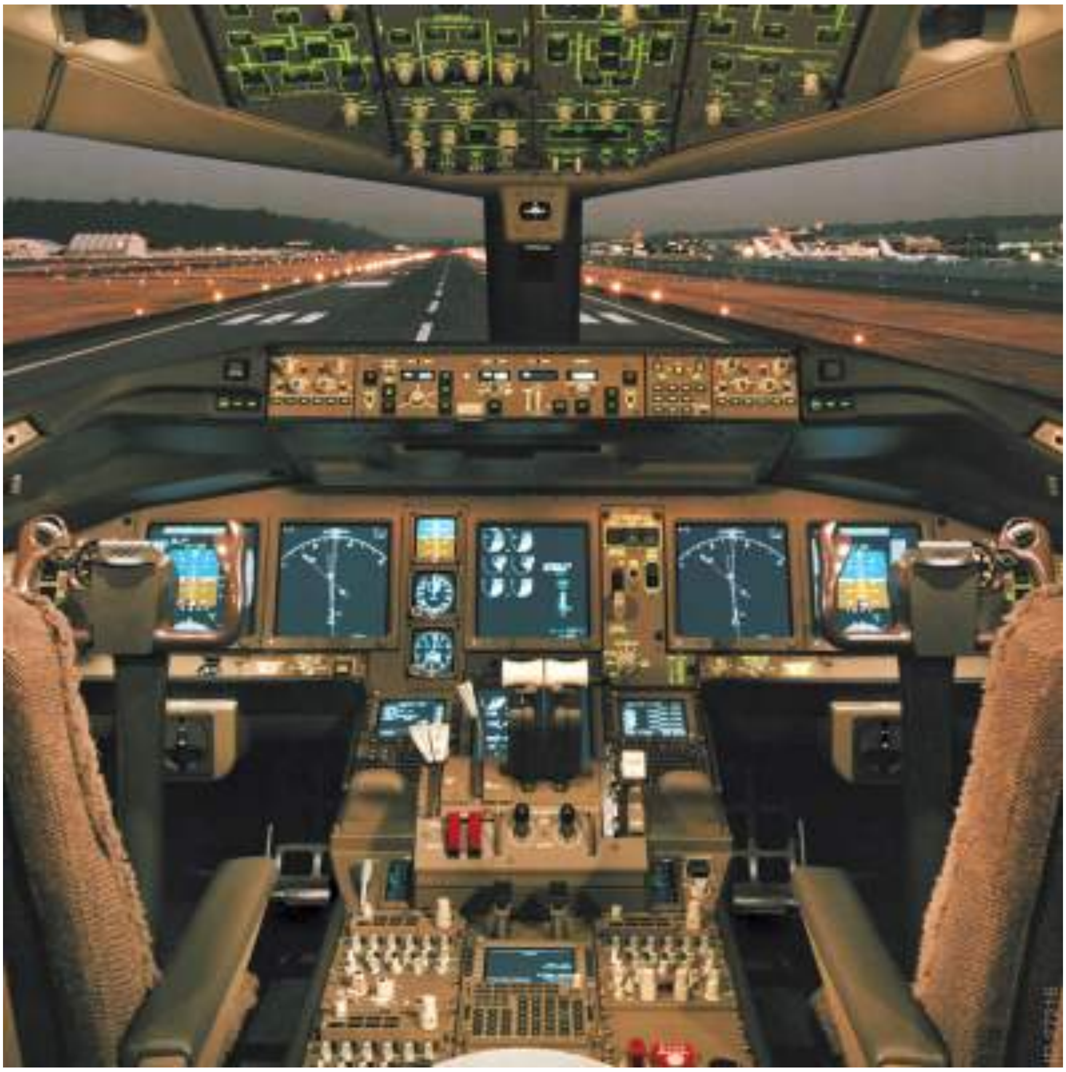
To perform these functions, the FMS automatically tunes the navigation radios and sets courses. The courses are not constrained to navaid radials. The system gives automated en route and terminal area guidance along defined procedures including standard instrument departures (SIDs), standard terminal arrivals (STARs), holding patterns, and procedure turns. It also gives guidance to a vertical path that honors defined altitude and speed constraints, and can fly lateral offsets to the defined path. In addition, the FMS calculates predicted arrival times and fuel consumption along the flight plan route and to the destination.



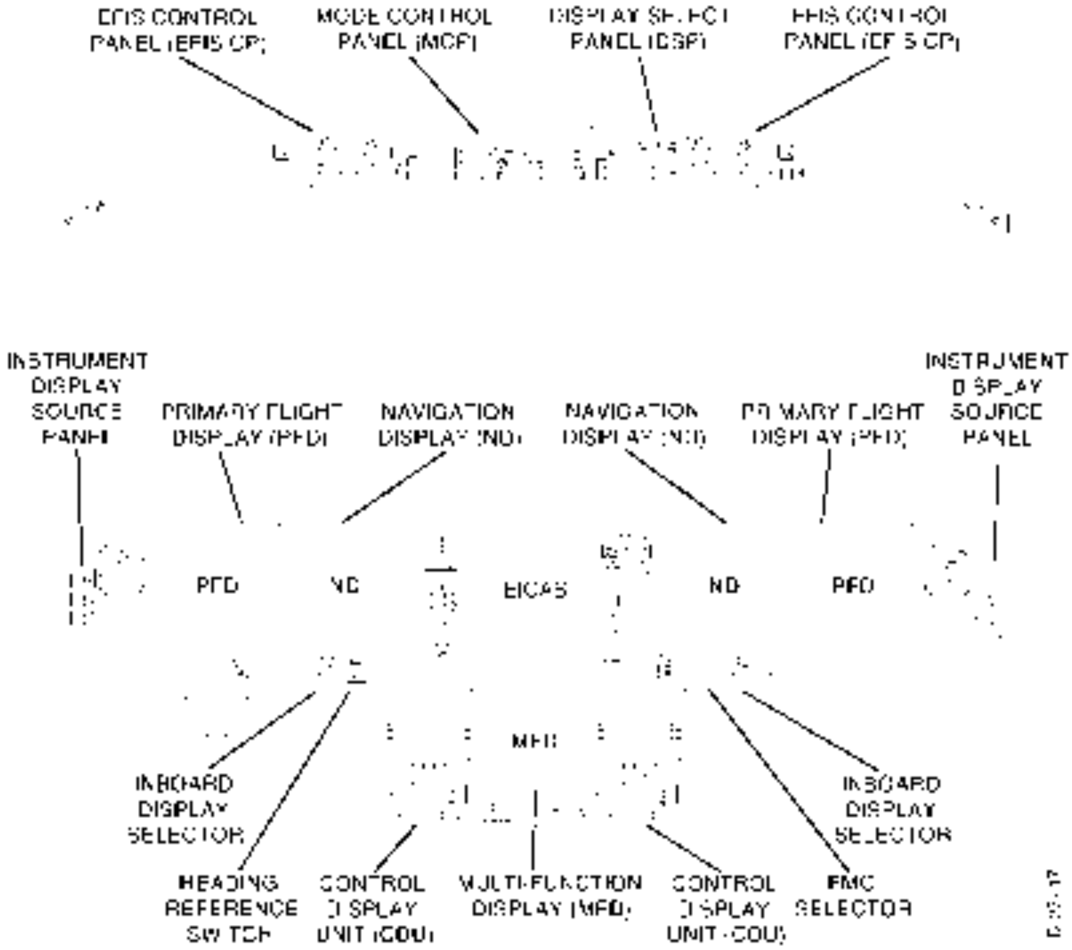
Flight Management Overview
Figure 2-2

FLIGHT DECK CONFIGURATION

The primary part of the FMCS is contained in the airplane information management system (AIMS) cabinets, with one independent function in each cabinet for redundancy. There are two CDUs installed on the left and right sides of the forward pedestal. A third CDU installed in the aft pedestal serves as an online backup in the event one of the forward CDUs becomes inoperative. Refer to Figures 2-3 and 2-4.



Flight Deck
Figure 2-3



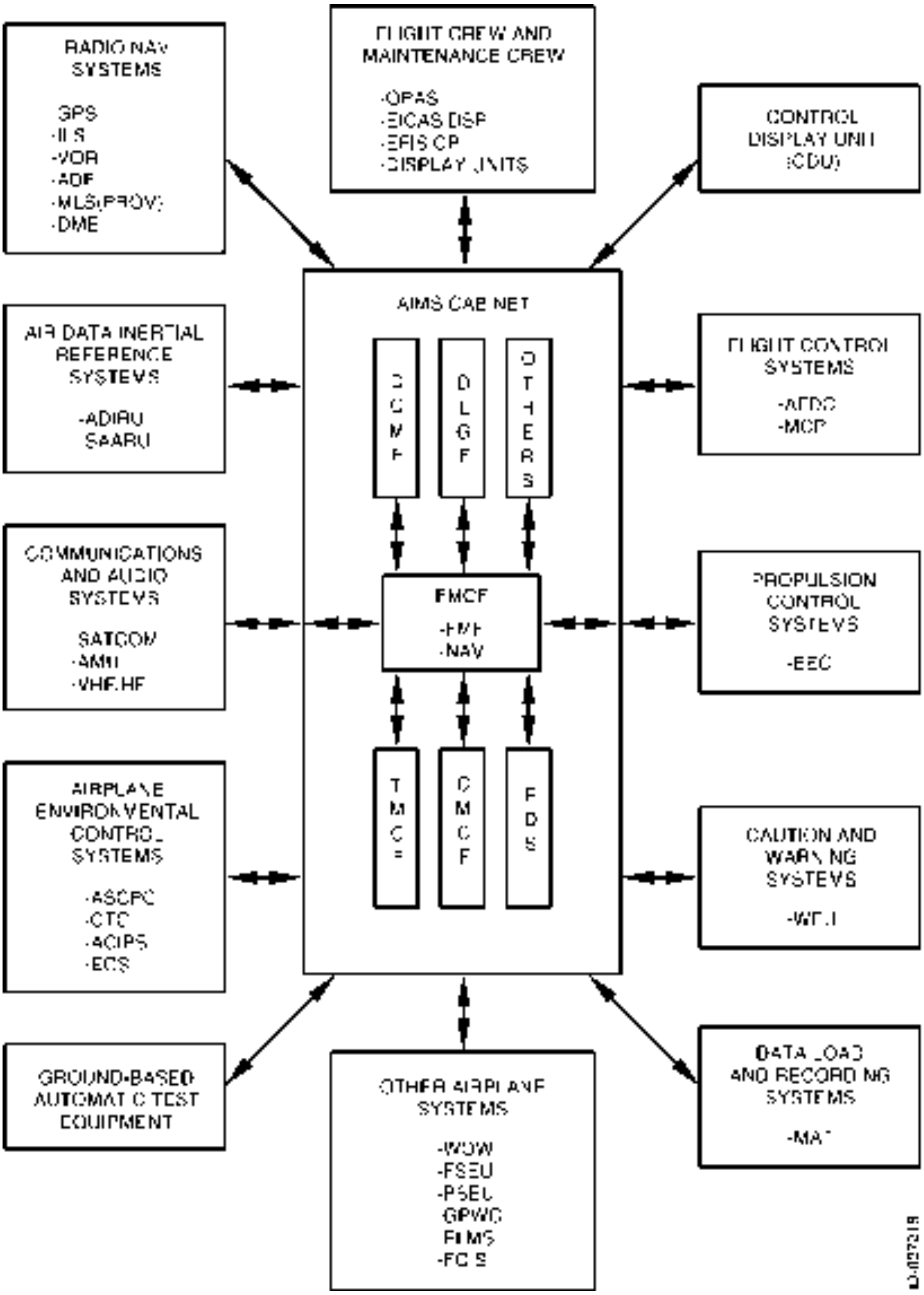
Flight Deck Layout
Figure 2-4

SYSTEM INTERFACES

The FMCS resides on one core processor in each AIMS cabinet. The FMCS consists of three partitions per AIMS cabinet. Each partition is a distinct software entity protected in space and time by the hardware environment supplied by AIMS. The three partitions are the flight management function, the navigation function, and the thrust management function.

The flight management function integrates information from air data and inertial reference system (ADIRS), navigation sensors, engine and fuel sensors, and other airplane systems, along with internal databases and crew-entered data to perform its functions.

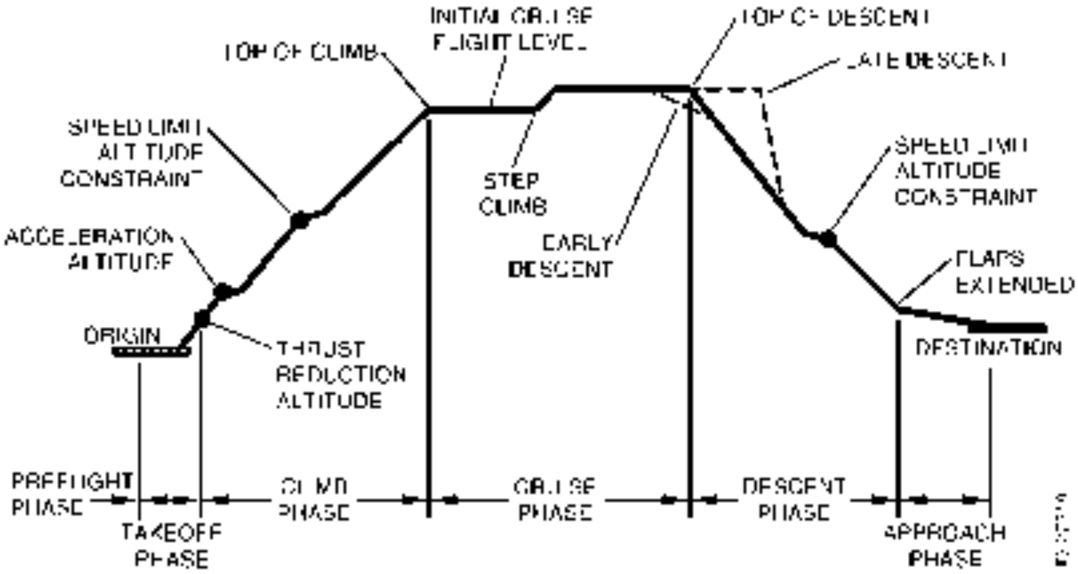
These multiple sources of information for the FMS are illustrated in Figure 2-5. Correct aircraft, engine and navigation database configuration are confirmed on the IDENT (identification) page on the CDU after aircraft power-up.



Flight Management System Interface
Figure 2-5

FLIGHT PHASES

Figure 2-6 illustrates a typical FMS profile from the preflight at the origin airport, to rollout at the destination airport. In addition to vertical navigation (VNAV) guidance and performance (PERF) modes, the FMS supplies lateral navigation (LNAV) guidance to follow waypoints along the predefined route.



Typical Flight Management System Profile
Figure 2-6

The FMS divides the predefined route into a number of flight phases: PREFLIGHT, TAKEOFF/CLIMB, CRUISE, DESCENT, and APPROACH.

- **PREFLIGHT** - In this phase the FMS is initialized. A flight plan can be recalled from the navigation database by company route designator or departure/destination ICAO code identifier, entered waypoint by waypoint on the ROUTE (RTE) page, or uplinked by datalink communications between the FMS and airline operations.

  Typically, the following is accomplished during the PREFLIGHT phase:

  - Check the IDENT page for an active nav database
  - Align air data inertial reference units (ADIRU)
  - Enter origin, destination, cruise altitude, flight number, and cost index
  - Enter flight plan route, runway, SID, transition, and waypoints, and revise to include speed and altitude constraints

- Enter fuel data and zero fuel weight
- Select economy or pilot-entered flight phase speeds
- Confirm or enter takeoff V_{SPEEDS}
- Enter thrust reduction/acceleration altitudes, assumed temperature for derated thrust performance, and engine out acceleration altitude
- Confirm autotuning of navigation radios for departure.

- **TAKEOFF** – This phase extends from initial thrust application to the thrust reduction altitude where takeoff thrust is normally reduced to climb thrust. LNAV and VNAV are normally armed before takeoff. The LNAV engages when the airplane is above 50 feet (ft), and within 2.5 nautical miles (NM) of the active route leg. The VNAV engages above 400 ft (as long as the PERF INIT (performance initialization) page is complete). The thrust reduction under these conditions is automatic at the thrust reduction altitude or flap setting.
- **CLIMB** – This phase extends from the thrust reduction altitude to the top-of-climb (T/C). The top–of–climb is the point where the aircraft reaches the cruise altitude entered on the PERF INIT page. The VNAV and PERF modes give guidance for accelerating the aircraft when it is above the speed transition and speed restriction altitude. These modes observe airspeed and altitude constraints that are stored in the nav database or inserted by the pilot.
- **CRUISE** – This phase extends from the top–of–climb to the top-of-descent (T/D). CRUISE could include step climbs as well as en route descents. The FMS calculates the optimum step climb point. A step climb requires setting a new altitude target on the MCP followed by pushing the altitude knob, or entering a new cruise altitude on the CDU. En route descents are initiated by setting a new altitude target on the MCP followed by pushing the altitude knob, or reinserting a new cruise altitude into the CDU.
- **DESCENT and APPROACH** – These phases start at the top–of–descent. The FMS calculates the appropriate point for the start of descent and initiates the descent automatically if the MCP altitude has been lowered and VNAV and LNAV are engaged. VNAV guidance can be used to transition onto the ILS approach, or to fly an entire non-precision approach. If a missed approach is necessary, LNAV and VNAV modes can again be engaged in order to automatically fly the missed approach procedure.

  After landing and engine shutdown, the FMS goes through a flight-complete phase, clearing the active flight plan in preparation for reinitializing. In addition, some of the data entry fields change to default data values.

OPERATION

The FMS sends LNAV, VNAV, and PERF speed control functions to the flight control systems.

FMS–generated data, commands, database information, performance data, and stored information (routes, waypoints runways, and navaids) are displayed on the CDU. Each flight mode has its own page(s).

Other available functions include:

- Aircraft status (identification)
- Initialization
- Radio navigation (radio tuning)
- Performance (takeoff, climb, cruise, descent, approach, go-around and climb/approach)
- Data (position monitor)
- Progress monitoring
- Fuel prediction
- Route data
- Alternates
- Position reporting
- Standby navigation.

The FMS is functional when electrical power is applied to the aircraft. There is an FMC in both the left and right AIMS cabinets. Under normal conditions, all flight management computing tasks are accomplished by the active FMC. The inactive FMC monitors the active FMC throughout the flight in what is called a "hot spare architecture." The inactive FMC automatically becomes active (with the FMC switch in AUTO) and assumes all FMC functions in the event the active FMC fails. The transition from the active to the inactive FMC is designed to be seamless and transparent to the pilot.

The FMC selector switch, located on the right forward panel, is used to select which FMC and TMC is the active. L (left) selects the left FMC and R (right) selects the right FMC. The AUTO position automatically selects the left or right FMC as the active FMC, and if the active FMC fails, the remaining FMC becomes active and automatically takes over the navigational tasks. The AUTO position is the normal switch position.

FUNCTIONS

The FMC part of the FMS consists of the flight management function partition and the navigation partition and performs navigation, performance calculations, and flight planning for the pilot. The guidance calculations are accomplished using a nav database and a performance database responding to CDU input from the pilot.

Navigation

The navigation function of the FMS generates aircraft position, velocity, heading/track, altitude data, and radio tuning data for use by the guidance and display functions. The navigation function resides in a separate partition. It calculates navigation parameters, and tunes the navigation radios (manual and automatic tuning).

All navigation is predicated on valid inertial position derived from the ADIRU, with the FMS position corrected by radio or satellite position updates (when available) to account for inertial system drift.

If global positioning system (GPS) position data is available, and is within certain tolerances of the ADIRU position (and the radio position, if available), it is used in conjunction with the inertial data to provide the best estimate of position.

If GPS position is not available, the FMS position is determined by combining inertial position with a triangulated radio position derived from nearby distance measuring equipment (DME) stations, corrected for slant range distances.

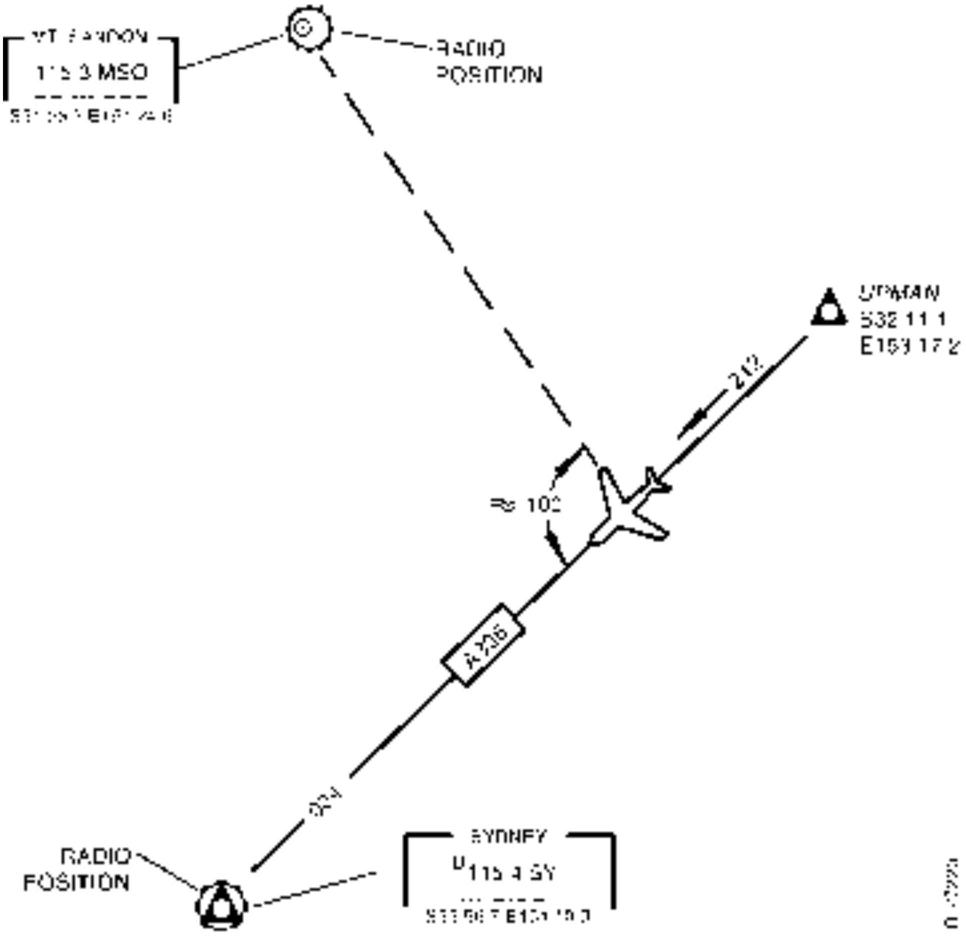
If the aircraft is below 12,500 ft, the FMS searches for the closest DME/DME pair that intersects the aircraft at an angle between 30° and 150°. Above 12,500 ft, FMS autotuning looks for the pair that comes closest to intersecting at an angle of 90° relative to the aircraft position.

When the DME/DME navigation mode is not valid, the FMS tries to calculate a radio position using bearing and range data received from a co-located VOR/DME station. If this mode is unavailable, the FMS establishes the aircraft position using the ADIRU only.

In the terminal area, if an instrument landing system (ILS) equipped runway is active, the FMS autotunes the ILS frequency/course. Localizer deviation data is used to update the FMS position in a direction normal to the runway centerline if stringent reasonableness checks on the data are satisfied.

The nav database contains information on the class and figure of merit of the available navaids. The class of a navaid is defined as VOR, DME, VOR/DME, VORTAC, TACAN, ILS, ILS/DME, LOC DME, LOC, or MLS. Figure of merit (reception quality) is based on the usable distance and altitude of the station relative to the aircraft. These criteria are established by the FAA and other regulatory authorities.

The criteria used for FMS selection of navaids for the internal calculation of a radio-derived aircraft position is illustrated in a typical example (see Figure 2-7). The example shown indicates that two frequencies are being tuned by the FMS. They are SY 115.4 and MSO 115.3. In this case, SY is used to display the bearing and distance to the next waypoint; MSO and SY are used for FMS internal calculation of the aircraft present position from DME/DME data. The FMS has automatically selected MSO and SY because these stations meet the figure of merit distance requirement and they intercept the aircraft position at an included angle that is closest to 90°, compared to other available navaids.



FMS Navaid Autotune Function
Figure 2-7

The navigation function also computes true and magnetic track, vertical flight path angle, drift angle, and magnetic variation.

The FMS does not update the ADIRU at any time, and uses the ADIRU position exclusively for navigation when GPS, DME, and/or VOR data is not available. When this occurs, after a predetermined time, the INERTIAL NAV ONLY message is displayed on CDU scratchpad. The relative FMS position to the ADIRU position is maintained until valid GPS or radio updating is again received.

Performance

The FMS performance modes optimize the aircraft's vertical profile integrated with the lateral profile. This function includes both flight plan predictions and flight optimization.

To develop an optimum flight path, the FMS determines the most economical climb (ECON CLB) and economical descent (ECON DES) speeds, the optimum target Mach for cruise (CRZ), optimum flight level, and an optimum top-of-descent from cruise to the destination airport. These predictions are periodically updated as the flight progresses, incorporating aircraft performance and groundspeed.

An economy profile results in an economical climb, cruise, and descent speed/Mach target that is calculated to obtain the minimum operating cost per mile traveled en route based on the entered cost index. A cost index of zero (0) is equivalent to a maximum range cruise (MRC) because time related cost is not considered, therefore, only fuel efficiency is considered. A minimum time speed/Mach can be obtained when the cost index is set to 9999 (producing maximum flight envelope speeds).

Pilot-entered speeds, such as speed requests from air traffic control (ATC), can alter the strategy for a flight segment when specific speed/Mach targets for CLIMB, CRUISE, and DESCENT flight phases are entered. These speeds are subject to flight envelope limits.

The computed speed target value is output to the vertical guidance function which generates the required pitch commands to maintain the desired calibrated airspeed (CAS) or Mach. The thrust target value is used by the thrust management system as a thrust setting parameter in those control modes where speed is controlled through the elevator and as an initial thrust setting parameter value when in CRUISE. For the CRUISE flight phase, the optimum CAS or Mach is calculated and thrust commands are sent by the autothrottle to maintain speed. For DESCENT, a vertical path is calculated based on a defined end-of-descent (E/D) waypoint. The vertical path accounts for such parameters as wind, temperature, number of operating engines, engine anti-ice, intermediate waypoint altitude and/or speed constraints, and the airspeed restriction below the speed transition altitude (250 knots below 10,000 ft, FAA rules). Ideally, an idle thrust optimum airspeed descent profile is flown. However, airspeed may vary, or thrust may be added, to remain on path and account for unforeseen wind conditions, or for tracking the vertical path between altitude constraints.

Without the autothrottle or autopilot engaged, the pilot can manually fly the optimum speed schedule by referring to the CDU and to the airspeed bug on the speed tape on the primary flight display (PFD).

Performance solutions are generated only when the gross weight, cost index, target altitude, and a route have been entered into the FMS. VNAV can only output valid vertical guidance if performance initialization is complete.

Guidance

The guidance function of the FMS generates commands for controlling aircraft roll, pitch, speed, and engine thrust. Fully automatic, performance-optimized guidance along the flight path in two or three dimensions is available in LNAV and VNAV. These modes are coupled to the flight director (FD) and/or the autopilot and autothrottle through the MCP. LNAV and VNAV can be used separately or together. LNAV gives lateral guidance, and VNAV gives vertical guidance and speed/thrust control. ATC constraints can be inserted along the flight plan route, allowing path and performance guidance to the three dimensional profile, when LNAV and VNAV are flown together.

- **Lateral Guidance** – Lateral guidance is provided by a primary flight plan with automatic route leg sequencing and route leg updating. The LNAV guidance function compares the actual aircraft position with the desired flight path and generates steering commands for the autopilot and flight director. This causes the aircraft to fly along the desired path. Direct guidance from the aircraft present position to any waypoint is also available. LNAV can only be engaged when a route has been activated and executed through the CDU.

- **Vertical Guidance** – Vertical guidance encompasses the takeoff, climb, cruise, descent, and approach phases of the flight plan. The flight planning capability of the FMS includes a way to enter published departure, arrival, and approach segments and individual waypoints that include speed/altitude and time constraints. These constraints, as well as the entered cruise altitude and cost index, define the vertical profile for FMS guidance. The entered profile can be changed at any time to comply with ATC requests.

  The vertical guidance outputs are pitch commands to the autopilot flight director computer (AFDC) and thrust or speed commands to the autothrottle. For unconstrained vertical paths (most climbs), the FMS generates pitch commands to control speed consistent with the performance management mode selected. The pitch commands are based on the difference between the actual CAS or Mach and the target CAS or Mach computed by the performance management function. During intermediate level-offs in CLIMB, or in CRUISE, or when tracking the descent path, pitch commands are generated to maintain the desired path or altitude.

  When the speed is controlled by the elevator (vary the rate of climb to control speed), the autothrottle is commanded to maintain a target N1/EPR setting (for example, climb thrust, hold or idle). However, when the path is controlled by the elevator, the autothrottle is commanded to maintain the target CAS, Mach, or idle.

Thrust Management

The thrust management function (TMF) of the FMS controls the autothrottles. The autothrottles give full-time automatic thrust control from start of takeoff through landing and rollout or go-around. The system uses the FMS to directly control the throttles for maximum fuel conservation without having to send commands to another computer.

Two autothrottle switches, two autothrottle servos, thrust mode switches, and indicators on the MCP are used for autothrottle control. The FMS operates the throttle servos in response to manual mode requests selected by the crew on the MCP, or to automatic mode requests from the FMS when VNAV is engaged.

The TMF calculates and displays thrust limits for all modes, and controls full-throttle operation for maximum thrust without exceeding engine operating limits. The TMF calculates a reference thrust based on existing pressure altitude and ambient temperature data from the ADIRU for the modes described in Table 2-1.

Mode	Description
TO	Takeoff
TO 1	Takeoff 1
TO 2	Takeoff 2
TO B	Takeoff thrust bump
D-TO	Assumed temperature takeoff
D-TO 1	Derate 1 assumed temperature takeoff
D-TO 2	Derate 2 assumed temperature takeoff
CLB	Climb
CLB 1	Climb 1
CLB 2	Climb 2
CRZ	Cruise
CON	Continuous
GA	Go-around

Autothrust Modes
Table 2-1

These modes can be selected with the THRUST LIM (thrust limit) page on the CDU. The selected thrust reference mode is displayed above the EPR/N1 indicators on the engine indicating and crew alerting system (EICAS) display.

The thrust reference mode automatically transitions for the respective phase of flight. During CLIMB, CLB 1 and CLB 2 derates are gradually removed to begin a thrust increase at 10,000 ft to reach full CLB at approximately 15,000 feet. In CRUISE, the thrust reference defaults to CLB or CRZ as set in the airline modifiable information (AMI) database. The reference can be manually selected on the THRUST LIM page on the CDU.

Flight Displays

The primary display system consists of several AIMS components that include processors in the left and right AIMS cabinets, six display units (DU), two electronic flight instrument system control panels (EFIS CP), a display select panel (DSP), and two cursor control devices (CCD).

The FMS is the primary source of data for the navigation display (ND) when operating in either the plan or map modes. Navigation data and position data for the ND are supplied to the AIMS display function that generates the required symbols and interface signals for the ND.

The data supplied by the FMS falls into the categories of map background data and airplane dynamic data. Map background data includes the flight plan and the location of waypoints, stations (navaids), airports, and selected reference points that are in the ND selected field of view.

The dynamic data is related to aircraft motion with respect to the flight plan. This data includes track and groundspeed, estimated time of arrival (ETA) or distance-to-go (DTG) to the next waypoint, range to altitude intercept from the MCP, magnetic (MAG) and TRUE heading, OFFPATH descent clean and OFFPATH descent drag data, present position, waypoint bearing, flight path angle, vertical deviation, and computed winds.

When VNAV is engaged, the appropriate flight mode annunciator (FMA) is displayed on the PFD. VNAV SPD is displayed when the aircraft speed is controlled by the elevator. VNAV PTH is displayed when the elevator controls the aircraft to maintain a path (level segments and the descent path). In DESCENT, the VNAV PATH deviation scale is displayed on the ND. VNAV ALT is displayed when altitude is constrained by the altitude window setting on the MCP, when reaching a point on the VNAV profile to begin a climb or descent with the MCP altitude window set at the current altitude, or when reaching the altitude in the MCP altitude window before the FMS target altitude.

The thrust management function generates the appropriate autothrottle annunciator on the PFD: speed (SPD), thrust (THR), thrust reference (THR REF), IDLE, and HOLD. Speed and thrust targets are supplied to the appropriate AIMS displays to drive the target bugs.

DATABASE

The FMS contains a navigation database and a performance database. There is also an airline modifiable information (AMI) database.

The FMS uses an aero engine model database to calculate detailed predictions along the entire aircraft trajectory. The data stored in the database includes accurate aircraft drag and engine model data, optimal speed data, maximum altitudes, and maximum and minimum speeds. A performance factor can be entered to refine the database for each aircraft by entering correction factors for drag and fuel flow.

Nav Database

The FMS nav database includes most of the information the pilot would normally determine by referring to navigational charts and maps. This information can be displayed on the CDU and/or on the ND in the map or plan modes. The geographical area covered includes all areas where the aircraft is normally flown and the data can be custom made to the individual airline requirements (referred to as airline-tailored data).

Airline-tailored data can include company routes, including an alternate destination to the company route, airport gates, custom navaids, runways, procedures, waypoints, and fuel policy.

The standard data is public property and can be obtained from ICAO and government sources, etc. This standard data is updated on a 28-day cycle that corresponds to the normal revision cycle for navigation charts. Each update disk contains the data for the new cycle, and the present cycle. This gives the airline a window of time in which to load the new database.

The database part number (which identifies the customer, data cycle, and revision number) and the effective cycles are printed on the data disks. This information is displayed on the CDU IDENT page after the nav database has been loaded by maintenance personnel. This loading is done through the maintenance access terminal (MAT).

Airline Modifiable Information Database

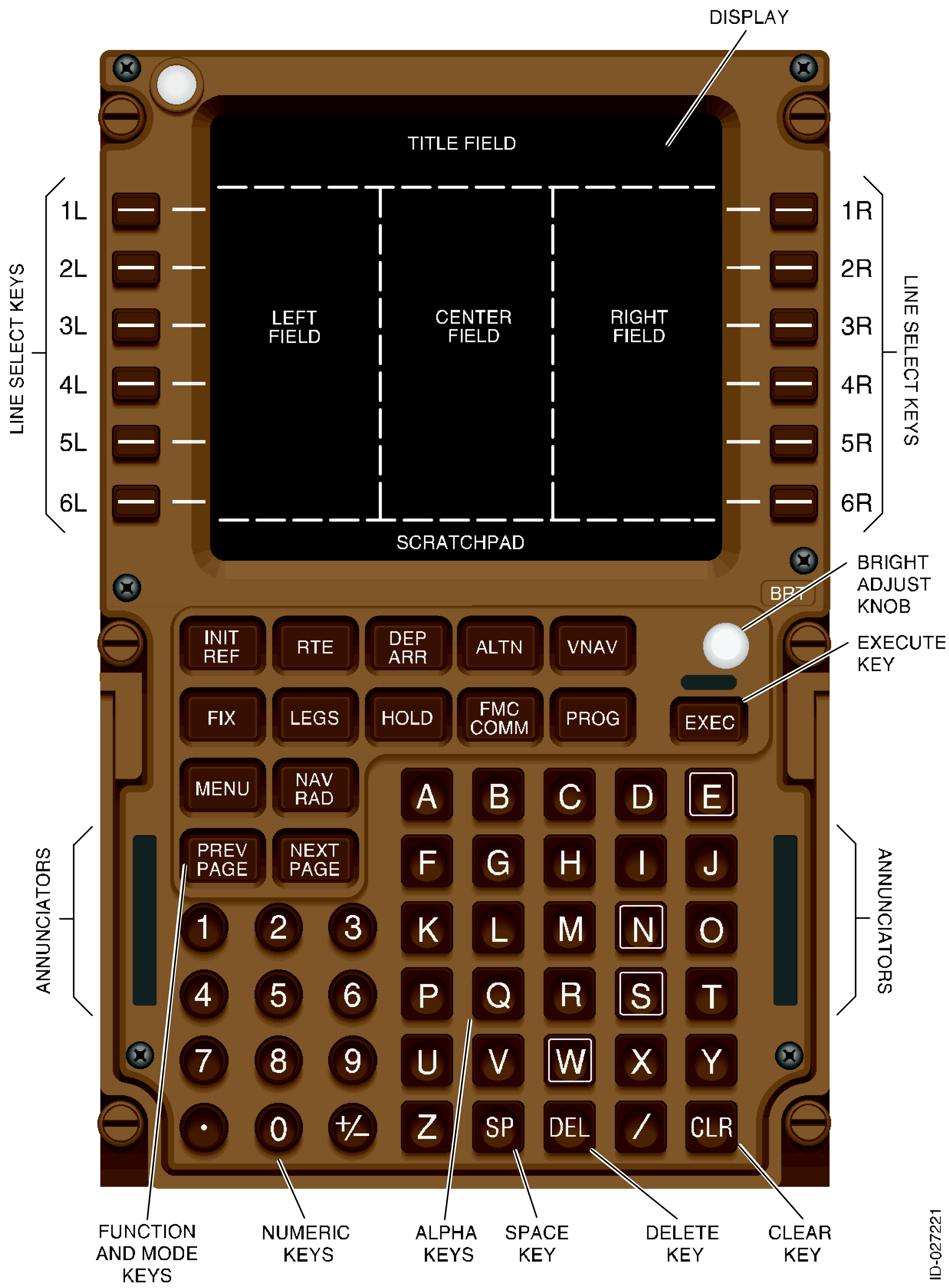
The AMI database is a separately loadable database containing parameters that can be modified by the airlines to tailor operations of the FMS performance and datalink functions. The AMI database is not required for the FMS to operate, as hardcoded defaults are used when the AMI is not loaded.

At power up, the FMS validates the loaded AMI parameters where appropriate. If an AMI parameter fails the validation check, the FMS uses the hardcoded default for that parameter. When this happens and the parameter is displayed on the CDU, the CDU scratchpad message CHECK AIRLINE POLICY is displayed.

CONTROL DISPLAY UNIT

The CDU is the interface between the pilot and the FMS. It is used primarily for long-term actions such as monitoring and revising flight plans, selecting operating modes, entering weights, winds, temperatures, as well as initializing performance data. It displays flight plan and advisory data, as well as other FMS data (that has been entered into memory) for the pilot to verify.

The CDU (Figure 2-8) has a full alphanumeric keyboard along with mode, function, and data entry keys. The keyboard also contains advisory annunciators, one integral automatic display light sensor, and a knob to manually adjust display brightness.



Control Display Unit
Figure 2-8

The display functional areas of the CDU are the liquid crystal display (LCD) screen, line select keys (LSK), brightness control, and annunciators. Refer to the CDU as shown in Figure 2-8, for the following explanations.

Display

The LCD display screen has 14 lines with a total of 24 characters per line. The display is divided into different areas:

- **Title Field** – The title field is the top line of the display area. It identifies the subject or title of the data on the displayed page. It also identifies page number and the number of pages in a series. For example,1/2 identifies the displayed page as the first in a series of two pages.

- **Left, Center and Right Fields** – These fields are made up of six pairs of lines extending from the left side of the display to the right side. A line pair has a header line and a data line. The pilot controls the left and right data lines with the adjacent LSKs.

- **Scratchpad** – The scratchpad is the bottom line of the display. This line displays alphanumeric data or messages. Data is entered into the scratchpad with the alphanumeric keys or an LSK, or automatically by the FMS. The pilot cannot normally enter data into the scratchpad when an FMS message is displayed there.

  Scratchpad entries are independent of page selection and remain displayed until cleared, even when page changes occur. Scratchpad data entries and deletions affect only the associated CDU. However, messages can be displayed and erased on both CDUs simultaneously.

Line Select Keys

There are six LSKs on each side of the display. For reference, the keys on the left are identified 1L through 6L and the keys on the right are identified 1R through 6R.

Pushing an LSK affects the adjacent line on the respective side of the CDU for entering, selecting, or deleting data. If data has been entered in the scratchpad (and the data is acceptable to the FMS), pushing an LSK transfers that data from the scratchpad to the associated data line.

Pushing an LSK next to a page prompt (indicated by a caret (< >) next to the page name) displays that page (or the first page of that series). An LSK can also select procedures or performance modes, as indicated.

Brightness Adjust Knob (BRT)

The BRT knob controls the brightness of the display. The brightness of the backlit keys is controlled by a remote flight deck control. CDU brightness is also controlled by the master brightness control system.

Annunciators

There are three annunciators located on the keyboard, one on the left side, and two on the right side. These annunciators are:

- **DSPY** (top left) – The **white** DSPY annunciator lights when the active lateral or vertical leg or performance mode is not displayed on the current CDU page.
- **MSG** (top right) – The **white** MSG annunciator lights when an FMS–generated message is displayed on the scratchpad, or is waiting to be displayed when the scratchpad is cleared. Pushing the CLR turns the MSG annunciator off and clears the message from the scratchpad.
- **OFST** (lower right) – The **white** OFST annunciator lights when LNAV is based on a parallel route offset from the active route.

Alphanumeric Keys

The alphanumeric keys are used to enter letters and numbers into the scratchpad. Letters and numbers can be entered together as required.

SLASH KEY

The slash [/] key is used to separate data that is entered into the data lines in pairs (for example, airspeed and Mach (280/.720), wind direction and velocity (240/75), bearing and distance (180/20), or airspeed and altitude (250/10,000)).

The slash key protocol is that the field closest to the center of the CDU display requires the slash entry. The field next to the line select key has an optional slash entry. Where no ambiguity can exist in the data entry, then the slash entry is optional on either field.

SPACE KEY

The space (SP) key inserts an underscore character between words or characters that are entered into the scratchpad, or when entering messages directly into the lines when using the CDU for other subsystems operations, or when data transfer from the scratchpad to the MFD requires spaces.

PLUS/MINUS KEY

The plus/minus (+/-) key is used to give a plus or minus value to a number that is entered in the scratchpad. The first push of the +/- key inserts a minus sign into the scratchpad. The second push inserts a plus sign. Subsequently pushing the +/- key toggles the sign between plus and minus.

Function Keys

Function keys control the contents of the page displayed on the CDU. The function keys are described in the following paragraphs.

- **EXEC Key** - The EXEC (execute) key is the command key of the FMS. This key is used to activate the flight plan, execute a change to the active flight plan, or execute a change to the vertical profile.

  Activating a flight plan is a two-step procedure:

  1. Select the ACTIVATE prompt on the desired RTE or LEGS page. This lights the light bar above the EXEC key.
  2. Push the EXEC key. This activates the flight plan.

  Changes to the active flight plan or the vertical profile are also a two-step procedure:

  1. Enter and review the provisional data. This lights the light bar above the EXEC key.
  2. Push the EXEC key. This executes the desired change.

- **NEXT PAGE and PREV PAGE Keys** - If more than one page of associated data is available, page numbers (1/2, 2/2) are displayed in the title line in the upper right corner of the CDU. Pushing the NEXT PAGE or PREV PAGE key displays the next or previous page of that series. The function is a closed loop, that is, the associated page wraps around from the last page to the first page. 1/1 is displayed on pages that may include additional pages of associated data if the displayed data is expanded (for example, by adding a waypoint to a flight plan).

  Changing a page with the NEXT PAGE and PREV PAGE keys does not change or erase a scratchpad entry.

- **CLR Key** - The CLR (clear) key is used to clear messages and data from the scratchpad or from a data field. If an entry has been made in the scratchpad, pushing the CLR key once erases the last character entered. Pushing and holding the CLR key erases the entire scratchpad entry. Pushing the CLR key also clears messages displayed on the scratchpad (one message for each key push). When the last message is cleared, the MSG annunciator goes out.

- **DEL Key** – The DEL (delete) key is used to delete the contents of a data field. If the scratchpad is empty, pushing the DEL key inserts the word DELETE into the scratchpad. Subsequently pushing the LSK next to a data field deletes the data from that field. If the deleted data has a default or FMS-calculated value, the data field reverts to that value. If the cleared data field is a leg in the flight plan, the leg is deleted from the flight plan and, in most cases, a discontinuity is created.

  NOTE: Not all information can be deleted.

  The DEL key is a special purpose key. The delete function is operational only on specific pages. If any data or message is displayed in the scratchpad, the DEL key is inoperative. The scratchpad must first be cleared with the CLR key. Also, pushing the CLR key with DELETE in the scratchpad, cancels the delete function.

Mode Keys

The mode keys control the type of page displayed on the CDU. The mode keys are described in the following paragraphs.

- **INIT REF Key** – Pushing the INIT REF key displays the first page of a series of pages used to initialize the position of the FMS and the ADIRU. Other pages of reference data are also included in this series.
- **RTE Key** – Pushing the RTE key displays the origin, destination and route information for route 1 or route 2. Origin, destination, and route data is entered and can be changed on the RTE pages.
- **DEP ARR Key** – Pushing the DEP ARR key displays an index listing all terminal area procedures in the nav database for departures (before traveling 400 miles), or for arrivals (after 400 miles or midpoint, whichever is less). Departure and arrival procedures are selected and can be changed on these pages.
- **ALTN Key** – Pushing the ALTN key displays the page for checking distance, predicted arrival fuel, and ETA at alternate airports. The page is also used for changing the destination and route to proceed to an alternate airport.
- **VNAV Key** – Pushing the VNAV key displays the CLB, CRZ, or DES page, depending on the flight phase. Vertical navigation information can be evaluated and changed on these pages.
- **FIX Key** – Pushing the FIX key displays the first of the FIX INFO pages. These pages are used to create waypoint fixes from the intersection of the active route and selected bearing or distance from stored waypoints. It is also used for the abeam points function.

- **LEGS Key** – Pushing the LEGS key displays the LEGS page for evaluating or modifying lateral or vertical details of each route leg with reference to speed/altitude crossing restrictions.

  The LEGS page controls the route segment displayed on the associated ND when the ND is in the plan mode.

  If an FMC fails, pushing the LEGS key displays the ACT ALTN NAV LEGS page on the CDU.

- **HOLD Key** – Pushing the HOLD key displays the HOLD page for entering or exiting a holding pattern. This page also lets the pilot modify a previously built holding pattern.

- **FMC COMM Key** – Pushing the FMC COMM key displays the FMC-CDU pages that can access datalink information and status.

- **PROG Key** – Pushing the PROG key displays current dynamic flight and navigation data. This includes estimated time of arrival and fuel remaining estimates for the next two waypoints and the destination or an entered waypoint, such as an alternate.

  If an FMC fails, pushing the PROG key displays to the ALTN NAV PROGRESS page on the CDU.

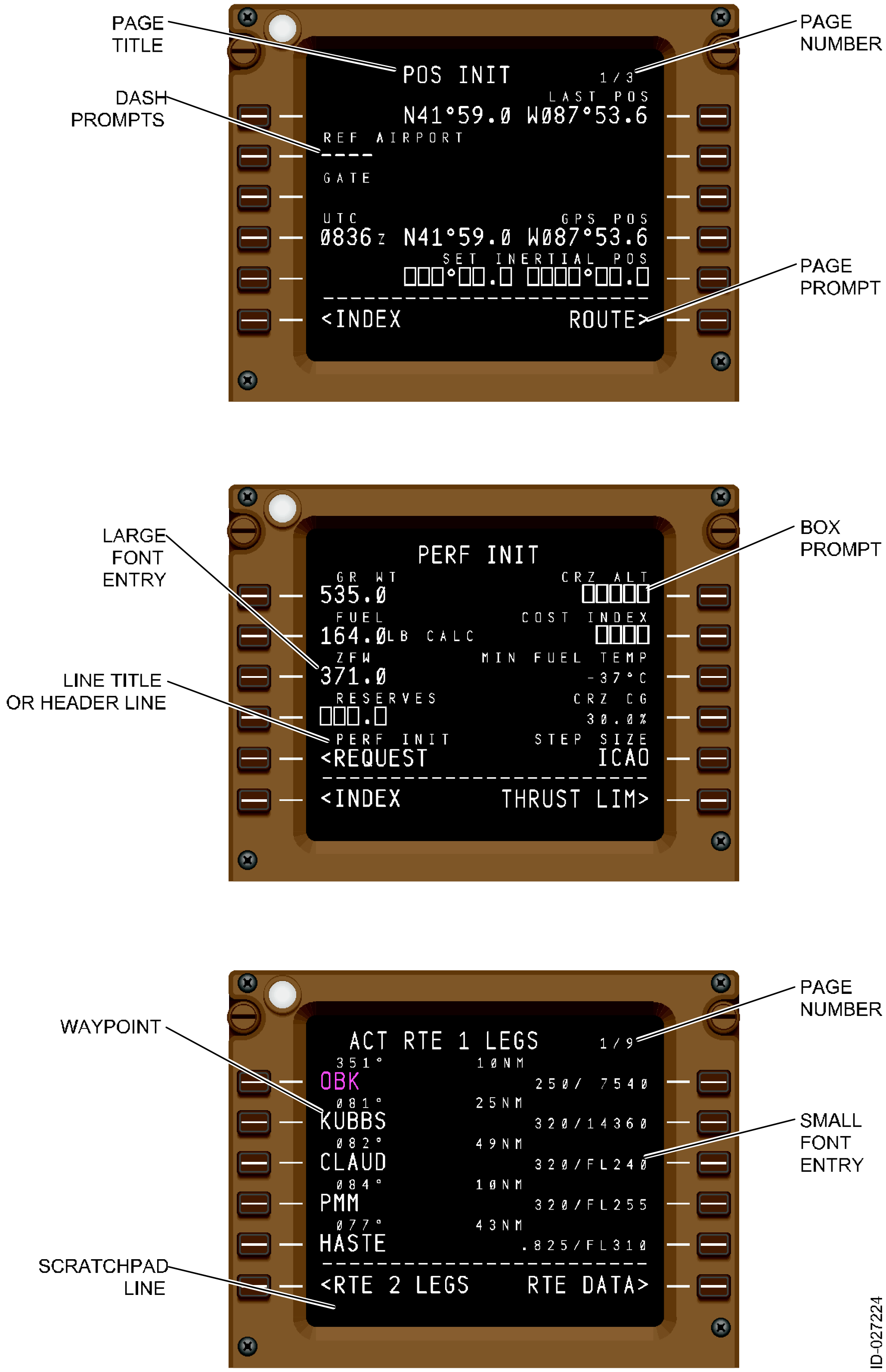
- **MENU Key** – Pushing the MENU key displays the MENU page. This page is used to access other aircraft subsystems through the CDU, such as the FMC and satellite communications. It also accesses the alternate control for the EFIS control panel and the display select panel.

- **NAV RAD Key** – Pushing the NAV RAD key displays the NAV RAD page for monitoring or modifying nav radio tuning.

  If an FMC fails, pushing the NAV RAD key displays the ALTN NAV RADIO page on the CDU.

Page Formats and Data Labels

Typical page formats and data labels are illustrated in Figure 2-9.



CDU Page Format
Figure 2-9

The display page format and data labels are described in the following paragraphs.

- **Page Title** – The page title identifies the selected page and the type of data displayed on that page. ACT or MOD may be displayed as part of the page title to indicate whether the page is active or modified.
- **Dash Prompts (– – – – –)** – Dashes mean that data can be entered to define navigational or performance parameters. This data entry is optional. Data is entered in the scratchpad and then transferred to this field by pushing the associated LSK. After the data has been entered, it is displayed in large font.
- **Small Font** – Predicted, default, or FMS–calculated values are displayed in small font. When this data is next to an LSK, it can be changed by the pilot. When the data has been changed by the pilot, it is displayed in large font.
- **Large Font** – Database or pilot entries that define FMS operation are displayed in large font.
- **Line Title** – The line title (or header line) is displayed in small font, it identifies the data displayed on line(s) below it.
- **Waypoint** – The waypoints on the selected route are displayed in large font.
- **Scratchpad** – The bottom line of the display is the scratchpad. This line displays FMS generated messages, keyboard entries, and data that is being moved from one line to another. When a scratchpad CDU message is displayed, the **white** MSG annunciator at the top right side of the CDU lights. CDU messages are described in detail in Section 14, FMS Messages.
- **Page Number** – If multiple pages of associated data are available, page numbers are displayed in the upper right corner of the display. The first digit indicates the page number and the second digit indicates total number of related pages. For example, 1/2 indicates there are two pages of related data and page 1 is displayed.
- **Page or Action Prompts (< or >)** – Carets (< or >) indicate the next logical page or pages in the flight plan progression can be accessed by pushing the associated LSK. These are also used to indicate that the pilot can initiate an action, such as an early descent or an engine out climb, by pushing the adjacent LSK.
- **Box Prompts (□□□□□)** – Boxes mean that data entry is required for minimum FMS operation. Data is entered in the scratchpad and then transferred to this field by pushing the associated LSK. After the data has been entered, it is displayed in large font.

- **Data Line** – The data line contains the data that the FMS uses for flight planning or calculations. If the displayed data is generated by the FMS, it is displayed in small font. If the data has been entered by the pilot, or is based on pilot-entered data, it is displayed in large font.

Data Entry

Data is entered into the scratchpad from left to right with the alphanumeric keys. Typically, the displayed data field acts as an example format for the pilot to follow. After the pilot has entered the data in the scratchpad and confirmed it as correct, pushing the appropriate LSK transfers the data from the scratchpad to the associated data field.

Data entry formats that are not obvious are explained in detail as they occur in the following sections. Data units of measure (for example, lbs/kgs) are set by the operational program configuration (OPC) database as determined by company policy.

Certain types of data can be transferred from a data field into the scratchpad by pushing the associated LSK when the scratchpad is empty. The data can then be transferred to another data field by pushing the LSK next to that data field. The data can also be cleared from the scratchpad by pushing the CLR key.

Color on the CDU

Color is used on the CDU to highlight key information. Color is used to indicate data that is active, modified, or applies to specific navigation radios. Data is displayed in color as follows:

- **White** is used for normal data lines and the active route page title.

- **Magenta** is used for the active waypoint information and FMS-commanded or fly-to parameters (waypoint, altitude, airspeed).

- **Cyan** is used for the inactive route page title.

- Shaded **white** is used for flight plan modifications not yet executed and for the word MOD in the page title when a modification has been made but not executed.

- **Green** is used to indicate the active state of two- and three-position selectors on a CDU display line.

On the navigation radio page:

- **Green** is used for VOR frequencies, course entries, and identifiers.

- **Cyan** is used for ADF frequencies.

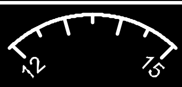
Navigational Display Symbols

The symbols in Table 2-2 can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

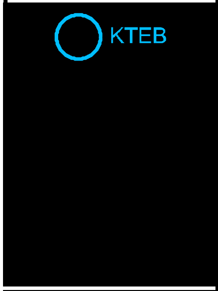
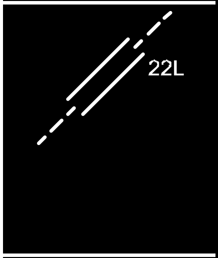
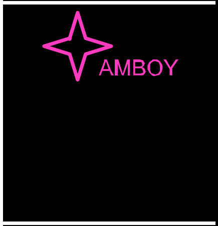
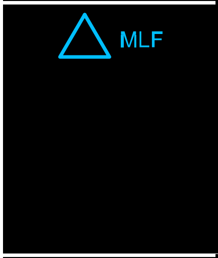
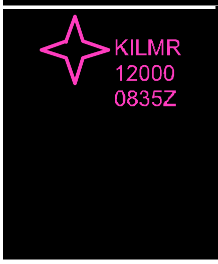
- **White** (W) – present status, range scales
- **Green** – dynamic conditions
- **Magenta** – command information, pointers, symbols, fly-to condition
- **Blue** or **cyan**– nonactive or background information
- **Amber** – cautions, faults, flags
- **Red** – warnings.

Symbol	Name	ND Mode	Remarks
GS310	Groundspeed	All	Current groundspeed.
TAS312	True airspeed	All	Current true airspeed displayed above 100 knots.
350°/15 ↙	Wind direction/speed and wind arrow	All	Wind bearing, speed, and direction, with respect to display orientation and heading/track reference. Arrow not displayed in the plan mode.
ABCDE	Active waypoint identifier	MAP MAP CTR PLAN	The active flight plan waypoint, the next waypoint on the route of flight.
VOR L, R ILS L, C, R	Reference receiver	VOR VOR CTR APP APP CTR	The selected receiver as the display reference.
111.90 or 116.80 or SEA	ILS (**white**)/VOR (**green**) reference receiver frequency or identifier display	VOR VOR CTR APP APP CTR	Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.

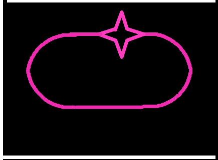
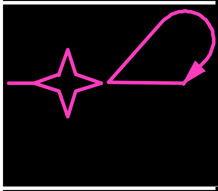
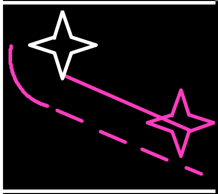
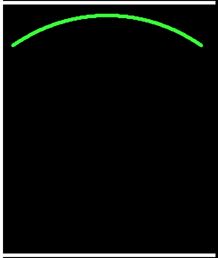
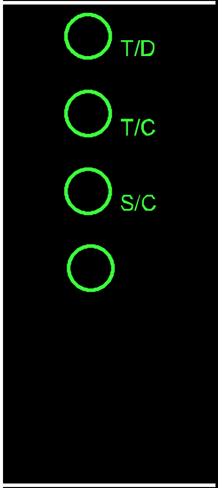
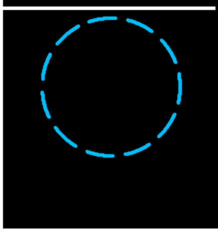
Navigation Display Symbols
Table 2-2 (cont)

Symbol	Name	ND Mode	Remarks
124 NM	Active waypoint distance	MAP MAP CTR PLAN	Distance to the active waypoint.
DME 24.6	DME distance	VOR VOR CTR APP APP CTR	DME distance to the reference navaid.
0835.4z	Active waypoint ETA	MAP MAP CTR PLAN	FMS-calculated ETA at the active waypoint.
CRS 135	Reference ILS or VOR course	VOR VOR CTR APP APP CTR	VOR course or ILS localizer course.
TRK 062 MAG	Track orientation, current track, and track reference	MAP MAP CTR	Displays TRK as the selected orientation, the current track, and MAG or TRU as the reference.
HDG 263 MAG	Heading orientation, current heading, heading reference, and heading pointer	VOR VOR CTR APP APP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.
MAG or TRU	Heading/track reference with box if in TRU, box is **amber** if TRU is displayed in descent	All except PLAN	Heading/track is referenced to magnetic north or true north. Switching from TRU to MAG, or from MAG to TRU displays a box around MAG for 10 seconds.
	Expanded compass	MAP APP VOR	Displays 90 degrees of compass rose.
	Current heading pointer	MAP MAP CTR	Points to current heading on the compass rose.
	Airport and runway	MAP MAP CTR PLAN	Displayed when selected as the origin or destination and ND range is 80, 160, 320, or 640 NM.

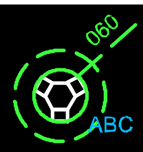
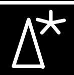
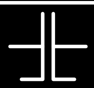
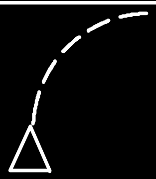
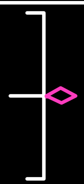
Navigation Display Symbols
Table 2-2 (cont)

Symbol	Name	ND Mode	Remarks
	Airport	MAP MAP CTR PLAN	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway	MAP MAP CTR PLAN	Displayed when selected as the origin or destination and ND range is 10, 20 or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Waypoint: active (**magenta**), inactive (**white**)	MAP MAP CTR PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
	Off route waypoint	MAP MAP CTR	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed in ND ranges of 10, 20, or 40.
	Flight plan route: active (**magenta**), modified (**white**), inactive (**blue**)	MAP MAP CTR PLAN	The active route is displayed with a continuous line (**magenta**) between waypoints. Active route modifications are displayed with short dashes (**white**) between waypoints. Inactive routes are displayed with long dashes (**blue**) between waypoints.
	Route data: active waypoint (**magenta**), inactive waypoint (**white**)	MAP MAP CTR	When the EFIS control panel DATA map switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.

Navigation Display Symbols
Table 2-2 (cont)

Symbol	Name	ND Mode	Remarks
	Holding pattern: active route (**magenta**), modified route (**white**), inactive route (**blue**)	MAP MAP CTR PLAN	A holding pattern is displayed when in the flight plan.
	Procedure turn: active route (**magenta**), modified route (**white**), inactive route (**blue**)	MAP MAP CTR PLAN	A procedure turn is displayed when in the flight plan. It increases in size upon entering the procedure turn.
	Offset path and identifier: active route (**magenta**), modified route (**white**)	MAP MAP CTR PLAN	A dashed line is displayed parallel to and offset from the active or modified route.
	Altitude range arc	MAP MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
	Altitude profile point and identifier	MAP MAP CTR	Indicates the approximate map position of the FMS-calculated top-of-climb (T/C), top-of-descent (T/D) points. Predicted altitude/ETA points entered on the FIX page display the altitude/ETA along with the profile point. Deceleration points have no identifier.
	Energy management circles (**blue**, **white**)	MAP MAP CTR	Indicates clean (**blue**) and speedbrake (**white**) energy management circles as defined on the CDU OFFPATH DES page.

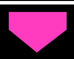
Navigation Display Symbols
Table 2-2 (cont)

Symbol	Name	ND Mode	Remarks
	Selected reference point and bearing and/or distance information	MAP MAP CTR PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes.
	ADIRU position	MAP MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMS position.
	Airplane symbol	MAP MAP CTR VOR APP	Current airplane position is at the apex of the triangle.
	Airplane symbol	VOR CTR APP CTR	Current airplane position is at the center of the symbol.
	Position trend vector (dashed +line)	MAP MAP CTR	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: ● greater than 20 NM, 3 segments ● = 20 NM, 2 segments ● = 10 NM, 1 segment.
	VNAV path pointer and deviation scale	MAP MAP CTR	Displays vertical deviation from selected VNAV path during descent only. Scale indicates +/–400 ft deviation. Digital display is provided when the pointer indicates more than +/–400 ft.

Navigation Display Symbols
Table 2–2 (cont)

Symbol	Name	ND Mode	Remarks
STA WPT ARPT	Selected map options	MAP MAP CTR	Displays EFIS control panel selected map options.
VOR L, R ADF L, R	VOR (**green**) or ADF (**blue**) selection	MAP MAP CTR VOR VOR CTR APP APP CTR	Located in lower left or right corner. Represents positions of the EFIS control panel VOR/ADF switches.
116.80 or SEA or 520 or BF	VOR frequency or identifier (**green**), ADF frequency or identifier (**blue**)	MAP MAP CTR VOR VOR CTR APP APP CTR	Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.
DME 24.6	DME distance	MAP MAP CTR VOR VOR CTR APP APP CTR	Indicates DME distance to the referenced navaid.
CDU L, C, R	Map source annunciator	MAP MAP CTR	Displays ND source if: • CDU is selected on respective navigation source select switch • Both FMCs fail, or • A manually selected FMC fails.
N↑	North up arrow	PLAN	Indicates map background is oriented and referenced to true north.
	GPS position	MAP MAP CTR	When the EFIS POS map switch is selected on, indicates GPS position relative to FMS position.

Navigation Display Symbols
Table 2-2 (cont)

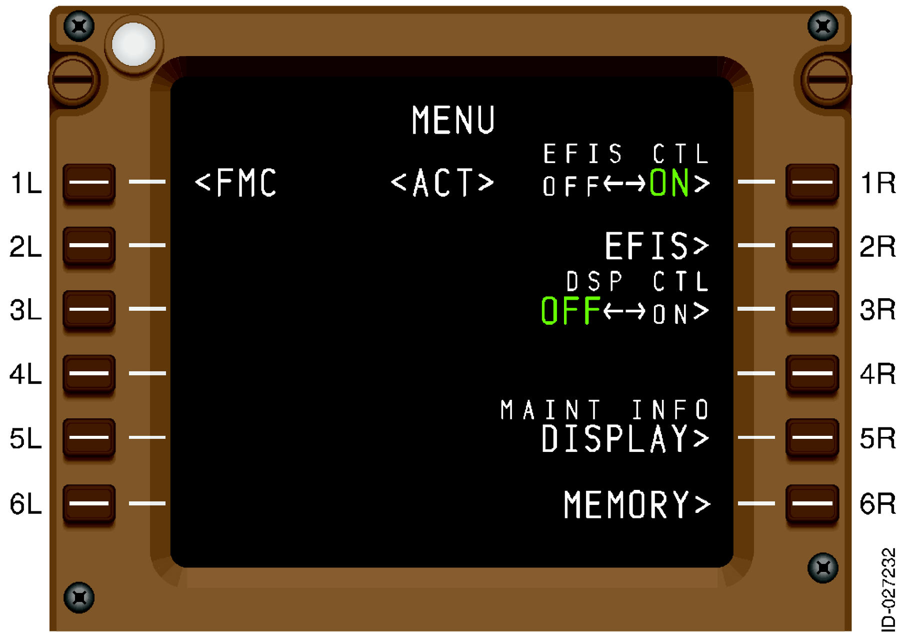
Symbol	Name	ND Mode	Remarks
	Selected heading bug	All except PLAN	Displays the MCP-selected heading. A dashed line may extend from the marker to the airplane symbol.
	Selected track bug	All except PLAN	Displays the MCP-selected track. A dashed line may extend from the marker to the airplane symbol.
	Airplane symbol	PLAN	Indicates actual position and track along the flight plan route in plan mode only. Inhibited north of 82N latitude and south of 82S latitude.
	Alternate airports	MAP MAP CTR PLAN	MAP, MAP CTR: displays the FMS or pilot-selected primary alternate airport. Displays up to four alternate airports when the EFIS control panel APRT map switch is selected on. PLAN: displays up to four alternate airports at all times.
GPS DME-DME VOR-DME LOC INERTIAL	FMS position update status	MAP MAP CTR	Indicates the system providing FMS position update.

Navigation Display Symbols
Table 2-2

Initial Power-up Operation

When power is initially applied to the aircraft, the CDU MENU page is displayed. From this page the pilot can access other subsystems that use the FMS CDU. The active system is indicated by <ACT> next to the system name (see Figure 2-10). If another system is requesting the CDU display, [REQ] is displayed next to that system name. This indicates that the non-active FMS CDU should be used to display the information from the subsystem requesting the FMS CDU.

To select the FMS, push the LSK next to <FMC. This displays the IDENT page (on initial power-up). If the FMS has been in use, then pushing the LSK next to <FMC displays the last page that was in use.



CDU Menu
Figure 2-10

FMS Terms

The terms that are used to describe the flight crew interaction with the FMS-CDU and the FMC are explained in the following paragraphs.

- **Active** – This describes flight plan information that is currently being used to calculate LNAV or VNAV guidance commands. The active waypoint is the point the system is currently navigating toward, and the active performance VNAV mode is the climb, cruise, or descent profile currently being used for pitch and thrust commands. ACT is displayed in the respective page titles.
- **Activate** – This is the process of designating one of the two routes as active. It is a two-step process, pushing the ACTIVATE LSK and then pushing the EXEC key.
- **Altitude Constraint** – This refers to a crossing restriction at a waypoint on the route.
- **ECON** – This is a speed schedule that is calculated to minimize the operating cost of the aircraft. This ECON or economy is based on a cost index that is entered into the CDU during preflight on the PERF INIT page. The cost index is determined by dividing the operating cost of the aircraft by the cost of fuel. If fuel costs are high, the number is low. A low cost index results in a low economy speed.
- **Enter** – This is typing or line selecting alphanumeric characters into the CDU scratchpad and then line selecting the information to the desired location.
- **Erase** – This is removing a modified LNAV and VNAV path from the system by pushing the LSK adjacent to the word ERASE.
- **Execute** – This is making entered information part of the active flight plan by pushing the EXEC key.
- **Inactive** – This refers to route, climb, cruise, or descent information that is not currently being used to calculate LNAV or VNAV commands.
- **Initialize** – This is entering information into the CDU that is required to make the FMS operative.
- **Message** – This is information the FMS automatically displays in the scratchpad to inform the pilot of some condition.
- **Modify** – This is changing active data. When a modification is made to the active route or performance mode, MOD is displayed in the page title, ERASE is displayed next to one of the LSKs, and the EXEC key lights. Pushing the ERASE LSK cancels the modification. Pushing the EXEC key makes the modified information active.

- **Prompt** – This is something displayed on the CDU page to help the flight crew in accomplishing a task. Prompts can be boxes (□□□□□), dashes (– – – – –), or a caret (< >) to remind the pilot to enter or validate information on the respective data line.

- **Select** – This refers to pushing a key to obtain the desired information or action.

- **Speed Restriction** – This is an airspeed limit beyond a specified altitude constraint entered by the pilot.

- **Speed Transition** – This is an airspeed limit that is automatically entered below a specified altitude.

- **Waypoint** – Refers to a point in the route. It can be a fixed point such as a latitude and longitude, VOR or NDB station, intersection on an airway, or a conditional point. An example of a conditional point is “when reaching 1000 feet”.

3. Flight Operations

The following sections describe FMS operation used on a typical airline revenue flight. It begins with system initialization prior to engine start and continues to engine shutdown at destination. All flight phases (PREFLIGHT, TAKEOFF, CLIMB, CRUISE, DESCENT, and APPROACH) are explained in detail. Not all system functions are described, however, those frequently used as part of the normal operation are covered.

NOTES, CAUTIONS, WARNINGS are used throughout this guide. These are as follows:

NOTE: Calls attention to methods that make the job easier or to pertinent information for the flight crew.

CAUTION

CALLS ATTENTION TO METHODS AND PROCEDURES THAT MUST BE FOLLOWED TO AVOID DAMAGE TO DATA OR EQUIPMENT.

WARNING

CALLS ATTENTION TO USE OF MATERIALS, PROCESSES, METHODS, OR LIMITS THAT MUST BE FOLLOWED PRECISELY TO AVOID EXTREMELY SERIOUS CONSEQUENCES, INJURY OR DEATH.

FLIGHT DATA

A typical flight from Chicago, IL (O'Hare International Airport – KORD) to London, UK (Heathrow Airport – EGLL) is shown in Figure 3-1. It is used in the following example. Table 3-1 lists the details pertaining to the flight.

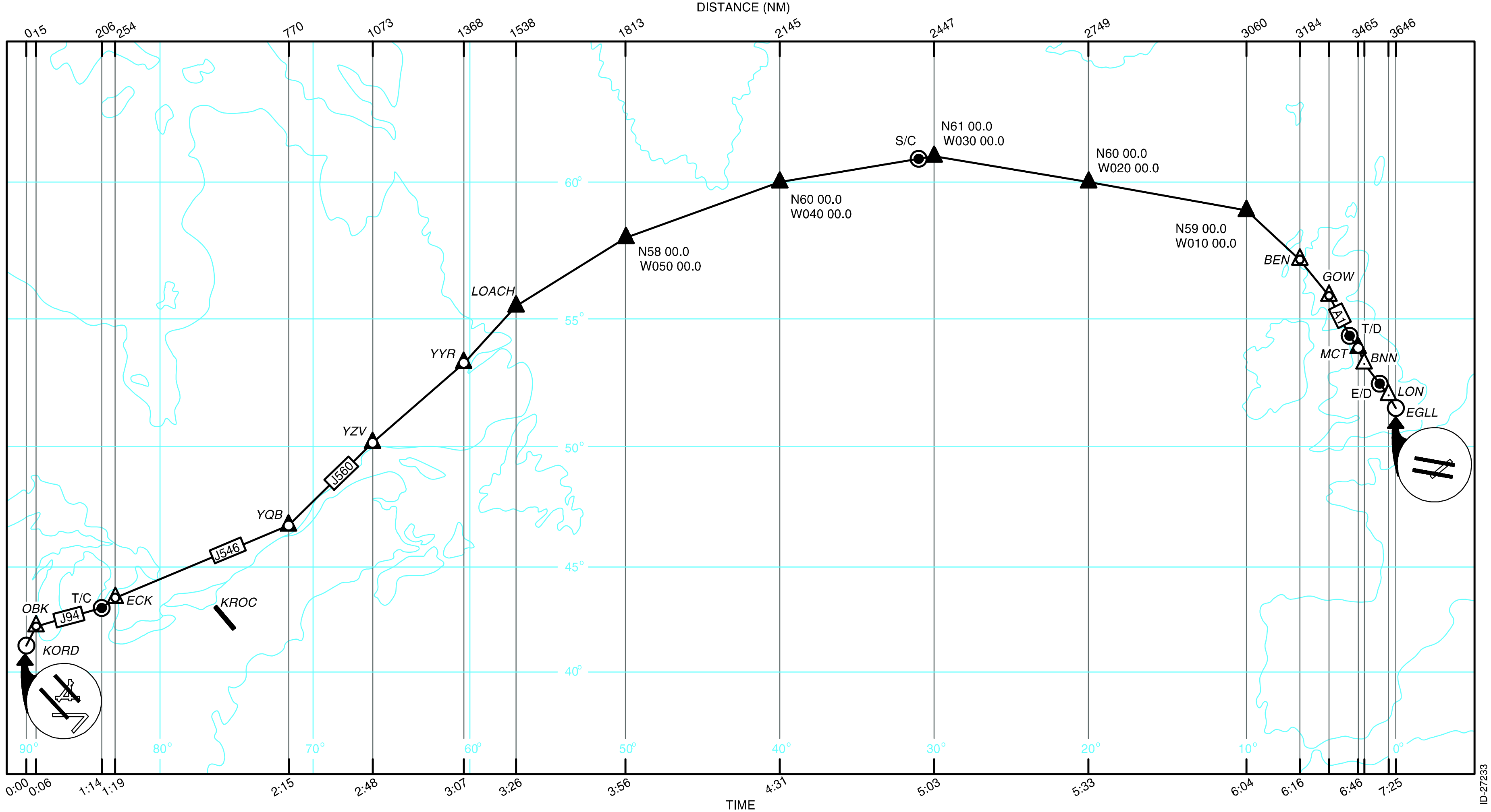
Airline	
Company Route	Not Available
Flight Number	777
Departure Airport	Chicago O'Hare (KORD)
Destination Airport	London Heathrow (EGLL)
Alternate Airport	Manchester (EGCC)
B777 Aircraft	
Perf Factor	+0.0/+0.0
Cost Index	80
TOGW	535,000 lbs
ZFW	371,000 lbs
CG	30%
Taxi Fuel	1000 lbs
Fuel Burnoff	110,000 lbs
10% Fuel	11,000 lbs
Reserve Fuel	15,000 lbs
Contingency Fuel	25,000 lbs
Cruise levels	FL350/FL390
Climb and Descent Flight Plan Summary	
Climb to FL350 initially	
Step Climb to FL390 after WPT N61W030	
Top-of-Descent begins 186 NM from EGLL	

Flight Data Chicago to London
Table 3-1 (cont)

Flight Plan Routing as filed is as following
KORD
M083F350 DCT OBK J94 ECK J546 YQB J560 YZV DCT YYR
DCT LOACH DCT N58W050 DCT N60W040 DCT N61W030
DCT N60W020 DCT N59W010 DCT BEN DCT GOW A1 CALDA
DCT LON DCT
EGLL

En route Winds
The winds at FL350 are 270 degrees at 100 kts.

Flight Data Chicago to London
Table 3-1



Flight Plan Routing
Figure 3-1

4. Preflight

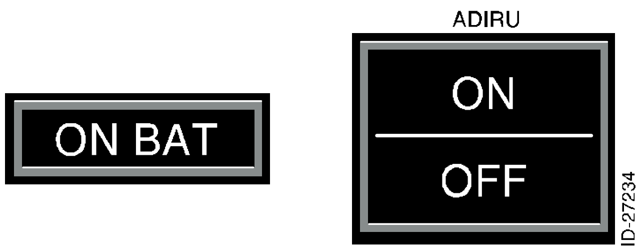
In addition to the normal preflight procedure, the pilot should do the following:

- Verify the FMS aircraft status
- Initialize the system
- Check/modify the flight plan
- Configure the FMS for flight:
  - — Winds
  - — Thrust limits
  - — Thrust reduction/acceleration altitudes
  - — Radio/navigation tuning
  - — Departure runway
  - — V_{SPEEDS}.

After engine start and prior to takeoff, the takeoff gross weight may need to be updated.

AIR DATA INERTIAL REFERENCE UNIT

One of the first things to do after the primary aircraft power is applied is to check that the ADIRU is powered up. Initial ADIRU power-up requires that primary aircraft power is available and the ADIRU switch is in the ON position (Figure 4-1). If the ADIRU is turned off, it must complete a full realignment cycle before the aircraft can be moved. If electrical power is subsequently removed from the aircraft and the battery switch is turned off, the hot battery bus continues to supply electrical power to the ADIRU. The ON BAT annunciator lights (Figure 4-1) and the horn in the landing gear wheel well sounds to alert maintenance that the ADIRU is on battery power.



ADIRU Switch and ON BAT Annunciator
Figure 4-1

ADIRU Alignment

On initial power-up, the ADIRU enters the align mode. The EICAS memo message ADIRU ALIGN MODE is displayed and there is no attitude or heading/track information displayed on the PFDs. A new aircraft latitude/longitude position must be entered on the CDU POS INIT page. The aircraft should not be moved during the align mode.

NOTES:

1. If the entered lat/long is not within 6 NM of the origin airport, the scratchpad message INERTIAL/ORIGIN DISAGREE is displayed.
2. If the entered latitude/longitude position does not pass the ADIRU internal comparison tests, the scratchpad message ENTER INERTIAL POSITION is displayed.
3. If a new aircraft present position entry fails the internal check twice, the scratchpad message ALIGNMENT REINITIATED is displayed and the system automatically begins a new alignment cycle.

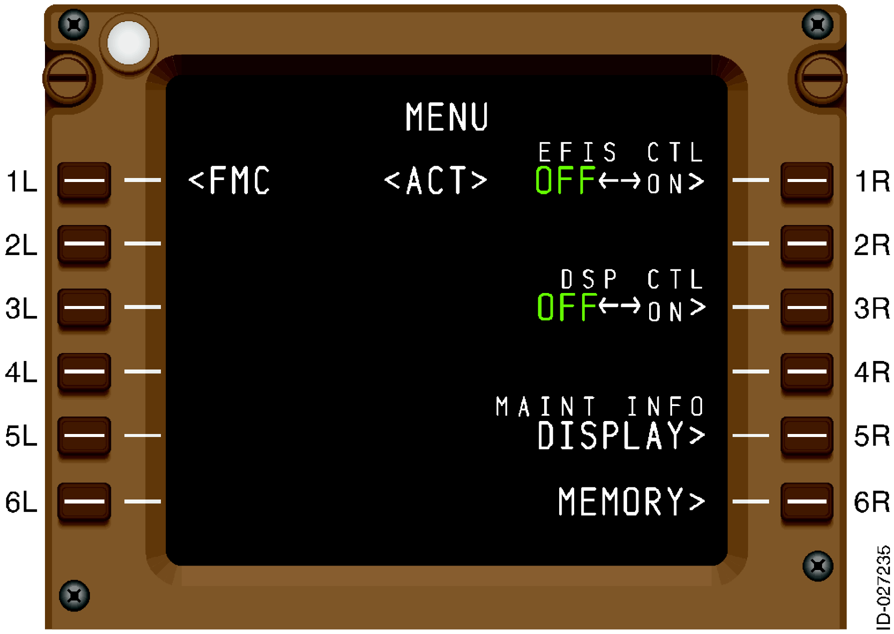
When the alignment is complete, the ADIRU enters the nav mode, and the aircraft can be moved. If the aircraft stops for an extended period, the ADIRU enters the automatic nav realign mode and refines the alignment. In the automatic realign mode, accumulated ADIRU position error is very small since all velocities are continually reset to zero. After 6 – 15 minutes, depending on latitude, dash prompts are displayed on the SET INERTIAL POS line on the POS INIT page and a new inertial position can then be entered.

If the aircraft is moved before the dash prompts are displayed, the automatic nav realign mode is terminated and the ADIRU enters the nav mode.

NOTE: The ADIRU cannot be realigned in flight.

AIRCRAFT IDENTIFICATION (IDENT) PAGE

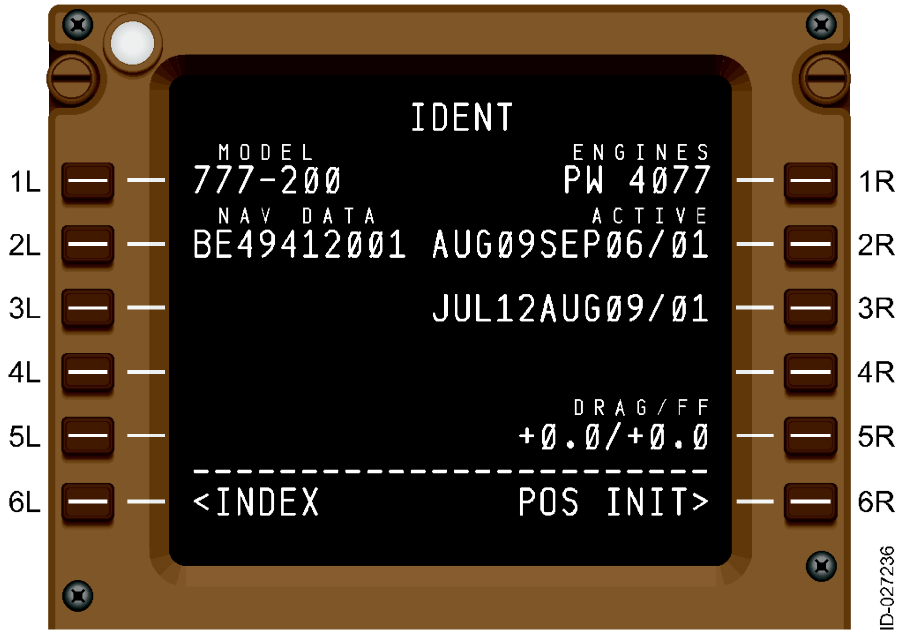
At power-up, the FMS executes an internal self-test. Normally (when the self-test is completed successfully), the MENU page is displayed and the <FMC is visible at 1L (see Figure 4-2).



MENU Page
Figure 4-2

Pushing 1L (FMC) on the MENU page displays the IDENT page. The IDENT page is also displayed by pushing 1L (IDENT) on the INIT/REF INDEX page.

The IDENT page (see Figure 4-3) lets the pilot review the aircraft type, engine type, and nav database information. The only data that can be changed on the IDENT page is the active nav database cycle, and the drag and fuel flow.



IDENT Page
Figure 4-3

Any CDU messages can be cleared from the scratchpad with the CLR key. CDU messages are described in Section 14, FMS Messages.

The INDEX prompt (6L) and the POS INIT prompt (6R) access the INIT/REF INDEX and POS INIT pages. Following the prompts in 6R of the succeeding pages guide the pilot through the FMS preflight entries.

NOTE: All data on the aircraft IDENT page should be reviewed for currency and applicability.

The IDENT page is described in the following paragraphs.

- **MODEL (1L)** - This is the particular aircraft model from the FMS performance database. In this case, it is the Boeing 777-200.

- **NAV DATA (2L)** – This is the nav database identifier used in FMS navigational planning. The first two digits of the database part number designate the airline. The third digit designates the airline database number. The fourth and fifth digits designate the year the database was produced. The sixth and seventh digits designate the database cycle number. There are 13 database cycles in one year, so sometimes the database cycle number coincides with the month that it is effective, and sometimes it does not. The eighth, ninth, and tenth digits designate the sequence number.

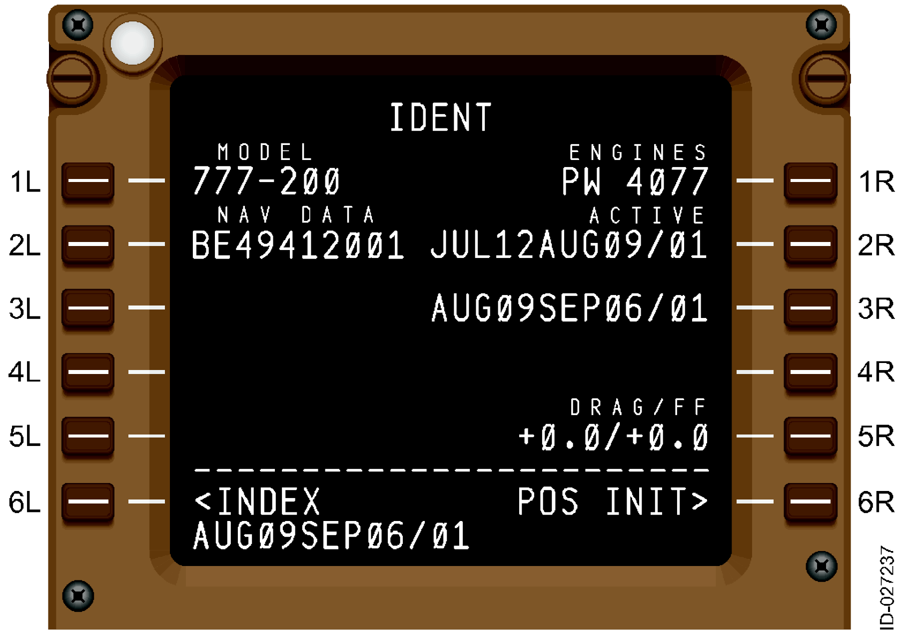
  NOTE: If the FMS time (which uses the AIMS clock) indicates the active nav database cycle is expired, NAV DATA OUT OF DATE is displayed in the scratchpad. This message is only displayed when the aircraft is on the ground.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **ENGINES (1R)** – This is the engine identification number model from the performance database. In this case, the engine type is Pratt & Whitney PW-4077. If the ENGINES field is blank, the FMS is not compatible with the aircraft configuration, and no other FMC pages are displayed.

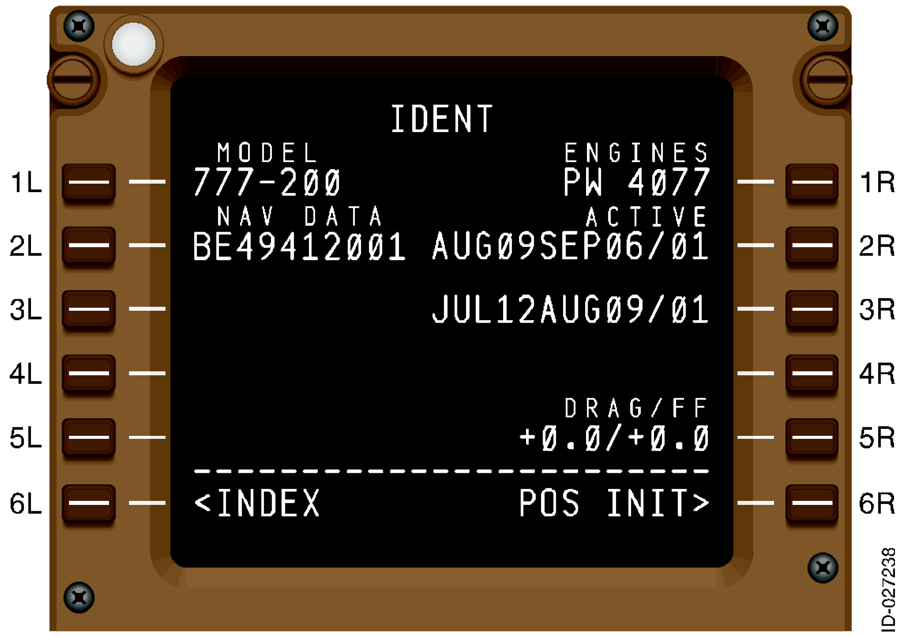
- **ACTIVE and INACTIVE Nav Databases (2R and 3R)** – The active FMS nav database cycle is displayed in 2R. The inactive FMS nav database cycle is displayed in 3R. To change the active nav database, do the following.

STEP: Push 3R to copy the inactive nav database cycle dates to the scratchpad (see Figure 4-4).



Change Active Nav Database
Figure 4-4

STEP: Push 2R to select the inactive nav database cycle from the scratchpad to 2R (see Figure 4-5). The nav database cycle that was in 2R moves to 3R.



New Nav Database
Figure 4-5

NOTES:

1. The active nav database cannot be selected to the scratchpad by pushing 2R.
2. The ACTIVE nav database can only be changed while the aircraft is on the ground.
3. Changing the ACTIVE nav database erases any information previously entered on the RTE, LEGS, PEF INIT and POS INIT pages.

- **DRAG/FF (5R)** – The DRAG value is the aircraft drag correction factor (as a percentage) from the performance database. The FF value is the aircraft fuel flow correction factor, as a percentage. When new values must be changed, enter the word ARM into the scratchpad and transfer it to the DRAG/FF line. This arms the line for data entry and ARM DRAG/FF is displayed.

  Enter the required drag/fuel flow data into the scratchpad and push 5R. If the drag factor is entered by itself, it must be followed by a slash (/). If the fuel flow factor is entered by itself, it must be preceded by a slash (/). Valid entries are from –5.0 to +9.9.

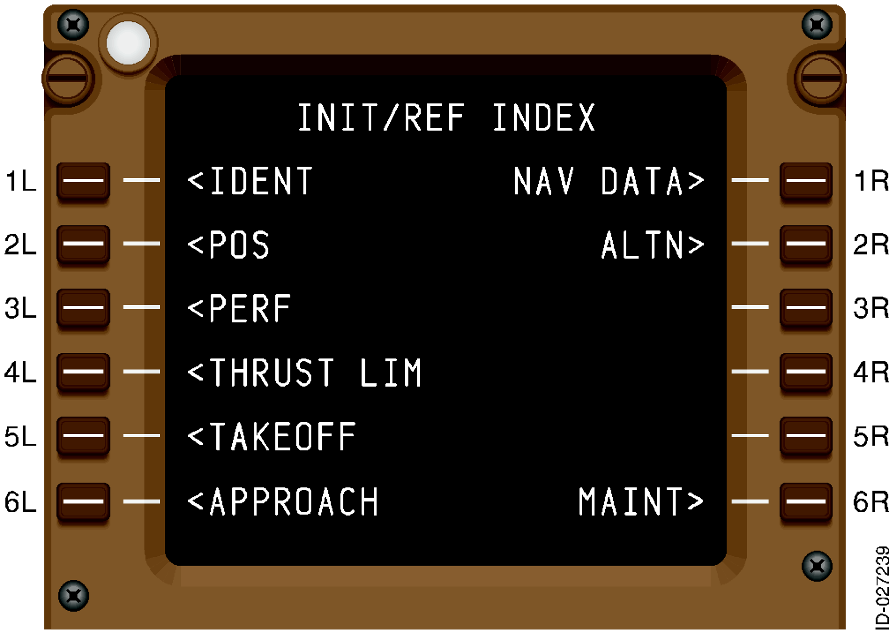
  NOTE: DRAG/FF entries cannot be made when the aircraft is airborne.

- **POS INIT> (6R)** – When all the data on the IDENT page has been checked and verified as correct, pushing 6R displays the POS INIT page. Following the prompts at 6R on the succeeding pages, guides the pilot through the FMS preflight entries.

INIT/REF INDEX PAGE

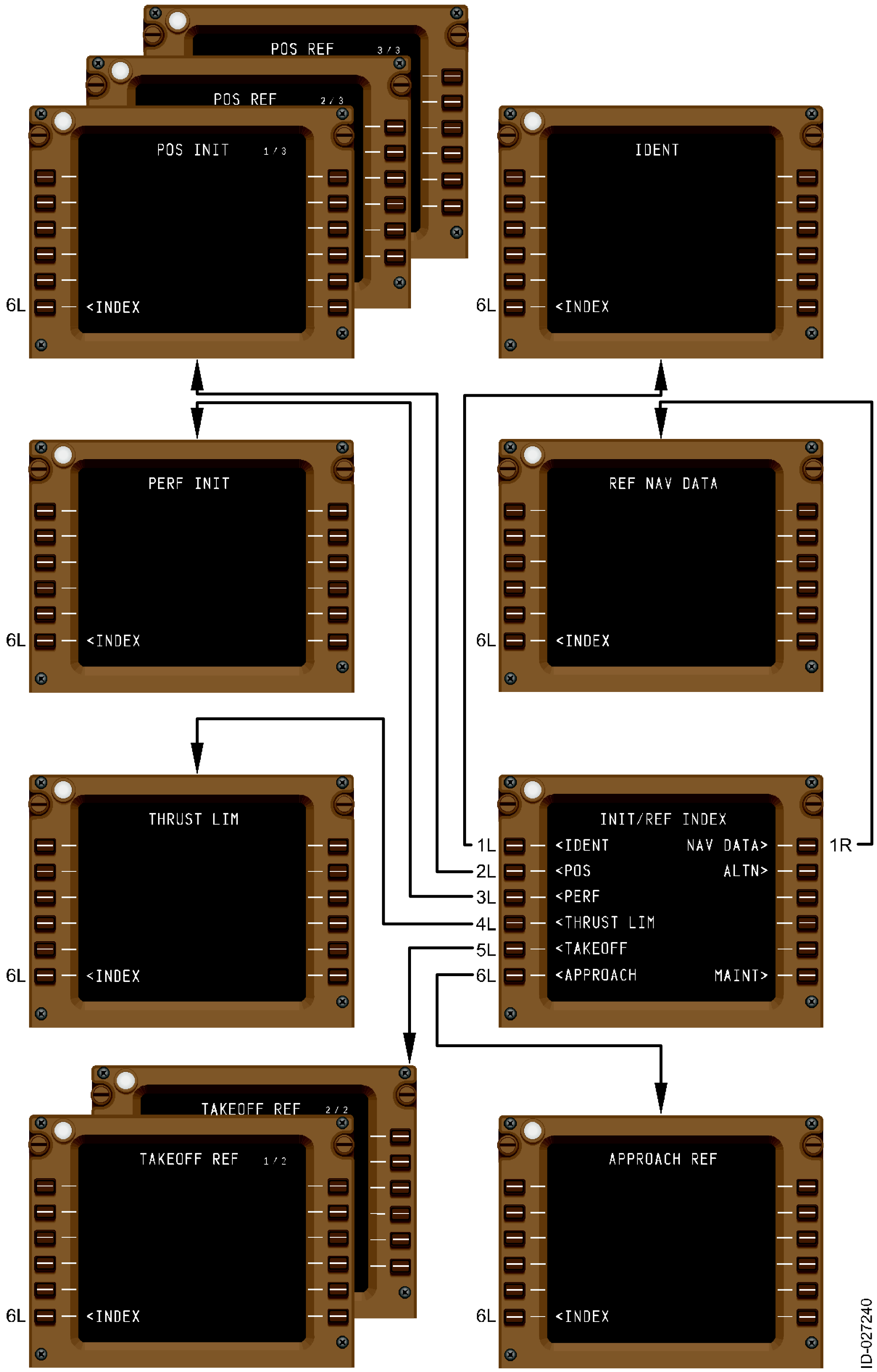
During the PREFLIGHT phase, the pilot can easily cycle through all pertinent preflight steps by pushing 6R on each of the preflight pages. The preflight pages include the IDENT, POS INIT, RTE, PERF INIT, THRUST LIM, and TAKEOFF pages.

The initialization or reference pages that require pilot-entry are displayed automatically when 6R is pushed. If the desired page is not displayed, pushing 6L (<INDEX) on any of the preflight pages displays the INIT/REF INDEX page (see Figure 4-6).



INIT/REF INDEX Page
Figure 4-6

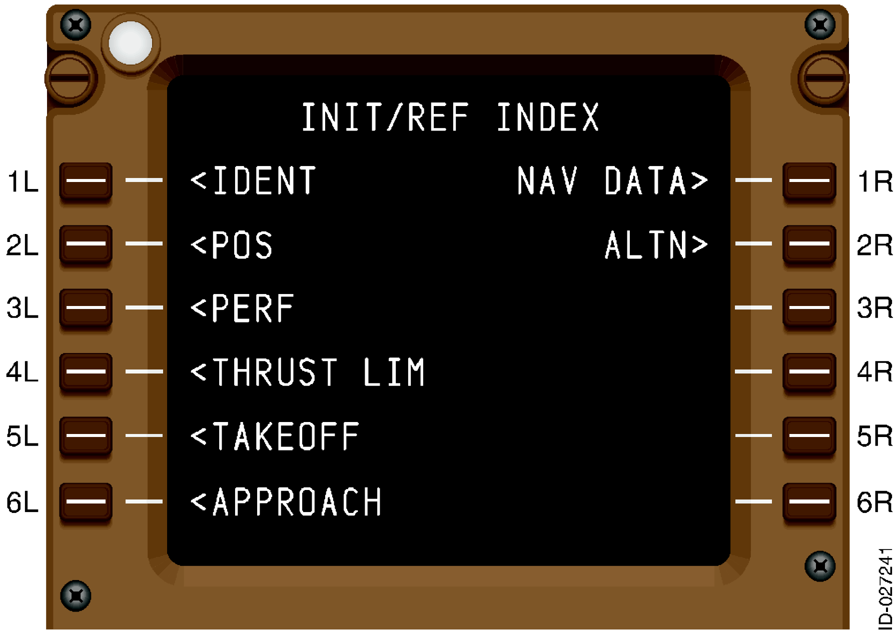
Any of the preflight pages can be selected from the INIT/REF INDEX. The only exception to this is the POS REF page, which is displayed by pushing the NEXT PAGE key when the POS INIT page is displayed (see Figure 4-7).



Initialization Pages
Figure 4-7

NOTES:

1. The alternate airports prompt (ALTN) in 2R on the INIT/REF INDEX page accesses the ALTN page. This page is described in Section 9, Alternate Page.
2. The MAINT prompt in 6R is only displayed when the aircraft is on the ground. Once the aircraft is airborne, this field is blank (see Figure 4-8).



INIT/REF INDEX Page – Airborne
Figure 4-8

POS INIT PAGE

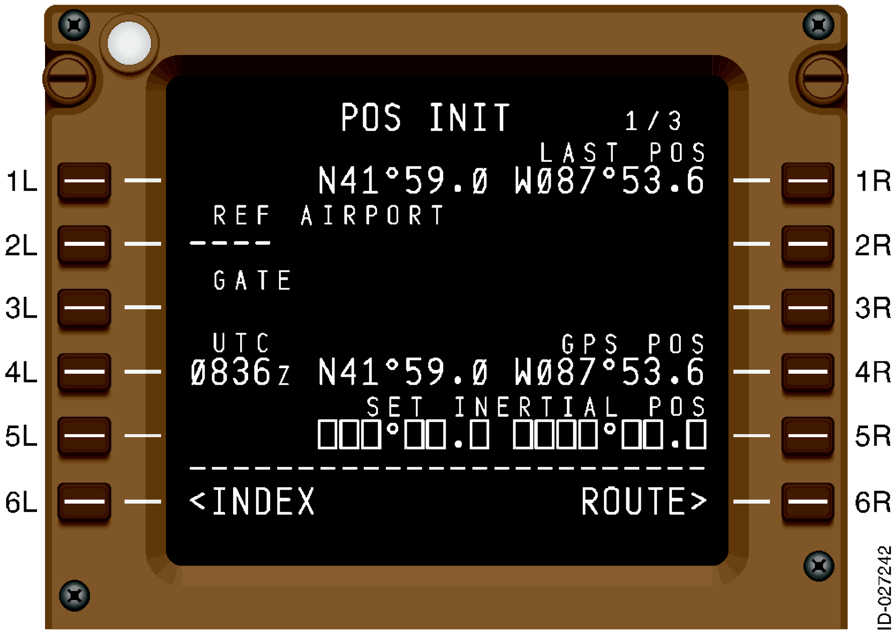
The POS INIT page lets the pilot enter present position into the ADIRU during preflight alignment. The same page is used to enter heading for the secondary attitude air data reference unit (SAARU) initialization when the ADIRU is inoperative. Pushing 6R on the IDENT page displays the POS INIT page.

The POS INIT page is shown in Figure 4-9. The pilot can use the CDU to initialize the ADIRU with the origin airport, specific gate, or GPS position. The initialization aligns the ADIRU to the present ground position of the aircraft.

If a manually entered position does not pass the ADIRU internal check, ENTER INERTIAL POSITION is displayed in the scratchpad. If the manually entered position still fails the ADIRU check after entering the position a second time, REALIGNMENT INITIATED is displayed in the scratchpad and the ADIRU realignment is automatically started.

The manually entered position is also compared with the FMS origin airport location. If the entered position is not within 6 NM of the FMS origin airport, INERTIAL/ORIGIN DISAGREE is displayed in the scratchpad.

To display the POS INIT page, push 6R (POS INIT) on the IDENT page or push 2L (POS) on the INIT/REF INDEX page.



POS INIT Page
Figure 4-9

The POS INIT page is described in the following paragraphs.

- **REF AIRPORT (2L)** – When the four letter ICAO airport identifier for the origin airport is entered in 2L, the airport reference point lat/long is displayed in 2R. Entering a valid airport identifier in 2L deletes any previously selected gate number entry and a new gate can be entered in 3L. The REF AIRPORT is cleared once the aircraft is airborne.

- **GATE (3L)** – If the origin gate at the reference airport has a specific identifier in the nav database, it can be entered in 3L. Dashes are displayed if the reference airport has been entered in 2L. When the gate identifier is entered in 3L, the lat/long for the gate is displayed in 3R. Valid gate entries are one to five alphanumeric characters. The GATE field is cleared at takeoff or returns to dashes when a different reference airport is entered in 2L.

- **UTC (4L)** – Universal time coordinated (UTC) is displayed when the FMS displays time from the GPS.

When MAN is displayed at 4L header, the time displayed is from the captain's clock when MAN is operating. Otherwise, it displays time from the first officer's clock. Hours are set by entering the desired hour reference and minutes are set by setting the appropriate pilot's clock.

- **SET HDG (5L)** – If the ADIRU is inoperative, a SET HDG field is displayed in 5L for the pilot to manually enter a heading and the EICAS caution message NAV ADIRU INERTIAL is displayed.

  The aircraft magnetic heading is entered in 5L for the SAARU initialization. A valid entry is from 0 to 360 (an entry of 360 is displayed as 000).

  The entry in 5L is displayed for 2 seconds and then dashes are again displayed to enter another heading. After landing, heading information is no longer displayed on the PFD and ND when the aircraft decelerates below 100 knots.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **LAST POS (1R)** – The last aircraft lat/long present position (as calculated by the FMS) is displayed in 1R at all times. This data is retained when the aircraft is powered down.

- **GPS POS (4R)** – The GPS present position is displayed in 4R.

- **SET INERTIAL POS (5R)** – Box prompts are displayed in 5R within one minute of ADIRU power-up (aircraft on the ground) if present position has not yet been entered. A lat/long can be entered into 5R with the keyboard, or by selecting the LAST POS (1R), GPS POS (4R), REF AIRPORT (2L), or GATE (3L) to the scratchpad and then pushing 5R.

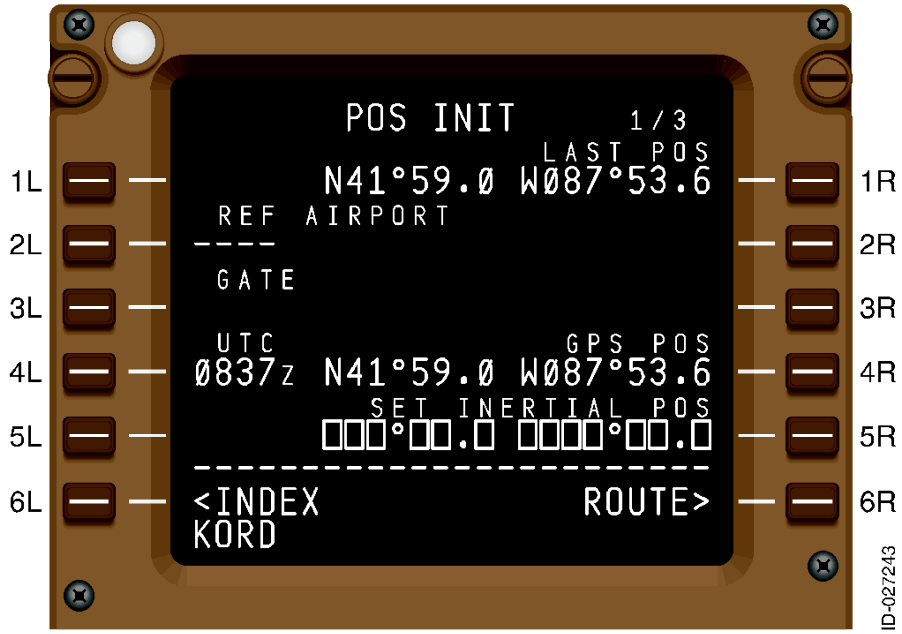
  The box prompts are removed when the ADIRU transitions from the alignment mode to the navigation mode or when the aircraft is moving or has not been stationary for a minimum of 6 minutes.

  Dashes are displayed when the ADIRU enters the automatic realignment mode on the ground. New position entries can be made during the ADIRU automatic realignment. New entries are displayed for 2 seconds and then dashes are again displayed to enter another position, if desired.

- **ROUTE> (6R)** – Pushing 6R displays the appropriate RTE page (MOD RTE, ACT RTE, or RTE 1). This is the next page in the preflight sequence.

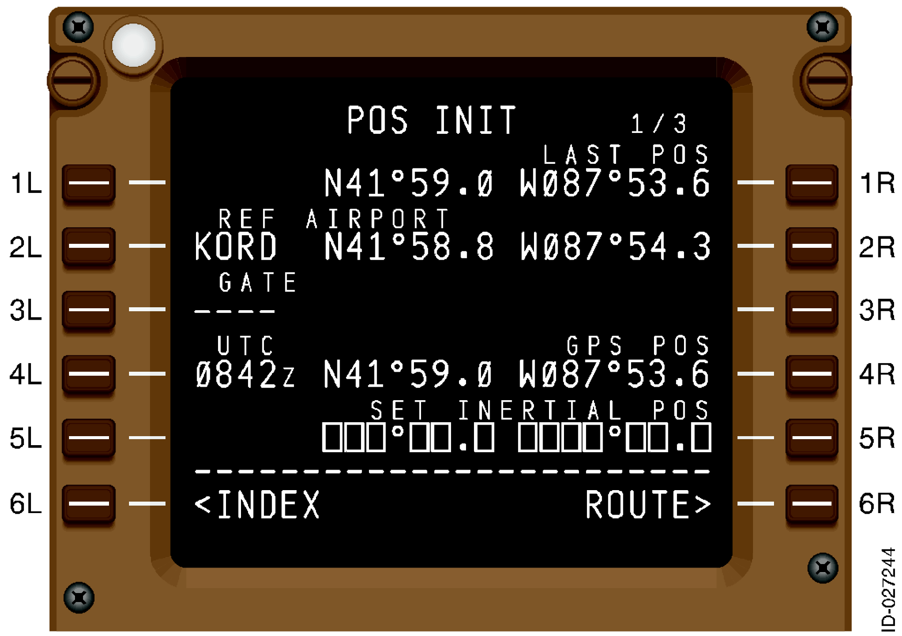
The following steps are used to initialize the POS INIT page for the flight from KORD to EGLL.

STEP: Enter the origin airport (KORD) in the scratchpad (Figure 4-10).



POS INIT Page – REF AIRPORT Before Entry is Made
Figure 4-10

STEP: Push 2L. The Chicago O'Hare airport lat/long is displayed in 2R (Figure 4-11).



POS INIT Page – REF AIRPORT After Entry Is Made
Figure 4-11

STEPS:

1. Push 2R to copy the lat/long from 2R to the scratchpad (Figure 4–12).

OR

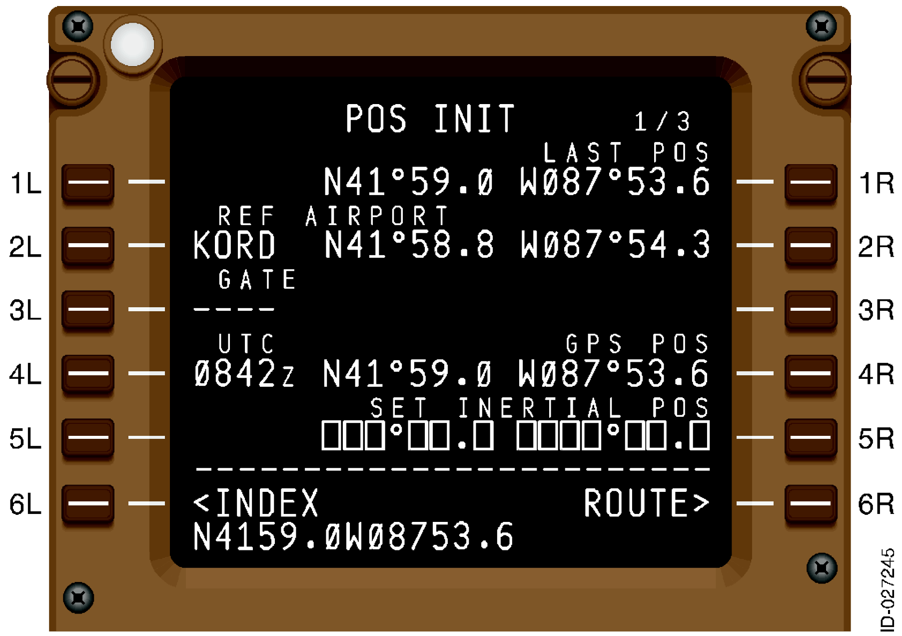
2. If there is a specific gate identifier, enter the gate in the scratchpad and push 3L. This displays the gate lat/long in 3R. Push 3R to copy the gate lat/long to the scratchpad.

OR

3. Push 4R to copy the GPS position lat/long to the scratchpad.

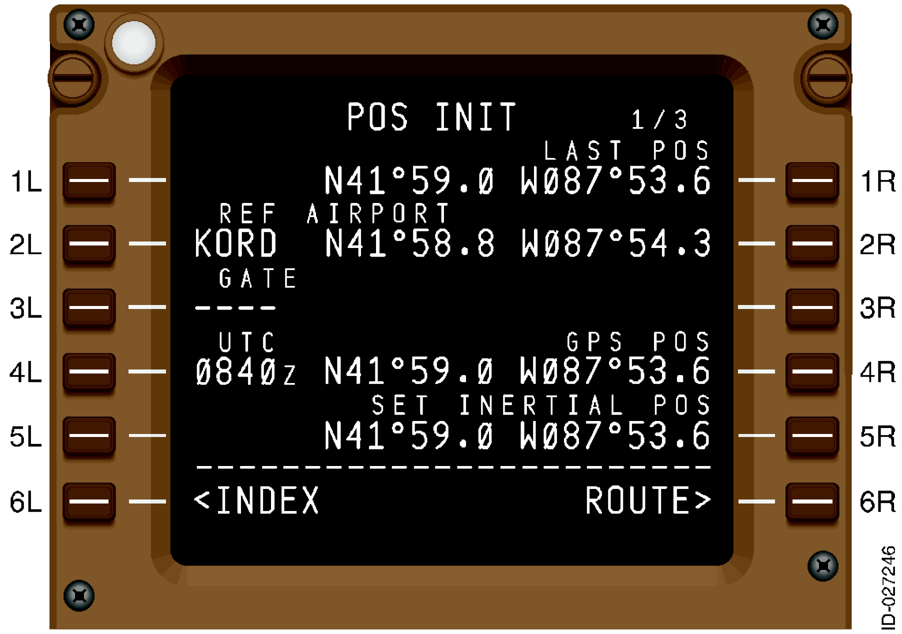
OR

4. Enter the lat/long into the scratchpad manually with the alphanumeric keyboard.



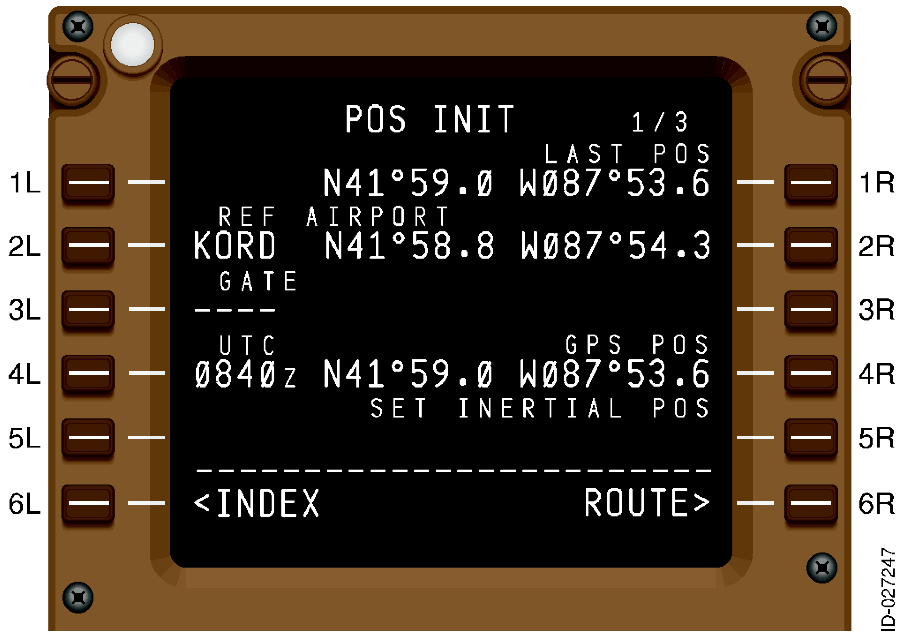
POS INIT – GPS LAT/LON In Scratchpad
Figure 4–12

STEP: Push 5R to enter the lat/long as the present inertial position (Figure 4-13).



POS INIT Page – Set Inertial Position
Figure 4-13

When the ADIRU has transitioned from the alignment mode to the navigation mode, the lat/long information is removed from 5R (Figure 4-14).

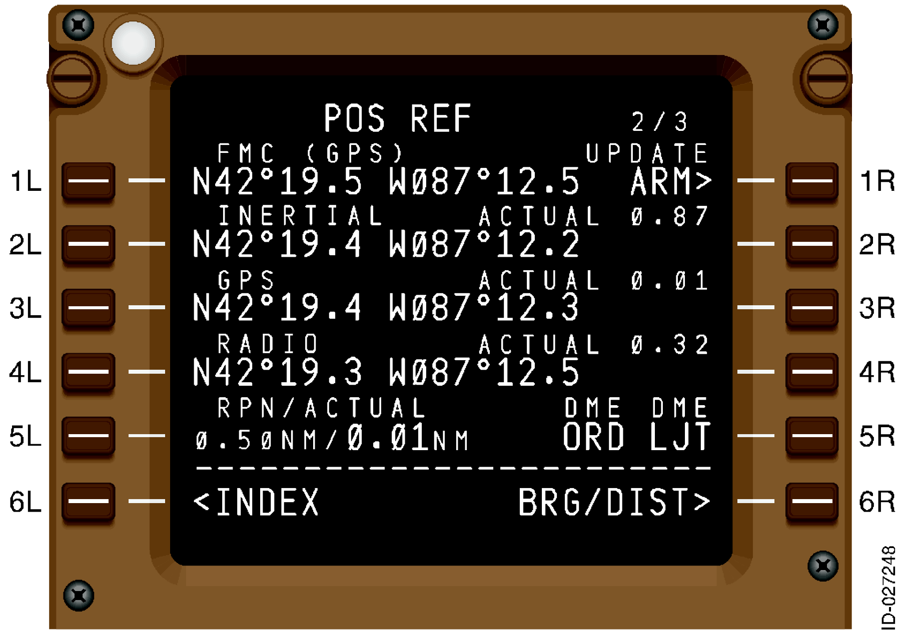


POS INIT Page – ADIRU Nav Mode
Figure 4-14

POS REF PAGES

The second and third pages of the POS INIT pages are POS REF page 2/3 and POS REF page 3/3.The POS REF page 2/3 displays the aircraft present position as calculated by the FMS, GPS, ADIRU, and radio navigation receivers. An FMS position update using ADIRU, GPS, or radio position can be initiated from this page.

POS REF page 2/3 and 3/3 are displayed by pushing either the NEXT PAGE or PREV PAGE key while the POS INIT page is displayed. The POS REF page 2/3 is shown in Figure 4-15.



POS REF Page 2/3
Figure 4-15

The POS REF page 2/3 is described in the following paragraphs.

- **FMC (1L)** - The present FMC lat/long computed position is displayed in 1L. If the FMC position is invalid, this field is blank. The FMC position is blank from power-up until an ADIRU enters the navigation mode. The FMC position at 1L can be copied to the scratchpad by pushing 1L.

  The source for calculating the FMC position is shown in parentheses in the header line (GPS in Figure 4-15). GPS indicates the FMC position is calculated using GPS position data. Other sources for calculating the FMC position are ADIRU position data (INERTIAL) or navigation radio position data (RADIO). RADIO can be DME-DME or VOR-DME. Other possible displays include LOC, LOC-GPS and LOC-RADIO. If GPS or RADIO data has been used to correct FMC position, a display of FMC (INERTIAL) is normally biased from the inertial position.

- **UPDATE ARM (1R)** – Pushing 1R arms the FMC position update function. This function is used to update the FMC position to match the INERTIAL, GPS, or radio position. When this function is armed, ARMED is displayed in 1R.

  When the ARMED prompt is displayed, NOW prompts are displayed on the right side of the INERTIAL, GPS, and RADIO lines. Pushing 2R updates the FMC position to match the inertial position. Pushing 3R updates the FMC position to match the GPS position. Pushing 4R updates the FMC position to match the radio position.

- **INERTIAL (Line 2)** – The lat/long position as determined by the ADIRU is displayed in 2L. The inertial position is blank from power–up until a position is entered. The ADIRU lat/long position can be copied to the scratchpad by pushing 2L. The actual estimate of nav accuracy of the inertial position is displayed in 2R. This value indicates a radius (in NM) around the displayed inertial position, inside which the actual aircraft position is located.

- **GPS (Line 3)** – The lat/long position as determined by the GPS is displayed in 3L. The GPS lat/long position can be copied to the scratchpad by pushing 3L. The actual estimate of nav accuracy of the GPS position is displayed in 3R. This value indicates a radius (in NM) around the displayed GPS position, inside which the actual aircraft position is located.

- **RADIO (Line 4)** – The lat/long position as determined by the navigation radios is displayed in 4L. The RADIO lat/long position can be copied to the scratchpad by pushing 4L. The actual estimate of nav accuracy of the radio position is displayed in 4R. This value indicates a radius (in NM) around the displayed radio position, inside which the actual aircraft position is located.

- **RNP/ACTUAL (5L)** – The required navigation performance (RNP) is displayed in 5L. The RNP default value is determined by the phase of flight, but can be overwritten with a pilot entry. The default values are listed in Table 4–1.

Phase of Flight	Default RNP Value
Oceanic/Remote	12.0 NM
En Route (Domestic)	2.0 NM
Terminal	1.0 NM
Approach	0.5 NM
NOTE: Individual airline default values may be less those listed.	

Default RNP Values
Table 4-1

The ACTUAL position accuracy displayed in 5L is an estimate of FMC position accuracy in nautical miles. The accuracy is displayed to the nearest 1/10 NM if it is greater than or equal to 10 NM, or to the nearest 1/100 NM if it is less than 10 NM. Position accuracy values can range from 0.00 to 99.9 NM. Position accuracy values greater than 99.9 NM are displayed as 99.9.

- **DME DME (5R)** – The three– or four-letter identifiers of the navigation stations that are currently being used by the FMS in the radio position updating are displayed in 5R. The header line indicates the active radio update mode either DME/DME (Figure 4–15), VOR/DME, or LOC.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **BRG/DIST or LAT/LON (6R)** – When the BRG/DIST prompt is displayed, pushing 6R changes the position display format to bearing/distance and the prompt in 6R changes to LAT/LON. Pushing 6R when the LAT/LON prompt is displayed changes the position display format back to lat/long.

  Figure 4–15 shows the lat/long position display format (POS REF page 2/3). Figure 4–16 shows the bearing/distance display format (POS REF page 3/3).

  NOTE: The bearing/distance format displays the bearing and distance of the other position sources relative to the FMC position. The latitude/longitude format displays are actual positions.

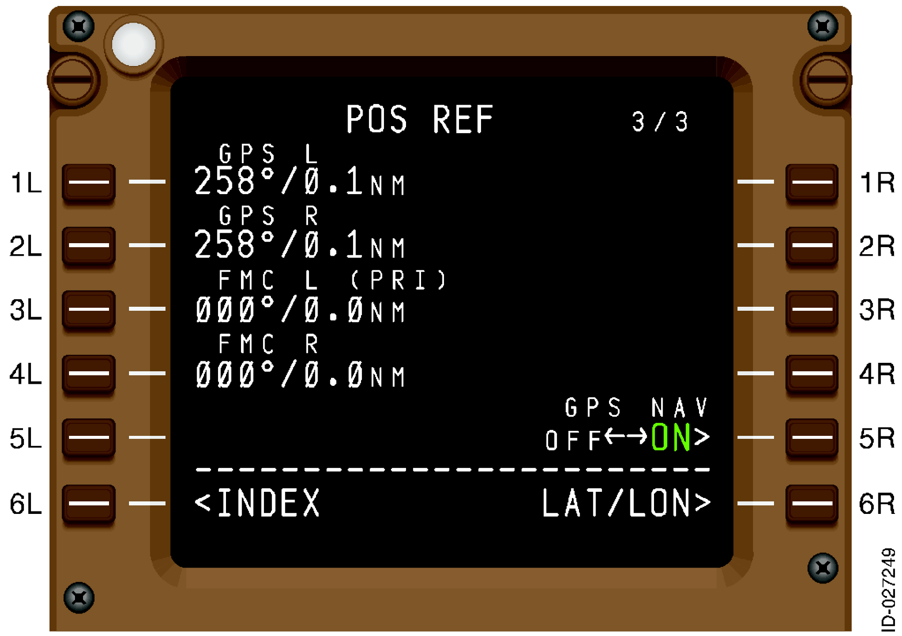
The POS REF page 3/3 (Figure 4-16) displays the calculated positions from the left and right GPS receivers and the left and right FMC position calculations.

STEPS:

1. Push the NEXT PAGE key when the POS REF page 1/3 is displayed.

OR

2. Push the PREV PAGE key when the POS INIT page 2/3 is displayed.



POS REF Page 3/3
Figure 4-16

The POS REF page 3/3 is described in the following paragraphs.

- **GPS L (1L)** - The left GPS position is displayed in 1L.
- **GPS R (2L)** - The right GPS position is displayed in 2L.
- **FMC L (PRI) (3L)** - The left FMC calculated position is displayed in 3L. (PRI) in 3L indicates that the left FMC is the active FMC and the right FMC is the inactive FMC. (PRI) is always displayed in the header line for the active FMC.
- **FMC R (4L)** - The right FMC calculated position is displayed in 4L.
- **<INDEX (6L)** - Pushing 6L displays the INIT/REF INDEX page.

- **GPS NAV (5R)** – Pushing 5R alternately selects GPS NAV ON (active) and OFF (inactive). In the ON position, GPS data can be used to compute FMC, position, ON is displayed in large **green** font, and OFF is displayed in small **white** font.

  In the OFF position, GPS position data is not used to compute FMC position, but is still displayed on 1L and 2L and PAGE 2/3 line 3L and PAGE 1/3 line 4R. OFF is displayed in large **green** font, and ON is displayed in small **white** font.

  NOTE: When power is applied to the aircraft, GPS NAV is automatically selected ON.

- **BRG/DIST or LAT/LON> (6R)** – When the BRG/DIST prompt is displayed, pushing 6R changes the position display format to bearing/distance and the prompt in 6R changes to LAT/LON. Pushing 6R when the LAT/LON prompt is displayed changes the position display format back to lat/long.

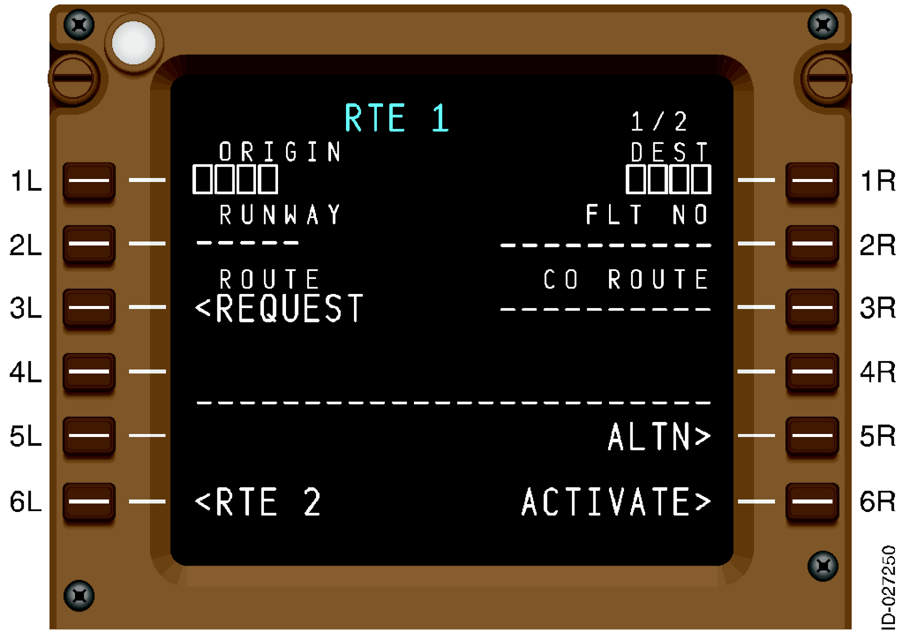
FLIGHT PLAN ROUTE ENTRY

Once the POS INIT process is completed, pushing 6R (ROUTE) on the POS INIT page displays the RTE pages. On the RTE pages the pilot can enter and activate the flight plan route in the FMS. The active route is deleted at engine shutdown after the flight is complete. Also, the active route is deactivated if electrical power is lost.

NOTES:
1. Pushing the RTE key also displays the RTE pages.
2. Two routes can be stored in the FMS, although only one can be active at any given time. Pushing 6L on the RTE pages lets the pilot select, view, and activate the other route (RTE 1 or RTE 2).

STEP: To display the RTE 1 page, push 6R on the POS INIT page or push the RTE key.

The RTE 1 page, shown in Figure 4–17, is described in the following paragraphs.



RTE 1 Page
Figure 4–17

- **ORIGIN (1L)** – When box prompts are displayed in 1L, the origin airport can be entered using ICAO identifiers contained in the nav database. Entering an origin for the active route is not allowed in flight.

  When the origin airport has been entered, departure or arrival procedures for that airport can be selected. An entry in 1L clears the existing route.

- **DEST (1R)** – The destination airport can be entered in 1R at any time using ICAO identifiers. When the destination airport has been entered, any STAR, STAR transition, approach, or approach transition associated with a previous destination airport is deleted. If the active leg is a part of the affected procedure, all legs of the procedure following the active leg are cleared.

  When the destination airport has been entered and the aircraft is more than 400 NM from the departure airport or more than halfway along the route of flight, whichever comes first, arrival procedures for the destination airport can be selected.

- **RUNWAY (2L)** – The departure runway is entered in 2L. Valid entries are runway numbers contained in the nav database for the origin airport entered in 1L. Runways can be entered in 2L with the keyboard or by line selecting them from the DEPARTURES page. The runway field is cleared when the first waypoint is sequenced.

NOTES: 1. If the RUNWAY entry is not compatible with the VIA entry, RUNWAY N/A FOR SID is displayed in the scratchpad and the runway entry is rejected.

2. A runway should be entered in order to anchor the beginning of the route to the first waypoint. Without the runway entry, there is no direct leg to the first waypoint, and the TAKEOFF REF page displays preflight as being incomplete.

- **<ROUTE REQUEST (3L)** – Pushing 3L transmits a datalink request for a flight plan route uplink. The pilot can fill in the origin, destination, runway, flight number, company route name, or route definition to qualify the route request.

- **<RTE 2 (6L)** – Pushing 6L displays RTE 2 page 1/x. If RTE 1 is active, RTE 2 is inactive and can be used to create a new route or modify a copy of the active route. Changes to the inactive route do not affect the active route. The prompt in 6L changes to RTE 1 when RTE 2 is displayed.

- **FLT NO (2R)** – A company flight number can be entered in 2R (either manually or with an uplink). This entry is optional for route activation. Up to 10 characters can be entered for the flight number.

  The flight number is displayed in the PROGRESS page title.

- **CO ROUTE (3R)** – A company route can be entered in 3R anytime the route is not active, or if the route is active and the aircraft is not airborne. Up to 10 characters can be entered for the company route identifier.

  Entering a valid company route loads the origin, destination, and en route procedures from the nav database into the route. Entering a new company route clears an old company route and enters the new one. If a company route is entered into a route that either has not been activated or has a pending modification, and no cruise altitude is defined, the cruise altitude specified in the company route is used. Similarly, if a cost index is defined by the company route, the company route cost index is used.

  NOTES: 1. Entering a company route into the flight plan fills in the origin and destination airports.

  2. If SIDs and STARs are not included in the company route, they have to be entered manually.

- **ALTN> (5R)** – Pushing 5R displays the ALTN page.

STEPS:

1. Enter KORD in the scratchpad and push 1L.

2. Enter EGLL in the scratchpad and push 1R.

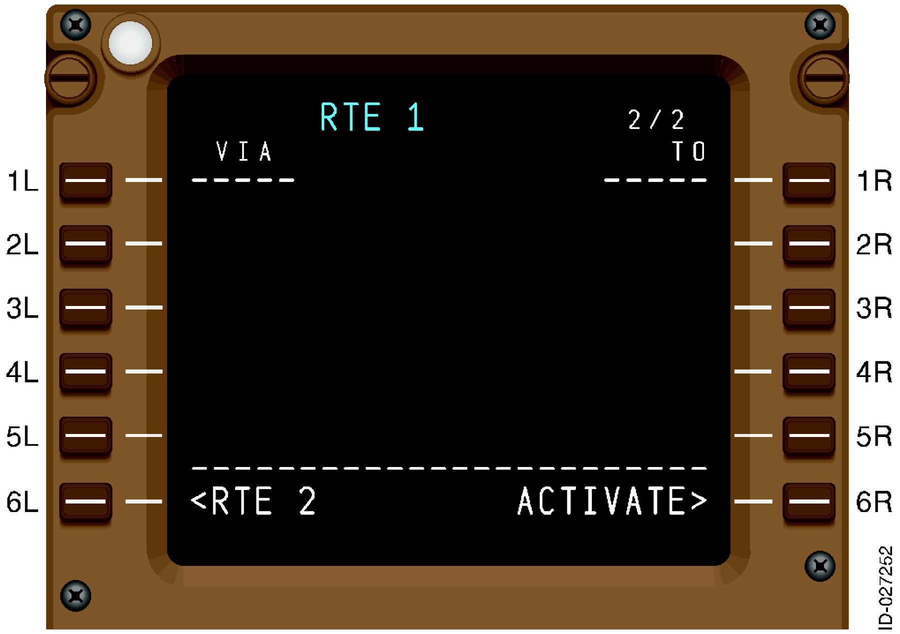
3. Enter 32R in the scratchpad and push 2L.

4. Enter 777 in the scratchpad and push 2R.

Figure 4-18 shows the resulting display.

RTE 1 – Origin, Destination, Runway, Flight Number Entered
Figure 4-18

STEP: Push the NEXT PAGE key to display the RTE 1 page 2/2, shown in Figure 4–19.



RTE 1 Page 2/2
Figure 4–19

VIA Route Segment

When entering airways, the beginning and ending waypoints determine if the entry is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the beginning point of the current route segment or a route discontinuity is created between the segments.

Entering a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when final SID waypoint is part of the route segment.

When no SID is used, entering an airway on the first line of the RTE 1 page 2 initiates an airway intercept from the runway heading and:

- Replaces the airway with dashes in 1L (VIA)
- Displays box prompts in 1R (TO waypoint)
- Moves the airway to line 2 after the TO waypoint is entered in 1L
- Enters the first fix on the airway nearest to being abeam of the departure heading in 2L (airway TO waypoint).

A route can contain segments formed by the intersection of two airways. Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMS to create an airway intersection waypoint for the transition from one segment to the next. The FMS-created waypoint intersection (INTC) is automatically displayed as the first airway segment TO waypoint.

The VIA fields (1L through 5L) display the procedure segments defining the route. The following rules govern the entries in the VIA lines.

- Valid entries are DIRECT or airway identifiers.
- Procedure names (SID, STAR, etc.) are automatically displayed when selected on the DEPARTURES or ARRIVALS page.
- Defaults to DIRECT if no entry is made and a valid entry is made in the corresponding TO line.
- Entering an airway with the corresponding or previous TO waypoint not on that airway is invalid.
- Entering an airway on the first VIA line initiates an airway intercept. Boxes are displayed under the first TO. Entering a waypoint in the boxes inserts dashes on the VIA line, and pushes the airway and waypoint down to the next line. The first fix on the leg of the airway that is closest to being abeam of the aircraft is then displayed on the first TO line.
- Dashes are displayed for the VIA line beyond the end of the route.
- Airway identifiers can be line selected into the scratchpad, but other VIA line entries cannot.
- VIA lines can be deleted, with the exception of DIRECT and any actions that affect the active leg while airborne.

The following VIA entries are invalid and display INVALID ENTRY in the scratchpad.

- Airways and company routes that do not contain the TO waypoint of the previous line.
- Airways that do not intersect the previous airway.
- Airways or company routes that are not in the nav database.

TO Waypoint

The TO fields (1R through 5R) display the leg termination waypoints for the corresponding VIA lines.

An entry can be made in the TO line only if dashes, box prompts, or a previous leg termination is displayed. Any entry must be consistent with the corresponding VIA line. The following entries are valid:

- Waypoint identifiers contained in the nav database or defined geographic points.
- Published waypoints (for example, a waypoint entered and displayed as LOACH).
- Intersections (place bearing/place bearing) (for example, a waypoint entered as LAX249/FIM140 and displayed as LAXNN where NN is FMS-assigned).
- Place bearing/distance (for example, a waypoint entered as OBK068/50 and displayed as OBKNN, where NN is FMS-assigned).
- VHF navaid (for example, a navaid entered and displayed as LON).
- Destination airport runway (for example, a runway entered as 32R and displayed as RW32R).
- ICAO AIRPORT (for example, an airport entered and displayed as KORD, PHNL, EGLL).
- Latitude/longitude (for example, a lat/long entered as N5000.5 W02000.8 and displayed as N50W020). Leading zeros are required. Trailing zeros are optional when the latitude or longitude is whole degrees (for example, N60W040).
- Conditional waypoints associated with the procedure selected on DEPARTURE or ARRIVAL page.
- Boxes are displayed for route discontinuities (breaks in the route).
- Dashes are displayed for the first TO line beyond the end of the route.

The flight plan route can now be entered by using the scratchpad and the appropriate LSKs next to the VIA and TO fields. To fly direct to a waypoint, enter that waypoint in the appropriate TO field. DIRECT is displayed in the corresponding VIA field. If part of the route follows a published airway, enter that airway in the appropriate VIA field. The CDU displays box prompts in the corresponding TO field. The pilot must then enter a TO waypoint for the airway.

NOTE: If the airway has more than one waypoint, only the final waypoint of the leg needs to be entered. The nav database has all waypoints along an airway in memory and they are subsequently displayed on the RTE LEGS pages.

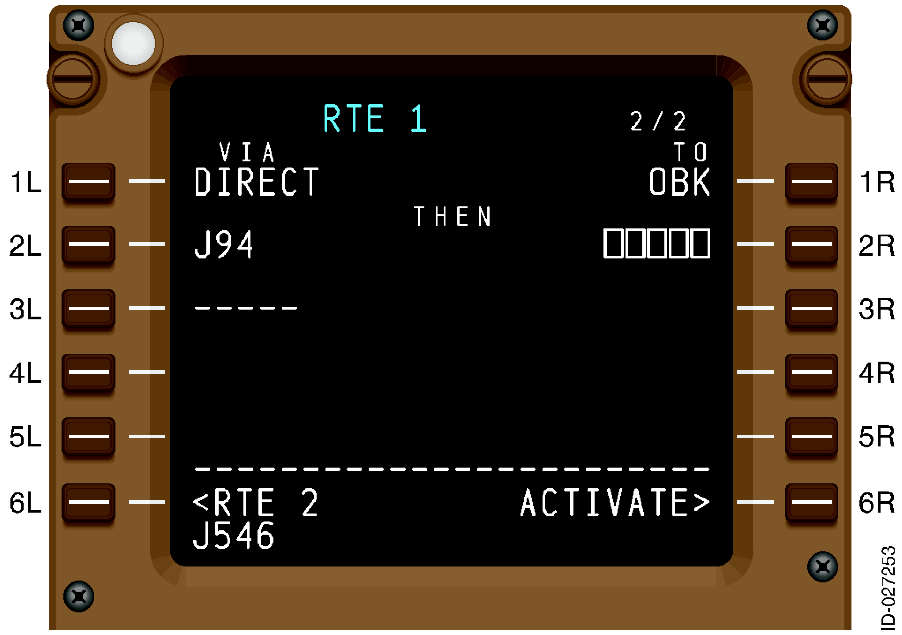
If a waypoint or an airway is not in the nav database, NOT IN DATA BASE is displayed in the scratchpad. If the airway is in the nav database but the preceding or following TO fix is not on the airway, INVALID ENTRY is displayed in the scratchpad.

Flight Plan – Route 1 Entry

The flight plan route as filed from KORD to EGLL, and as described in Section 3, Flight Data.

STEPS:

1. Enter OBK in the scratchpad and push 1R.
2. Enter J94 in the scratchpad and push 2L.
3. Enter J546 in the scratchpad. The resulting display is shown in Figure 4-20.



RTE 1 – Route Entry – (1)
Figure 4-20

STEP: Push 3L. The resulting display is shown in Figure 4-21.

RTE 1 – Route Entry – (2)
Figure 4-21

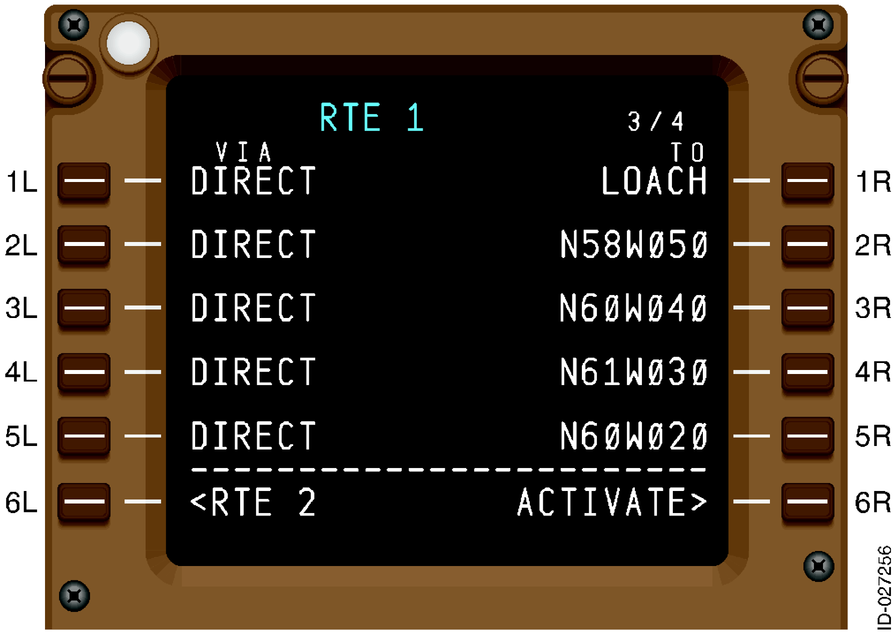
STEPS:

1. Enter YQB in the scratchpad and push 3R.
2. Enter J560 in the scratchpad and push 4L.
3. Enter YZV in the scratchpad and push 4R.
4. Enter YYR in the scratchpad and push 5R. The resulting display is shown in Figure 4-22.

RTE 1 – Route Entry – (3)
Figure 4-22

STEPS:

1. Enter LOACH in the scratchpad and push 1R.
2. Enter N58W050 in the scratchpad and push 2R.
3. Enter N6000.0W04000.0 in the scratchpad and push 3R.
4. Enter N61W030 in the scratchpad and push 4R.
5. Enter N60W020 in the scratchpad and push 5R. The resulting display is shown in Figure 4-23.



RTE 1 – Route Entry - (4)
Figure 4-23

Enter the remaining waypoints and airways as described in the steps above. Figure 4-24 shows the completed route entry for the remaining waypoints in the flight plan.

RTE 1 – Route Entry Complete
Figure 4-24

DEPARTURE AND ARRIVAL SELECTION

The departure and arrival pages can be displayed any time during the preflight phase by pushing the DEP/ARR key on the CDU. The DEP/ARR INDEX page is used to select the departure or arrival page for the origin and destination airports for each route. Departure or arrival information for any other airport in the nav database can also be accessed from the DEP/ARR INDEX page.

The following rules determine which page is displayed when the DEP/ARR key is pushed.

- If there is no active route, or an inactive RTE or inactive LEGS page is displayed, the DEP/ARR INDEX is displayed.

- If a route is pending activation, but no origin airport has been defined, the ARRIVALS page for the destination for that route is displayed. If no destination has been defined, the DEP/ARR INDEX is displayed.

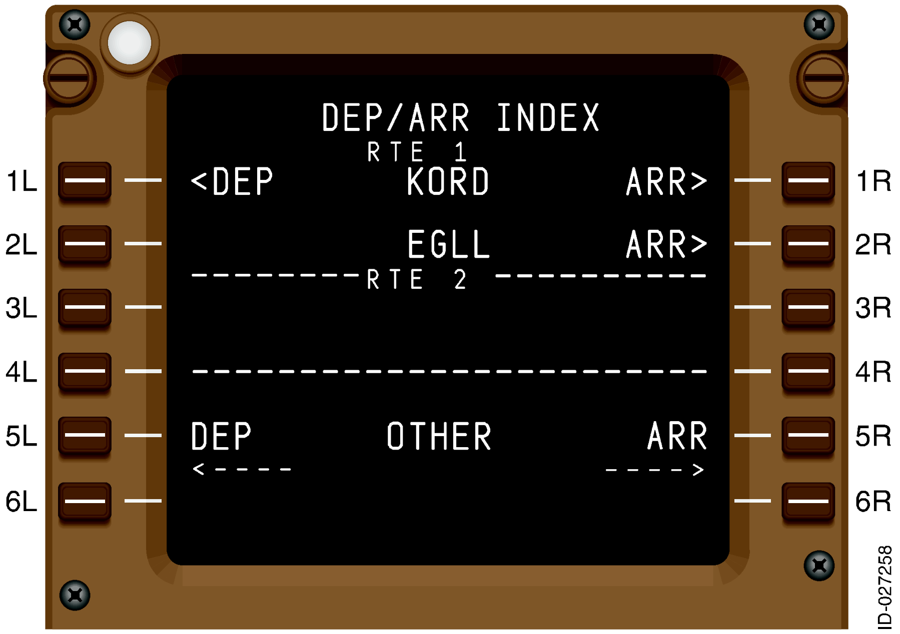
- If no origin has been defined on the active route and no pending activations exist, the ARRIVALS page for the destination is displayed. If no destination has been defined, the DEP/ARR INDEX is displayed.

- If the aircraft is on the ground and there is an active route, the DEPARTURES page for the origin is displayed. If the aircraft is airborne with no destination defined, the ARRIVALS page for the origin is displayed

- If there is an active route and the aircraft present position is invalid, or the aircraft is greater than 50 NM from the origin, or the aircraft is more than halfway along the route, the ARRIVALS page for the destination is displayed.

The DEP/ARR INDEX (Figure 4-25) gives the pilot access to departures and arrivals for the origin and destination airports of both flight plan routes (assuming two routes have been defined). In this case, only RTE 1 has been defined.

To display the DEP/ARR INDEX page if route 1 is not activated, push the DEP/ARR key. To display the DEP/ARR INDEX page if route 1 is active, push 6L (INDEX) on the DEPARTURES page.



DEP/ARR INDEX Page
Figure 4-25

RTE 1 and RTE 2 are displayed in small font as labels above lines 1 and 3, respectively. The origin airports are displayed in the center of the first and third lines (assuming two routes have been defined). The destination airports are displayed in the center of the second and fourth lines (assuming two routes have been defined). In this example, only RTE 1 has been defined and it is still inactive.

NOTES:

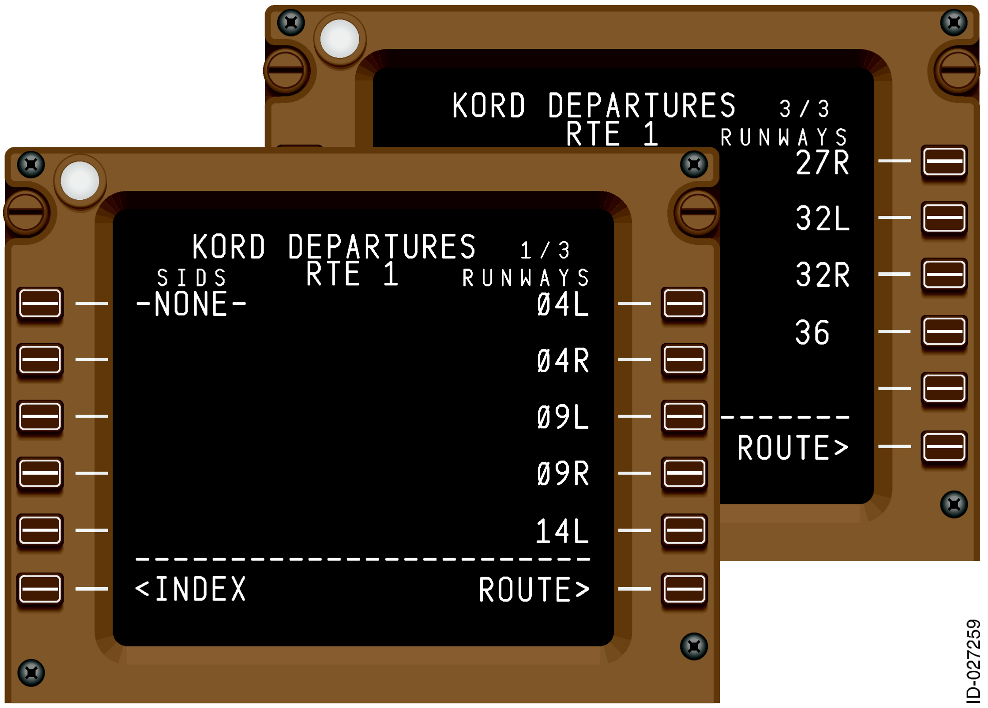
1. If a route has been activated, (ACT) is displayed next to the RTE 1 or RTE 2 line in small font.
2. If RTE 1 and/or RTE 2 have not been defined, the data fields below the respective labels are blank.

A DEP prompt is displayed in 1L and/or 3L to access the SIDs and runways of the defined departure airport(s). ARR prompts are displayed for the departure and arrival airports of both routes in lines 1R and 2R and/or 3R and 4R.

The DEP/ARR INDEX also lets the pilot access departure and arrival information of airports not defined in one of the two routes. The title OTHER is displayed in large font in the center of the line 6. The pilot can review departures of an airport not defined in RTE 1 or RTE 2 by entering its identifier in the scratchpad and pushing 6L. Arrivals for an airport can be reviewed by entering its identifier in the scratchpad and pushing 6R. Entries must be four-character ICAO identifiers in the nav database for departures or arrivals to be displayed.

SID and Departure Runway Entry

To enter a departure runway and SID, if the appropriate DEPARTURES page is not already displayed after pushing the DEP/ARR key, push the correct LSK, 1L in this case. KORD DEPARTURES is displayed as the title of the page (see Figure 4-26). Figure 4-26 shows both page 1/3 and page 3/3 for KORD DEPARTURES. Page 2/3 and 3/3 are displayed by pushing the NEXT PAGE or PREV PAGE key when page 1/3 is displayed. The left data fields display the available SIDs and the right data fields display the available departure runways.



KORD DEPARTURES – Pages 1/3 and 3/3
Figure 4-26

NOTE: If a runway was defined on the RTE pages, <ACT> is displayed next to that runway. <SEL> is displayed if the route has not been activated.

STEPS:

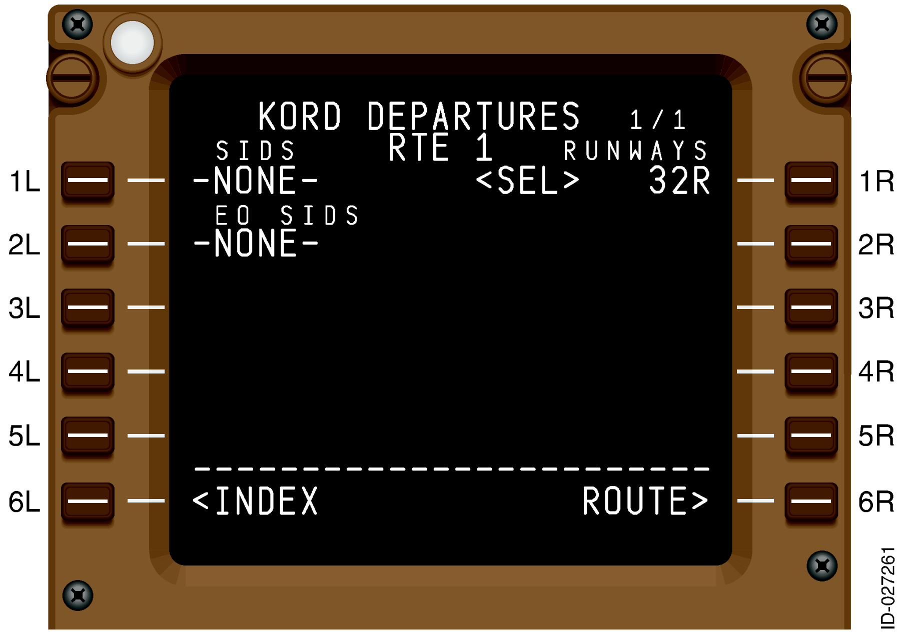
1. Select the appropriate runway by pushing the associated LSK. The flight plan uses runway 32R (located in 3R on page 3/3). The selected runway is indicated by <SEL> and is displayed on RTE 1 page 1.

   NOTE: Selecting a departure runway before selecting a SID causes only the SIDs applicable to the selected runway to be displayed. For airports with numerous SIDs, selecting the runway first can make it easier to find a particular SID on the DEPARTURES pages.

2. To select a SID, push the appropriate LSK. In this case, there are no SIDs available. Once a SID (if available) is selected, only those runways and transitions compatible with the SID are displayed.

   After a SID is selected, any applicable departure transitions (TRANS) are displayed in the left data fields beginning at 1L on page 1. A transition can be selected by pushing the associated LSK, and is indicated by <SEL>.

Figure 4-27 shows the KORD DEPARTURES page after all the departure selections have been completed for the flight from KORD to EGLL.



KORD DEPARTURES – RWY Selected
Figure 4-27

ROUTE DISCONTINUITY

A ROUTE DISCONTINUITY is created whenever there is no defined path between successive waypoints in a flight plan. Discontinuities can be created by deleting a waypoint, line selecting, or stringing a procedure.

The FMS does not automatically bridge discontinuities by inserting route legs into the flight plan. Inserting legs must be done by the pilot. Whenever LNAV is engaged and the aircraft enters a route discontinuity, DISCONTINUITY is displayed in the scratchpad, and the aircraft maintains its existing track.

NOTE: Many route modifications result in a discontinuity after activation. The pilot should always check for this situation and correct it when necessary.

Discontinuities can normally be cleared by entering the next waypoint after the route discontinuity into the scratchpad by line selecting the appropriate LSK. The pilot then pushes the LSK next to the discontinuity box prompts, followed by the EXEC key, to clear the route discontinuity.

ACTIVATING THE FLIGHT PLAN ROUTE

Push 6R on the KORD DEPARTURES page to display the RTE 1 page (Figure 4–28).

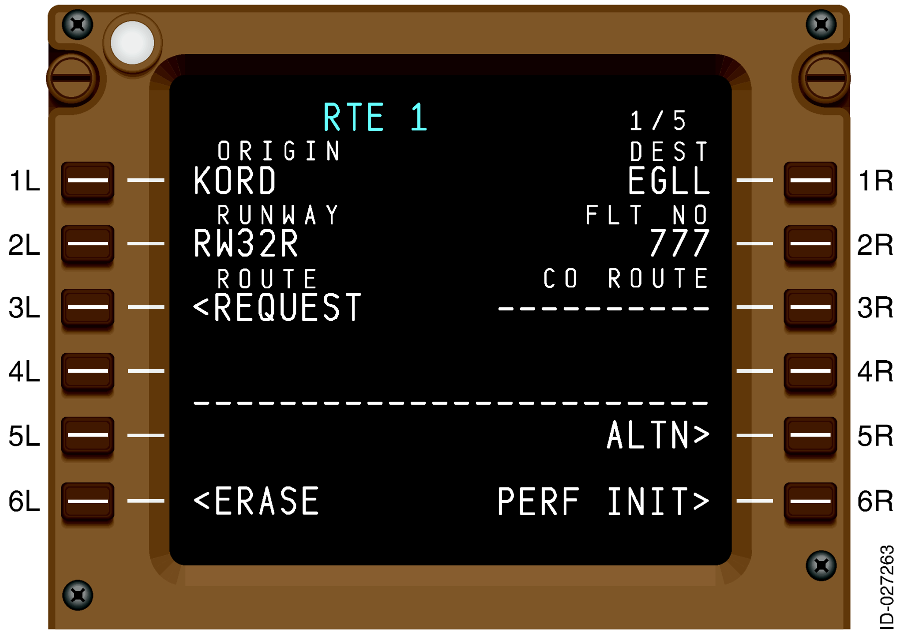
RTE 1 – Route Entry Complete
Figure 4–28

The remaining fields on the RTE 1 page are described in the following paragraphs.

- **<RTE 2 (6L)** – If there is no provisional or pending activation, the alternate route prompt is displayed in 6L (RTE 1 or RTE 2). Pushing 6L displays the RTE page for that route.

  If the route is pending activation or a modification is in progress (MOD displayed in the page title), then an ERASE prompt is displayed in 6L and pushing 6L erases any lateral or vertical route modifications or pending activations.

- **ACTIVATE> (6R)** – Pushing 6L, in Figure 4–28, one time after the route has been entered and verified as correct turns the EXEC light on and displays the ERASE prompt in 6L (Figure 4–29). Pushing the EXEC key activates the flight plan and changes the page title to ACT RTE 1 or ACT RTE 2, as applicable (Figure 4–30). LNAV is available once the route is activated.



RTE 1 – Route Activation – (1)
Figure 4–29

RTE 1 – Route Activation – (2)
Figure 4–30

If the performance initialization is not complete (with the aircraft on the ground and the route not activated) the PERF INIT> prompt is displayed in 6L and pushing 6L displays the PERF INIT page. After performance initialization is complete, TAKEOFF> is displayed in 6L on the active RTE pages (with the aircraft on the ground).

- **RTE COPY> (4R)** – After the route has been activated, the RTE COPY prompt is displayed in 4R. Pushing 4R copies the entire active route (RTE 1) into the inactive route (RTE 2). The RTE COPY prompt is only displayed on the active route page. After the route has been copied, RTE COPY COMPLETE is displayed in 4R (Figure 4–31).

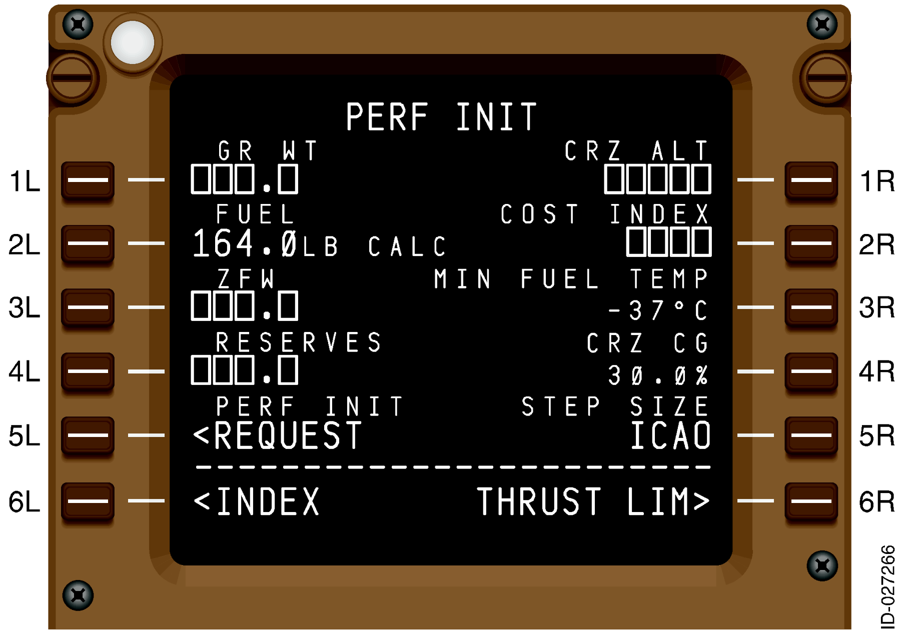
RTE COPY COMPLETE
Figure 4–31

PERFORMANCE INITIALIZATION

Once the flight plan has been activated and executed, the PERF INIT prompt is displayed in 6R on the RTE pages. Pushing 6R displays the PERF INIT page. This page is used to initialize the FMS performance calculations. Entered values on the PERF INIT page are cleared if electrical power is lost or when the engines are shutdown after flight.

NOTE: The PERF INIT page can also be displayed by pushing 3L (PERF) on the INIT REF INDEX page or by pushing the INIT REF key on the ground after aircraft position has been initialized.

The PERF INIT page is shown in Figure 4-32.



PERF INIT Page
Figure 4-32

The PERF INIT page is described in the following paragraphs.

- **GR WT (1L)** – The gross weight is displayed in thousands of pounds (or thousands of kilograms when the kilograms option is selected). If ZFW has not been entered in 3L, entering a gross weight in 1L causes the FMS to calculate the ZFW and display it in 3L. If gross weight has not been entered, entering ZFW in 3L causes the FMS to calculate the gross weight and display it in 1L.

  The gross weight is always the sum of the zero fuel weight (ZFW) in 3L and the fuel weight in 2L. If the fuel quantity indicating system is inoperative, the gross weight field is blank until fuel weights are manually entered.

Valid entries for gross weight are three-digit values, optionally followed by a decimal point and tenths. A pilot-entered value is verified using the performance database to determine if the entry is reasonable for the airframe configuration.

NOTES:

1. Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.
2. The header displays GR WT ADV when gross weight is available and displayed from a single weight and balance system. A dual weight and balance systems displays GR WT DUAL.
3. If the WBS gross weight is not valid, the header line is GR WT.

- **FUEL (2L)** - The FMS-calculated fuel quantity (CALC) is normally displayed in 2L. Before engine start, the FMS-calculated fuel quantity is set equal to the aircraft fuel totalizer system value. If anytime after engine start the fuel flow values are invalid for more than two minutes, the calculated value goes invalid and the fuel totalizer system value is then used for FMS calculations. When this happens, SENSED is displayed after the fuel quantity.

  The pilot can enter a fuel quantity at any time if a calculated value (CALC) is displayed. When this is done, MANUAL is displayed after the fuel quantity and the FMS ignores the fuel totalizer system input until the flight is completed.

  NOTES:

  1. Only manual entries can be deleted.
  2. Box prompts indicate the aircraft sensing is not possible and a pilot-entry is required.

  Figure 4-32 shows the 164.0 CALC as the fuel quantity for the flight from KORD to EGLL. Fuel quantity is displayed in thousands of pounds for this flight.

- **ZFW (3L)** - Zero fuel weight is displayed in thousands of pounds (or thousands of kilograms when the kilograms option is selected). Box prompts are displayed until a valid gross weight and fuel quantity are entered. If gross weight has not been entered in 1L, entering ZFW in 3L causes the FMS to calculate the gross weight and display it in 1L. If ZFW has not been entered, entering a gross weight in 1L causes the FMS to calculate the ZFW and display it in 3L.

  NOTE: Enter gross weight or zero fuel weight, but not both. Either entry causes the FMS to calculate the other and display it in the appropriate field.

- **RESERVES (4L)** – The reserve fuel weight is displayed in 4L in thousands of pounds (or thousands of kilograms when the kilograms option is selected). The reserves weight is used in determining an insufficient fuel condition and in calculating performance predictions.

  Valid entries for reserve fuel weight are three-digit values, optionally followed by a decimal point and tenths or hundredths (if the entry is less than 100). The allowable entry range is determined by the performance database and entries that are not in this range cause INVALID ENTRY to be displayed in the scratchpad.

  NOTE: Entry is required to complete the preflight process.

- **<REQUEST (5L)** – Pushing 5L transmits a datalink request for a performance data uplink. The pilot can fill in ZFW, CG, cruise altitude, reserves, cost index, or fuel temperature to qualify request. See Section 11, FMC Datalink, for more information.

- **INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **CRZ ALT (1R)** – The desired cruise altitude is entered in 1R. Valid entries for cruise altitude while the aircraft is on the ground are standard altitude entries above the current aircraft altitude. While airborne, a standard altitude can be entered into the box prompts, but is not allowed over existing cruise altitude. An altitude entry greater than the maximum certified altitude is rejected and INVALID ENTRY is displayed in the scratchpad.

  A cruise altitude entry in 1R is propagated to or from the CLIMB or CRUISE pages and can be changed by an approach procedure entry or by transitioning into the missed approach. The cruise altitude entry is cleared when the flight is complete.

- **COST INDEX (2R)** – The cost index is used in calculating ECON speed values. The cost index is determined by dividing aircraft operating cost ($/hour) by fuel cost (cents/pound). Only those portions of operating costs affected by trip time should be included in the calculation. A cost index of zero results in minimum trip fuel operation, including cruise at maximum range cruise and a slow speed descent. Higher cost index entries result in higher climb, cruise, and descent speeds, which increase trip fuel costs but decrease trip time costs.

  Valid entries for cost index are one to four-digit values ranging from 0 to 9999. Trying to enter a cost index within 10 NM of the top-of-descent point is rejected and INVALID ENTRY is displayed in the scratchpad. When a valid cost index is entered, the performance predictions on the ACT RTE LEGS page are cleared and recalculated.

Company routes may enter the cost index automatically. The values used are determined by the operator. See Section 15, Additional Information, for more information on the cost index.

- **MIN FUEL TEMP (3R)** – The minimum fuel operating temperature is displayed in 3R. The default value is from the AIRLINE POLICY page and is displayed in small font.

  Crew entered or uplinked values are displayed in large font. Valid entries are –99 to –1°C.

  NOTE: Minimum operating temperature is defined to be 3°C warmer than the fuel freeze temperature for a given fuel.

- **CRZ CG (4R)** – The cruise center of gravity is displayed in 4R. the displayed value is either a default value or a pilot-entered cruise CG value. This value is used by the FMS to calculate maximum altitude and the maneuver margin to buffet. The valid entry range is from CGMIN to CGMAX values from the performance database.

  The pilot can overwrite the default entry to more accurately reflect the current CG of the aircraft. A pilot–entered or uplinked value is displayed in large font. Valid entries are 14.0 through 44.0.

- **STEP SIZE (5R)** – The step size for the climb increment used for planning an optimum step climb profile is displayed in 5R. The default value is the ICAO step size. The pilot can enter a different step size (in feet) as a four-digit multiple of 1000 ft, up to a maximum of 9000 ft. The pilot-entered value can be deleted, in which case, the step size returns to the ICAO default.

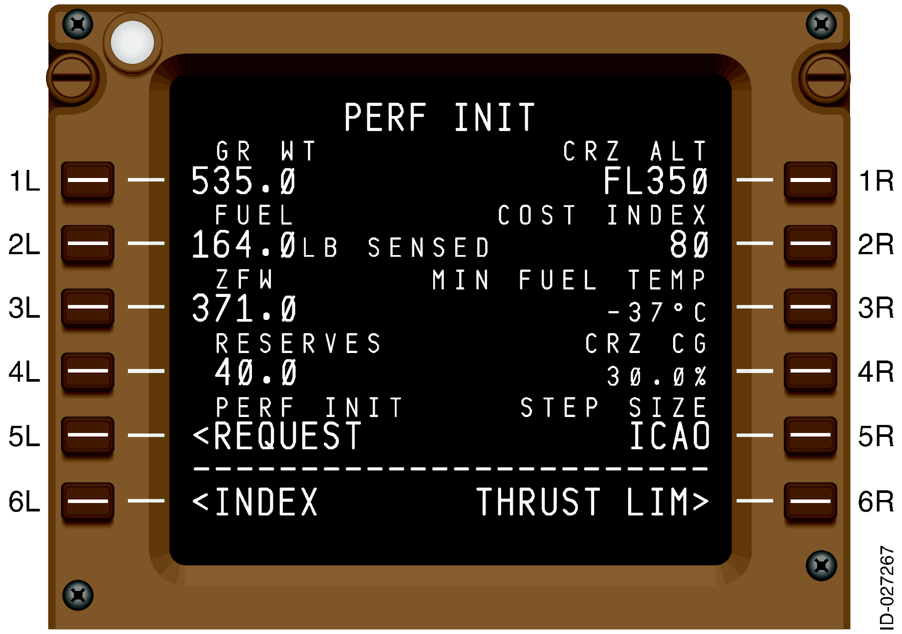
  NOTE: If no step climbs are made, it is important to enter zero for the step size so that the performance calculations are the most fuel efficient solution and make accurate fuel predictions. Otherwise, the performance calculations assume the computed optimum steps are made, possibly resulting in non–conservative predictions of fuel at the destination.

- **THRUST LIM> (6R)** – Pushing 6R displays the THRUST LIM page.

STEPS:

1. Enter 371 in the scratchpad and push 3L (ZFW).
2. Enter 40.0 in the scratchpad and push 4L (RESERVES).
3. Enter 350 in the scratchpad and push 1R (CRZ ALT).
4. Enter 80 in the scratchpad and push 2R (COST INDEX).

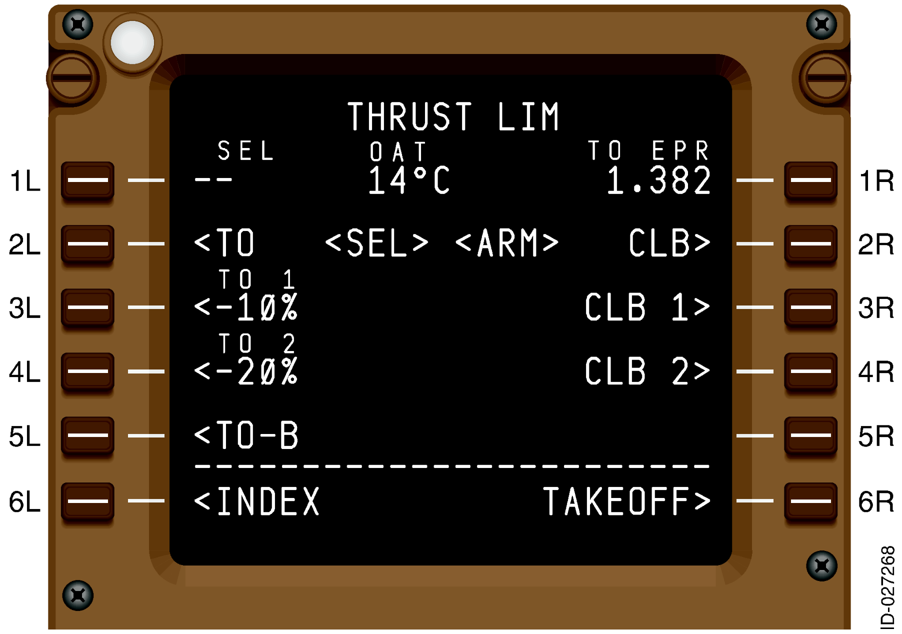
The completed PERF INIT page is shown in Figure 4–33.



PERF INIT Page – Complete
Figure 4–33

THRUST LIMIT DATA

The THRUST LIM page is used to manually select thrust limit modes. The thrust limits are displayed on the THRUST LIM page as shown in Figure 4-34. The THRUST LIM page is displayed by selecting the THRUST LIM prompt on the PERF INIT page or on the INIT/REF INDEX page.



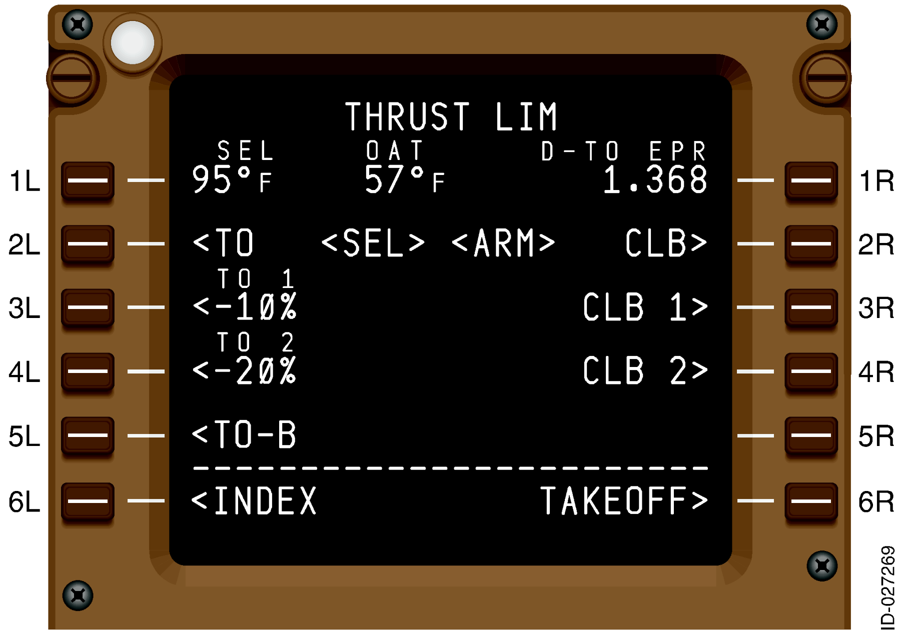
THRUST LIM Page
Figure 4-34

In the data fields, <SEL> always indicates the current thrust limit mode as displayed on the EICAS, except during reverse thrust operation. <ARM> is displayed for the appropriate climb thrust limit mode when a takeoff thrust limit is selected.

STEPS:

1. Push 2L to select the takeoff thrust limit.
2. Enter 95F in the scratchpad and push 1L. This enters 95°F as the assumed temperature derate.

The resulting display is shown in Figure 4-35.



THRUST LIM Page – Derate
Figure 4-35

The THRUST LIM page is described in the following paragraphs.

- **SEL and OAT (1L and 1C)** – The pilot-entered assumed temperature (SEL) is displayed in 1L. This entry is for the thrust limit derate. Valid entries are 0 to 99°C or 32 to 210°F. Assumed temperature cannot be entered after takeoff is initiated with the TOGA switch.

  The outside air temperature is displayed in field 1C in either °C or °F, as appropriate. The OAT default display is in °C. If the assumed temperature is entered on 1L in °F, OAT is displayed in °F.

  Entering a temperature derate in 1L after the takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

  NOTE: The assumed temperature derate also reduces TO 1 and TO 2 when they are the selected takeoff thrust limits.

- **TO EPR (1R)** – This field displays EPR or N1, depending on the setting in the performance database. This field displays the current EPR (or N1) mode limit calculated by the thrust management function. The D– in front of the header line in Figure 4–35 indicates that an assumed temperature derate is being used.

- **<TO (2L)** – The default thrust limit mode (normal takeoff thrust limit) is displayed in 2L.

- **<TO 1 (3L)** – The TO 1 thrust limit mode in 3L is a percentage derate (if enabled). Selecting a derate in 3L clears an entered temperature in 1L.

- **<TO 2 (4L)** – The TO 2 thrust limit mode in 4L is a percentage derate (if enabled). Selecting a derate in 4L clears an entered temperature in 1L.

- **<TO–B (5L)** – The TO–B thrust limit mode in 5L is a thrust bump. Selecting thrust bump increases the takeoff thrust to greater than full rated TO thrust. Selecting TO–B arms CLB. It also prohibits assumed temperature derate and V_{SPEED} calculation. If TO–B is used, refer to the Airplane Flight Manual (AFM) for the performance limitations and data required to use this feature.

NOTES:

1. Takeoff percentage derates and thrust bump are optional and may not be enabled. If they are not enabled, 3L, 4L, and/or 5L are blank.

2. Takeoff datalink automatically selects a thrust derate or thrust bump.

- **INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **CLB> (2R)** – Pushing 2R selects a full rated climb thrust limit.

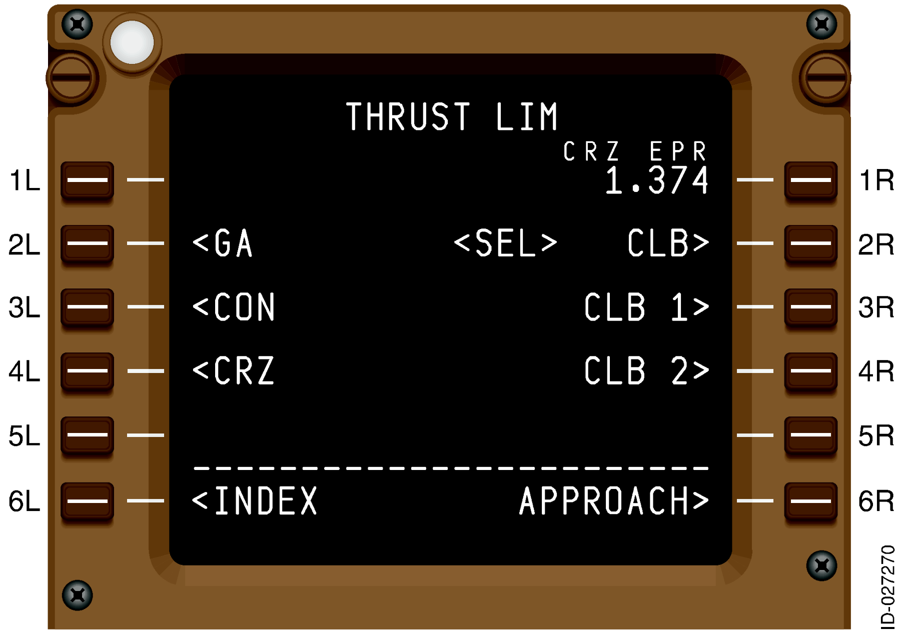
- **CLB 1> (3R)** – Pushing 3R selects a 10% climb thrust derate. Before transitioning to CLIMB, <ARM> is displayed next to the armed climb thrust limit mode. When the thrust limit mode is active, <SEL> is displayed.

- **CLB 2> (4R)** – Pushing 4R selects a 20% climb thrust derate. Before transitioning to CLIMB, <ARM> is displayed next to the armed climb thrust limit mode. When the thrust limit mode is active, <SEL> is displayed.

- **TAKEOFF> (6R)** – Pushing 6R displays the TAKEOFF REF page 1/2. This is the next page to be completed during the preflight.

THRUST LIM Page – Airborne

When the aircraft is airborne, the THRUST LIM page displays the information shown in Figure 4-36. This page is automatically displayed at thrust reduction from the takeoff mode.



THRUST LIM Page – Airborne
Figure 4-36

The THRUST LIM page (when the aircraft is airborne) is described in the following paragraphs.

- **<GA (2L)** – Pushing 2L selects the go-around thrust limit. The go-around thrust limit is automatically selected during final approach when the flaps are extended.

- **<CON (3L)** – Pushing 3L selects the maximum continuous thrust limit.

- **<CRZ (4L)** – Pushing 4L selects cruise thrust limit. If it is designated on the AIRLINE POLICY page, the cruise thrust limit is automatically selected after the FMS mode transitions at top-of-climb if VNAV is engaged.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **APPROACH (6R)** – Pushing 6R displays the APPROACH REF page. This prompt is displayed in 6R when the aircraft is airborne.

TAKEOFF DATA ENTRY

The TAKEOFF REF page lets the pilot manage takeoff performance. On this page, takeoff flap setting and V_{SPEEDS} are entered and verified, and thrust limits, takeoff position, and takeoff gross weight are verified or changed. Preflight completion status is annunciated until this page is complete. The TAKEOFF REF page is displayed by doing any of the following:

- Push 5L on the INIT/REF INDEX page.
- Push 4L on the FMC COMM page.
- Push 6R on the THRUST LIM page (before takeoff).

After all the information has been entered and the appropriate selections made on the THRUST LIM page, push 6R to display the TAKEOFF REF page (Figure 4-37).

TAKEOFF REF Page 1/2
Figure 4-37

The TAKEOFF REF page is described in the following paragraphs.

- **FLAPS (1L)** – Box prompts are displayed in 1L to enter the takeoff flap setting. Valid entries for flap setting are 5, 15, and 20. This entry can be made by the pilot or with a datalink.

  Entering 5 when FLAPS 5 is the climb thrust reduction point displays INVALID ENTRY in the scratchpad. Entering a value after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

  Flap position is required for takeoff V_{SPEED} speed calculations.

- **THRUST (2L)** – The assumed temperature for takeoff thrust (pilot–entered or uplinked) is displayed in 2L. Valid entries are 0 to 99°C or 32 to 210°F.

  Entering a value after takeoff speeds are selected removes the speeds TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

- **CG TRIM (3L)** – The center of gravity and stabilizer trim (TRIM) data is displayed in 3L. Center of gravity values are blank when airborne. Valid entry is within valid range for the airplane.

  After center of gravity is entered, the FMS calculates and displays stabilizer takeoff setting to the right of the CG entry. Trim display is in 0.25 unit increments.

- **RWY/POS (4L)** – The runway identifier and pilot-entered bias (shift) distance of the takeoff brake release point from the runway threshold are displayed in 4L. The runway number automatically transfers from the RTE page.

  When a runway number is displayed in 4L, it is followed by either /00FT or /00M. A position shift (the distance that the aircraft is past the runway threshold) can be entered to be used for a position update at takeoff. The position update uses the exact lat/long position for the runway threshold, as stored in the nav database.

  The optional pilot-entered offset from the threshold updates the aircraft position when the TO/GA button is pushed. Valid pilot entries are in + or – hundreds of feet or meters (+300 is 300 feet/meters beyond the normal takeoff position).

  NOTE: The runway threshold lat/long for all runways in the nav database, both for takeoff and landing is the runway displaced threshold lat/long position.

- **<TAKEOFF DATA REQUEST (5L)** – Pushing 5L transmits a datalink request for takeoff data uplink.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **V1, VR, and V2 (1R, 2R, and 3R)** – The takeoff V_{SPEEDS} are displayed in 1R, 2R, and 3R. The speeds can be overwritten by the pilot. Dashes are displayed until valid gross weight, ZFW, OAT, and runway identifier are received, along with flap entry and thrust selection.

  The FMS calculates and displays (prompted values) a recommended set of V_{SPEEDS} based on gross weight, runway condition, derates, altitude, temperature, and other performance factors. REF is displayed in the header line for each speed if the value displayed is not pilot-entered or prompt selected. Valid entries are three-digit numbers ranging from 100 to 300, and can be entered over the existing values. If the pilot enters a speed that is less than the minimum value allowed for that speed, the minimum speed is displayed and preceded by MIN in small font to indicate a minimum value.

  Any change of performance information results in the V_{SPEEDS} in 1R, 2R, and 3R being replaced by FMS-calculated speeds in small font. Also, all V_{SPEEDS} are removed from the PFD and the PFD speed tape message NO V SPD is displayed.

- **TOGW (4R)** – The takeoff gross weight the aircraft is entered in 4R. An entry or uplink to this field results in a new V_{SPEED} calculation.

  Valid entry is any weight within the allowable aircraft takeoff gross weight range. Entering a value after takeoff speeds are selected removes the V_{SPEEDS} and TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

- **GR WT (4C)** – The aircraft gross weight from the PERF INIT page is displayed in 4C.

- **REF SPDS (5R)** – Pushing 5R enables or disables the display of the FMS-calculated reference V_{SPEEDS} in the center column to the left of the V_{SPEED} fields. REF SPDS are shown in Figure 4-41 and Figure 4-42.

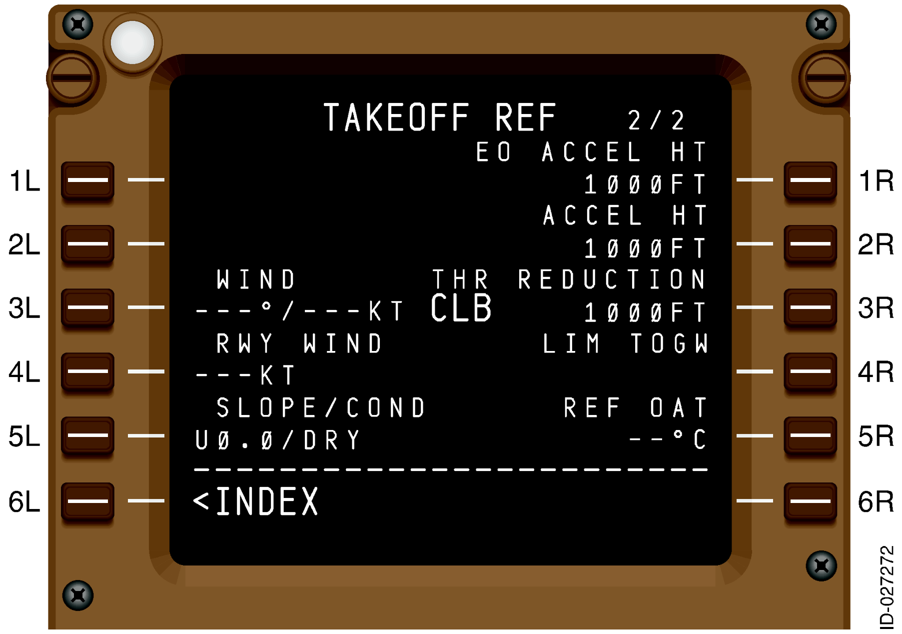
  Pushing 5R toggles between ON and OFF. When ON, the FMS-calculated takeoff speeds are displayed for comparison with the V_{SPEEDS} in the right column.

  The active state (ON or OFF), is displayed in large green font and the inactive state is displayed in small white font.

- **THRUST LIM> (6R)** – Pushing 6R displays the THRUST LIM page.

The TAKEOFF REF page 2/2 displays supplementary takeoff data. Changes can be made to the parameters that affect takeoff calculations on pages 1/2 or 2/2 or on the THRUST REF page.

To display the TAKEOFF REF page 2/2 (Figure 4-38), push the NEXT PAGE or PREV PAGE key when the TAKEOFF REF page 1/2 is displayed.



TAKEOFF REF Page 2/2
Figure 4-38

The TAKEOFF REF page is described in the following paragraphs.

- **ALTN THRUST (2L)** (Not shown in Figure 4-38) – The ALTN THRUST header line is displayed in 2L if a TAKEOFF REF uplink that includes alternate thrust data has been accepted. The header line can be ALTN THRUST or ALTN THRUST/FLAPS. The data line can display:

  — TO, TO/FLAPS
  — TO 1, TO 1/FLAPS
  — TO 2, TO 2/FLAPS
  — yy TO x (assumed temperature)
  — yy TO x /FLAPS.

Pushing 2L with data in the line selects the displayed alternate thrust or alternate thrust/flaps for takeoff and the following occurs:

— V_{SPEEDS} are recalculated

— STD THRUST or STD THRUST/FLAPS is displayed in the header line

— ACCEPT/REJECT prompt is displayed on the TAKEOFF REF page 1/2

— New takeoff data is displayed

— EICAS •FMC message is displayed

— TAKEOFF DATA LOADED is displayed in the scratchpad.

- **WIND (3L)** - Airport wind conditions are entered in 3L to calculate runway wind components. Entry is optional for preflight completion. Initial wind direction and speed can be entered by the pilot or uplinked.

  Initial entry is wind direction/speed. Subsequent entries can be wind direction or speed only. Valid directions are from 0 to 360°, with 0 and 360 displayed as 000.

  Entering a new wind direction or speed results in recalculation of runway wind in 4L. Entering a value after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

- **RWY WIND (4L)** - The calculated headwind/tailwind and crosswind components for the takeoff runway and surface wind are displayed in 4L.

  Calculated values are in small font. Speed is displayed in knots and: H is headwind, T is tailwind, R is right crosswind, and L is left crosswind.

  Pilot-entry is limited to headwind/tailwind entry. Valid entries are a two-digit number followed by H or T.

  NOTE: Pilot-entered wind speed without a letter defaults to a headwind component. Also, a pilot-entry clears the WIND line.

- **SLOPE/COND (5L)** - The runway slope and condition can be entered in 5L. Entry is optional for preflight completion and can be either a pilot-entry or uplinked.

  Valid runway slope is U for up or D for down followed by 0.0 through 2.0 in percent gradient. Entering a value after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the scratchpad.

  If the CAA/JAR Flight Rules option has been enabled in the OPC, the header line includes /**COND** (runway condition).

  When enabled, RWY COND is displayed in large font. Entering W or WET displays WET in 5L. Entering D or DRY displays DRY in 5L. The display returns to the default value when the flight is complete.

- **<INDEX (6L)** - Pushing 6L displays the INIT/REF INDEX page.

- **EO ACCEL HT (1R)** - The engine out acceleration height in 1R is the acceleration height in feet above the origin airport for an engine out condition. VNAV commands acceleration at this altitude or at first flap retraction.

  The small font default value is from the AIRLINE POLICY file. Valid pilot entries are from 400 to 9999 ft above the origin airport elevation. Entry is optional for preflight completion.

- **ACCEL HT (2R)** - The acceleration height in feet above the origin airport is displayed in 2R. VNAV commands acceleration at this altitude or at first flap retraction.

  The small font default value is from the AIRLINE POLICY file. Valid pilot entries are from 400 to 9999 ft above the origin airport elevation. Entry is optional for preflight completion.

- **THR REDUCTION (3R)** – The thrust reduction altitude in 3R is the altitude for reduction from takeoff thrust to climb thrust. The thrust reduction point can be either an altitude or a flap position.

  The default value displayed is a value from the AMI. Valid pilot entries are altitudes from 400 to 9999 ft above the origin airport elevation.

  Valid flap entries are 1 for FLAPS 1 and 5 for FLAPS 5. Entering 5 when FLAPS 5 is specified as the takeoff flap setting on the TAKEOFF REF 2/2 page displays INVALID ENTRY in the scratchpad.

  The selected climb thrust rating from the TAKEOFF REF page 2/2 is displayed.

  Entry is optional for preflight completion.

- **LIM TOGW (4R)** – The uplinked takeoff gross weight limit for the current thrust, flaps, and temperature conditions is displayed in 4R.

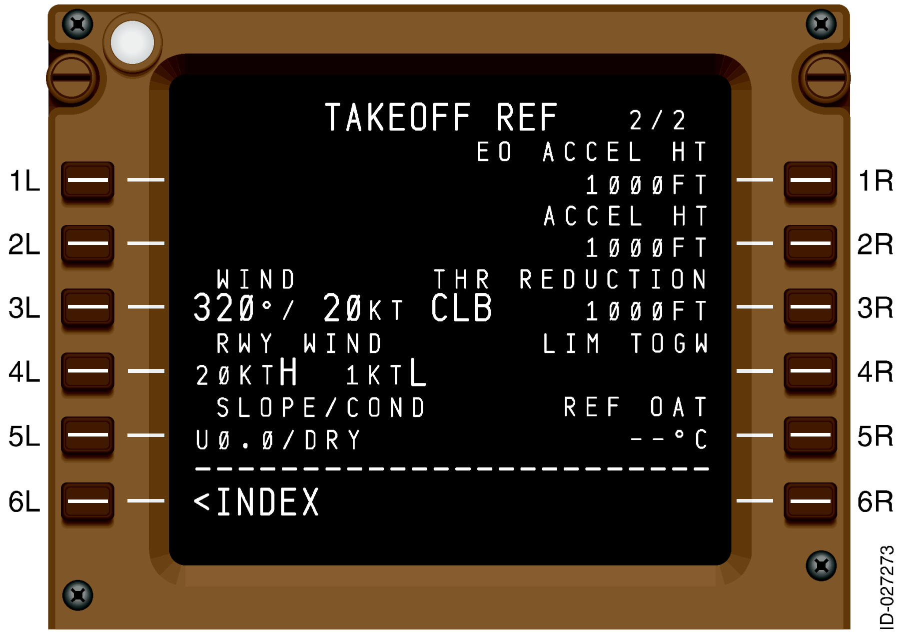
  The header line displays ALTN LIM TOGW when the alternate takeoff data is pending. The header line displays STD LIM TOGW when the standard takeoff data is pending. LIM TOGW is always displayed in the header line. Pilot-entry is not allowed.

- **REF OAT (5R)** – Outside air temperature is entered in 5R for STD LIM TOGW weight calculations. Entry is optional for preflight completion.

  Pilot-entered or uplinked data entry can be entered. Valid entries are –54 to 99°C, or –65 to 199°F.

To complete the preflight on the TAKEOFF REF pages 1/2 and 2/2 for the flight from KORD to EGLL, do the following (make entries on TAKEOFF REF page 2/2 first).

STEP: Enter 320/20 (wind) in the scratchpad and push 3L (Figure 4-39).



TAKEOFF REF Page 2/2 – Completed
Figure 4-39

STEPS:

1. Push the NEXT PAGE or PREV PAGE key to display page 1/2.
2. Enter 20 (takeoff flap setting) in the scratchpad and push 1L.
3. Enter 30 (aircraft CG) in the scratchpad and push 3L. Push 5R (REF SPDS ON).

The resulting display is shown in Figure 4-40.

TAKEOFF REF Page 1/2 – Entry Completed
Figure 4-40

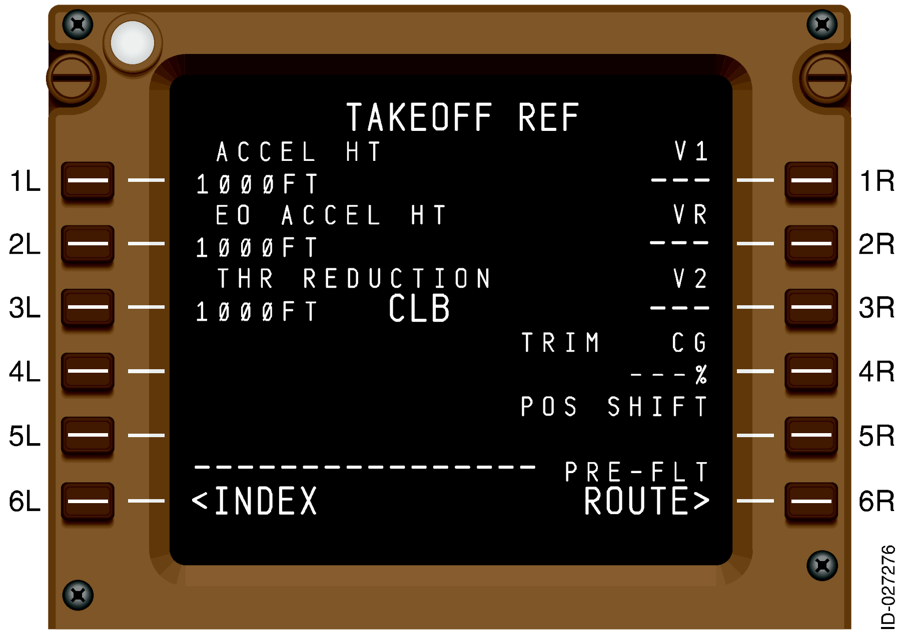
STEPS:

1. Push 1R. Verify and activate.
2. Push 2R. Verify and activate.
3. Push 3R. Verify and activate.

NOTE: V_{SPEEDS} change from small font to large font, as shown in Figure 4-41.

TAKEOFF REF Page 1/2 – Completed
Figure 4-41

Figure 4-42 shows an example of the TAKEOFF REF page with a different format. In this situation the FMS does not calculate the V_{SPEEDS}, they must be entered by the crew.



TAKEOFF REF Page
Figure 4-42

NOTES:

1. The header line in 6R displays PRE-FLT until all of the required preflight data sequence entries have been completed. If the preflight is complete, the header line displays dashes which means the minimum required data entries are complete as in Figure 4-41.

2. The minimum required preflight data entries on each page are represented by box prompts before data is entered in that line.

5. Takeoff and Climb

The FMS TAKEOFF flight phase begins when takeoff/go-around (TO/GA) is selected. Preparation for this phase begins in the preflight phase and includes entering data on the TAKEOFF REF page.

The TAKEOFF phase automatically transitions to the CLIMB phase when the FMS commands climb thrust. The CLIMB phase continues to the top-of-climb point, where the CRUISE phase begins.

AUTOTHROTTLE TAKEOFF

To engage autothrottle takeoff, the pilot advances the throttles slowly and smoothly to approximately 1.05 EPR and allows the EGTs to stabilize. Once the EGTs are stabilized, pushing the TO/GA switch lets the TMCF advance the throttles to the takeoff EPR reference bugs by 50 kts CAS. The throttles are advanced to the thrust level selected on the THRUST LIM page. This value for the flight from KORD to EGLL is the derated takeoff EPR setting of 1.368.

Once the TMCF has set the thrust level and the aircraft reaches a speed of 80 kts, control of the throttles is relinquished (HOLD) until 400 feet AGL. This is indicated by the THR REF annunciator on the PFD until 80 knots, then HOLD replaces THR REF (above 80 knots). The pilot has command of the throttles throughout the takeoff process, and can terminate the HOLD mode and cancel any derate thrust limits by pushing the TO/GA switch a second time (after liftoff).

If VNAV is engaged, the FMS automatically reduces takeoff thrust to the climb thrust limit on the THRUST LIM page. In this flight scenario, the climb thrust is set at the thrust reduction altitude (1000 ft AGL). If VNAV is not engaged, the thrust can be reduced to the climb thrust limit by pushing the THR button on the MCP. If operating with an engine out, then the maximum continuous thrust (CON) limit is set rather than climb, after flaps are up.

CLIMB PHASE

At the flap retraction acceleration height, or AFDS altitude capture before the acceleration, VNAV commands an airspeed increase, limited by the aircraft flap and gear configuration, to the greater of:

- 250 kts
- VREF+80 kts or
- The airspeed limit associated with the origin airport.

The VNAV commanded speed is limited by the current aircraft configuration. Following takeoff acceleration, VNAV initially commands a speed 5 kts below the flap placard speed for the current flap setting.

At the climb thrust reduction point, the FMS commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the CRUISE phase. Waypoint speed constraints take priority, as long as they are greater than VREF+80 or 250 kts.

During the climb, VNAV complies with the ACT RTE LEGS page waypoint altitude and speed constraints. A temporary level off for a crossing altitude restriction is done at the current commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, UNABLE NEXT ALTITUDE is displayed in the scratchpad. A different speed profile that provides a steeper climb angle must be manually selected.

If a CLB 1 or CLB 2 derate is selected, the derate is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust by the time the aircraft reaches the scheduled altitude.

If an altitude conflict exists between the FMS target altitude and the MCP selected altitude, RESET MCP ALT is displayed in the scratchpad. This condition can occur when the MCP altitude is set at or below aircraft altitude in CLIMB, or at or above aircraft altitude in DESCENT.

CLIMB PAGE

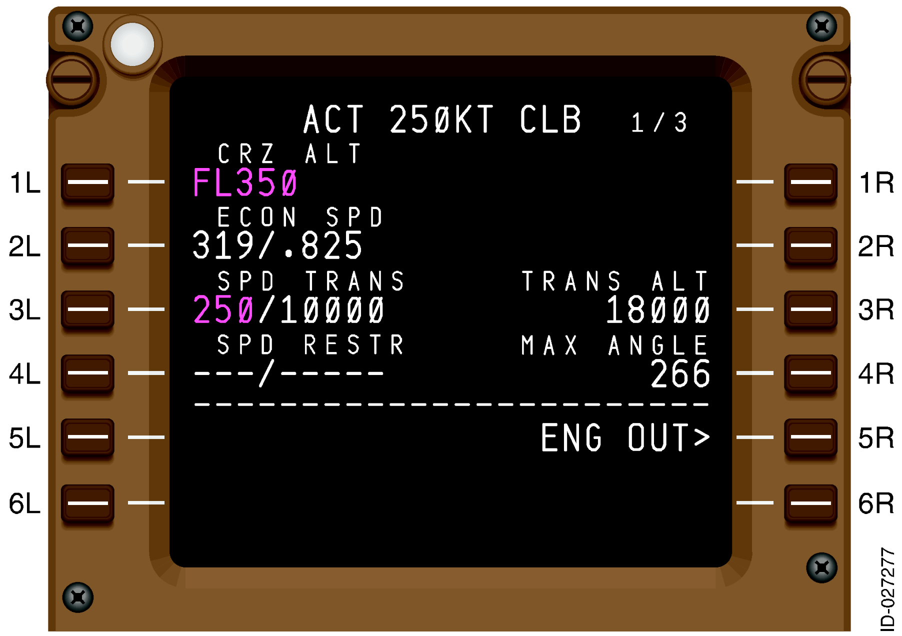
The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages, and from the airline policy file.

The climb page is automatically selected by pushing the VNAV key when the aircraft is on the ground, during takeoff, and during climb. When the FMS transitions to the CRUISE, the climb page data is blank. The CLB page is the first (page 1/3) of the three vertical navigation pages.

NOTE: The VNAV key is used to select climb, cruise, and descent performance modes. When the VNAV key is pushed, the page for the active performance mode is displayed. Pushing the PREV PAGE or NEXT PAGE key displays the pages for the inactive performance modes.

The CLB page (Figure 5-1) displays the current and upcoming climb profile conditions, with the active climb speed mode displayed in the title line. During the TAKEOFF phase, the title displays the limit speeds for the flap position. After takeoff acceleration, the title changes to ACT 250KT CLB (or reflects any speed restrictions). In this case, the aircraft (in a clean configuration) is subject to a minimum speed based on gross weight. The flight scenario displays ACT 250 KT CLB. When the aircraft reaches the speed transition altitude, the title changes to ACT ECON CLB (or the selected climb mode).

STEP: To display the CLB page (Figure 5-1), push the VNAV key.



CLB Page
Figure 5-1

The CLB page title displays one of the following:

- The active climb speed (XXXKT) if controlling to a fixed speed. M.XXX is displayed if controlling to a fixed Mach, or ECON if controlling to economy speed based on the cost index entered on the PERF INIT page.
- VREF+80 if an engine failure occurs during the TAKEOFF phase, engine out is not selected, and speed is not restricted by limit speed (for example, flap placard speed). Engine failure is described later in this section.
- E/O if engine out is selected.
- MCP SPD if speed intervention is selected on the MCP.
- LIM SPD if controlling to a limit speed, such as flap placard speed.

The CLB page is described in the following paragraphs.

- **CRZ ALT (1L)** – The cruise altitude entry from the PERF INIT page is propagated to this line. Valid entries are standard altitude entries. The FMS automatically lowers the cruise altitude to the maximum engine out altitude when ENG OUT is selected and the current cruise altitude is above the maximum engine out altitude.

  NOTE: The cruise altitude can be changed by two methods:

  - A new altitude can be manually entered on the CDU at any time. Changing the altitude this way creates a modification. The modified cruise altitude is displayed in shaded **white** until the modification is executed.
  - A new altitude can be entered on the MCP, as long as no intermediate altitude constraints exist between the current aircraft altitude and the MCP target altitude. Selecting a new altitude on the MCP and pushing the altitude selector displays the new altitude in the CRZ ALT field. Entering a new cruise altitude in this way does not create a modification.

- **Speed Line (2L)** – ECON SPD, SEL SPD, or E/O speed is displayed in this line, as appropriate. In the ECON mode, the command speed is a FMS–calculated value. A pilot-entered speed and/or Mach changes this field to SEL SPD. Valid entries are a three-digit CAS value, a one- to three-digit Mach number preceded by a decimal point, and a CAS/Mach or Mach/CAS schedule, where the CAS and Mach are separated by a slash.

The speed display changes to **magenta** when it becomes the current FMS commanded speed. Normally, during the CLIMB phase, the CAS speed is **magenta** until the CAS/Mach transition point. After the transition point, the Mach value changes to **magenta** and CAS value changes to **white**.

For the flight from KORD to EGLL, the speed mode is ECON SPD, with a calculated value of 319 kts and a Mach of .825.

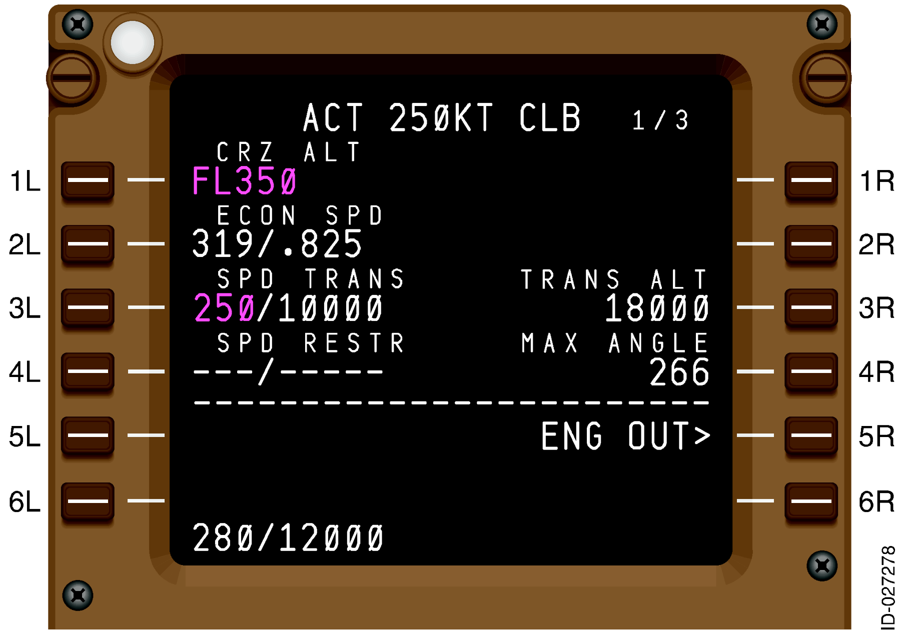
- **SPD TRANS (3L)** – The speed transition displayed in 3L is the speed/altitude value defined in the nav database for the origin airport. The default value is 250/10,000, or the CAS/altitude value required by performance calculated limits.

  The speed transition is blank after climbing through the speed transition altitude. Pilot-entry to the SPD TRANS field is not allowed, however, the speed transition can be deleted.

- **SPD RESTR (4L)** – The pilot can enter a speed restriction for an altitude less than the cruise altitude in 4L. A new entry creates a modification and is displayed in shaded **white** until executed. The speed is displayed in **magenta** when it is the FMS target speed.

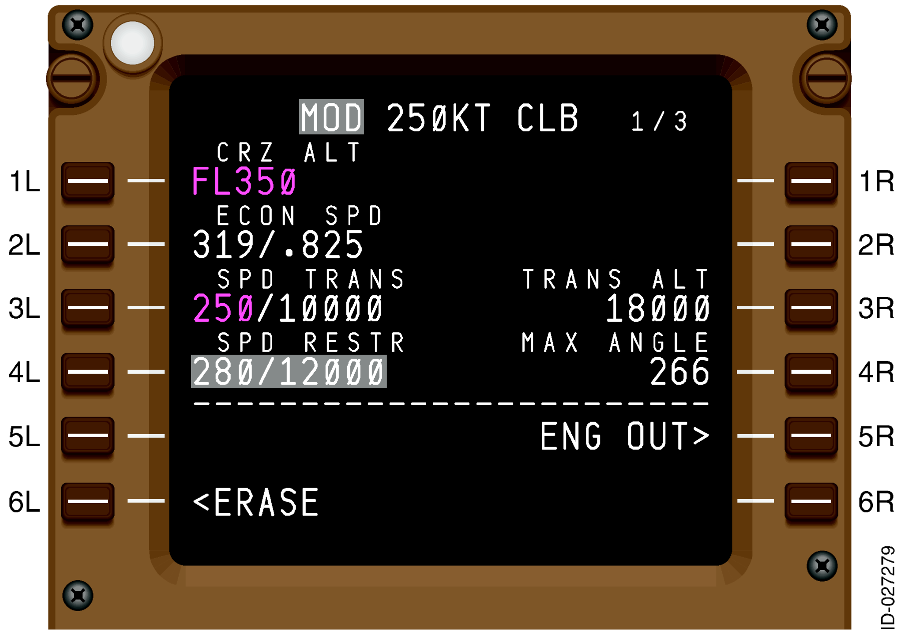
  Valid entries for speed restriction are a valid speed and a valid altitude separated by a slash. Altitude entries must be at or above the current aircraft altitude and below the cruise altitude.

STEP: To enter the speed restriction of 280 kts at 12,000 ft, enter 280/12000 in the scratchpad (Figure 5–2).



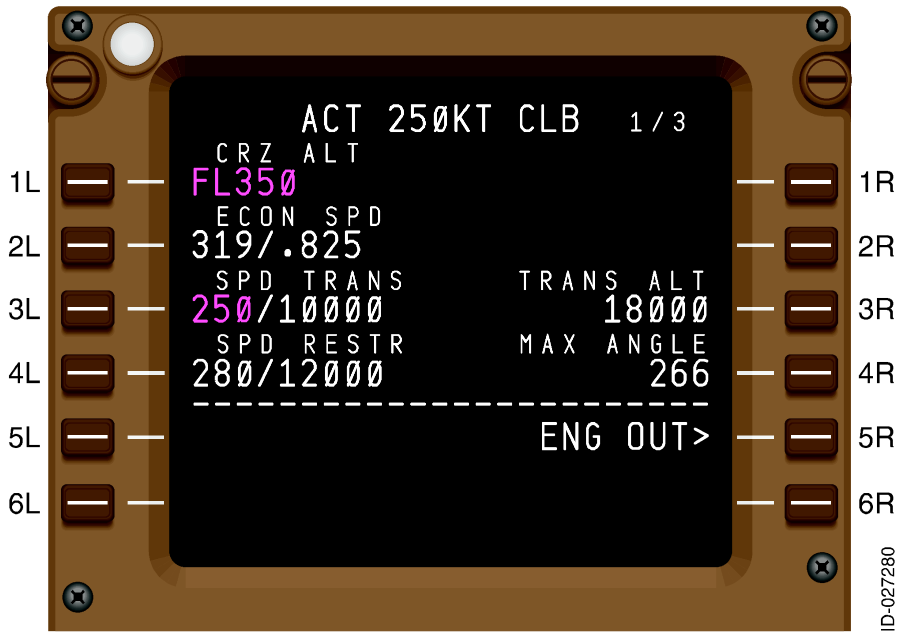
Entering a Speed Restriction – (1)
Figure 5–2

STEP: Push 4L to enter the speed restriction in the SPD RESTR field and create the modification (Figure 5-3).



Entering a Speed Restriction – (2)
Figure 5-3

STEP: Push the EXEC key to execute the modification (Figure 5-4).



Entering a Speed Restriction – (3)
Figure 5-4

- **AT XXXXX (1R)** (Not shown in Figure 5-4) - The next waypoint speed and altitude constraint are displayed in 1R. The field is blank if no restriction exists, as is the case for the flight from KORD to EGLL.

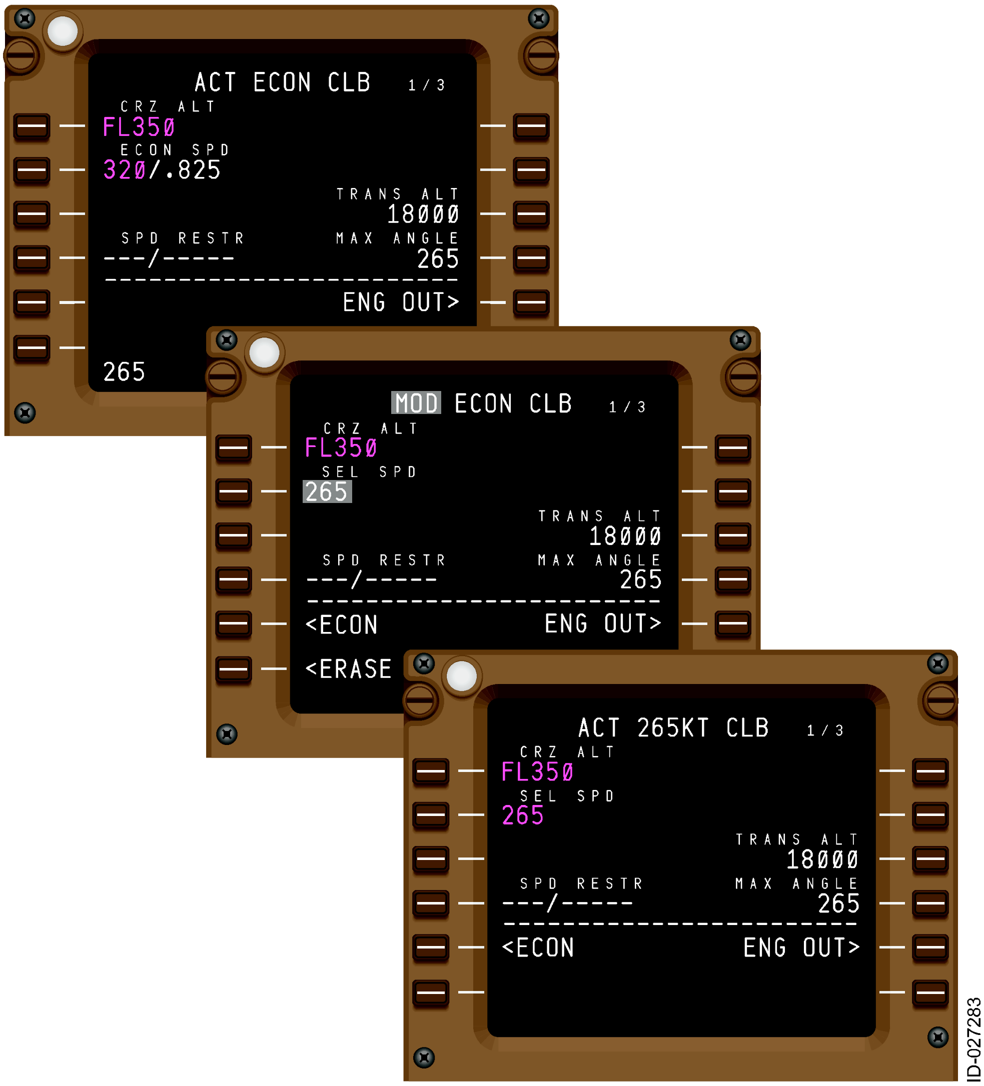
- **ERROR (2R)** (Not shown in Figure 5-4) - This field displays the error at the next waypoint. It displays the altitude error (below - with a resolution of 10 ft) and distance past the waypoint (long - with a resolution of 1 NM) where altitude will be reached.

- **TRANS ALT (3R)** - The climb transition altitude is displayed in 3R in feet MSL. This is the transition altitude for the origin airport if defined in the nav database. If not, then a default value of 18,000 ft is used but can be changed with a standard altitude entry.

- **MAX ANGLE (4R)** - The maximum climb angle speed is displayed in 4R. This speed can be copied into the scratchpad and entered in 2L to initiate a maximum angle climb, as shown in the following example.

STEPS (Refer to Figure 5-5):

1. Push 4R to copy 265 into the scratchpad.
2. Push 2L to enter this value as a selected speed. This creates a modification.
3. Push the EXEC key to execute the modification.



MAX ANGLE – Entry
Figure 5-5

- **MAX ALT (4R)** (Not shown in Figure 5-5) - If the engine out mode has been selected, the maximum engine out altitude is displayed in 4R. A pilot-entry is not allowed into this field.

  The maximum engine altitude is defined by the lower of the following:

  — Engine out climb maximum altitude (using the engine out climb speed

— The engine out maximum cruise altitude (using the engine out cruise speed).

- **ENG OUT> (5R)** – Pushing 5R when the ENG OUT prompt is displayed results in an engine out speed schedule, performance predictions, and guidance. The engine out speed is propagated to the top-of-climb and into the cruise segments. The new engine out performance data is displayed in shaded white until the modification is executed.

  When the ENG OUT prompt has been selected, the ALL ENG prompt is displayed in 5R. Pushing 5R with the ALL ENG prompt displayed cancels the engine out mode and it results in an economy mode with performance and guidance based on all engine operation. The ALL ENG prompt is displayed in 5L when an engine out has been detected but not confirmed.

- **CLB DIR> (6R)** (Not shown in Figure 5–5) – CLB DIR is displayed in 6R when climb is active and an altitude constraint exists in the CLIMB phase between the current aircraft altitude and the cruise altitude. Pushing 6R deletes all the altitude constraints at waypoints between the current altitude and the MCP displayed altitude, except if the altitude constraint occurs at the MCP displayed altitude, then the altitude constraint is retained.

  The speed/altitude constraints not related to waypoints are not affected. If the MCP altitude is higher than the cruise altitude in 1L the cruise altitude is not changed.

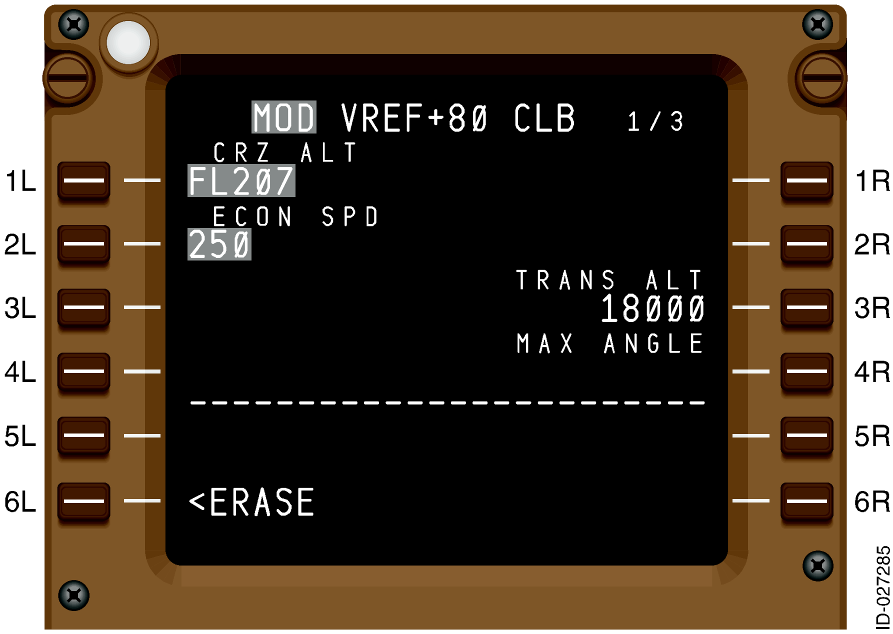
ENGINE FAILURE ON TAKEOFF

Engine failure on the TAKEOFF phase of flight causes the ACT CLB page to change to ACT VREF+80 CLB. The ACT VREF+80 CLB page means engine failure has been detected, but not verified, during VNAV takeoff, and the aircraft is above flap retraction altitude (see Figure 5-6).

ACT VREF+80 CLB Page
Figure 5-6

NOTE: Both the ALL ENG prompt in 5L and the ENG OUT prompt in 5R are displayed.

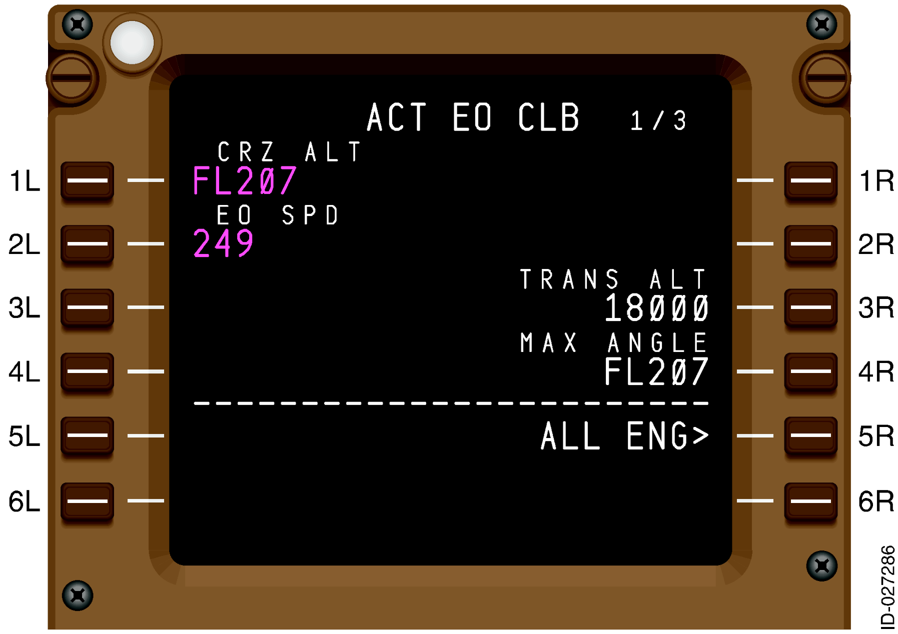
STEP: Push 5R to select the engine out mode and create a modification, as shown in Figure 5-7.



MOD VREF+80 CLB Page
Figure 5-7

NOTE: MOD VREF+80 CLB means a modified flight plan exists, an engine failure has been detected, but not verified, during VNAV takeoff, and the aircraft is above flap retraction altitude.

STEP: Push the EXEC key to execute the modification, shown in Figure 5-8.



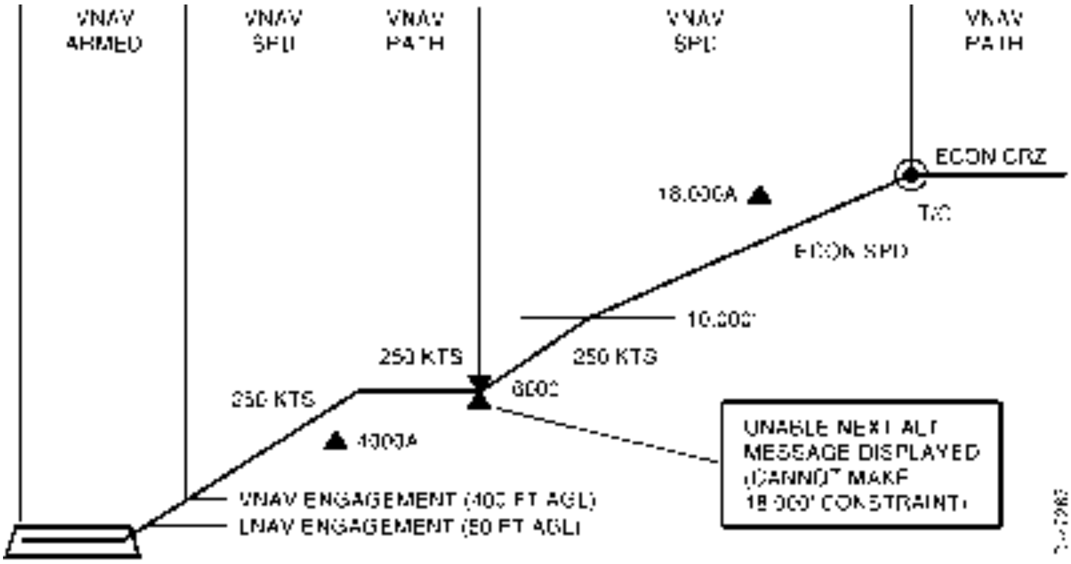
ACT EO Page
Figure 5-8

NOTE: The header line in 5R now displays the ALL ENG prompt. The cruise altitude, max altitude, and engine out speed are now the updated information and the page title is ACT EO CLB.

CLIMB PROFILE

The normal default climb profile is a 250 kt climb to 10,000 ft, followed by an economy climb to cruise altitude. The pilot can alter the default climb profile by entering any speed and/or altitude restrictions required to meet ATC clearances. If flaps are extended, the 250 kt climb is limited by the maximum speed allowed for flaps selected (LIM SPD CLB). The UNABLE NEXT ALT message is displayed if the aircraft cannot make the next defined constraint using the current mode, such as ECON.

Figure 5-9 illustrates a climb profile. In this example, the 18000A (AT OR ABOVE) constraint is not possible with ECON speed and the the UNABLE NEXT ALT message is displayed upon crossing the 6000 ft constraint.



Climb Profile
Figure 5-9

CLIMB PERFORMANCE CHANGE

The climb performance can be changed on the climb page by entering a different airspeed.

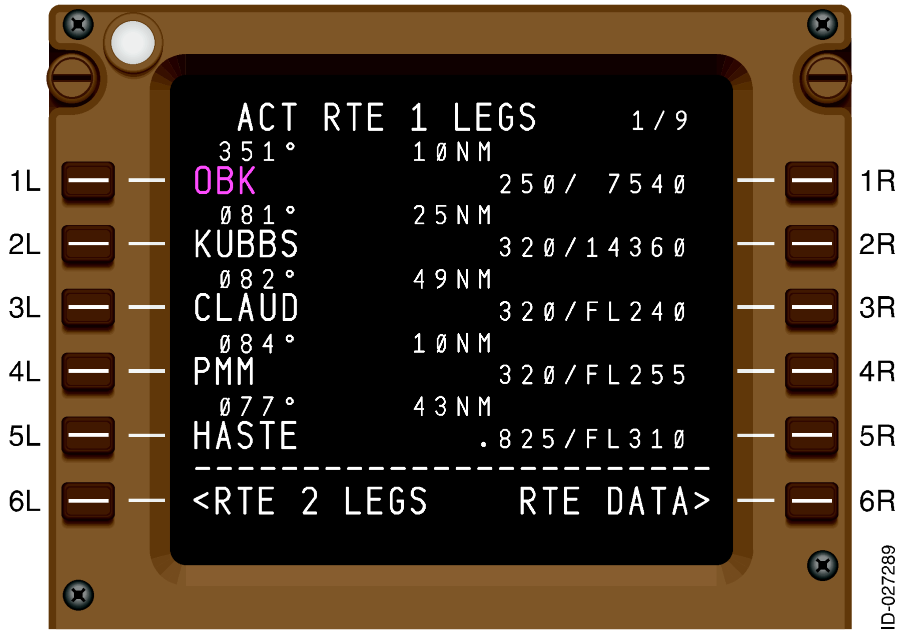
To climb at 320 kts, enter 320 in the scratchpad and push 2L to enter the modified speed.

STEP: Push the EXEC key to activate the new speed. The page title changes to ACT 320 KT CLB. The header line in 2L changes to SEL SPD (see Figure 5-10).

Climb Page – SEL SPD
Figure 5-10

RTE LEGS PAGES

The RTE LEGS pages display the waypoints in the flight plan route and pertinent information about each waypoint. The first waypoint listed on the LEGS pages of an active route is the waypoint that the aircraft is navigating to. It is also referred to as the active waypoint. Pushing the LEGS page displays the ACT RTE LEGS page (Figure 5-11).



ACT RTE LEGS Page
Figure 5-11

The active waypoint in Figure 5-11 is OBK (Northbrook). The calculated distance-to-go to the active waypoint is 10 NM. This distance is dynamic. The FMS predicts the aircraft will cross over OBK at 250 knots and 7,540 feet. As the aircraft passes over OBK, the ACT RTE LEGS display moves up one line, deleting the waypoint that has been passed (OBK), and inserting the next active waypoint (KUBBS) at the top of the page.

NOTE: No distance-to-go (DTG) is displayed for conditional waypoints.

RTE LEGS pages are available for both routes. The RTE N LEGS (where N is 1 or 2) prompt in line 6L is displayed to access to the other route.

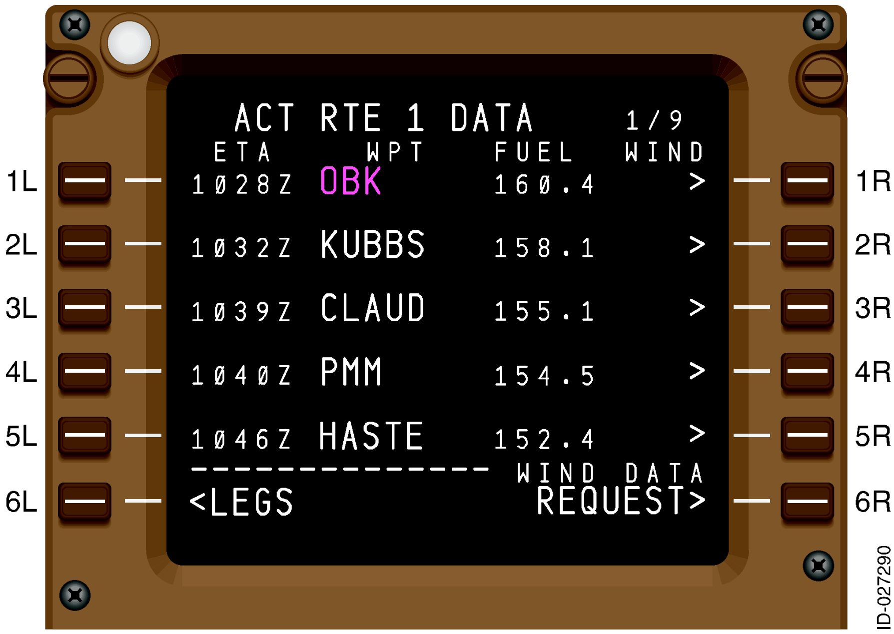
NOTE: The ERASE prompt is displayed in 6L if a pending activation or modification exists.

Route Data

Each RTE LEGS page has a corresponding ROUTE DATA page that is displayed by pushing 6R (RTE DATA). The ROUTE DATA page, displays progress data for each waypoint on the ACT RTE LEGS page.

The ROUTE DATA page displays estimated time of arrival (ETA), fuel remaining at the waypoints, and access to the waypoint wind page. Pilot entries are not allowed on the RTE DATA page.

STEP: Push 6R on the RTE LEGS page to display the RTE DATA page (Figure 5-12).



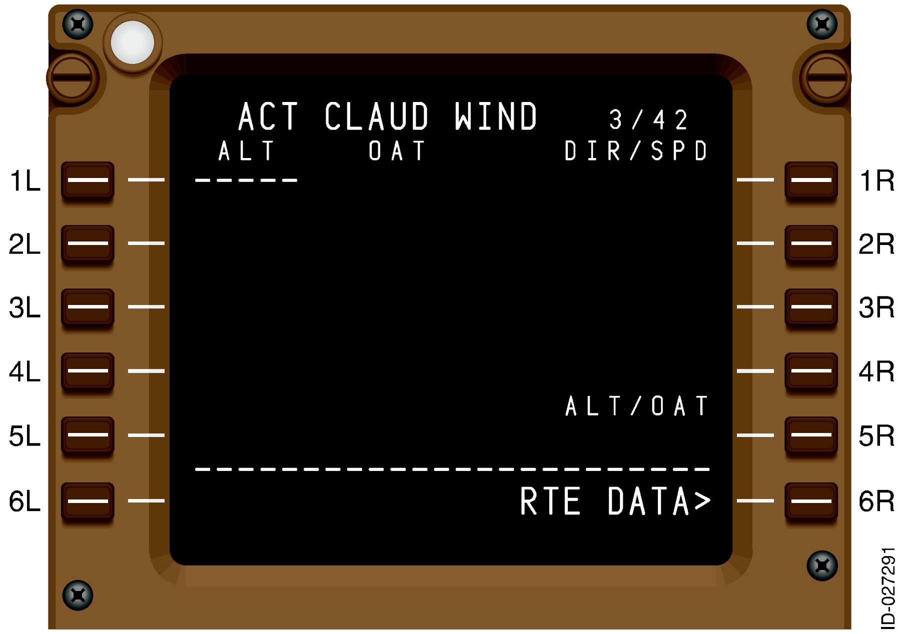
ACT RTE 1 DATA Page
Figure 5-12

The ACT RTE DATA page is described in the following paragraphs.

- **ETA (1L through 5L)** – The FMS-calculated ETA for each waypoint is displayed in the left field of each line.
- **WPT (1C through 5C)** – The waypoint identifier is displayed in 1C through 5C. These are the same waypoints as on the ACT RTE LEGS page.
- **FUEL (1C through 5C)** – The FMS-calculated fuel remaining at each waypoint is displayed in the center field of each line.
- **WIND> (1R through 5R)** – The WIND page for each waypoint is displayed by pushing the associated right LSK. W next to the caret indicates that wind data has been entered for the waypoint.

- **<LEGS (6L)** – Pushing 6L displays the ACT RTE 1 LEGS page.
- **REQUEST> (6R)** – Pushing 6R transmits a datalink request for wind and descent forecast data. The pilot can enter up to four altitudes on any wind page to qualify the request.

STEP: To display the WIND page for CLAUD (see Figure 5-13), push 3R.



ACT CLAUD WIND – Page 3/42
Figure 5-13

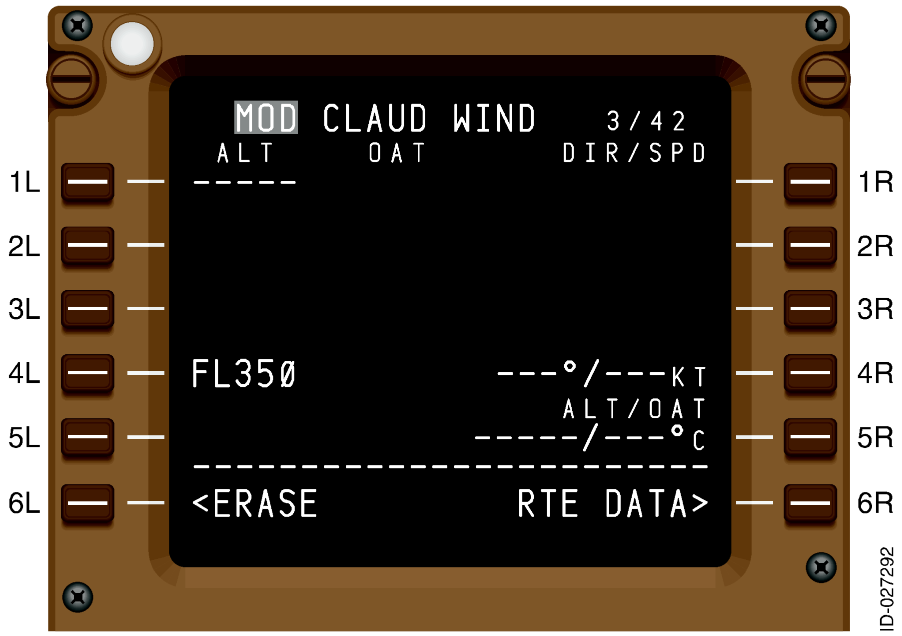
WIND PAGE

Forecast winds and temperatures at selected altitudes for specific waypoints can be entered on the WIND page, shown in Figure 5-14, to enhance VNAV performance.

The FMS calculates step climb points based on the wind effect but does not calculate step climb points based on wind data entered at the step climb altitude.

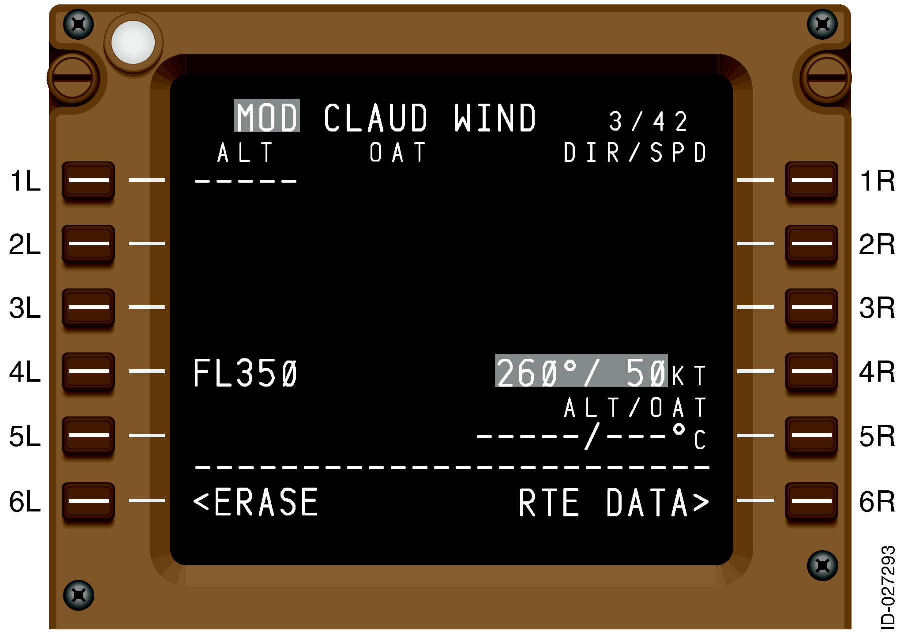
Up to four altitudes can be entered and displayed for each waypoint. The wind effect is applied along the entire route in both directions, if no other waypoint winds have been entered. The altitudes are entered first and in any order. The FMS sorts and displays the altitudes in ascending order. Wind speed and direction are entered for the specified altitudes.

STEP: To enter wind data for FL350, enter 350 in the scratchpad and push 1L.



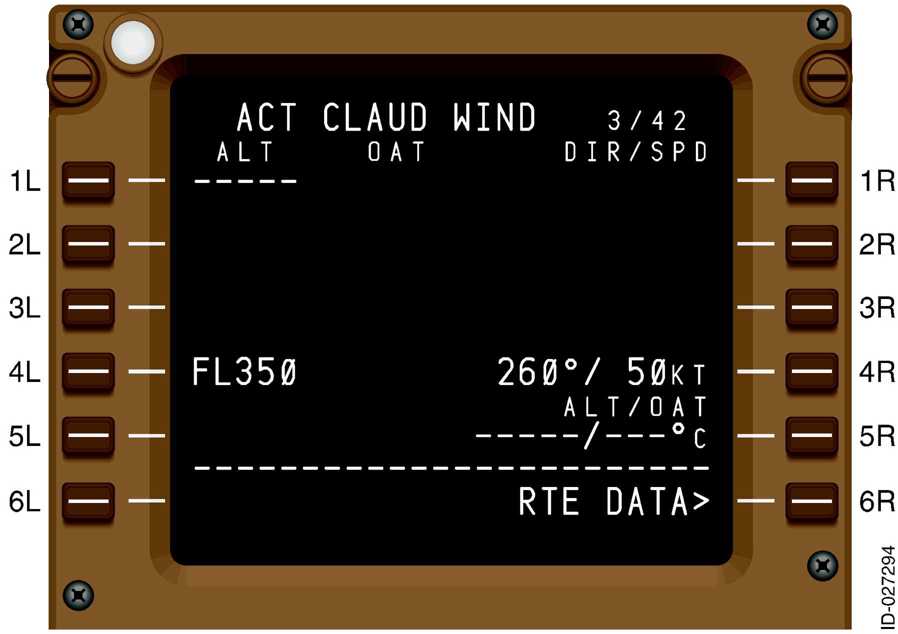
MOD CLAUD WIND – FL350
Figure 5-14

STEP: Enter 260/50 in the scratchpad and push 4R, as shown in Figure 5-15.



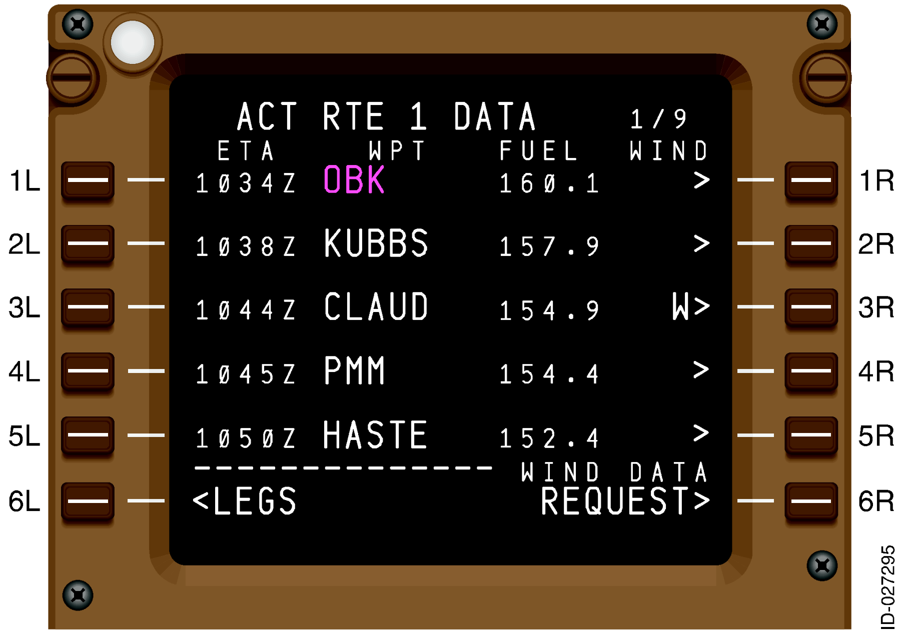
Wind Direction/Speed Entry
Figure 5-15

STEP: Push the EXEC key.



ACT CLAUD WIND
Figure 5-16

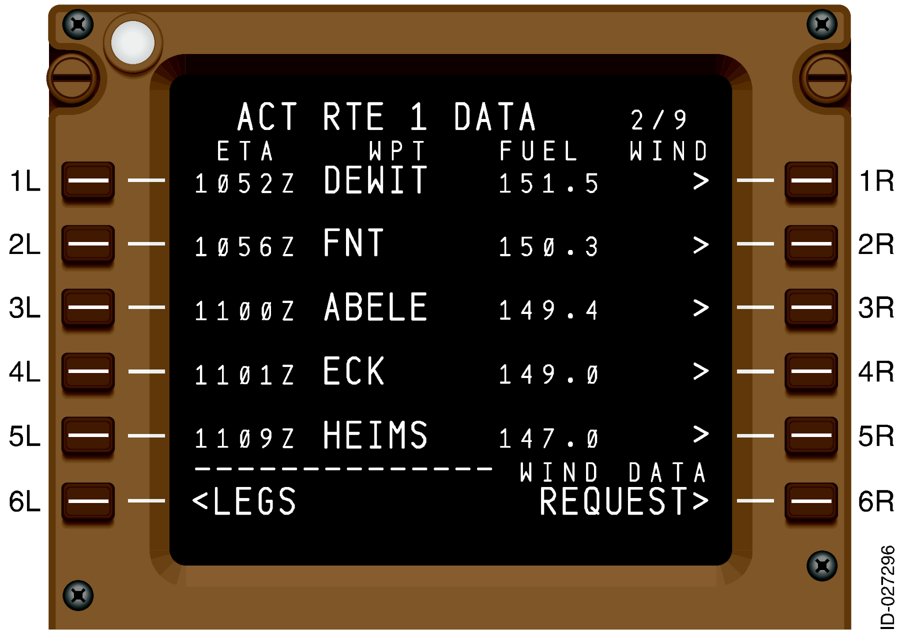
The WIND page can also be use to check the propagated wind values. To do this for waypoint PECK (ECK) push 6R (RTE DATA) on the ACT CLAUD WIND page in Figure 5-16. The page in Figure 5-17, is displayed.



ACT RTE 1 DATA Page – W>
Figure 5-17

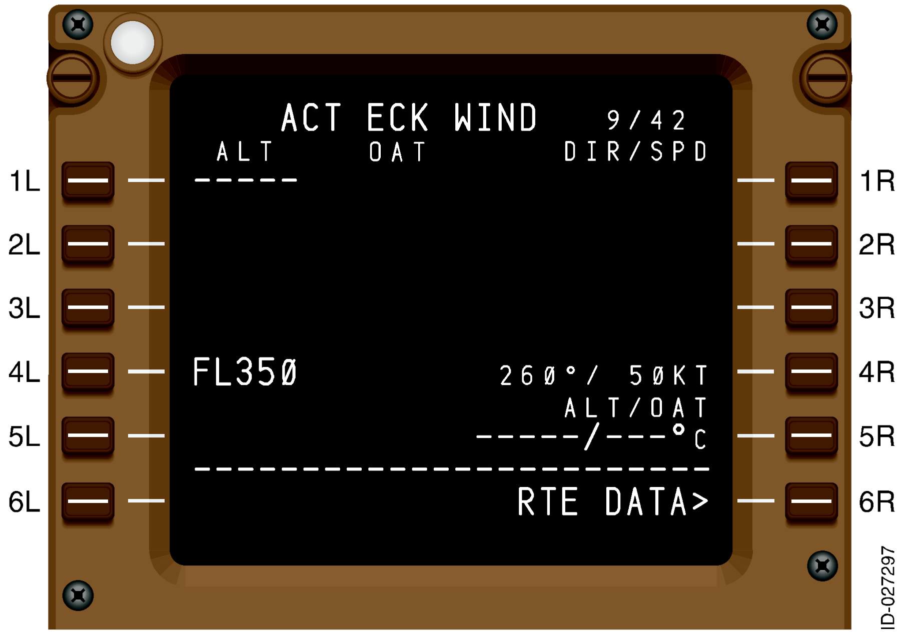
NOTE: The W in 3R indicates that wind data has been entered for CLAUD.

STEP: Push the NEXT PAGE key to display the downpath waypoints (Figure 5-18).



ACT RTE 1 DATA – Page 2/9
Figure 5-18

STEP: Push 4R to display the WIND page for ECK (Figure 5-18). The screen in Figure 5-19, is displayed.

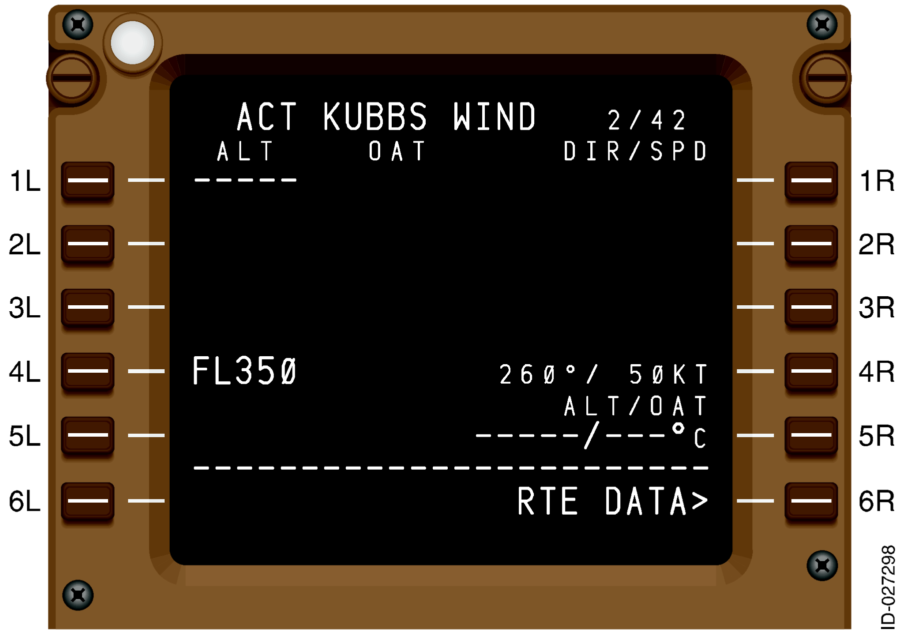


ACT ECK WIND
Figure 5-19

NOTE: The propagated wind at FL350 is displayed in small font in 4R.

Backward wind propagation to the waypoints between CLAUD and the aircraft present position can also be checked.

- Push 6R (RTE DATA) on the ACT ECK WIND page.
- Push the PREV PAGE key to display the ACT RTE 1 DATA page 1/9.
- Push 2R to display the WIND page for KUBBS (Figure 5-20).



ACT KUBBS WIND Page
Figure 5-20

NOTE: The wind direction and speed was propagated back from CLAUD to the waypoint KUBBS. The propagated wind for FL350 is displayed in small font in 4R.

The following are guidelines for understanding forecast wind and temperature entries.

- If there are no wind entries on any waypoint wind page, zero winds are assumed for the wind forecast for all waypoints at all altitudes.
- Entries in 2L through 4L are not allowed.
- Entering an altitude in 1L displays dashes for wind direction (DIR) and speed (SPD) on the right side of the CDU in the line corresponding to the sorted location of the altitude on the left side of the CDU.
- It is necessary for the altitude on a wind page to be deleted before a new altitude is entered to replace it. When the altitude is deleted the associated winds on all pages are also deleted at all the waypoints.

- Entering a wind value (not altitudes) at a waypoint results in the wind value being propagated downpath until another waypoint wind entry at the same altitude (same field) is encountered.
- If no wind entry has been made up-path from a waypoint with a forecast wind, the up-path waypoints display the first waypoint wind in small font.
- Propagated wind values are displayed in small font.
- Pilot-entered wind values are displayed in large font.
- Waypoint temperature forecasts are entered at a single altitude on any waypoint wind forecast page. Entering an OAT at an altitude is displayed in 5R and this results in modification of the displayed OATs in lines 1L through 4L.
- The OAT is entered in °C. Valid entries are a minimum of −80°C for all altitudes and a maximum interpolated from −40°C at 45,100 ft and +55°C at sea level.
- All temperatures on the page where the entry is made are displayed in large font and all propagated temperatures on the other pages are in small font.
- If waypoint OAT entries are not made, then standard daytime temperatures are used.

Climb Airspeed/Altitude Constraints

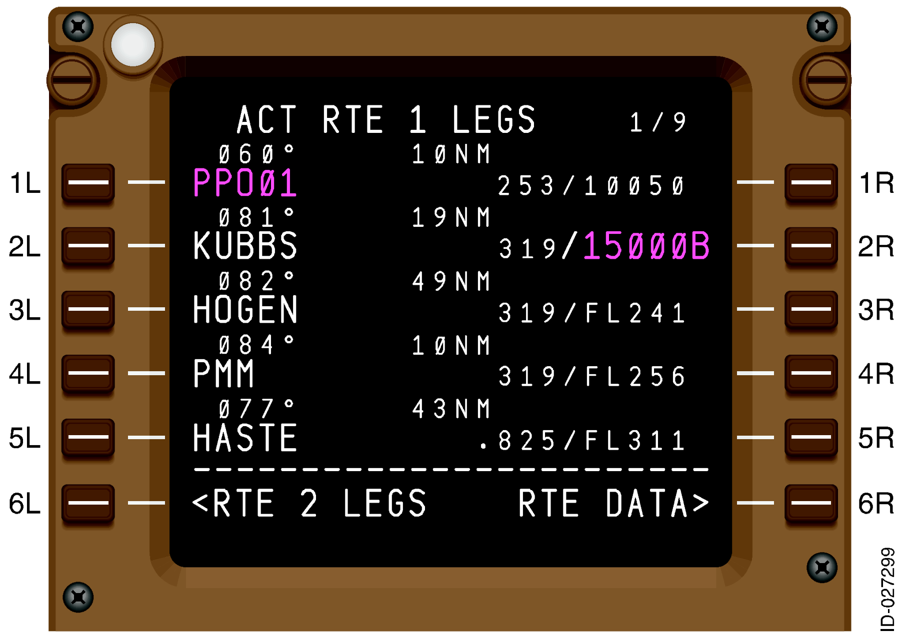
When vertical altitude constraints are entered or deleted during CLIMB, the FMS updates vertical guidance and performance. Changes can be made to waypoint altitude and airspeed constraints (on the RTE LEGS pages), and to CRZ ALT (on the CLB page).

When flight plan changes are made, performance predictions are invalid (dashes) until the FMS calculates new information. The CRZ ALT that was initially selected must be eventually attained or changed, or the FMS does not transition into the CRUISE flight phase.

ALTITUDE CONSTRAINTS

Altitude constraints let the pilot enter ATC specified constraints at flight plan waypoints. Altitude constraints are entered in the right field of the corresponding waypoint on the RTE LEGS page.

For example, ATC instructions call for crossing KUBBS AT OR BELOW 15,000 ft. AT OR BELOW 15,000 ft is inserted in the flight plan as a constraint by entering 15000B in the scratchpad and pushing 2R (KUBBS). After this is done, the modification must be executed by pushing the EXEC key (see Figure 5-21).



Altitude Constraint Entry
Figure 5-21

Only altitude constraints that are defined by the pilot as AT, AT OR BELOW, or a block altitude are restrictive in the TAKEOFF/CLIMB flight phase. If the aircraft is in a climb and a constraint is entered with an altitude below the aircraft, the entry is accepted and, if VNAV is engaged, the aircraft levels off and holds altitude until sequencing the constrained leg, then the aircraft continues the climb. In the flight from KORD to EGLL, the aircraft crosses KUBBS AT OR BELOW 15,000 ft, and once the aircraft sequences KUBBS, it continues climbing to FL350.

AIRSPEED CONSTRAINTS

Airspeed constraints can be inserted during the climb on the RTE LEGS pages. To enter an airspeed constraint at a waypoint, enter the constraint in the scratchpad (CAS is the only type of airspeed allowed), and push the right LSK for the constrained waypoint, and then push the EXEC key. The constraint can be entered with an altitude constraint separated by a slash (/). The constraint can also be entered without an altitude as long as it is followed by a slash (for example, 330/). An airspeed only constraint entered at a predicted altitude (small font) is not allowed and INVALID ENTRY is displayed in the scratchpad.

RULES FOR AIRSPEED/ALTITUDE CONSTRAINTS

The following paragraphs explain the conditions for entering airspeed/altitude constraints. Except where noted, the rules outlined also apply to constraints in the CRUISE, DESCENT, and APPROACH flight phases.

- Constraints can be entered on any leg other than an altitude termination leg (course from a fix to an altitude, holding termination at an altitude, or a heading to an altitude).

- Constraints are entered on the RTE LEGS pages, and also on the RTE HOLD pages for holding patterns. Constraints associated with an entered departure or arrival procedure are inserted into the route if the constraints are contained in the nav database. Constraints can be deleted on the RTE LEGS, RTE HOLD, CLB, and DES pages. Changes to the CRZ ALT may also delete constraints in a route.

- Entry format is important when entering both an airspeed and an altitude constraint. They must be separated by a slash (/) with the speed first (airspeed/altitude). Airspeed only entries must be followed by a slash (for example, 330/). Altitudes only entries may be preceded by a slash, but it is not required. Altitude constraints are identified as AT, AT OR ABOVE, AT OR BELOW, or Block Altitudes.

- Airspeed entries are only allowed in three-digit CAS format from 100 to 400 kts (Mach entries are not allowed). Airspeed only entries can only be entered if an altitude constraint already exists for that waypoint. Airspeed only entries cannot be made over dashes, next to a predicted altitude (small font), or at an altitude termination leg.

- Altitude entries of less than 1,000 ft must be preceded with zeros. A minimum entry of at least four digits is required (i.e., 800 ft is entered as 0800). Negative altitude entries must be entered as -NNNN, (minimum of -1,000 ft). Altitude constraint entries must be lower than the CRZ ALT (they can be equal to the CRZ ALT only if the entry is made on a holding pattern leg and is not a block altitude).

  NOTE: All entries must be executed with the EXEC key.

INVALID ENTRY is displayed in the scratchpad for any entry not meeting this criteria.

INSERTING A CONSTRAINT

Constraints can be inserted when new constraints are created and entered over dashes, predicted airspeed/altitudes, or existing constraints. Old constraint airspeeds are never saved when new constraints are entered. This is true even if an altitude only constraint is entered.

If the aircraft is in a climb and a climb constraint is entered with an altitude below the aircraft, the entry is accepted. With VNAV engaged, the aircraft levels off and holds altitude until sequencing the constrained waypoint.

Constraints are deleted with the DEL key. Dashes, boxed, predicted values, and altitude terminations cannot be deleted and INVALID DELETE is displayed in the scratchpad. Deleting a constraint displays dashes in the constraint field. The dashes are then replaced by new predicted values.

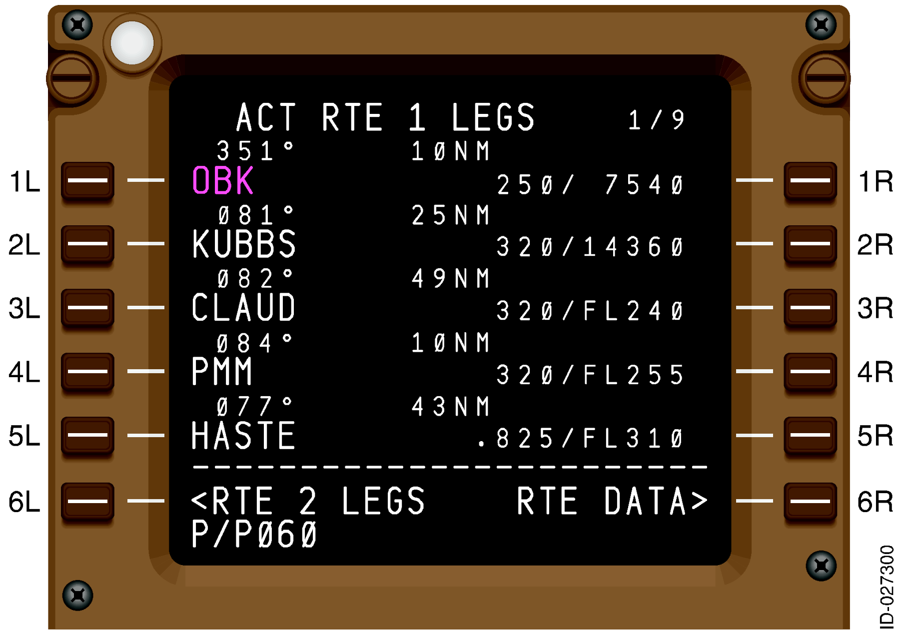
Rules for airspeed/altitude constraints in the CRUISE, DESCENT, and APPROACH flight phases are described in the appropriate sections.

Intercepting a Course From Present Position

For the flight from KORD to EGLL, Chicago departure requests a right turn to a heading track of 060°. ATC wants the heading held until intercept course as filed to waypoint KUBBS.

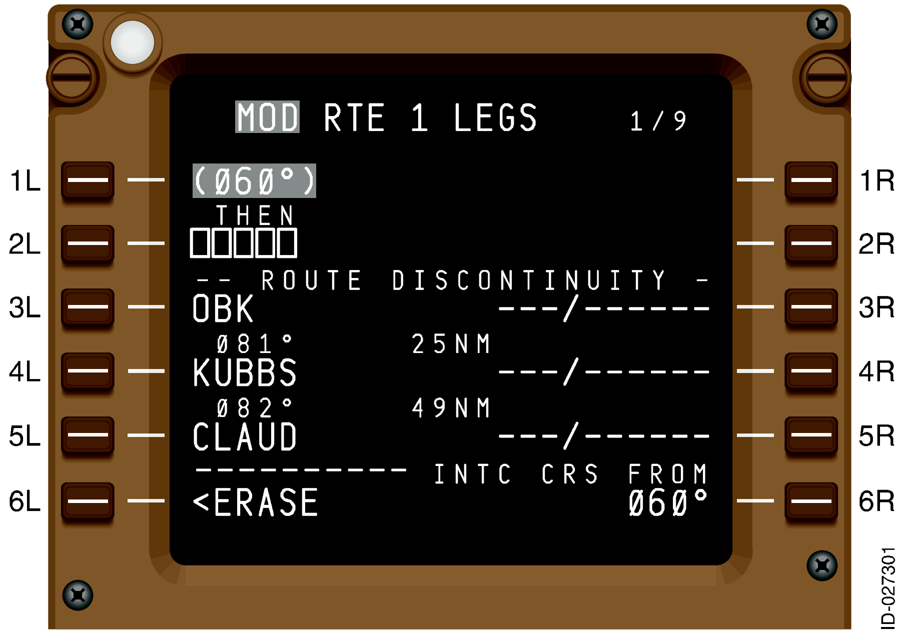
The following steps and figures show how this can be done using the present/position (P/P) feature.

STEP: Enter P/P060 in the scratchpad (Figure 5-22).



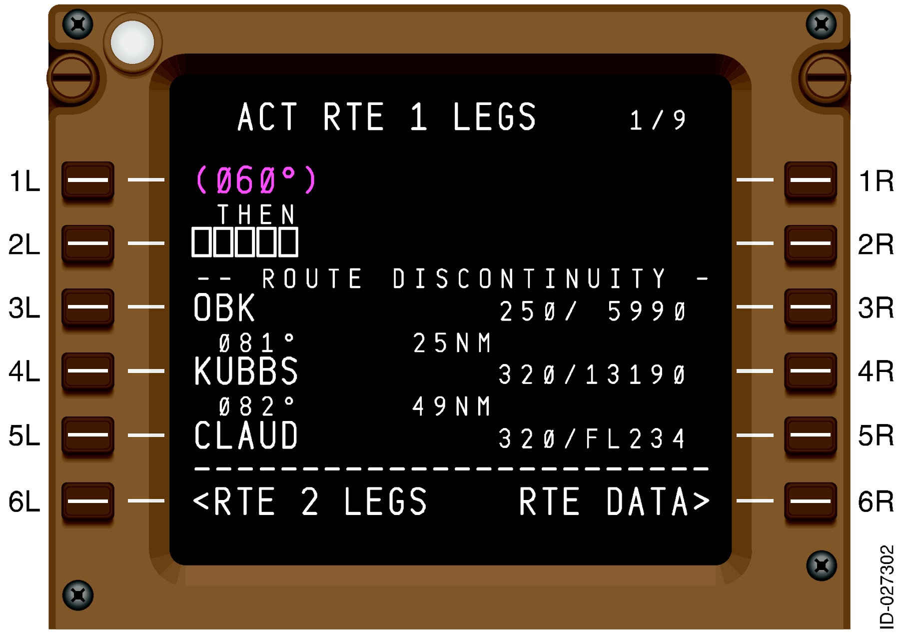
P/P060 Entry
Figure 5-22

STEP: Push 1L (Figure 5-23).



P/P060 – MOD
Figure 5-23

STEP: Push the EXEC key (Figure 5-24).



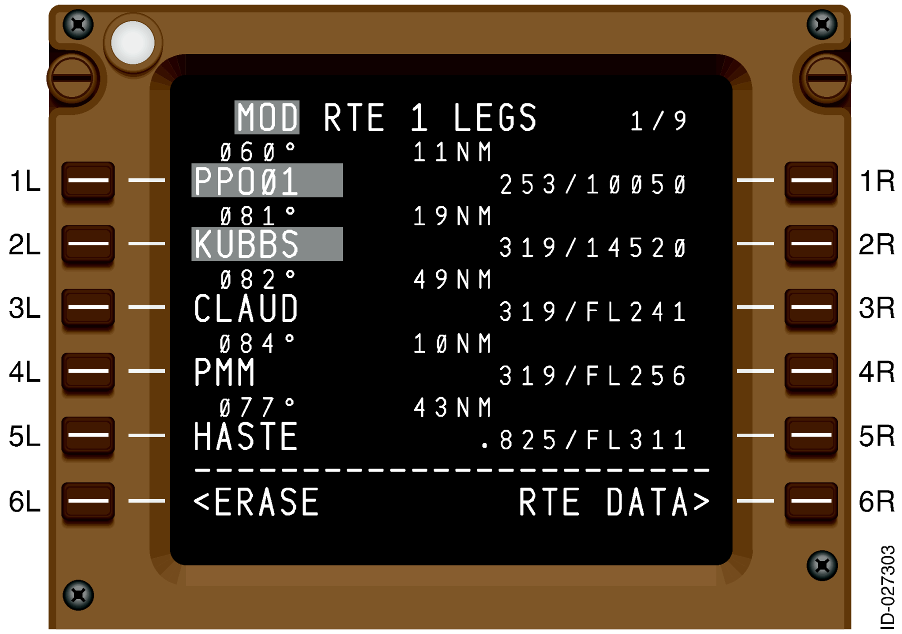
ACT RTE 1 LEGS – 060 Course
Figure 5-24

NOTE: This creates a course line that is displayed on the ND in **magenta** and extends for 700 NM. A route discontinuity is also created before the next waypoint.

Complete the remaining steps to comply with the ATC clearance to intercept the airway and proceed on course to KUBBS.

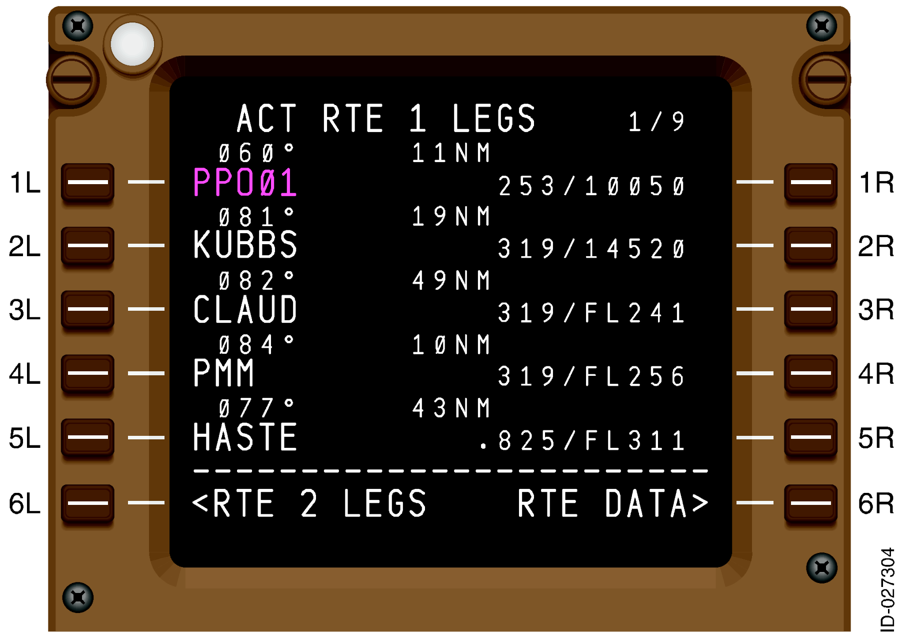
STEPS:

1. Push 4L to downselect KUBBS to the scratchpad.
2. Push 2L to enter KUBBS into the box prompts (Figure 5-25).



MOD RTE 1 LEGS – PP001 Waypoint
Figure 5-25

STEP: Push the EXEC key (Figure 5-26).



PP001 – Active Waypoint
Figure 5-26

The FMS creates a waypoint PP001 at the intercept point on the airway inbound to KUBBS. The route discontinuity was removed with the above steps.

6. Cruise

The FMS CRUISE flight phase starts at the top-of-climb (T/C) and ends at the top-of-descent (T/D). During CRUISE the pilot may be required to make navigation changes, transmit position reports, monitor flight progress, change cruise altitude, and prepare for descent to the destination airport. Preparing for descent can include selecting a STAR, entering descent forecast wind, and reviewing approach and missed approach data. These items are described in this section.

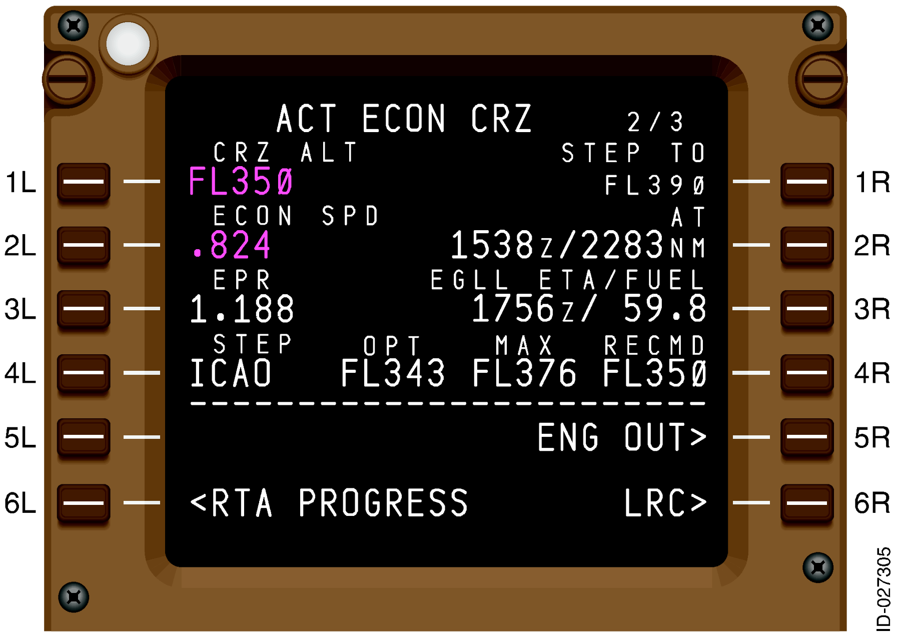
CRUISE PAGE

The cruise page is displayed by pushing the VNAV key when the FMS is in the CRUISE phase. If the CRUISE phase is not active, the CRZ page is page 2/3 of the vertical navigation pages and is displayed by pushing either the PREV PAGE or NEXT PAGE key after the VNAV key has been pushed.

The cruise page is automatically selected when the FMS transitions from CLIMB to CRUISE if VNAV is active.

The CRUISE page is used to evaluate, monitor, or change cruise altitude, speed, and step climb path. The available speeds are: economy, selected speed, long-range cruise, engine out, cruise climb, cruise descent, and limit speed.

STEP: To display the cruise page (Figure 6-1), push the VNAV key after the FMS has transitioned to the CRUISE flight phase.



ACT ECON CRZ Page
Figure 6-1

The page title displays the active or modified type of cruise. Normally, the title displays ECON for economy cruise mode. Selecting fixed speed, engine out, and long-range cruise change the title. The page titles are described in the following paragraphs.

- XXXKT is displayed if controlling to a fixed speed. M.XXX is displayed if controlling to a fixed Mach, or ECON if controlling to economy speed based on cost index from the PERF INIT page.
- LRC is displayed if long-range cruise is selected.
- EO is displayed if engine out is selected. CO is displayed if a company specified engine out cruise speed is selected.
- EO LRC D/D is displayed when engine out is selected and the current aircraft altitude is greater than maximum altitude for engine out performance.
- MCP SPD is displayed if speed intervention is selected on the MCP.
- LIM SPD is displayed if controlling to a limit speed such as V_{MO}/M_{MO}.
- CRZ CLB or CRZ DES is displayed if a new cruise altitude is entered on the active page.

The CRZ page is described in the following paragraphs.

- **CRZ ALT (1L)** – The current VNAV cruise altitude is displayed in 1L. The cruise altitude entry from the PERF INIT page is propagated to this page. An altitude entry in 1L while the CRZ page is active changes the page title to CRZ CLB or CRZ DES.

  When a cruise altitude is entered that is greater than the maximum certified altitude, the entry is rejected and INVALID ENTRY is displayed in the scratchpad. When a cruise altitude is entered that is greater than the performance computed maximum altitude, the entry is accepted and MAX ALT FLXXX is displayed in the scratchpad.

  NOTE: A cruise altitude entry above the maximum altitude deletes the fuel predictions on the PROGRESS page 1/2 for all waypoints in the flight plan. However, entering a waypoint other than a flight plan waypoint in 3L on the PROGRESS page 1/2 displays time and fuel predictions, even if cruise altitude entry is above the maximum altitude.

  A cruise altitude entry deletes any HOLD waypoint constraints greater than the entered cruise altitude. All other waypoint constraints greater than or equal to the entered cruise altitude are deleted.

- **Speed Line (2L)** – The cruise speed target for the current leg of the CRUISE flight phase is displayed in 2L. The header line displays ECON SPD when the speed mode is economy cruise. This is the speed used for the flight from KORD to EGLL. SEL SPD is displayed when the speed mode is a selected CAS or Mach number. CO SPD is displayed for company speed. LRC SPD is displayed when the speed mode is long-range cruise (LRC), including engine out LRC modes.

  EO SPD is displayed when the speed mode is engine out best gradient speed cruise. The speed is displayed either as a three-digit CAS, ranging from 100 to 400 knots, or a three-digit Mach number preceded by a period ranging from .100 to .990.

- **EPR (3L)** – The target EPR or N1 required to maintain target airspeed at cruise altitude is displayed in 3L when on an active cruise, cruise climb or cruise descent page. This field is blank when a modification (MOD) is in progress or when the page is inactive.

- **STEP SIZE (4L)** – This is the default ICAO or pilot-entered step size increment used for optimum step point predictions and step climb trip predictions. Valid entries are zero and multiples of 1,000 ft up to 9,000 ft. Entering zero causes the flight plan predictions to be calculated with **no** step climbs. The step size value is propagated from the PERF INIT page. Deleting a pilot-entered step size defaults this field back to the ICAO value.

  NOTE: If step climbs are displayed, the FMS fuel predictions are based on the step climbs being done at the appropriate points. If no step climbs are to be made, then entering zero as the STEP SIZE is the correct procedure for accurate fuel predictions.

- **<ERASE (5L)** (Not shown in Figure 6–1) – An ERASE prompt is displayed in 5L when a vertical or lateral flight plan modification is pending. Selecting this prompt erases the pending modification.

- **<ECON (5L)** (Not shown in Figure 6–1) – When speed or Mach has been manually entered in 2L, an ECON prompt is displayed in 5L Pushing 5L selects economy cruise speed and ECON SPD is displayed in 2L.

- **STEP TO (1R)** – The next altitude that minimizes either the trip cost or fuel cost based on step size is displayed in 1R. If the step size is ICAO, cruise altitude is selected before takeoff.

  The STEP TO altitude can be overwritten with an altitude higher than cruise altitude and this entry remains until a new cruise altitude is entered.

Step to altitudes can also be entered at waypoints on the LEGS page. These altitudes can be higher or lower than the cruise altitude. If a step to altitude from the LEGS page is displayed in this field, it cannot be overwritten on this page.

This field is blank if there is no active flight plan, or if the aircraft is within 200 NM of the top-of-descent point or within 500 NM of the destination. The field is also blank if zero has been entered in 4L (STEP SIZE).

NOTE: ICAO safe separation, step increments are additive to the OPTIMUM ALTITUDE base for the cruise altitude selected before takeoff. Inflight changes to the cruise altitude do not change this base altitude. For example, for the flight from KORD to EGLL, Figure 6-1 displays a cruise altitude of FL350 (1L) selected at takeoff and an OPTIMUM ALTITUDE of FL343 (4C). The STEP TO altitude is FL390 (1R).

- **AT (2R)** - The estimated time of arrival and distance-to-go to the optimum step point are displayed in 2R. For the flight from KORD to EGLL, the step point has an ETA of 1538Z and a distance of 2282 NM. If a recommended step to point has passed, NOW is displayed in 2R.

  The header line changes to AVAIL AT if a climb is restricted by thrust limit or buffet.

  The header line changes to TO T/D within 200 NM of the top-of-descent point and the ETA and distance are relative to that point.

- **Destination ETA/FUEL (3R)** - The estimated time of arrival and calculated remaining fuel at the destination (assuming step climbs (if displayed) are made at optimum points to the STEP TO altitude) are displayed in 3R. If there are planned steps on the LEGS page, predicted values assume step climbs are made at the planned STEP AT points.

  This field displays the ETA and fuel remaining for the alternate airport when a DIVERT NOW modification is done on the ALTN page.

- **OPT Altitude (4L)** - The optimum altitude is displayed under the OPT label in 4C. This is the altitude that minimizes trip cost when ECON speed is selected. In other words, OPT displays the most economical altitude to fly, based on gross weight. When LRC or SEL SPD is selected, this field displays the altitude that minimizes trip fuel.

- **MAX Altitude (4C)** – The current maximum altitude based on current gross weight, number of operating engines, and current cruise speed target is displayed under the MAX label in 4C. This value assumes that the aircraft would climb directly to the altitude without regard for altitude or speed constraints.
- **RECMD (4R)** – The recommended cruise flight level in 4R is the recommended altitude to fly at for the next 500 NM. This calculation is based on the following:

  — Specified route
  — Selected cruise speed schedule
  — Step altitude schedule
  — Estimated airdraft drag and fuel flow information
  — Wind and temperature forecast.

  The recommended flight level can be any flight level in the present step altitude schedule up to the maximum altitude and down to 9000 ft below the current FMS cruise altitude.
- **ENG OUT> (5R)** – Pushing 5R displays the engine out information with the page title EO LRC CRZ, EO LRC CRZ DES, EO LRC CRZ CLB, or EO LRC D/D, as appropriate for the situation.

  When an engine out mode is selected and the cruise altitude is set above the drift down altitude, the cruise altitude is automatically lowered to the engine out maximum altitude. Selecting this prompt also changes the command speed to engine out LRC speed.
- **LRC> (6R)** – Pushing 6R selects a long-range cruise mode for either all engine or engine out configuration, based on the current engine out status.

Route Copy

The route copy function lets the pilot to copy the active flight plan into the alternate route, in this case, RTE 2. When this is done, changes can be made to a copy of the active route, or the active route can be preserved before making a major modification.

The RTE COPY prompt is displayed in 4R on the ACT RTE page (after the route has been activated) and in 5R on the RTE LEGS page after a direct-to entry in1L. Selecting the RTE COPY prompt copies the active route into the alternate route and replaces the RTE COPY prompt with RTE COPY COMPLETE.

For the flight from KORD to EGLL, the route was copied after RTE 1 was activated during the preflight. See Figures 6-2 and 6-3.

NOTE: Copying the active route replaces any previously entered information in the alternate route (in this case, RTE 2) with a copy of the active flight plan.

Copying the Route
Figure 6-2

STEP: Push 4R (Figure 6-2) to copy the active route into the alternate route. Figure 6-3 shows the route copy complete.

Route Copy – Complete
Figure 6-3

The prompts that are related to route copying and the alternate route are described in the following paragraphs.

- **RTE COPY> (4R)** – Pushing 4R copies the active unmodified route into the inactive route. The previous inactive route is erased. After the route has been copied, RTE COPY COMPLETE is displayed in 4R indicating the process is complete.

- **<RTE 2 (6L)** – This prompt is RTE 1 on the ACT RTE 2 LEGS page. Pushing 6L on the ACT RTE page displays the copied route on the appropriate page (RTE or LEGS page).

Abeam Points

The abeam points function lets the pilot retain reference points along a direct-to path. Flight plan waypoints on the active flight plan that are downpath of the aircraft and before the direct-to waypoint are projected onto the direct path abeam the original position. The abeam points are inserted into the flight plan as follows:

- If the original fix is a database waypoint, navaid, NDB, or airport; then a PBD waypoint is created on the direct path.

- If the original fix is a lat/long waypoint, then a new lat/long waypoint is created abeam the original point.

- If the original fix is a PBD, a new PBD is created abeam the nav database fix of the original PBD.

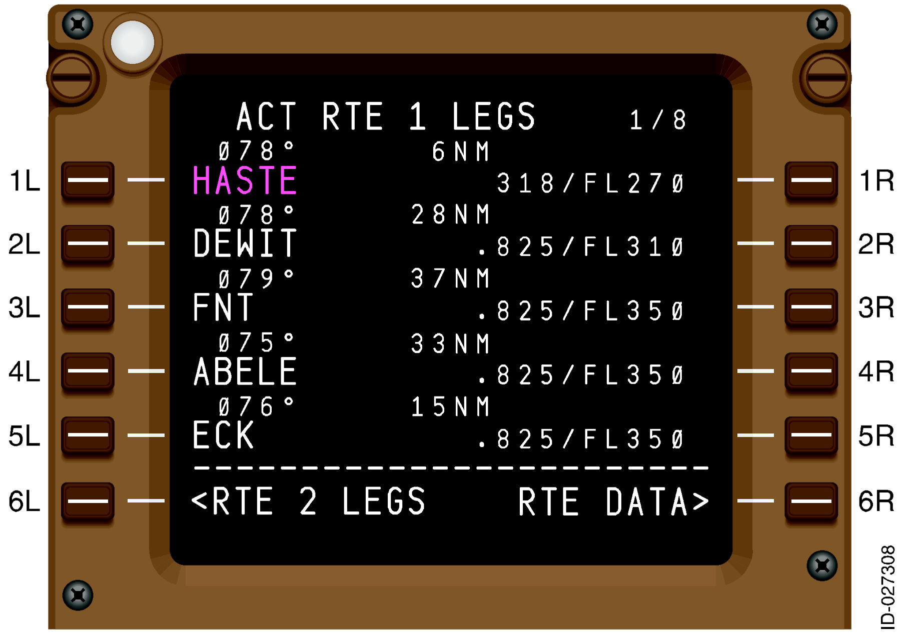
- If the original fix was a lat/long reporting point, the lat/long reporting point is recomputed so that it accurately marks the crossing of a particular latitude or longitude (that is, it is not located abeam the original location).

NOTE: If the abeam location is within 100 NM of the original location, entered wind information is retained. However, altitude or speed constraints are not retained for the created abeam points.

Abeam waypoints are not generated if the distance from the original waypoint to the abeam waypoint is more than 700 NM.

Abeam points are not generated from procedural waypoints (runways, departures, arrivals, approaches, and transitions) except for the fix terminating the last leg of any departure procedure in the route, and the fix terminating the leg immediately preceding the first leg of any arrival procedure in the route.

The abeam point function is accessed after a direct-to entry. Figure 6–4 shows the aircraft location on the active route for the flight from KORD to EGLL. The ACT RTE 1 LEGS page shows the aircraft 6 NM from the active waypoint **HASTE**.

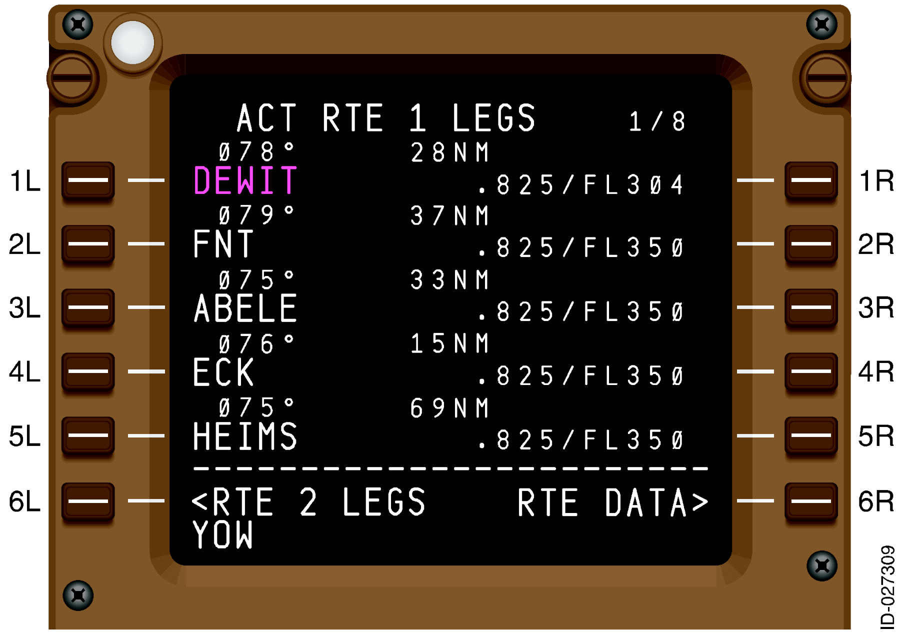


ACT RTE 1 LEGS Page 1/8
Figure 6–4

ATC has issued a clearance, from over HASTE cleared direct to OTTAWA (YOW).

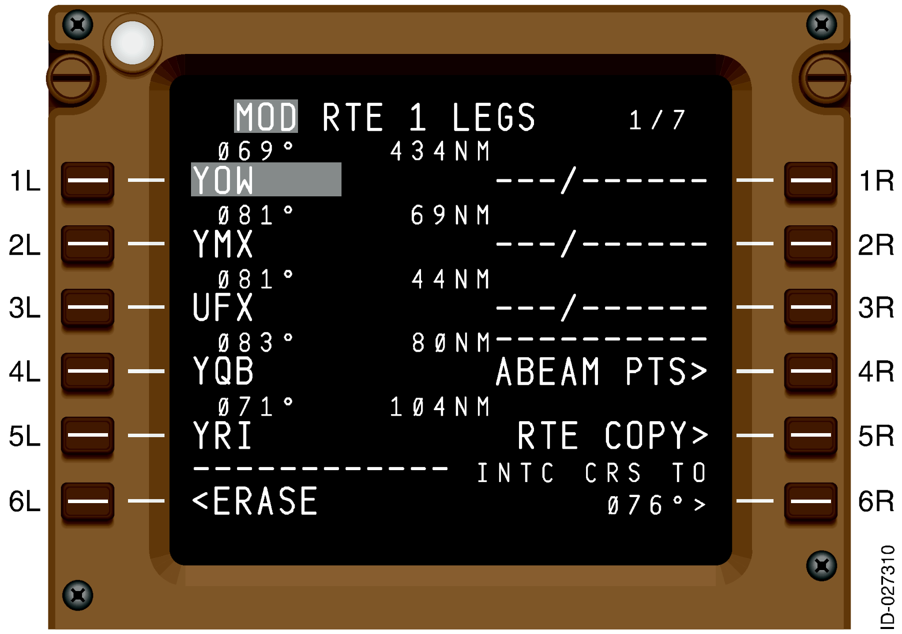
STEPS:

1. Push the NEXT PAGE key to display the ACT RTE 1 LEGS page 2/8.
2. Push 3L (YOW) to copy YOW into the scratchpad.
3. Push the PREV PAGE key to display the ACT RTE 1 LEGS page 1/8 (Figure 6-5).



ACT RTE 1 LEGS Page 1/8
Figure 6-5

STEP: Push 1L to copy YOW into the TO waypoint field. The ABEAM PTS prompt is displayed in 4R, as shown in Figure 6-6.

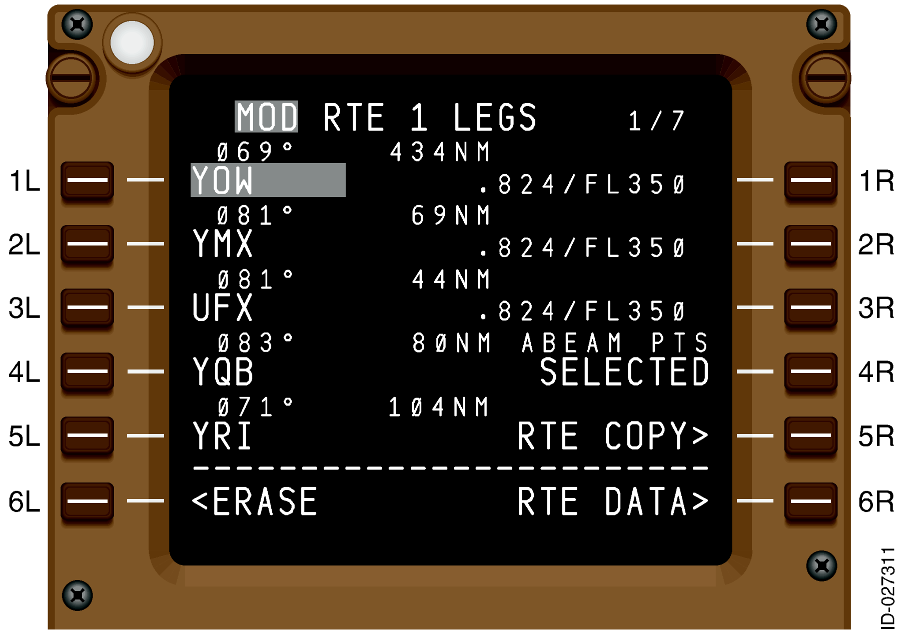


MOD RTE 1 LEGS – ABEAM PTS>
Figure 6-6

The ABEAM PTS prompt is described in the following paragraphs.

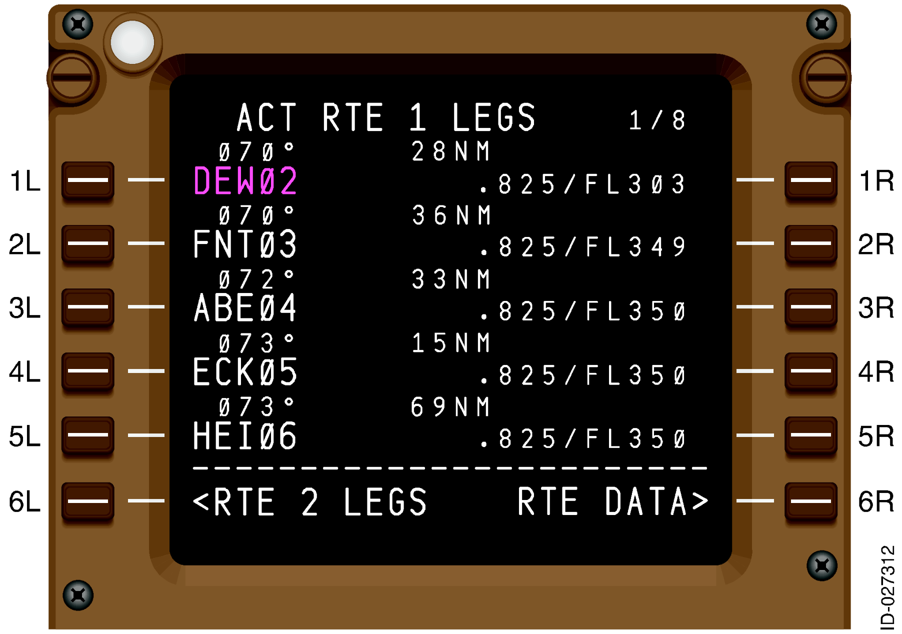
- **ABEAM PTS> (4R)** – Pushing 4R creates abeam points on the new route to indicate waypoints bypassed by the direct-to function to waypoint YOW. The abeam points are perpendicular to the bypassed waypoints.

  The header line changes to ABEAM PTS SELECTED (Figure 6–7) and the EXEC key lights.



ABEAM PTS SELECTED
Figure 6–7

STEP: Push the EXEC key to create the abeam points (Figure 6-8). After the direct-to function has been executed, the abeam points are inserted into the active route as shown in Figure 6-8.



ACT RTE 1 LEGS – Abeam Waypoints
Figure 6-8

Direct-To/Intercept Course

Direct-to flight plan entries let the pilot to fly direct to a particular fix or to intercept a course to any waypoint. The fix can be part of the active route or modified active route, or it can be offpath.

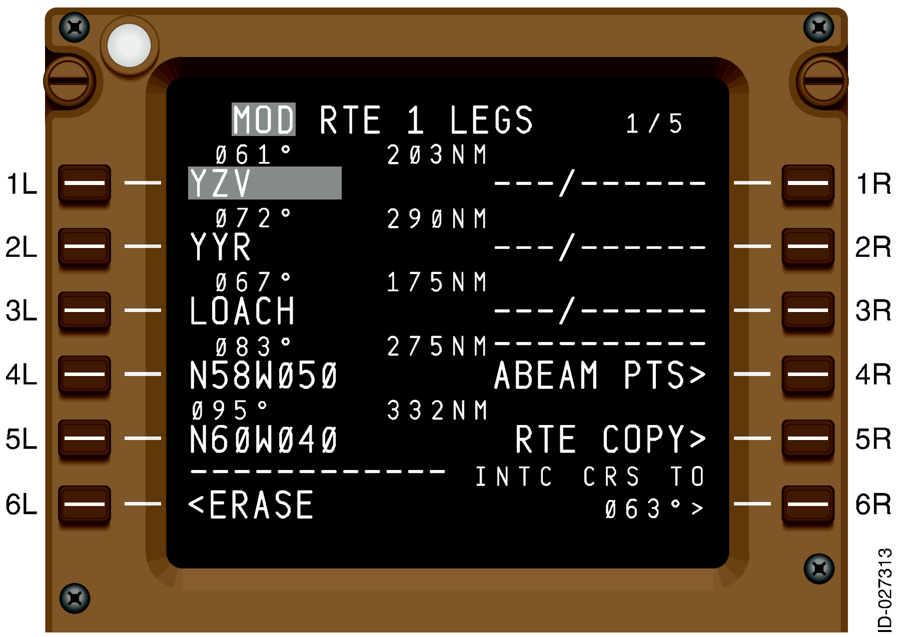
DIRECT-TO

A direct-to is done by entering the desired fix in 1L on the first ACT RTE LEGS page or MOD RTE LEGS page. The following can be entered in 1L:

- Any waypoint, airport, navaid, or NDB contained in the nav database
- Any fix defined in the active or modified active route excluding conditional legs
- A valid PBD waypoint
- An along track waypoint
- A lat/long waypoint or lat/long reporting point
- A course intersection waypoint.

Once an entry has been made in 1L, a modification is created. After verifying the modified path on the ND, the pilot can execute or erase the direct-to. To do a direct-to to SEPT-ILES (YZV) do the following:

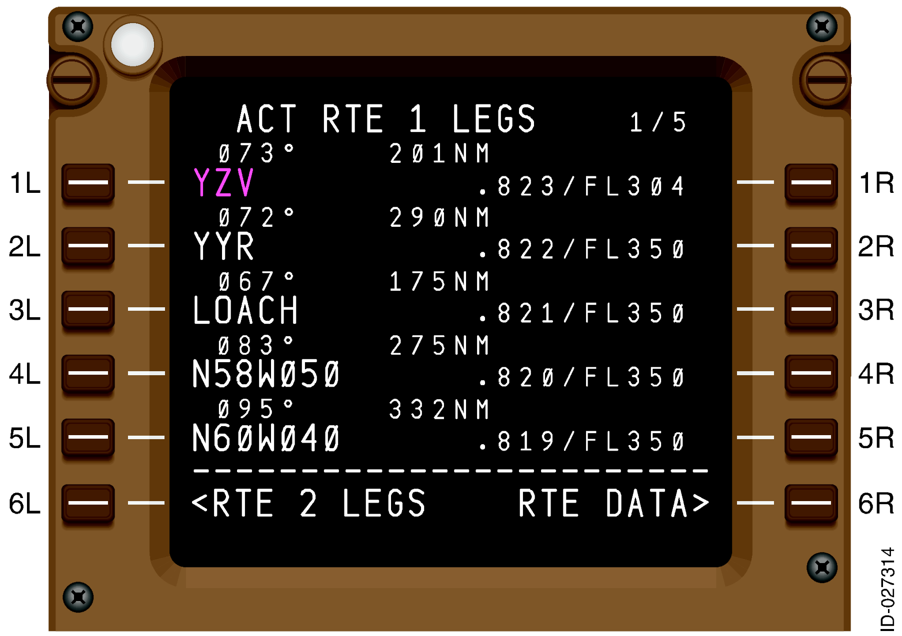
STEP: Enter YZV in the scratchpad and push 1L (Figure 6-9).



Direct-To YZV – Modification
Figure 6-9

The direct-to waypoint (YZV) with the inbound course is displayed in 1L. The ERASE prompt is displayed in 6L to erase the pending modification, if desired.

STEP: Push the EXEC to execute the modification (Figure 6–10).



Direct-To YZV – Active
Figure 6–10

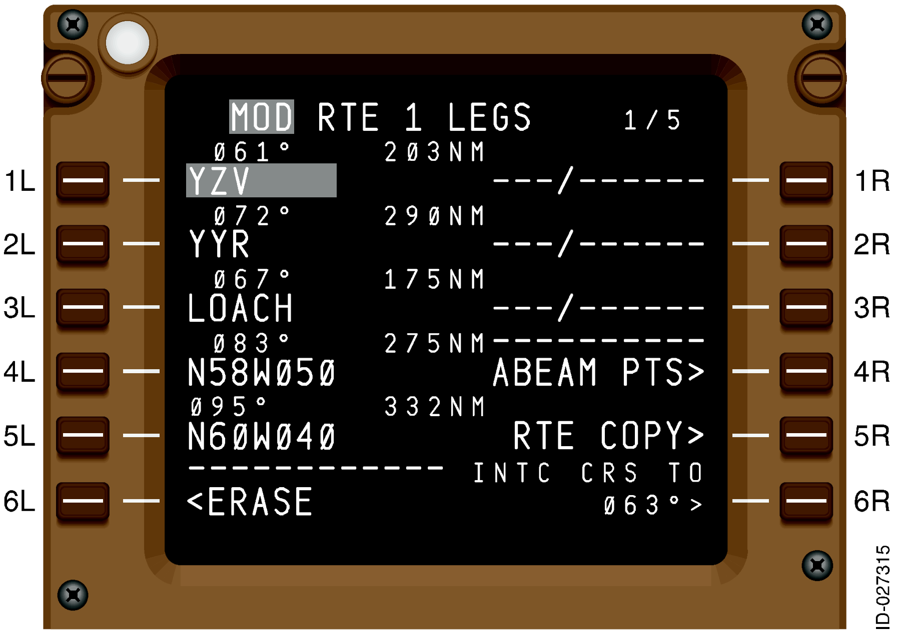
INTERCEPT COURSE TO

Creating an intercept course to a particular fix is similar to doing a direct-to. A fix is entered into 1L on the first ACT RTE LEGS page or MOD RTE LEGS page. If the fix is part of the flight plan (that is, not offpath), the current course into the fix is displayed in 6R (063° in Figure 6-11). If the fix is offpath, box prompts are displayed in 6R. If desired, an intercept course can be entered in 6R (overwriting the displayed value or into the box prompts).

When the modification is executed, the aircraft captures the intercept leg (if LNAV is engaged and the current aircraft track crosses the intercept leg). The course displayed in the header line in 1L is the course required to follow a great circle path that intercepts the fix at the selected course. If the current track does not cross the intercept leg, NOT ON INTERCEPT HEADING is displayed in the scratchpad.

For the flight from KORD to EGLL, fly direct to YZV and intercept a course of 075° from a position west of waypoint YYR (MONT-JOLI).

STEP: Enter YZV in the scratchpad and push 1L.

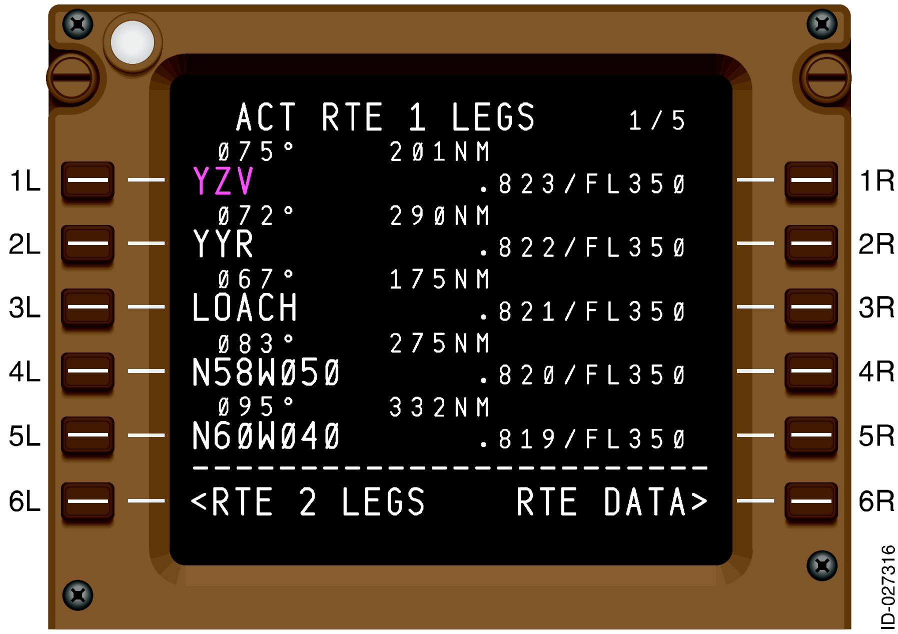


MOD RTE 1 LEGS – Intercept Course
Figure 6-11

The current course to the waypoint entered in 1L is displayed in 6R (063°). This value can be overwritten. When 6R is pushed, the ABEAM PTS prompt and the ROUTE COPY prompt are removed. To fly an intercept course of 075° to YZV, do the following:

STEPS:

1. Enter 075 in the scratchpad and push 6R.
2. Push the EXEC key to execute the modification. The screen in Figure 6-12 is displayed.



ACT RTE 1 LEGS – 075° Course
Figure 6-12

INTERCEPT COURSE FROM

An intercept course from a waypoint can also be selected. This procedure is similar to selecting an intercept course to a waypoint.

To fly an intercept course from, enter a waypoint and course (for example YZV075) into the active waypoint line. The INTC CRS FROM prompt is displayed in 6R. Another course from the reference point can be entered in 6R, if desired.

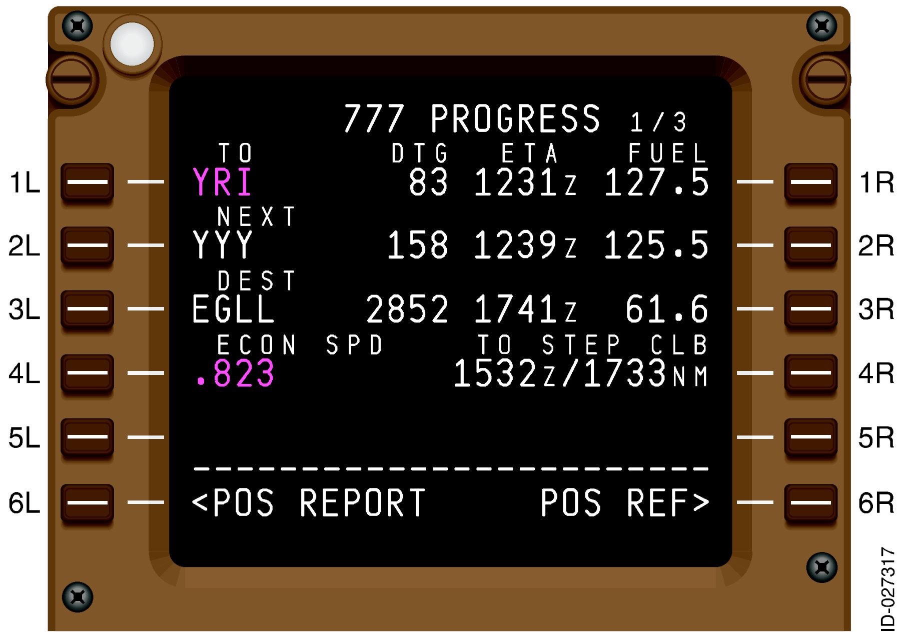
The INTC CRS FROM prompt replaces the INTC CRS TO prompt when a point of reference **and** course are entered into the active waypoint line.

PROGRESS PAGES

The PROGRESS pages displays information about the progress of the flight. There are three PROGRESS pages (PROGRESS 1/3, PROGRESS 2/3, and RTA PROGRESS 3/3).

PROGRESS Page 1/3

STEP: To display the PROGRESS page 1/3 (Figure 6-13), push the PROG key, or push the PREV PAGE key if the PROGRESS page 2/3 is displayed, or push the NEXT PAGE key if the RTA PROGRESS page 3/3 is displayed.



PROGRESS Page 1/3
Figure 6-13

The PROGRESS page 1/3 is described in the following paragraphs.

- **TO Waypoint Information (Line 1)** - The waypoint identifier, distance-to-go, estimated time of arrival, and estimated fuel remaining for the active waypoint are displayed in line 1. The distance-to-go is the direct distance from the aircraft to the termination point of the active leg. The waypoint identifier is displayed in magenta.

- **NEXT Waypoint Information (Line 2)** - The waypoint identifier, distance-to-go, estimated time of arrival, and estimated fuel remaining for the next waypoint are displayed in line 2. The distance-to-go is along the flight path from the aircraft to the termination point of the next leg.

- **DEST (3L)** – The destination identifier, distance-to-go, estimated time of arrival, and estimated fuel remaining are displayed in line 3.

  The destination information is displayed when the active route has not been modified and an alternate destination has not been entered. The information is calculated based on the en route distance from the aircraft to the destination.

  During a flight plan modification, the predicted information is for the modified route. DEST is replaced with MOD. The predictions are based on the direct distance to the active waypoint plus the en route distance to the destination.

  The alternate destination waypoint can be entered over the displayed destination. If this is done, the DEST label is replaced by DIR TO ALTERNATE. The predicted information is then based on flying direct to the alternate using the current speed and cruise altitude. Deleting the alternate or exiting the page returns 3L to the original destination.

  A flight plan waypoint can be entered over the displayed destination. If this is done, the DEST label is replaced by ENROUTE WPT and predicted information shown is based on the current route. If the en route waypoint exists more than once in the route, predictions are for the first occurrence in the route. Sequencing an en route waypoint that is displayed in 3L returns 3L to the original destination or to the last leg identifier.

- **Speed Line (4L)** – The active FMS command speed is displayed in **magenta** in 5L and the speed mode is displayed in the header line in **white**.

  The active speed mode is the same as displayed on the performance page, unless changed by the MCP or a limit. The speed modes are:

  — LRC SPD – Long-range speed

  — ECON SPD – Economy speed

  — SEL SPD – Manually entered speed

  — LIM SPD – Speed is limited by V_{MO}, M_{MO}, flap limit, or buffet limit

  — MCP SPD – Speed intervention entered on the MCP IAS/MACH indicator

  — EO SPD – Engine out operations

  — CO SPD – Engine out operations at the airline specified engine out company speed

  — VREF+80 – Engine out detected during takeoff.

- **<POS REPORT (6L)** – Pushing 6L displays the POS REPORT page.

- **TO (4R)** – The ETA and DTG to different points as the flight progresses are displayed in 4R. These points include:

  — T/C (Top-of-climb) – CLIMB phase is active

  — STEP CLB (Step climb) – When remaining distance permits it

  — T/D (Top-of-descent) – CRUISE phase is active and the aircraft is within 200 NM of the top–of–descent.

  — E/D (End-of-descent) – DESCENT phase is active

  — LEVEL AT – The active guidance/performance mode is drift down (D/D).

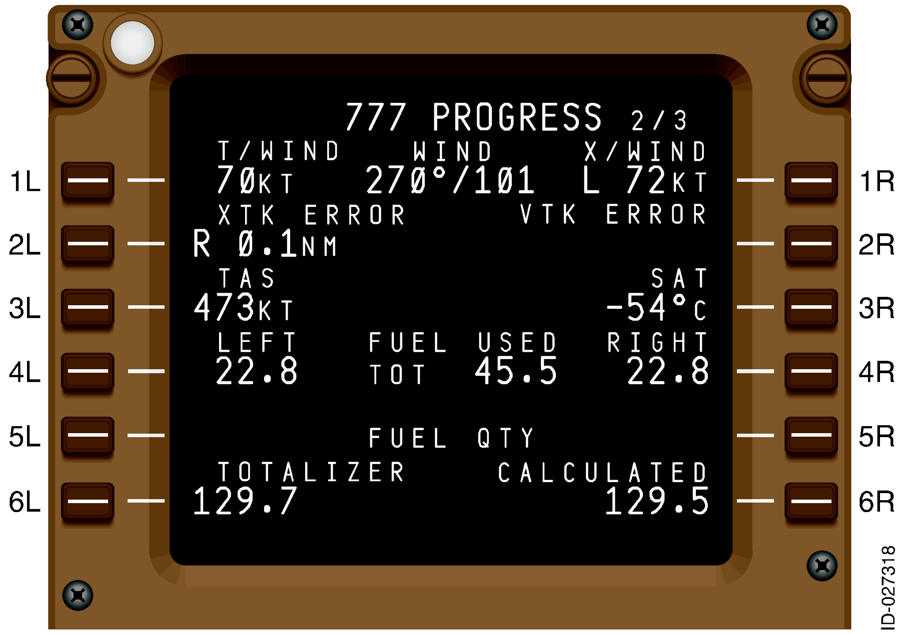
  The information in 4R always applies to the active route. If the header line is TO STEP CLB or TO T/D and the aircraft is past that profile point, NOW is displayed. If the header line is TO STEP CLB and a step to the specified altitude on the cruise page is not advised, NONE is displayed.

- **<POS REF (6R)** – Pushing 6R displays the POS REF page.

PROGRESS Page 2/3

The PROGRESS page 2/3 displays wind information, tracking errors, airspeed, temperature, and fuel information, and lets the pilot select the fuel information source when there is a discrepancy.

STEP: To display the PROGRESS page 2/3, shown in Figure 6–14, push the NEXT PAGE key when the PROGRESS page 1/3 is displayed or push the PREV PAGE key when the RTA PROGRESS page 3/3 is displayed.



PROGRESS Page 2/3
Figure 6–14

The PROGRESS page 2/3 is described in the following paragraphs.

- **Wind Information (Line 1)** – The wind information is displayed in line 1. The headwind/tailwind component is displayed in 1L with H/WIND or T/WIND in the header line. The actual wind information is displayed in 1C. Current wind bearing is in degrees TRUE and speed is in knots. The crosswind component is displayed in 1R with L for left and R for right in the header line.

  NOTE: The above winds are referenced to aircraft heading.

- **XTK ERROR (2L)** – The crosstrack error is displayed in 2L in nautical miles. This is the distance the aircraft is left or right of the active route.

- **VTK ERROR (2R)** – The vertical track error is displayed in 2R when the aircraft is in the DESCENT flight phase. A plus sign (+) means the aircraft is above path and a minus sign (–) means the aircraft is below the vertical path. This field is blank when DESCENT flight phase is not active.

- **TAS (3L)** – The current true air speed is displayed in 3L.

- **SAT (3R)** – The outside static air temperature is displayed in 3R. If the SAT in invalid, then this field is blank.

- **FUEL USED (Line 4)** – The total fuel used by the two engines is displayed in 4C. The fuel used by the left and right engine is displayed in 4L and 4R, respectively.

  If a fuel flow sensor becomes invalid, the FUEL USED for the affected engine, as well as, the FUEL USED TOT are blank. The FUEL USED for the unaffected engine continues to display current data.

- **<USE and USE> (Line 5)** (Not shown in Figure 6–14) – The USE prompts are not displayed unless a 9,000 pound or more discrepancy exists for five continuous minutes between the totalizer and calculated fuel quantity values. This totalizer value is from the fuel quantity indicating system (FQIS) and the calculated value is from the FMS.

  FUEL DISAGREE-PROG 2/3 is displayed in the scratchpad, prompting the pilot to display the PROGRESS page 2/3.

  The pilot can push 5L or 5R to select either the totalizer fuel quantity or the FMS–calculated fuel quantity. If no selection is made, the FMS continues to base performance calculations and predictions on the FMS–calculated fuel quantity.

  Pushing 5L blanks the CALCULATED and FUEL USED fields and the PERF INIT page fuel quantity is relabeled SENSED.

  Pushing 5R blanks the TOTALIZER field and the FMS uses the calculated fuel quantity.

  NOTE: A manual fuel weight entry on the PERF INIT page when the USE prompts are displayed removes both prompts.

- **TOTALIZER (6L)** – The totalizer fuel quantity is displayed in 6L. This is the total fuel quantity calculated by the FQIS. The totalizer fuel quantity is not displayed if the FQIS is inoperative or fails in flight, or a manual fuel entry is made on the PERF INIT page or the USE calculated fuel prompt in 5R is selected.

- **CALCULATED (6R)** – Before engine start, 6R displays fuel quantity calculated by the totalizer. After engine start, it displays fuel quantity calculated by decreasing fuel on board at engine start at the EICAS fuel flow rate.

  Calculated fuel quantity is not displayed if the fuel flow sensors are inoperative or fail in flight, or when the USE totalizer fuel prompt in 5L is selected.

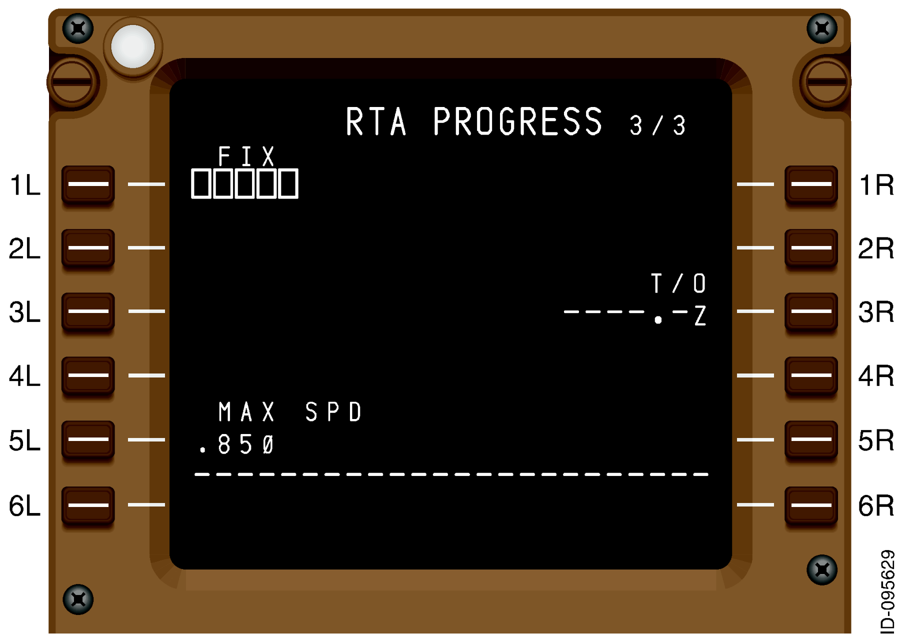
  NOTE: The calculated value is set equal to the totalizer value following any fuel jettisoning.

RTA PROGRESS Page 3/3

The RTA PROGRESS page 3/3 lets the pilot enter a waypoint with a required time of arrival (RTA). If this entry is made before takeoff, the FMS calculates the recommended takeoff time. If this entry is made after takeoff, the FMS calculates the speed required to reach the entered waypoint at the required time.

To display the RTA PROGRESS page 3/3, push the NEXT PAGE key when the PROGRESS page 2/3 is displayed or push the PREV PAGE key when the PROGRESS page 1/3 is displayed. The RTA PROGRESS page 3/3 is also accessed by selecting the RTA PROGRESS prompt in 6L on the ACT RTA CRZ page. The RTA PROGRESS page 3/3 when it is first accessed is shown in Figure 6–15.

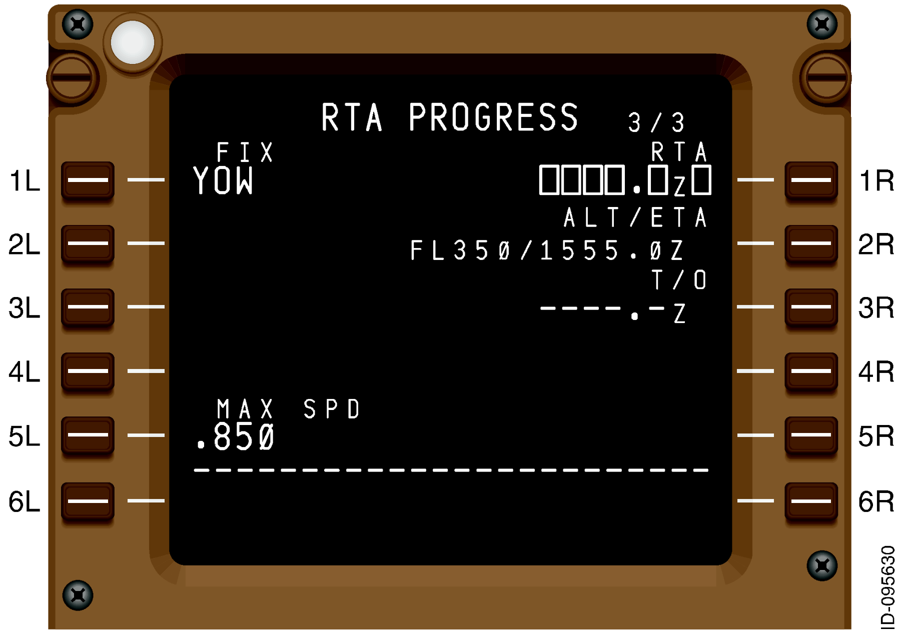
NOTE: If this page is accessed when airborne, line 3R is blank.



RTA PROGRESS Page 3/3 – (1)
Figure 6–15

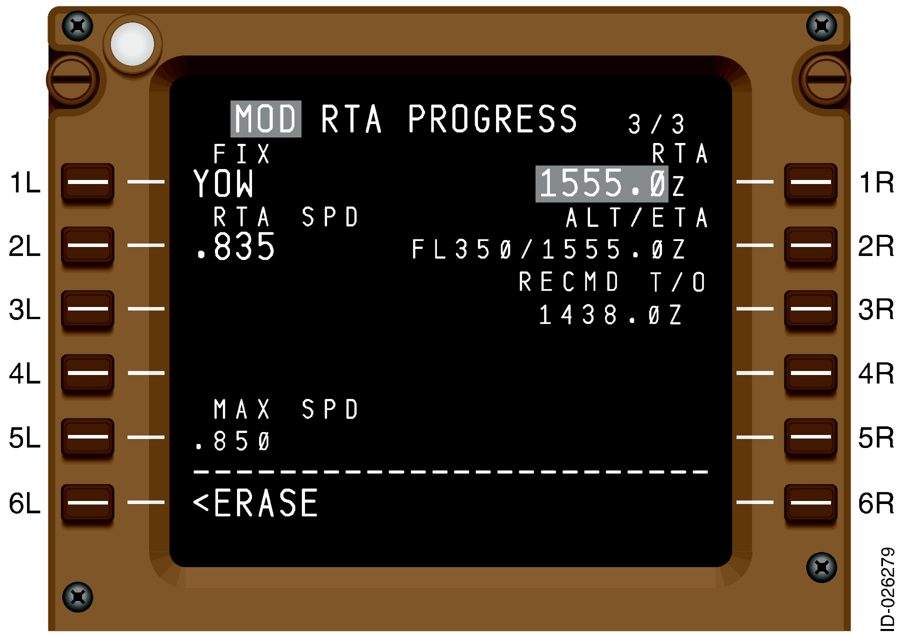
The RTA PROGRESS page 3/3 is described in the following paragraphs.

- **FIX (1L)** – Any waypoint in the active flight plan can be entered in 1L. After a waypoint is entered, the page title RTA PROGRESS remains as shown in Figure 6–16.



RTA PROGRESS Page 3/3 – (2)
Figure 6–16

- **RTA (1R)** – The pilot can enter an RTA in this field for the FMS to calculate a new speed schedule to meet the RTA constraint, as shown in Figure 6–17. If the FMS calculates the entered waypoint cannot be reached at the entered RTA, UNABLE RTA is displayed in the scratchpad.



RTA PROGRESS Page With Pilot Entered RTA
Figure 6-17

- **RTA SPD (2L)** – After a fix is entered in 1L, the predicted speed to arrive at that waypoint at the time displayed in 1R is displayed in 2L. If the pilot enters an RTA constraint in 1R, this field displays the calculated speed required to reach the waypoint at the entered RTA. This data cannot be changed by the pilot.

- **ALT/ETA (2R)** – The predicted altitude and ETA for the waypoint entered in 1L are displayed in 2R. This data can only be changed if the pilot changes the RTA time in 1R.

- **RECMD T/O (4R)** – The takeoff time field is displayed in 4R while the aircraft is on the ground. After an RTA time has been entered (before takeoff), this field displays the takeoff time that is required in order to meet the RTA constraint.

- **MAX SPD (5L)** – The max speed is displayed in 5L. The FMS uses this speed in calculating whether or not it can make the RTA constraint.

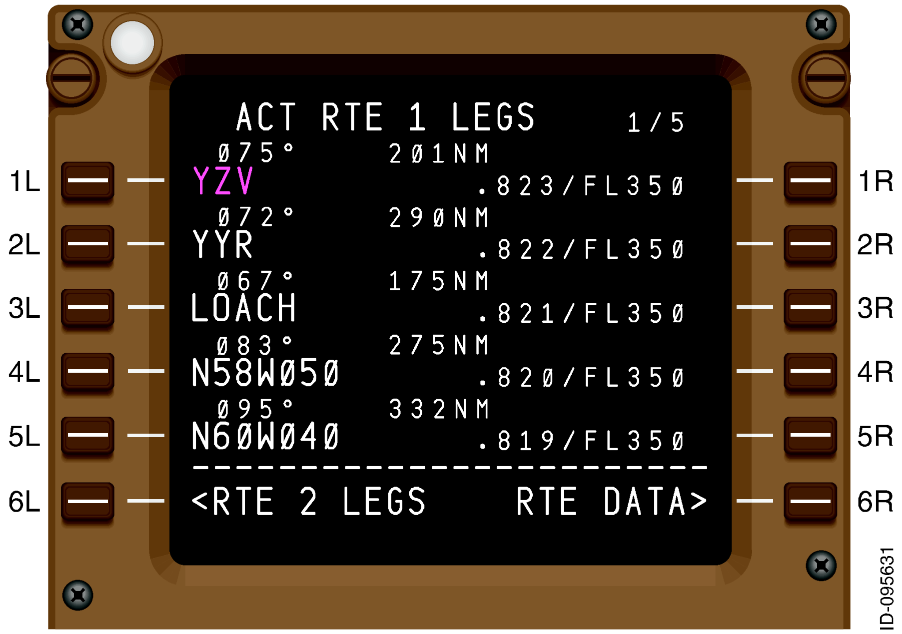
- **<ERASE (6L)** – Pushing 6L erases the pending RTA constraint.

Once an RTA modification has been executed, the RTA PROGRESS page 3/3 title changes to ACT RTA PROGRESS. The CRZ page title for the affected legs changes to RTA CRZ and an ECON prompt is displayed in 5L to change the performance mode from RTA to ECON.

CRUISE SPEED SEGMENT

The cruise speed segment function lets the pilot enter a target speed that is to be flown for a defined portion of the flight plan in the CRUISE phase. There can be multiple cruise speed segments, either adjacent to each other or scattered throughout the CRUISE phase. Each cruise speed segment requires a starting and ending waypoint.

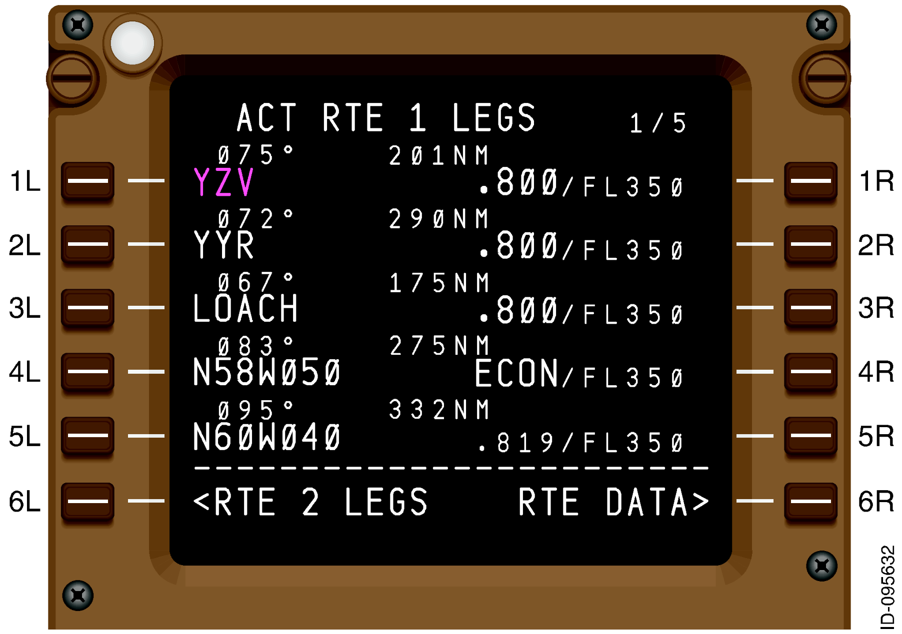
For the sample flight from KORD to EGLL, the pilot wants to fly a constant speed (.800M) from YZV to N58W050 (see Figure 6-18). The desired cruise speed is entered in the right side of the ACT RTE 1 LEGS page at the starting waypoint. The target speed for the leg after the cruise speed segment is entered at the last waypoint of the cruise speed segment.



Cruise Speed Segment - (1)
Figure 6-18

STEPS:

1. Enter .800 in the scratchpad and push 1R. This creates a MOD RTE 1 LEGS page.
2. Enter ECON in the scratchpad and push 4R. The resulting display is shown in Figure 6–19.



Cruise Speed Segment – (2)
Figure 6–19

The cruise speed segment is also displayed on the RTA PROGRESS page in line 3.

ALTITUDE STEP POINTS

The FMS calculates advisory step points for both planned and FMS-calculated step climbs. A step climb is executed by dialing the step altitude on the MCP altitude window and pushing the altitude knob. The FMS then enters a cruise climb (CRZ CLB) to the step altitude.

All performance predictions are based on the pilot executing all planned and/or optimum step altitudes. If a step point is crossed and the step is not initiated, the performance predictions assumes the pilot has initiated the step climb.

NOTES:

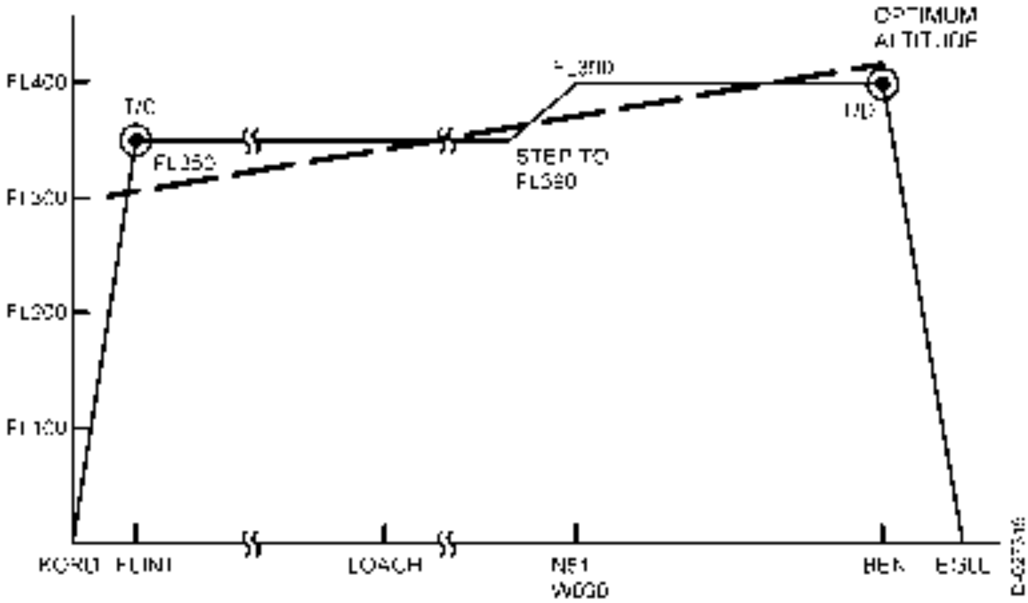
1. No steps can be executed without pilot action.
2. If the planned or optimum steps are not made, zero should be entered into 4L (STEP SIZE) on the ACT CRZ page for accurate predictions (fuel remaining, top-of-descent, and ETAs).

For more details on wind adjusted best step climb point calculations, see Section 12, Using Winds in the FMS Flight Plan.

Optimum Steps

The FMS calculates altitude step points based on the entered step size. This results in minimum trip cost for the economy cruise mode or minimum trip fuel consumption for the LRC and selected speed cruise modes. The STEP TO altitude is the next ICAO standard altitude or step interval but cannot exceed the maximum altitude at the step point. Figure 6-20 shows an optimum step cruise profile for the flight scenario from KORD to EGLL.

The calculated step point (displayed as S/C on the ND) is the position along the route where the cruise climb should be initiated. No steps are predicted within 200 NM of the top-of-descent.



Optimum Step Cruise Profile
Figure 6-20

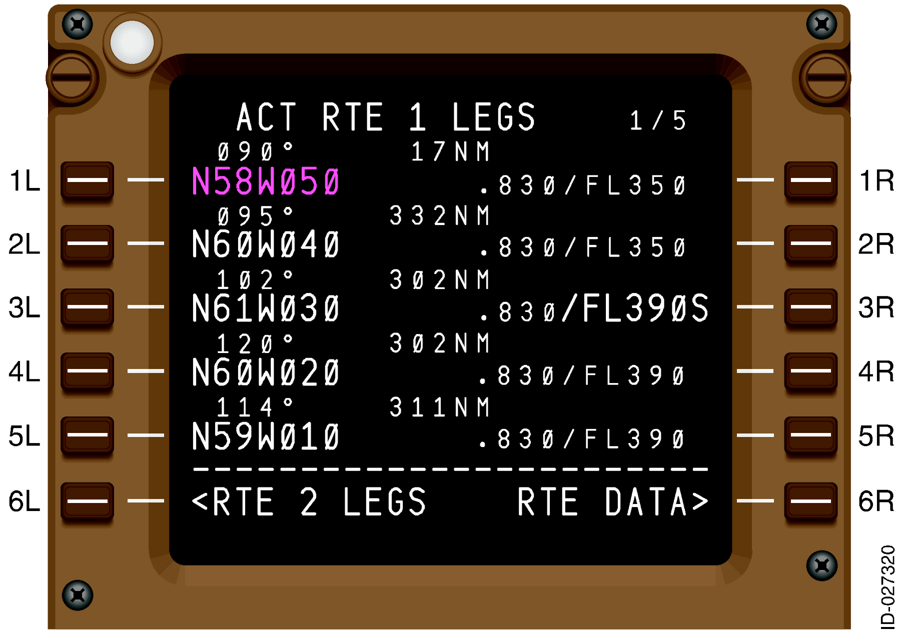
Planned Steps

Planned steps let the pilot specify step altitudes at flight plan waypoints. The FMS uses the pilot-entered step points in performance calculations, and displays the planned step on the ND. Planned steps, like optimum steps, are advisory and must be initiated by the pilot using the MCP altitude window and knob to depart the current cruise altitude.

A planned step point is made on the RTE LEGS page by entering the step altitude followed by S in right side of the CDU at the desired step point. The flight from KORD to EGLL requires a step climb to FL390 at N61W030.

STEPS:

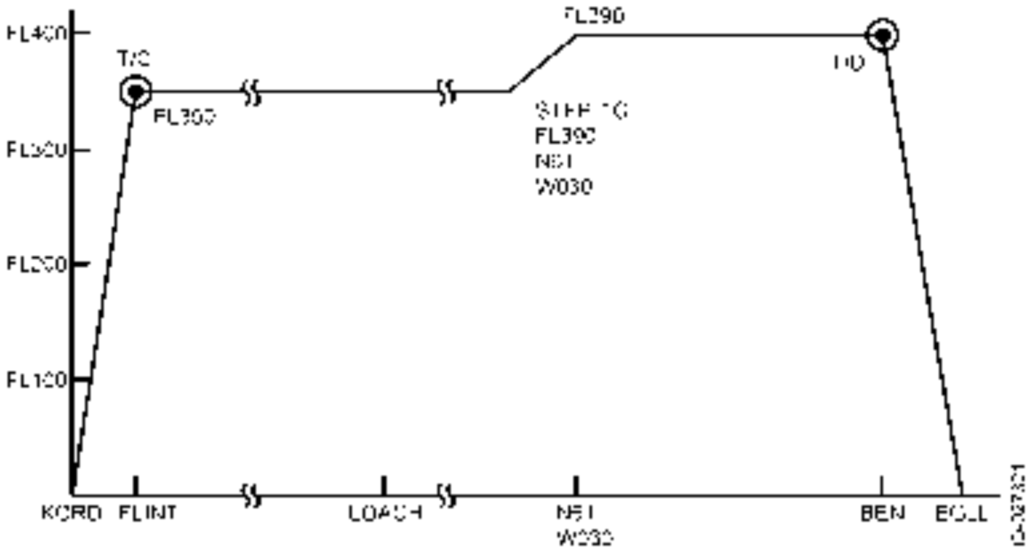
1. Enter /390S in the scratchpad and push 3R.
2. Push the EXEC key to execute the modification (Figure 6-21).



Step Climb Entry
Figure 6-21

The FMS follows planned steps from the first step to the last pilot-defined step followed by calculated optimal steps. If the last step is a step down, that step is maintained until the descent profile is intersected.

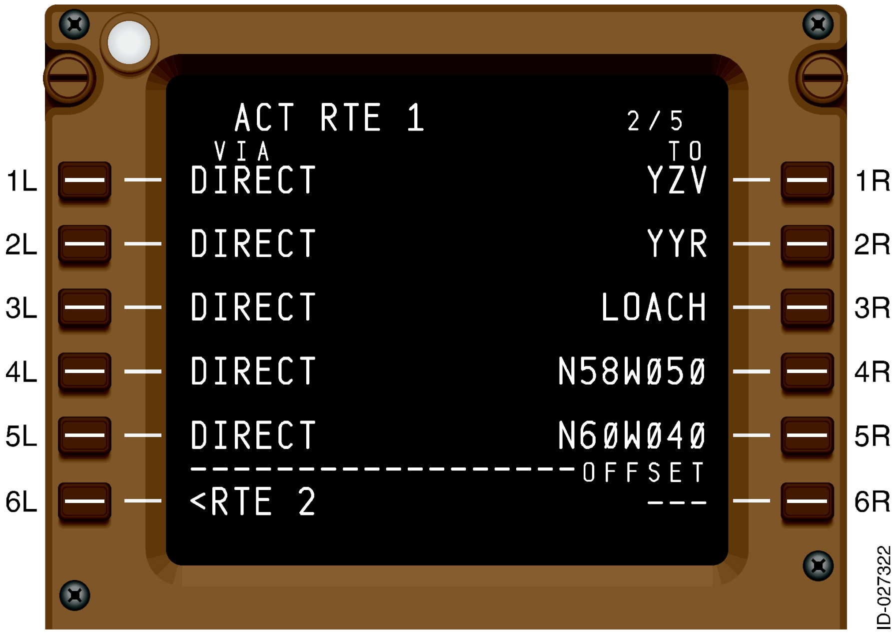
For the flight from KORD to EGLL, the FMS calculates a step climb from FL350 to FL390 at N61W030. Figure 6-22 shows the planned step cruise profile for the flight scenario.



Planned Step Cruise Profile
Figure 6-22

LATERAL OFFSET ROUTE

The pilot can establish a parallel lateral path offset to the left or right of the original flight path. A lateral offset can only be done on the active leg. Valid offsets are distances of 1 to 99 NM. The offset distance is entered at the OFFSET prompt in 6R on the ACT RTE page (Figure 6-23) with the aircraft airborne.



ACT RTE 1 – OFFSET
Figure 6-23

The pilot can initiate, change, or cancel the offset at any time. When an offset is executed and becomes the active path, the LNAV mode turns the aircraft to leave the original path and capture the offset route.

An offset can only be entered with the aircraft airborne and not active in the selected SID procedure or SID transition. The offset entry propagates through the remaining flight plan up any of the following:

- The end-of-route waypoint
- A discontinuity
- The start of a published STAR transition or STAR or approach transition or approach procedure
- A DME arc
- A heading leg
- A holding pattern
- A course change of 135° or greater.

The offset is displayed as a **white** dashed line on the ND until the offset modification is executed or erased. After it is executed, the offset route is displayed as a dashed **magenta** line on the ND. The original route is displayed as a solid **magenta** line.

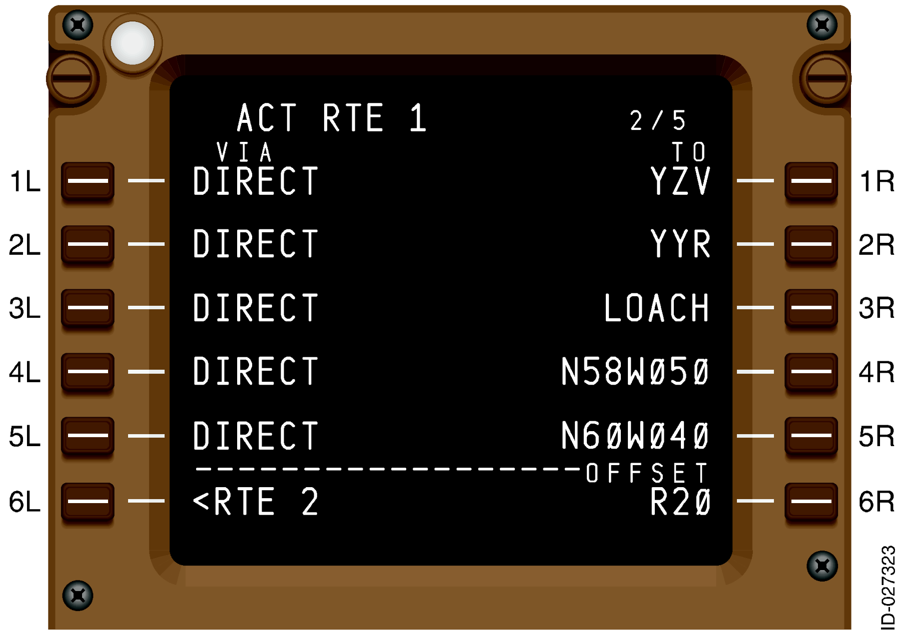
At 2 minutes before passing the last leg of the offset path, END OF OFFSET is displayed in the scratchpad.

A valid entry is L (left) or R (right) for the direction or the offset followed by the distance of the offset in NM. For the flight from KORD to EGLL, an offset of 20 NM to the right of the original path is entered as follows.

STEPS:

1. Enter R20 in the scratchpad and push 6R, as shown in Figure 6-24.

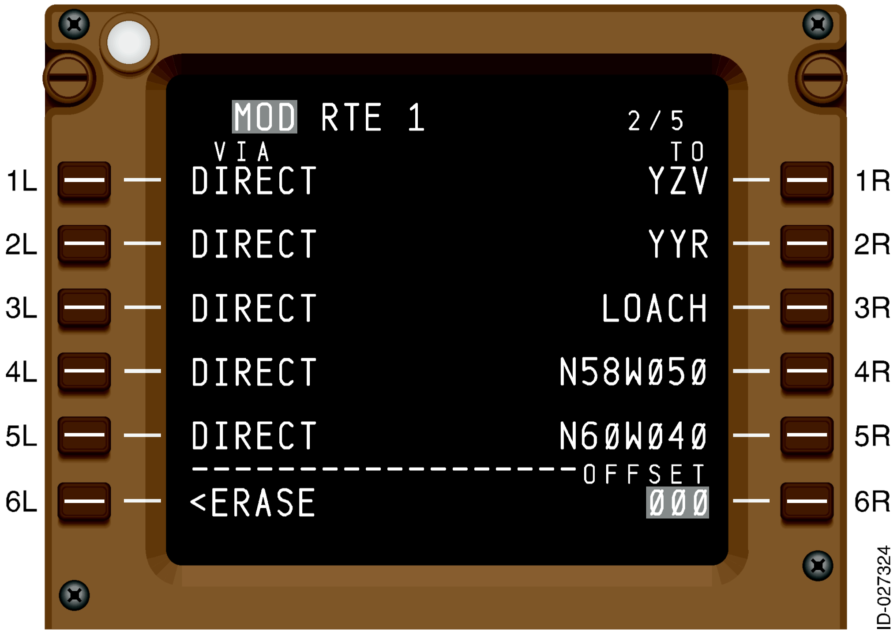
2. Push the EXEC key. Verify the OFST annunciator lights.



OFFSET – R 20
Figure 6-24

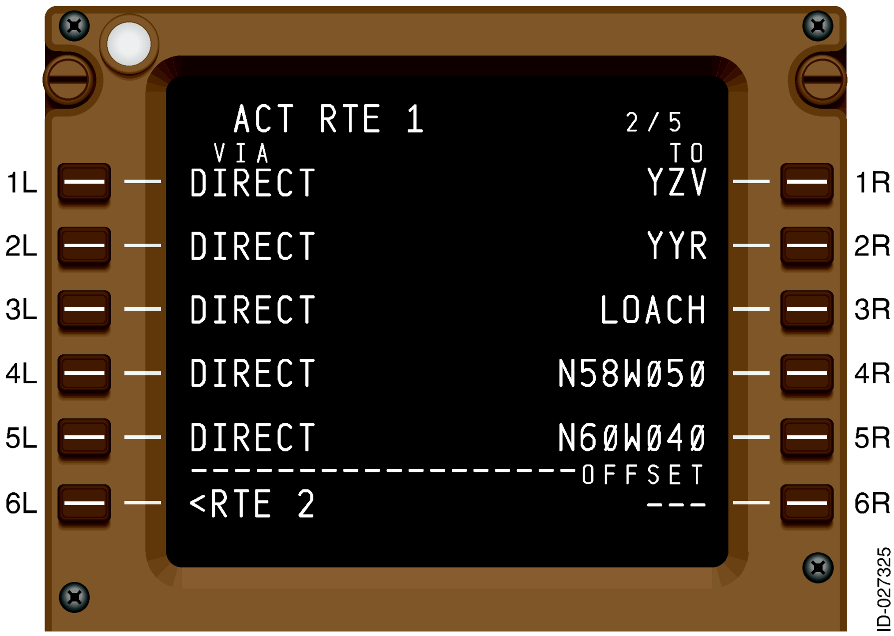
An active offset is canceled by pushing the DEL key, and then 6R, and the EXEC key. Entering L0, 0, or R0 in 6R, or using the direct-to/intercept function also cancels the offset.

STEP: To cancel the offset in the sample flight plan, enter 000 in the scratch pad, as shown in Figure 6-25, and push 6R.



OFFSET – MOD
Figure 6-25

STEP: Push the EXEC to execute the modification, shown in Figure 6-26.



ACT RTE 1 – OFFSET Removed
Figure 6-26

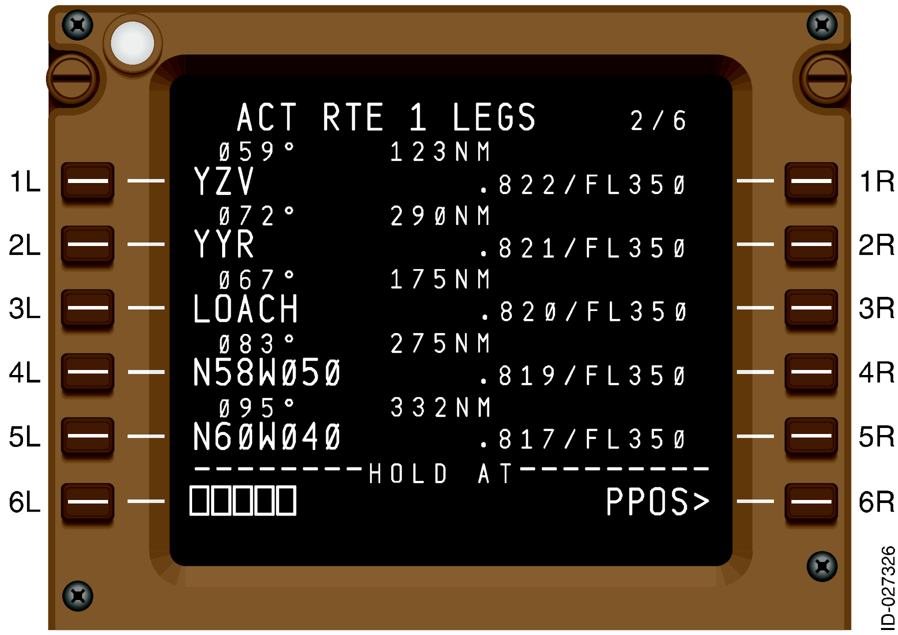
HOLDING PATTERNS

This section describes creating and modifying holding patterns and holding pattern guidance. Holding patterns and types of holding patterns are discribed in detail in Section 10, Advanced Flight Planning.

RTE 1 LEGS Page – HOLD AT Function

The HOLD AT function on the RTE LEGS page (Figure 6-27) lets the pilot initiate a holding pattern at a fix on path, at the current aircraft position, or any other geographical point.

This page is displayed by pushing the HOLD key (if the displayed route does not contain a holding pattern) or by selecting the NEXT HOLD prompt on the RTE HOLD page.



ACT RTE 1 LEGS Page – HOLD AT
Figure 6-27

The fields associated with the hold function are described in the following paragraphs.

- **HOLD AT (6L)** – The waypoint that is to be used as the holding fix is entered in 6L. Any of the waypoints displayed on the ACT RTE LEGS page can be copied to the scratchpad and then selected to 6L. The HOLD AT leg is created after the leg to that waypoint. All intervening legs remain in the route and the page title changes to MOD RTE HOLD.

Pushing the EXEC key executes the hold and the aircraft enters the holding pattern at the holding fix. The page title changes to ACT RTE 1 HOLD.

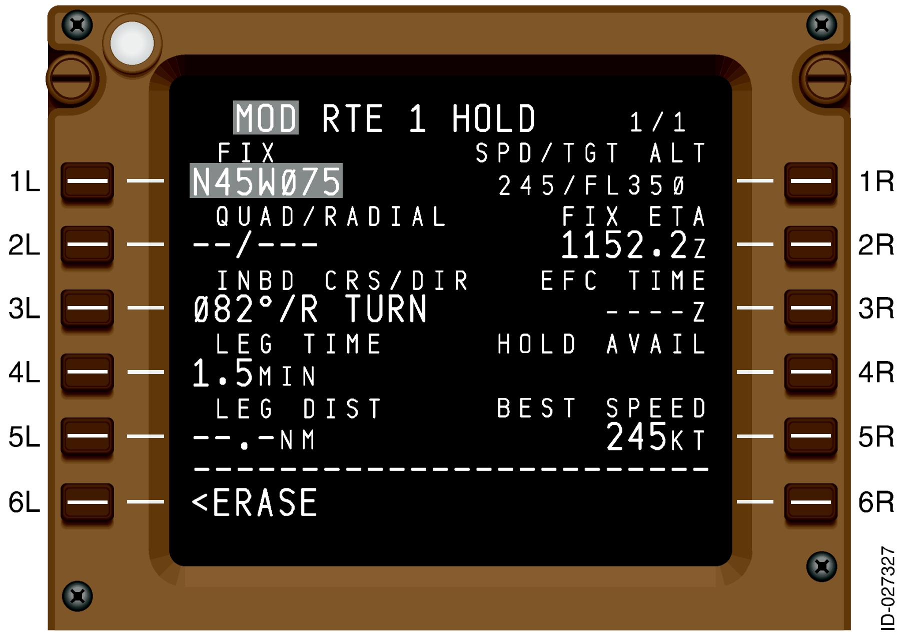
NOTE: The aircraft does not enter a pre-planned holding pattern if it is on an offset path.

- **PPOS (6R)** – Pushing 6R creates a holding pattern at aircraft present position when the EXEC key is pushed. A PPOS hold can be done when flying on an offset path.

NOTE: Selecting the PPOS while on an offset path deletes the offset path.

RTE 1 HOLD Page

The RTE HOLD page (Figure 6–28) is used to review and change the data associated with the holding pattern contained in the route and to exit the active holding pattern. Modifications made to a holding pattern while active in the hold only become effective on the next crossing of the holding fix.



MOD RTE 1 HOLD Page
Figure 6–28

The RTE HOLD page is described in the following paragraphs.

- **FIX (1L)** – The holding fix is displayed in 1L. The holding fix cannot be changed or deleted on the RTE HOLD page but can be deleted on the RTE LEGS page.

- **QUAD/RADIAL (2L)** – The quadrant and radial are displayed in 2L. This field defaults to dashes and a holding quadrant/radial can be entered. A valid entry is three-digit radials, optionally preceded by a slash (/), or a quadrant followed by a three-digit radial, optionally separated by a slash (/). The FMS corrects the quadrant entry display if the entered radial does not fall within the limits defined below. Deletions are not permitted for this field.

  Table 6–1 shows the quadrant boundaries.

Quadrant	Boundary Radials
N	From 337.5° to 22.5°
NE	From 22.5° to 67.5°
E	From 67.5° to 112.5°
SE	From 112.5° to 157.5°
S	From 157.5° to 202.5°
SW	From 202.5° to 247.5°
W	From 247.5° to 292.5°
NW	From 29.5° to 337.5°

Quadrant Boundaries
Table 6–1

NOTE: An entry in the QUAD/RADIAL dashes prompts changes the inbound course value in 3L.

- **INBD CRS/DIR (3L)** – The inbound course and turn direction are displayed in 3L. Valid entries for the course are three–digit bearings optionally followed by L for left turn and R for right turn. L and R can also be entered without the inbound course to change the turn direction.

  The holding turn direction is displayed as either L TURN or R TURN. An entry in 3R overrides any entry that was made in 2L (QUAD/RADIAL).

NOTE: The default value in 3L is the inbound course to the holding fix on the preceding leg with right turns.

- **LEG TIME (4L)** – The length of the inbound leg of the pattern is specified in terms of elapsed time. It displays 1.0 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet. This time can be changed by the pilot. Leg time overrides LEG DIST.

If a LEG DIST is entered in 5L (manually or from a nav database stored procedure), the LEG TIME data is blank and dashes are displayed.

- **LEG DIST (5L)** – This field normally displays dashes, unless an entry is made or a value is inserted from the nav database stored procedure. If leg distance is entered, dashes are displayed in the LEG TIME field (4L).

- **<ERASE (6L)** – The ERASE prompt is displayed only on the MOD RTE HOLD page. Pushing 6L when this prompt is displayed deletes any vertical and/or lateral modifications that are pending, and returns the display to the RTE LEGS page (if the holding fix is deleted as a consequence).

- **SPD/TGT ALT (1R)** – The speed/target altitude in 1R displays the fix target speed/altitude constraint from the RTE LEGS page. Dashes are displayed if no holding target altitude has been specified and the predicted altitude at the fix is undefined or not equal to the cruise altitude.

  Predicted speeds or altitudes are displayed in small font. Large font indicates constraints that are pilot-entered or specified in the nav database. An airspeed and/or altitude entry is propagated to the HOLD AT waypoint on the RTE LEGS page.

  During cruise, entering a target altitude lower than cruise altitude displays the DESCENT page and results in descent at the top-of-descent point. The DESCENT page remains displayed and active unless a new cruise altitude is entered.

  Valid entry in 1R is three digits and a slash (/) for SPD and three to five digits for TGT ALT. Speed entries require an altitude constraint and the altitude entry must be below cruise altitude.

  If a descent profile exists beyond a holding pattern, and the holding pattern does not have a target altitude specified, the hold is in level flight and the descent only resumes after exiting the hold.

- **FIX ETA (2R)** – The time that the FMS predicts the holding fix will be crossed is displayed in 2R. No changes can be made to this field.

- **EFC TIME (3R)** – The time that further clearance can be expected is entered in 3R. No changes are allowed to this field. When an EFC time is entered, performance predictions downpath of the holding pattern assume the aircraft exits the holding pattern at the EFC time. If no EFC time is entered, performance predictions are based on an immediate exit from the holding pattern.

- **HOLD AVAIL (4R)** – The predicted holding time available before the aircraft must exit the hold to reach the destination with the required fuel reserves is displayed in 4R. This is the value from the PERF INIT page. If reserves are not entered, 4,000 lbs is assumed.

- **BEST SPEED (5R)** – The best speed for the holding pattern for the current altitude and conditions is displayed in 5R. The best speed represents the maximum endurance speed to provide the maximum time aloft.

  NOTE: This speed may exceed ICAO limit speed.

ACT RTE 1 HOLD

When the hold is executed (EXEC key pushed with the MOD RTE 1 HOLD page displayed), the page title changes to ACT RTE 1 HOLD (Figure 6-29). The aircraft present position when the EXEC key was pushed becomes the hold fix (N45W075 in Figure 6-29).

ACT RTE 1 HOLD
Figure 6-29

The ACT RTE HOLD page is similar to the MOD RTE HOLD page, described earlier in this section. The fields that are different from the MOD RTE HOLD page are described in the following paragraphs.

- **<NEXT HOLD (6L)** – The NEXT HOLD prompt is displayed in 6L if the route is **not modified**, that is if the EXEC light is not lit. Selecting the NEXT HOLD prompt displays another ACT RTE 1 LEGS – HOLD AT page.

- **EXIT HOLD> (6R)** – The EXIT HOLD prompt is displayed in 6R if the leg is the active leg of an active flight plan and the exit function of the holding pattern is not armed.

  When the EXIT HOLD prompt is selected, the prompt in 6R changes to EXIT ARMED. This lights the EXEC light and pushing the EXEC key routes the aircraft to the holding fix by way of the inbound course and continued flight along the active route. Lateral guidance continues to fliy the hold and exits the hold when sequencing the waypoint. The pattern is shortened if EXIT is ARMED while flying turn number 1, or the first turn after crossing the holding fix.

  EXIT ARMED is displayed in 6R if any of the following holding exit criteria is met.

  — When the holding pattern is terminated after a specific altitude is reached (these patterns are only applicable in the CLIMB phase of flight).

  — When the holding pattern is terminated after crossing the fix the first time.

  — When the holding pattern is terminated after the pilot selects the EXIT HOLD prompt and pushes the EXEC key.

STEP: To arm the exit function for the present position hold in the flight from KORD to EGLL, push 6R (EXIT HOLD) and then push the EXEC key. See Figure 6-30.

ACT RTE 1 HOLD – EXIT ARMED
Figure 6-30

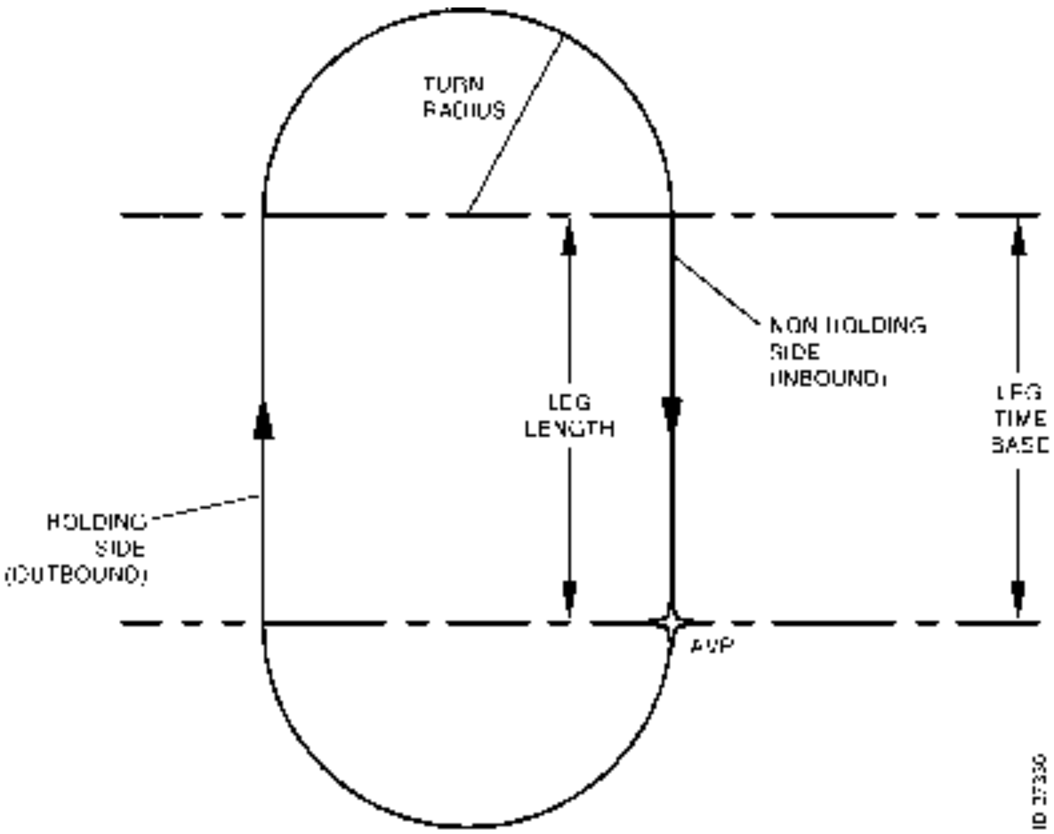
CAUTION

IT IS THE PILOT'S RESPONSIBILITY TO ENSURE THE HOLDING PATTERN CONFORMS TO ATC REQUIREMENTS. THE FMS DOES NOT AUTOMATICALLY GENERATE HOLDING PATTERNS AS PUBLISHED ON THE ASSOCIATED NAVIGATION CHART, UNLESS THE HOLDING PATTERN IS PART OF A MISSED APPROACH PROCEDURE.

Holding Pattern Guidance

The geometry of the holding pattern shown in Figure 6-31 is calculated each time the aircraft passes over the holding fix and the new pattern is displayed on the ND. The holding pattern turn radius is limited to not exceed FAA or ICAO protected airspace and is calculated based on the true airspeed equivalent of the VNAV speed target for the hold plus the wind magnitude and a bank angle of 25°. A bank angle limit of 30° is used for all holding patterns and holding pattern entries.

The leg length is calculated using the wind component parallel to the inbound course and the true airspeed equivalent of the FMS commanded speed.

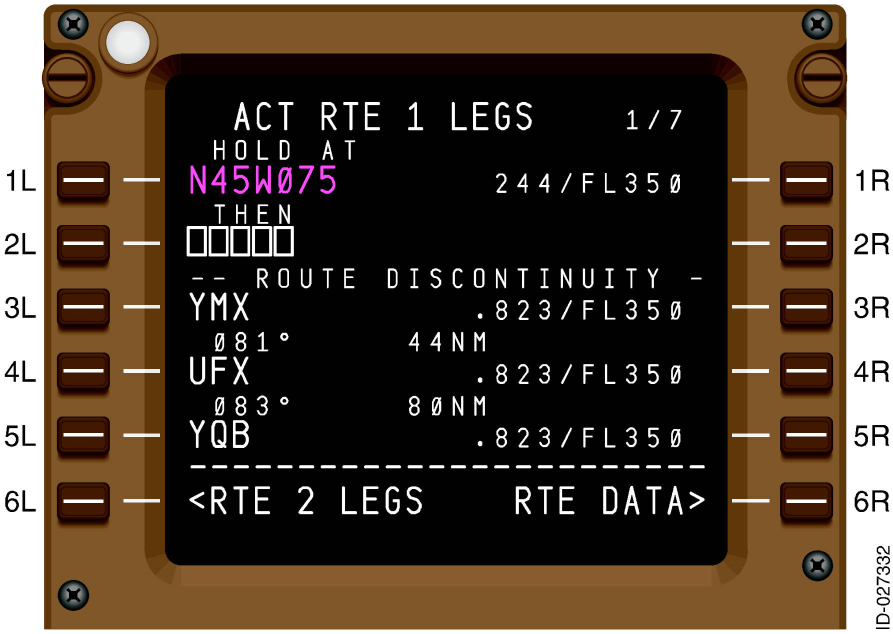


Holding Pattern Geometry
Figure 6-31

Route Discontinuity – Holding Pattern

The present position hold that was created in flight from KORD to EGLL at waypoint N45W075 created a ROUTE DISCONTINUITY on the ACT RTE 1 LEGS page, shown in Figure 6-32.

Before exiting the holding pattern the ROUTE DISCONTINUITY should be removed.

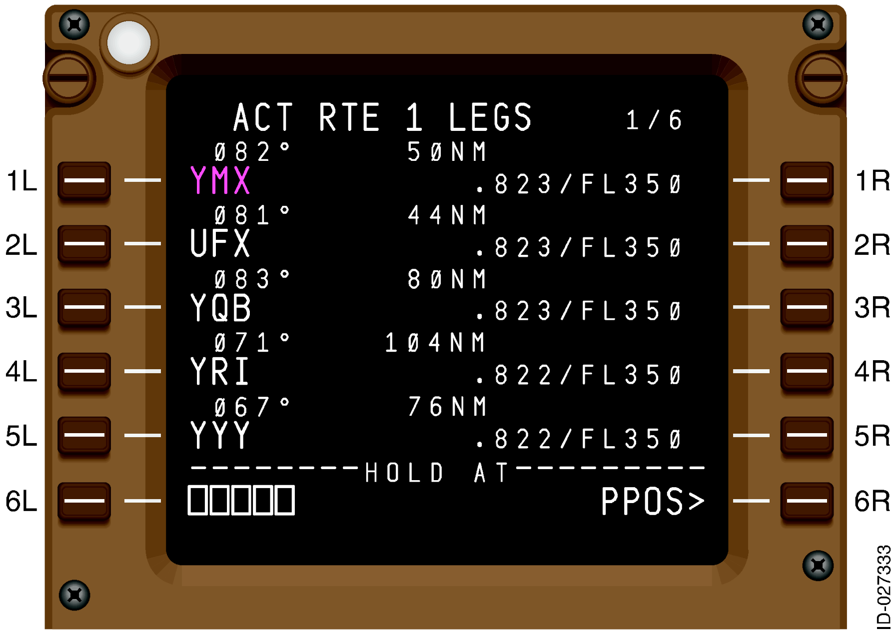


ROUTE DISCONTINUITY
Figure 6-32

STEPS:

1. To clear the ROUTE DISCONTINUITY in Figure 6–32, push 3L to copy the waypoint YMX into the scratchpad.
2. Push 2L to select YMX into the box prompts in line 2.
3. Push the EXEC key to execute the modification.

When the holding fix is sequenced, the ACT RTE 1 HOLD page (Figure 6–30) changes to the display shown in Figure 6–33 (if there are no more holds in the flight plan).

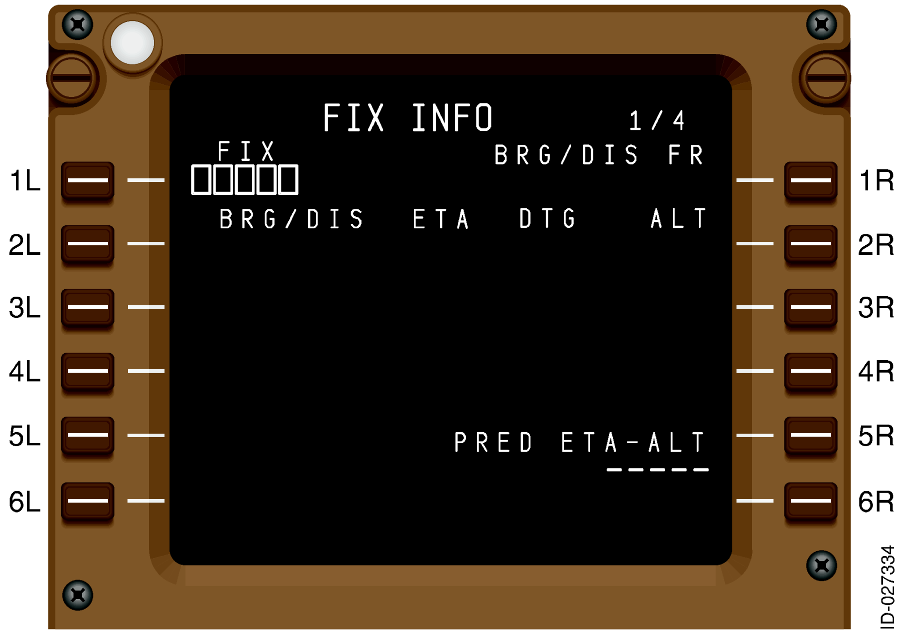


ACT RTE 1 LEGS – HOLD AT Page
Figure 6–33

FIX INFO PAGE

The FIX INFO pages let the pilot create waypoint fixes from the intersection points of the present flight plan and selected radials or distances from known waypoints for display on the ND. There are four different FIX INFO pages, each works the same way. The bearing data is magnetic or true depending on the position of the heading reference switch, or present position.

STEP: Push the FIX key (Figure 6-34).



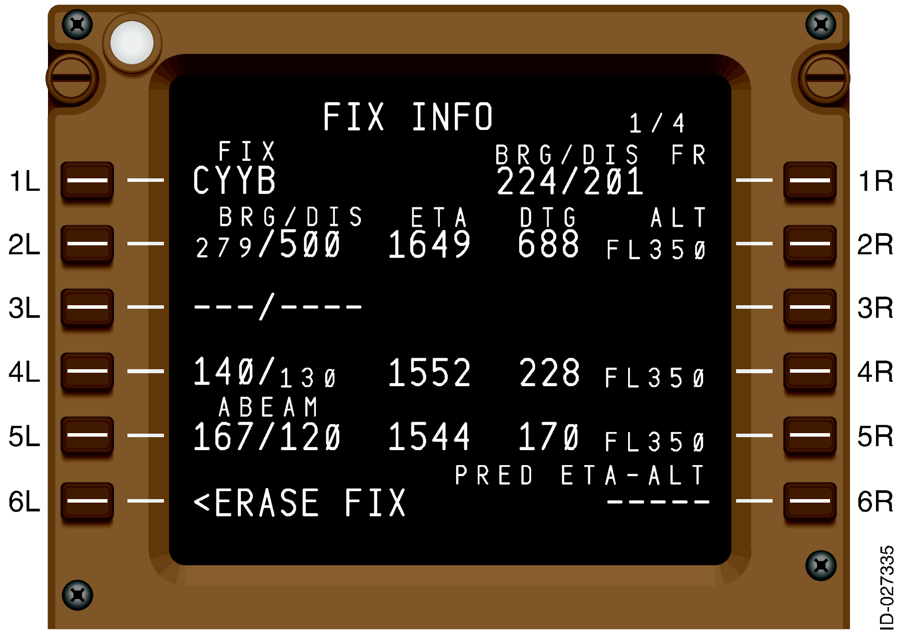
FIX INFO Page
Figure 6-34

Airports, navaids, or waypoint identifiers contained in the nav database or pilot-created waypoints can be entered in 1L. LAT/LON, Place Bearing Distance (PBD), Place Bearing Place Bearing (PBPB), along track waypoint airway intersection, Reproting Point waypoints that are found in any route, as well as LAT/LON, PBD or PBPB waypoint fixes are not contained in the route can be entered in the 1L fix boxes. Entering a fix identifier displays the fix on the ND with a small circle around the navaid, waypoint, or airport identifier.

For the flight from KORD to EGLL, the pilot wants to know the bearing and distance to North Bay, as well as when the aircraft is abeam North Bay. The identifier is CYYB, as shown in Figure 6-35.

STEPS:

1. Enter CYYB in the scratchpad and push 1L.
2. When the FIX INFO page for CYYB is displayed, push 5L (ABEAM).
3. Enter /120 in the scratchpad and push 2L.
4. Enter 140 in the scratchpad and push 4L.



FIX INFO – CYYB
Figure 6-35

The FIX INFO page is described in the following paragraphs.

- **FIX and BRG/DIS FR (1L)** – The entered fix is displayed in 1L. The bearing and distance from the fix are displayed in 1C. In this example, the bearing is 199° and the great circle distance is 119 NM from the fix to the aircraft. A new fix can be entered over the existing fix, or the fix can be copied to the scratchpad.

  NOTE: The fix can only be erased by selecting the ERASE FIX prompt at 6L, or using the CDU DEL key.

- **BRG/DIS, ETA, DTG, ALT (Lines 2, 3, and 4)** – Bearing and/or distance (BRG/DIS) references are entered into 2L through 4L.

A bearing can be entered in 2L, 3L, or 4L. Valid bearing (radial) entries are three digits ranging from 000 to 360° degrees. The entered radial is displayed on the ND relative to the current map display. If the entered radial intersects the active flight plan within 9999 NM of the reference fix, the intersecting distance is displayed in small font following the slash (/). If no intersection is found, the distance portion of the line 2, 3, or 4 is blank.

A distance can be entered in 2L, 3L, or 4L, preceded by a slash. If the distance circle intersects the active flight plan, the intersecting radial is displayed in small font before the slash. If no intersection is found within 9999 NM, the bearing portion of line 2, 3, or 4 is blank.

If 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 is displayed.

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

  If an abeam point to the active or active offset flight path cannot be found, INVALID ENTRY is displayed in the scratchpad.

  A valid intersection can be downselected as a PBD waypoint to insert into the route. An abeam point can be removed by deleting the distance/bearing value.

- **<ERASE (6L)** – Pushing 6L removes all fix data from that page (excluding an entry in 6R), as well as from the CDU and ND. The ERASE prompt is not displayed if no fix has been entered in 1L.

  NOTE: Pushing the NEXT PAGE key lets the pilot select three radials and/or distances and a point abeam from a second fix and a second ETA-ALT entry.

- **2C, 3C, 4C, 5C ETA/DTG** – The ETA and DTG are displayed in 2C through 5C for bearing, distance, or abeam references for which an intersection with the active flight plan exists.

  If the aircraft crosses a predicted intersection, the DTG is displayed as the distance back to the intersection, signified by a negative value. If no intersection exists, the corresponding ETA and DTG fields are blank.

- **ALT (2R through 5R)** – If 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. If no intersection exists, the corresponding altitude field is blank.

- **PRED ETA – ALT (6R)** – An ETA or altitude can be entered in 6R for the FMS to predict a crossing point at the entered ETA or altitude. The crossing point is displayed on the ND as a profile circle with an altitude or time label located on the lateral flight path.

  A valid ETA entry is a four-digit time value followed by Z. The FMS then estimates the aircraft position at the entered time and displays the distance to the position. The entered time is displayed next to the profile circle on the ND.

  A valid altitude entry is a three- to five-digit value in standard altitude format. The FMS estimates what the aircraft lateral position will be when it reaches that altitude.

  For either ETA or altitude entries, if the predicted position does not occur on the flight path, the distance portion of the 6R is blank. Once a valid predicted position is passed, the entry returns to dashes and the distance is blank. A predicted entry can be overwritten with another valid entry or can be deleted.

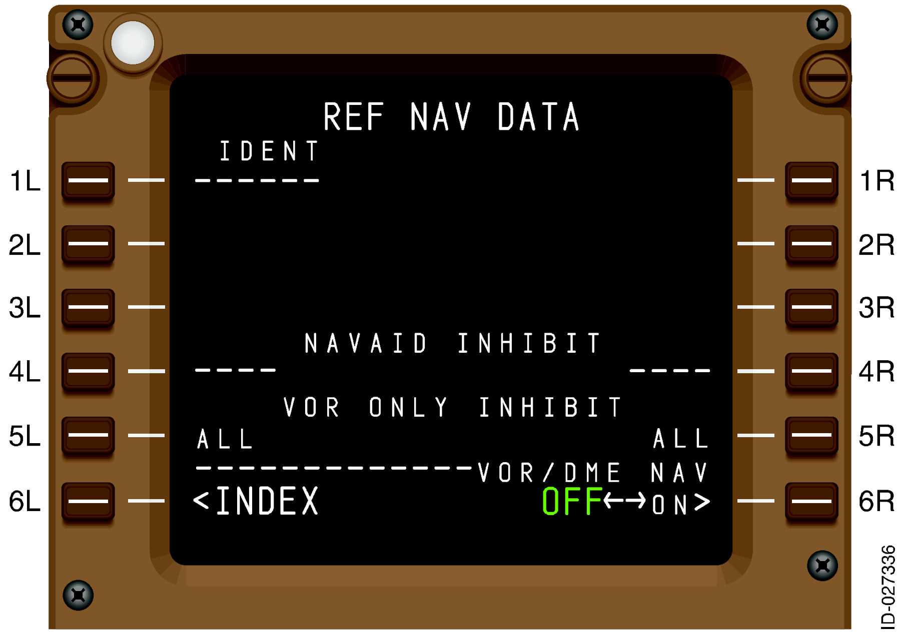
REF NAV DATA PAGE

The REF NAV DATA page displays information for waypoints, navaids, airports, and runways in the nav database. The page is also used to select navaid inhibit and to inhibit VOR/DME FMS radio update mode.

The REF NAV DATA page is accessed from the INIT REF INDEX page. To display the REF NAV DATA page (Figure 6-36), do the following:

STEPS:

1. Push the INIT REF key.
2. Push 6L (INDEX) on the INIT REF page.
3. Push 1R (NAV DATA) on the INIT REF INDEX page.



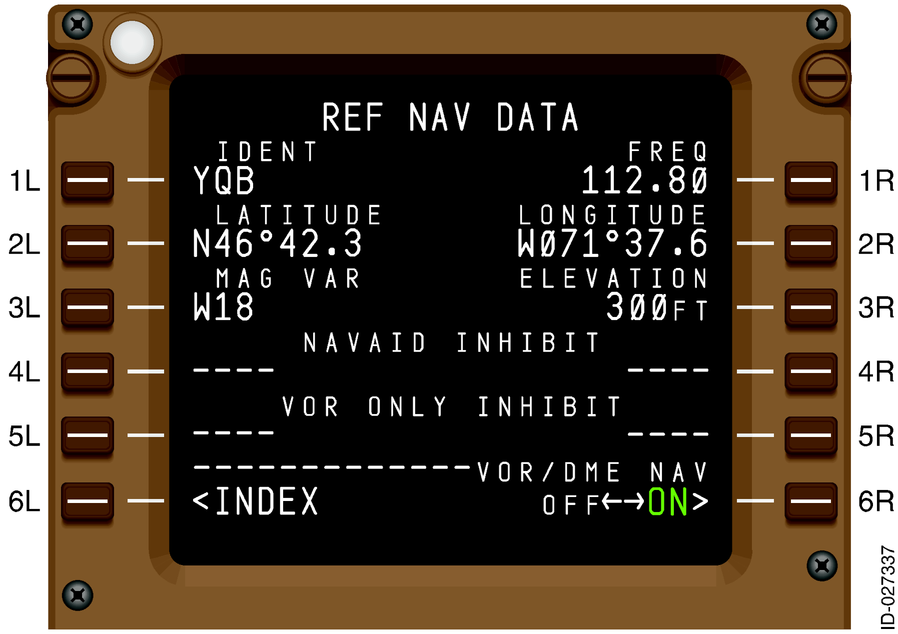
REF NAV DATA Page
Figure 6-36

The REF NAV DATA page is described in the following paragraphs.

- **IDENT (1L)** – A waypoint, navaid, airport, or destination runway identifier is entered in 1L. If the entry is in the nav database, the information about that entry is displayed. If the entry is not in the nav database, NOT IN DATA BASE is displayed in the scratchpad.

  Changing the page removes the entry in 1L and any associated data. When the page is redisplayed, dashes are displayed in 1L to make another entry. Deleting an entry in 1L is not allowed.

STEP: For the flight from KORD to EGLL, enter YQB in 1L to display the REF NAV DATA page for the Quebec navaid (Figure 6–37).



REF NAV DATA – YQB
Figure 6–37

The REF NAV DATA page is described in the following paragraphs.

- **FREQ (1R)** – If the identifier in 1L represents a navaid, then the navaid frequency is displayed in 1R. In this example, the frequency for YQB is 112.80.

- **LATITUDE and LONGITUDE (2L and 2R)** – The latitude and longitude for the navaid, waypoint, airport (reference point), or runway threshold entered in 1L is displayed in line 2.

- **MAG VAR or LENGTH (3L)** – Magnetic variation from true north is displayed in 3L when the identifier in 1L is for a navaid.

  If the identifier in 1L is a runway, the header line in 3L is LENGTH and the runway length is displayed

  For any other entries in 1L, this field is blank.

- **ELEVATION (3R)** – The elevation of the navaid, airport (reference point), or runway threshold entered in 1L is displayed in 3L. If the identifier in 1L is for a waypoint, this field is blank.

- **NAVAID INHIBIT (Line 4)** – Initially, dashes are displayed in 4L and 4R. The pilot can inhibit (or blackball) up to two VORs, VOR/DMEs, VORTACs, or DMEs contained in the nav database, from FMS radio updating. This is done by entering the identifier in 4L or 4R.

  Once a valid entry is made, the FMS is inhibited from using that navaid for radio updating. Overwriting a navaid in 4L or 4R re-enables that navaid and inhibits the newly entered navaid.

  Deleting a navaid in 4L or 4R re-enables that navaid for FMS use in radio updating. Entries in 4L and 4R are automatically cleared at flight completion or after a long-term power interrupt.

  NOTE: Navaids that are entered in these fields are not inhibited from route tune, manual tune, or procedure tune capability. Entering a navaid inhibits the FMS from using the whole navaid for radio updating.

- **VOR ONLY INHIBIT (Line 5)** – Initially, dashes are displayed in 5L and 5R. The pilot can inhibit up to two VORs contained in the nav database for radio updating.

  Only the VOR portion of the navaid is inhibited when an identifier is entered in line 5. Deleting or overwriting a navaid in 5L or 5R re-enables that navaid. Entries in 5L and 5R are cleared at flight completion.

  NOTE: VORs that are entered in these fields are not inhibited from route tune, manual tune, or procedure tune capability. If the inhibited VOR is paired with a DME, the DME is not inhibited from being autotuned or from being used for DME/DME position updating.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **VOR/DME NAV (6R)** – Pushing 6R toggles VOR/DME NAV ON (active) and OFF (inactive). The selected state is displayed in large green font the non-selected state is displayed in small white font.
  - — ON – VOR/DME data is available to the FMS for position updates.
  - — OFF – VOR/DME data is not available to the FMS.

  Selecting OFF displays ALL in both locations of the VOR ONLY INHIBIT line (line 5).

SELECT DESIRED WPT

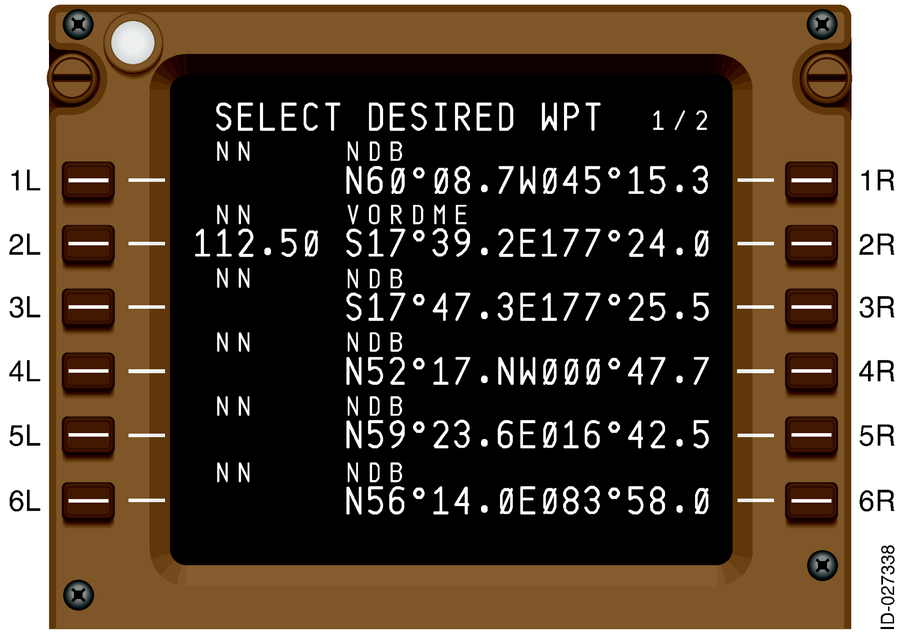
The SELECT DESIRED WPT page is automatically displayed when an identifier is entered into the CDU and the nav database contains more than one component (waypoint, NDB, VOR) with that identifier. The SELECT DESIRED WPT page is displayed to let the pilot select the desired nav database fix.

Displayed fixes are generally displayed by increasing distance from the aircraft. However, if the entry is made on the RTE or RTE LEGS pages, the fixes are displayed by increasing distance from the fix before the entry position.

A fix is selected from the SELECT DESIRED WPT page by pushing the associated LSK. When this is done, the display returns to the previous page. The selected waypoint is inserted where the pilot had previously tried to do so.

If more than six non-unique identifiers exist, the remaining fixes are accessed by pushing the NEXT PAGE or PREV PAGE key. If the page is exited before a fix is selected, no fix is selected.

STEP: To display the SELECT DESIRED WPT page for nav database components with the identifier NN (Figure 6-38), enter NN in the scratchpad and push 1L on the REF NAV DATA page.



SELECT DESIRED WPT Page 1/2
Figure 6-38

STEP: Push the NEXT PAGE or PREV PAGE key to display the SELECT DESIRED WPT page 2/2 (Figure 6-39).

SELECT DESIRED WPT Page 2/2
Figure 6-39

The SELECT DESIRED WPT page is described in the following paragraphs.

- **Identifier/Fix Type and Frequency (1L through 6L)** – The fix identifier and fix type are displayed in the header lines in 1L through 6L. Fix types can be any of the following:

  — APRT
  — ILS
  — NDB
  — MLS
  — WPT
  — ILSDME
  — VOR
  — VORTAC
  — TACAN
  — MLSDME
  — LOC
  — DME
  — VORDME.

  If the fix is a navaid, the frequency is displayed in the data line in 1L through 6L, as appropriate.

- **Position (1R through 6R)** – The position of each fix is displayed in 1R through 6R.

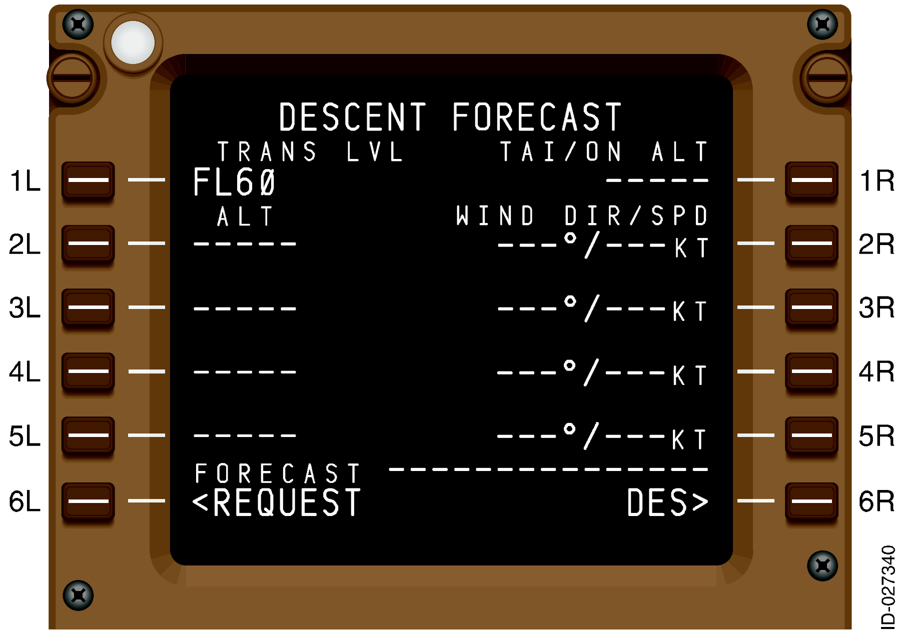
DESCENT FORECAST PAGE

The DESCENT FORECAST page is used to enter forecast winds and the altitude where thermal anti-icing is turned on to more accurately define the descent path. The page is accessed by selecting the FORECAST prompt in 5R on the DES page, which is page 3/3 of the VNAV pages.

To display the DESCENT FORECAST page (Figure 6-40), do the following:

STEPS:

1. Push the VNAV key.
2. Push the NEXT PAGE key to display the DES page 3/3.
3. Push 5R (FORECAST).



DESCENT FORECAST Page
Figure 6-40

The DESCENT FORECAST page is described in the following paragraphs.

- **TRANS LVL (1L)** – The transition level (TRANS LVL) for the DESCENT flight phase defaults to FL180. The value can be changed by pilot-entry. The value changes automatically when a destination or arrival procedure with a stored transition level is entered, if a pilot-entry has not already been made. For the flight from KORD to EGLL, the transition level is FL60. This information is stored in the nav database.

- **ALT (2L through 5L)** – The descent wind altitudes are entered in 2L through 5L in standard altitude format. An altitude entry that is equal to an altitude already in 2L through 5L is not allowed (only one wind entry can be made for a given altitude).

  If one of the altitudes in 2L through 5L is deleted, the fields in that line default to dashes.

- **<REQUEST (6L)** – Pushing 6L transmits a datalink request for descent wind data.

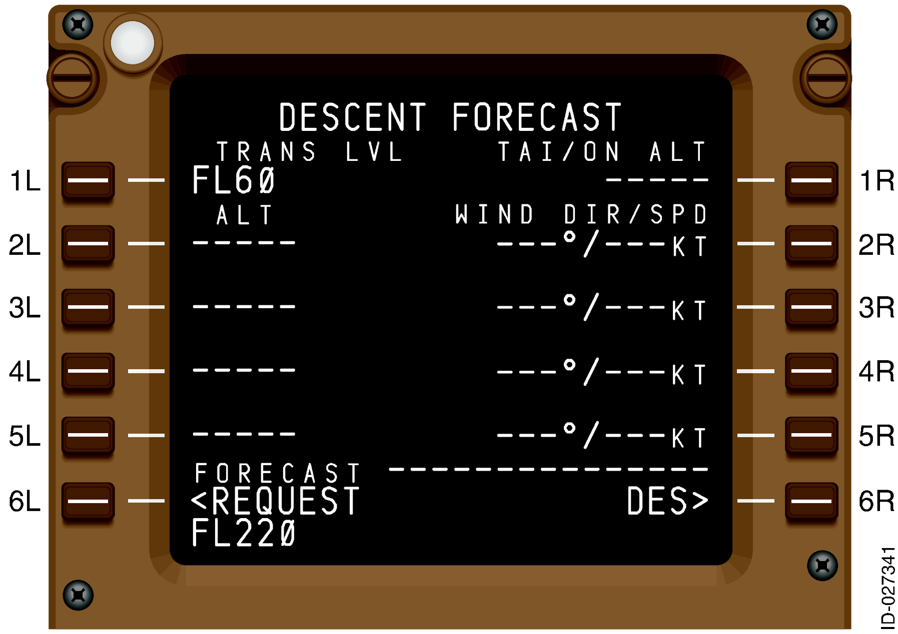
- **TAI/ON ALT (1R)** – An altitude below which thermal anti-ice is expected to be used can be entered in the thermal anti–ice field. The FMS performance function uses the TAI altitude to make adjustments in the descent profile for a more cost-effective and accurate descent. If a pilot–entered value is deleted, dashes are displayed.

- **WIND DIR/SPD (2R through 5R)** – Wind direction and speed corresponding to the altitudes in 2L through 5L are entered in 2R through 5R.

  Valid entries are a wind direction and speed separated by a slash (/). Wind direction is a three–digit value, referenced to true north. Wind speed is a one– to three–digit entry ranging from 1 to 250 knots. Leading zeros are optional for wind speed but are required for wind direction. Initial entries must consist of both speed and direction. However, subsequent entries can be partial and only the entered portion is changed. If only wind direction is entered, it must be followed by a slash.

- **DES> (6R)** – Pushing 6R displays the DES page.

STEP: To enter a thermal anti-ice on altitude of FL220 for the flight from KORD to EGLL, enter FL220 in the scratchpad (Figure 6-41) and push 1R.



TAI/ON Altitude Entry
Figure 6-41

ALTITUDE INTERVENTION

Altitude intervention is the function of incorporating the MCP altitude window and knob-push operation with the FMS VNAV flight planning for heads-up operation. For CRUISE, altitude intervention lets the pilot raise or lower the current cruise altitude without using the CDU and without confirmation using the EXEC key.

Cruise Altitude Modification

If the MCP altitude is set to an altitude above the current cruise altitude, pushing the altitude knob changes the current cruise altitude to the MCP selected altitude.

If the MCP altitude is set to an altitude below the current cruise altitude but above the first descent constraint, and the aircraft is more than 50 NM from the top-of-descent point, the cruise altitude is lowered to the MCP selected altitude. If the aircraft is within 50 NM of the top-of-descent, an early descent is initiated consisting of a 1250 fpm descent until the descent path is intercepted.

7. Descent

The FMS DESCENT flight phase begins when the aircraft departs the cruise altitude at the top-of-descent or begins the deceleration segment prior to reaching the top-of-descent. The DESCENT phase extends to the last constraint in the descent (end-of-descent point).

The descent path is calculated starting at the end-of-descent and going backwards to the cruise altitude. The descent vertical path is calculated to satisfy decelerations, configuration changes, altitude and airspeed constraints, forecast winds, preselected descent speeds, and other constraining factors.

The FMS creates a deceleration segment at the top-of-descent point when the cruise speed is greater than the descent speed. If necessary, an acceleration segment is also created to meet speed constraints during the descent.

A descent path can be one of two types. The first type is an ECON descent where the path is constructed for an optimal descent speed, subject to defined airspeed/altitude constraints. The second type is a selected speed descent where the path is constructed to fly a pilot-entered speed, still subject to defined airspeed/altitude constraints.

The descent speed is maintained until the intermediate deceleration point when the aircraft begins to slow to the transition altitude speed, or speed restriction altitude airspeed. The FMS default is a speed transition of 240 kts (a 10 kt buffer so as not to exceed 250 kts) below 10,000 ft. The aircraft decelerates to 240 kts upon reaching the intermediate deceleration point prior to 10,000 ft.

The FMS continuously updates the appropriate deceleration distance from the destination to slow to approach speeds. The approach phase normally begins at the last descent constraint in the flight plan.

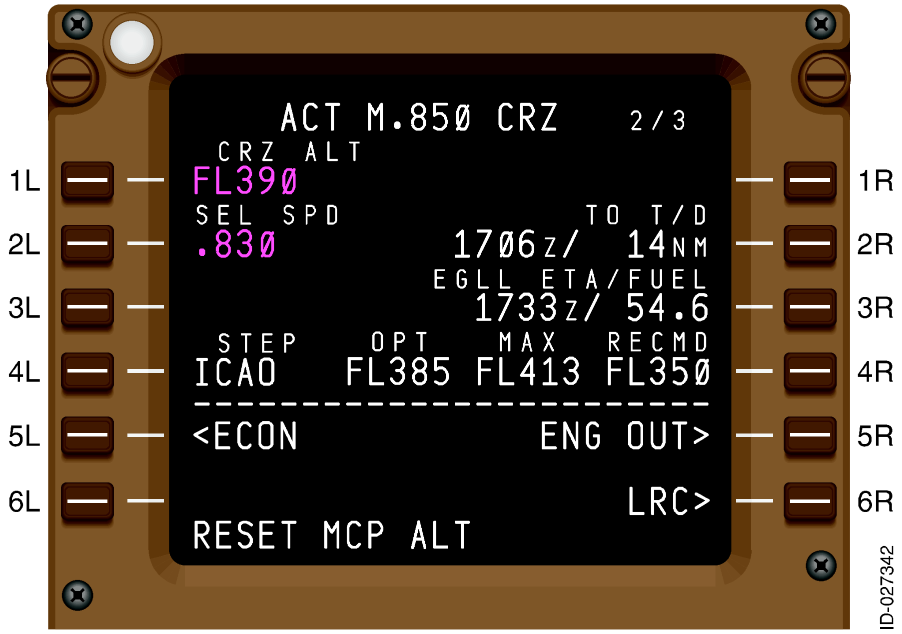
DESCENT PAGE

The descent page is displayed by pushing the VNAV key when the DESCENT mode is active. If the DESCENT mode is not active then the DES page 3/3 (of the vertical navigation pages) is displayed by pushing the NEXT PAGE or PREV PAGE key after pushing the VNAV key.

The descent page is used by the pilot to evaluate or revise the descent path. Available speeds are economy and selected speeds. The descent page is blank with DES as the title only when there are no altitude constraints below the cruise altitude.

Figure 7-1 shows the VNAV page 2/3 14 NM before the top-of- descent.

STEP: To display the VNAV page 2/3, push the VNAV key.



ACT M.850 CRZ Page
Figure 7-1

The scratchpad message RESET MCP ALT is displayed two minutes before the top-of-descent point when MCP altitude is still set at the current altitude.

Sequencing the top-of-descent point automatically changes the VNAV page to ACT ECON DES page 3/3 (Figure 7-2).

ACT ECON DES Page
Figure 7-2

The page title includes ECON when VNAV economy speed mode is selected. When a fixed speed is selected, the title includes XXXKT for CAS or M.XXX for Mach selections.

The page title displays the type of descent and includes the following:

- ECON – Indicates that the speed is based on a cost index.
- MCP SPD – Indicates speed intervention is selected on the MCP.
- LIM SPD – Indicates controlling to a limit speed, such as flap placard.
- END OF DES – Indicates when the end-of-descent waypoint is reached if not followed by a climb segment.

- **E/D AT (1L)** – The end-of-descent point in 1L displays the altitude and waypoint with the lowest altitude constraint propagated from the LEGS page. Figure 7-2 shows the descent ending at 1410 ft for RWY 27R at EGLL.

  The altitude is displayed in **magenta** when it becomes the FMS altitude target. The waypoint is displayed in **magenta** when the end-of-descent waypoint becomes the active waypoint.

If no constraint exists, the page is blank with DES as the page title. If the end-of-descent constraint is a window constraint, the lower altitude is displayed. The altitude can be followed by A for AT OR ABOVE, B for AT OR BELOW, or an altitude window.

- **AT (1R)** – The next descent waypoint constraint is displayed in 1R. These constraints are entered on a RTE LEGS page by procedure selection or by pilot-entry.

  These constraints can be deleted on this page or on the RTE LEGS page. The label line can also display HOLD AT (name of fix), AT VECTORS or AT (INTC).

  Speed and/or altitude are displayed in **magenta** when they are the FMS target values. This field is blank when no constraint exists.

- **Speed Line (2L)** – The speed line displays the command speed used above all waypoint speed constraints, speed restrictions, and speed transition altitudes.

  Speed and/or Mach can be entered by the pilot and when it is entered the line title changes to SEL SPD.

  The aircraft flies the constraint speed or the current performance speed, whichever is less.

  Speed is displayed in **magenta** when it is the FMS active target speed. Both CAS and Mach values are displayed and normally Mach becomes **magenta** first.

  Figure 7–2 shows an ECON speed of .825 Mach at this stage of the descent into London.

- **SPD TRANS (3L)** – The speed transition altitude is displayed in 3L. This value is 10 knots less than the nav database speed limit at the destination airport to ensure that the speed limit is not exceeded. The displayed value is 240/FL100. The default value of 240/10000 is automatically displayed if a different value is not in the database for the destination.

  If the aircraft is below the speed transition altitude, this field is blank. Deleting this field causes the aircraft to fly an economy or selected speed if not limited by a waypoint constraint or speed restriction. Speed is displayed in **magenta** when it is the FMS speed target.

- **WPT/ALT and FPA, V/B, and V/S (3R and 4R)** – Flight path angle, vertical bearing, and vertical speed are displayed in 4R to the waypoint and altitude displayed in 3R. The data field in 3R defaults to the waypoint and altitude in 1L. The pilot can enter any waypoint in the active or nonactive route, or any waypoint in the nav database into 3R. The FMS calculates the flight path angle, vertical bearing, and vertical speed to that waypoint and displays them in 4R. These calculations are listed below:

  — FPA – Displays the current airplane flight path angle whenever the airplane descents (the data blanks if the ariplane levels or climbs).

  — V/B – Displays the vertical bearing from current position to the displayed waypoint and altitude. The data blanks if the WPT/ALT line displays _ _ _ _ _ / _ _ _ _ _ .

  — V/S – Displays required vertical speed to maintain the vertical bearing. The data blanks if the WPT/ALT line displays _ _ _ _ _ / _ _ _ _ _ .

- **SPD RESTR (4L)** – The speed restriction is displayed in 4L if a valid speed restriction has been entered and the speed restriction altitude has not been crossed. The data field contains the restriction speed followed by the speed restriction altitude.

  The altitude must be below the cruise altitude and the current aircraft altitude, and above the end-of-descent constraint in 1L. The airspeed must be less than the CAS speed of the first remaining descent segment and be between 100 to 400 kts. Speed restriction entries that conflict with the speed transition causes the speed transition displayed in 3L to be blank. If an entered speed restriction is then deleted, a speed transition may be redisplayed. Speed is displayed in **magenta** when it is the FMS target speed.

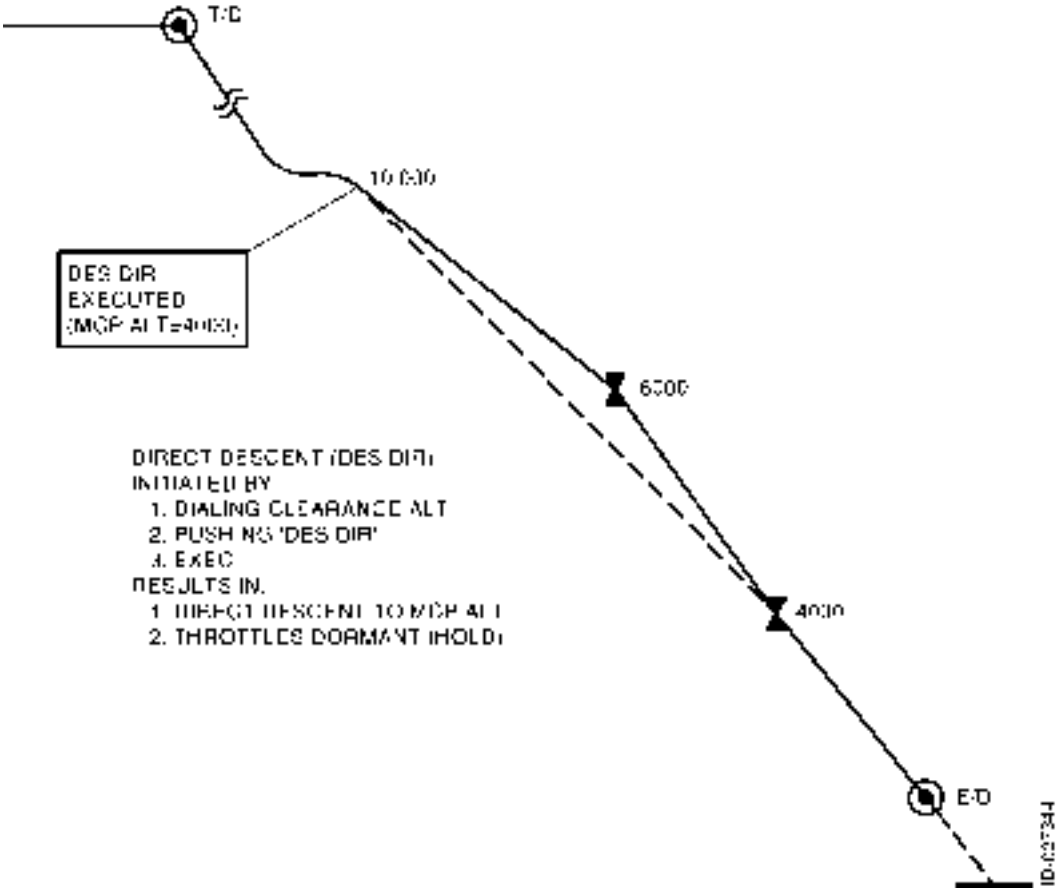
- **FORECAST> (5R)** – Pushing 5R displays the DESCENT FORECAST page.

- **<OFFPATH DES (6L)** – Pushing 6L displays the OFFPATH DES page (described later in this section).

- **Descent Line (6R)** – The descent line displays either the DES NOW prompt or the DES DIR prompt.

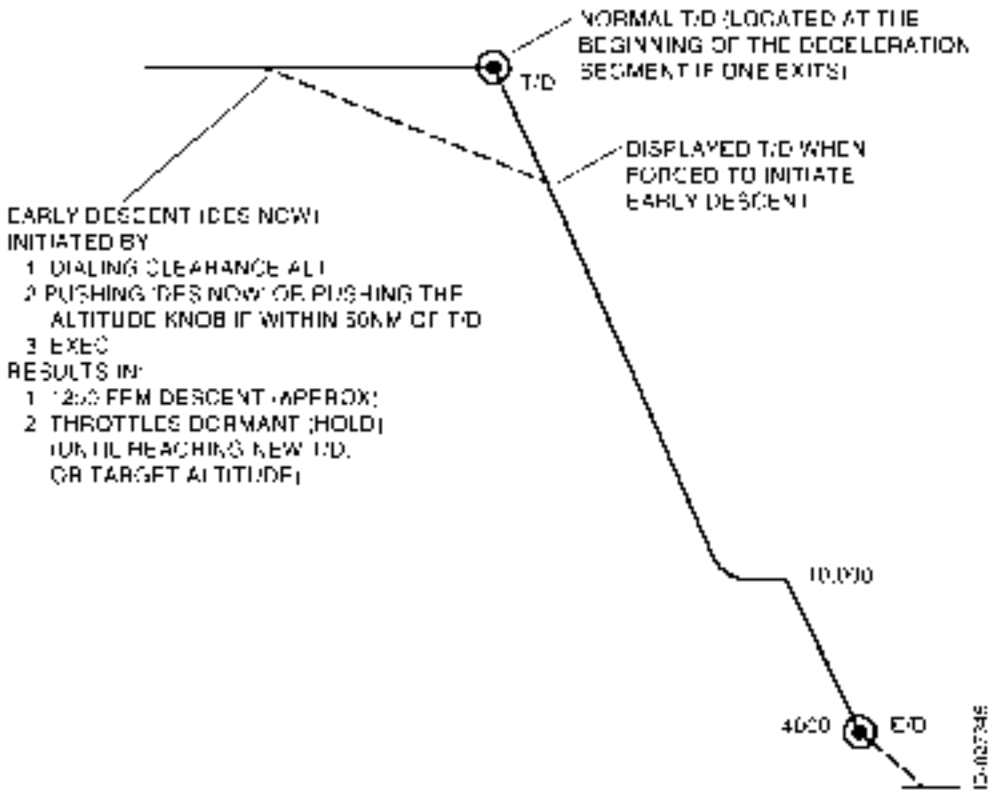
  — **DES DIR>** – The DES DIR prompt is displayed when the descent is active and an altitude constraint exists in the flight plan between the current altitude and the end-of-descent.

  Selecting the DES DIR prompt lights the EXEC light. Pushing the EXEC key deletes all descent constraints above the MCP altitude window and initiates a descent to reach the MCP altitude. Upon reaching the MCP altitude, the vertical guidance function captures the computed vertical path for the selected mode of descent and meets any remaining descent constraints. This is shown in Figure 7-3.



Descend Direct Vertical Path
Figure 7-3

— **DES NOW>** – The DES NOW prompt is displayed when the aircraft is not in active descent. Selecting the DES NOW prompt lights the EXEC light. Pushing the EXEC key activates the displayed descent profile, deletes all climb and cruise constraints, and initiates an early descent (descent before reaching the calculated top-of-descent). The vertical path is shown in Figure 7–4. It consists of a 1250 fpm descent rate (approximately) until reaching the calculated path. The autothrottles go into throttle hold mode upon reaching the 1250 fpm descent rate to let the pilot re–adjust the throttles to change the rate of descent. Upon intersecting the original descent path, the vertical guidance function captures the calculated vertical path for the selected descent mode.



Descend Now Vertical Path
Figure 7–4

OFFPATH DES PAGE

The OFFPATH DES page lets the pilot analyze the descent performance off the current route of flight direct to a selected waypoint. Data entered on this page displays clean and drag descent ranges on the CDU and on the ND. The ranges are based on an entered waypoint and altitude constraint. The range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

STEP: The OFF PATH DES page (Figure 7-5) is displayed by pushing 6L on the descent page.

OFFPATH DES Page
Figure 7-5

The OFFPATH DES page is described in the following paragraphs.

- **DES TO, DTG, and SPD/ALT (Line 1)** – The end-of-descent point from the descent page is displayed in 1L. Any valid waypoint from the nav database can be entered in 1L. If a pilot-entry is deleted, the end-of-descent point from the descent page is redisplayed.

  When the aircraft altitude is within 150 ft of the waypoint in 1L, the display defaults to the new end-of-descent point from the descent page, or to box prompts.

  The direct-to distance to the waypoint in 1L is displayed in 1C.

  The speed/altitude restriction for the waypoint in 1L is displayed in 1R.

- **Speed Line (2L)** - ECON SPD or SEL SPD is displayed in the header line in 2L with the appropriate speed in the data field. Mach and/or airspeed can be entered. A pilot-entered speed causes the header line to change to SEL SPD. Whenever SEL SPD is displayed, an ECON prompt is displayed in 5L.

- **SPD TRANS (3L)** - The speed transition displayed in 3L is the transition speed and altitude from the descent page. This data can be deleted on either the descent page or this page. If it is deleted, this field and header line are blank on both pages and the EXEC light lights. When deleted, the speed transition is only redisplayed by entering a new cruise altitude above the nav database stored altitude. Deleting the speed transition causes the aircraft to fly ECON or selected speed if not limited by a waypoint constraint or speed restriction.

  The field automatically displays 240/10000 if a different value is not available from the nav database.

- **SPD RESTR (4L)** - The speed restriction field in 4L displays dashes before a pilot-entry is made. The pilot can enter a speed limit at an altitude higher than the end-of-descent altitude. When a transition is made to a limiting speed, dashes are again displayed. The header line and data field are blank when a valid end-of-descent is not displayed in 1L.

- **<ECON (5L)** (Not shown in Figure 7-5) - An ECON prompt is displayed in 5L when SEL SPD is displayed in 2L.

- **<DES (6L)** - Pushing 6L displays the DESCENT page.

- **TO CLEAN (2R)** - The direct-to distance from the aircraft to the clean idle descent path is displayed in 2R. CLEAN represents the energy circle with no speed brakes, flaps, or gear down, which allows the aircraft to reach the constraint flying direct to the fix displayed in 1L.

  Prior to reaching the clean circle the descent can be made without losing excess energy. Once the clean circle is crossed, some degree of drag or path lengthening is necessary to meet the entered constraint.

  A negative distance is indicated when the aircraft has passed the clean energy circle. In the descent into London Heathrow, the aircraft present position is past the top-of-descent point by 13 NM.

- **TO DRAG (3R)** – The drag circle displays the direct-to distance from the aircraft to the computed top-of-descent point at the current altitude for a full speed brake idle descent. The computed descent path is calculated direct to the fix displayed in 1L, crossing the fix at the speed and altitude displayed in 2L through 4L.

  The drag circle represents the energy circle with full speed brakes applied, no flaps or gear extended, which allows the airplane to make the constraint at the offpath descent fix. The distance to the drag circle is not displayed until the aircraft has crossed the clean energy circle. The constraint speed and/or altitude cannot be met once the aircraft has entered into the drag circle, without additional drag or path extension.

- **DISPLAY (6R)** – Pushing 6R toggles the clean and drag circles on and off the associated ND. The active state is displayed in large **green** font, and the inactive state is displayed in small **white** font.

  The display automatically changes to **OFF** within 150 feet of the waypoint constraint altitude.

ARRIVALS PAGE

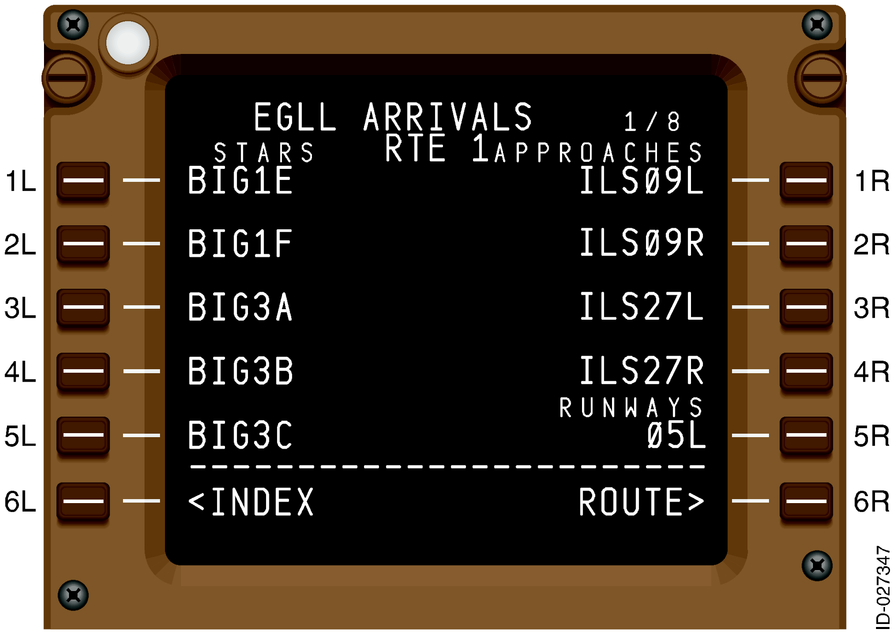
The ARRIVALS page is used to select the desired STAR or profile descent, approach, and transitions stored in the nav database for the destination airport. Route 1 and route 2 have separate arrival pages.

The ARRIVALS page can also display information about a selected airport that is not the destination, although no selections can be made for that airport.

When the DEP/ARR key is pushed and the aircraft is less than 400 NM from the departure airport or less than halfway along the active route, (whichever is less), arrivals for the departure airport are displayed. Otherwise, arrivals for the destination airport are displayed.

Leaving and returning to the ARRIVALS page redisplays all the items.

At this point in the sample flight, pushing the DEP/ARR key displays the ARRIVALS page for EGLL (Figure 7-6).



EGLL ARRIVALS Page
Figure 7-6

The ARRIVALS page can also be displayed by selecting the ARR prompt on the DEP/ARR INDEX page. The airports with more than five runways or STARS have multiple arrivals pages. Subsequent pages are displayed pushing the NEXT PAGE or PREV PAGE key.

The page title for the ARRIVALS page displays the arrival airport identifier and route number.

The ARRIVALS page is described in the following paragraphs.

- **STARS (1L)** – The STARS/profile descent lines are listed for the EGLL airport. If NONE is displayed, then there are no STARS in the nav database for that airport.

  If STARS are listed, pushing the associated LSK selects a STAR. Once a STAR is selected, <SEL> is displayed beside the selected arrival procedure, all other arrival procedures are removed and transitions for the selected procedure are displayed. Selecting a procedure deletes any previously selected procedure.

- **<INDEX (6L)** – Pushing 6L displays the DEP/ARR INDEX page.

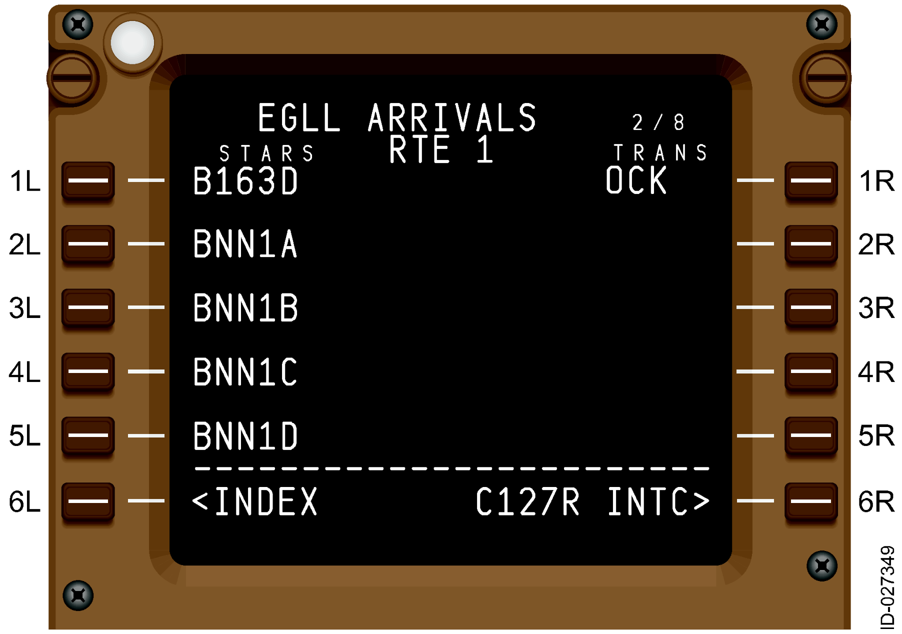
- **APPROACHES (1R)** – The approaches and runways contained in the nav database for the arrival airport are listed on the right side of the display under the APPROACHES header line. An approach is selected by pushing the associated LSK. The selected approach is then indicated by <SEL> or <ACT> next to it.

  To select the ILS approach to RWY27R at EGLL, push 4R on the EGLL ARRIVALS page. Figure 7–7 shows ILS27R selected.

EGLL ARRIVALS Page – ILS27R Selected
Figure 7–7

- **TRANS (2R)** – The approach transitions for a selected approach are displayed in the right data fields beginning in 2R after an approach has been selected. A transition is selected by pushing the associated LSK. The selected approach transition is indicated by <SEL> next to it. The clearance from ATC for approach to EGLL is the BNN1B STAR and BNN transition.

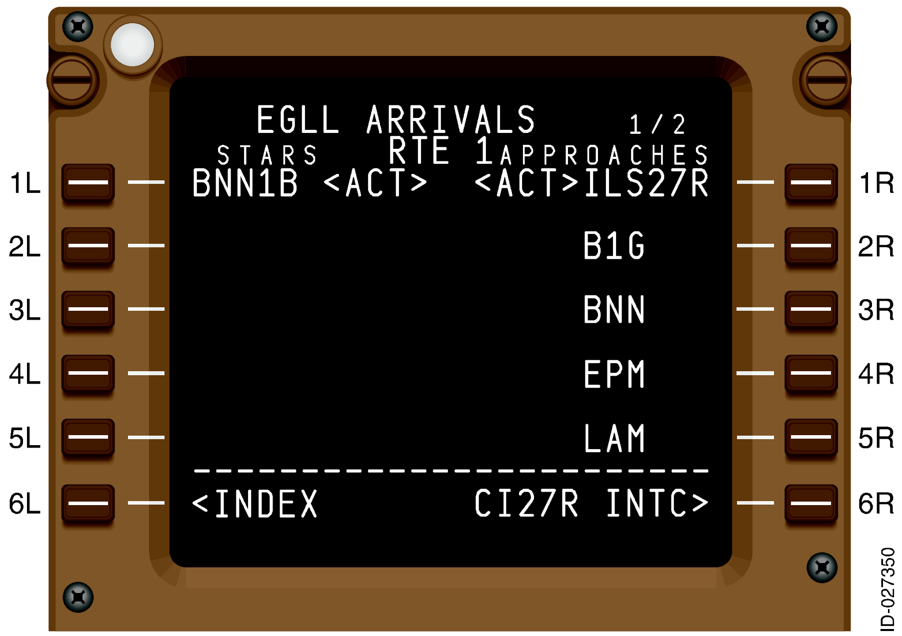
STEP: To select the BNN1B STAR, push the NEXT PAGE key to display the EGLL ARRIVALS page 2/8, shown in Figure 7-8.



EGLL ARRIVALS Page 2/8
Figure 7-8

STEPS:

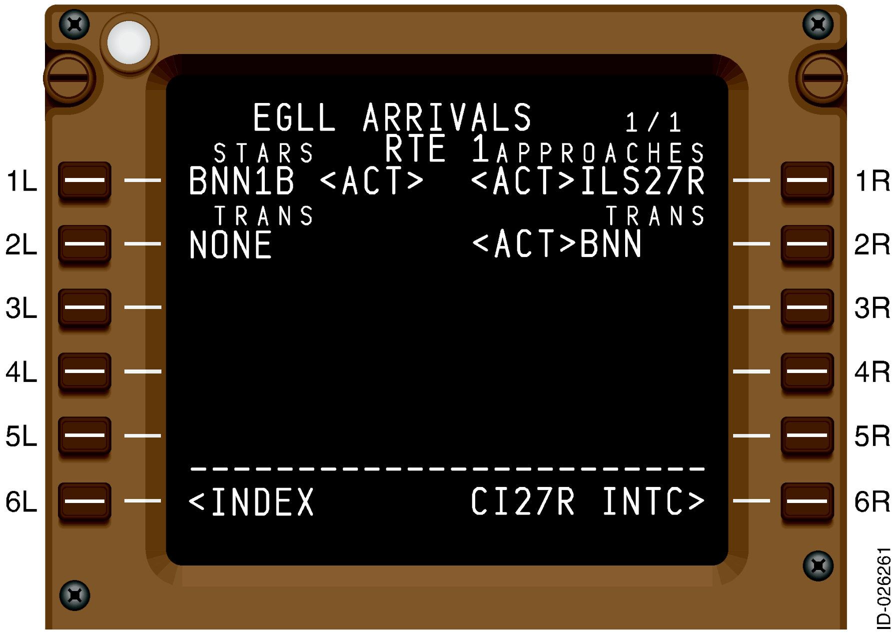
1. Push 3L to select the BNN1B STAR, shown in Figure 7-9.
2. Select the BNN transition.



EGLL ARRIVALS – STAR and Transition Selected
Figure 7-9

- **Approach Intercept> (6R)** – An approach intercept fix is displayed in 6R in flight when an arrival runway or procedure is selected or is in the active flight plan. It displays a waypoint or approach course for the selected approach or approach transition. The waypoint sequences along the approach route as the flight progresses. Pushing 6R selects the intercept leg to the approach fix or runway.

  After pushing 6R the RTE LEGS page is displayed and a flight plan modification is created with the intercept approach fix as the active flight plan waypoint and a defined intercept course TO the fix. The LEGS page displays the routing with the approach intercept fix waypoint as the active waypoint, as shown in Figure 7-10. The intercept inbound course to the fix is the same as the course outbound from the fix to the next fix/runway in the procedure.



EGLL Arrival Page Showing RTE 1 Approach
Figure 7-10

For runway only selections, the intercept course is the same as the nav database runway heading.

The RTE COPY and ABEAM waypoint prompts are not displayed on the RTE LEGS page after selecting the APPROACH INTC prompt. Any previously existing flight plan waypoints are deleted.

This field is blank if no arrival runway or procedure has been selected, or if none exists in the active flight plan. The field is also blank if the airport on the displayed ARRIVALS page does not match the selected approach.

NOTE: If a transition exists between a STAR and an approach, it is entered into the arrival route automatically once both the STAR and the approach/initial approach fix (IAF) have been selected.

Approach Intercept Function – Additional Information

The approach intercept selection is enabled for the following:

- All published and tailored approaches defined in the nav database for the selected destination airport.
- All runway selections with a VFR approach for the selected destination airport.
- All runways with an entered runway extension fix distance for the selected destination airport.
- Arrivals with only the runway selected at the destination airport.

The default approach fix is determined as follows:

- For published and tailored approaches, the default approach fix is the first fix for the selected approach.
- For runway selections with a VFR approach, the default approach fix is the FMS-created final approach fix for the selected runway.
- For runway selections with an entered runway extension fix, the default approach fix is the FMS-created runway extension fix for the selected runway.
- For runway only selections, the runway is considered the default approach fix.

CAUTION

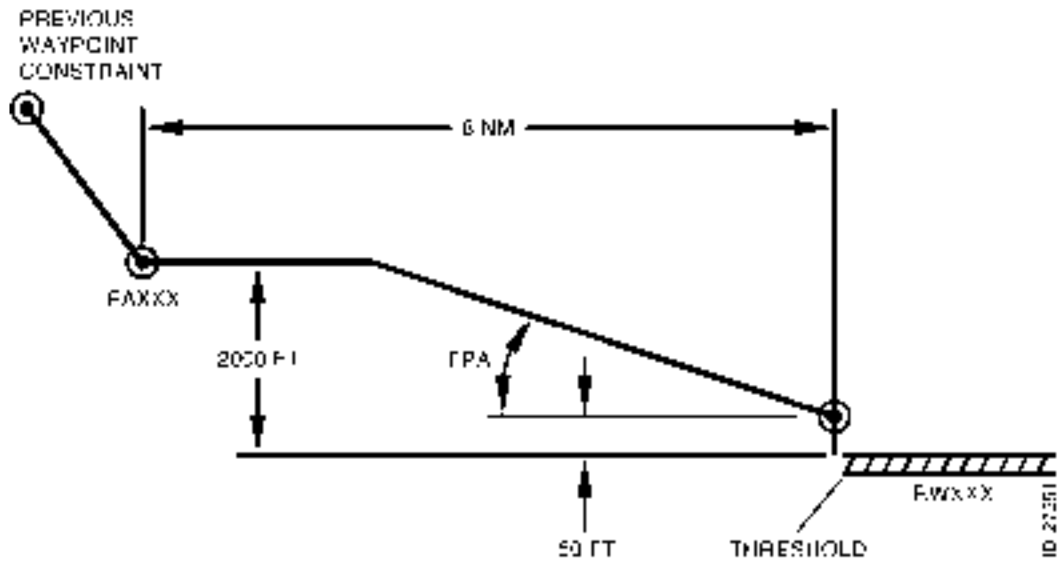
THE APPROACH INTERCEPT FUNCTION AUTOTUNES THE ILS FREQUENCY FOR THE NEW APPROACH ONLY IF THE ILS TUNING MODE IS AUTO. IF THE ILS TUNING MODE IS MANUAL, THEN AUTOTUNING IS INHIBITED.

VFR Approaches

VFR approaches can be enabled for particular runways in the nav database as an airline option, based upon compatibility with obstacle clearance limits or procedural requirements. The VFR APPR prompt is displayed when a runway is selected without an approach but has a VFR approach enabled in the nav database.

Selecting the VFR APPR prompt generates LNAV and/or VNAV guidance to the entered runway as an aid to the pilot during a VFR approach. The FMS creates a path in line with the runway centerline beginning at a point 50 feet above the runway threshold and extending upward at the specified flight path angle until it intercepts a plane 2000 ft above the runway threshold.

The flight path angle has a default value of 3° but can be varied between 2.4° and 3.7° by the pilot. The path then extends level from the intersection point at 2000 ft above runway threshold to a point 8 NM from the runway threshold. This point is identified as the final approach fix, FAXXX, where XXX is the designated runway. This profile is shown in Figure 7‑11.



VFR Approach Profile
Figure 7‑11

Guidance is generated to arrive at the final approach fix at a speed of 170 kts, along the path to the 50-foot point above the runway threshold. The speed can be varied by the crew through the speed intervention mode or by entering the desired speed on the CDU.

GPS Approaches

GPS approaches are non-precision approaches similar to RNAV approaches, but are for runways that do not have adequate navaid coverage for an RNAV approach. GPS approach capability is enabled with an OPC option. If a GPS approach is available at an airport, it is displayed on the right side of the ARRIVALS page for that airport.

Lateral and vertical guidance (if enabled) is available for GPS approaches. The FMS constructs a lateral approach path similar to an RNAV approach, but based on GPS position. The final leg of the approach lines up with the runway centerline. The vertical approach path is based on a defined vertical angle starting from a point above the runway threshold (usually 50 ft above). The vertical angle is stored in the nav database with the GPS approach information.

When a GPS approach is selected from the ARRIVALS page, the vertical angle for the leg to the runway waypoint (if available) is displayed on the RTE LEGS page. If a vertical angle for any other approach leg is defined, it is also displayed on the RTE LEGS page. The vertical angle for GPS approaches is displayed with a GP in front of it in the right side of the header line for the associated waypoint.

The pilot cannot change the vertical angle value from the nav database.

NDB Approaches

NDB (or ADF) approaches are non-precision approaches similar to VOR approaches, but are for runways that do not have adequate navaid coverage for a VOR approach. NDB approach capability is enabled with an OPC option. If an NDB approach is available at an airport, it is displayed on the right side of the ARRIVALS page for that airport.

Lateral guidance is available for NDB approaches. The FMS constructs a lateral path similar to a VOR approach but based on aircraft position relative to the specified NDB. The final leg of the approach may or may not line up with the runway centerline.

NOTE: Vertical guidance is not available for NDB approaches.

The FMS does not automatically tune the procedure specified navaid for NDB approaches. It must be tuned manually.

Runway Extension

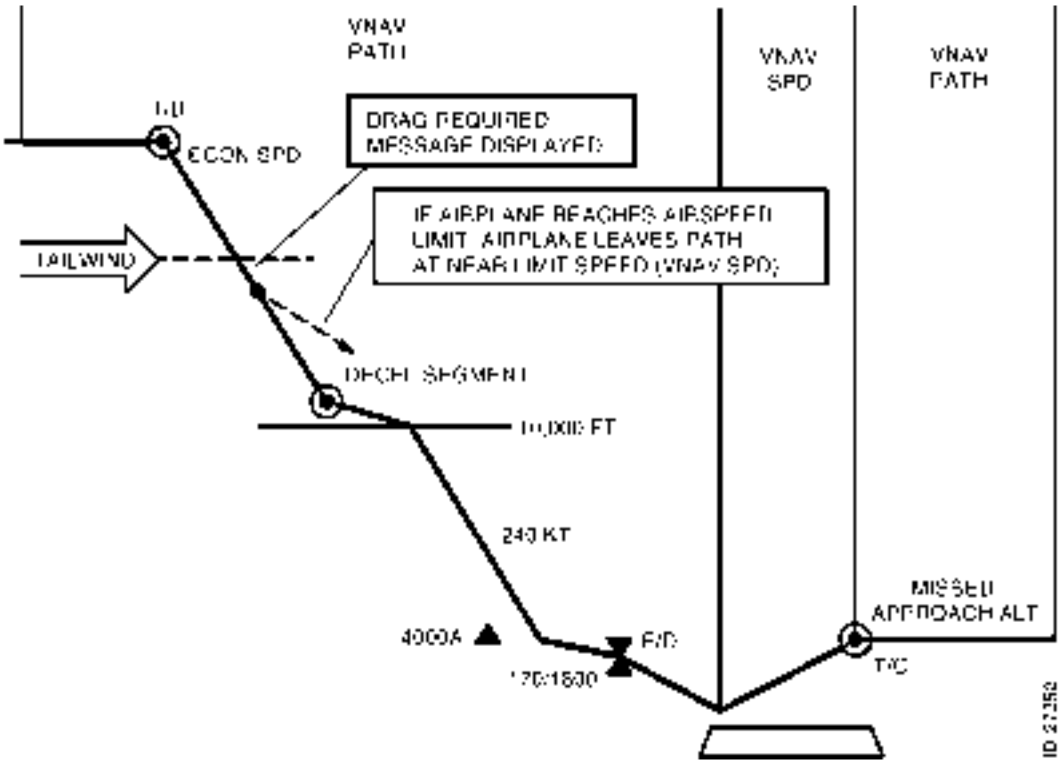
Runway extension fixes are pilot-defined waypoints that are in line with the runway centerline at a specified distance. When a runway is selected without an accompanying approach procedure, a runway extension distance can be entered into 3R (RWY EXT / – –.–NM) on the destination airport ARRIVALS page. Valid entries are one– or two-digit distances (NM), optionally followed by tenths, ranging from 1.0 to 25.0. When a distance is entered, the FMS creates a flight plan fix along the runway centerline at the entered distance. The fix is named RXYYY, where YYY is the designated runway (for example RX34).

The purpose of creating the runway extension fix when a runway is selected is to give an end-of-descent target for VNAV guidance, particularly when radar vectoring is expected. VNAV optimizes the descent to arrive at the runway extension fix in position for final approach, regardless of vectoring. VNAV guidance also results in descent to the required crossing altitude followed by level flight at the specified speed.

DESCENT PROFILE

The default descent profile is an economy descent to 10,000 ft followed by a 240 kt CAS speed descent. The pilot can change the default descent profile by entering any speed and/or altitude restrictions required to meet ATC clearances.

If the airplane reaches the limit speed, such as with an unforeseen tailwind, the aircraft departs the vertical path (VNAV PATH mode) and commands a speed target (VNAV SPD). The DRAG REQUIRED and THRUST REQUIRED messages are displayed to advise the pilot of speed changes required to maintain the descent path. Figure 7-12 shows a descent profile.



Descent Profile
Figure 7-12

ALTITUDE INTERVENTION

Altitude intervention incorporates the MCP altitude window and knob with the FMS VNAV flight planning for heads-up operation. For descent, altitude intervention lets the pilot delete constraints, perform altitude level offs, and resume descent.

Constraint Deletion

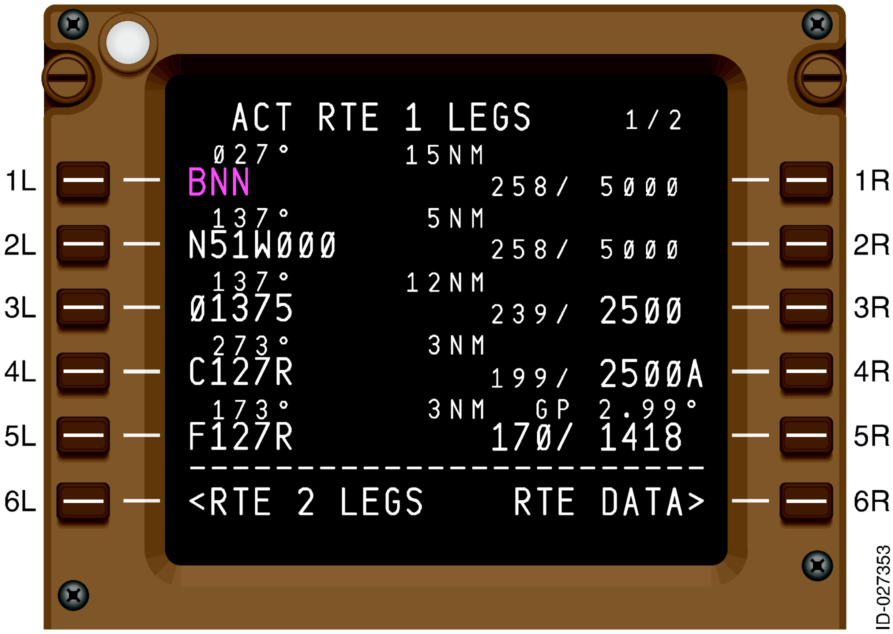
If the aircraft is actively descending, the pilot can dial the MCP altitude window to an altitude below the current altitude and delete descent constraints. Each time the MCP altitude knob is pushed the next descent constraint below the current altitude and above the MCP altitude is deleted.

Altitude Level Off and Resuming Descent

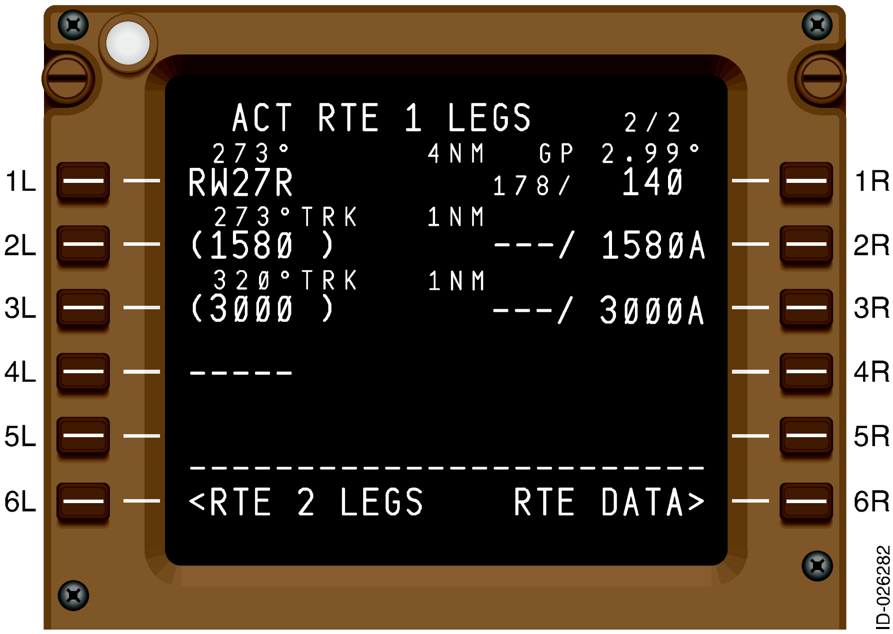
If the altitude window is set to an altitude between the current aircraft altitude and the end-of-descent constraint, the aircraft levels off at the MCP altitude. The descent can be resumed by dialing the altitude window to a lower altitude and pushing the altitude knob on the MCP.

8. Approach

This section describes the reference information available for approach. This information is displayed on the APPROACH REF page, NAV RADIO page, PROGRESS page, and POS REF page. Figures 8–1 and 8–2 show the ACT RTE 1 LEGS with the aircraft flying to the active waypoint BNN on descent into EGLL.



ACT RTE 1 LEGS Page – Preparing for Approach
Figure 8–1



ACT RTE 1 LEGS Page – On Approach
Figure 8–2

APPROACH REF PAGE

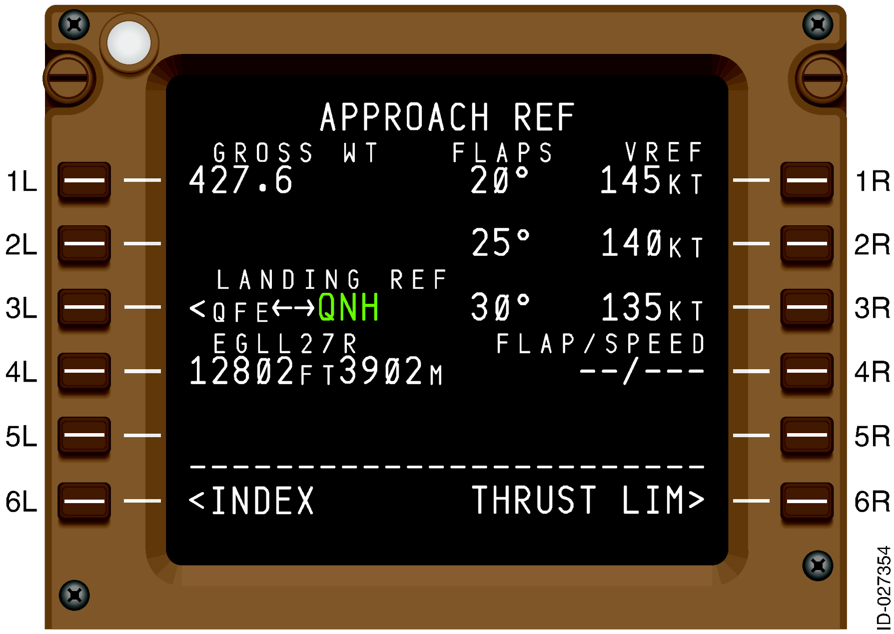
The APPROACH REF page, shown in Figure 8-3, displays data about the approach profile. The APPROACH REF page is displayed by doing either of the following:

STEPS:

1. Push the INIT REF key when the aircraft is airborne

OR

2. Select the APPROACH prompt on the INIT REF/INDEX page.



APPROACH REF Page – EGLL
Figure 8-3

The APPROACH REF page is described in the following paragraphs.

- **GROSS WT (1L)** – The gross weight in 1L is the instantaneous FMS-calculated aircraft gross weight, or a pilot-entered gross weight. Manually entered gross weight is replaced by instantaneous calculated gross weight when the page is exited.

  Box prompts are displayed when gross weight is not available from the FMS.

  The weight is displayed in thousands of pounds or thousands of kilograms, depending on the OPC option.

  Pilot-entered gross weights in 1L are for approach reference speed calculation only and these weights do not affect the airplane gross weight or the values displayed on the PERF INIT page.

- **LANDING REF (3L)** – Pushing 3L toggles the landing reference between QFE and QNH. The active mode is displayed in large green font, and the inactive mode is displayed in small white font.

- **Runway Length (4L)** – The origin or destination airport and runway are displayed in the 4L header line. The origin runway information is displayed until the aircraft is more than halfway to the destination or the aircraft is more than 400 NM from the origin runway. At that point the destination runway information data is displayed.

  The data field in 4L displays the runway length in feet and meters. For the flight from KORD to EGLL, the selected landing runway at EGLL is RWY27R, which is 12,802 ft long or 3902 meters long.

  NOTE: The pilot cannot enter or clear any data from 4L and this field is cleared when the flight is complete.

- **<INDEX (6L)** – Pushing 6L displays the INIT/REF INDEX page.

- **FLAPS/VREF (1R, 2R, 3R)** – The reference speeds (V_{REF}) for up to three flap settings (20°, 25°,and 30°) can be displayed in 1R through 3R. The reference speeds are computed from the performance database for the gross weight in 1L. If the performance database contains less than three flap references, 2R and/or 3R are blank.

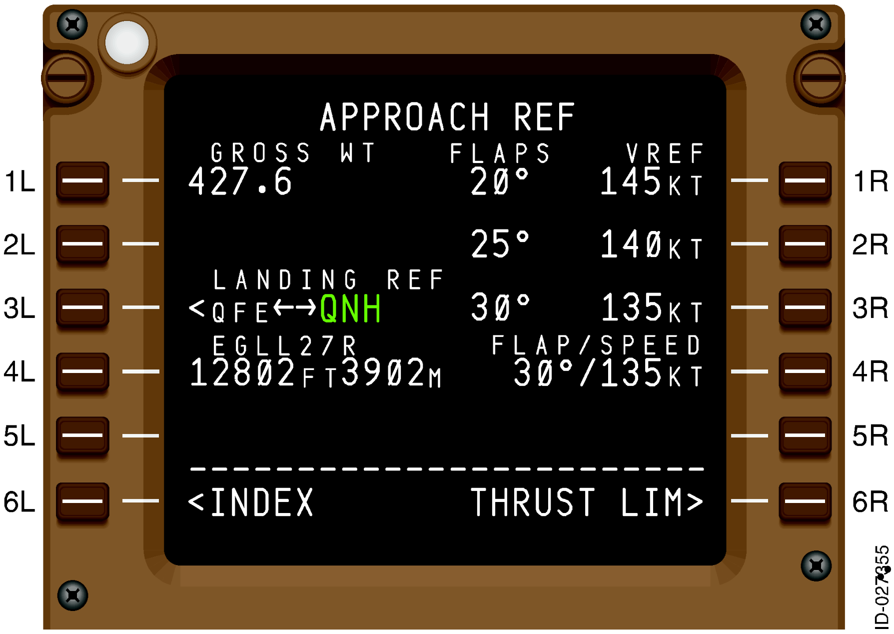
  Although these V_{REF} values are not displayed on the speed tape, they can be copied to the scratchpad and entered in 4R to give a speed tape reference. The pilot cannot enter or clear any data from 1R through 3R.

- **FLAP/SPEED (4R)** – The pilot can enter a speed or flap setting/ speed in 4R to use for landing. Dashes are displayed in 4R until data is entered.

STEPS:

1. To enter 30° of flaps and 135 kts for landing, push 3R to copy these values to the scratchpad.

2. Push 4R to select these values to the FLAP/SPEED field, as shown in Figure 8-4.



APPROACH REF – Completed
Figure 8-4

NOTES:

1. The V_{REF} speed is now displayed on the PFD.

2. Deleting a pilot-entered value displays dashes in 4R.

- **THRUST LIM (6R)** – Pushing 6R displays the THRUST LIMIT page.

RADIO TUNING

The radio tuning function can be handled automatically by the FMS, or the radios can be tuned manually using manual entries on the NAV RADIO page. VOR, ADF, and ILS receivers can be tuned on this page. If an FMC fails, radio tuning is handled by the CDU using pilot-selected stations or frequencies. Additional information on degraded performance is in Section 13, Backup Functions.

NAV RADIO PAGE

The NAV RADIO page is displayed by pushing NAV RAD key. The NAV RADIO page (Figure 8-5) displays current radio information and gives tuning capability for TACAN, VOR, ADF, and ILS receivers.

STEP: To display the NAV RADIO page, push the NAV RAD button.

NAV RADIO Page
Figure 8-5

The NAV RADIO page is described in the following paragraphs.

- **VOR L/VOR R (Line 1)** – The VOR information for the currently tuned stations is displayed in 1L and 1R. Valid entries are VOR and non–ILS DME station identifiers or VOR frequencies or identifier (frequency)/course.

  An entry in 1L or 1R tunes the associated DME frequency in the respective radio. These fields display frequency, identifiers, and the tuning status. The tuning status is displayed in small font and is in the following order of priority:

  — M (manual tuning) – The displayed station or frequency is pilot-entered.

  — P (procedure autotuning) – The FMS selects navaids required for approach or departure procedure guidance.

  — R (route autotuning) – The FMS–selected navaid is the next VOR, previous VOR, or a downpath VOR on the active route and within 250 NM of the current aircraft position.

  — A (autotuning) – The FMS selects the closest VOR/DME navaid.

  All tuning status symbols are displayed in small font.

  Deleting a manual tuned frequency and/or station clears the corresponding VOR course and reverts the corresponding channel to autotuning.

- **CRS/RADIAL (Line 2)** – The VOR course and radial for the selected VORs are displayed in line 2. Valid entries are course or VOR identifier (frequency)/course.

  A course is autoslected for procedure tuned navaids on a VOR approach and some VOR transitions.

  The VOR course can be entered when a course or dashes are displayed. Course information is not displayed for autotuned (A) navaids. Deleting 2L or 2R while a manually entered course is displayed clears the displayed course. Autotuned coruses cannot be deleted.

  The actual VOR radials received from the corresponding VOR receivers are displayed in 2C. If a VOR radial is invalid, the corresponding radial display is blank. Entries or deletions are not possible.

- **ADF L/ADF R (Line 3)** – ADF tuning information is displayed in 3L and 3R. The ADF frequency is followed by BFO or ANT for the corresponding tuning mode. For the ADF mode (default mode), no suffix is displayed.

  Valid entries are three or four-digit frequencies optionally followed by a decimal point and tenths digit. A valid frequency can be entered over existing ADF frequencies or when dashes are displayed. The ADF frequency can be entered followed by A for ANT mode, or by B for BFO mode. Also, if the current mode is BFO, A can be entered without a frequency to change the mode to ANT. If the mode is either ANT or BFO, deleting an entry causes the mode to return to ADF (no suffix displayed). Any other attempt to delete an ADF frequency is not allowed.

  NOTE: ADF frequencies are **not** tuned automatically. The frequency must be entered manually.

- **ILS – MLS (4L)** – ILS and MLS tuning information is displayed in 4L. Valid entries are an ILS frequency and front course, or front course with frequency already entered, or the MLS channel and azimuth, depending on which is being used.

  The display defaults to PARK at power–up. When an ILS, LOC, back course approach, or an ILS/LOC runway is entered in the active flight plan, the appropriate frequency/course is displayed in small font with a caret, followed by PARK. This display becomes active when the aircraft is within 200 NM of the top-of-descent or the aircraft is more than halfway along the active route, whichever is closer to the destination. The pilot can select the small font display in order to manually tune the ILS.

  When a valid frequency is manually or automatically tuned, PARK is replaced with the frequency/course display (large font).

  The FMS autotunes the ILS/MLS associated with the active flight plan destination runway when the aircraft is within 50 NM of top-of-descent, or within 150 NM direct distance of the runway threshold (whichever is greater), or when active in descent.

  PARK indicates that the ILS tuning is not active, it is in a standby mode waiting for the proper conditions before the tuning becomes active.

  The tuning status following the frequency/course is A for automatic tuning, M for manual tuning, and PARK for selected but not active.

  NOTE: Autotuning will NOT override manual tuning. Deleting a manually tuned frequency allows autotuning.

ILS receivers are inhibited from changes in manual or automatic tuning under any of the following conditions:

— An autopilot engaged and either the localizer or glideslope is captured

— No autopilot engaged and a flight director engaged, either localizer or glideslope captured, and the aircraft is below 500 ft RA

— On the ground and localizer is alive, with airplane heading within 45 degrees of localizer front course, and groundspeed greater than 40 knots.

Manual ILS tuning is restored when:

— Either TOGA switch is pushed

— The autopilot is disengaged and both flight directors are turned off

— The MCP approach switch is deselected when the aircraft is above 1500 ft RA

NOTE: Autotuning is inhibited for ten minutes after takeoff, unless a change in the destination runway has been made.

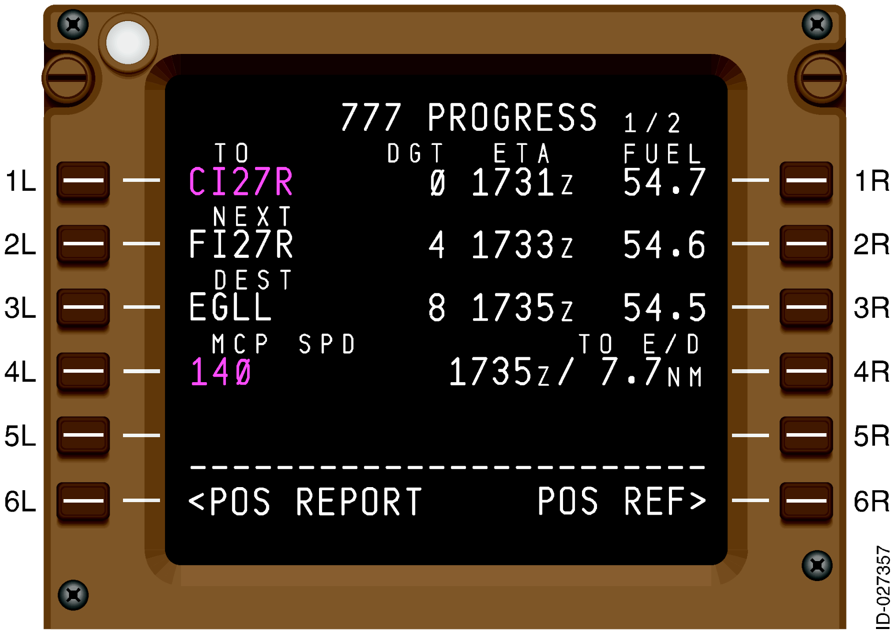
- **PRESELECT** - The tuning preselect fields in 6L and 6R let the pilot preselect an entry for any field on the NAV RADIO page. This lets the pilot enter a frequency, etc. before actually making the tuning change. Once preselected, the entry can be line selected to the scratchpad and then entered in the appropriate field on the NAV RADIO page. Valid entries are any valid tuning entry.

NOTE: When the flight is complete and the engines are shutdown, all the entered frequencies on the NAV RADIO page (including the manual tuned frequencies) are automatically cleared.

PROGRESS PAGE

Figure 8-6 shows the PROGRESS page for the aircraft on short final for a landing on runway 27R at London Heathrow Airport.

STEP: To display the PROGRESS page push the PROG key.



PROGRESS Page 1/2 – Short Final
Figure 8-6

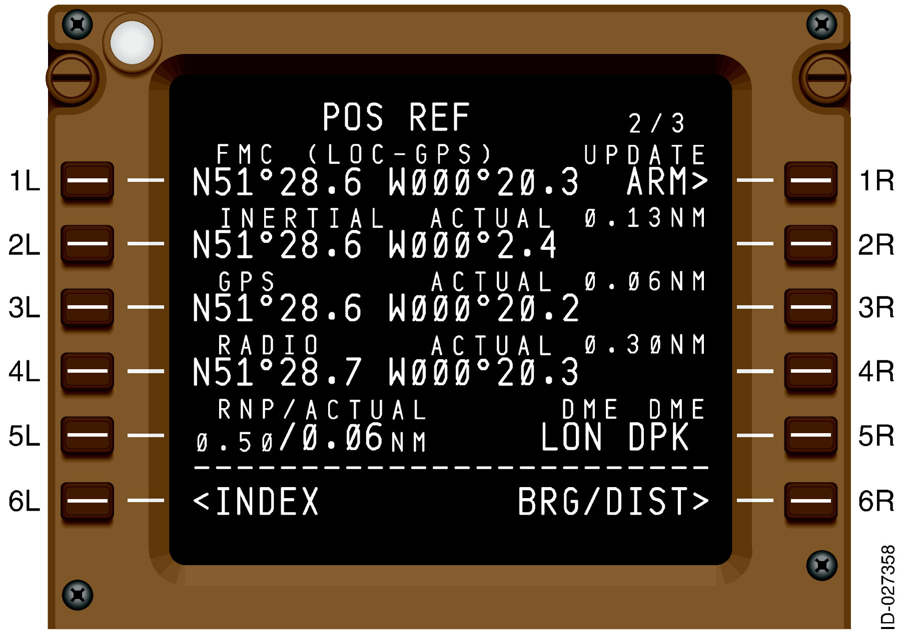
The MCP speed (140 kts) is displayed in 4L, and the aircraft is 7.7 NM from touchdown.

POS REF PAGE 2/3

The localizer radio updating and identifier in the APPROACH phase are displayed on the POS REF page. To display the POS REF page, shown in Figure 8-7, do the following:

STEPS:

1. Push the INIT REF key to display the INIT REF page.
2. Push 6L (INDEX) on the INIT REF page.
3. Push 2L (POS) on the INIT REF INDEX page.
4. Push the NEXT PAGE key to display the POS REF page 2/3.



POS REF 2/3
Figure 8-7

The fields on the POS REF page that display information used in APPROACH are described in the following paragraphs.

- **RNP/ACTUAL (5L)** – The position accuracy is displayed in 5L at about 0.5/0.06 NM.
- **DME/DME (5R)** – This section displays DME-DME radio identifers used for FMS radio updating.

9. Alternate Page

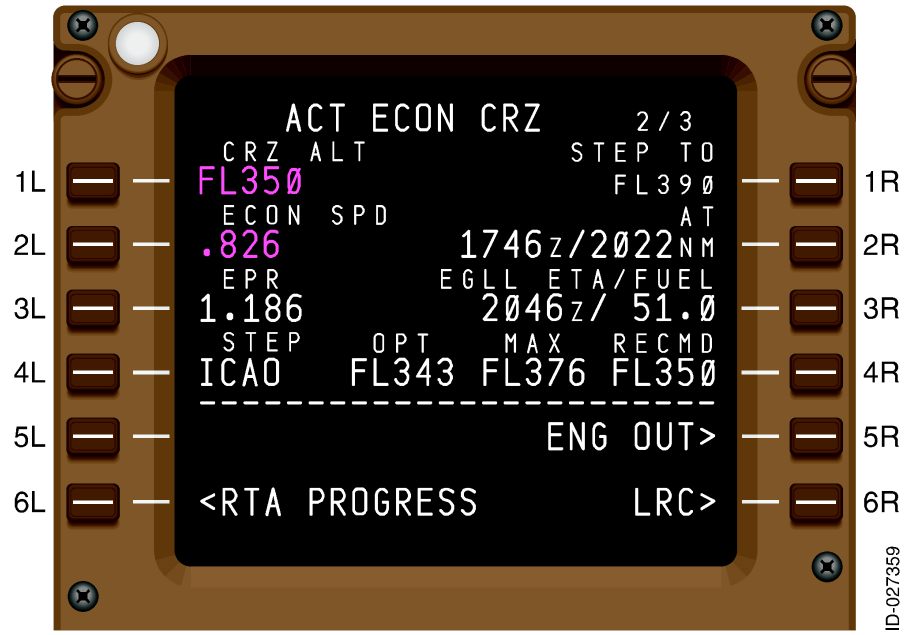
The ALTN page lets the pilot select alternate airports and displays data about the alternates. It is also used to initiate a diversion to an alternate airport.

The following scenario describes the procedure to divert to an alternate on the sample flight from KORD to EGLL. In this case, the reason for diversion is an engine failure en route.

ENGINE FAILURE EN ROUTE

Figure 9-1 shows the PERF page (ACT ECON CRZ) when an engine failure has occurred.

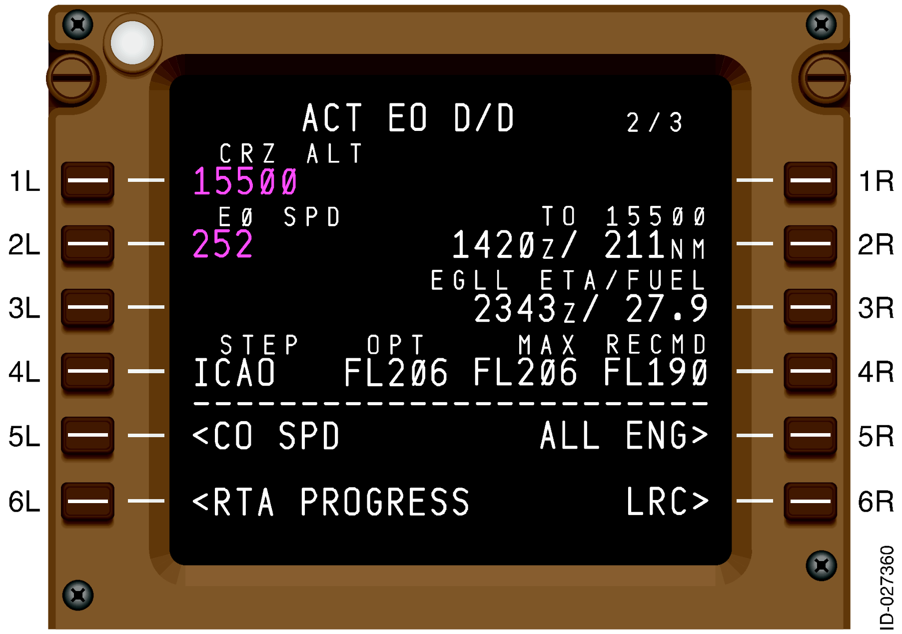
STEP: To display this page, push the VNAV key.



ACT ECON CRZ Page – Engine Failure.
Figure 9-1

STEPS:

1. Push 5R (ENG OUT).



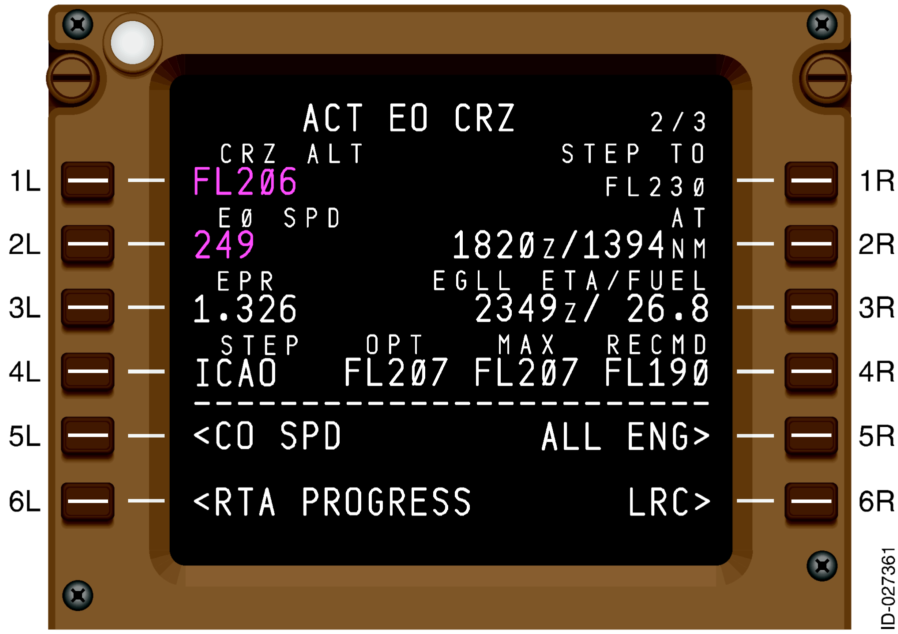
2. Push the EXEC key to display the ACT EO D/D page, shown in Figure 9-2.

ACT EO D/D Page
Figure 9-2

The ACT EO D/D page is described in the following paragraphs.

- **CRZ ALT (1L)** – The FMS-calculated new cruise altitude is displayed in 1L. In this case, it is 15,500 ft.
- **EO SPD (2L)** – The FMS-calculated engine out speed is displayed in 2L. In this case, it is 252 kts.
- **OPT MAX (4R)** – The optimum and maximum engine out altitudes are displayed in 4R. In this case, both altitudes are FL206.

Figure 9-3 shows the ACT EO CRZ page after the aircraft has leveled at FL206.



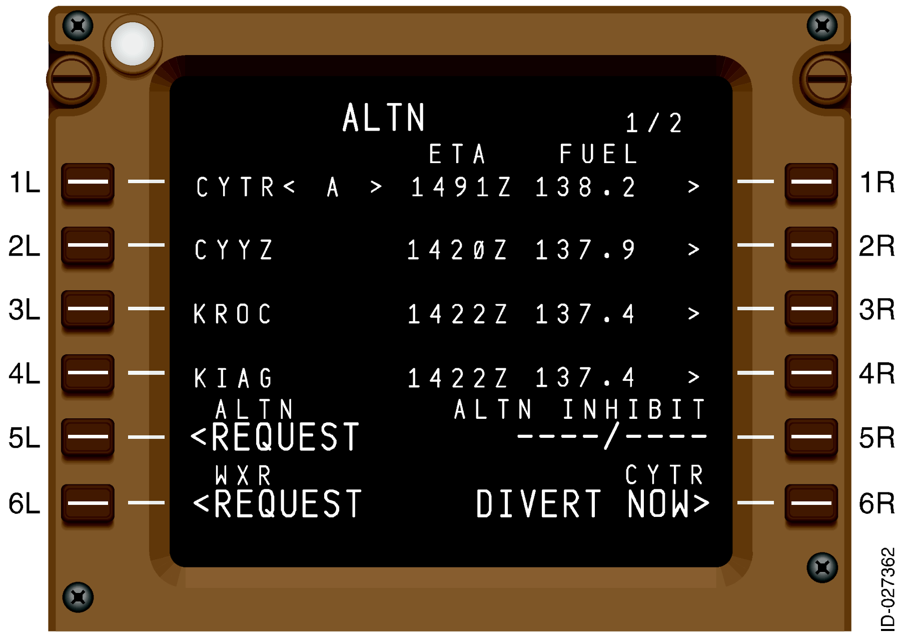
ACT EO CRZ Page – FL206
Figure 9-3

ALTERNATE PAGE 1/2

The ALTN page, shown in Figure 9-4, is used to check the alternates available along the route of flight. The ALTN page can be displayed by pushing the ALTN key or by selecting the ALTN prompt on any of the following pages:

- RTE 1/X page
- INIT REF/INDEX page
- FMC COMM page.

STEP: To display the ALTN page, push the ALTN key.



ALTN 1/2 Page
Figure 9-4

The ALTN page displays a list of up to four alternate airports. The source of alternate airports can be:

- An uplink directly to this page
- Automatic selection from the ALTN LIST page
- Automatic selection from the nav database
- Manual entry.

Alternate airports that are automatically selected from the alternate list or the nav database are displayed in small font. All four alternates can be displayed on the ND as a **cyan** alternate symbol. The currently selected alternate airport is displayed at all times on the ND map display. The remaining three alternates are displayed on the ND map display when the ARPT switch is ON.

NOTE: All four alternate airports are automatically displayed in the ND plan mode.

- **Alternates (1L through 4L)** – The identifiers for the four alternate airports are displayed in 1L through 4L. They are displayed in order of ETA when airborne and in order of distance when on the ground.

  The selected alternate is identified with an <A> or <SEL> to the right of the airport identifier. Normally, the closest alternate is automatically selected and identified with <A>. This is the case for CYTR in Figure 9-4. Manually selecting an alternate displays <SEL> to the right of the airport identifier.

  The selected alternate identifier is displayed in the header line in 6R (DIVERT NOW prompt).

  If an alternate airport is manually entered in 1L through 4L, it is displayed in large font and the alternates are resequenced according to ETA. The alternate that was in the line where the new airport is entered is removed from the list.

  The DEL key can be used to remove manually entered alternate airports from the ALTN page. Deleting a manually selected alternate removes the airport from the page and a new alternate is automatically selected to replace it.

- **<ALTN REQUEST (5L)** – Pushing 5L transmits a datalink request for a preferred list of alternates (up to four). Uplinked airports are displayed in order of ETA but are assigned a priority number by the transmitting site.

- **<WXR REQUEST (6L)** – Pushing 6L transmits a datalink request for alternate airport weather information. Uplinked weather is sent to the flight deck printer.

- **ETA (1C through 4C)** – The ETA is displayed for each of the alternates in 1C through 4C. The ETA is blank when the aircraft is on the ground.

  NOTE: The alternate ETA predictions only update every 5 minutes. Predictions continue to update after selecting the DIVERT NOW prompt and executing the diversion.

- **FUEL (1R through 4R)** – The predicted arrival fuel is displayed for each alternate airport in 1R through 4R. The fuel display is blank when the aircraft is on the ground.

- **ALTN INHIBIT (5R)** – One or two airport identifiers can be entered in 5R to inhibit those airports from automatically being displayed on this page. Inhibited alternates can be manually entered or uplinked. Valid entries are airport identifiers in the nav database.

- **DIVERT NOW> (6R)** – Pushing 6R modifies the route to fly from the present position to the selected alternate using the route displayed on the XXXX ALTN page. It creates a LNAV route modification for a diversion to the selected alternate.

  When 6R is pushed, the MOD XXXX ALTN page for the selected alternate is automatically displayed.

  Executing the diversion does the following:

  — Changes the route destination airport

  — Incorporates the route modification into the active flight plan

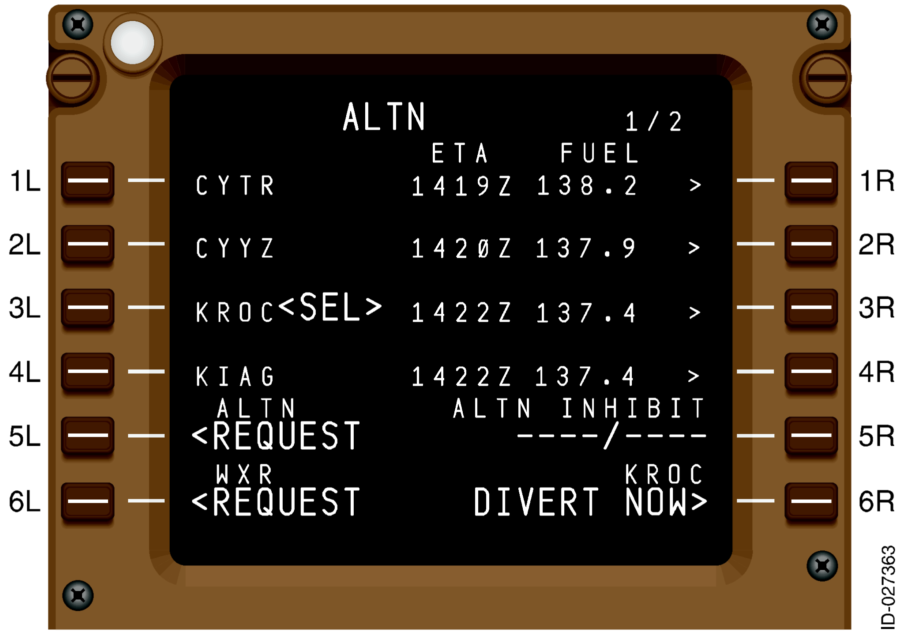
  — Deletes all parts of the original route that are not part of the diversion

  — If a descent path exists, deletes all descent constraints (DESCENT PATH DELETED is displayed in the scratchpad when DIVERT NOW is selected).

  NOTE: After a diversion is executed, the XXXX ALTN page is not updated until the XXXX ALTN page is exited on all CDUs.

On this flight scenario the aircraft is going to Greater Rochester International airport (KROC) rather than the alternate automatically selected, which is Trenton airport (CYTR).

STEP: Push 3L to select KROC as the alternate. The screen in Figure 9-5 is displayed.



ALTN 1/2 – KROC Selected
Figure 9-5

NOTE: KROC is now selected as the alternate (<SEL>) and 6R displays KROC above the DIVERT NOW prompt.

ALTERNATE PAGE 2/2

The ALTN page 2/2 is displayed by pushing the NEXT PAGE or PREV PAGE key when the ALTN page 1/2 is displayed.

The ALTN page 2/2 displays a list of previously uplinked alternate airports. The alternates displayed on the ALTN 1/2 page are automatically selected from this list, or from the nav database when a list does not exist.

This page contains up to 20 airports that can be used as alternates. The four lines display up to five alternate airports on each line. The alternates displayed on the ALTN page 1/2 can be manually selected from this list if preferred uplinked airports do not use all four selections.

The alternate list is uplinked directly to this page. No manual entry is allowed. Manual airport entries can only be done on the ALTN 1/2 page.

The entire alternate list can be deleted. If this is done, a new list must be uplinked. When no list exists, the alternate airports are automatically selected from the nav database.

Selecting the PURGE prompt in 5R displays a CONFIRM prompt. Selecting the CONFIRM prompt deletes all current airports from the alternate airport list.

XXXX ALTN PAGES

The XXXX ALTN pages display specific information about alternate airports, the route used for a diversion, and conditions for ETA and fuel calculations.

The KROC ALTN page is shown in Figure 9-6.

STEP: Push 6R (DIVERT NOW) or push 3R on the ALTN page 1/2.

KROC ALTN Page 3/4
Figure 9-6

This page is also selected when the ALTN key is pushed or when DIVERT NOW is not yet executed, and the ALTN prompt is selected on these pages:

- RTE X page
- INIT/REF INDEX page
- FMC COMM page.

All the data on this page is related to the alternate airport displayed in the page title (KROC ALTN 3/4 in Figure 9-6).

Three routes to the selected airport can be selected:

- DIRECT
- OFFSET
- OVERHEAD.

The selected route is identified by <SEL>. The ETA and fuel remaining calculations are based on the selected route. Selecting a route for one alternate selects the same route calculation for the other three alternates.

The XXXX ALTN page is described in the following paragraphs.

- **VIA (1L through 3L)** – The three route options are displayed in 1L through 3L under the VIA label.
  - **DIRECT TO (1L)** – Pushing 1L selects a direct route from the aircraft present position to the airport.
  - **OFFSET (2L)** – A left or right offset to the current active route to the airport can be entered in 2L and selected. Normal procedures for selecting an offset apply.
  - **OVERHEAD (3L)** – Pushing 3L selects the current active route until overhead the specified waypoint, then creates a direct route to the alternate airport.

    Selecting and executing an overhead diversion deletes all waypoints from the original active flight plan except those waypoints that are between the aircraft position and the selected overhead waypoint. The overhead point in Figure 9–6 is a waypoint called AMERT.
- **<ALL ENG (5L)** – Pushing 5L returns engine out information to all engine information.
- **ALTN (6L)** – Pushing 6L displays the ALTN page 1/2.
- **ALT (1R)** – The altitude that is used for ETA and arrival fuel calculations is displayed in 1R. Valid entry is any altitude or flight level.
- **SPD (2R)** – The speed that is used for ETA and arrival fuel calculations is displayed in 2R. This flight scenario displays the EO speed condition.
- **WIND (3R)** – The estimated average wind for the divert route is displayed in 3R. Valid entry is a direction in degrees and a speed in knots from 1 to 999.
- **ALT/OAT (4R)** – The OAT for a specified altitude is displayed in 4R. Valid entry is an altitude and temperature in °C.
- **ETA/FUEL (5R)** – The calculated airport ETA and arrival fuel based on the selected route, altitude, and speed are displayed in 5R.

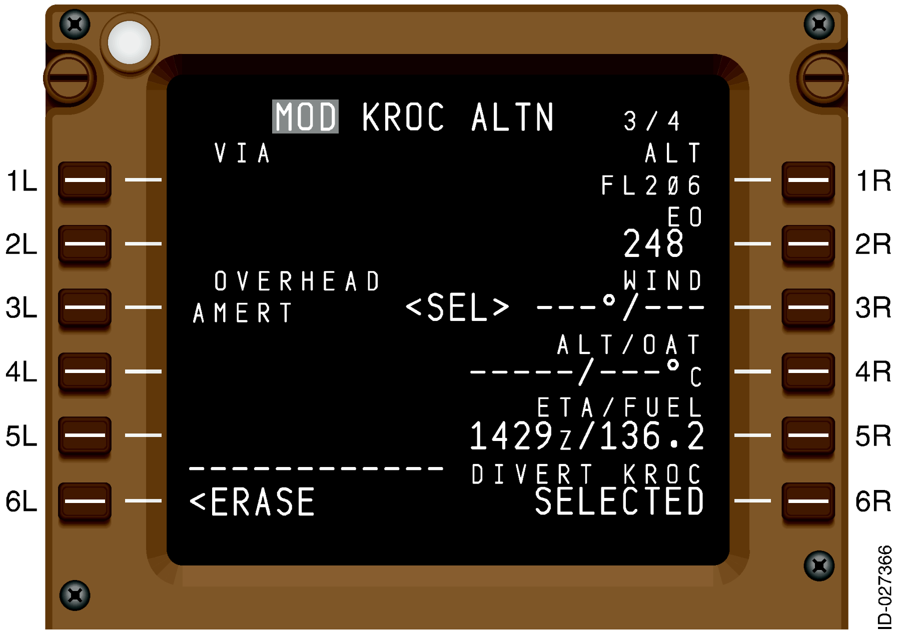
- **DIVERT NOW> (6R)** – This prompt is the same as on the ALTN page 1/2 (described earlier in this section).

The following steps select an overhead route (to the waypoint AMERT) and then to the alternate KROC.

STEP: Push 3L to select OVERHEAD on the KROC ALTN page 3/4, shown in Figure 9-7.

KROC ALTN Page – OVERHEAD <SEL>
Figure 9-7

STEP: Push 6R to select the diversion. The prompt in 6R changes to SELECTED and the page title changes to MOD KROC ALTN, shown in Figure 9-8.



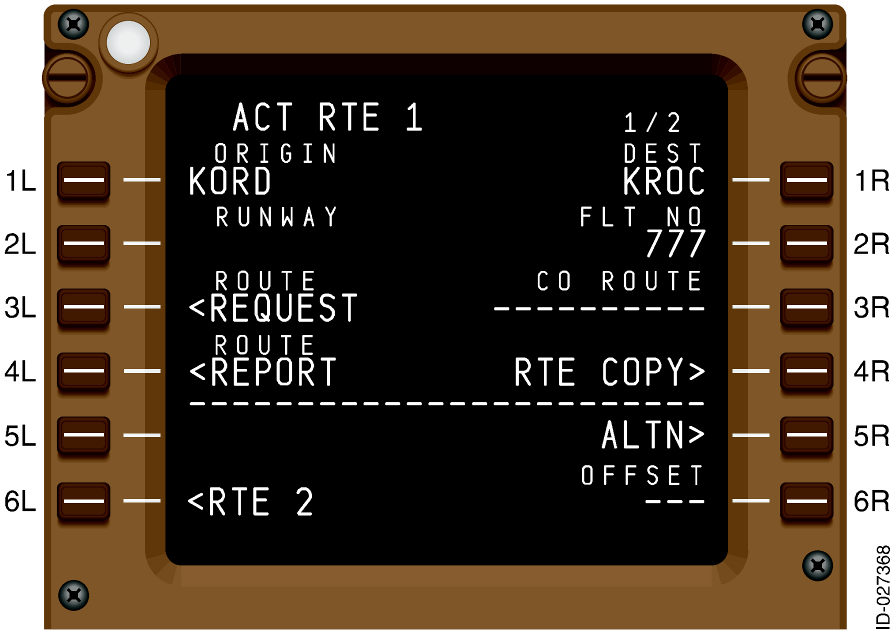
DIVERT KROC – SELECTED
Figure 9-8

STEP: Push the EXEC key to execute the diversion. <ACT> is displayed in 3L, as shown in Figure 9-9, to indicate the active route option.

ACT KROC ALTN Page
Figure 9-9

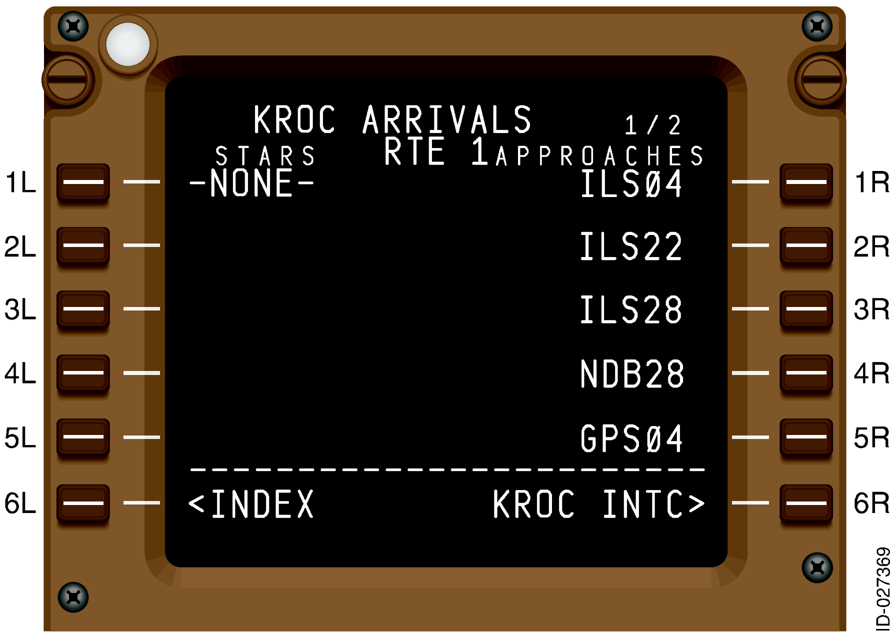
Executing the diversion to KROC changes the destination in the active route to KROC. This is shown on the ACT RTE 1 page (Figure 9-10).

STEP: To display this page, push the RTE key and then push the PREV PAGE key.



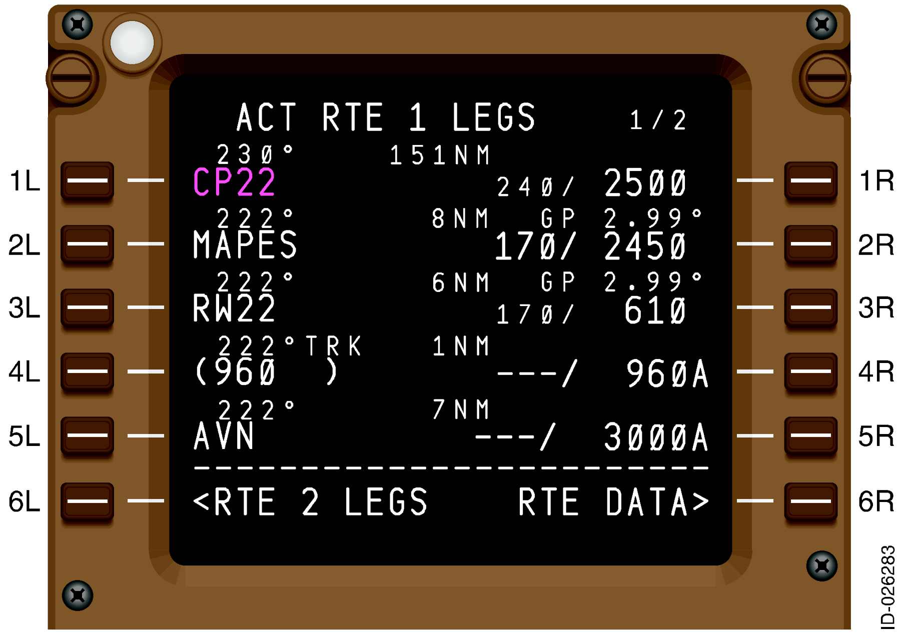
ACT RTE 1 Page
Figure 9-10

STEP: Push the DEP/ARR key to display the KROC ARRIVALS page (Figure 9-11).



KROC ARRIVALS Page 1/2
Figure 9-11

STEP: Select runway ILS 22 and EXECUTE. The page in Figure 9-12 is displayed.



ACT RTE 1 LEGS to KROC
Figure 9-12

10. Advanced Flight Planning

This section covers the following:

- Creating waypoints
- FMS waypoint abbreviations
- Polar operations
- Holding patterns.

PILOT-DEFINED WAYPOINTS

There are two different types of waypoints, nav database waypoints and pilot-defined waypoints.

Pilot-defined waypoints include the following:

- Place/bearing/distance
- Place bearing/place bearing
- Along track
- Latitude/longitude
- Course intersection.

Generally, waypoints are entered in the scratchpad, then moved to the desired location by pushing the associated LSK. If the pilot tries to enter a waypoint into the flight plan that is not in the proper format, INVALID ENTRY is displayed in the scratchpad. If the pilot tries to enter a waypoint that refers to an identifier that is not in the nav database, NOT IN DATA BASE is displayed in the scratchpad.

PBD/PBD and PB/PB Waypoints

Waypoints entered as a place/bearing/distance (PBD) or place bearing/place bearing (PB/PB) are identified by the first three characters of the entry followed by a two-digit sequence number. For example, the PBD entry of SEA330/13 becomes SEA01, or the PB/PB entry of SEA330/OLM020 becomes SEA02.

Along Track Waypoints

Along track waypoints are entered using the waypoint name followed by a slash (/) and minus sign (–) or no sign, then the offset (in miles) for the newly defined waypoint. The created waypoint is then inserted over the original waypoint. For example, entering ELN/25 creates an along track waypoint 25 miles after ELN on the present route, and entering ELN/–30 creates an along track waypoint 30 miles before ELN on the present route. The distance offset must be less than the distance between the original waypoint and next waypoint (positive value) or preceding waypoint (negative value). Along track waypoints cannot be created using lat/long.

Latitude/Longitude Waypoints

Lat/long waypoints are entered with no space or slash between latitude or longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude is in full degrees. Waypoints entered as a lat/long are displayed in a seven-character format. For example, N47° W008° is entered as N47W008 and displayed as N47W008. N47°15.4” W008°3.4” is entered as N4715.4W00803.4 and displayed as N47W008.

Latitude or longitude reporting waypoints are entered as the latitude or longitude followed by a dash, then the desired increment for the multiple waypoints. For example entering W060-10 adds waypoints starting at W060 in ten-degree increments from that point to the destination. The Latitude or longitude reporting waypoints are entered on a ROUTE LEGS page on the line before the first desired reporting point. Normally, this entry is made on the active waypoint line and the FMS sequences the waypoints as they are crossed.

Airway Crossing Fixes

Airway crossing fixes are entered as a five-character waypoint name (if a waypoint exists at the intersection) or by entering consecutive airways on the RTE page. If consecutive airways are entered, the FMS calculates the intersection of the two airways and displays the intersection as XJNN, when NN is the number of the second airway. For example, when J70 is entered on the left side of a VIA line on the RTE page, box prompts are displayed on the right side of that line. Leave the box prompts empty and enter J52 on the next VIA line, directly below J70. After the FMS has calculated the intersection, the box prompts are replaced with the waypoint identifier, XJ52. Table 10–1 gives a synopsis of pilot waypoint constructions.

Summary of Pilot Waypoint Construction

Waypoint construction is summarized in Table 10-1.

Type of Waypoint	CDU Page and Valid Entry	Valid Entry	Invalid Entry	Examples
Nav database waypoint	RTE or LEGS	Navaid, airport, waypoint, runway	NOT IN DATA BASE	Navaid: BAE, TOTNB Airport: ASSY Waypoint: AUGER Runway: RW30R
Place/bearing/distance	RTE or LEGS	Navaid, waypoint	Runway fix, LOM, MM, lat/long	DEN090/70 OBK274/61
Place bearing/place bearing	RTE or LEGS	Navaid, waypoint	Lat/long, distance greater than 700 NM from either fix	ORD125/CGT097 FSO360/CCR090
Latitude/longitude	RTE or LEGS	Lat/long with leading zeros (required)	If lat or long contains minutes, both lat and long must have trailing zeros	N45W165 N3728.0W13309.0 N3750.0W12500.0
Along track waypoint	LEGS	Waypoint must exist on LEGS page. (–) is prior to waypoint	Cannot coincide or extend beyond another existing waypoint	SFO/-35 DEN/30
Crossing lat or long	LEGS	Route crosses entered lat or long	Route does not cross entered lat or long	W123, N05
Interval lat or long	LEGS	Route crosses entered lat or long	An interval greater than 20 degrees	W125-5 S05-10
Airway intersection	RTE	Airways that intersect	Airways that do not intersect. Destination must be defined.	VIA TO J70 LWT J70 XJ204 J204 MLS

Pilot Waypoint Construction
Table 10-1

CONDITIONAL WAYPOINTS

Conditional waypoints are automatically entered in a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Conditional waypoints **cannot** be manually entered. These waypoints indicate when an event occurs and are not at a geographically fixed position.

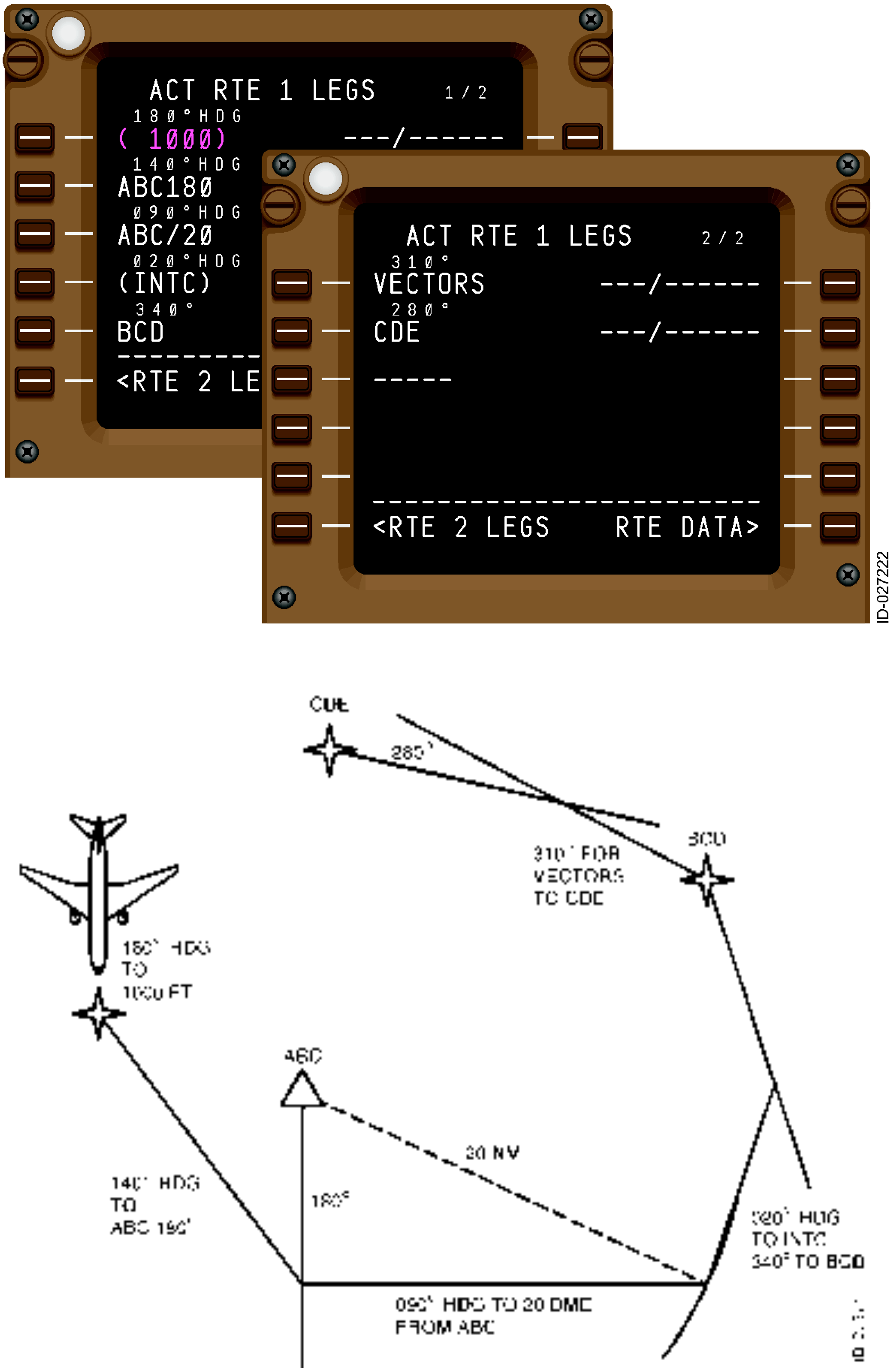
There are five types of conditions that create conditional waypoints:

- Passing an altitude
- Flying a heading to a radial
- Flying a heading to DME distance
- Intercepting a course
- Heading vectors.

Altitude and course intercept conditional waypoints are displayed on the CDU inside parentheses ( ).

VECTORS is displayed in the waypoint identifier field on a LEGS page when flying a conditional leg under ATC heading instructions. When released from ATC vector control, the FMS uses LNAV heading hold to intercept the active leg.

Figure 10-1 shows different types of conditional waypoints.



Conditional Waypoints
Figure 10-1

FMS ABBREVIATIONS

Waypoints located at unnamed runway-related fixes are identified by adding a two-letter prefix to the runway number. The following abbreviations are used with the runway number if a single approach exists to that runway:

- CF – Final approach course fix
- IF – Initial approach fix
- FF – Final approach fix
- OM – Outer marker
- MM – Middle marker
- IM – Inner marker
- RX – Runway extension fix
- RW – Runway threshold
- MA – Missed approach point (not runway)
- MD – Minimum descent altitude
- TD – Touchdown point inboard of threshold
- BM – Back course marker
- FA – VFR approach fix
- A – (+ an alpha) Step down fix

For example, ILS 28L can have the following runway–related fixes: CF28L, FF28L, RW28L.

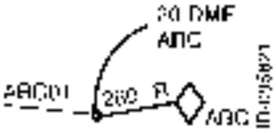
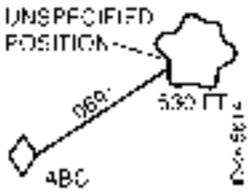
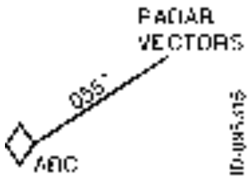
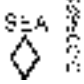
The abbreviations in Table 10-2 are used with the runway number if multiple approaches exist to that runway (parentheses after the waypoint type are included to compare with abbreviations above). The first letter identifies the type of fix and the second letter identifies the type approach. For example, VOR 32R can have the following runway related fixes: CV32R, FV32R, PV32R, RW32R.

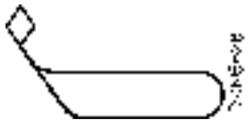
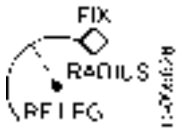
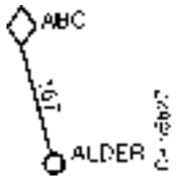
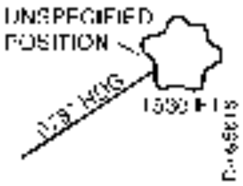
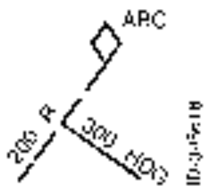
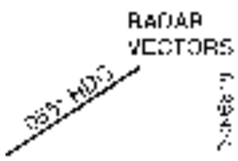
Waypoint Type	Procedure Type				
	ILS(B)	ILS(I)	ILS(L) LOC only)	MLS	NDB (N)
Course fix (CF)	CB	CI	CL	CM	CN
FAF (FF)	FB	FI	FL	FM	FN
MAP (MA)	PB	PF	PL	PM	PN
IAP (IF)	IB	II	IL	IM	IN
MDA (MD)	DB	DI	DL	DM	DN
TD (TD)	TB	TI	TL	TM	TN
	NDB (Q) w/ DME points)	RNAV	VOR (D) DME	VOR (S) w/ DME points)	VOR (V)
Course fix (CF)	CQ	CR	CD	CS	CV
FAF (FF)	FQ	FR	FD	FS	FV
MAP (MA)	PQ	PR	PD	PS	PV
IAP (IF)	IQ	IR	ID	IS	IV
MDA (MD)	DQ	DR	DD	DS	DV
TD (TD)	TQ	TR	TD	TS	TV

FMS Abbreviations for Runways With Multiple Approaches
Table 10-2

Navigation Leg Types

Table 10-3 shows the different types of flight plan legs that are displayed on the CDU and ND during a typical flight.

Legs	Example	Description	MCDU	Condition
AF		DME arc to a fix	20 ARC L ABC01	ABC01 is PBD waypoint ABC260/20. Tuned navaid required.
CF		Course to a fix	166° BTG	Tuned navaid required.
DF		Computed track to a fix	164° OED	Direct to fix, fix to fix, or intercept to fix. Tuned navaid may be required.
FA		Course from a fix to an altitude	069° (530)	Tuned navaid required.
FM		Course from a fix to a manual termination	055° VECTORS	Tuned navaid required.
HA HF HM		Holding pattern terminating automatically after reaching an altitude (HA), at a fix after one full circuit (HF), or manually (HM).	HOLD AT (8000) HOLD at SCARR HOLD AT SCARR PROC HLD SCARR	Hold until reaching a specific altitude (climb only). Exit hold after one turn (HF only). Exit hold manually. For HF legs
IF		Initial fix	- - -° SEA	Leg is ignored if created by the nav database. Leg is inserted as a route discontinuity if created manually.

Legs	Example	Description	MCDU	Condition
PI		Procedure turn	PROC TURN (INTC)	Tuned navaid required. Always followed by a CF leg.
RF		Constant radius turn between two database fixes, lines tangent to the arc, and a center fix.	DD ARC WPT	
TF		Track between two fixes	167° ALDER	Direct to fix, fix to fix, or intercept to fix. No required navaid.
VA		Heading to an altitude	078° HDG (1530)	Tuned navaid may be required.
VD		Heading to a DME distance	020° HDG PXR/13	Heading to a DME arc. Tuned navaid required.
VI		Heading to a course intercept	300° HDG (INTC)	Heading to an intercept leg. Tuned navaid may be required.
VM		Heading to a manual termination	055° HDG VECTORS	Tuned navaid may be required.
VR		Heading to a VOR/DME radial	085° HDG PXR350	Tuned navaid required.

Navigation Leg Types
Table 10-3

LNAV WAYPOINT IDENTIFIERS

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display. The CDU message NOT IN DATA BASE is displayed if a manually entered waypoint identifier is not stored in the nav database. The waypoint can still be entered as a lat/long, PBD, or PB/PB waypoint.

FMS-generated waypoints are identified with a five-character (maximum) identifier assigned according to the following rules.

Navaid Waypoint Names

Waypoints located at VHF navaids (VOR/DME/LOC) are identified by the official one-, two-, three-, or four-character facility identifier. For example:

- Los Angeles VORTAC - LAX
- Tyndall TACAN - PAM
- Riga Engure, USSR - AN.

Waypoints located at NDBs and identified by the station identifier. For example:

- FORT NELSON, CAN - YE.

Fix Waypoint Names

Waypoints located at fixes with names containing five or fewer characters and identified by the name. For example:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Waypoints located at fixes with names containing more than five characters are abbreviated using the following rules in sequence until five characters remain.

- Double letters are deleted. For example:
  - — KIMMEL becomes KIMEL
  - — COTTON becomes COTON
  - — RABBITT becomes RABIT.
- Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. For example:
  - — ADOLPH becomes ADLPH
  - — BAILEY becomes BAILY
  - — BURWELL becomes BURWL.
- Keep the last letter, then delete consonants from right to left. For example:
  - — ANDREWS becomes ANDRS
  - — BRIDGEPORT becomes BRIDT
  - — HORSBA becomes HORSA.
- For fixes with multi-word names, use the first letter of the word and abbreviate the last word, using the above rules in sequence until five characters remain. For example:
  - — CLEAR LAKE becomes CLAKE
  - — ROUGH ROAD becomes RROAD.

Unnamed Point Waypoint Names

This section covers unnamed turn points, intersections and DME fixes, unnamed flight information region reporting points, and unnamed oceanic control area reporting points.

TURN POINTS, INTERSECTIONS, AND DME FIXES

If an unnamed turn point, intersection, or fix is co-located with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the co-located waypoint is used. For example:

- An unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs are co-located with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifiers for unnamed turn points not co-located with a named waypoint are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 NM or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 NM or more, the last two digits of the distance are used and placed ahead of the navaid identifier. For example (NAVAID - DISTANCE - IDENT):

- INW - 18 becomes INW18
- CSN - 106 becomes 06CSN
- TCS - 89 becomes TCS89.

FLIGHT INFORMATION REGION, UPPER FLIGHT INFORMATION REGION, AND AIRSPACE REPORTING POINTS

Unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points have cases where the government authority does not assign unique, five-letter (or less) waypoint names. In cases where the supplied name cannot be converted to a unique five-letter identifier using the previous rules, the following rules are applied:

- **FIR** - Use the three characters for the FIR plus a number from 02 to 99. An identifier so developed is to be unique within the geographical area.

- **UIR** - Use the three characters for the UIR plus a number from 02 to 99. An identifier so developed is to be unique within the geographical area.

- **Controlled Airspace** - Use the three-letter characters for the type of controlled airspace plus a number from 2 to 99. For example:
  - — TMA - Terminal area
  - — CTR - Controlled zone
  - — ATZ - Aerodrome traffic zone
  - — CTA - Controlled area
  - — TIZ - Traffic information zone.

OCEANIC CONTROL AREA REPORTING POINTS

Entry/exit positions to oceanic areas are often defined by waypoints that are designated as geographical coordinates (lat/long) expressed in full degrees.

Positions in the northern hemisphere use the letters N and E, and positions in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three-digit value are used.

The position of the designator in the five-character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100°.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude.

For example:

- N50°W040° becomes 5040N
- N75°W170° becomes 75N70
- N50°E 020° becomes 5020E
- N06°E110° becomes 06E10
- S52°W075° becomes 5275W
- S07°W120° becomes 07W20
- S50°E020° becomes 5020S
- S06°E110° becomes 06S10.

TERMINAL AREA FIXES ON A DME ARC

Unnamed terminal area fixes along a DME arc are identified with the first character D. The second, third, and fourth characters indicate the radial that the fix is on. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 NM, B = 2 NM, C = 3 NM, etc. For example:

- EPH252°/24 becomes D252X
- EPH145°/24 becomes D145X
- GEG006°/20 becomes D006T.

An unnamed waypoint along a DME arc with a radius greater than 26 NM is identified as an unnamed turn point that is not co-located with a named waypoint. For example:

- CPR338°/29 becomes CPR29
- GEG079°/30 becomes GEG30.

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 NM, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. For example:

- CPR134°/29 becomes CP29A
- CPR190°/29 becomes CP29B
- CPR201°/29 becomes CP29C.

POLAR OPERATION

This section describes operating procedures unique to the polar region.

Heading Reference Switch

Selecting magnetic or true reference is normally done with the HDG REF switch located on the left forward panel. However, the reference is automatically changed to true (independent of the position of the HDG REF switch) when the aircraft is operating above or below 82° latitude.

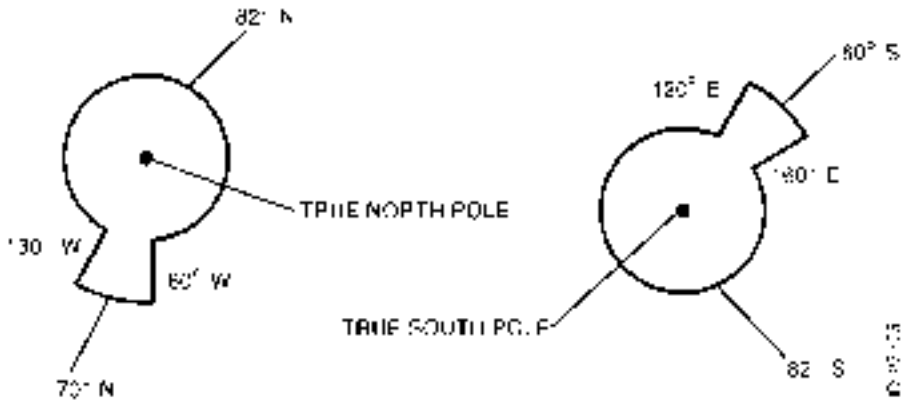
When the aircraft leaves this region, the heading reference is again determined by the position of the HDG REF switch. When operating in the true reference mode, bearing information entered by the pilot is assumed to be referenced to true north.

With the heading reference switch in the TRUE position, headings are referenced to true north regardless of latitude.

In the NORM position, the headings are referenced to magnetic north. In this position, there is no reference for AFDS roll modes other than LNAV when north of 82°N or south of 82°S latitude or in the vicinity of the magnetic poles.

FMS Polar Operations

The FMS automatically begins polar operation when the calculated aircraft position enters a polar region. All information from the FMS to the flight displays is referenced to true north while in these regions. Figure 10–2 displays the Polar Regions.



Polar Regions
Figure 10–2

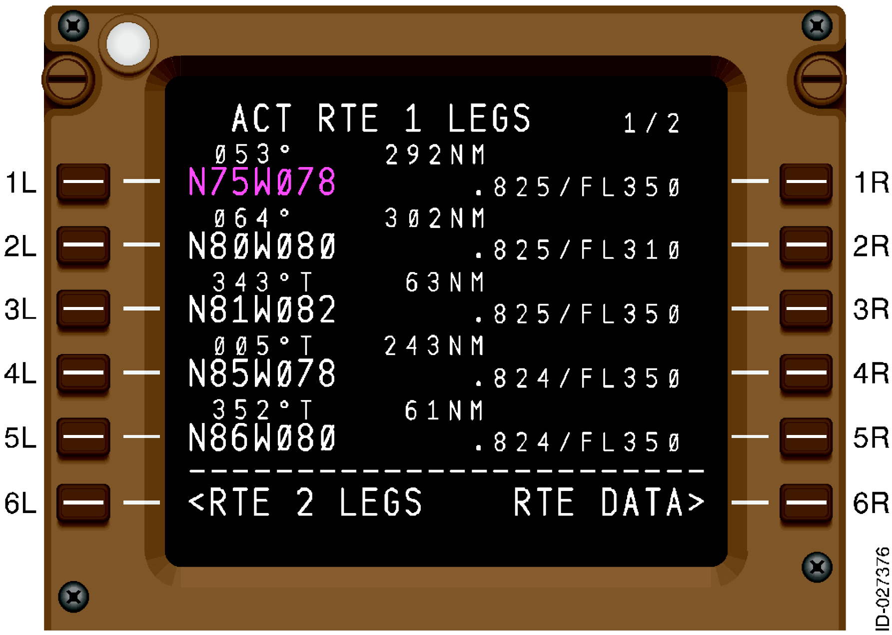
When the aircraft enters a polar region and the north reference is switched automatically, TRU is annunciated in a flashing **white** box on the ND. A true heading reference can be selected with the HDG REF switch inside or outside the polar region. Transition back to magnetic reference is annunciated by MAG inside a **green** box on the ND. If a descent is made with the HDG REF switch in TRU, an **amber** box is displayed around TRU.

NOTES:

1. When operating the autopilot in the polar region in other than LNAV, the HDG REF switch must be selected to the TRUE position.
2. When operating in the polar region with the ND PLAN mode displayed, the aircraft symbol is displayed as a circle.

LEGS Page in Polar Navigation

The waypoints where the heading reference automatically switches from magnetic to true north are displayed on the ACT RTE LEGS page (Figure 10-3).



RTE LEGS – Magnetic vs True
Figure 10-3

The ACT RTE 1 LEGS page in Figure 10-3 shows the magnetic course in 1L and 2L. The course heading in 3L is displayed as a true heading (indicated by a T after the heading).

This means at some point between waypoint N80W080 and waypoint N81W082, the heading reference automatically switches from magnetic to true.

NOTE: This example shows the heading reference switching in what is called the “key hole” area of the pole, which is bounded by N70°, N82°, W80°, and W130° (see Figure 10-2).

Polar Navigation Operating Recommendations

The primary and preferred roll mode for polar operations is LNAV. This mode can be used with the heading reference switch in the NORM position. HDG SEL/HOLD and TRK SEL/HOLD are functional but require that the heading reference switch be selected to the TRU position. Deviations from the planned route can be made in TRK SEL or HDG SEL. When operating the autopilot in the polar region in other than LNAV, the heading reference switch **must** be selected to the TRUE position.

The ND track and **magenta** lines may exhibit ratcheting when transiting routes in close vicinity of the pole. When operating in the polar region with the ND plan mode displayed, the airplane position symbol is removed. This occurs when flying into the polar region.

If either the North Pole waypoint (NPOLE) or the South Pole waypoints (99SP, S90EXXXXX or S90WXXXXX) are used, a rapid heading and track reversal occurs as the airplane passes over the polar waypoint. If operating in HDG/TRK SEL or HOLD while near either pole, the flight crew needs to rapidly update the heading or track selector to reflect the changing or reversed heading or track. Otherwise, the AFDS will command an unwanted turn. LNAV is the preferred roll mode.

GPS FAILURE IN POLAR NAVIGATION

Loss of both GPS units will result in an increased actual navigation performance (ANP) and possible display of the NAV UNABLE RNP message, but this normally would not prevent polar operation.

ADIRU FAILURE IN POLAR NAVIGATION

The air data inertial reference unit (ADIRU) is a fault tolerant unit. Total failure is extremely unlikely because a number of independent failures must occur before all navigation functions are lost. In the unlikely event the ADIRU does fail, the non-normal checklist provides the crew with inoperative items and necessary crew actions.

With at least one GPS operational, the ND is operational and accurately displays the FMS route and airplane track and position information. LNAV is inoperative. A heading reference must be entered into the FMS to regain use of the compass rose.

Because of the large and rapidly changing magnetic variations in the polar region, it may be more practical to enter the true track as a heading reference while in the polar region. If this is done, the display on the ND is more intuitive and the planned route can be tracked in HDG SEL. True track can be obtained from the computer flight plan or from the ND. Magnetic compass information should be used, if available, to update the heading reference when departing the polar region. With a total ADIRU failure, flight crews should plan a raw data instrument landing system (ILS) approach or a non-precision approach.

HOLDING PATTERNS

This section describes holding patterns and how the FMS calculates a holding pattern.

Types of Holding Patterns

There are three types of holding patterns:

- Holding Fix (HF) terminated – Patterns terminated by crossing the holding fix the first time after entering the hold.
- Holding Altitude (HA) terminated – Patterns terminated by reaching a specific altitude.
- Holding Manually (HM) terminated – Patterns terminated manually.

All three types may exist in terminal area procedures extracted from the nav database and can be accessed by the pilot. Only manually terminated holds can be created on the HOLD page. Altitude terminated and fix terminated holds cannot be created on the HOLD page.

If a direct-to is executed while in any type of hold, the FMS exits the hold immediately.

FIX TERMINATED HOLD (HF)

Fix terminated holds can occur in any flight phase but usually occur in descent. This type of hold consists of only one turn (or partial turn) around the pattern. The FMS exits the hold when the aircraft crosses the hold fix the first time after entering the hold. There is no special annunciator to alert the pilot when the hold is terminated.

The fix holding pattern type shown as a PROC HOLD on the ACT RTE 1 LEGS page shown in Figure 10–4, refers to procedure.

Example of PROC HOLD on ACT RTE 1 LEGS Page
Figure 10-4

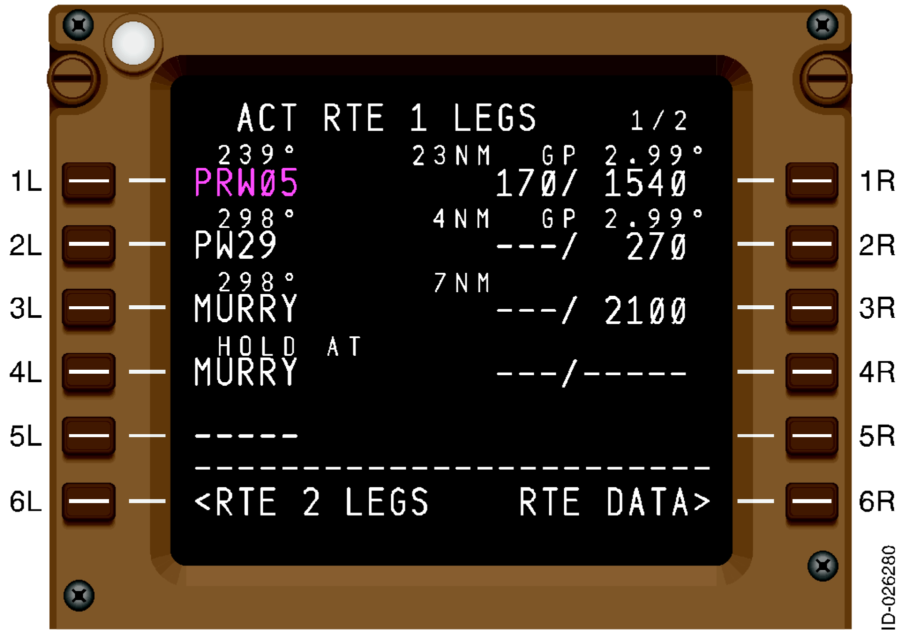
ALTITUDE TERMINATED HOLD (HA)

The altitude for altitude terminated holds is an AT OR ABOVE constraint, so altitude terminated holds only occur in climb. The FMS stays in the holding pattern until the AT OR ABOVE constraint is met. If the aircraft is already at or above the specified altitude upon reaching the holding fix, the hold is not flown. When the altitude constraint is met, the FMS enters the exit armed state, adjusts the holding pattern size to give the shortest route to the hold fix, and exits the hold the next time the hold fix is crossed.

MANUALLY TERMINATED HOLD (HM)

Manually terminated holds can occur in all flight phases. The pilot must manually terminate this hold by selecting the EXIT HOLD prompt on the HOLD page. When this prompt is selected, the FMS enters the exit armed state, adjusts the holding pattern size to give the shortest route back to the hold fix, and exits the hold the next time the hold fix is crossed.

The HM and HA hold patterns are designated with a “HOLD AT” shown on the ACT RTE 1 LEGS page shown in Figure 10-5.



Example of "HOLD AT" On ACT RTE 1 LEGS Page Display
Figure 10-5

Creating and Modifying Holding Patterns

Pilot-generated holding patterns are created on the ACT RTE HOLD page. This page is displayed by pushing the HOLD key on the MCDU. If a hold does not already exist in the flight plan, pushing the HOLD key displays the ACT RTE LEGS HOLD AT page for the pilot to specify a desired fix for the hold by entering the fix in 6L, or to define a present position hold by pushing 6R (PPOS). If one or more hold(s) already exist in the flight plan when the HOLD key is pushed, the ACT RTE HOLD page is displayed, showing the characteristics of the nearest hold in the flight plan. The pilot can access the ACT RTE LEGS HOLD AT page, by pushing 6L (NEXT HOLD) on the ACT RTE HOLD page. If more than one hold exists, the pilot can access the next nearest hold in the flight plan by pushing the NEXT PAGE key.

The fix at which the hold is defined is displayed in 1L on the HOLD page. The holding quadrant and radial are displayed in 2L. The quadrant abbreviations are N, NE, E, SE, S, SW, W, NW. The inbound course and turn direction of the hold are displayed in 3L. For manually terminated holds, the inbound course defaults to the leg course of the leg preceding the hold fix and the turn direction defaults to the right. The holding pattern straight leg size is defined by either its length or the time spent flying wings level. The leg time is displayed in 4L and the leg distance is displayed in 5L. Leg time and leg distance are mutually exclusive. Entering a value in one erases the value in the other. The FMS defaults to leg time. The leg time defaults to 1 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet. The altitude used to determine the leg time is as follows:

- If the holding pattern is in the FMS CLIMB or DESCENT segment, the constraint altitude for the hold is used. If a constraint altitude does not exist for the hold, the constraint altitude for the flight leg prior to the hold is used. If neither exist, the time defaults to 1 minute.

  NOTE: If a window constraint is defined, the upper altitude is used.

- If the holding pattern is in the FMS CRUISE segment, the cruise altitude is used. If the CRUISE segment cannot be determined because the PERF INIT data has not been completed, the time defaults to 1 minute.

The speed and altitude targets for the hold are displayed in 1R. FMS-predicted values are displayed in small font and defined constraint values are displayed in large font. For manually terminated or fix terminated holds, the pilot can enter both an altitude and speed constraint for the hold. Speed-only constraints are not allowed but an altitude-only constraint can be entered. If an altitude constraint already exists, a speed constraint can be added separately. The predicted time the aircraft will cross the next holding fix is displayed in 2R. An expect further clearance (EFC) time can be entered in 3R. The predicted holding time available is displayed in 4R (only available for manually terminated holds). The FMS-computed best hold speed is displayed in 5R.

Holding Patterns on the ND

There are two types of displays for holding patterns, a small symbol that does not change size as aircraft dynamics change (aircraft speed, wind direction and magnitude, etc.), and a large symbol that changes size as aircraft dynamics change. The small symbol is used when the map scale is more than 80 NM or anytime the hold fix is not the TO fix (the holding fix is **white**). The large symbol is used when the map scale is less than or equal to 80 NM and the hold fix is the TO fix (the holding fix is **magenta**).

The displayed holding pattern size may change when crossing the holding fix. This is especially true of the first holding fix crossing during DESCENT holding patterns without a deceleration segment (see Section 7, Descent).

Calculating Holding Pattern Size

The holding pattern size is first calculated when the holding pattern fix becomes the TO fix (the fix changes from **white** to **magenta**). If the FMS performance function is initialized (data has been entered on the PERF INIT page), the holding pattern turn radius is calculated by assuming a 25° bank angle at the current groundspeed, plus the absolute magnitude of the wind vector. If the FMS performance function is not initialized, the speed used is the true air speed from the ADC, plus the absolute magnitude of the wind vector. After the initial calculation, the pattern size is recalculated each time the aircraft crosses the holding fix. The holding pattern turn radius is calculated by assuming a 25° bank angle at a groundspeed equal to the true airspeed equivalent of the FMS holding command speed, plus the absolute magnitude of the wind vector. The FMS holding command speed is determined according to the following:

- If speed intervention is being used, the FMS command speed is the MCP speed.
- Otherwise, if the pilot has entered a constraint speed for the hold on either the ACT RTE HOLD page or the ACT RTE LEGS page, the lesser of the pilot-entered constraint speed or best hold speed limited by V_{GMIN} is used. Otherwise, the FMS computed best hold speed limited by V_{GMIN} is used.

NOTE: When the holding pattern is entered initially in DESCENT, the FMS command speed may be the active descent speed (for example, ECON speed) if a deceleration segment has not been constructed.

The hold turn radius is limited to ensure compliance with protected airspace limitations as defined by the FAA and ICAO.

If a leg time is used, the leg distance is calculated using the leg time divided by 60, times a groundspeed (equal to the true airspeed equivalent of the FMS holding command speed plus the wind vector along the inbound course), or times the true airspeed from the ADC plus the wind vector along the inbound course (if the FMS performance function is not initialized).

Deceleration Segments

While in CLIMB or CRUISE, the FMS decelerates to the FMS holding command speed before entering the hold. While in DESCENT, deceleration to the FMS holding command speed occurs before entering the hold only when there is an altitude constraint for the hold. Therefore, if the hold does not already have an altitude constraint, the pilot must manually enter one in 1R on the ACT RTE HOLD page, or for the holding pattern fix on the ACT RTE LEGS page, for FMS-commanded deceleration to occur before entering the hold.

Holding Pattern Entry Types

The aircraft must cross the holding fix before the FMS generates guidance commands to enter the hold. The FMS uses three types of holding pattern entry:

- Parallel
- Teardrop
- Direct entry.

The type of entry is determined by the aircraft course when crossing the holding fix.

Parallel entries are constructed with a leg parallel to the inbound course and a 180° turn towards the holding fix. After the turn, LNAV captures the inbound course. The length of the parallel leg is 2.41 times the turn radius. The crosstrack distance of the leg is determined by LNAV control using course angle error and groundspeed when the hold fix is crossed.

Teardrop entries are constructed with a leg from the holding fix on a course offset 40° from the reciprocal of the inbound course and a 180° turn toward the inbound course. The distance of the teardrop leg is 2.95 times the turn radius. After the turn, LNAV captures the inbound course.

Direct entries do not have defined segments. LNAV captures the inbound course or the outbound leg depending on aircraft course when crossing the hold fix.

Holding Pattern Guidance in CLIMB

During the CLIMB phase, the FMS does not generate guidance commands to descend. While in the holding pattern, LNAV guidance commands up to 30° of bank angle to track the lateral path. All types of holding patterns are allowed in the CLIMB phase.

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ALTITUDE TERMINATED HOLDS IN CLIMB

For altitude terminated holding patterns, the hold is flown until the AT OR ABOVE constraint is met. If the aircraft is already above the constraint before reaching the hold fix, the hold is not flown.

FIX TERMINATED HOLDS AND MANUALLY TERMINATED HOLDS IN CLIMB

If the hold is constrained by an AT OR BELOW constraint, the FMS climbs until reaching the constraint or the MCP altitude, whichever is lower. If the aircraft is already above the constraint or the MCP altitude when VNAV is engaged, the FMS levels off at the current aircraft altitude.

If the hold is constrained by a window constraint, the FMS climbs until reaching the upper altitude constraint or the MCP altitude, whichever is lower. If the aircraft is already above the upper altitude constraint or the MCP altitude when VNAV is engaged, the FMS levels off at the current aircraft altitude.

If the hold is constrained by an AT OR ABOVE constraint, the FMS climbs until reaching the cruise altitude, the next AT constraint, the next AT OR BELOW constraint, or the MCP altitude, whichever is lowest.

If the hold is not constrained, the FMS climbs until reaching the cruise altitude, the next AT constraint, the next AT OR BELOW constraint, or the MCP altitude, whichever is lowest.

Holding Pattern Guidance in CRUISE

While flying holding patterns in the CRUISE phase, LNAV guidance commands up to 30° of bank angle to track the lateral path. Only fix terminated and manually terminated holding patterns are allowed in CRUISE. The hold is always at the cruise altitude and all types of altitude constraints are allowed but cannot be above the cruise altitude. However, if a constraint that is below the cruise altitude is entered for the hold, the FMS enters the DESCENT flight phase.

Holding Pattern Guidance in DESCENT

While flying in the DESCENT flight phase, the FMS does not generate guidance commands to climb. While in the holding pattern, LNAV guidance commands up to 30° of bank angle to track the lateral path. Only fix terminated and manually terminated holding patterns are allowed in DESCENT.

The following assumes the MCP altitude is set below the descent path altitude and all constraint altitudes. While in DESCENT, the FMS always captures the MCP altitude when descending from above the MCP altitude and levels off at the current aircraft altitude if VNAV is engaged when the aircraft is below the MCP altitude.

If the hold is constrained by an AT OR BELOW constraint, the FMS descends until reaching the constraint or the descent path altitude, whichever is lower. If the aircraft is already below the constraint and the descent path altitude when VNAV is engaged, the FMS levels off at the current aircraft altitude.

If the hold is constrained by a window constraint, the FMS descends until reaching the lower altitude constraint or the descent path altitude, whichever is higher. If the aircraft is already below the lower altitude constraint when VNAV is engaged, the FMS levels off at the current aircraft altitude. If the descent path altitude at the hold fix is above the upper altitude constraint, the FMS descends until reaching the upper altitude constraint.

If the hold is constrained by an AT OR ABOVE constraint, the FMS descends until reaching the constraint altitude or the descent path altitude, whichever is higher. If the aircraft is already below the constraint when VNAV is engaged, the FMS levels off at the current aircraft altitude. If the hold is not constrained, the FMS descends until reaching the descent path altitude. If the aircraft is already below the descent path altitude when VNAV is engaged, the FMS levels off at the current aircraft altitude.

11. FMC Datalink

The onboard communications system facilitates two-way datalink communications between the FMC and airline operations. Information can be downlinked from the FMC either manually or automatically. Information can be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.

This section describes manual and automatic downlinks.

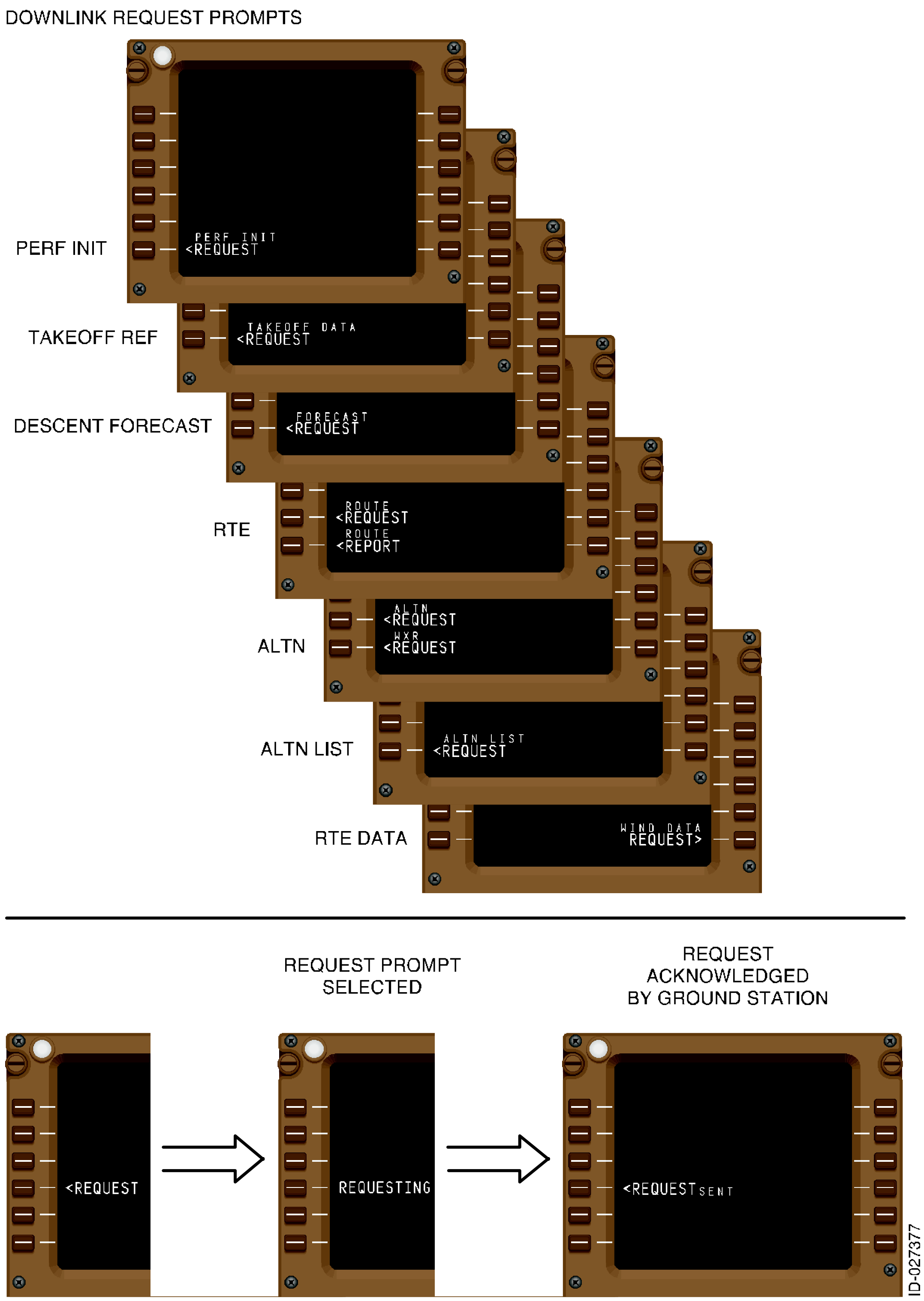
MANUAL DOWNLINKS

The following description of manual downlinks is divided into two parts:

- Systems with the takeoff datalink option
- Systems without the takeoff datalink option.

Systems With the Takeoff Datalink Option

See Figure 11–1. Downlink requests for data can be initiated by selecting the REQUEST prompt on the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages.



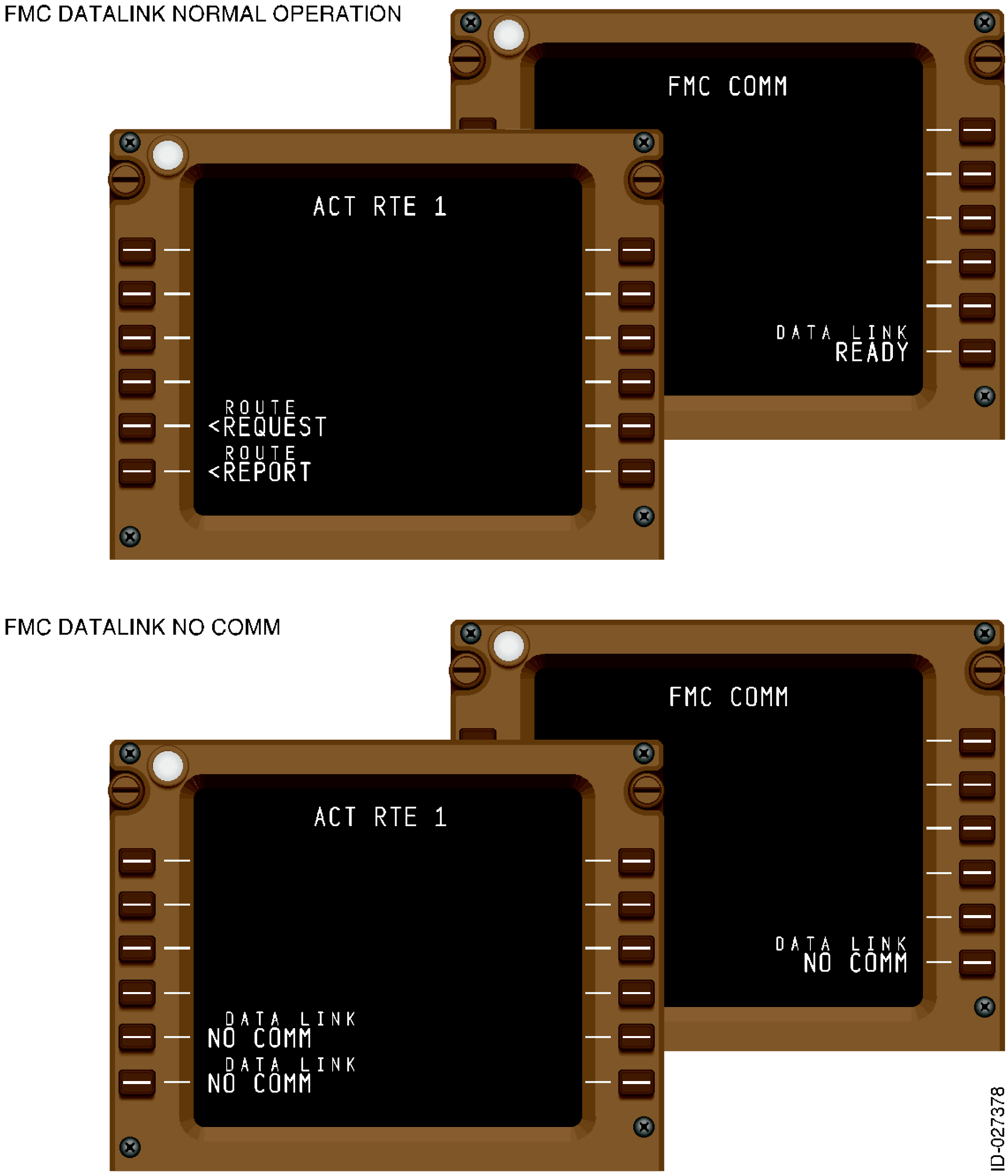
FMC Datalink Requests – With Takeoff Option
Figure 11–1

A report of the current route can be downlinked by selecting the REPORT prompt on the RTE page, and a position report can be downlinked by selecting the REPORT prompt on the POS REPORT page.

When the communications function cannot process FMC downlinks, FAIL, NO COMM, or VOICE is displayed on the CDU page in place of the REQUEST and REPORT prompts. The datalink status is also displayed on the FMC COMM page, as shown in Figure 11-2. VHF and SATCOM radios supporting datalink operations can be reconfigured by the crew with the FMC COMM function.

The status messages are as follows:

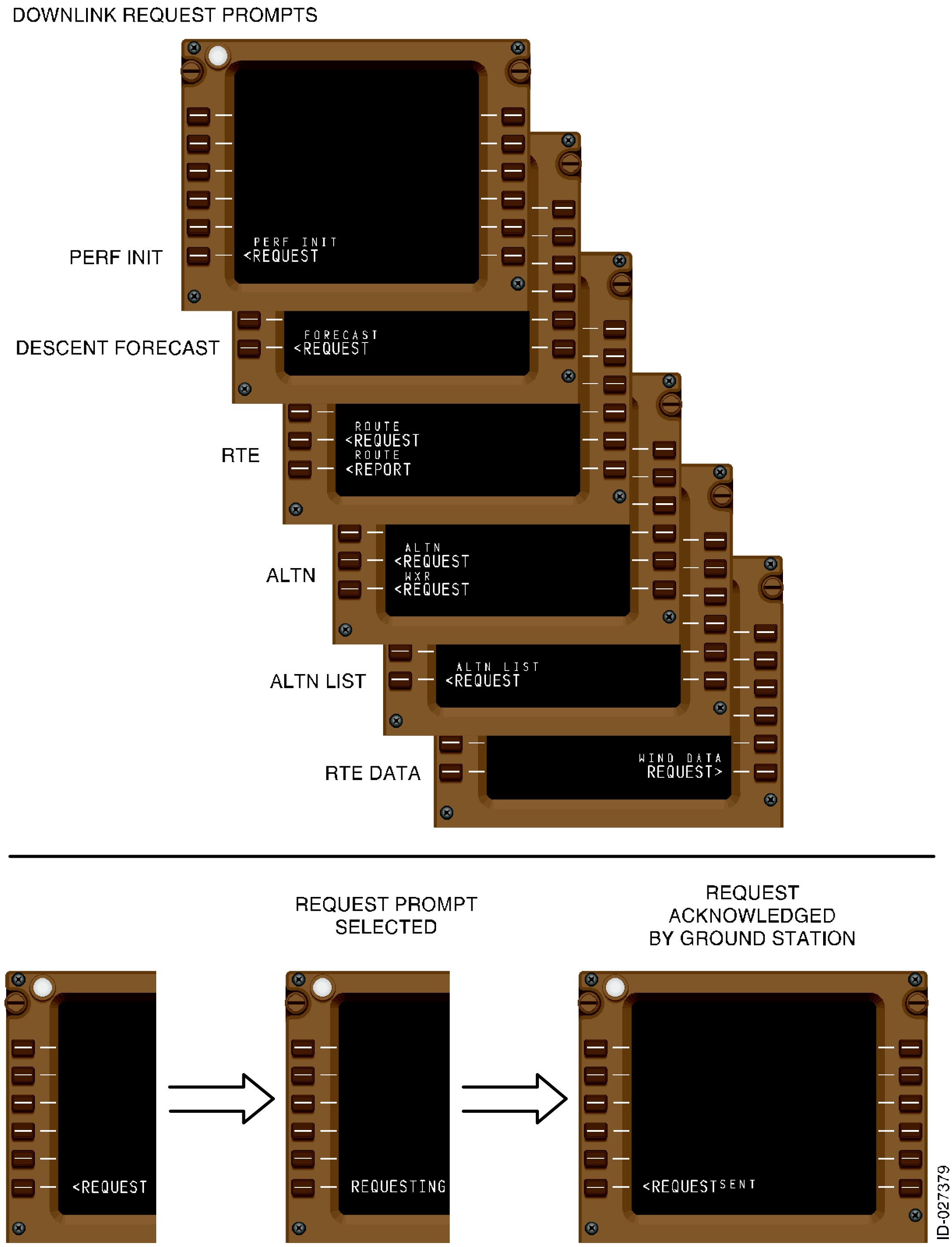
- **FAIL**
  - — The AIMS data communications management function is inoperative, or
  - — Both the VHF and SATCOM data radios have failed.
- **NO COMM**
  - — The VHF and SATCOM data radios are operational but not available, or
  - — The VHF data radio has failed and the SATCOM data radio is not available, or
  - — The SATCOM data radio has failed and the VHF data radio is not available.
- **VOICE** - All available radios are operating in the VOICE mode.



FMC Datalink Status
Figure 11-2

Systems Without the Takeoff Datalink Option

Downlink requests for data can be initiated by selecting the REQUEST prompt on the PERF INIT, DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages, shown in Figure 11–3.



FMC Datalink Requests – Without Takeoff Option
Figure 11–3

A report of the current route can be downlinked by selecting the REPORT prompt on the RTE page, and a position report can be downlinked by selecting the REPORT prompt on the POS REPORT page.

When the communications function cannot process FMC downlinks, FAIL, NO COMM, or VOICE is displayed on the CDU page in place of the REQUEST and REPORT prompts. The datalink status is also displayed on the FMC COMM page. VHF and SATCOM radios supporting datalink operations can be reconfigured by the crew with the FMC COMM function.

The status messages are as follows:

- **FAIL**
  - — The AIMS data communications management function is inoperative, or
  - — Both the VHF and SATCOM data radios have failed.
- **NO COMM**
  - — The VHF and SATCOM data radios are operational but not available, or
  - — The VHF data radio has failed and the SATCOM data radio is not available, or
  - — The SATCOM data radio has failed and the VHF data radio is not available.
- **VOICE** – All available radios are operating in the VOICE mode.

AUTOMATIC DOWNLINKS

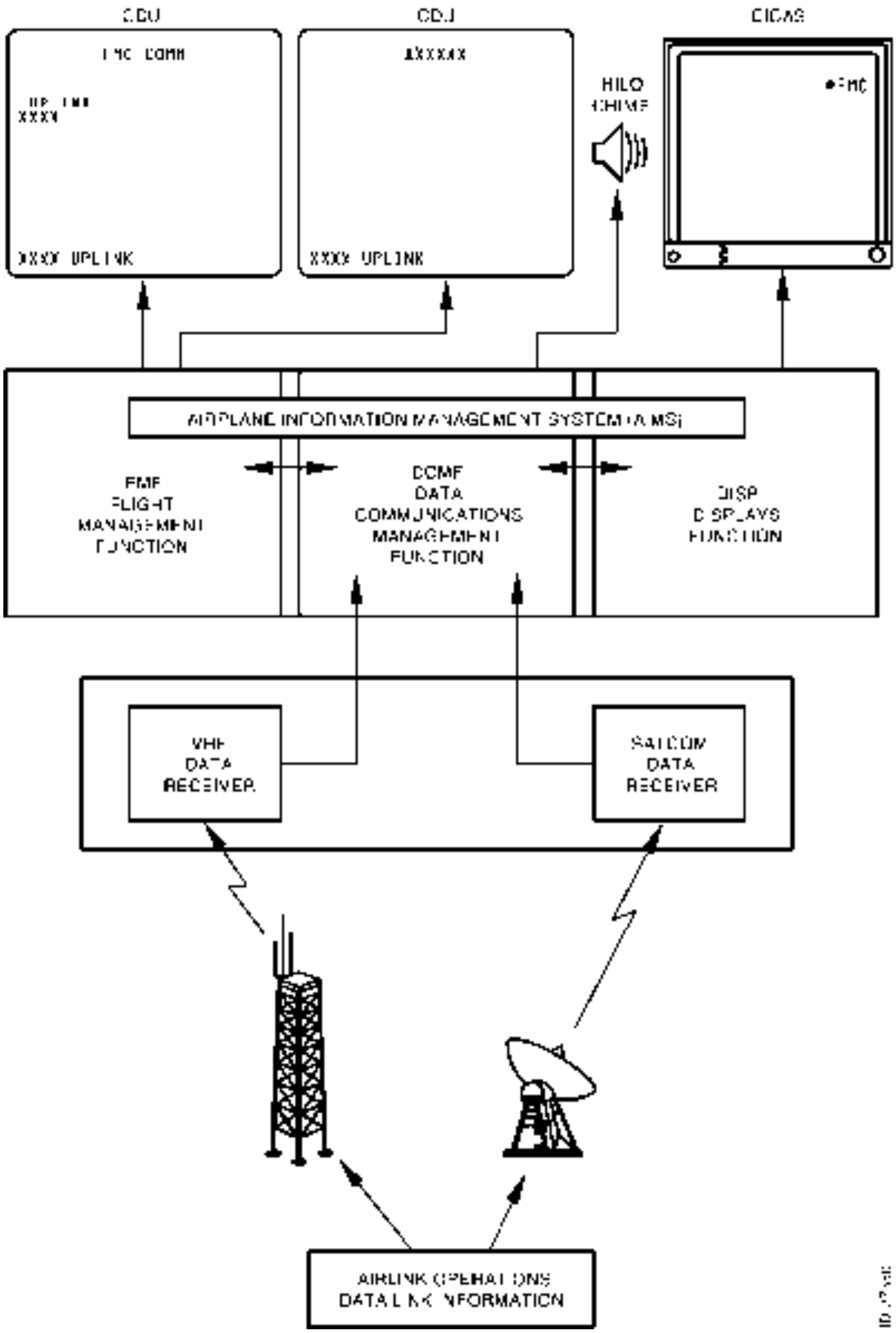
The FMC can be configured by the airline to automatically transmit downlinks of the FMC data at predetermined points during the flight or in response to specific information requests from the airline dispatcher. The FMC response in these cases is completely automatic and no crew action is required.

MANUAL UPLINKS

The following description of uplinks is divided into two parts:

- Systems with the takeoff datalink option
- Systems without the takeoff datalink option.

Figure 11-4 shows the FMC datalink uplink message flow.



FMC Datalink Uplinks
Figure 11-4

Systems With the Takeoff Datalink Option

Data can be uplinked from the airline dispatcher directly to the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, and WIND pages. The uplinks are annunciated to the crew by the •FMC EICAS communications alert and a hi-lo chime. The uplink is identified with a CDU scratchpad message and with an UPLINK label above the appropriate COMM page prompt.

If there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the COMM page is not displayed.

Takeoff uplinks are not annunciated until:

- Gross weight is entered on the PERF INIT page
- A route is activated
- The active route has a departure runway (and intersection, if applicable) matching the TAKEOFF uplinks (up to six takeoff records can be uplinked).

Systems Without the Takeoff Datalink Option

Data can be uplinked from the airline dispatcher directly to the PERF INIT, DESCENT FORECAST, RTE, ALTN, ALTN LIST, and WIND pages. The uplinks are annunciated to the crew by the •FMC EICAS communications alert and a hi-lo chime. The uplink is identified with a CDU scratchpad message and with an UPLINK label above the appropriate COMM page prompt.

If there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the COMM page is not displayed.

Processing Uplinks – Accept/Reject

The following description of processing uplinks with an accept or reject response is divided into two parts:

- Systems with the takeoff datalink option
- Systems without the takeoff datalink option.

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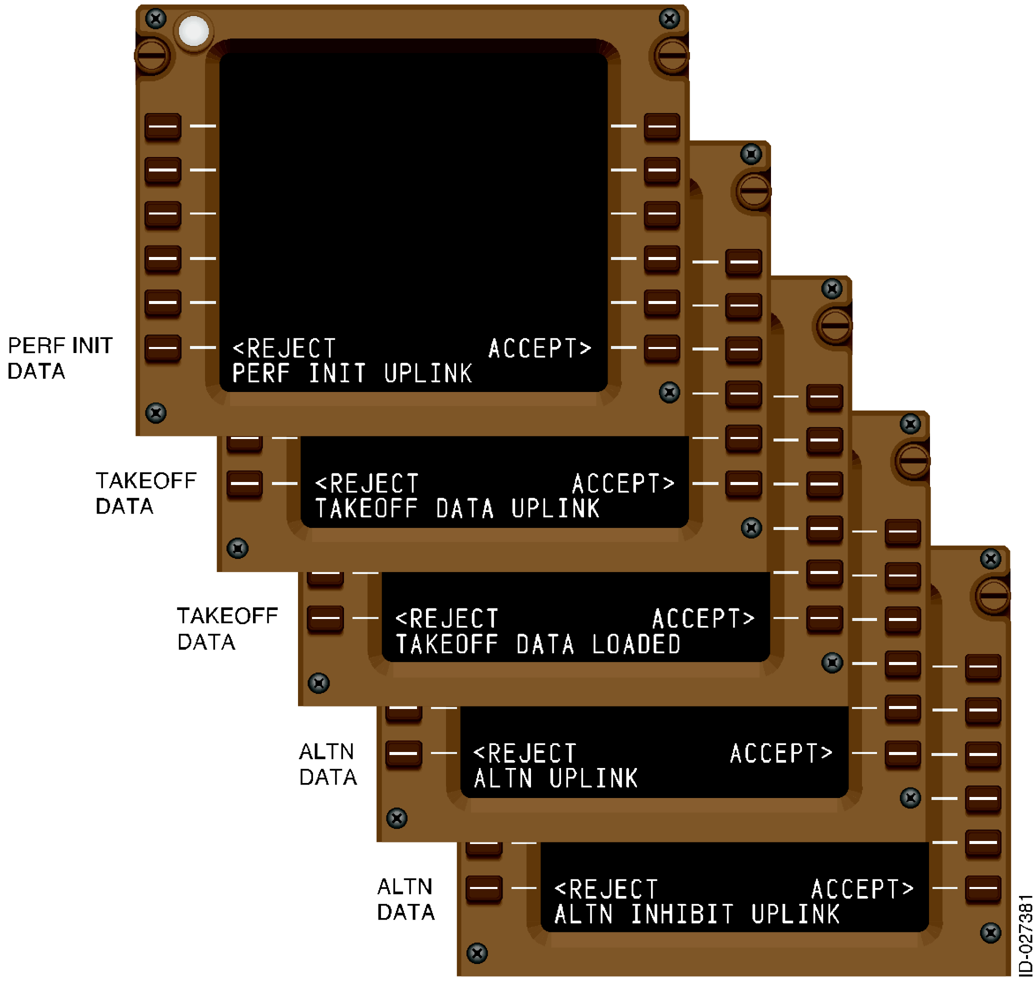
SYSTEMS WITH THE TAKEOFF DATALINK OPTION

After receiving uplinked data, the ACCEPT and REJECT prompts are displayed on the PERF INIT, TAKEOFF page 1/2, and ALTN pages, shown in Figure 11-5.



Accept/Reject Prompts – With Takeoff Option
Figure 11-5

The uplink is displayed initially in small font for preview.

Selecting ACCEPT:

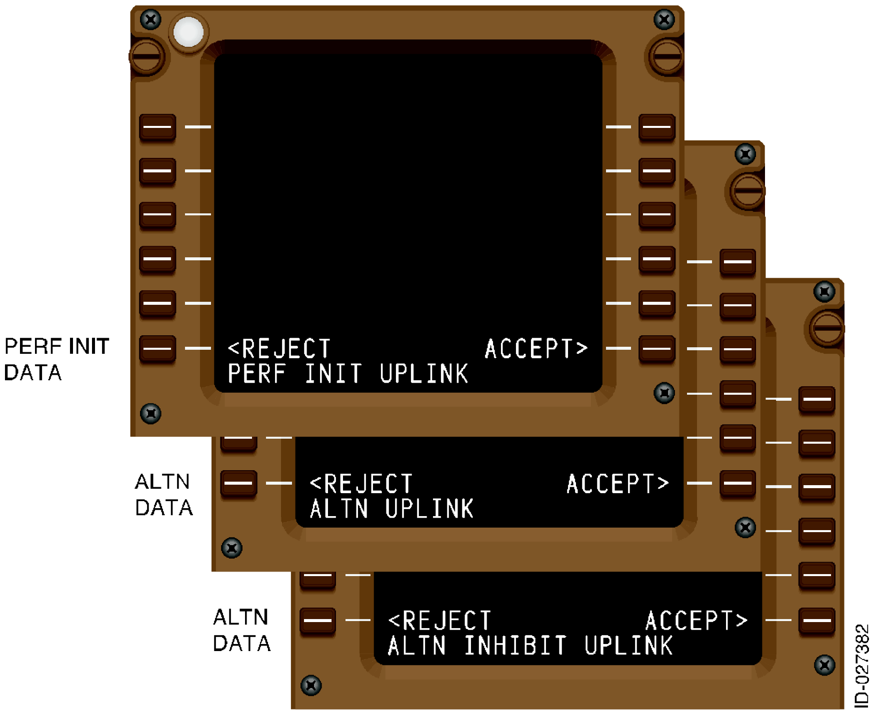
- Displays uplinked data in large font
- Replaces previous data with uplinked data
- Returns page display to normal (pre-uplink) format
- Clears scratchpad message
- Transmits a downlink accept message (if enabled) to acknowledge accepting the uplink.

Selecting REJECT:

- Replaces uplinked data with previous data
- Returns page display to normal (pre-uplink) format
- Clears scratchpad message
- Transmits a downlink reject message (if enabled) to inform that the uplink was rejected.

SYSTEMS WITHOUT THE TAKEOFF DATALINK OPTION

After receiving uplinked data, the ACCEPT and REJECT prompts are displayed on the PERF INIT and ALTN pages, shown in Figure 11-6.



Accept/Reject Prompts – Without Takeoff Option
Figure 11-6

The uplink is displayed initially in small font for preview.

Selecting ACCEPT:

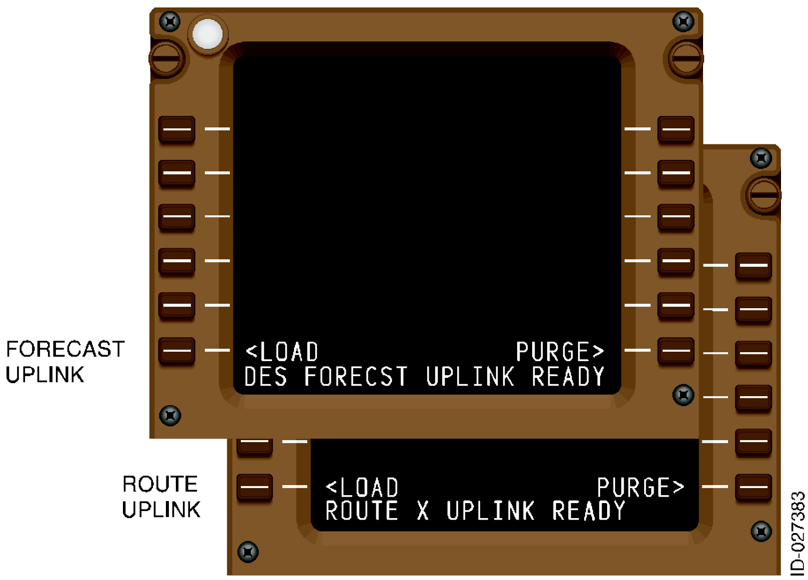
- Displays uplinked data in large font
- Replaces previous data with uplinked data
- Returns page display to normal (pre-uplink) format
- Clears scratchpad message
- Transmits a downlink accept message (if enabled) to acknowledge accepting the uplink.

Selecting REJECT:

- Replaces uplinked data with previous data
- Returns page display to normal (pre-uplink) format
- Clears scratchpad message
- Transmits a downlink reject message (if enabled) to inform that the uplink was rejected.

Processing Uplinks – Load/Purge

After receiving uplinked data, the LOAD and PURGE prompts are displayed on the DESCENT FORECAST page, shown in Figure 11-7. LOAD and PURGE prompts are also displayed on the active RTE 1 or RTE 2 page when there is an uplink to the inactive route.



Load/Purge Prompts
Figure 11-7

Selecting LOAD:

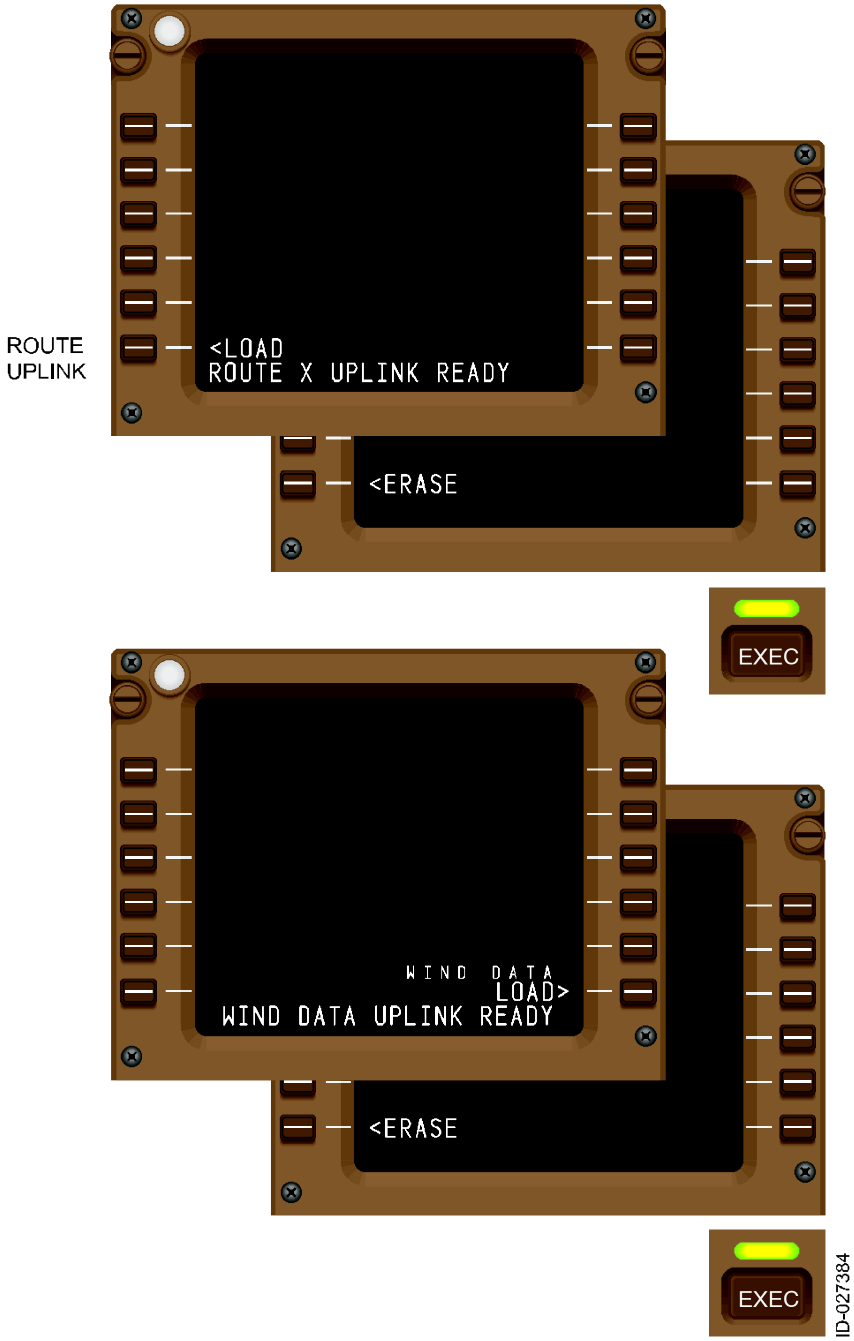
- Loads uplinked data into FMC for display
- Clears scratchpad message
- Replaces previous data with uplinked data
- Returns page display to normal (pre-uplink) format
- Transmits a downlink accept message (if enabled) to acknowledge accepting the uplink.

Selecting PURGE:

- Replaces uplinked data with previous data
- Clears scratchpad message
- Returns page display to normal (pre-uplink) format
- Transmits a downlink reject message (if enabled) to inform that the uplink was rejected.

Processing Uplinks - Load/Exec – Erase

After receiving uplinked data, the LOAD prompt is displayed on the RTE and WIND pages. After the uplinked data is loaded, the EXEC key lights, as shown in Figure 11-8, and the ERASE prompt is displayed.



Load/Execute – Erase Prompts
Figure 11-8

Selecting LOAD:

- Loads uplinked data into FMC for display
- Clears scratchpad message
- Uplinked data modifies previous data
- Page title displays MOD
- ERASE prompt is displayed
- EXEC key lights.

Pushing the EXEC key:

- Incorporates modified data into active flight plan
- Returns page display to normal (pre-uplink) format
- Transmits a downlink accept message (if enabled) to acknowledge accepting the uplink.

Selecting ERASE:

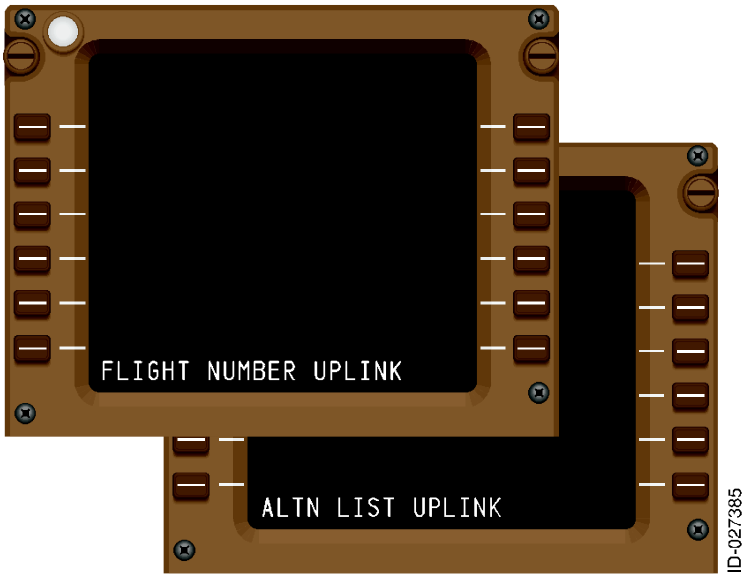
- Removes modified data
- Returns page display to normal (pre-uplink) format
- Transmits a downlink reject message (if enabled) to inform that the uplink was rejected.

AUTOMATIC UPLINKS

The FLT NO and ALTN LIST data can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page and does not require the pilot to ACCEPT or EXEC.

See Figure 11-9. The list of 20 alternates automatically loads into the ALTN LIST page and does not require the pilot to ACCEPT, LOAD, or EXEC.

The scratchpad messages FLIGHT NUMBER UPLINK or ALTN LIST UPLINK remain in the scratchpad display queue until the appropriate CDU page is selected.

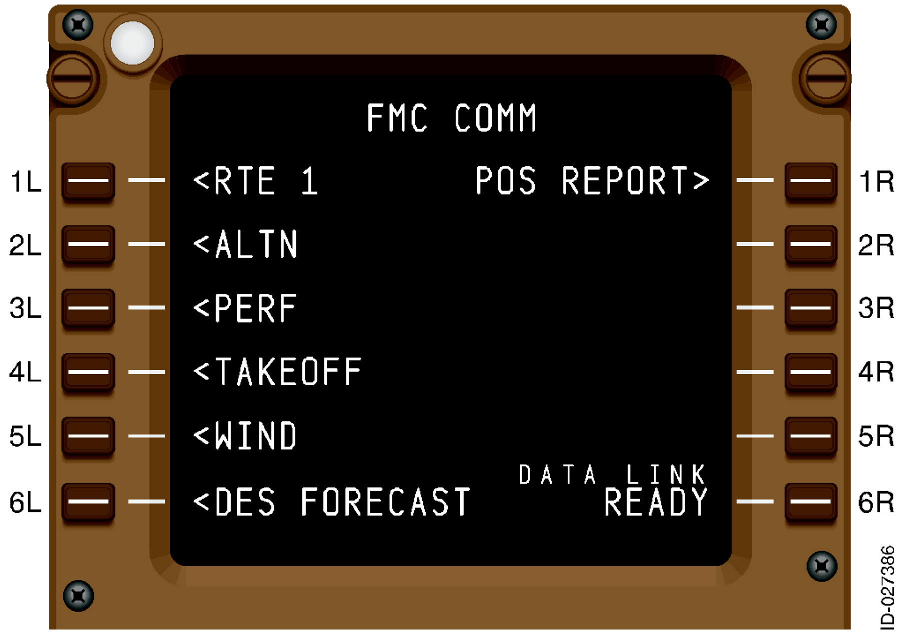


Scratchpad Messages
Figure 11-9

FMC COMM PAGE

The general datalink status and message uplink status are displayed on the FMC COMM page. Page prompts on the FMS COMM page access pages that display other datalink information.

To display the FMC COMM page (Figure 11-10), push the FMC COMM key.



FMC COMM – With Takeoff Option
Figure 11-10

Systems With the Takeoff Datalink Option

For systems with the takeoff datalink option, the following prompts are displayed on the FMC COMM page:

- RTE X
- ALTN
- PERF
- TAKEOFF
- WIND DES FORECAST
- POS REPORT.

Pushing an LSK displays the associated page.

Systems Without the Takeoff Datalink Option

For systems without the takeoff datalink option, the following prompts are displayed on the FMC COMM page:

- RTE X
- ALTN
- PERF
- WIND
- DES FORECAST
- POS REPORT.

Pushing an LSK displays the associated page.

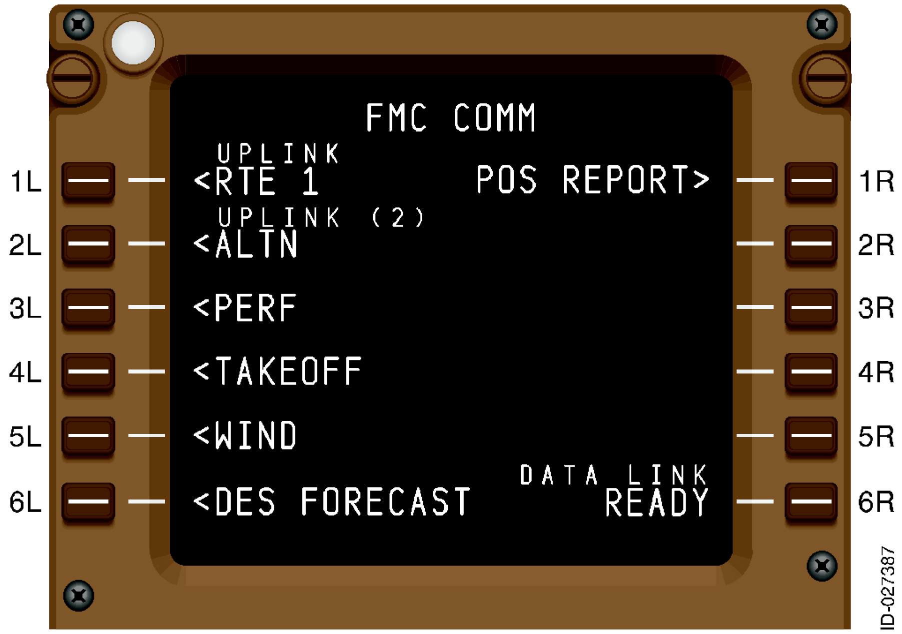
UPLINK STATUS

The following description of processing uplinks with an accept or reject response is divided into two parts:

- Systems with the takeoff datalink option
- Systems without the takeoff datalink option.

Systems With the Takeoff Datalink Option

When an uplink message is pending and all the preprocessing is complete, UPLINK is displayed in the header line above the associated datalink page prompt, as shown in Figure 11-11. Preprocessing of uplinks ensures that all of the necessary data is available for display when the uplink message is selected.



Uplinks – With Takeoff Option
Figure 11-11

Examples of preprocessing include:

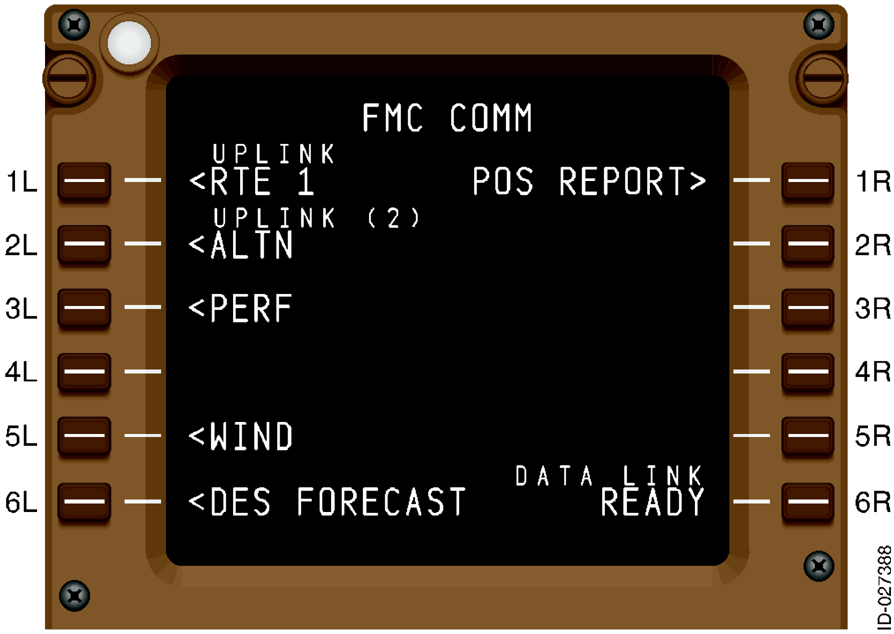
- RTE, ALTN, ALTN, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete.
- Subsequent uplinks of the same type are held until previous uplinks are processed by the pilot.
- TAKEOFF uplink is held until gross weight is entered, a pending PERF uplink is processed, or a takeoff runway is entered.

When both ALTN and ALTN LIST uplinks are pending, (2) is displayed to the right of UPLINK in the header line.

The ECIAS message •FMC is displayed whenever any uplink message is pending.

Systems Without the Takeoff Datalink Option

When an uplink message is pending and all the preprocessing is complete, UPLINK is displayed in the header line above the associated datalink page prompt, as shown in Figure 11-12. Preprocessing of uplinks ensures that all of the necessary data is available for display when the uplink message is selected.



Uplinks – Without Takeoff Option
Figure 11-12

Examples of preprocessing include:

- RTE, ALTN, ALTN, PERF, and WIND uplinks are held until route activation or modifications are complete.
- Subsequent uplinks of the same type are held until previous uplinks are processed by the pilot.

When both ALTN and ALTN LIST uplinks are pending, (2) is displayed to the right of UPLINK in the header line.

The ECIAS message •FMC is displayed whenever any uplink message is pending.

FMC DATALINK REPORTS

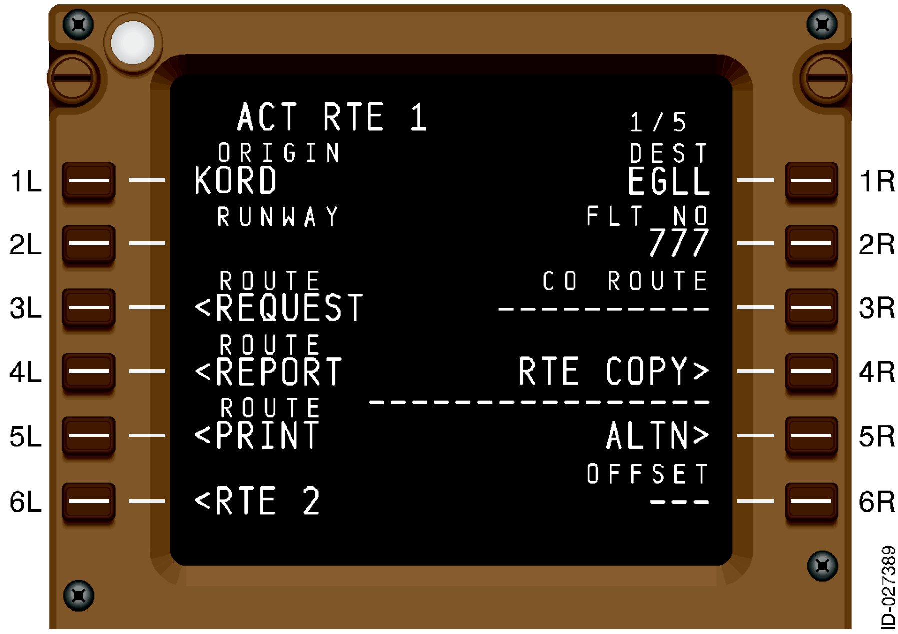
FMC datalink reports are sent for the route (RTE) and the position report (POS REPORT) when the appropriate LSK is pushed.

Route Report

To downlink a route report, do the following:

STEPS:

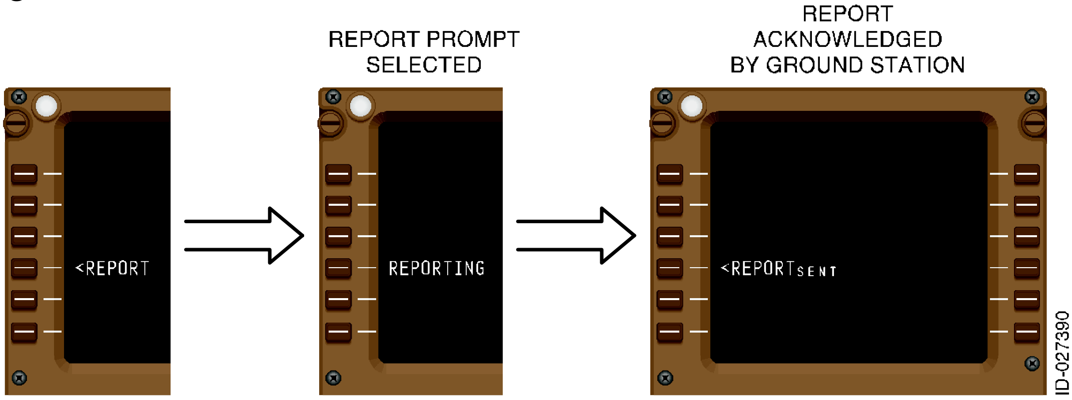
1. Push the FMC COMM key to display the RTE page.
2. Push 1L on the FMC COMM page to display the FMC COMM RTE page, shown in Figure 11-13.



RTE 1 – REPORT
Figure 11-13

STEP: Push 4L (ROUTE REPORT) to downlink the active route to the company.

While the report is being sent, the prompts in 4L change as shown in Figure 11-14.



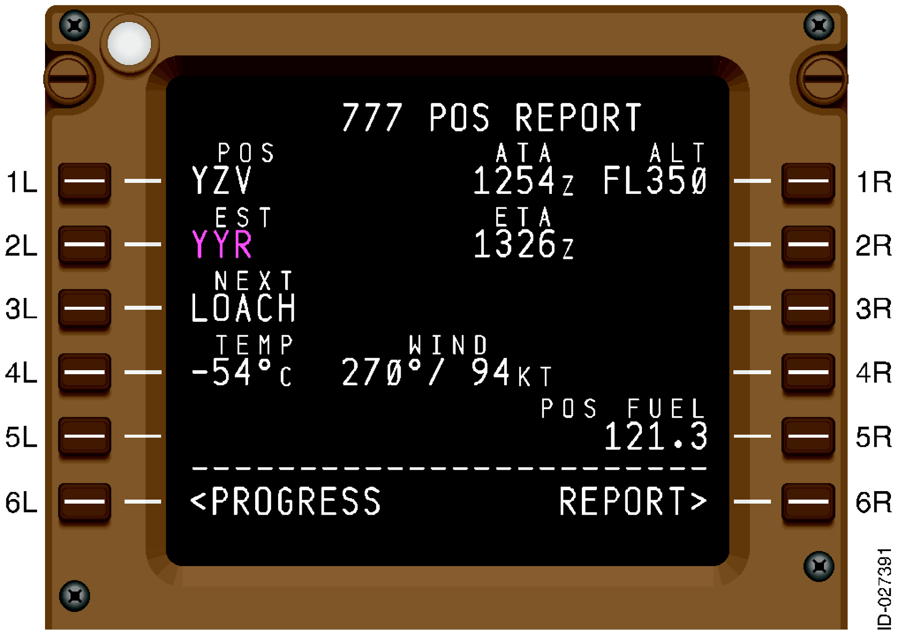
Selecting <REPORT
Figure 11-14

Position Report

To downlink a position report, shown in Figure 11-15, do the following:

STEPS:

1. Push the FMC COMM key to display the RTE page.
2. Push 1R on the FMC COMM page to display the FMC COMM RTE page.



POS REPORT
Figure 11-15

STEP: Push 6R (ROUTE REPORT) to downlink the position report to the company.

While the report is being sent, the prompts in 4L change as shown in Figure 11-14.

12. Using Winds in the FMS Flight Plan

This section covers wind entry and propagation, the effects of flight plan wind modifications, wind mixing, and winds and step climbs.

ENTRY AND PROPAGATION OF FORECAST WINDS

For simplicity in discussing wind propagation, this section refers to a typical flight plan that consists of the origin, ten waypoints and the destination. The CLIMB flight phase contains waypoints A and B. The CRUISE flight phase contains waypoints C, D, E, F, G, and H. The DESCENT flight phase contains waypoints I and J. The initial entry and propagation of wind data are discussed first.

Wind Entry for CLIMB and CRUISE Flight Phase

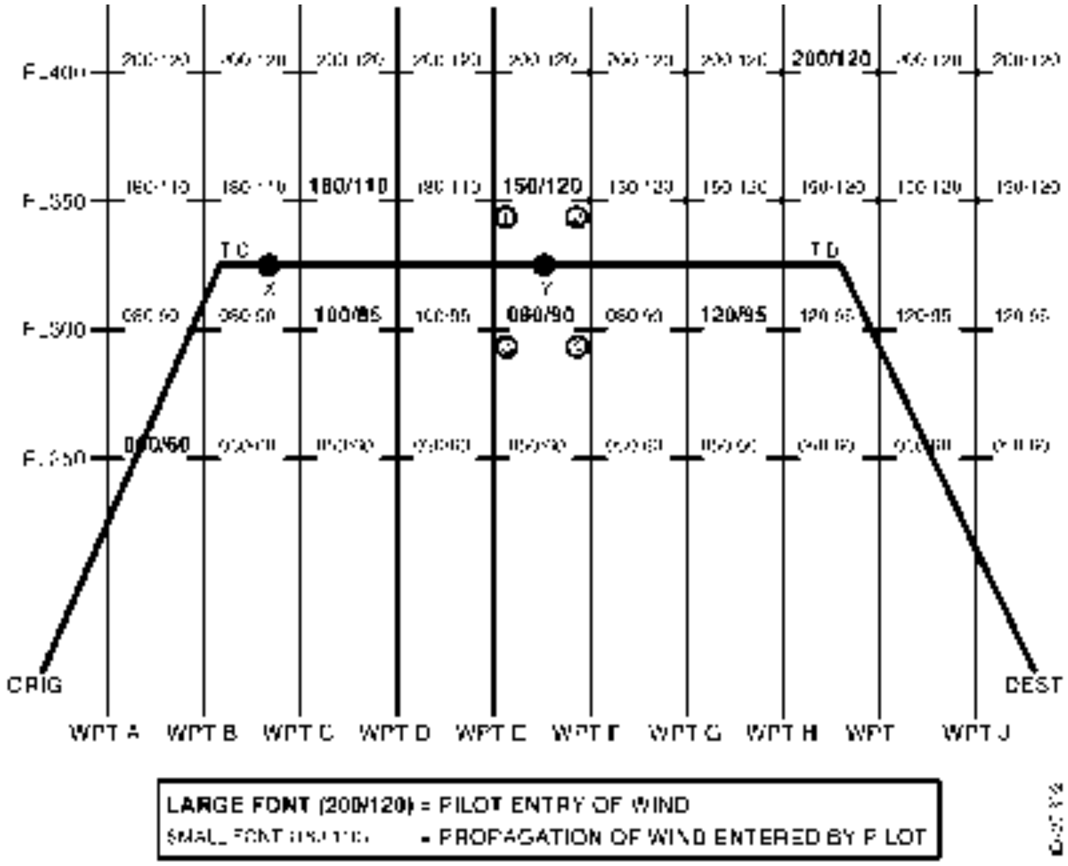
Entry and propagation of wind values are the same for CLIMB and CRUISE waypoints. Wind information for a waypoint is entered on the WIND DATA page for that waypoint. To display the WIND DATA page for a specific waypoint, do the following:

STEPS:

1. Push 6R (RTE DATA) on any RTE LEGS page.
2. Push the right LSK (WIND>) for the desired waypoint on the RTE DATA page.

Wind information can be entered for up to four altitudes on the WIND DATA page. The same four altitudes are applied to all waypoints in the flight plan. Wind information is propagated for each altitude independently. A wind entry at one altitude cannot be propagated to another altitude. When an altitude has been entered, but no winds have been entered for that altitude, all of the winds for that altitude are dashed (– – – / – – –). When the first wind entry is made for that altitude it propagates forward and backward to all waypoints in the flight plan. This is the only time wind information propagates backwards to preceding waypoints, since any wind entry on the first waypoint (except dashes) is propagated forward to the next wind entry.

Additional winds entered on the WINDS DATA pages are always propagated forward through the flight plan to the next wind entry. Considering these rules for entry and propagation of wind information, see Figure 12-1 for an example of a typical flight plan.



Entry and Propagation of Winds in CLIMB and CRUISE Flight Phase
Figure 12-1

- **Winds at FL400** – At FL400, wind information is entered at waypoint H. Although this wind is entered at the end of the CRUISE flight phase, it is the only wind entered at FL400. Therefore, the wind entry is propagated backward to waypoints A, B, C, D, E, F, and G and forward to waypoints I and J.

- **Winds at FL250** – Similarly, a wind entry at the first waypoint in the flight plan for FL250 is propagated to all the waypoints in the flight plan.

- **Winds at FL350** – The first wind entry at FL350 is made at waypoint C and is propagated backwards to the first waypoint (since it is the first wind entry at FL350) and forward to all downpath waypoints (until the wind entry at waypoint E is made). Once the wind entry at waypoint E is made, that wind information is propagated forward to the remaining waypoints. At this point the winds at FL350 are as shown in Figure 12-1.

The small font winds at waypoints A, B, and D were propagated from waypoint C (large font). The small font winds at waypoints F, G, H, I, and J were propagated from waypoint E.

- **Winds at FL300** – At FL300 three wind entries are made. The first entry is made at waypoint E and is initially propagated to all waypoints in the flight plan. The second entry is made at waypoint C and is propagated forward to waypoint D. The last wind entry made at waypoint G is propagated forward to the remaining waypoints, replacing the old value that was propagated from waypoint E. At this point, the winds at FL300 are as shown in Figure 12–1.

  The small font winds at waypoints A and B were propagated from waypoint E (since that was the first wind entry made at FL300). These winds were also propagated to waypoints C and D, but when the wind information was entered for waypoint C, the propagated winds were overwritten. The entered winds at waypoint C were then propagated to waypoint D.

  The small font winds at waypoint F were propagated from waypoint E and the small font winds at waypoint H, I, and J were propagated from waypoint G.

  Note that the first wind entry made (when the winds are all dashes) will end up on the first waypoint, so the first wind entry should always be the one closest to the aircraft. To “fix“ the winds at FL300 in Figure 12–1, the wind entry at waypoint C should be copied to waypoint A.

  Note the cruise altitude for the typical flight plan in Figure 12–1 lies between the entered wind altitudes. The FMS interpolates the winds from the nearest known values to determine the wind at the desired point. For example, if the FMS is at point X in Figure 12–1, and needs to predict the wind at point Y, it uses the winds at points 1, 2, 3, and 4 to estimate the wind at point Y. If all forecast wind entries are above the cruise altitude, the FMS interpolates from the lowest (altitude) entered wind value to a wind magnitude of zero at the origin altitude if in CLIMB or the destination altitude if in CRUISE. If either the origin or destination altitude is not defined (for example, if no destination is specified), zero altitude is used. If all forecast wind entries are below the cruise altitude, the FMS distributes the highest (altitude) wind entry up to the cruise altitude.

Wind Entry for DESCENT Flight Phase

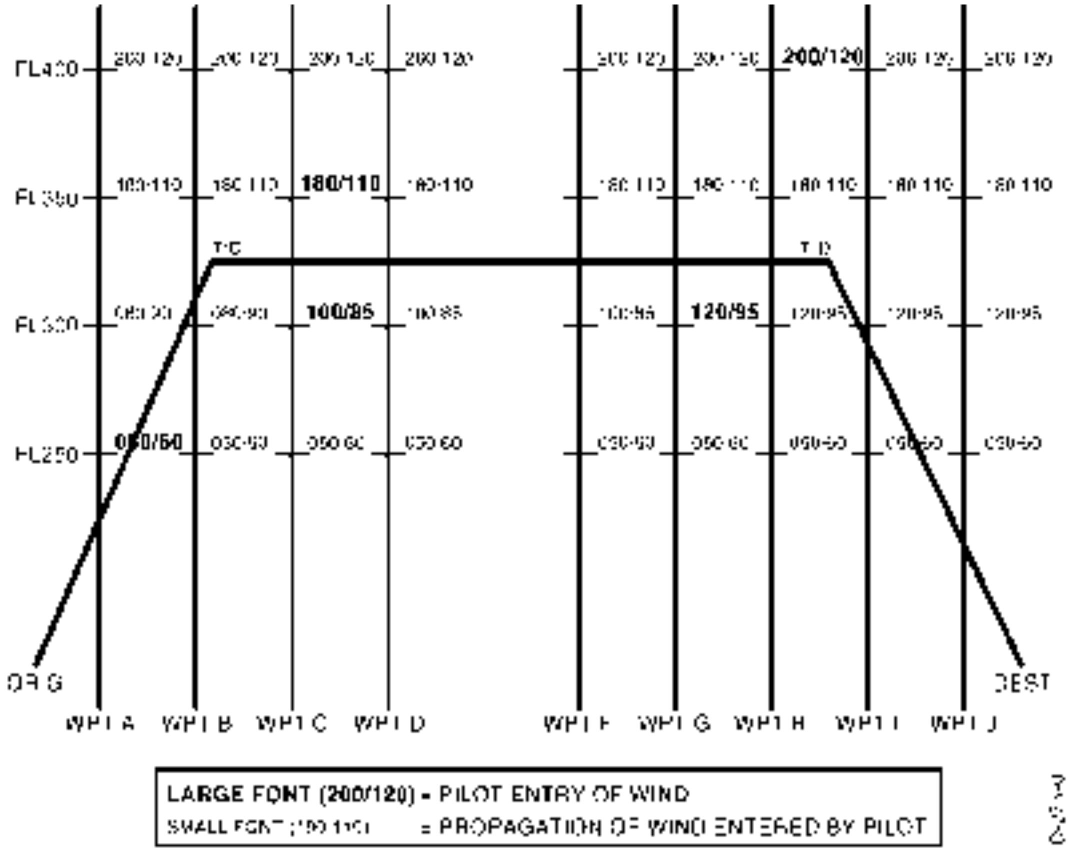
Forecast winds for the DESCENT flight phase are entered on the DESCENT FORECAST page. Pushing 5R (FORECAST) on the DES page displays the DESCENT FORECAST page. Up to four wind/altitude pairs can be entered on this page. The winds entered on this page are mixed with the cruise winds for a smooth transition from CRUISE to DESCENT flight phase. If no cruise winds exist and descent forecast winds have been entered, the highest (altitude) entered winds are distributed up to the cruise altitude. The lowest (altitude) descent wind is interpolated to zero winds at the destination altitude. If the destination altitude is not defined (for example, if no destination is specified), zero altitude is used.

Effect of Flight Plan Modifications on Wind Propagation

DELETING WAYPOINTS

For the B777 FMS software, deleting flight plan waypoints that contain the single wind entry for a given flight level does not affect the wind profile propagation, since the wind at the first waypoint in the flight plan is being propagated forward. If waypoint A (Figure 12-1) is deleted, the wind on the remaining waypoints would be unchanged.

If a waypoint that contains wind entries for certain flight levels is deleted, but there are other wind entries for those flight levels in the wind profile, the wind propagation is revised. The other wind entries for those flight levels are used to determine the revised propagation. If waypoint E (Figure 12-1) is deleted, the wind propagation is redistributed as shown in Figure 12-2.



Effect of Flight Plan Changes on Wind Propagation
Figure 12-2

When waypoint E is deleted, the entered wind at FL350 for waypoint C is now propagated to waypoint F, G, H, I, and J. Also, the entered wind at FL300 for waypoint C is now propagated to waypoint F.

The B777 FMS software retains wind propagation on all waypoints as waypoints are sequenced. For example, if the aircraft has passed waypoints A and B when waypoint E is deleted, the wind on the remaining waypoints is unchanged.

ADDING WAYPOINTS

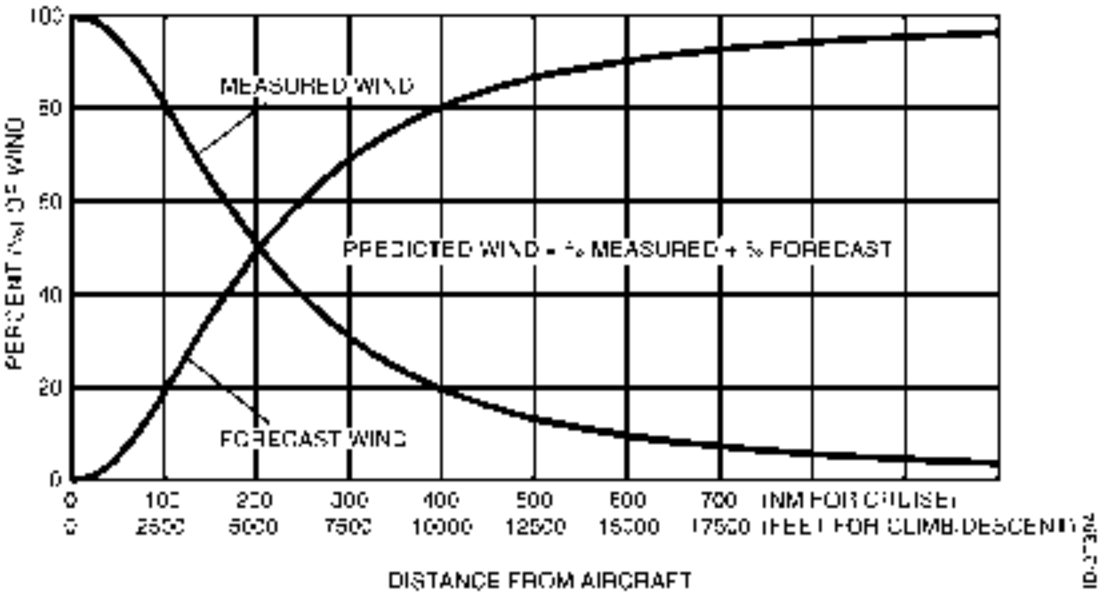
If waypoints are added to the flight plan, the added waypoints comply with the wind propagation rules outlined above. For example, if a waypoint is added between waypoints C and D in Figure 12-1 and wind values are entered at FL400 and FL300, the wind entry at FL400 propagates forward to waypoints D, E, F, and G. The pre-existing wind entry at waypoint H is now only propagated to waypoints I and J. Similarly, the wind entry at FL300 is propagated forward to waypoint D. The wind entry at FL300 on waypoint C now exists only at waypoint C.

When abeam waypoints are created with the abeam function, the pilot-entered winds are retained on the new abeam waypoints.

NOTE: Waypoint winds are retained for the abeam waypoint up to a distance of 99 NM miles from the original waypoint. If the abeam waypoint is more than 99 NM from the original waypoint, the winds for the abeam waypoint are deleted.

Mixing Measured Winds With FMS Propagated/ Forecast Winds

The FMS mixes measured winds with propagated/forecast winds to determine the predicted wind at points in front of the aircraft. Figure 12-3 shows a graph of the mixing calculation for the CRUISE flight phase. In the example shown in Figure 12-1, the predicted wind at waypoint B is a mix of the forecast wind at waypoint B (interpolated from winds around waypoint B) and the measured wind at the aircraft position at waypoint A. Figure 12-3 shows the FMS uses 100% of the measured wind vector at the aircraft position. At 200 NM in front of the aircraft the FMS uses 50% of the measured wind vector and 50% forecast wind. At distances over 200 NM in front of the aircraft, the FMS uses successively less measured wind until the wind used is almost 100% forecast wind.

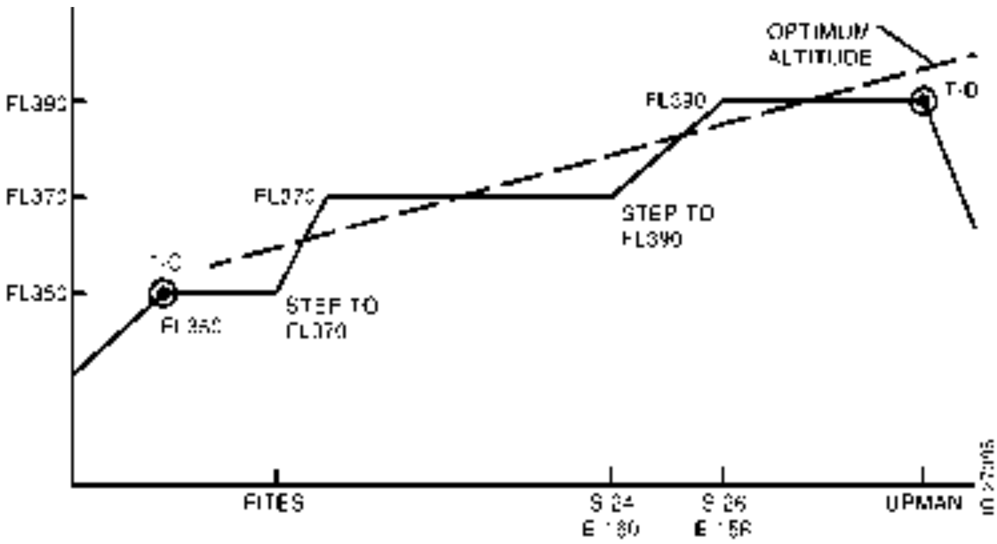


Mixing of Measured Wind With FMS Propagated/Forecast Winds
Figure 12-3

In the CLIMB and DESCENT flight phases, the wind is mixed the same way except the equal weight distance is 5,000 ft rather than 200 NM and the DISTANCE FROM AIRCRAFT units are feet rather than nautical miles.

STEP CLIMBS

The FMS–calculated step climb points are based on the aircraft optimum altitude so that the optimum cruise profile matches the optimum altitude profile (see Figure 12–4). The FMS computes optimum altitude based on the selected cruise mode (ECON, long-range cruise (LRC), selected CAS (SEL CAS), or selected Mach (SEL MACH)), cost index, and gross weight. The FMS calculated step points result in minimum trip cost (cost index is used) for ECON mode and minimum trip fuel consumption (cost index is not used) for LRC, SEL CAS, and SEL MACH modes. Pilot-entered forecast winds and temperature are considered when the FMS calculates fuel and ETA predictions. These predictions also assume all FMS–calculated and pilot-entered step climbs are completed on schedule. If a step point is passed without executing the step, the FMS fuel and ETA predictions are calculated assuming the step climb is initiated immediately.



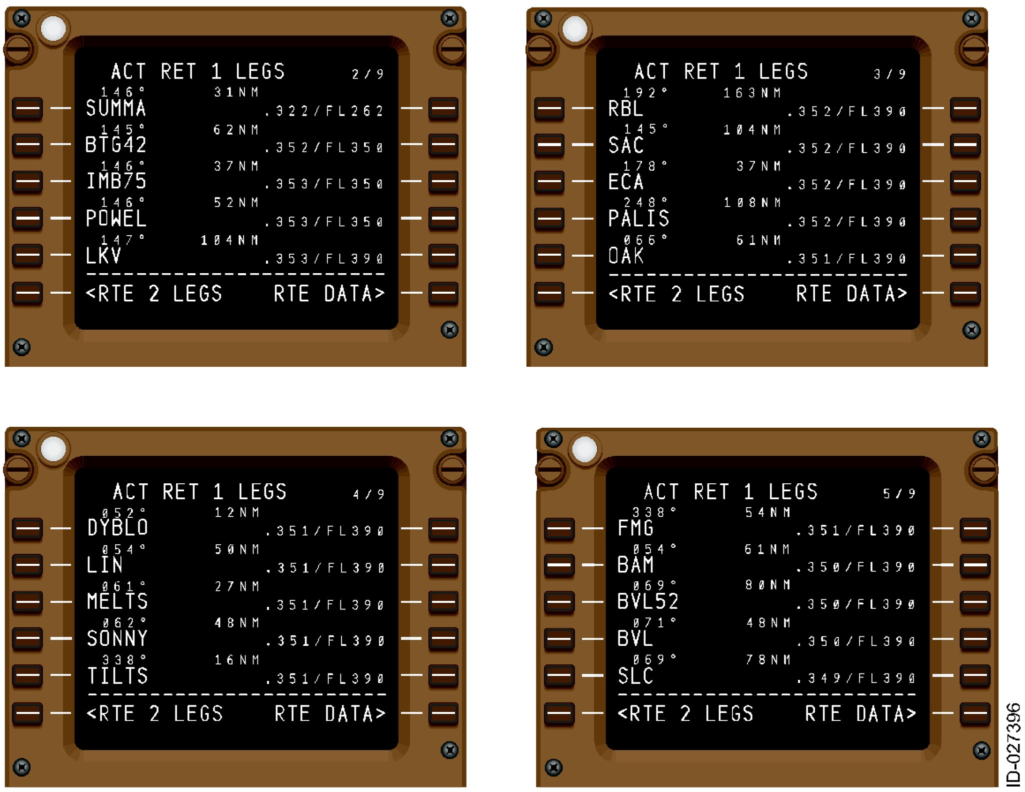
Optimum Vertical Flight Path
Figure 12–4

Using the Step Climb Feature to Evaluate Wind Trade

Figure 12-5 shows an example of a LEGS page for an FMS recommended step to FL390 from FL350.

The PERF INIT information for this example is:

- Zero fuel weight - 350,000 lbs
- Fuel on-board - 100,000 lbs
- Reserves - 5,000 lbs
- Cost index - 80
- Initial cruise altitude - 35,000 feet.



LEGS Pages for Wind Trade Step (Step Climb) Example
Figure 12-5

Initially, there are no winds entered and the FMS predicts destination ETA of 0633Z and fuel at destination of 14,200 lbs. The FMS recommends a step to FL390 and these predictions assume the pilot makes the step. Next, a wind value of 120 knots at 234° is added on waypoints OAK, DYBLO, LIN, MELTS, SONNY, BAM, BVL52, BVL, and SLC at FL350, and a wind value of 120 knots at 054° is added for the same waypoints at FL390. No other winds are added. These wind values provide a substantial tailwind at FL350 (the initial cruise altitude) and a substantial headwind at FL390. With these added wind values, the FMS now predicts a destination ETA of 0648Z and fuel at destination of 9,500 lbs. But keep in mind, the FMS is basing these predictions on the assumption the step climb to FL390 is completed.

To do a wind trade calculation to see the FMS predictions if the aircraft stays at FL350, enter a STEP SIZE of zero on the CRZ page and let the FMS calculate the destination ETA and fuel remaining. With a step size of zero, the FMS step climb predictions are disabled and the FMS calculates performance parameters assuming the aircraft stays at FL350. These new predictions show a destination ETA of 0627Z and fuel at destination of 16,800 lbs. So, the FMS can show the savings of staying at a lower altitude, but with a substantial tailwind.

As another example, consider the flight plan with winds given above except the headwind is at FL350, the tailwind is at FL390, and the initial cruise altitude is 37,000 feet. In this case, the FMS is recommending a step climb to 41,000 feet 1,243 NM into the flight. This step point is approximately halfway between BVL52 and BVL. The ETA and fuel at the destination for this step climb are 0632Z and 16,000 lbs. However, this step climb recommendation is calculated based on the no-wind optimum altitude curve. To determine if it may be more beneficial to take the step earlier in the flight, the pilot can use the specified step point function. Entering a 410S altitude constraint on the BVl52 waypoint inserts the step climb at BVL52 rather than the point initially calculated by the FMS. There is no need to execute the flight plan modification, since the FMS recalculates the ETA and fuel at destination and displays them with MOD in the page title. With this modification, the ETA is 0634Z and the fuel at destination is 15,800 lbs. So, taking the step at this point actually results in a time/fuel penalty rather than a savings. However, this flight plan modification can be erased and the process can be repeated on other waypoints in the flight plan.

Through this method, the best step point with flight plan entered winds is found at the waypoint POWEL. When the 410S constraint is placed on this waypoint, the FMS predicts an ETA of 0629Z and a fuel at destination of 16,800 lbs. Also, the step point is approximately 975 NM sooner in the flight. Now the flight plan modification can be executed and the pilot can plan for early ATC request for clearance to 41,000 ft at POWEL. Specified step points can also be entered on pilot-generated waypoints (for example, along track waypoints) so the step can be specified between route waypoints such as POWEL and LKV.

By using a step size of zero and/or the specified step point function, the FMS can be used to plan and evaluate wind trade steps. When changing step size values, the FMS does not temporarily blank the speed/flight level predictions on the LEGS page, but it does temporarily blank ETA and fuel at destination predictions on the PROGRESS page. However, the specified step point entries temporarily blank displays on both the LEGS and PROGRESS pages. The ETA and fuel at destination predictions are more accurate with as much reliable wind data as possible in the wind profile discussed in Figure 12-1.

NOTE: Using the step size zero function eliminates all downpath step climbs. So in situations where multiple step climbs are forecast, planning should consider that all downpath step climbs are eliminated.

USING FLIGHT PLAN WIND AVERAGE

Which is better: using a single wind average or entering a wind on each waypoint? The easy way is using the single wind average but it is not necessarily the most accurate.

The following information illustrates why using a single average is less accurate than entering a wind on each waypoint in the flight plan.

The problem with attempting to compute an average headwind is best demonstrated by an example.

Consider a route that starts at waypoint A, goes 400 NM directly to waypoint B, and then turns around and returns to waypoint A, for a total distance of 800 NM (neglecting the turn). If the aircraft flies at a constant 400 knots TAS and there is a constant wind of 100 knots coming from the direction of waypoint B, there would be a headwind flying from A to B and a tailwind while flying from B to A.

The headwind and tailwind would seem to cancel out and give an average headwind of zero. Using a headwind of zero, the time required to fly from A to B and back to A is 2:00 hours (800 NM/400 knots).

However, this is inaccurate. Because of the 100 knot wind, the aircraft would have a groundspeed of 300 knots flying from A to B, and a groundspeed of 500 knots flying from B to A. Therefore, the actual time required to fly from A to B is 1:20 (400 NM/300 knots) and the actual time required to fly from B to A is 0:48 (400 NM/500 knots) making the total trip time of 2:08.

NOTE: Because of the way the wind affects the groundspeed, a headwind hurts performance more than an equivalent tailwind helps performance.

Another example uses a route with two legs. The first leg is 400 NM with a wind of zero, and the second leg is also 400 NM with a headwind of 200 knots. The actual flight time is 3:00 hours ([400 NM/400 knots] + [400 NM/200 knots]). If this example used an average wind of 100 knots, the estimated time en route would be 2:40 to fly the 800 NM (800 NM/300 knots).

NOTE: If the wind magnitude and direction do not change much over the course of the route, then entering a single average wind is fairly accurate. The more the wind magnitude or direction changes, the less accurate performance predictions will be if a single average wind is entered.

13. Backup Functions

This section describes the reference information available for the backup functions supported by the CDU.

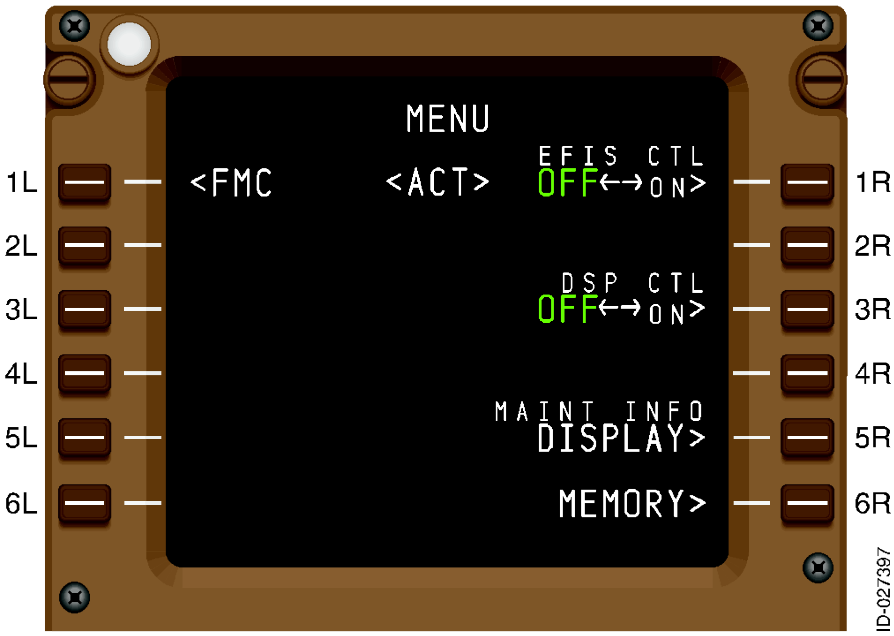
EFIS CONTROL PANEL FUNCTIONS

If an EFIS control panel fails, the CDU gives the pilot an alternate means of controlling the functions of the EFIS control panel.

NOTE: The control callouts on the following pages correspond to the control names on the EFIS control panel. Explanations of the CDU are the same as on the related control panels.

The EFIS control function on the CDU is in 1R on the MENU page (Figure 13–1).

STEP: To display the MENU page, push the MENU button.



MENU Page
Figure 13–1

The EFIS control functions on the MENU page are described in the following paragraphs.

- **EFIS CTL (1R)** – Pushing 1R (EFIS CTL) transfers control of the EFIS from the EFIS CP to the CDU. Pushing 1R on the left CDU transfers the left EFIS CP to the left CDU. Pushing 1R on the right CDU transfers the right EFIS CP to the right CDU. When the EFIS CP functions have been transferred to the associated CDU, ON is displayed in large font in 1R on the MENU page.

  NOTE: Selecting EFIS CTL displays the EICAS advisory message EFIS CONTROL PNL L or R, depending on CDU being used.

  When EFIS CTL (1R) has been selected ON, the MENU page displays an EFIS> prompt in 2R (Figure 13–2).

MENU – EFIS CTL
Figure 13–2

- **EFIS> (2R)** – This prompt is displayed in 2R on the MENU page when the EFIS CTL (1R) has been selected ON. Pushing 2R (when the EFIS> prompt is displayed) displays the EFIS CONTROL page.

EFIS CONTROL Page

The EFIS CONTROL page gives the pilot an alternate means of EFIS control for the PFD and ND.

STEP: To display the EFIS CONTROL page (Figure 13-3), push 2R (EFIS>) on the MENU page when EFIS CTL (1R) has been selected **ON**.

EFIS CONTROL Page
Figure 13-3

The EFIS CONTROL page is described in the following paragraphs.

- **BARO SET (1L)** – The backup altimeter barometer setting (BARO SET) is displayed in 1L. The default value is the last barometer setting received from the EFIS control panel.

  Valid entries are in inches of mercury or hectopascals. A valid inches of mercury entry is between 22.00 and 32.00, 22 and 32, or 2200 and 3200. A valid hectopascals entry is a three- or four-digit entry between 745 and 1084. Valid entries are displayed with the units determined by the entry. IN is displayed for inches of mercury and HPA is displayed for hectopascals.

  I, H, S, or STD can also be entered into 1L.

  — I – The display changes to inches of mercury
  — H – The display changes to hectopascals
  — S or STD – The display changes to the standard value (29.92 inches of mercury or 1013 hPa).

If the entry in 1L is deleted, it defaults to the standard value.

- **RAD/BARO (2L)** – Pushing 2L toggles the altitude minimum set field in 3L between RAD (radio) and (BARO) barometric. The active selection is displayed in large **green** font.

- **MINS SET (3L)** – The MINS SET field in 3L displays the active approach minimum setting. Valid BARO entries are from –101 to 15,000 ft (MSL), and valid RAD entries are from –20 to 999 ft (AGL). The BARO minimum defaults to 200 ft and the RAD minimum defaults to 100 ft.

- **MINS RESET (4L)** – Pushing 4L resets the approach alert on the respective PFD. This alert is normally reset by pushing the RESET SWITCH on the EFIS CP.

- **RANGE INCR and RANGE DECR (5L and 6L)** – These prompts are used to control the display range on the ND. The default value is the last display range received from the EFIS CP. The current range setting is displayed between 5L and 6L.

  Display range settings are 10, 20, 40, 80, 160, 320, and 640 NM. The range setting wraps around from 640 to 10 (INCR) and from 10 to 640 (DECR).

- **Mode Selections (1R through 5R)** – These LSKs are the ND mode selectors. The selected ND mode is indicated with <SEL> next to the mode name. Only one mode can be active at a time. The mode selection operation is the same as the ND selector and CTR switch.

  The prompts in 1R through 5R correspond to the following EFIS CP ND modes:

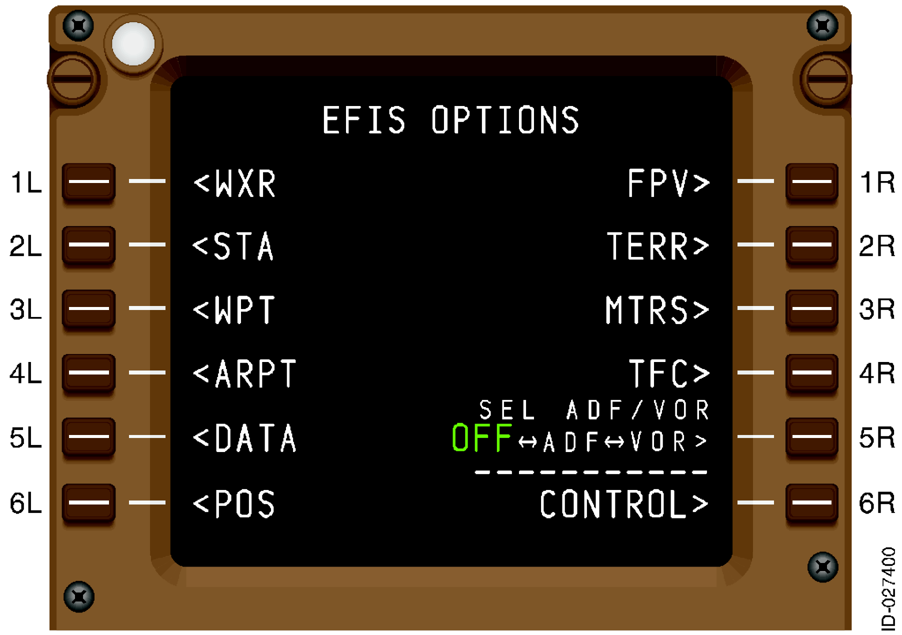
  — APP – Approach
  — VOR – VOR
  — MAP – Map
  — PLN – Plan
  — CTR – Center.

- **OPTIONS (6R)** – Pushing 6R displays the EFIS OPTIONS page.

EFIS OPTIONS Page

The EFIS OPTIONS page gives the pilot an alternate means of controlling the PFD and ND

STEP: To display the EFIS OPTIONS page (Figure 13-4), push 6R on the EFIS CONTROL page.



EFIS OPTIONS Page
Figure 13-4

The EFIS OPTIONS page is described in the following paragraphs.

- **ND MAP SWITCHES (1L through 6L)** – Pushing these LSKs displays the selected information on the appropriate ND. The prompts in 1L through 6L correspond to the following ND map information.
  - — WXR – Weather
  - — STA – Stations
  - — WPT – Waypoints
  - — ARPT – Airports
  - — DATA – Data
  - — POS – Aircraft position.
- **FPV (1R)** – Pushing 1R toggles the the flight path vector on the PFD on and off.
- **TERR (2R)** – Pushing 2R toggles the EGPWS terrain information on the ND on and off.
- **MTRS (3R)** – Pushing 3R selects meters or feet for the displayed altitude on the respective PFD.

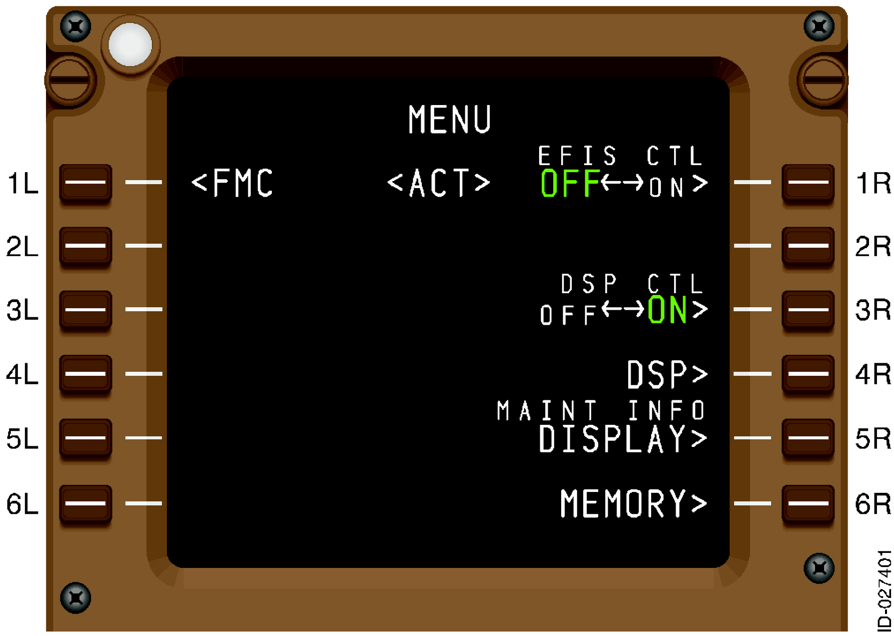
- **TFC (4R)** – Pushing 4R displays air traffic information on the ND. For air traffic to be displayed, the Mode S selector must be in either TA or TA/RA.
- **SEL ADF/VOR (5R)** – Pushing 5R displays VOR or ADF information on the respective ND in the lower right and lower left corner. The active state is displayed in large green font and the other two inactive states are displayed in small white font.
- **CONTROL (6R)** – Pushing 6R displays the EFIS CONTROL page.

DISPLAY SELECT PANEL CONTROL

The display select panel (DSP) control page gives the pilot an alternate means of controlling the MFD.

NOTE: The control callouts on the following pages correspond to the control names on the DSP control panel. Explanations of the CDU are the same as on the related control panel.

STEP: On the MENU page, push the 3R to select the CDU display control ON, as shown in Figure 13-5.



DSP CTL – ON
Figure 13-5

The display control functions on the MENU page are described in the following paragraphs.

- **DSP CTL (3R)** – Pushing 3R transfers display control from the DSP control panel to the CDU. When the DSP control panel functions have been transferred to the CDU, ON is displayed in large font in 3R on the MENU page.

  NOTE: Selecting DSP CTL displays the EICAS advisory message DISPLAY SELECT PNL.

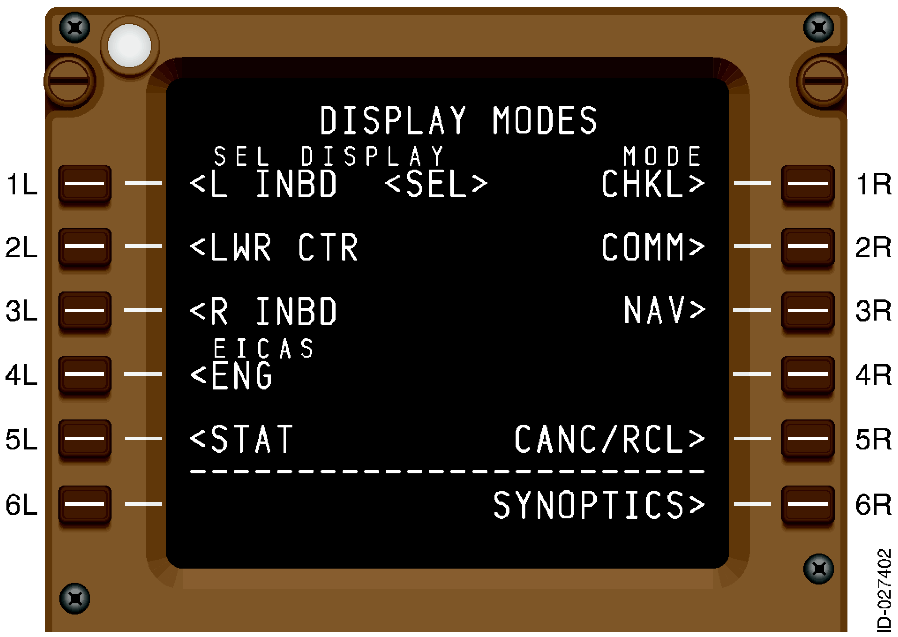
  When DSP CTL (3R) has been selected ON, the MENU page displays a DSP> prompt in 4R.

- **DSP>** – This prompt is displayed in 4R on the MENU page when the DSP CTL (3R) has been selected ON. Pushing 4R (when the DSP prompt is displayed) displays the DISPLAY MODES page.

DISPLAY MODES Page

The DISPLAY MODES page gives the pilot an alternate means controlling the functions of the DSP.

STEP: To display the DISPLAY MODES page (Figure 13-6), push 4R on the MENU page when the DSP prompt is displayed.



DISPLAY MODES
Figure 13-6

- **SEL DISPLAY L INBD, LWR CTR, R INBD (1L, 2L, and 3L)** – Pushing 1L, 2L, or 3L selects which MFD the selected information is displayed on. When a display is selected, <SEL> is displayed next to it. The MFD selection is as follows:

  — L INBD – Left inboard display
  — LWR CTR – Lower center display
  — R INBD – Right inboard display.

- **ENG (4L)** – Pushing 4L displays the secondary engine information on the display selected in 1L, 2L or 3L.

- **STAT (5L)** – Pushing 5L displays the airplane status on the display selected in 1L, 2L, or 3L.

- **CHKL (1R)** – Pushing 1R displays the checklist on the display selected in 1L, 2L, or 3L.

- **COMM (2R)** – Pushing 2R displays the communications display on the display selected in 1L, 2L, or 3L.

- **NAV (3R)** – Pushing 3R displays the navigation display on the display selected in 1L, 2L, or 3L.

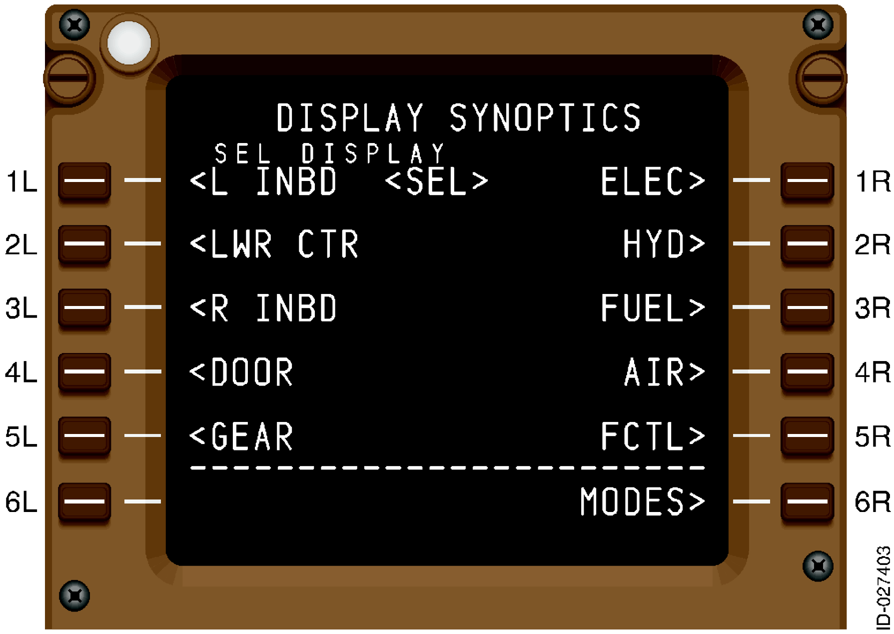
- **CANC/RCL (5R)** – Pushing 5R displays caution and advisory messages on the display selected in 1L, 2L, or 3L. When these messages are displayed, pushing 5R steps to the next page of messages (if not currently on final page of messages), or cancels caution and advisory message displays (if on final page of messages).

- **SYNOPTICS** – Pushing 6R displays the DISPLAY SYNOPTICS page.

DISPLAY SYNOPTICS Page

The DISPLAY SYNOPTICS page gives the pilot an alternate means controlling the functions of the DSP.

STEP: On the DISPLAY MODES page, push the 6R to display the DISPLAY SYNOPTICS page (Figure 13-7).



DISPLAY SYNOPTICS Page
Figure 13-7

The DISPLAY SYNOPTICS page is described in the following paragraphs.

- **SEL DISPLAY L INBD, LWR CTR, R INBD (1L, 2L, and 3L)** – Pushing 1L, 2L, or 3L selects which MFD the selected information is displayed on. When a display is selected, <SEL> is displayed next to it. The MFD selection is as follows:

  — L INBD – Left inboard display
  — LWR CTR – Lower center display
  — R INBD – Right inboard display.

- **Synoptics Pages (4L, 5L, 1R through 5R)** – Pushing one of these LSKs displays that synoptics page on the display selected in 1L, 2L, or 3L. The synoptic page selections are as follows:

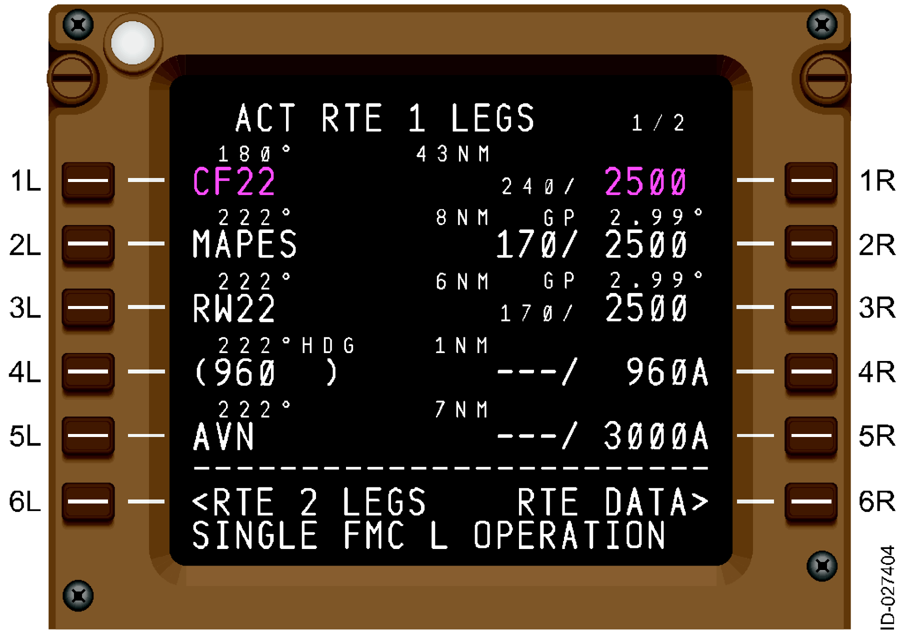
  — DOOR – Door system
  — GEAR – Landing gear and brakes
  — ELEC – Electrical system
  — HYD – Hydraulic system
  — FUEL – Fuel system
  — AIR – Pneumatic system
  — FCTL – Flight controls system.

- **MODES (6R)** – Pushing 6R displays the DISPLAY MODES page.

ALTERNATE NAVIGATION

If both FMCs fail, or the FMC that has been manually selected as active fails, all three CDUs automatically initialize as a source of alternate navigation. The CDUs give the pilot an alternate source of lateral navigation guidance to the AFDC, and an alternate source of navigation radio tuning.

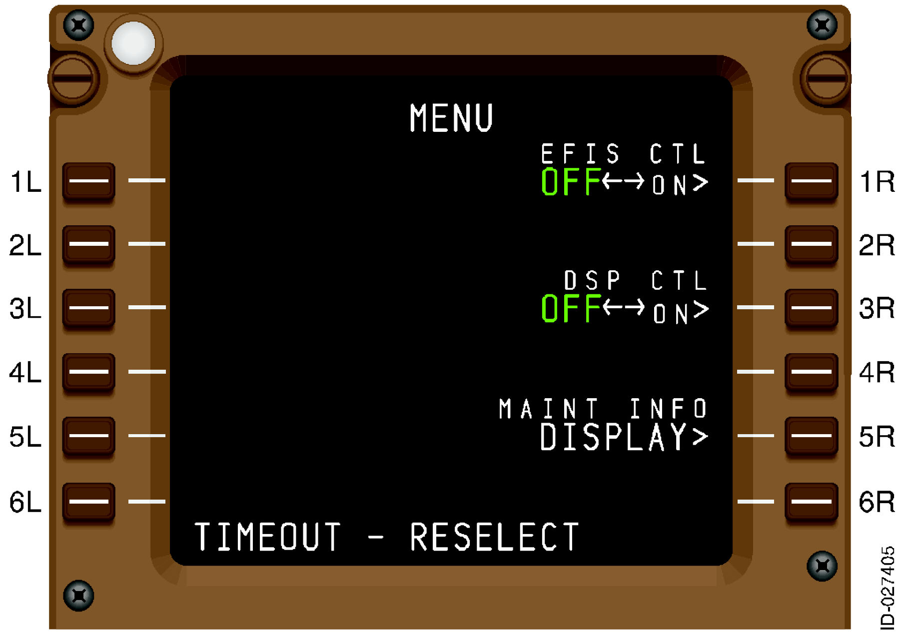
A loss of a single FMC displays the scratchpad message SINGLE FMC L (R) OPERATION. See Figure 13-8.



Single FMC Operation
Figure 13-8

NOTE: In this case, the FMC selector is selected to the AUTO position or L position for continued operation.

If both FMCs fail, the MENU page shown in FIgure 13-9 is displayed.



Dual FMC Failure
Figure 13-9

Initializing alternate navigation does not require any pilot action. It occurs automatically 2.0 seconds after the last FMC fails. Alternate navigation initializes using the last flight plan and last set of navigation radio frequencies downloaded from the FMC prior to FMC failure. Alternate lateral guidance is not enabled for an additional 3.0 seconds after alternate navigation initializes. Alternate navigation radio tuning is available as soon as alternate navigation initializes.

All CDU calculations are based on a great-circle course between waypoints. The CDU does not accept undefined waypoints or conditional waypoints. Complete departure or arrival/approach procedures cannot be manually entered or crossloaded from the FMC if they contain undefined or conditional waypoints. The CDU creates a discontinuity between such waypoints. However, individual legs of a procedure can be manually entered or crossloaded if they constitute a great-circle course.

Route changes are made on the ALTN NAV LEGS page the same as with normal FMS operations. All courses between waypoints are direct routes. Modifying the active waypoint computes a present position direct course. A route change to any one CDU crossloads the route change to the other CDU when the change is executed.

Only the active waypoint course can be referenced to magnetic north because the ADIRU can provide magnetic variation only for present position. All subsequent waypoint courses are displayed as true courses.

The radio must be manually tuned on each CDU in alternate navigation. The left CDU tunes the left VOR, DME, ADF, and left and center ILS. The right CDU tunes the right VOR, DME, ADF, and right ILS. In all cases, manual radio tuning is done on the ALTN NAV RADIO page.

The alternate navigation system operates from three CDU pages:

- ALTN NAV LEGS page
- ALTN NAV PROGRESS page
- ALTN NAV RADIO page.

These pages are the only ones available in the alternate navigation mode. Executed flight plan modifications made on one CDU ALTN NAV LEGS page are displayed on the other CDUs.

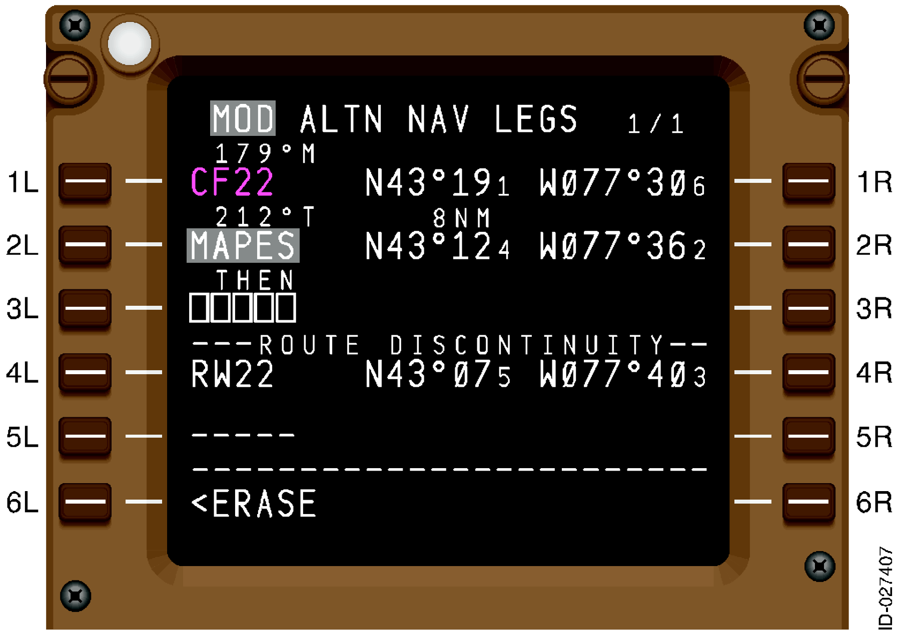
ALTN NAV LEGS Page

This page displays complete information about each leg of the route and the route can be modified from this page. Because VNAV is not available in alternate navigation, waypoint speed and altitude restrictions are not displayed.

The ALTN NAV LEGS page, shown in Figure 13-10, is displayed by pushing the LEGS key when both FMCs have failed. Subsequent LEGS pages are selected with the NEXT PAGE and PREV PAGE keys.

ACT ALTN NAV LEGS Page
Figure 13-10

The page title is ACT ALTN NAV LEGS. If the route is modified, the page title is MOD ALTN NAV LEGS (Figure 13–11) until the EXEC key is pushed.



MOD ALTN NAV LEGS
Figure 13–11

When the MOD ALTN NAV LEGS page is displayed, pushing the EXEC key executes the change and the page title changes to ACT ALTN NAV LEGS, shown in Figure 13–12.

ACT ALTN NAV LEGS Page (With Modification Executed)
Figure 13–12

Only two types of fix entries are allowed in 1L through 5L on the ACT ALTN NAV LEGS page.

- Fix identifiers that are already in the flight plan (flight plan waypoints)
- Latitude/longitude waypoints.

When a flight plan waypoint is entered, the route is searched for the entered identifier. If the identifier is not found and the entry is not a latitude/longitude waypoint, INVALID ENTRY is displayed in the scratchpad.

Available waypoint operations include:

- Adding new waypoints (latitude/longitude entry only)
- Removing existing waypoints
- Changing the sequence of existing waypoints
- Correcting discontinuities.

The current active waypoint is displayed on the first line of the LEGS page in **magenta.** Modified waypoints are displayed in shaded **white** until the EXEC key is pushed.

COURSE/HEADING

The computed course information is displayed in 1L through 5L between the waypoint identifiers. The current desired course on the ACT ALTN NAV LEGS page is relative to magnetic north (designated by M). Computed course for other than active waypoint is relative to true north (designated by T). The CDU uses the same manual/automatic MAG/TRUE selection as the FMC.

LEG DISTANCE

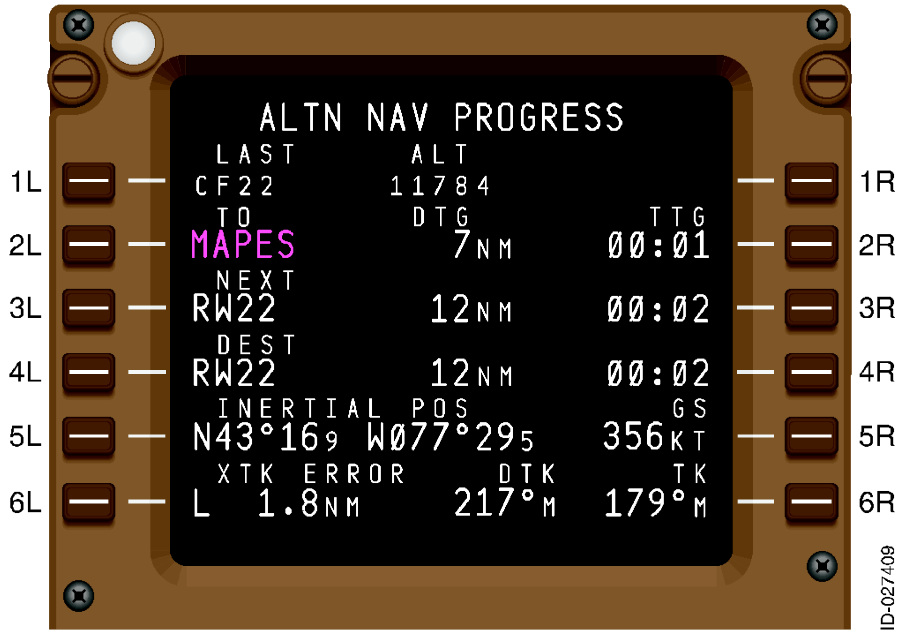
The distance from the previous waypoint to the leg termination is displayed in 1C through 5C header lines. No distance is displayed for the active leg.

LATITUDE/LONGITUDE

The lat/long of the associated waypoint is displayed 1R through 5R. This value is displayed in degrees, minutes, and tenths of minutes.

ALTN NAV PROGRESS Page

The ALTN NAV PROGRESS page, shown in Figure 13-13, displays the current dynamic flight information relative to the progress of the flight. The ALTN NAV PROGRESS page is displayed by pushing the PROG key when both FMCs have failed.



ALTN NAV PROGRESS Page
Figure 13-13

The ALTN NAV PROGRESS page is described in the following paragraphs.

- **LAST and ALT (1L and 1C)** – Information about the last waypoint sequenced is displayed in line 1. The waypoint identifier is displayed in 1L. The crossing altitude (in standard MSL altitude) at the time of the leg sequence is displayed 1C.

- **TO, DTG, and TTG (2L, 2C, and 2R)** – Information about the active leg in the route is displayed in line 2. The fix identifier is displayed in 2L and the distance-to-go is displayed in 2C.

  The distance represents the distance along the flight plan to the point where the next leg sequence occurs. If the aircraft is off path, then the distance is measured from the point abeam the aircraft and on the flight plan.

  Time-to-go (in hours and minutes) is based on the current groundspeed and is displayed in 2R. The TTG field is blank if the groundspeed or the aircraft position is invalid.

- **NEXT (Line 3)** – Information about the leg following the active waypoint is displayed in line 3. The distance-to-go in 3C is the distance-to-go to the active waypoint plus the great–circle distance between the active and next active waypoints.

- **DEST (Line 4)** – Information about the destination waypoint is displayed in line 4. A flight plan waypoint or lat/long waypoint can be entered in 4L. The header line of 4L displays one of the following to indicate the information displayed:

  — **DEST** – The route is not modified and no alternate destination has been selected. The data is relative to the along path distance from the aircraft to the displayed fix.

  — **MOD** – A flight plan modification is in progress and the predicted data is relative to the modified flight plan. After erasing or executing the change, line 4L changes to the destination of the active route.

  — **DIR TO ALTERNATE** – If a waypoint is entered that is not in the active flight plan, DIR TO ALTERNATE, is displayed in the header line. The predictions are for flying direct from the aircraft present position to the alternate destination. Leaving the ALTN NAV PROGRESS page causes any alternate destination waypoint entered in 4L to be cleared. Also, changing the route after entering an alternate destination clears the alternate destination.

  — **ENROUTE WPT** – If the alternate destination is in the active flight plan, the predictions are for flying the active flight plan to the en route waypoint. Sequencing an en route alternate destination waypoint that was entered in 4L causes the display to revert to the destination for the active route.

  NOTE: If the en route waypoint exists more than once in the route, the predictions for the first occurrence in the route are used.

- **INERTIAL POS (5L)** – The present position information received from the ADIRU is displayed in 5L.

- **GS (5R)** – Current groundspeed is displayed in 5L. This field is blank if the groundspeed is invalid.

- **XTK ERROR (6L)** – Crosstrack error is displayed in 6L. This error indicates the computed distance in nautical miles that the aircraft is left or right of the active flight path.

- **DTK (6C)** – Desired track is displayed in 6C. This is the desired track angle relative to the selected magnetic reference setting (M for magnetic or T for True).

- **TK (6R)** – Track is displayed in 6R. This is the current track relative to the selected magnetic or true reference setting.

ALTN NAV RADIO Page

The ALTN NAV RADIO page gives the pilot alternate means of navigation radio tuning in case both FMCs fail. The alternate radio tuning is handled by the CDU with pilot-entered frequencies. There is no autotuning capability. All alternate navigation radio tuning information is entered and displayed on the ALTN NAV RADIO page.

The ALTN NAV RADIO page (Figure 13–14) is displayed by pushing the NAV RAD key when both FMCs have failed.

ALTN NAV RADIO Page
Figure 13–14

The FMC sends radio information to the CDU each time a tuning change occurs. This means the CDU can initially tune the same stations the FMC was tuning at the time the FMC failed.

NOTE: The center CDU cannot be used to tune the navigation radios when in alternate navigation. This display is blank on the center CDU.

The ALTN NAV RADIO page is described in the following paragraphs.

- **VOR (1L)** – The currently tuned VOR frequency is displayed in 1L. A valid entry is the VOR frequency or VOR frequency/course. This entry also tunes the associated DME frequency in the respective radio. Manually entering a valid frequency tunes that frequency. The default value is the last selected frequency. Deleting a frequency in 1L displays dashes.

- **CRS (2L)** – The VOR course is displayed in 2L. Valid entries are course or VOR frequency/course. Deleting the course in 2L clears the displayed course.

- **ADF (3L)** – ADF tuning data and the tuning mode status (ANT or BFO) are displayed in 3L. The tuning mode is selected by entering an A or B following the frequency, or by entering A or B with a frequency already displayed.

  Deleting the ADF frequency in 3L displays dashes.

- **ILS-MLS (4L)** – ILS or MLS tuning information is displayed in 4L. PARK is displayed if the ILS/MLS is not tuned. Valid ILS entries are ILS frequency, frequency and front course, or front course with frequency already entered. Valid MLS entries are MLS channel and azimuth.

  The default value is the last selected frequency/front course or PARK. The front course defaults to runway course if the runway is in the active route and only the frequency is entered. Otherwise, when only the frequency is entered, front course defaults to 000° or the last entered front course.

  NOTES:

  1. If the ILS was in autotune when the FMC failed, the frequency and course are automatically crossloaded to the ALTN NAV RADIO page.

  2. PARK in the ILS frequency indicates that no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

- **PRESELECT (6L)** – The PRESELECT field lets the pilot preselect an entry for any field on the ALTN NAV RADIO page in order to verify the entry as correct. A preselected entry can be transferred to the appropriate field on the ALTN NAV RADIO page by pushing the associated LSK.

  Valid entries are entries that are valid for any line on the ALTN NAV RADIO page.

14. FMS Messages

Messages are generated by the FMS when a condition exists that degrades the operation of the system or when a FMS datalink message is received. The messages are categorized as follows:

- Alerting messages
- Communications messages
- Advisory messages
- Entry-error advisory messages.

The messages are displayed in the scratchpad according to priority. Lower priority messages replace displayed messages as the CLR key is pushed or the condition is corrected.

Alerting messages cause FMC MESSAGE to be displayed on the EICAS display. Communications messages cause the communications message •FMC to be displayed on the EICAS display. All FMS messages light the CDU message (MSG) light. Clearing the message or correcting the condition cancels the message.

FMS ALERTING MESSAGES

FMS alerting messages:

- Are displayed in the CDU scratchpad
- Display FMS MESSAGE on the EICAS display
- Light the CDU message light (MSG).

Use the CLR key or correct the condition responsible for the message to remove the message. The message is pushed to the background when data is manually entered into the scratchpad. The message returns when the data is removed from the scratchpad. FMS alerting messages are listed in Table 14-1.

Message	Description
ALIGNMENT REINITIATED	ADIRU alignment has automatically restarted due to airplane motion disturbing the alignment process, or due to the flight crew-entered initial position failing the alignment comparison test.
CHECK ALT TGT	VNAV is selected when the aircraft is between the MCP window altitude and the VNAV target altitude. VNAV holds level flight.
CHECK AIRLINE POLICY	After loading a new airline modifiable information file, the FMS determines a parameter is invalid. The FMS uses the loaded value and notifies the flight crew of the differences. This is a maintenance function.
DESCENT PATH DELETED	The last remaining altitude constraint required to define the descent profile has been deleted. **NOTE:** Once the scratchpad message is displayed and is cleared, it is not redisplayed again for that load.

Alerting Messages
Table 14-1 (cont)

Message	Description
DISCONTINUITY	The route is not defined beyond the waypoint (except when the waypoint is followed by a manually terminated leg, such as FM, VM, HM, legs). ● FM – A course from a fix to a crew entered manual route termination. ● VM – A heading leg from a fix to a crew entered manual route termination. ● HM – A holding pattern to a crew entered manual route termination.
DRAG REQUIRED	The aircraft is unable to maintain the precomputed nominal descent path and stay within speed tolerances.
END OF OFFSET	The aircraft is two minutes prior to the offset termination point.
END OF ROUTE	The aircraft is passing the last route leg.
ENTER INERTIAL POSITION	The flight crew-entered present position did not pass one of the ADIRU comparison checks, or the ADIRU is ready to transition to navigate mode and has not received a present position entry. The CLEAR key must be used to remove this message.
FUEL DISAGREE PROG 2/3	Totalizer (TOTL) fuel quantity and FMS calculated (CALC) fuel quantity disagree by 9000 pounds for more than 5 minutes.
ILS TUNE INHIBIT MCP	The flight control computer is inhibiting changes in ILS tuning and either a manual operation in the ILS tuning was attempted or a new arriveal ILS approach field was activated.
INERTIAL/ORIGIN DISAGREE	The airplane is on the ground and one of the following conditions exist: ● The inertial position entered on the POS INIT page differs from the position of the origin airport in the active route by more than 6 NM. ● A route is activated and executed containing an origin airport with a position that differs from the current ADIRU inertial position by more than 6 NM

Alerting Messages
Table 14-1 (cont)

Message	Description
INSUFFICIENT FUEL	Because of a change in flight conditions or the route, the computed route fuel burn exceeds the total fuel on board, less reserves.
LIMIT ALT FLXXX	The crew or FMS selected altitude is greater than the VNAV limit altitude.
LNAV BANK ANGLE LIMITED	Before entering or while flying a curved path or holding pattern, the FMC predicts the LNAV roll command will be limited b thrust or buffet based on roll rates.
NAV DATA OUT OF DATE	The clock calendar date exceeds the active nav database valid calendar cycle.
NAV INVALID-TUNE XXX	RNAV or VOR approach procedures require a specific navaid be tuned. It is either not tuned or a valid signal is not being received.
NO ACTIVE ROUTE	No active FMS lateral route is available and LNAV is selected on the MCP.
NO ROUTE DATA	No active CDU lateral route is available when operating in ALTN NAV, and LNAV is selected on the MCP.
PERF/VNAV UNAVAILABLE	VNAV is selected on the MCP without gross weight, cost index, or cruise altitude entered.
RESET MCP ALT	Displayed two minutes before the top of descent point when MCP altitude is still set at the current altitude.
RW/ILS CRS ERROR	Either the airplane is within ILS automatic tuning range and the tuned ILS frequency does not match the frequency for the active arrival runway, or the FMS is not receiving valid course data from the same ILS that the FMS is using for frequency data. This message is inhibited when the scratchpad message ILS TUNE INHIBITED-MCP is displayed.
RTA FIX DELETED	RTA fix has been deleted from the modified flight plan.

Alerting Messages
Table 14–1 (cont)

Message	Description
RW/ILS FREQ ERROR	Either the airplane is within ILS automatic tuning range and the tuned ILS course does not match the course for the active arrival runway, or the FMS is not receiving valid frequency data from either ILS. This message is inhibited when the scratchpad message ILS TUNE INHIBITED-MCP is displayed.
SINGLE FMC L OPERATION	The right FMC is no longer operational.
SINGLE FMC R OPERATION	The left FMC is no longer operational.
TAKEOFF SPEEDS DELETED	New performance data is entered after the V_{SPEEDS} have been entered on the TAKEOFF REF page, or a takeoff thrust selection change is entered after the V_{SPEEDS} have been entered. The crew must select new V_{SPEEDS}.
THRUST REQUIRED	The autothrottle is not engaged and the airplane is not able to maintain the VNAV descent path without increasing thrust.
UNABLE FLXXX AT RTA FIX	Directed crossing altitude at RTA fix is less than FLxxx, but the predicted ETA is within tolerance.
UNABLE HOLD AIRSPACE	The radius of the holding pattern, calculated by the FMC, exceeds the FMC maximum protected airspace limits.
UNABLE RTA	RTA cannot be achieved within applicable arrival time tolerance.
UNABLE NEXT ALT	VNAV is not able to meet the next climb restriction altitude.

Alerting Messages
Table 14-1 (cont)

Message	Description
VERIFY POSITION	The current FMS calculation of airplane present position is based on conflicting data. The possible conflicts are: • The left FMS position differs from the right FMS by more than twice the RNP for 5 seconds. • The difference between FMC position and the navigational aid being useed (GPS, DME, VOR or inertial) is grater than 12 NM for 5 seconds.
VERIFY RND-POS REV 2/3	The default RNF has changed due to a change in flight phase and the flight crew entered RNP value exceeds the crew default RNP value.
VIA OFFSET INVALID	Flight conditions invalidate the pending alternate airport diversion with the entered OFFSET.

Alerting Messages
Table 14-1

FMC COMMUNICATIONS MESSAGES

FMC communications messages:

- Are displayed in the CDU scratchpad
- Cause the EICAS communications message (FMC) to be displayed
- Light the CDU message light (MSG)
- Sound the communications aural chime (high-low).

FMS communications messages are listed in Table 14-2.

Message	Description
ALTN UPLINK	Up to four company-preferred alternate airports and associated data has been received and is available for preview on the ALTN page.
ALTN INHIBIT UPLINK	A company list of alternate airports that will be inhibited from automatic selection and display on the ALTN page has been received and is available for preview on the ALTN page.
ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.
DES FORECAST UPLINK READY	Descent forecast data has been received and is available for loading on the DESCENT FORECAST page.
FLT NUMBER UPLINK	A new flight number has been received and is available on the RTE page 1/X.
INVALID TAKEOFF XXX/YYY	Takeoff data for up to six runways or runway intersection pairs has been received but some data for one runway or runway intersection pair (RWXXX/YYY) is invalid.
PARTIAL ROUTE X UPLINK	A new route has been uplinked to the FMS but a portion of the route could not be loaded.
PERF INIT UPLINK	Performance initialization data has been received and is available for preview on the PERF INIT page.
ROUTE X UPLINK READY	A new route or route modification has been received and is available for loading on the RTE X page.

Communications Messages
Table 14-2 (cont)

Message	Description
TAKEOFF DATA LOADED	An uplink that contains takeoff data matching the runway/pos entry on the takeoff page is available for preview (only displayed after an initial takeoff uplink has been received) or alternate thrust and/or flaps have been selected.
TAKEOFF DATA UPLINK	An uplink that contains takeoff data matching the runway on the takeoff page is available for preview.
WIND DATA UPLINK READY	Wind data has been received and is available for loading into the active route.

Communications Messages
Table 14-2

FMS ADVISORY MESSAGES

FMS advisory messages:

- Are displayed in the CDU scratchpad
- Light the CDU message light (MSG).

FMS advisory messages are listed in Table 14-3.

Message	Description
DELETE	The DELETE key was pushed.
HOLD AT XXXX	A waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, following selection of the HOLD function key. Selection of HOLD AT XXXX into a RTE LEGS page waypoint data line creates a holding fix at the XXXX waypoint.
INVALID ALTN UPLINK	A company-preferred list of alternate airports and associated alternate data has been received but the data is not valid and cannot be displayed.
INVALID ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received but the data is not valid and cannot be displayed.
INVALID FLT NO UPLINK	A new flight number has been received but the data is not valid and cannot be displayed.
INVALID FORECAST UPLINK	Descent forecast data has been received but the data is not valid and cannot be displayed.
INVALID PERF INIT UPLINK	Performance initialization data has been received but the data is not valid and cannot be displayed.
INVALID ROUTE UPLINK	A new flight plan route or modification to the active flight plan route has been received but the data is not valid and cannot be displayed.
INVALID TAKEOFF UPLINK	Takeoff data for up to six runways or runway-intersection pairs has been received but the data is not valid and cannot be displayed.
INVALID WIND DATA UPLINK	En route wind data has been received but the data is not valid and cannot be displayed.

Advisory Messages
Table 14-3 (cont)

Message	Description
MAX ALT FLXXX	The altitude entry on any CDU page is above the performance computed maximum altitude.
NOT ON INTERCEPT HEADING	LNAV is selected on MCP and the airplane is not within the capture criteria of active leg, or the current heading will not intercept the active leg.
STANDBY ONE	The FMC requires more than 4 seconds to display data.
TIMEOUT- RESELECT	Communication between the FMC and CDU has failed. The flight crew must reselect FMC on the CDU MENU page.
UNABLE CRZ ALT	Performance predicts a zero cruise time at the entered cruise altitude.

Advisory Messages
Table 14–3

FMS ENTRY ERROR MESSAGES

FMS entry error messages:

- Are displayed in the CDU scratchpad
- Light the CDU message light (MSG)
- Must be removed by pushing the CLEAR key
- Must be removed before the scratchpad is used.

FMS entry error messages are listed in Table 14-4.

Message	Description
ARR N/A FOR RUNWAY	The runway/approach selected is not compatible with arrival selected.
CRS REVERSAL AT FA FIX	A conflict exists between the default final approach (FA) waypoint (result of a runway or VFR approach selection) and the preceding flight plan.
ENG OUT SID MOD	An engine failure is sensed after takeoff before the flaps are fully retracted. The FMS has automatically loaded an available engine out standard instrument departure as a route modification to the active route.

Entry Error Messages
Table 14-4 (cont)

Message	Description
ILS TUNE INHIBITED – MCP	ILS tuning is inhibited with the: • Autopilot engaged • MCP APP switch selected • Localizer or glideslope captured. Any attempt to manually change the ILS frequency or select another ILS approach on the CDU displays this message. To make the desired changes: • Above 1500 feet radio altitude – deselect approach on the MCP • Below 1500 feet radio altitude – select TOGA OR • Disengage the autopilot • Turn both flight directors off, and • Turn at least one flight director on.
INVALID DELETE	Deleting the selected data is not allowed.
INVALID ENTRY	Attempted entry of data into a CDU field and the data is not properly formatted for that field.
NOT IN DATABASE	The required data is not found in the route or the nav database.
ROUTE FULL	The route is filled to the allowable capacity.
ROUTE X UPLINK LOADING	A new flight plan route or modification to the active flight plan route has been received and is being loaded following the pilot selecting the LOAD prompt.
RUNWAY N/A FOR SID	The selected runway is not compatible with the selected departure.
TAKEOFF FLAPS DELETED	The FMC has deleted the takeoff flap setting on the TAKEOFF REF page. This occurs when the thrust reduction value is changed to the same value as the takeoff flap setting.
STANDBY ONE	The FMS requires more than four seconds to display data.

Entry Error Messages
Table 14–4 (cont)

Message	Description
UNABLE TO SEND MSG	The selected datalink message cannot be transmitted.
V-SPEEDS UNAVAILABLE	For certain high thrust/low gross weight takeoff conditions, FMC V_{SPEEDS} are not calculated. Adjust gross weight and/or takeoff thrust limit to enable V_{SPEED}.
VERIFY RNP ENTRY	The entered RNP value is greater than the default RNP value for the present flight phase, or it is less than the present Actual Navigation Performanc (ANP).

Entry Error Messages
Table 14-4

CDU ANNUNCIATORS

The following CDU annunciators light when certain conditions exist. These annunciators are described in Table 14-5.

Annunciator	Description
DSPY	The RTE, RTE LEGS, RTE DATA, or RTE HOLD page not containing the active leg or route segment is displayed, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is displayed.
OFST	An offset path has been entered and executed.
MSG	An FMS message is awaiting display or is displayed.

CDU Annunciators
Table 14-5

15. Additional Information

This section describes in more detail the use of cost index and how it is calculated for airline use. This section also covers the maintenance CDU pages and how they are accessed.

COST INDEX

The FMS normally flies the aircraft in the economy (ECON) mode. The computed ECON speed results in minimum cost per mile flown or maximum distance per pound of fuel. ECON Mach is calculated in the performance database and is a function of gross weight, selected altitude, temperature, and cost index. Cost index is a number that governs the speed the aircraft flies. The higher the number the faster the speed, which saves time. The lower the number the slower the speed, which saves fuel. Valid entries are 0 to 9999.

Cost index is the ratio of the flying time to the cost of fuel. It is determined by dividing the dollar cost per hour to operate the aircraft, excluding fuel, by the cost of fuel in cents per pound.

For example, if it costs $1200 per hour for flying time and 10 cents per pound for fuel, the cost index is 120.

If the cost of fuel increases to 20 cents per pound the cost index is 60. The aircraft would fly slower to save fuel.

If in the example, flying time per hour increased to $1500 per hour, the cost index would then be 150. The faster speed would save time.

Determining an airlines’ cost of flying time per hour depends on the airline’s economic situation and how they figure operating expenses. It can include insurance, crew costs, maintenance, passenger handling, etc. Each airline must decide its particular priorities and use a cost index that achieves the desired results. Segment costs can vary with the direction of flight over a specific route, and whether the flight is domestic or international.

If an airline is not certain what cost index to use over a new route segment, a good starting point is to select a cost index that produces a cruise Mach number close to long range cruise (LRC). This can be determined prior to departure by first entering a cost index on the PERF INIT page and then checking the ACT CRZ page for the resulting Mach number. After flying the route several times, the cost index can then be adjusted as needed to better fit the route segment.

Cost index is **only** associated with ECON speed mode. When flying ECON speed, cost index may vary the speed slightly due to changing wind conditions. This is a normal function of cost index since its major purpose is to constantly optimize economy of flight.

MAINTENANCE PAGES

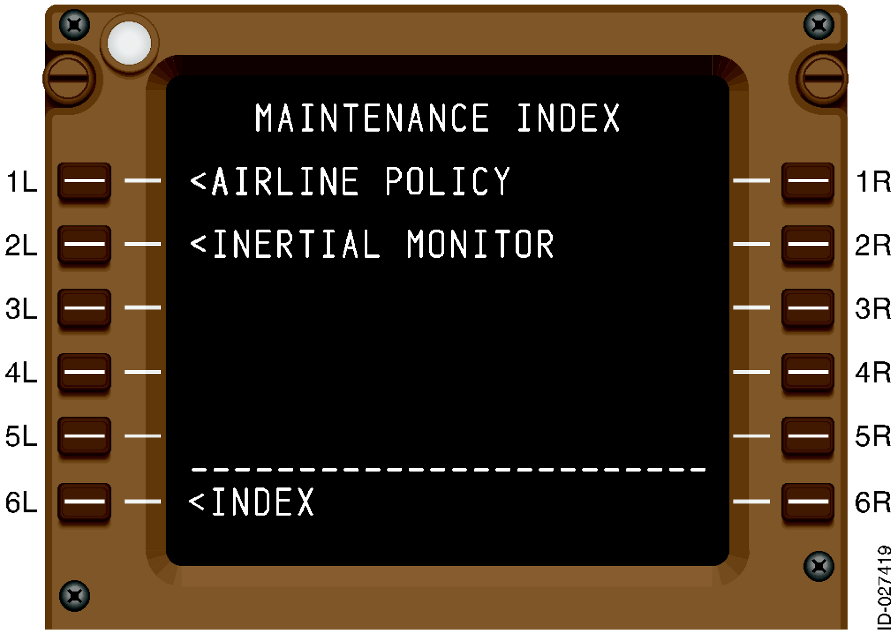
The maintenance pages can only be accessed while the aircraft is on the ground. The maintenance pages are accessed from the MAINTENANCE INDEX page and include the AIRLINE POLICY pages and the INERTIAL MONITOR page.

MAINTENANCE INDEX Page

The MAINTENANCE INDEX page is accessed by pushing 6R (MAINT) on the INIT/REF INDEX page. To display the MAINTENANCE INDEX page (Figure 15-1), do the following:

STEPS:

1. Push the INIT REF key while the aircraft is on the ground.
2. Push 6R (MAINT) on the INIT REF INDEX page.



MAINTENANCE INDEX Page
Figure 15-1

The MAINTENANCE INDEX page has prompts for pages that are normally used only on the ground. These pages let maintenance personnel examine the AIRLINE POLICY pages and evaluate ADIRU integrity.

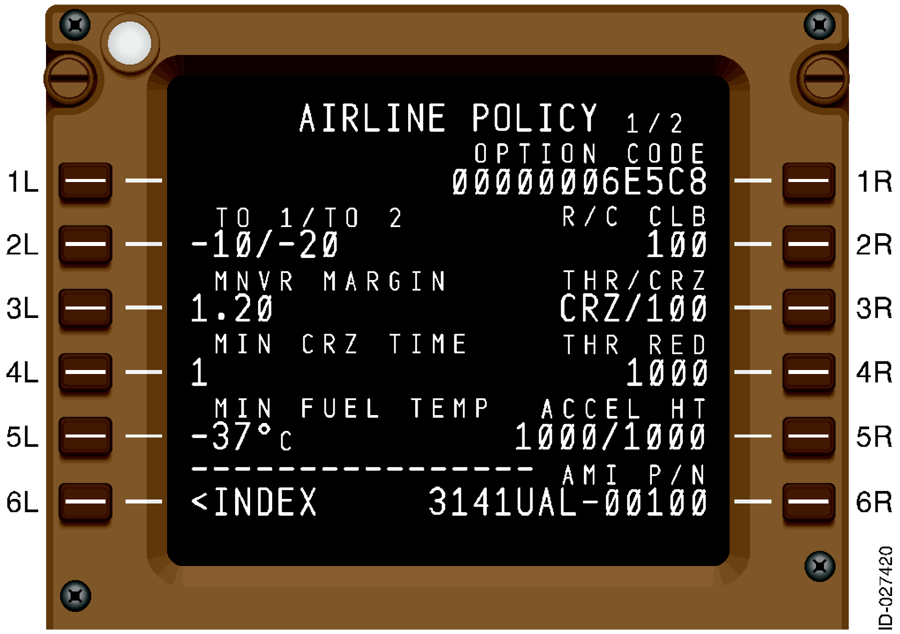
NOTE: Access to the MAINTENANCE INDEX page is inhibited in flight.

Pushing 1L (AIRLINE POLICY) or 2L (INERTIAL MONITOR) displays the associated maintenance page. Pushing 6L (INDEX) returns the display to the INIT/REF INDEX page.

AIRLINE POLICY Pages

The AIRLINE POLICY pages display operating parameters saved in the airline maintained file. The FMS first references this file for data values before computing FMS default values. These pages are not normally used by the flight crew.

STEP: To display the AIRLINE POLICY page 1/2 (Figure 15-2), push 1L (AIRLINE POLICY) on the MAINTENANCE INDEX page.



AIRLINE POLICY Page 1/2
Figure 15-2

The AIRLINE POLICY pages display performance factors. These performance factors can be changed to tailor performance optimization and takeoff performance/guidance to individual airline policy or aircraft characteristics. The AIRLINE POLICY page 1/2 is described in the following paragraphs.

- **TO 1/TO 2 (2L)** – Takeoff derates (TO 1/TO 2) are displayed in 2L if the takeoff derate option is enabled. If not, this field is blank. Valid entries are one, two, or three characters and the range of entries is 0 to 30%. Entering a minus sign is optional. If both derates are entered together, they must be separated by a slash (/). If a takeoff derate 2 is entered by itself, the entry must be preceded by a slash (/). The entry is displayed in large font and cannot be deleted.

- **MNVR MARGIN (3L)** – The maneuver (MNVR) margin gives the value, in gravitational units, to be used when calculating speed limits, maneuver altitude, and maximum altitude. Valid entry is 1.20 to 1.30 for FAA configuration. Valid entry range is 1.30 for CAA (JAR) configuration. The default value is the last entered value. If no value has previously been entered, then 1.20 is displayed for FAA configuration and 1.30 is displayed for CAA configuration.

- **MIN CRZ TIME (4L)** – The minimum cruise time (in minutes) is used as a lower limit for the minimum cruise time extracted from the performance database for optimum altitude calculations. It is used only in calculating the optimum altitude for short trips. The entry forces the displayed optimum altitude to be lower, if required, to provide the entered minimum cruise time. Valid entry is 1 to 20 minutes. Default value is the last entered value. If no value has been previously entered, 1 is displayed.

- **MIN FUEL TEMP (5L)** – The label line displays either FUEL FRZ TEMP or MIN FUEL TEMP as determined by the FUEL FRZ option code, as stored in the AMI. If the AMI is invalid, the FMS default value is used.

  The fuel freeze temperature/minimum fuel temperature is displayed on the PERF INIT page.

- **<INDEX (6L)** – Pushing 6L displays the MAINTENANCE INDEX page.

- **OPTION CODE (1R)** – The option code in 1R displays the current OPC authorized for use by the airline. Availability of additional options is coordinated through the Boeing Commercial Airplane Company.

- **R/C CLB (2R)** – The minimum rate-of-climb for climb in 2R is displayed in this field. This is the residual rate-of-climb capability desired by the airline in a climb mode at the thrust limited maximum altitude based on climb speed and climb thrust limits. The default value is 100 fpm, and can be changed by entering a one- to three-digit rate ranging from 0 to 500. Default value is the last entered value. If no value has been previously entered, 100 is displayed.

- **THR/CRZ (3R)** – The first entry in 3R (THR) can be set to CLB or CRZ to indicate what default thrust limit is to be set by the FMS at cruise altitude capture. The default (CLB) results in maximum climb thrust being set as the thrust limit during all-engine cruise. The second entry in 3R (R/C CRZ) is the residual rate–of–climb capability desired by the airline at the thrust limited maximum altitude based on cruise speed and the specified cruise thrust limit (CLB or CRZ as previously defined). The default value is 100 fpm, and can be changed by entering a one to three-digit rate ranging from 0 to 500. Partial entries for THR or R/C CRZ only change the entered parameter.

- **THR RED (4R)** – The thrust reduction altitude (AGL) or flap setting in 4R is the point at which the thrust limit is automatically reduced from takeoff thrust to the selected climb thrust (when VNAV and A/T are engaged). The default value for thrust reduction altitude is 1000 and is displayed in large font. This value is propagated to the TAKEOFF REF page 1/2. Valid entries are from 399 to 9999.

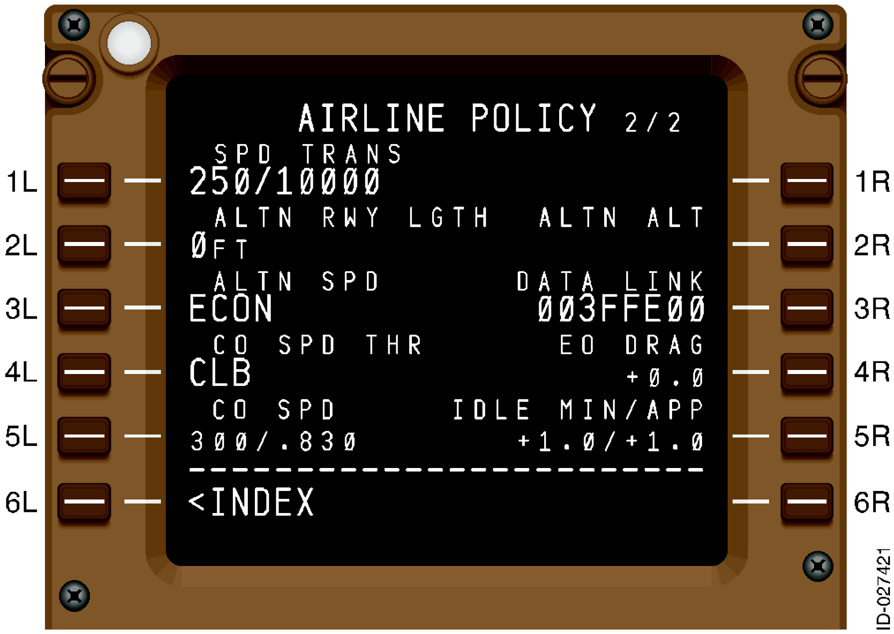
  The valid flap setting entries are 5 or 1 and result in the display showing FLAPS 5 or FLAPS 1.

- **ACCEL HT (5R)** – The acceleration height in 5R displays engine out and all engine flap retraction heights in feet above the origin airport (AGL) where acceleration begins for flap retraction in VNAV. If the ACCEL HT option code has not been enabled, these fields are blank.

  The ACCEL HT value is propagated to the TAKEOFF REF page 2/2. The engine out value is displayed in the inner field. The two values are separated by a slash (/). Entering an engine out or an all–engines flap retraction height only is not allowed. Valid entries are from 400 to 9999. The default value is the last entered value.

- **AMI P/N (6R)** – The AMI part number is displayed in 6R.

STEP: To display the AIRLINE POLICY page 2/2 (Figure 15-3), push the NEXT PAGE key when the AIRLINE POLICY PAGE 1/2 is displayed.



AIRLINE POLICY Page 2/2
Figure 15-3

The AIRLINE POLICY page 2/2 is described in the following paragraphs.

- **SPD TRANS (1L)** - The specified speed and transition altitude are displayed in 1L.
- **ALTN RWY LGTH (2L)** - The alternate minimum runway length in 2L is the minimum runway to be used in the nav database search for alternate airports.
- **ALTN SPD (3L)** - The default cruise speed mode in 3L is the speed schedule for alternate cruise predictions. Selections are CAS/Mach, LRC, ECON, EO, EOLRC, and CO SPD.
- **CO SPD THR (4L)** - The company speed thrust rating in 4L is the thrust rating to be used when company speed is active.
- **CO SPD (5L)** - The company speed (in CAS) in 5L is used in the engine out mode. The range is from 100 knots to 400 knots with a default value of 250 knots.

  Company speed in Mach is used in the engine out mode. The range is from 0.100 Mach to 0.990 Mach with a default of 0.800 Mach.

- **<INDEX (6L)** – Pushing 6L displays the MAINTENANCE INDEX page.

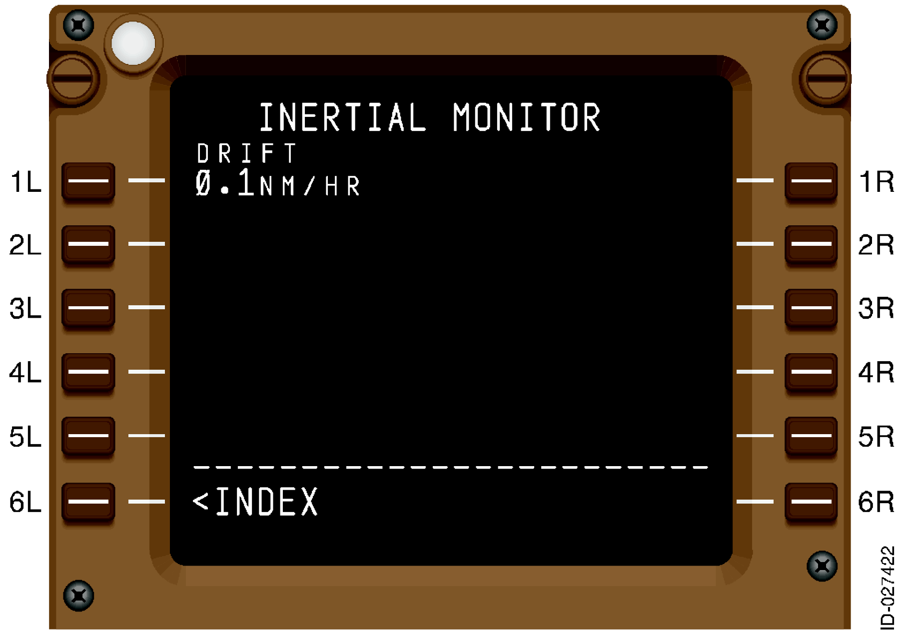
- **ALTN ALT (2R)** – The alternate altitude in 2R is the default advisory altitude used in alternate flight plan predictions. The range is from 1500 to 40,000 feet.

- **DATA LINK (3R)** – The AMI datalink option code is displayed in 3R.

- **EO DRAG (4R)** – Selection, entry and deletion is non-operational when a black label performance database is loaded.

INERTIAL MONITOR Page

STEP: To display the INERTIAL MONITOR page (Figure 15-4), push 2L (INERTIAL MONITOR) on the MAINTENANCE INDEX page.



INERTIAL MONITOR Page
Figure 15-4

The INERTIAL MONITOR page is described in the following paragraphs.

- **DRIFT (1L)** – After the flight is complete, inertial drift data is displayed in 1L. The computed drift rate is automatically cleared at ground to air transition, if not manually cleared before then.

  The computed drift is the difference between the position error at flight start (NM) and position error at flight end (NM) divided by the flight length (hours).

The position error at flight start is the distance between ADIRU and FMS position in nautical miles at the ground to air transition or at cold start recovery while airborne.

The position error at flight end is the distance between ADIRU and FMS position in nautical miles at flight complete.

The flight length is the interval of time in hours between flight start and flight complete.

NOTE: The data field in 1L is blank while airborne and until the flight is complete with engine shutdown.

- **<INDEX (6L)** – Pushing 6L displays the MAINTENANCE INDEX page.

Acronyms and Abbreviations

Acronyms and abbreviations used in this manual are defined as follows:

TERMS	DEFINITION
A	at or above, autotuning
ACCEL	acceleration
ACIPS	airfoil and cowl ice protection system
ACT	activated
ADF	automatic direction finder
ADIRS	air data and inertial reference system
ADIRU	air data inertial reference unit
AF	arc to fix
AFDC	autopilot flight director computer
AGL	above ground level
AIMS	airplane information management system
ALT	altitude
ALTN	alternate
AMI	airline modifiable information
AMU	audio management unit
ANP	actual navigation performance
APRT	airport
ARPT	airport
ARR	arrival
ASCPC	air supply and cabin pressure controllers
ATC	air traffic control
ATZ	aerodrome traffic zone
AVAIL	available
B	below
BARO	barometer
BARO SET	barometer setting
BAT	battery
BM	back course marker
BRG/DIST	bearing/distance
BRT	brightness
°C	degrees centigrade
CAA	Civil Aviation Administration
CALC	calculated
CANC	cancel

TERMS	**DEFINITION**
CAS	calibrated airspeed
CCD	cursor control device
CDU	control display unit
CF	course fix, course to a fix
CG	center of gravity
CHKL	checklist
CI	cost index
CLB	climb
CLR	clear
CMCF	central maintenance computing function
CO	company
COMM	communication
CON	continuous
CRS	course
CRZ	cruise
CRZ CLB	cruise climb
CTA	controlled area
CTC	cabin temperature controller
CTL	control
CTR	controlled zone
D	down
D/D	drift down
DCMF	data communication management function
DECR	decrease
DEL	delete
DEP	departure
DEP ARR, DEP/ARR	departure arrival
DEST	destination
DF	direct to fix
DIR	direct, direction
DLGF	data loading gateway function
DME	distance measuring equipment
DSP	display select panel
DSPY	display
DTG	distance-to-go
DTK	desired track
DU	display unit

TERMS	**DEFINITION**
E	east
E/D	end-of-descent
ECON	economy
ECON CLB	economical climb
ECON DES	economical descent
ECS	environmental control system
EEC	electronic engine control
EFC	expect further clearance
EFIS	electronic flight instrument system
EFIS CP	electronic flight instrument system control panel
EICAS	engine indicating and crew alerting system
ELEC	electrical
ELMS	electrical load management system
ENG	engine
EO	engine out
EPR	engine pressure ratio
ETA	estimated time of arrival
EXEC	execute
°F	degrees fahrenheit
FA	fix to an altitude, VFR approach fix
FAA	Federal Aviation Administration
FD	flight director
FF	final approach fix, fuel flow
FIR	flight information region
FL	flight level
FLT NO	flight number
FM	fix to a manual termination, flight management
FMA	flight mode annunciator
FMCF	flight management computer function
FMCS	flight management computer system
FMF	flight management function
FMS	flight management system
fpm	feet per minute
FPV	flight path vector
FQIS	fuel quantity indicating system

TERMS	DEFINITION
FR	from
FREQ	frequency
FSEU	flap slat electronic unit
ft	feet
GA	go-around
GPS	global positioning system
GPWC	ground proximity warning computer
GR WT	gross weight
GS	groundspeed
H	headwind
H/WIND	headwind
HA	holding to an altitude
HDG	heading
HF	high frequency, holding to fix
HM	holding with manual termination
hPa	hectopascals
HT	height
HYD	hydraulic
IAF	initial approach fix
ICAO	International Civil Aviation Organization
IDENT	identification
IF	initial approach fix, initial fix
ILS	instrument landing system
IM	inner marker
IN	inches
INBD	inbound
INCR	increase
INFO	information
INIT	initialize
INIT REF	initialize reference
INTC	intersection
JAR	Joint Airworthiness Requirement

TERMS	DEFINITION
kgs	kilograms
kt	knot
kts	knots
L	left, left crosswind
L INBD	left inboard
lat, LAT	latitude
LAT/LON	latitude/longitude
lbs	pounds
LCD	liquid crystal display
LIM	limit
LNAV	lateral navigation
LOC	localizer
LON	longitude
long	longitude
LRC	long-range cruise
LSK	line select key
LVL	level
LWR CTR	lower center
M	manual tuning
MA	missed approach
MAG	magnetic
MAT	maintenance access terminal
MAX	maximum
MCP	mode control panel
MD	minimum descent
MFD	multifunction display
MIN	minimum
MLS	microwave landing system
MM	middle marker
MMO	maximum operating mach
MNVR	maneuver
MOD	modification
MRC	maximum range cruise
MSG	message
MTRS	meters
N	north

TERMS	DEFINITION
N/A	not available
NAV	navigation
NAV RAD	nav radio
ND	navigation display
NDB	nondirectional beacon
NE	northeast
NM	nautical miles
NW	northwest
OAT	outside air temperature
OFST	offset
OM	outer marker
OPAS	overhead panel ARINC 629 system
OPC	operational program configuration
ORIG	original
P	procedure autotuning
P/P	present/position
PB/PB	place bearing/place bearing
PBD	place/bearing/distance
PDS	primary display system
PERF	performance
PFD	primary flight display
PI	procedure turn to an intercept
PNL	panel
POS	position
PPOS	present position
PRED	predict
PRI	primary
PSEU	proximity switch electronic unit
QUAD	quadrant
R	right, right crosswind, route autotuning
R INBD	right inboard
R/C	rate-of-climb
RA	radio altitude

TERMS	DEFINITION
RAD	radio
RCL	recall
RECMD	recommended
REF	reference
RESTR	restriction
RNP	required navigation performance
RTA	required time of arrival
RTE	route
RW	runway
RWY	runway
RX	runway extension fix
S	south
SAARU	secondary attitude air data reference unit
SAT	static air temperature
SATCOM	satellite communications
SE	southeast
SEL CAS	selected CAS
SEL MACH	selected Mach
SID	standard instrument departures
SP	space
SPD	speed
SPD RESTR	speed restriction
SPDS	speeds
STA	stations
STAR	standard terminal arrival
STAT	status
STD	standard
SW	southwest
T	tailwind
T/C	top-of-climb
T/D	top-of-descent
T/WIND	tailwind
TACAN	tactical air navigation
TAI	thermal anti-ice
TAS	true air speed
TD	touchdown
TERR	terrain

TERMS	DEFINITION
TF	track between two fixes
TFC	traffic
TGT	target
THR	thrust
THR REF	thrust reference
TIZ	traffic information zone
TK	track
TMA	terminal area
TMCF	thrust management control function
TMF	thrust management function
TO	takeoff
TO/GA	takeoff/go-around
TOGW	takeoff gross weight
TOTL	totalizer
TRANS	transitions
TTG	time-to-go
U	up
UIR	upper flight information region
UTC	universal time coordinated
V/B	vertical bearing
V/S	vertical speed
VAR	variation
VFR	visual flight rules
VHF	very high frequency
VIA	versatile integrated avionics
VMO	maximum operating velocity
VNAV	vertical navigation
VOR	VHF omnidirectional radio range
VORTAC	combined VOR and TACAN stations
VREF	reference speeds
VTK	vertical track
W	west, white
WEU	warning electronic system
WOW	weight on wheels
WPT	waypoint
WT	weight

TERMS	DEFINITION
WXR	weather
XTK	crosstrack
ZFW	zero fuel weight

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