FMS

Honeywell

PILOT'S GUIDE

Flight Management System (FMS) for the Boeing 787

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Flight Management System (FMS)

for the
Boeing 787

Pilot's Guide

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List of Effective Pages
LEP-7

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Table of Contents

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

Table of Contents (cont)

List of Figures

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REV 0   Mar 2014

Table of Contents

TC-9

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Table of Contents (cont)

List of Figures (cont)

Table of Contents (cont)

List of Figures (cont)

Table of Contents (cont)

List of Figures (cont)

Table of Contents (cont)

List of Figures (cont)

Table of Contents (cont)

List of Figures (cont)

Table of Contents (cont)

List of Tables

Table of Contents (cont)

List of Procedures

1. Introduction

The Honeywell Boeing 787 Flight Management System (FMS) Pilot's Guide describes the operation of the Honeywell Flight Management System installed on the Boeing 787 aircraft.

This publication is intended to be used as a guide and is written for system familiarization only. This guide does not supersede any Federal Aviation Administration (FAA) or original equipment manufacturer (OEM)–approved procedures.

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, temperature, and operating costs, within the scope of information available to the FMS, it fills in the details, suggesting the most economical climb profile, cruise altitude, airspeed, step climb, and descent. These features may be used in conjunction with other airline flight planning procedures or tools (e.g., – flight plans) to optimize aircraft operation. When 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 optimal operational profile for the flight considering cost and time while attempting to satisfy all operational constraints that are imposed on it. The key roles of the system are optimizing performance and providing accurate 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 (FMC) 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 use from preflight, through typical inflight use, to landing and flight completion. The guide contains sufficient details to answer most of the questions generated through normal system use, including some aspects of non–normal operations.

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

This revision reflects inclusions to Block Point 1B.

STRUCTURE OF THIS GUIDE

This guide is divided into the following sections:

- **Section 1 – Introduction** – Describes the structure of this guide and gives product support and publications ordering information.

- **Section 2 – Flight Management** – Describes the flight management process of the FMS.

- **Section 3 – Flight Operations** – Describes flight operations used on a typical airline revenue flight.

- **Section 4 – Preflight** – Describes the preflight phase of flight.

- **Section 5 – Takeoff and Climb** – Describes the takeoff and climb phase of flight.

- **Section 6 – Cruise** – Describes the cruise phase of flight.

- **Section 7 – Descent** – Describes the descent phase of flight.

- **Section 8 – Approach** – Describes the approach phase of flight.

- **Section 9 – Alternate Airport Pages** – Describes the alternate airport page function of the FMS.

- **Section 10 – Advanced Flight Planning** – Describes the FMS flight planning procedure.

- **Section 11 – Flight Management Computer (FMC) Datalink** – Describes the datalink communication process of the FMS.

- **Section 12 – Wind Entry and Use** – Describes the wind entry and use procedures in the FMS.

- **Section 13 – FMS Backup Navigation, Controls, and Display Functions** – Describes the backup functions available on the FMS for navigation, controls, and displays.

- **Section 14 – Flight Management Computer (FMC) Messages** – Describes the messages generated by the FMC.

- **Section 15 – FMS Additional Information, Features, and Functions** – Describes the cost index and how it affects the flight, maintenance pages, airline policy pages, the inertial monitor, and time/date manual entry when necessary.

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2. Flight Management

INTRODUCTION

The pilot enters a flight plan, selects various flight control modes, and enters other necessary flight data into the FMS with the control display unit (CDU), the multifunction keyboard (MFK), cursor control device (CCD), and mode control panel (MCP). Flight progress is monitored on the control display unit (CDU) and the pilot's respective PFDs and NDs.

After data entry, the FMS generates an optimum flight profile from the origin to the destination airport within the bound of the information it has available. The system provides aircraft guidance along the defined flight path while computing and displaying current and predicted progress along the flight plan. The aircraft can follow this guidance through the autopilot (AP) function, by pilot manual control using the flight director, or by direct reference to the navigation displays. Lateral and vertical flight plan profiles are shown in Figure 2-1.
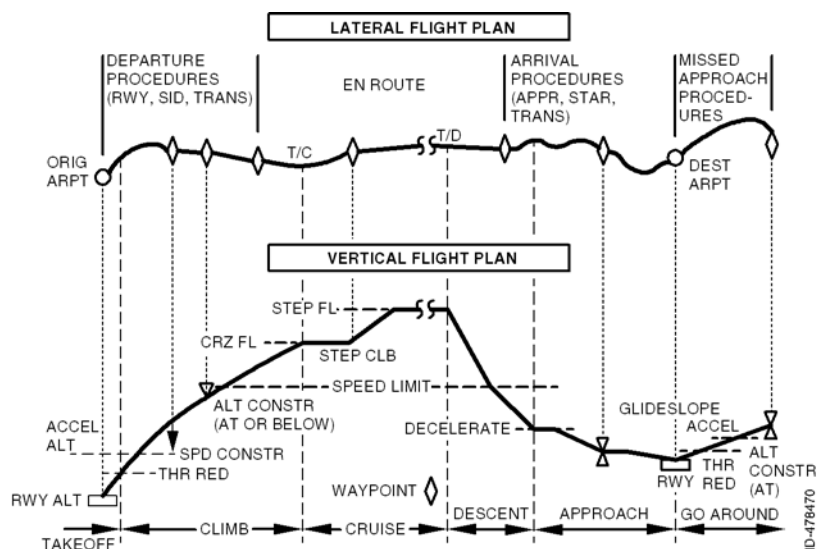
**Figure 2-1
Flight Management System Profiles**

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, as well as safe and expeditious operation within airspace procedures.

To perform these functions, the FMS manages navigation sensors including automatically tuning of certain radios. The FMS accesses and extracts information from both a navigation database (NDB) and an aircraft performance database to generate optimum lateral and vertical flight path information and to display flight guidance information. The flight path information is constructed so as to be consistent with and optimize use of any applicable departure procedures (DPs), standard instrument departures (SIDs), routes, standard terminal arrivals (STARs), and a variety of types of instrument approach procedures to be used.

The system can comply with criteria for required navigation performance (RNP) for procedures from departure, through en route phase of flight, to approach. When necessary, the FMS can provide suitable path compliance for procedure turns, missed approach paths, and holding patterns.

Optimum vertical guidance is computed to optimize aircraft performance requirements as well as to comply with route or instrument procedure altitude or speed constraints. The FMC calculates predictions for ETAs, as well as for fuel consumption and fuel remaining at flight plan waypoints, destination airports, and alternate airports. The system can determine along track progress to provide for necessary speed and thrust control to satisfy **time of arrival** constraints at waypoints.

An overview of how the FMS manages the flight from takeoff to touchdown is shown in Figure 2–2.

AN ACCURATE TOP OF DESCENT POINT
FOR A CABIN REPRESSURIZATION
AND A COST EFFICIENT DESCENT

OPTIMUM ECONOMY VERTICAL PROFILE
CHANGES AS THE CRUISE PROGRESSES

AIRPLANE CRUISES AT OPTIMUM ALTITUDES
AND AT THE MOST ECONOMICAL SPEED

PROVIDES CONTINUING GUIDANCE
ALONG THE FLIGHT PLAN ROUTE
USING OPTIMUM ROUTES

CONTINUOUS EVALUATION AND
PREDICTION OF FUEL CONSUMPTION
AND ETA's ALONG WITH
TRANSMISSION OF POSITION DATA

NAVIGATION INFORMATION IS
DISPLAYED ON THE MOVING MAP
DISPLAY AND PFD

FUEL-SAVING IDLE THRUST DESCENT
TO THE DESTINATION OR
ALTERNATE AIRPORT

PROVIDES GUIDANCE FOR STARS AND
APPROACH PROCEDURES

AUTOMATICALLY COMPLIES WITH
SPEED AND ALTITUDE RESTRICTIONS

ADJUSTS SPEED TO MEET ASSIGNED
TIME OF ARRIVAL CONSTRAINTS

COMMANDS SPEED AND THRUST
FOR OPTIMUM FUEL ECONOMY

WHEN APPLICABLE,
PROVIDES THE TRANSITION TO
THE AUTOMATIC LANDING SYSTEM

AIRCRAFT DELIVERED AT PROPER
APPROACH SPEED

CAPTURES AND TRACKS THE
ASSIGNED FLIGHT PLAN ROUTE
FLYS DPS AND SIDS

TAKEOFF PERFORMANCE
SPEEDS ARE DISPLAYED

POST FLIGHT
DIAGNOSTIC INFORMATION

SUITABLE FLAP AND LANDING SPEEDS
ARE COMPUTED AND DISPLAYED

THE FLIGHT PLAN ROUTE IS ENTERED AND
FUEL PLANNING DATA IS COMPUTED

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Figure 2-2
Flight Management Overview

FLIGHT DECK CONFIGURATION

The primary part of the flight management computer (FMC) is contained in the common computing resource (CCR) cabinets, with one independent function in each cabinet for redundancy. Two graphical depictions of CDUs can be displayed at any time. Normally the CDUs are displayed side–by–side just in front of the throttle quadrant, however can be shown on any display unit (DU). The flight deck is shown in Figure 2–3.

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Figure 2–3
Flight Deck

The flight deck layout is shown in Figure 2–4.
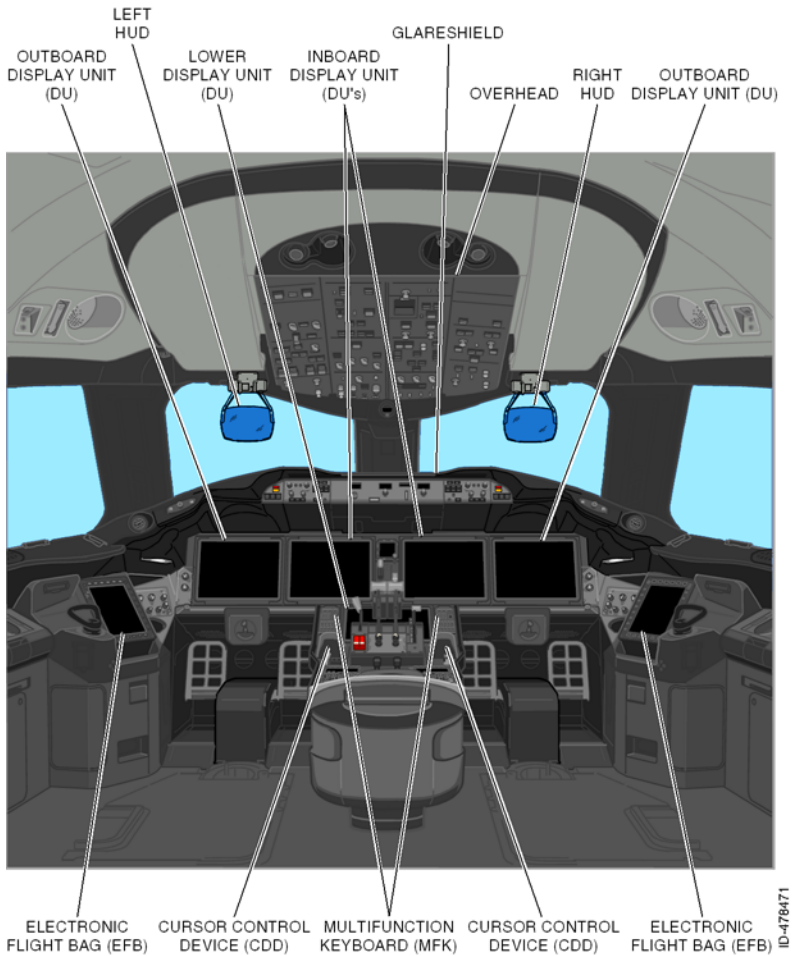
Figure 2–4
Flight Deck Layout

User Interfaces

The auxiliary (AUX) display, primary flight display (PFD), navigation display (ND), engine indication and crew alerting system (EICAS) are normally displayed on the outboard and inboard upper–MFDs. Normally the CDUs are displayed on the lower MFD, as shown in Figure 2–5.
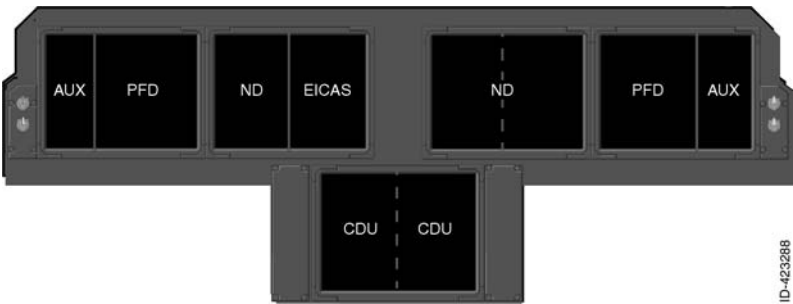
Figure 2–5
Default Display Configuration

The displays on the inboard upper DUs are controlled by display select panels (DSP) on the glareshield. Two DSPs are installed (one for each pilot) to provide control of the MFDs for the on–side inboard DU. Pushing one of the display buttons on the DSP displays the selected configuration on the selected side of the MFD. Pushing the button again returns the display back to the default configuration. Each DU has a left and right window. The display light over the L or R button indicates which side of the window is currently selected. Only one side is selectable at a time as indicated by the light.

The lower–DU is controlled by display select switches on the MFK. The lower DU has a left and right window, similar to the upper inboard DUs. Each side of the lower DU is controlled by the onside display select switch on each MFK. This enables selection of the same MFD functions as the upper inboard DUs.

SYSTEM INTERFACES

The common core system (CCS) provides a common computing network and data exchange system for the majority of the aircraft systems. CCS operation is automatic.

The main component of the CCS is the common computing resource (CCR), which has a left and right cabinet. Separate modules within each CCR cabinet perform distinct functions. The CCRs can isolate most faults, permitting the cabinet to continue operation.

There are no CCS controls or indications for normal operations. In the event a CCR fault occurs resulting in the loss of displays, a CCR reset procedure can be used. Two CCR RESET switches, shown in Figure 2-6, are located on the overhead panel for use during this procedure.

Figure 2-6
CCR RESET Switches

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

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

These multiple sources of information for the FMS are illustrated in Figure 2–7. Correct aircraft, engine and navigation database configuration are confirmed on the identification (IDENT) page on the CDU after aircraft power–up.
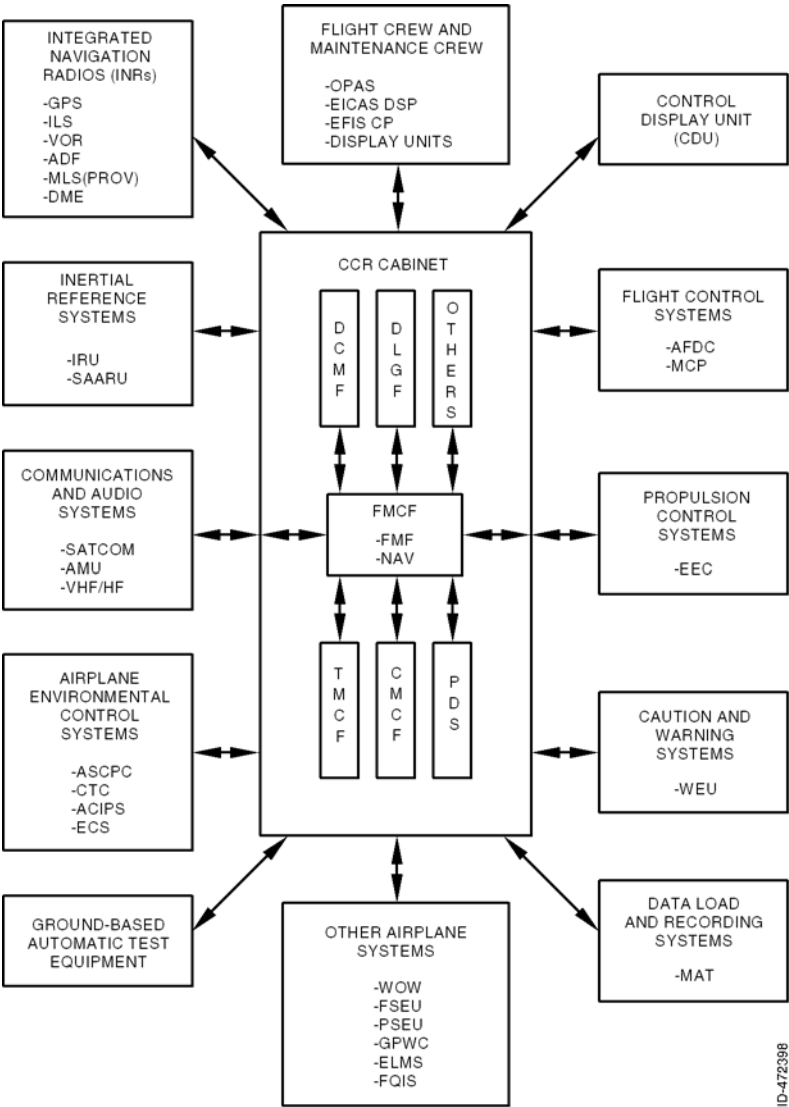
**Figure 2‑7
Flight Management System Interface**

FLIGHT PHASES

Figure 2–8 illustrates a typical FMS profile from the preflight at the origin airport, to landing and shutdown 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 pre–defined route.
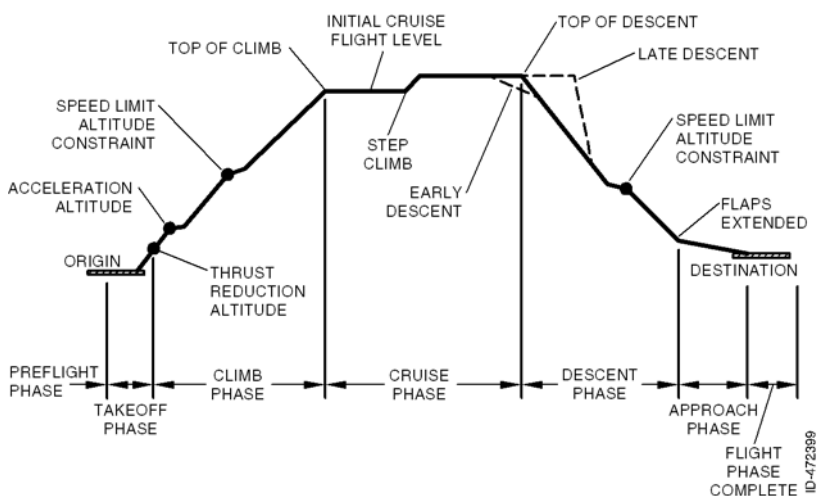
**Figure 2–8
Typical Flight Management System Profile**

The FMS divides the pre–defined route into a number of flight phases: PREFLIGHT, TAKEOFF, CLIMB, CRUISE, DESCENT, APPROACH, and FLIGHT COMPLETE.

- **PREFLIGHT** – In this phase the flight crew enters the flight plan and aircraft weight (load sheet) data into the CDU. A flight plan can be recalled from the navigation database by company route designator or by entering departure/destination International Civil Aviation Organization (ICAO) code identifiers and routes or waypoints on the ROUTE (RTE) page or LEGS page. Flight plan waypoints can also be uplinked by datalink communications between the FMS and the airline flight planning facility.

   The flight plan defines the route of flight and initializes LNAV. The flight plan and weight data provides performance information which initializes the VNAV flight profile.

The following data entry is required to accomplish the PREFLIGHT phase:

— Valid initial position
— Route of flight
— Performance data
— Takeoff data.

The following data entry is not required for the FMS to function but is typically entered during the PREFLIGHT phase of flight to optimize flight and performance planning.

— Standard instrument departure (SID) and standard terminal arrival route (STAR) entry
— Navigation database selection (if necessary to assure use of a current valid NDB)
— Alternate airport
— Thrust limits
— Wind entry
— Route 2.

The PREFLIGHT phase of flight is described in detail in Section 4, Preflight.

● **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 RA, and within 2.5 nautical miles (NM) of the active route leg. The VNAV engages above 400 feet RA (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.

The TAKEOFF phase of flight is described in detail in Section 5, Takeoff and Climb.

● **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.

The CLIMB phase of flight is described in detail in Section 5, Takeoff and Climb.

- **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 considering FMS entered winds, cost index, and route distance. 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.

  The CRUISE phase of flight is described in detail in Section 6, Cruise.

- **DESCENT** – This phase starts at the top–of–descent point or when the VNAV descent page becomes active and ends at the start of the approach phase. The FMS calculates the correct point for the top–of–descent and initiates the descent automatically when the MCP altitude is lowered and VNAV is engaged.

  The DESCENT phase of flight is described in detail in Section 7, Descent.

- **APPROACH** – This phase starts when the first waypoint of the approach procedure sequences or when the runway is the active waypoint and the distance to go is less than 25 NM, or when flaps are extended from up position. LNAV and VNAV guidance can be used to transition to an instrument approach. When a missed approach is necessary, LNAV and VNAV modes can again be engaged in order to fly the missed approach procedure with the autopilot or manually using the flight director.

  The APPROACH phase of flight is described in detail in Section 8, Approach.

- **FLIGHT COMPLETE** – This phase starts after landing and 30 seconds after engine shutdown. The FMS clears 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 and autothrust systems.

FMS–generated data, commands, database information, performance data, and stored information (routes, waypoints runways, and NAVAIDs) are displayed on the CDU. Flight modes and functions have individual pages for INIT REF, RTE, DEP ARR, ALTN, VNAV, FIX, LEGS, HOLD, FMC COMM, PROG, and NAV RAD.

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.

There are three independent FMCs. At power–up, the three FMCs are designated as master, spare, and backup. All flight management computing tasks are accomplished by the master (active). The spare automatically replaces the master FMS and assumes all FMC functions in the event the master FMC fails or becomes degraded. The backup automatically replaces both the master and spare and assumes all FMC functions in the event the master and spare fail or become degraded. The transition occurs automatically and is not apparent to the crew. No crew action is necessary. LNAV and VNAV remain active and all flight plan and performance data is retained.

More information about FMC backup functions is described in Section 13, FMS Backup Navigation, Controls, and Display Functions.

FUNCTIONS

The FMC part of the FMS consists of the flight management function partition and the navigation partition. The FMC navigates, calculates navigation aspects of flight performance, and accomplishes aspects of flight planning for the flight crew (i.e., determining estimated time of arrivals (ETAs) and fuel predictions). The guidance calculations are accomplished using the NAV database and aircraft performance database.

Navigation

The inertial reference system (IRS) calculates airplane altitude, airspeed, attitude, heading, and position data for the displays, FMC, flight controls, engine controls, and other systems. The major components of IRS are the inertial reference units (IRUs), and attitude and heading reference units (AHRUs).

The IRS combines inertial reference functions with global positioning system (GPS) position information to provide hybrid GPS–inertial position to the navigation function of the FMC. The navigation function resides in a separate partition. It calculates navigation parameters and tunes the navigation radios (manual and automatic tuning).

NOTE: If the IRS becomes unavailable, the GPS supplies the position and track directly to the FMC.

If GPS position is not available, the FMC 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 feet, the FMS searches for the closest DME/DME pair that intersects the aircraft at an angle between 30° and 150°. Above 12,500 feet, 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 invalid, 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 IRS only.

In the terminal area, if an instrument landing system (ILS) or GPS landing system (GLS) equipped runway is active, the FMS autotunes the ILS or GLS 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 shown in Figure 2-9. 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.
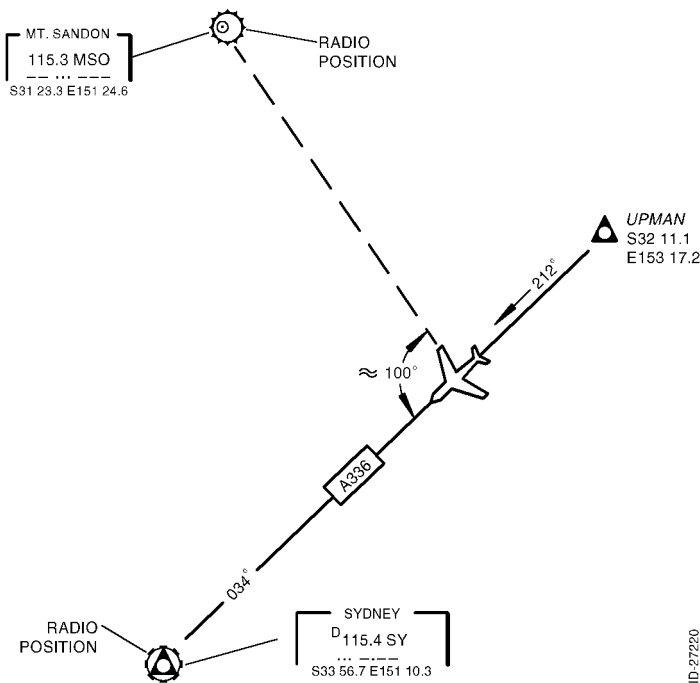
Figure 2-9
FMS NAVAID Autotune Function

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

The FMS does not update the IRU at any time, and uses the IRU position exclusively for navigation when GPS, DME, and/or VOR data is not available. When this occurs, after a pre-determined time, the INERTIAL NAV ONLY message is displayed on CDU help window. The relative FMS position to the IRU 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 lower cost index results in a lower economy speed in all phases maximum range cruise (MRC) or the minimum fuel speed may be obtained by entering a cost index of 0. Higher cost index entries result in higher climb, cruise, and descent speeds that increase trip fuel costs but decrease trip time costs.

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 that 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 feet, FAA rules). Ideally, an idle thrust optimum airspeed descent profile is flown. However, airspeed can vary, or thrust or speed brakes can be used, 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 are inserted along the flight plan route, permitting 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 results in the aircraft flying 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 FMC 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 FMC 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 FMC operates the throttle servos in response to manual mode requests selected by the crew on the MCP, or to automatic mode requests from the FMC 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 air data system (ADS) for the modes listed in Table 2–1.

Table 2–1
Autothrust Modes

Mode	Description
TO	Takeoff
TO 1	Takeoff 1
TO 2	Takeoff 2
TO B	Takeoff thrust bump (OPC option)
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
G/A	Go–around

These modes are selected with the CDU THRUST LIM (thrust limit) page. The selected thrust reference mode is displayed above the EPR/N1 indicators on the engine indication 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 feet 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 is manually selected on the THRUST LIM page on the CDU.

Flight Displays

The primary display system consists of several components that include five display units (DU), display select panels (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 CCR 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 correct 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 correct autothrottle annunciator on the PFD: speed (SPD), thrust (THR), thrust reference (THR REF), IDLE, and HOLD. Speed and thrust targets are supplied to the correct CCR displays to drive the target bugs.

DATABASE

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

The FMC uses an Aero Engine Database (AEDB) 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 FMC 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 includes 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. The FMC contains two sets of navigation data, each valid for 28 days. The 28–day cycle corresponds to the normal revision cycle for navigation charts. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and transferred to the FMC before expiration date of the active data.

The database part number (that identifies the customer, data cycle, and revision number) and the effective cycles are displayed on the CDU IDENT page.

Airline Modifiable Information (AMI) Database

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

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

CREW INTERFACE LAYOUT

The control display units (CDUs) are normally displayed side-by-side on the lower MFD in front of the throttle quadrant. The flight crew interacts with the CDU through use of a cursor-based graphical user interface consisting of a cursor control device (CCD), a rotary cursor control selector (CCS), and a multifunction keypad (MFK), as shown in Figure 2-10.
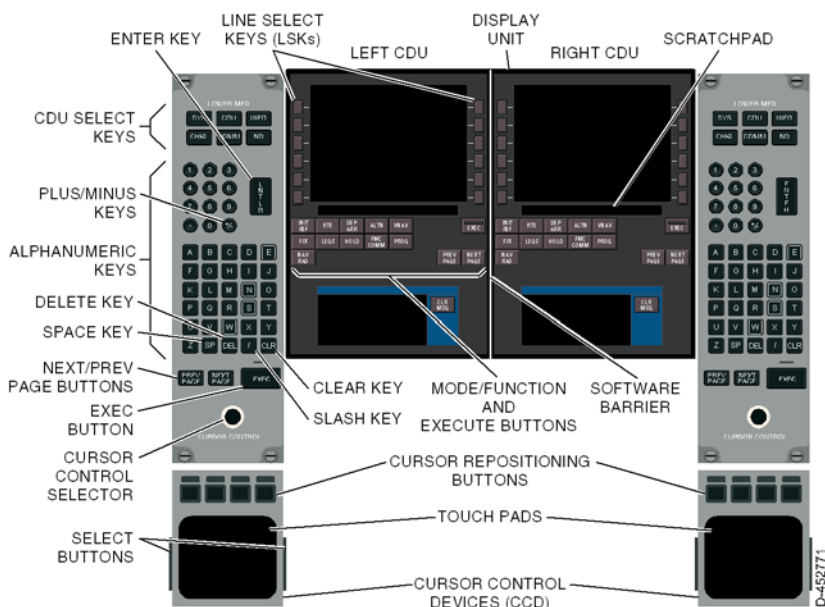
Figure 2-10
Crew Interface Layout

The FMF transmits a graphic of the CDU with cursor selectable line select keys (LSKs) at power–up, shown in Figure 2–11. The FMF displays the current date and time from the GPS, when available, on the top of the CDU layout.
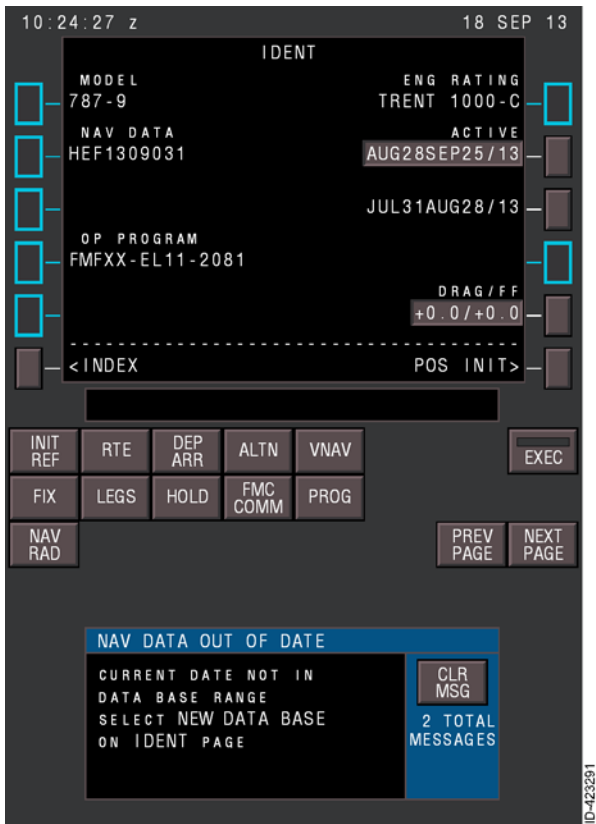
Figure 2–11
CDU Faceplate

A virtual scratchpad is incorporated onto the CDU. The pilot and copilot CDU virtual scratchpads are independent.

CONTROL DISPLAY UNIT (CDU)

The CDUs, shown in Figure 2-12, are part of the graphical user interface to the flight management function (FMF). Each CDU is a software-produced graphical depiction of a multifunction control display unit (MCDU) which contains line select keys (LSKs), mode keys, the scratchpad, a CDU display window, and a help window.
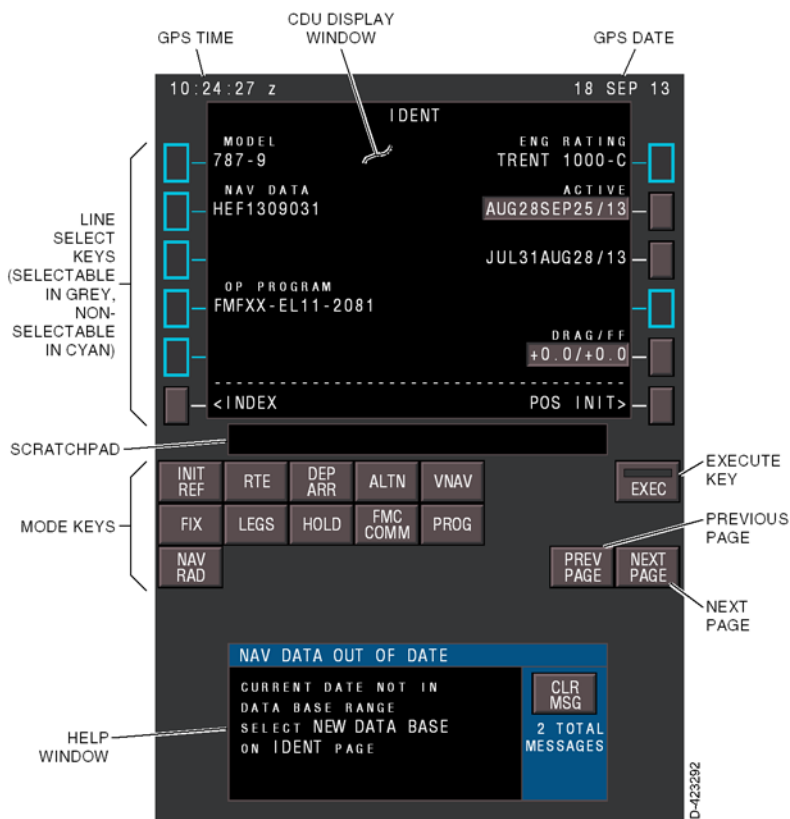
Figure 2-12
Control Display Unit (CDU)

The CDU 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. The CDU displays flight plan and advisory data, as well as other FMC data (that has been entered into memory) for the pilot to verify.

Focus Area

Each CDU is controlled by the on--side CCD touch pad and/or associated cursor control selector (CCS). When using the CCD, hovering the cursor over an active area of the CDU displays a highlight box in magenta.

Rotating the CCS associated with a MFD displaying a CDU results in the highlighted focus area moving in the direction of rotation. Clockwise for forward movement and counterclockwise for backwards movement, as shown in Figure 2--13.
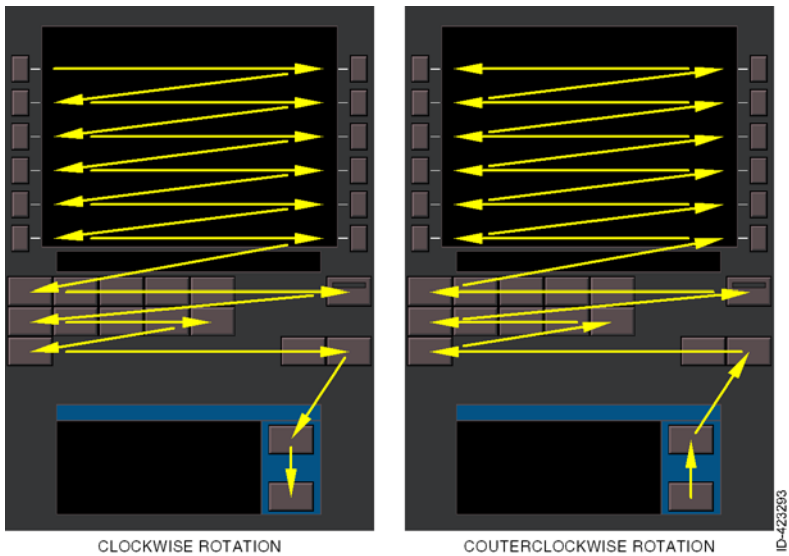
Figure 2--13
Focus Area Movement

The highlight moves though the CDU page display and the function keys in the basic order shown in Figure 2--13. The highlight does not warp to the top or bottom when it reaches the bottom or top, respectively. The highlight movement includes the **CLR MSG** button in the Help window, when active, however non--active areas are skipped.

Three hot points are associated with the CCS, such that when the operator spins the knob, the next hot point in the direction of rotation results in the highlighting of the corresponding 1L LSK, 6R LSK, and the **EXEC** mode key.

To help the pilot identify the cursor position, an active area is marked on the CDU page field with a magenta highlight box surrounding the LSK and the adjacent data field, as shown in Figure 2–14. The focus area also extends to the mode keys where the magenta highlight surrounds the selected mode key. The highlighted focus area can be manually manipulated by the CCS, or automatically by the FMF with data entry of certain fields during preflight operations.
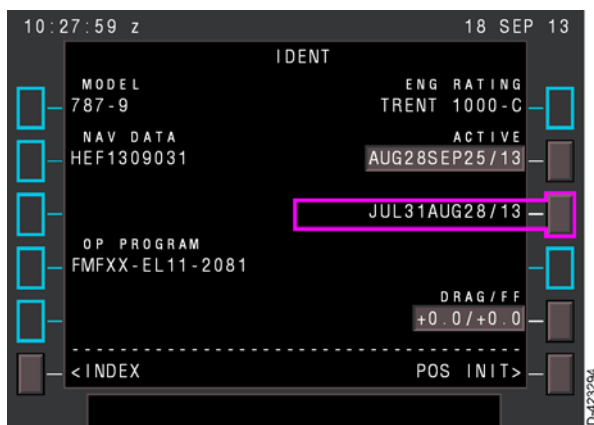
**Figure 2–14
Cursor Highlight Box**

CDU pages are composed of active and inactive areas. The cursor highlight box, shown in Figure 2–14, only displays over active areas. When the cursor highlight box is displayed, an action may be performed such as entering data or selecting a line select key (LSK).

AUTOTABBING

Autotabbing is a feature (enabled by AMI) that helps speed up and guide the pilot through the data entry process during the preflight phase of flight. When data is entered into a field which has autotabbing enabled, the cursor automatically moves to the next correct field.

NOTE: Autotabbing does not operate when a function key is used to enter a page and only works when a line select key is used to display a page.

Autotabbing is enabled on the following pages:

- Route 1/X
- PERF INIT
- TAKEOFF REF 1/2.

For a complete description of the autotabbing features of the ROUTE 1/X, PERF INIT, and TAKEOFF REF 1/2 pages, see Section 4, Preflight.

The highlight box can still be moved using the CCD or CCS to any active area within a page even while autotabbing is active. Moving the highlight box manually does not disable the autotabbing feature. As long as a valid entry is made in a field that is in the autotabbing sequence, autotabbing resumes positioning the cursor highlight box again.

The autotabbing sequence does not resume when a entry is made into a field that is not part of the autotabbing sequence or when a delete is performed.

Autotabbing does not include the CDU function keys and is discontinued after the FMC preflight is complete.

CDU Display Window

The CDU display faceplate 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 can enter data into the scratchpad even when an FMS message is displayed in the CDU help window.

    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.

CDU display brightness is controlled by the respective MFD brightness control knob. The lower–MFD brightness is controlled by the LOWER DSPL/CONTRAST knob on the overhead panel. Each upper inboard MFD brightness is controlled by the respective INBD DSPL/CONTRAST knob on the sidewall panels.

Line Select Keys

There are six virtual 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.

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

Selecting 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.

Mode Keys

The mode keys, shown in Figure 2–12, control the type of page displayed on the CDU. The mode keys are described in the following paragraphs.

- **INIT REF Key** – Selecting the **INIT REF** key displays the first page of a series of pages used to initialize the position of the FMS and the IRU. Other pages of reference data are also included in this series.

- **RTE Key** – Selecting the RTE key displays the origin, destination and route information for route 1 or route 2. Origin, destination, and route data is entered and changed on the RTE pages.

- **DEP ARR Key** – Selecting 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 changed on these pages.

- **ALTN Key** – Selecting 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** – Selecting the **VNAV** key displays the CLB, CRZ, or DES page, depending on the flight phase. Vertical navigation information is evaluated and changed on these pages.

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

  The RTE LEGS page controls the route segment displayed on the associated ND when the ND is in the plan mode. When the ND is in plan mode, a STEP prompt is displayed in 6R on the RTE LEGS page that cycles through the route segments.

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

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

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

- **PROG Key** – Selecting 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, selecting the **PROG** key displays to the ALTN NAV PROGRESS page on the CDU.

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

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

- **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. Selecting 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 can 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.

Help Window

The CDU help window displays additional help and explanation to aid the pilot in formatting an entry correctly or providing an action to help resolve a current FMF-related condition. The help window consists of a title line, message box, **CLR MSG** button, and a total message readout, as shown in Figure 2-15. A **LOAD FMC** button is displayed when required for datalink operations (not shown in Figure 2-15).
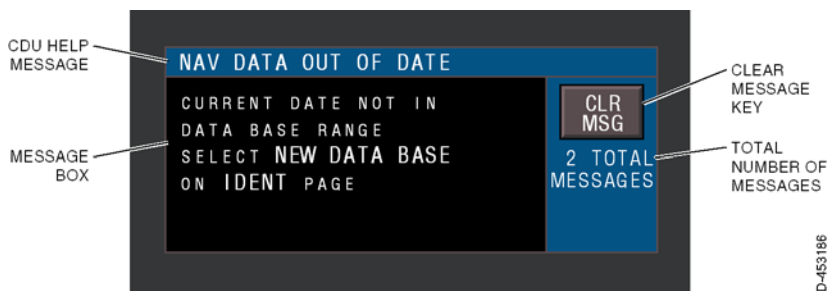
Figure 2-15
Help Window

The help window is only displayed when a FMF-generated EICAS message, system message, or error message exists that has an associated reactive help message text. All other times the help window is not displayed.

The **CLR MSG** key permits the pilot to remove message text from the display window and the next text message, if any, will be displayed. Text messages are also removed from display when the conditions that result in the message to display no longer exists. In addition, the message text is removed from the display window when the message condition no longer exists

The **LOAD FMC** key permits the pilot to load the uplinked ATC flight plan into the modified flight plan.

Page Formats and Data Labels

Typical page formats and data labels are illustrated in Figure 2−16.
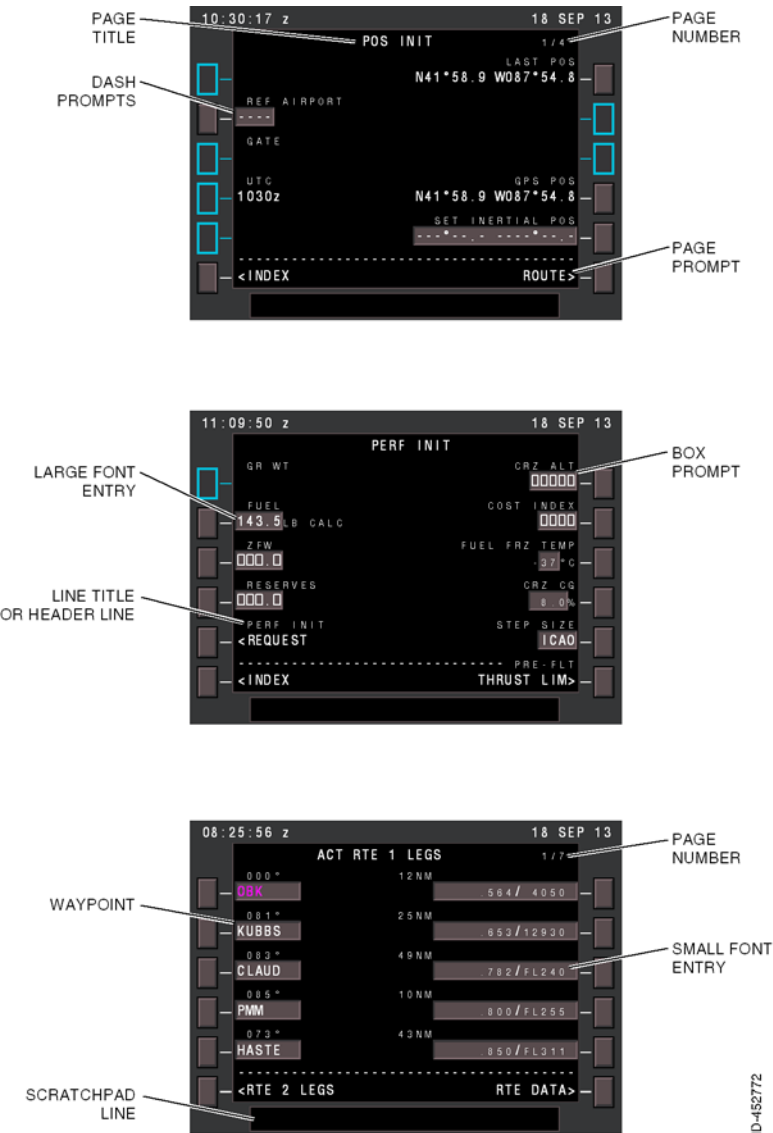
Figure 2−16
CDU Page Format

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 is displayed as part of the page title to indicate whether the page is active or modified.

● **Dash Prompts (– – – – –)** – Dashes represent where 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 selecting 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 and identifies the data displayed on the 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. CDU help window messages are described in detail in Section 14, Flight Management Computer (FMC) 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 selecting 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 selecting the adjacent LSK.

● **Box Prompts (□□□□□)** – Boxes represent where data entry is required for minimum FMS operation. Data is entered in the scratchpad and then transferred to this field by selecting 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, selecting the correct 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 selecting the associated LSK when the scratchpad is empty. The data can then be transferred to another data field by selecting 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.

MULTIFUNCTION KEYBOARD (MFK)

Two MFKs are installed, one on each side of the forward aisle stand. Each MFK controls cursor position and operation of the on–side inboard DU and the on–side MFD on the lower DU. The MFK is shown in Figure 2–17.
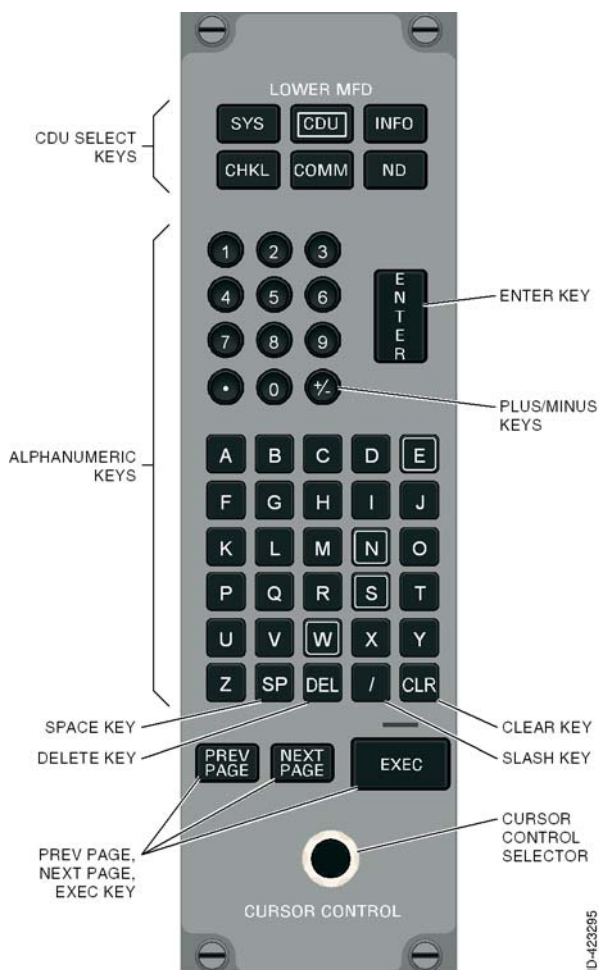
Figure 2–17
Multifunction Keyboard (MFK)

Control Display Unit (CDU) Select Keys

The lower–MFD is controlled by display select keys on the MFK. The lower MFD has a left and right window, similar to the upper–inboard MFDs. Each side of the lower–MFD is controlled by the onside display select switch on each MFK. This allows selection of the same MFD functions as the upper inboard DUs.

Alphanumeric Keys

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

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.

ENTER KEY

Pushing the **ENTER** key performs an associated action to the highlighted 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 multifunction display (MFD) requires spaces.

DELETE 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 selecting 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. When 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. When any data 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.

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 (250/10000)).

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.

CLEAR KEY

The **CLR** (clear) key is used to clear data from the scratchpad or from a data field. When 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.

PREV PAGE, NEXT PAGE, and EXEC Key

The CDU provides a graphical PREV PAGE, NEXT PAGE, and EXEC buttons. These buttons are also incorporated on the MFK with hardware buttons.

NEXT PAGE AND PREV PAGE KEY

When 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. 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 can 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.

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 RTE 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.

Cursor Control Selector (CCS)

The CCS is located on the bottom of the MFK to provide a secondary highlight control and selector device. Rotating the outer knob moves the highlight in a predetermined path on the active MFD.

Pushing the inner cursor select switch selects the highlighted field.

CURSOR CONTROL DEVICE (CCD)

Two CCDs are provided to control the cursor position and for selecting display configuration. One CCD is located on each side of the throttle quadrant for each pilot.

The left CCD controls the upper inboard DU and the lower DU cursor position and operation. The right CCD controls the right inboard DU and the lower DU cursor position. Figure 2–18 shows the left CCD. The right CCD is similar except the **EFB** and **LWR** button positions are switched.
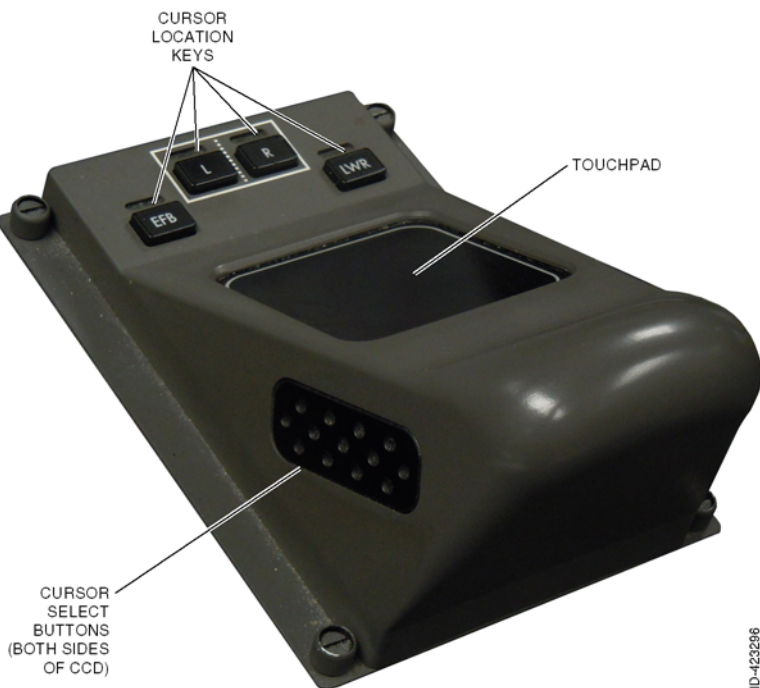
Figure 2–18
Cursor Control Device (CCD)

Additional manual manipulation of the highlight focus area is provided by four hot corners on the CCD touchpad. When the associated corner is touched, the result is highlighting of the corresponding 1L, 1R, 6L, or 6R position.

NAVIGATIONAL DISPLAY SYMBOLS
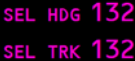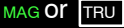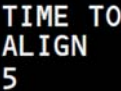
The symbols in Table 2–2 can be displayed on each ND, depending on electronic flight instrument system (EFIS) control panel switch selections. Colors indicate the following:

- **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.

Table 2–2
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
Heading, Track, and Speed			
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.
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, and points to the heading on the compass rose.
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.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
SEL HDG 132 SEL TRK 132	Selected heading/track reference	Mini-map	When HDG is selected on the MCP, SEL HDG is displayed. When TRK is selected on the MCP, SEL TRK is displayed.
MAG or TRU	Heading/track reference with box if in TRU, box is **amber** if TRU is displayed in descent	MAP MAP CTR mini-map	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.
TIME TO ALIGN 5	Time to align	All	Indicates time remaining for IRU alignment. Replaces wind direction/speed and wind arrow when on ground during alignment.
GRID 155	Grid heading	MAP MAP CTR	Displays near the top of both NDs when north of 70 degrees north latitude or south of 70 degrees south latitude.
40	Track line and range scale	MAP MAP CTR mini-map	Indicates current track and number indicates range.
Expanded compass	Expanded compass	MAP	Displays 90 degrees of compass rose.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
◁▷	Selected heading bug	MAP MAP CTR mini-map	Displays the MCP-selected heading. A dashed line may extend from the marker to the airplane symbol. In MAP mode with LNAV, LOC, or ROLLOUT active, the dashed line is removed 10 seconds after the selected heading bug is removed.
▽	Selected track bug	MAP MAP CTR mini-map	Displays the MCP-selected track. A dashed line may extend from the marker to the airplane symbol.
▽	Current heading pointer	MAP MAP CTR mini-map	Points to current heading on the compass rose.
Radio Navigation			
VOR L, R	VOR selection	MAP MAP CTR	Located in lower left or right corner. Represents positions selected on the MAP or MAP CTR dropdown menu.
116.80 or SEA	VOR frequency or identifier	MAP MAP CTR	Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.

Table 2–2 (cont)
Navigation Display Symbols
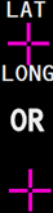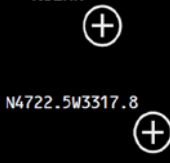
Symbol	Name	ND Mode	Remarks
	Left VOR pointer head and tail Right VOR pointer head and tail	MAP MAP CTR	Indicates bearing to (head) and from (tail) the tuned station, when selected on the respective MAP or MAP or MAP CTR dropdown menu.
	VOR DME/TACAN VORTAC VOR/DME raw data radial and distance	MAP MAP CTR PLAN	When the STA key is selected, VHF NAVAIDs are displayed in **cyan**. Tuned VHF are displayed in **green** regardless of menu key selection. When a NAVAID is manually tuned, the selected course and reciprocal are displayed. When the POS key is selected, the station radial extends to the airplane.
DME 24.6	DME distance	MAP MAP CTR	DME distance to the reference NAVAID.
ADF L, R	ADF selection	Mini–map	Located in lower left or right corner, when ADF frequency is entered on the CDU NAV RADIO page.
520 or BF	ADF frequency or identifier	Mini–map	Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency.
	Left ADF pointer head and tail Right ADF pointer head and tail	Mini–map	Indicates bearing to (head) or from (tail) the tuned station when an ADF frequency is entered on the CDU NAV RADIO page.
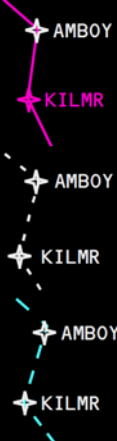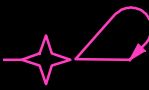
Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
Map			
124 NM	Active waypoint distance-to-go	All	Distance to the active waypoint and located in the upper-right corner.
0835.4z	Active waypoint ETA	All	FMC-calculated ETA at the active waypoint and located in the upper-right corner.
KABC 22L	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.
ABCDE	Active waypoint identifier	All	Represents positions selected on the MAP or MAP CTR dropdown menu and located in the upper-right corner
KTEB	Airport	MAP MAP CTR PLAN	Displayed if the EFIS control panel APT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
22L	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.
AMBOY	Waypoint: active (**magenta**), inactive (**white**)	MAP MAP CTR PLAN mini-map	Active - represents the waypoint the airplane is currently navigating to. Inactive - represents the waypoints on the active route.
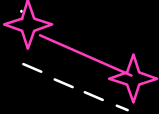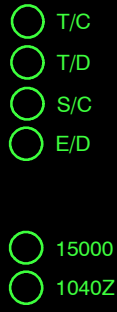
Table 2–2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
△ MLF	Off route waypoint	MAP MAP CTR	When the EFIS control panel WPT switch is selected on, waypoints not on the selected route are displayed in ND ranges of 10, 20, or 40.
LAT ✛ LONG OR ✛	Pick waypoint cursor	MAP MAP CTR PLAN	Displayed when the PICK WPT key is selected. When the cursor highlights a waypoint, airport, or NAVAID, the letters LAT and LONG are removed.
AMBOY ⊕	Highlight waypoint	MAP MAP CTR PLAN	Displayed when a visible route waypoint, background waypoint, airport, or NAVAID is passed over by the cursor.
KILMR ⊕ N4722.5W3317.8 ⊕	Temporary waypoint	MAP MAP CTR PLAN	Displayed after a waypoint is selected when PICK WPT cursor is active. Displays selected waypoint name when visible waypoint, airport, or NAVAID is selected. Displayed latitude and longitude when visible waypoint, airport, or NAVAID is not selected.
◎	Cursor shape for Center on Cursor mode	PLAN	Displayed when Center on CURSOR key is selected.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
	Flight plan route: active (**magenta**), modified (**white**), inactive (**blue**)	MAP MAP CTR PLAN mini-map	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.
KILMR 12000 0835Z	Route data: active waypoint (**magenta**), inactive waypoint (**white**)	MAP MAP CTR mini-map	When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed. Times are based on distance to go and groundspeed. Times do not consider FMC performance predictions and may differ from other FMC ETAs that do.
	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. Depicts entry path until entry is completed.
	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 on entering the procedure turn. Also used for procedure hold course reversal.

Table 2–2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
	Offset path and identifier: active route (**magenta**), modified route (**white**)	MAP MAP CTR PLAN mini–map	A dashed line is displayed parallel to and offset from the active or modified route.
	Altitude range arc	MAP MAP CTR mini–map	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
RANGE 40	Range readout	MAP MAP CTR mini–map	Displays the current selected range.
T/C T/D S/C E/D 15000 1040Z	Altitude profile point and identifier	MAP MAP CTR mini–map	Indicates the approximate map position of the FMC-calculated top–of–climb (T/C), top–of–descent (T/D), step climb (S/C), and end–of–descent (E/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.
O 190	Speed profile point and settings	MAP MAP CTR mini–map	Indicates the approximate map position for FMC-calculated speed settings. Position and settings are calculated to be on speed, on path, and on time at the FAF.

Table 2‑2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
O F1 190	Flap speed profile point and settings	MAP MAP CTR mini‑map	Indicates the approximate map position for FMC‑calculated flap and speed settings. Flap setting is indicated only for flaps 1, 5, and 20. Position and settings are calculated to be on speed, on path, and on time at the FAF.
(dashed circle)	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.
R060 ABC	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.
*	IRU position	MAP MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates IRU position relative to FMC position.
△	Airplane symbol	Mini‑map	Current airplane position is at the apex of the triangle.
△ 1.2 R RNP 1.00 ANP 0.04	Airplane symbol	MAP MAP CTR	Current airplane position is at the apex of the triangle. Displays lateral path deviation distance. If ANP exceeds RNP, the ANP and RNP labels and values are displayed in **amber**.

Table 2‑2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
	Position trend vector (dashed +line)	MAP MAP CTR mini‑map	Predicts position at the end of 30, 60, and 90‑second intervals. Each segment represents 30 seconds. Based on bank angle, groundspeed, and wind. Selected range determines the number of segments displayed. For range: • greater than 20 NM, 3 segments • = 20 NM, 2 segments • = 10 NM, 1 segment. Mini‑map always shows 3 segments even though range is always 20 NM.
50	VNAV path pointer and deviation scale	MAP MAP CTR	Displays vertical deviation from selected VNAV path during descent only. Scale indicates +/‑400 feet deviation. Digital display is provided when the pointer indicates more than +/‑ 20 feet.
50 RNP 200 ANP 60	Path deviation band, vertical path deviation, and vertical ANP/RNP values	MAP MAP CTR	Path deviation band is symmetric about the pointer and represents vertical RNP. If ANP exceeds RNP, the ANP/RNP labels are displayed in amber. Displayed only during the FMC descent phase of flight.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
STA WPT ARPT	Selected map options	MAP MAP CTR mini-map	Displays MAP menu selected map options.
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 FMC position.
✈ or ⊗	Airplane symbol	PLAN	Indicates actual position and track along the flight plan route. Symbol changes to a circle North of 82N latitude and South of 82S latitude.
Ⓐ KGEG ↖ KEAK 1123NM	Alternate airports	MAP MAP CTR PLAN	MAP, MAP CTR: displays the FMC or pilot-selected primary alternate airport. Displays up to four alternate airports when the EFIS control panel APT map switch is selected on. PLAN: displays up to four alternate airports at all times. Offscale airports (when 1280 NM range is selected) are displayed with a directional arrow relative to airplane position or PLAN center point and distance.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
GPS DME-DME VOR-DME LOC LOC-GPS LOC-DME-DME LOC-VOR-DME INERTIAL	FMC position update status	MAP MAP CTR mini-map	Indicates the system providing FMC position update.
Airport Map			
✪	Airport beacon	MAP MAP CTR PLAN	Displayed at 0.5, 1, and 2 NM ranges.
KORD	ICAO ID	MAP MAP CTR PLAN	Airport ICAO identifier is displayed in the grid heading box at all ranges. Not displayed when in grid heading (above 70 degrees latitude).
<ICAO> LOAD	LOAD message	MAP MAP CTR PLAN	Displayed at all ranges during delay between execution of flight plan and display of airport map.
<ICAO> DATE	DATE message	MAP MAP CTR PLAN	Displayed at all ranges when active cycle of Airport Map database is expired or out of range.
<ICAO> WXR ON	WXR ON message	MAP MAP CTR PLAN	Displayed at all ranges when WXR switch is selected.
C4 C8 C5 C6 C7	Concourse and gates	MAP MAP CTR PLAN	Concourse is displayed at ranges of .5, 1, and 2 NM. Gates are displayed at a range of .5 NM.

Table 2‑2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
	Runway	MAP MAP CTR PLAN	Displayed at ranges of .5, 1, 2, and 5 NM.
32R	Runway identifier	MAP MAP CTR PLAN	Displayed at ranges of .5, 1, and 2 NM.
	Taxiway holding short position, land and hold short line	MAP MAP CTR PLAN	Taxiway holding short position displayed at ranges of .5 and 1 NM. Landing and hold short lines are displayed at ranges of .5, 1, and 2 NM.
32R	Closed runway indication	MAP MAP CTR PLAN	Displayed at ranges of .5, 1, 2, and 5 NM.
	Partially closed runway indication	MAP MAP CTR PLAN	Displayed at ranges of .5, 1, 2, and 5 NM.
	Stopway/blastpad and stopway chevrons	MAP MAP CTR PLAN	Stopway/blastpad displayed at ranges of .5, 1, 2, and 5 NM. Chevrons displayed at .5, 1, and 2 NM.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
G	Taxiway and taxiway identifier	MAP MAP CTR PLAN	Taxiway displayed at ranges of .5, 1, 2, and 5 NM. Taxiway identifier displayed at .5, 1, and 2 NM.
DE-ICE	De-icing area	MAP MAP CTR PLAN	Displayed at ranges of .5 and 1 NM.
H	Helicopter landing area	MAP MAP CTR PLAN	Displayed at ranges of .5 and 1 NM.
Vertical Situation Display (VSD)			
	Airplane symbol	MAP MAP CTR	Current airplane altitude is at the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle.
	En route corridor	MAP MAP CTR	Indicates area of the map shown on the VSD. Displayed when VSD is selected. During turns, the corridor edge leading the turn opens in the direction of the turn.
	Selected altitude bug and line	MAP MAP CTR	Bug indicates the altitude set in the MCP window. When the selected altitude is off scale, the bug parks at the top or bottom, with only one-half the bug visible. Dashed line extends from bug to background display boundary. Line does not park.

Table 2‑2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
	Baro minimums pointer and line	MAP MAP CTR	Pointer indicates the barometric minimums selected on the EFIS control panel. Dashed line extends from pointer to background display boundary. Pointer and line turn amber when airplane descends below selected minimum altitude. Reset with the RST switch on the EFIS control panel.
	Decision gates	MAP MAP CTR	Indicates suggested points where the airplane should be on path and speed stable on approach. Gates are placed on the 3‑degree reference line or FMC approach glidepath angle line: • At 1,000 feet above field elevation (white) • At 500 feet above field elevation (amber) Decision gates that are below the missed approach waypoint altitude are not displayed.
	Flight path vector	MAP MAP CTR	Fixed length line indicates current flight path angle and rotates about the point of the triangle. Angle of the line is dependent on the vertical speed and groundspeed of the airplane.

Table 2‑2 (cont)
Navigation Display Symbols
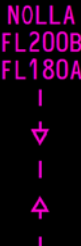
Symbol	Name	ND Mode	Remarks
	MCP selected vertical speed vector or flight path angle	MAP MAP CTR	Dashed line indicates the selected vertical speed as a target angle when the MCP vertical speed mode is selected. Indicates selected flight path angle when the MCP flight path angle (FPA) mode is selected. Extends to the edge of the background display and rotates about the point of the triangle.
	Range to target speed dot	MAP MAP CTR	Indicates where the airplane will achieve the FMC or MCP target speed. When the airplane is within 5 knots of target speed, the dot blanks. When the airplane increases 5 knots or more faster than the target speed, the dot is displayed again. Displayed at the end of the flight path vector as an unfilled dot when target speed will not be achieved within the vector length.

Table 2-2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
◯ T/D ◯ T/C ◯ S/C ◯	Altitude profile point and identifier	MAP MAP CTR	Indicates the approximate map position of the FMC-calculated top-of-climb (T/C), top-of-descent (T/D), step climb or descent (S/C), and end-of-descent (E/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.
◯ 190	Speed profile point and settings	MAP MAP CTR	Indicates the approximate map position for FMC-calculated speed settings. Position and settings are calculated to be on speed, on path, and on time at the FAF.
◯ F1 190	Flap speed profile point and settings	MAP MAP CTR	Indicates the correct map position for FMC-calculated flap and speed settings. Flap setting is indicated only for flaps 1, 5, and 20. Position and settings are calculated to be on speed, on path, and on time at the FAF.

Table 2–2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
NOLLA 2500	Waypoint altitude constraint	MAP MAP CTR	At altitude example is shown here. **Magenta** is active and **white** is inactive.
NOLLA 2500A	Waypoint altitude constraint	MAP MAP CTR	At or above altitude example is shown here. **Magenta** is active and **white** is inactive.
NOLLA 2500B	Waypoint altitude constraint	MAP MAP CTR	At or below altitude example is shown here. **Magenta** is active and **white** is inactive.
NOLLA FL200B FL180A	Waypoint altitude constraint	MAP MAP CTR	Block altitude example is shown here. **Magenta** is active and **white** is inactive.

Table 2–2 (cont)
Navigation Display Symbols

Symbol	Name	ND Mode	Remarks
HOLD	Hold symbol	MAP MAP CTR	Shown centered between the first and second instance of the hold waypoint. **Magenta** is active and **white** is inactive.
← ←	Hold return symbol	MAP MAP CTR	Shown during holding entry and when in holding. Shown to the left of the second hold waypoint.

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, selecting the ACTIVATE LSK and then selecting 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 pending modification by selecting the LSK adjacent to the word ERASE.

- **Execute** – This is making entered information part of the active flight plan by selecting 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. Selecting the ERASE LSK cancels the modification. Selecting the **EXEC** key makes the modified information active.

- **Prompt** – 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 selecting a key to obtain the desired information or action.

- **Speed Restriction** – This is a pilot–entered airspeed limit below a specified altitude.

- **Speed Transition** – This is navigation database defined airspeed limit below a specified altitude.

- **Waypoint** – Refers to a point in the route. Waypoints 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 1,000 feet.

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3. Flight Operations

INTRODUCTION

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, and 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), shown in Figure 3–1, is used as an example flight plan for this guide. Table 3–1 lists the data necessary for the example flight.

Table 3–1
Flight Data Chicago to London

Flight Number	787
Departure Airport	Chicago O'Hare (KORD)
Destination Airport	London Heathrow (EGLL)
Alternate Airport	Manchester (EGCC)
B787 Aircraft	
Cost Index	80
TOGW	500,000 lbs
ZFW	325,000 lbs
CG	20%
Taxi Fuel	1,000 lbs
Fuel	176,000 lbs
Reserve Fuel	15,000 lbs
Cruise levels	FL350/FL390
Climb and Descent Flight Plan Summary	
Climb to FL350 initially	
Step Climb to FL390 before WPT N61W030	

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

Flight Plan Routing as filed is as following
KORD   OBK J94 ECK J546 YQB J560 YZV YYR LOACH   N58W050 N60W040 N61W030 N60W020 N59W010   BEN GDW CALDA LON   EGLL
En route Winds   The winds at FL350 are 270 degrees at 100 knots.

Blank Page
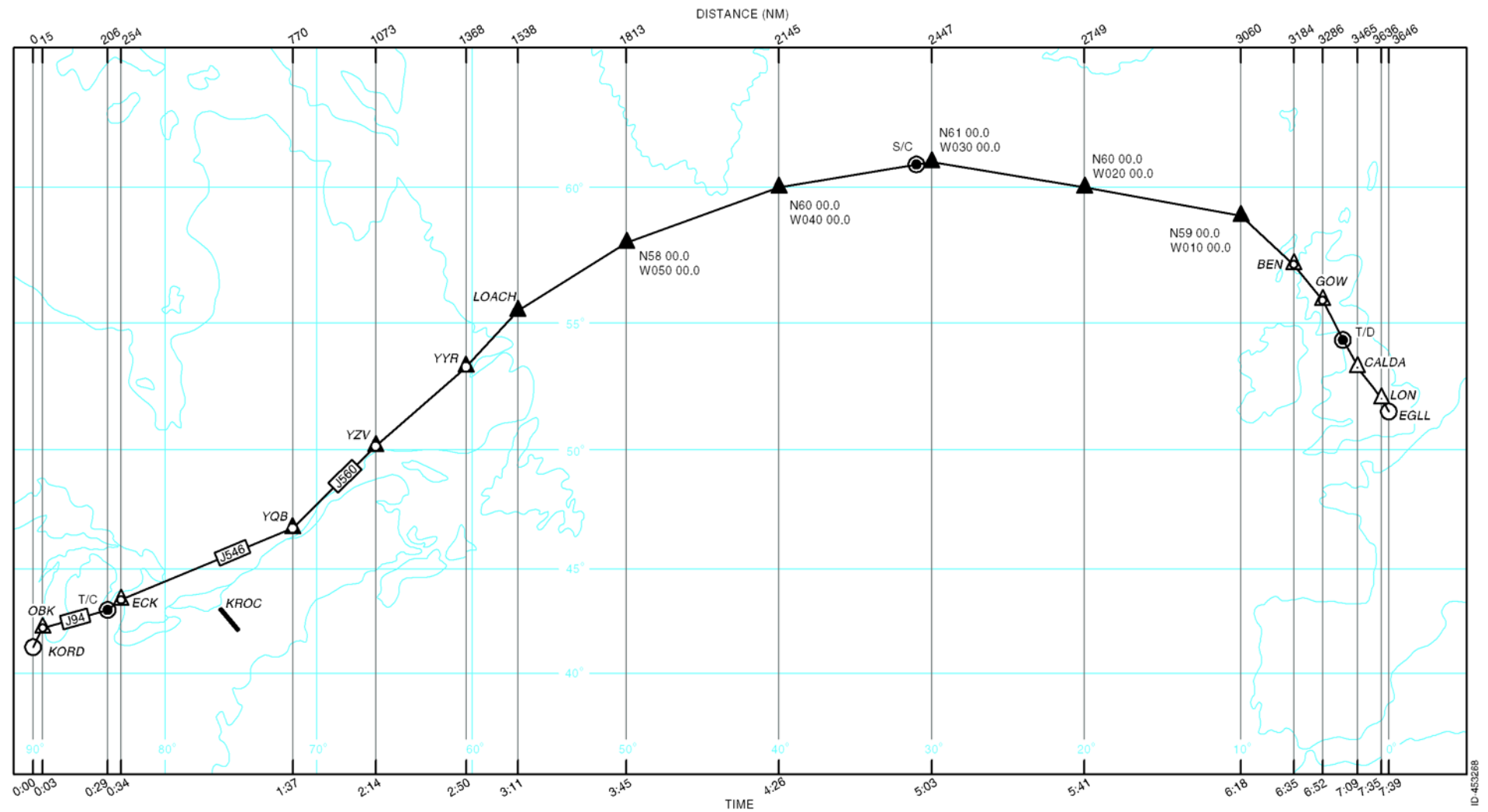
Figure 3-1
Flight Plan Routing

4.   Preflight

INTRODUCTION

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 have to be updated.

INERTIAL REFERENCE SYSTEM (IRS)

The IRS calculates airplane altitude, airspeed, attitude, heading, and position data for the displays, FMS, flight controls, engine controls, and other systems. The major components of IRS are the inertial reference units (IRUs), and attitude and heading reference units (AHRUs).

The IRS combines inertial reference functions with GPS position information to provide hybrid GPS–inertial position outputs.

Initial power–up requires battery bus power and the IRS switches to be ON, as shown in Figure 4–1. If the IRSs are switched off, they must complete a full realignment cycle before the airplane can be moved.

Figure 4–1
IRS Switch and ON BAT Annunciator

If electrical power is subsequently removed from the airplane and the battery is switched to OFF, the hot battery bus continues to supply electrical power to the IRS. When this occurs, the ON BAT light illuminates, as shown in Figure 4–1, and the horn in the landing gear wheel well sounds to alert that the IRS is on battery power.

IRU Alignment

On initial power-up, the IRUs enter the align mode. The EICAS memo message IRU ALIGN MODE L+R is displayed and there is no attitude or heading/track information displayed on the PFDs. When the GPS system is operating normally, there is no requirement for the flight crew to enter present position on the CDU POS INIT page. The POS INIT page displays dashes in the SET INERTIAL POS line to permit the option of manually entering present position. If the GPS position is not available during alignment, the dashes are replaced with boxes and the present position must be entered to complete the alignment. Alignment time is approximately 7 to 10 minutes at mid latitudes and up to 17 minutes at high latitudes. The aircraft should not be moved until alignment is complete.

NOTES: 1. If the entered lat/long is not within 6 NM of the origin airport, the EICAS advisory message FMC MESSAGE is display along with the CDU help window message INERTIAL/ORIGIN DISAGREE.

2. If the entered present position does not pass the IRU internal comparison tests, the EICAS advisory message FMC MESSAGE is displayed along with the CDU help window message ENTER INERTIAL POSITION.

3. If a new aircraft present position entry fails the internal check twice, the EICAS advisory message FMC MESSAGE is displayed along with the CDU help window message ALIGNMENT REINITIATED. The system automatically begins a new alignment cycle.

When the alignment is complete, the IRU enters the NAV mode, and the aircraft can be moved. When the aircraft stops for an extended period, the IRS enters the automatic NAV realign mode and refines the alignment until the aircraft is moved again.

In the automatic realign mode, IRS velocity and acceleration errors are reset to zero. The inertial position can be manually updated when the IRS is in automatic realign mode by entering a new latitude/longitude position on the POS INIT 1/3 page.

The IRU has the additional capability to complete an alignment while in flight. This capability permits the IRU to completely recover from an in flight loss of alignment due to a power interruption or inadvertent shutdown. When power is restored to the IRU while in flight, attitude information becomes available within a few seconds and full navigation capability is restored within about 10 minutes. This capability relies on GPS data and is therefore not available if the GPS receivers are not functioning.

A position update is recommended if the total time in the navigation mode is expected to exceed 18 hours.

IRU Failure

If both IRUs fail, the EICAS advisory message NAV IRU is displayed. The FMC will continue to receive a hybrid GPS–inertial position solution using the AHRUs inertial sensors combined with GPS position.

Attitude and Heading Reference Unit (AHRU)

The AHRUs supply a stable source of attitude, heading and rate information used in voted solutions for flight controls, displays, and other using systems. Although the AHRUs do not have the ability to provide an independent inertial position, they do contribute to a hybrid GPS–inertial position that combines the accuracy of the GPS position with the stability of the AHRUs inertial sensors.

IRS Failure

If the IRS fails, meaning both AHRUs and both IRUs fail, the EICAS caution message NAV INERTIAL SYS is displayed. GPS output from the integrated navigation radios (INRs) provides the necessary position and track data for the FMC to continue to operate without the IRS. In this mode, the FMC continues to provide flight planning, navigation, and performance information to the crew. ND map center and map expanded modes are still available. LNAV and VNAV guidance coupled to the autopilot, however, are not available when the IRS is inoperative.

The CDU POS INIT page displays the SET HDG prompt immediately after any IRU or AHRU failure. However, voted heading information is still being sent to the IRS from the working IRUs and AHRUs and no aircrew action is required. Should the IRS fail, however, the aircrew must use the SET HDG prompt to periodically sync the display heading to the standby compass magnetic heading.

The following AFDS modes are inoperative after failure of the IRS:

- LNAV
- VNAV
- TO/GA
- LOC
- G/S
- FPA
- TRK HOLD/SEL
- HDG HOLD/SEL (operative when standby magnetic compass heading is entered on the POS INIT page).

The following navigation functions are inoperative after failure of the IRS:

- FMC VNAV pages
- FMC performance predictions
- ND wind direction and speed (wind arrow).

PFD heading is inoperative after failure of the IRS. The PFD becomes operative when standby magnetic compass heading is entered on the POS INIT page.

The ND map display references TRK following the failure of the IRS.

The following additional functions are inoperative after failure of both the IRS and GPS:

- ND Map (center and expanded)
- CDU active leg course and distance
- CDU direct–to a waypoint
- FMC alternate airport DIVERT NOW
- FMC navigation radio autotuning.

AIRCRAFT IDENTIFICATION (IDENT) PAGE

At power–up, the FMS executes an internal self–test. When the self–test is completed successfully, the IDENT page, shown in Figure 4–2, is displayed.
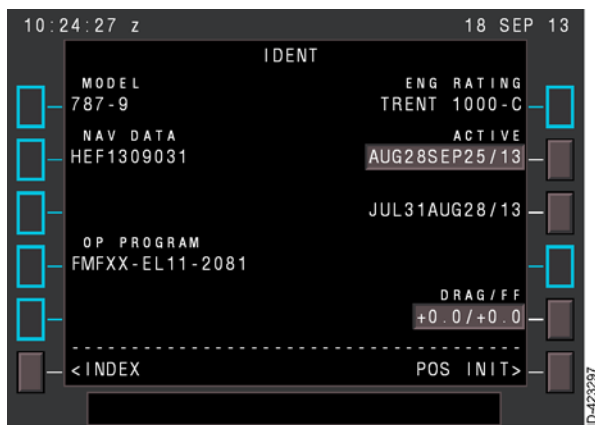
**Figure 4–2
IDENT Page**

The IDENT page permits the pilot to 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/fuel flow.

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 787–9.

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REV 0   Mar 2014

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Preflight

4-5

- **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 1 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 (that uses the GPS clock) indicates the active NAV database cycle is expired, NAV DATA OUT OF DATE is displayed in the CDU help window. This message is only displayed when the aircraft is on the ground.

- **<OP PROGRAM (4L)** – The FMF operational program part number is displayed in 4L. This field is not modifiable.

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

- **ENG RATING/INTERMIX RATING (1R)** – When the ENG RATING header is displayed, the engine identification number model from the performance database is displayed. In this case, the engine type is Rolls–Royce Trent 1000–C. If the ENG RATING field is blank, the FMS is not compatible with the aircraft configuration, and no other FMC pages are displayed. The header displays INTERMIX RATING for engine intermix installations.

● **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, select 3R to copy the inactive NAV database cycle dates to the scratchpad, as shown in Figure 4–3.
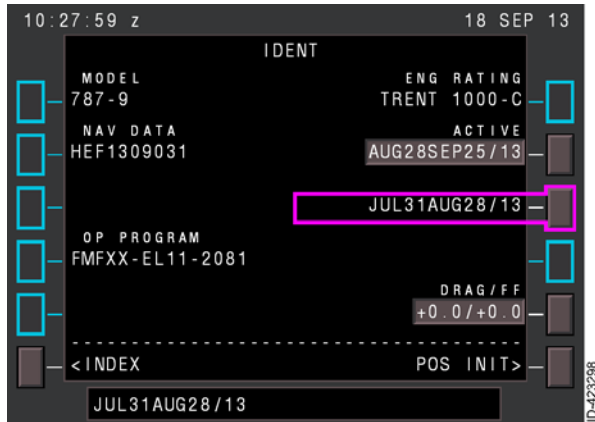
Figure 4–3
Change Active NAV Database

Selecting 2R selects the inactive NAV database cycle from the scratchpad to 2R, as shown in Figure 4–4. The NAV database cycle that was in 2R moves to 3R.
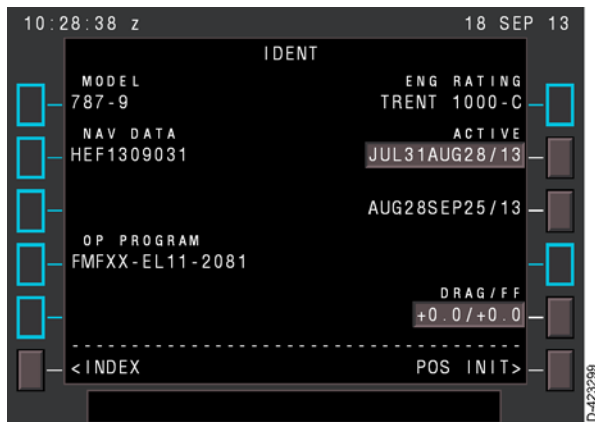
Figure 4–4
New NAV Database

The active NAV database cannot be selected to the scratchpad by selecting 2R. Selection of 2R is non–operational when the scratchpad is empty. Attempted deletion while on the ground results in the INVALID DELETE message displayed in the Help window.

The ACTIVE NAV database can only be changed while the aircraft is on the ground. Changing the ACTIVE NAV database erases all pilot–entered data on the following pages:

— REF NAV DATA
— TAKEOFF REF
— WINDS
— FIX INFO
— ALTN
— XXXX ALTN
— RTE
— RTE LEGS
— PERF INIT
— POS INIT
— En route or alternate destination of the PROGRESS page 1
— Manually entered STEP SIZE on the PERF INIT and CRZ pages
— Manually entered CRZ ALT on the PERF INIT and VNAV pages.

The database expires at 0900Z on the last day in the range. The navigation database automatically sequences to the database cycle at 0900Z. When an active database expires in flight, the expired database is used until the active date is changed after landing.

- **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. To enter new values, 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 select 5R. If the drag factor is entered alone, it must be followed by a slash (/). If the fuel flow factor is entered alone, it must be preceded by a slash (/). Valid entries are from –9.9 to +9.9. The leading + symbol is optional for positive values. Valid entries of drag or fuel flow factors invalidate the current performance predictions.

  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, selecting 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 selecting 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 selected. When the desired page is not displayed, selecting 6L (<INDEX) on any of the preflight pages displays the INIT/REF INDEX page, shown in Figure 4–5.
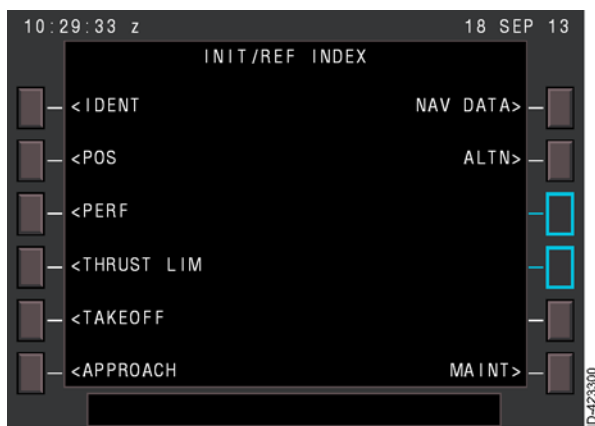
Figure 4–5
INIT/REF INDEX Page

The INIT/REF INDEX page is described in the following paragraphs:

- **IDENT (1L)** – Selecting 1L displays the IDENT page which is used to verify basic airplane data and currency of the NAV database.

- **POS (2L)** – Selecting 2L displays the POS INIT page which is used for IRS initialization.

- **PERF (3L)** – Selecting 3L displays the PERF INIT page which is used for initialization of data required for VNAV operations and performance predictions.

- **THRUST LIM (4L)** – Selecting 4L displays the THRUST LIM page which is used to select thrust limits and derates.

- **TAKEOFF (5L)** – Selecting 5L displays the TAKEOFF REF page which is used to enter takeoff references data and V$_{SPEEDS}$.

- **APPROACH (6L)** – Selecting 6L displays the APPROACH REF page which is used to enter approach V_{REF} speeds.

- **NAV DATA (1R)** – Selecting 1R displays the REF NAV DATA page which is used to display data on waypoints, NAVAIDs, airports, or runways, and can be used to inhibit NAVAIDs.

- **ALTN (2R)** – Selecting 2R displays the ALTN page which is used for alternate airport planning and diversions. The ATLN page is described in Section 9, Alternate Airport Pages.

- **MAINT (6R)** – Selecting 6R displays the maintenance page which is used only for maintenance purposes. The MAINT prompt in 6R is only displayed when the aircraft is on the ground. Once the aircraft is airborne, this field is blank.

Any of the preflight pages are selectable from the INIT/REF INDEX page, shown in Figure 4–6. The only exception is the POS REF page that is displayed by selecting the **NEXT PAGE** key when the POS INIT page is displayed.
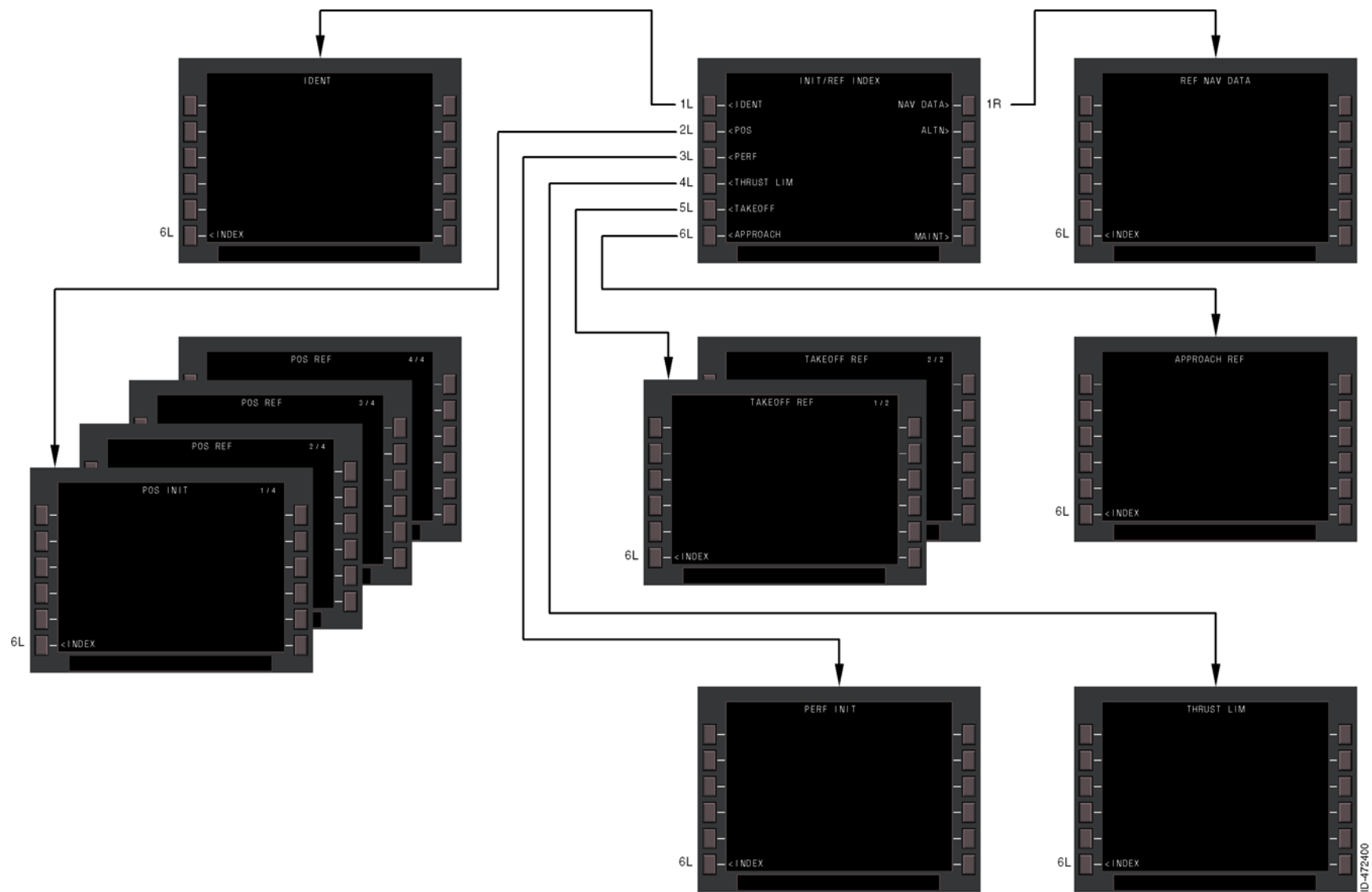
Figure 4-6
Initialization Pages

POS INIT PAGE

The POS INIT page, shown in Figure 4–7, permits the pilot to enter the present position for IRS alignment in the event that automatic GPS updating is not available. The page is also used to enter the heading if the IRS is in reversionary attitude mode. Selecting 2L on the IDENT page displays the POS INIT page.
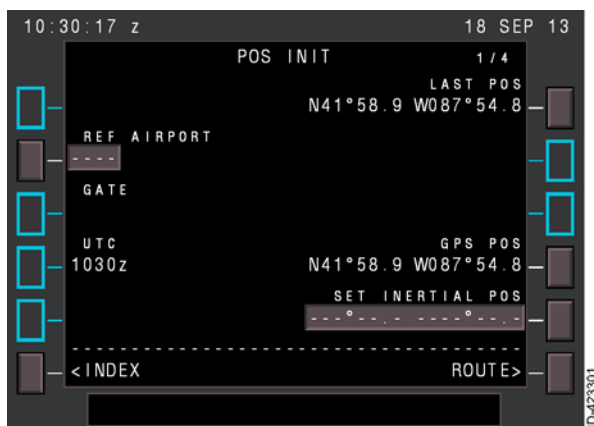
Figure 4–7
POS INIT Page

The page provides the ability to initialize the references position or set magnetic heading for the IRS alignment and display of the FMF time reference. Normally the IRS components (IRU and AHRS) which require position initialization use the GPS position as the reference position for alignments, however, manual entry is permitted using dashes in 5R. When a manual entry is required by the IRU or AHRU, box prompts are displayed indicating pilot–entry is required.

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

The POS INIT page is described in the following paragraphs:

- **REF AIRPORT (2L)** – When the four–letter International Civil Aviation Organization (ICAO) airport identifier for the origin airport is entered in 2L, the airport reference point lat/long is displayed in 2R. The airport reference point is the average lat/long of all runway centerpoints. 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)** – When the origin gate at the reference airport has a specific identifier in the NAV database, it can be entered in 3L. Dashes are displayed when the reference airport has been entered in 2L. Valid gate number entries are permitted when the aircraft is on the ground and 2L displays a reference airport identifier. Otherwise 3L data field is blank. 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. The displayed valued cannot be selected, modified, or overwritten. The data field is blank if the FMS UTC time is invalid.

- **SET HDG (5L)** – If the IRU or AHRU is in reversionary attitude mode, a SET HDG field is displayed in 5L for the pilot to manually enter a heading and the EICAS caution message NAV INERTIAL SYS is displayed.

  The aircraft magnetic heading entered in 5L is displayed on the PFDs only if all IRUs and AHRUs have failed. 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)** – Selecting 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. Selection of LSK 4R when a position is displayed in 4R and the scratchpad is empty, results in a down selection of the displayed position to the scratchpad. Data cannot be entered or deleted in 4R.

  The on–side GPS current position is displayed in standard lat/long format when a valid GPS position exists and the associated GPS horizontal integrity limit (HIL) from the on–side GPS is less than 0.5 NM.

  If a valid GPS position and GPS HIL do not exist from the on–side GPS or the associated on–side GPS HIL value exceeds 0.5 NM, and a valid GPS position and GPS HIL exist from the off–side GPS and the off–side GPS HIL value is less than 0.5 NM, then the off–side GPS current position is displayed in 4R.

The data field in 4R is blank if a valid GPS position and GPS HIL do not exist or the GPS HIL value exceeds 0.5 NM for the on–side and off–side GPS.

- **SET INERTIAL POS (5R)** – The set inertial position entry is optional since the IRS has continuous access to the GPS position. Dashed prompts are displayed in 5R when any IRU or AHRU is in alignment mode and can receive a new position update. A lat/long can be manually entered into 5R with the keyboard, or by selecting the LAST POS (1R), GPS POS (4R), REF AIRPORT (2R), or GATE (3R) to the scratchpad and then selecting 5R.

  If a manually entered position does not pass the IRS internal check, ENTER INERTIAL POSITION is displayed in the CDU help window. If the manually entered position still fails the IRS check after entering the position a second time, REALIGNMENT INITIATED is displayed in the CDU help window and the IRS 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 CDU help window.

  When box prompts are displayed, present position entry is required. Box prompts are displayed if the GPS position is not available and any IRU or AHRU is requested a position. The box prompts are removed when the IRS 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.
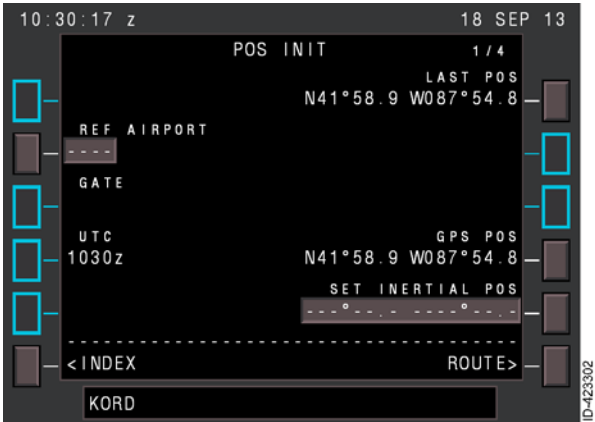
  Dashes are displayed when the IRU enters the automatic realignment mode on the ground. New position entries can be made during the IRU automatic realignment. New entries are displayed for 2 seconds and then dashes are again displayed to enter another position, when desired.
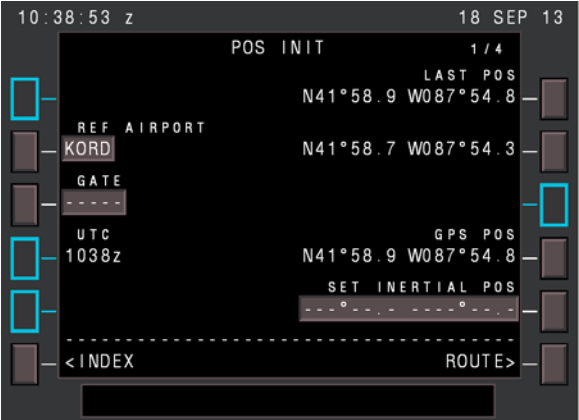
  When none of the inertial systems are in stationary align or auto realign mode, the header and data fields in 5R are blank. 5R header and data fields also blank when airborne.
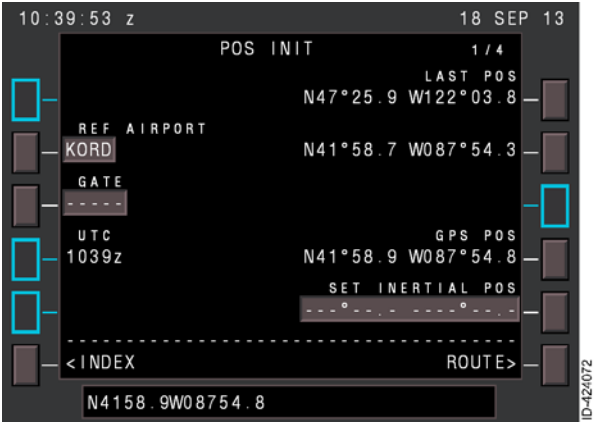
- **ROUTE> (6R)** – Selecting 6R displays the correct RTE page (MOD RTE, ACT RTE, or RTE 1). This is the next page in the preflight sequence.
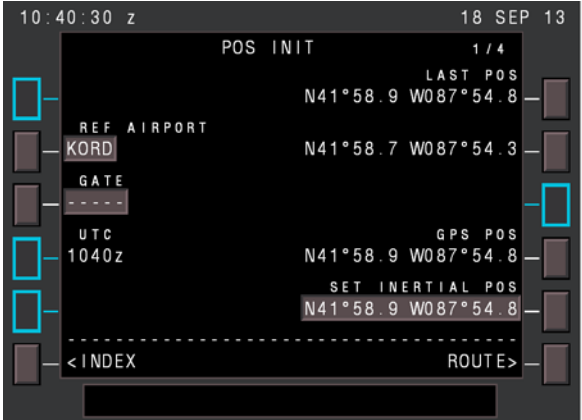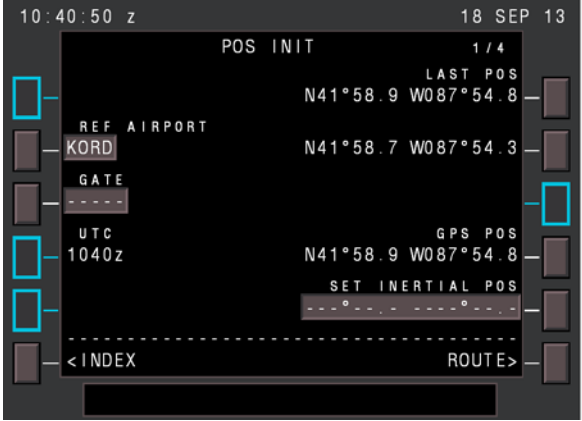
Normally the POS INIT page does not have to be initialized and the ROUTE prompt is selected at 6R. However, if automatic GPS updating is not available or if the IRS is in reversionary attitude mode, the POS INIT page must be initialized. Procedure 4–1 describes the steps to initialize the POS INIT page for the flight from KORD to EGLL.

Step	Procedure 4–1 Initialize POS INIT Page
1	Enter the origin airport (KORD) in the scratchpad, as shown in Figure 4–8. **Figure 4-8** **POS INIT Page – REF AIRPORT Before Entry is Made**

Step	Procedure 4–1 Initialize POS INIT Page (cont)
2	Select 2L. The Chicago O'Hare airport lat/long is displayed in 2R, as shown in Figure 4–9.

Figure 4-9
POS INIT Page – REF AIRPORT After Entry is Made

Step	Procedure 4–1 Initialize POS INIT Page (cont)
3	Select 2R to copy the lat/long from 2R to the scratchpad or • Enter the specific gate identifier in the scratchpad and select 3L. This displays the gate lat/long in 3R. Select 3R to copy the gate lat/long to the scratchpad or • Select 4R to copy the GPS position lat/long to the scratchpad, as shown in Figure 4–10, or • Enter the lat/long into the scratchpad manually with the alphanumeric keyboard. **Figure 4–10** **POS INIT – GPS LAT/LON in Scratchpad**

Step	Procedure 4–1 Initialize POS INIT Page (cont)
4	Select 5R to enter the lat/long as the present inertial position, as shown in Figure 4–11. **Figure 4–11** **POS INIT Page – Set Inertial Position**
5	When the IRS has transitioned from the alignment mode to the navigation mode, the lat/long information is removed from 5R, as shown in Figure 4–12. **Figure 4–12** **POS INIT Page – IRS NAV Mode**

POSITION REFERENCE PAGES

The second, third, and fourth pages of the POS INIT pages are POS REF 2/4 page, POS REF 3/4 page, and POS REF 4/4 page.

POS REF 2/4 Page

The POS REF 2/4 page displays the aircraft present position as calculated by the FMS, GPS, IRU, and radio navigation receivers. An FMS position update using IRU, GPS, or radio position can be initiated from this page.

The POS REF 2/4 page is displayed by selecting the **NEXT PAGE** key while the POS INIT 1/4 page is displayed or by selecting the **PREV PAGE** key when the POS REF 3/4 page is displayed. The POS REF 2/4 page is shown in Figure 4–13.
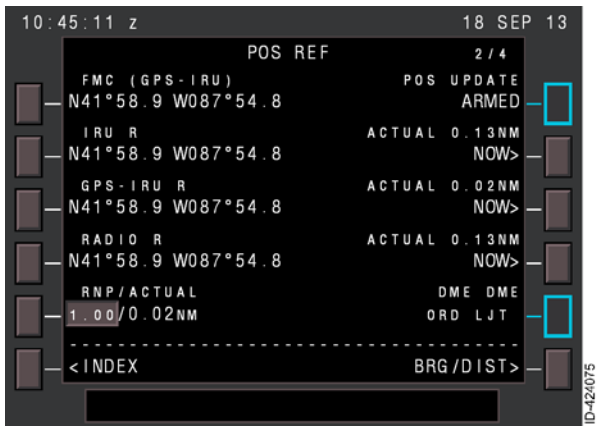
Figure 4–13
POS REF 2/4 Page

The POS REF page 2/4 displays latitude/longitude or bearing/distance. Position displays are in actual latitude and longitude, as calculated by the displayed system. IRU, GPS, and radio position data can be changed to display bearing/distance.

The POS REF 2/4 page 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 IRU enters the navigation mode. The FMC position at 1L can be copied to the scratchpad by selecting 1L.

The source for calculating the FMC position is shown in parentheses in the header line (GPS–IRU in Figure 4–13). GPS indicates the FMC position is calculated using GPS position data. Other sources for calculating the FMC position are IRU position data (INERTIAL) or navigation radio position data (RADIO). RADIO can be DME/DME/IRS or VOR/DME/IRS. GPS–IRU is displayed when the update mode is GPS–IRU or HYBRID GPS–IRU. GPS–AHRU is displayed when the update mode is GPS–AHRU or HYBRID GPS–AHRU–IRU. LOC is displayed when the update mode is LOC/IRU. LOC–RADIO is displayed when the update mode is LOC/DME/DME/IRU or LOC/VOR/DME/IRU. If GPS or RADIO data has been used to correct FMC position, a display of FMC (INERTIAL) is normally biased from the inertial position.

The source for calculating the FMC position is blank when the FMF is not in NAV update mode.

- **IRU (2L)** – IRU L or R is displayed in the header depending on the current IRU being used by the FMF master. When no IRU is being used by the master FMF, the header field displays IRU in small font. The lat/long position as determined by the IRU is displayed in 2L. The IRU lat/long position can be copied to the scratchpad by selecting 2L.

- **GPS (3L)** – The current GPS sensor being used by the FMF master is displayed in the header field. Possible header displays are GPS–IRU L, GPS–IRU R, GPS–AHRU L, GPS–AHRU R, GPS L, and GPS R. GPS is displayed in the header field if neither GPS is being used by the master FMF. The lat/long position being used by the GPS sensor is displayed in 3L. The GPS lat/long position can be copied to the scratchpad by selecting 3L.

If a valid GPS position does not exist for the sensor displayed in the header of 3L, the data field is blank.

- **RADIO (4L)** – 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 selecting 4L. The data field is blank if a valid RADIO position does not exist.

- **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. Valid manual RNP entries range from 0.01 to 99.9, followed by an optional trailing slash (/). Deleting of a manually entered RNP values returns the default value for the current phase of flight. Manually entered RNP values are cleared at flight completion.

The default RNP values are listed in Table 4–1.

Table 4–1
Default RNP Values

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 can be less than those listed.	

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 when greater than or equal to 10 NM, or to the nearest 1/100 NM WHEN less than 10 NM. Position accuracy values range from 0.00 to 99.9 NM. Position accuracy values greater than 99.9 NM are displayed as 99.9.

VERIFY RNP ENTRY is displayed in the Help window following entry of a manual RNP and either the manual RNP entry is greater than the current default RNP or the manual RNP entry is less than the current ANP.

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

- **POS UPDATE (1R)** – Selecting 1R arms the FMC position update function. This function is used to update the FMC position to match the IRU, 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 IRU, GPS, and RADIO lines.

- **ACTUAL (IRU) (2R)** – The position of uncertainty of the IRU position in 2L is displayed in 2R. If the master FMF IRU position is invalid, the position of uncertainty is not displayed. When the master IRU position is displayed in 2L and the FMF position update function is armed, NOW> is displayed in the data field in 2R in large font. Selecting 2R when NOW> is displayed updates the calculated FMF position to match the IRU position currently displayed in 2L.

- **ACTUAL (GPS) (3R)** – The position of uncertainty of the GPS position in 3L is displayed in 3R. If the master FMF GPS position is invalid, the position of uncertainty is not displayed. When the master GPS position is displayed in 3L and the FMF position update function is armed, NOW> is displayed in the data field in 3R in large font. Selecting 3R when NOW> is displayed updates the calculated FMF position to match the GPS position currently displayed in 3L.

- **ACTUAL (RADIO) (4R)** – The position of uncertainty of the radio position in 4L is displayed in 4R. If the radio position is invalid, the position of uncertainty is not displayed. When the radio position is displayed in 4L and the FMF position update function is armed, NOW> is displayed in the data field in 4R in large font. Selecting 4R when NOW> is displayed updates the calculated FMF position to match the RADIO position currently displayed in 4L.

- **DME/DME or VOR/DME (5R)** – The two– to 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 shown in Figure 4–13, or VOR/DME.

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

  Figure 4–13 shows the lat/long position display format (POS REF 2/4 page). Figure 4–14 shows the bearing/distance display format (POS REF 3/4 page).

  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.

POS REF 3/4 Page

The POS REF 3/4 page, shown in Figure 4–14, displays the current computed FMF positions (FMF L, FMF R, and FMF C) and enables the pilot to turn off or on the GPS NAV, DME/DME NAV, VOR/DME NAV, and LOC NAV modes. The title next to each FMC indicates which FMC is being used as MASTER, SPARE, or BACKUP.
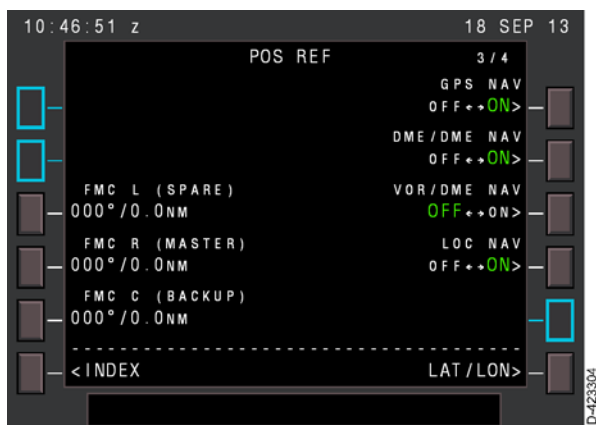
Figure 4–14
POS REF 3/4 Page

The POS REF 3/4 page is displayed by selecting the **NEXT PAGE** key while the POS REF 2/4 page is displayed or by selecting the **PREV PAGE** key when the POS REF 4/4 page is displayed.

The POS REF 3/4 page is described in the following paragraphs.

- **FMC L, FMC R, and FMC C (3L thru 5L)** The current position from the left, right, or center FMF NAV partition is displayed in LAT/LON format or BRG/DIST format (depending on the toggle state of 6R). The header field displays the current usage of the FMC as either (MASTER), (SPARE), or (BACKUP). Selecting 3L, 4L, or 5L down selects the displayed position to the scratchpad in expanded LAT/LON format.

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

- **GPS NAV (1R)** – Selecting 1R alternately selects GPS NAV ON (active) and OFF (inactive). In the ON position, GPS position data is available to the FMC, ON is displayed in large green font, and OFF is displayed in small white font. In the OFF position, GPS position data is not available to the FMC, ON is displayed in small white font, and OFF is displayed in large green font.

The power-up default is ON and is initialized to ON at flight completion. If both IRUs fail or become invalid, 1R toggles to the ON position and selection of 1R becomes non-operational (cannot selected to OFF).

Inhibiting GPS updating may be required in certain operational situations such as making an approach at a non WGS-84 surveyed airport.

- **DME/DME NAV (2R) –** Selecting 2R alternately selects DME/DME NAV ON (active) and OFF (inactive). In the ON position, DME/DME position data is available to the FMC, ON is displayed in large green font, and OFF is displayed in small white font. In the OFF position, DME/DME position data is not available to the FMC, ON is displayed in small white font, and OFF is displayed in large green font.

  The power-up default is ON and is initialized to ON at flight completion.

- **VOR/DME NAV (3R) –** Selecting 3R alternately selects VOR/DME NAV ON (active) and OFF (inactive). In the ON position, VOR/DME position data is available to the FMC, ON is displayed in large green font, and OFF is displayed in small white font. In the OFF position, VOR/DME position data is not available to the FMC, ON is displayed in small white font, and OFF is displayed in large green font.

  When ON is displayed in large font, four large dashes (----) are displayed on the REF NAV page in the data fields of 5L and 5R. When OFF is displayed in large font, ALL is displayed in small font on the REF NAV page in the data fields of 5L and 5R.

  The power-up and flight completion default is determined by Airline Modifiable Information (AMI) setting.

- **LOC NAV (4R) –** Selecting 4R alternately selects LOC NAV ON (active) and OFF (inactive). In the ON position, LOC position data is available to the FMC, ON is displayed in large green font, and OFF is displayed in small white font. In the OFF position, LOC position data is not available to the FMC, ON is displayed in small white font, and OFF is displayed in large green font.

  The power-up default is ON and is initialized to ON at flight completion.

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

POS REF 4/4 Page

The POS REF 4/4 page, shown in Figure 4–15, displays the bearing/distance difference from the master FMC to each navigation sensors position. The POS REF 4/4 page enables the pilot to deselect navigation sensor and associated data for FMC usage. Sensors selected to be unavailable are displayed in small cyan font and (OFF) is displayed in the selected sensor header, as shown in 4R in Figure 4–15. Bearing/distance information is not displayed without valid sensor data or if a valid master FMF position does not exist.
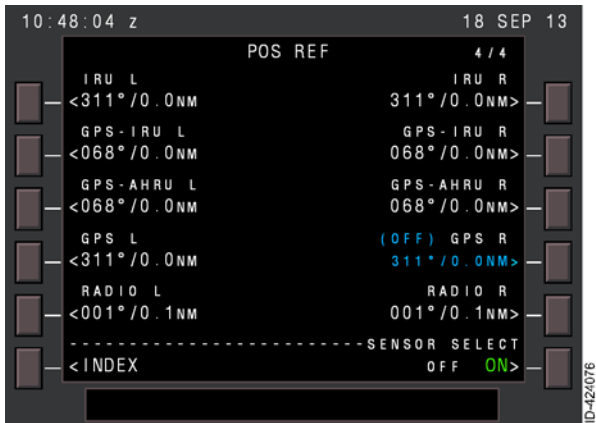
Figure 4–15
POS REF 4/4 Page

The POS REF 4/4 page is displayed by selecting the **NEXT PAGE** key while the POS REF 3/4 page is displayed or by selecting the **PREV PAGE** key when the POS INIT 1/4 page is displayed.

When the aircraft is airborne and no inertial system is in Attitude mode, selecting the **NEXT PAGE** key when the POS REF 4/4 page is displayed results in the POS REF 2/4 page being displayed. Otherwise, the POS INIT page 1/4 is displayed.

Line 1 through 5 displays individual navigation sensors with the distance from the master FMC. When a caret (< or >) symbol is displayed next to the distance, the navigation sensor can be selected on or off. When no carrot symbol is displayed, selecting any of the associated LSKs next to a navigation sensor results in no response.

● **INDEX (6L)** – Selecting 6L displays the INIT/REF INDEX page.

- **SENSOR SELECT (6R)** – Selecting 6R toggles the sensor select state OFF or ON. The current selection is displayed in green. When selected ON, carats (< or >) are displayed next to the navigation sensors which permits the deselection of a sensor. When selected OFF, carats are not displayed next to the navigation sensors.

The system prevents both of the IRU sensors and both of the GPS sensors from being deselected at the same time.

FLIGHT PLAN ROUTE ENTRY

Selecting 6R (ROUTE) on the POS INIT 1/4 page displays the RTE pages. The RTE pages permit the pilot to 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.

NOTE: Two routes can be stored in the FMS, although only one can be active at any given time. Selecting 6L on the RTE pages permits the pilot to select, view, and activate the other route (RTE 1 or RTE 2).

To display the RTE 1 page shown in Figure 4–16, select the ROUTE prompt (6R) on the POS INIT page.

Figure 4–16
RTE 1 Page

The RTE page can also be access by selecting the **RTE** mode key using the following priority order:

- When the aircraft is not airborne, the modified active or pending activation route is displayed.

- When the aircraft is not airborne and the **RTE** key is selected when the RTE, RTE LEGS, RTE DATA, RTE HOLD, RTE LEGS HOLD AT, WIND, DEPARTURE, or ARRIVAL page is displayed, the same route is displayed.

- When the aircraft is not airborne, the route that is active is displayed.

- When none of the previously mentioned conditions are met, RTE 1 is displayed.

The RTE 1/X page has autotabbing capabilities when enabled by the AMI. When data is entered into a field which has autotabbing enabled, the cursor automatically moves to the next correct field in the following order:

ORIGIN → DEST → FLT NO

Routes can be entered by the flight crew or uplinked through datalink. The first page of RTE page displays origin and destination information. The subsequent pages display route data between waypoints and fixes. RTE 1 and RTE 2 pages enable the flight crew to manage alternate or future routes while the active route remains unmodified. RTE 2 page has identical page structure as RTE 1 page. When RTE 2 page is active, the display logic is the same as the RTE 1 page.

The page title of the RTE page displays in white when the route is active and cyan when the route is inactive or pending activation. MOD is displayed in the header before RTE when the route is modified and the change is not executed.

The RTE page is described in the following paragraphs.

- **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 permitted 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.

- **RUNWAY (2L)** – The departure runway can be entered in 2L. Entry is optional. 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. When the RUNWAY entry is not compatible with the VIA entry, RUNWAY N/A FOR SID is displayed in the CDU help window and the runway entry is rejected.

2. A departure runway should be entered in order to cross–check the GPS position with the selected departure runway. During takeoff, this information is used to ensure the aircraft is on the selected runway.

- **<ROUTE REQUEST (3L)** – Selecting 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.

  The header line displays DATA LINK when the datalink status is NO COMM, VOICE, or FAIL.

- **<ROUTE REPORT (4L)** – The header displays ROUTE and <REPORT is displayed in the data field. Selecting the <REPORT prompt when displayed in the data line initiates a flight plan downlink.

  When a flight plan uplink load pending condition exists, the header field displays ROUTE UPLINK and <LOAD is displayed in the data field. When a flight plan reload pending condition exists and the RTE page was accessed from the FMC COMM page, the header field displays ROUTE UPLINK and <RELOAD is displayed in the data field. Selecting either the <LOAD or <RELOAD prompt when the route is inactive results in the inactive route being replaced or modified by the flight plan uplink. Selecting either the <LOAD or <RELOAD prompt when the route is active results in the active route being replace or modified route being created based on the flight plan uplink.

  The header and data line blank when any of the following conditions are met:

  — The datalink option is not installed
  — The flight plan report inhibit AMI option is enabled and no flight plan uplink load pending conditions exists
  — No flight plan uplink load or reload pending condition exists and the active route is not being displayed.

  Datalink is described in detail in Section 11, Flight Management Computer (FMC) Datalink.

- **<ROUTE PRINT (5L)** – The header displays ROUTE and <PRINT is displayed in the data field when when a printer is installed and a print job is not in progress. Selecting the <PRINT prompt initiates a print job of the active route (RTE 1 or RTE 2) associated with the RTE page displayed. The <PRINT prompt changes to <PRINTING when a print job is in progress. <PRINTERROR is displayed in the data field if a print job error occurs, a print job time–out occurs, or a FMC master/spare transition occurs. UNAVAILABLE is displayed in the data field when the printer is not available.

  When a printer is not installed, the 5L header displays dashes and the data line is blank.

- **<RTE 2/ERASE (6L)** – Selecting 6L displays RTE 2 page 1/x. When 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.

  When 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 selecting 6L erases any lateral or vertical route modifications or pending activations.

- **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. When the active leg is a part of the affected procedure, all legs of the procedure following the active leg are cleared.

- **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 inactive, or when 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, when 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.

- **RTE COPY/PURGE> (4R)** – RTE COPY> is displayed in the data field when either an active route exists and the alternate route is not pending activation or a modified active route exists. Selecting the RTE COPY> prompt results in the active route being copied into the alternate route. When route copy is complete, RTE COPY is displayed in the header field and COMPLETE is displayed in the data field.

  PURGE> is displayed when the inactive route is displayed and a flight plan uplink load pending exists. Selecting the PURGE> prompt results in the clearing of the route uplink and a downlink response message is initiated.

  The header and data fields in 4R are blank when no flight plan uplink is pending and no active routes exist, or an active route exists and the other route is pending activation. The data field in 4R is also blank when the inactive route is displayed and a flight plan uplink reload pending condition exists.

- **ALTN> (5R)** – Selecting 5R displays the ALTN page. The ALTN page is used to view alternates available along the route of flight.

- **ACTIVATE/PERF INIT/TAKEOFF/OFFSET (6R)** – The ACTIVATE prompt is displayed when the RTE page 1 being displayed is inactive and a flight plan uplink is not currently being processed. Selecting the ACTIVATE> prompt after the route has been entered lights the EXEC light.

  The PERF INIT> prompt is displayed when not airborne, the route is pending activation, active, or in the MOD state, and performance initialization is incomplete. Selecting the PERF INIT> prompt displays the PERF INIT page.

  The TAKEOFF> prompt is displayed when not airborne, the route is pending activation, active, or in the MOD state, and performance initialization is complete. Selecting the TAKEOFF> prompt displays the TAKEOFF REF page.

The OFFSET header is displayed when all of the following conditions are met:

— The aircraft is airborne
— The displayed route is in the active or modified active state
— The active leg of the route displayed is a course to a fix, direct to a fix, or track to a fix leg
— The active leg of the route is not part of a SID, STAR, or missed approach unless it is a direct to a waypoint in the procedure
— The active leg does not terminate at a runway or course from a fix to an altitude
— A direct–to/intercept modification to the displayed route is not in progress
— The aircraft is not flying the offset return path to the default end waypoint.

When OFFSET header is displayed, the pilot can establish a parallel lateral path to the left or right of the original flight path. Offsets are described in detail in Section 6, Cruise.

VIA Route Segment

The RTE 1 2/X page, shown in Figure 4–17, is displayed by selecting the **PREV PAGE** or **NEXT PAGE** key when the RTE 1 1/X page is displayed. This page provides access to the VIA and TO data fields for creating, modifying, and displaying the flight plan. The number of page is dependent on the number of procedure segments in the flight plan.

Figure 4–17
RTE 1 2/X Page

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 results in 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).

  NOTE: Additional information about latitude/longitude waypoints is described in detail in Section 10, Advanced Flight Planning.

- 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 be entered by using the scratchpad and the correct LSKs next to the VIA and TO fields. To fly direct to a waypoint, enter that waypoint in the correct TO field. DIRECT is displayed in the corresponding VIA field. When part of the route follows a published airway, enter that airway in the correct VIA field. The CDU displays box prompts in the corresponding TO field. The pilot must then enter a TO waypoint for the airway.
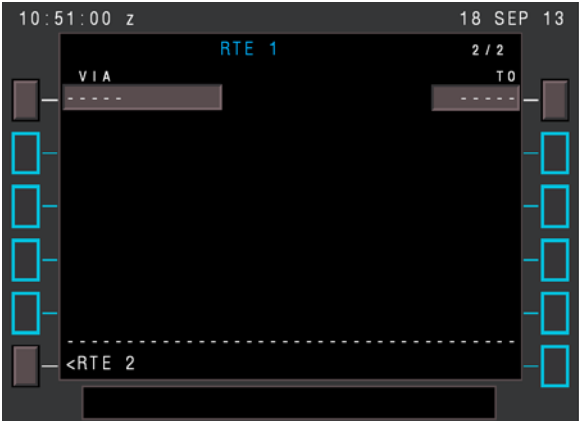
NOTE: When the airway has more than one waypoint, only the final waypoint of the leg needs to be entered. The NAV database has all waypoints along an airway in memory and they are subsequently displayed on the RTE LEGS pages.

When a waypoint or an airway is not in the NAV database, NOT IN DATA BASE is displayed in the CDU help window. 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 CDU help window.

Flight Plan – Route 1 Entry
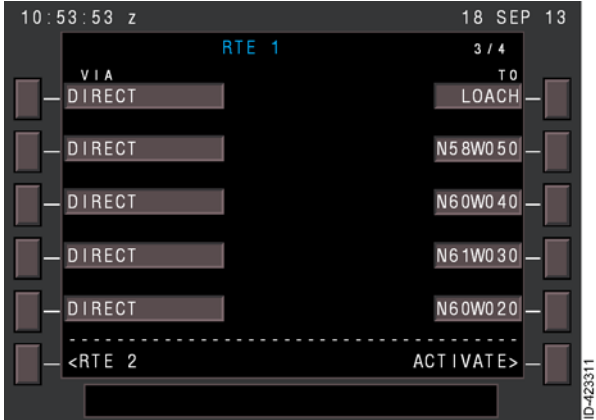
Procedure 4-2 describes the steps to enter the flight plan route filed from KORD to EGLL, described in Section 3, Flight Operations.

Step	Procedure 4-2 Flight Plan Route Entry
1	On the RTE 1 page, enter KORD in the scratchpad and select 1L.
2	Enter EGLL in the scratchpad and select 1R.
3	Enter 32R in the scratchpad and select 2L.

Step	Procedure 4–2 Flight Plan Route Entry (cont)
4	Enter 787 in the scratchpad and select 2R. The resulting display is shown in Figure 4–18.

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

Step	
5	Select the **NEXT PAGE** key to display the RTE 1 page 2/2, shown in Figure 4–19.

Figure 4–19
RTE 1 – Route Entry

Step	Procedure 4–2 Flight Plan Route Entry (cont)
6	Enter OBK in the scratchpad and select 1R.
7	Enter J94 in the scratchpad and select 2L.
8	Enter J546 in the scratchpad and select 3L. The resulting display is shown in Figure 4–20. **Figure 4–20** **RTE 1 – 2/2 Page**
9	Enter YQB in the scratchpad and select 3R.
10	Enter J560 in the scratchpad and select 4L.
11	Enter YZV in the scratchpad and select 4R.

Step	Procedure 4–2 Flight Plan Route Entry (cont)
12	Enter YYR in the scratchpad and select 5R. The resulting display is shown in Figure 4–21. **Figure 4-21** **RTE 1 – 2/3 Page**
13	Select the **NEXT PAGE** key, enter LOACH in the scratchpad and select 1R.
14	Enter N58W050 in the scratchpad and select 2R.
15	Enter N60W040 in the scratchpad and select 3R.
16	Enter N61W030 in the scratchpad and select 4R.

Step	Procedure 4–2 Flight Plan Route Entry (cont)
17	Enter N60W020 in the scratchpad and select 5R. The resulting display is shown in Figure 4–22.

Figure 4-22
RTE 1 – 3/4 Page

Step	
18	Enter the remaining waypoints and airways as described in the previous steps. Figure 4–23 shows the completed route entry for the remaining waypoints in the flight plan.

Figure 4-23
Route Entry Complete

DEPARTURE AND ARRIVAL SELECTION

The departure and arrival pages are displayed any time during the preflight phase by selecting the **DEP ARR** key on the CDU. The DEP/ARR INDEX page, shown in Figure 4–24, 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.

Figure 4–24
DEP/ARR INDEX Page

The DEP/ARR INDEX page 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). For this example flight plan, only RTE 1 has been defined.

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

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. When a route has been activated, (ACT) is displayed next to the RTE 1 or RTE 2 line in small font.

2. When 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 ARR prompt is displayed for the departure airport in the event an air return is necessary. When a STAR or approach procedure for the departure airport is selected, the selected STAR or approach procedure is appended to the end of the flight plan, the destination airport is changed, and a DISCONTINUITY is inserted between the last waypoint in the active flight plan and the first waypoint in the STAR and/or approach procedure.

The DEP/ARR INDEX page also permits the pilot to select 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 the identifier in the scratchpad and selecting 6L. Arrivals for an airport can be reviewed by entering the identifier in the scratchpad and selecting 6R. Entries must be four–character ICAO identifiers in the NAV database for departures or arrivals to be displayed.

The following rules determine which page is displayed when the **DEP ARR** key is selected:

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

● When 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.

● When 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.

● When the aircraft is on the ground and there is an active route, the DEPARTURES page for the origin is displayed. When 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 400 NM from the origin, or the aircraft is more than halfway along the route, the ARRIVALS page for the destination is displayed.

SID and Departure Runway Entry

To enter a departure runway and SID when the correct DEPARTURES page is not already displayed after selecting the **DEP ARR** key, select the <DEP prompt (1L in this example). KORD DEPARTURES 1/3 page is displayed as the title of the page, as shown in Figure 4–25. Pages 2/3 and 3/3 are displayed by selecting the **NEXT PAGE** or **PREV PAGE** key when 1/3 page is displayed. The left data fields display the available SIDs and the right data fields display the available departure runways.
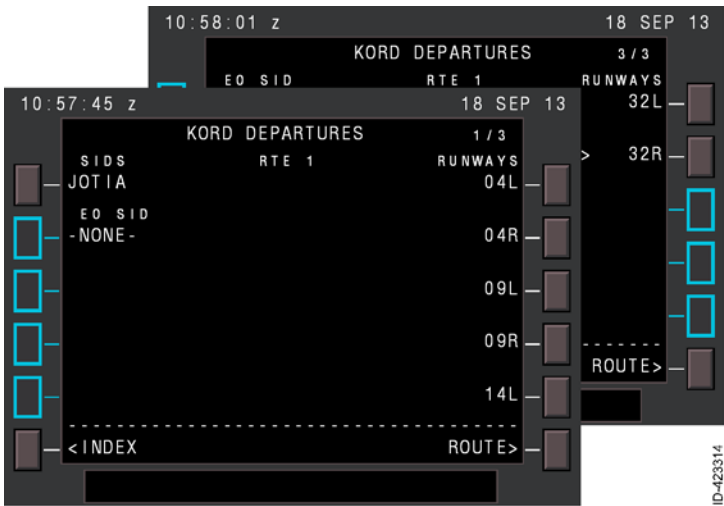
Figure 4–25
KORD DEPARTURES – 1/3 and 3/3 Pages

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

Select the correct runway by selecting the associated LSK. The sample flight plan uses runway 32R which is located in 3R on DEPARTURES 3/3 page, shown in Figure 4–25.

The selected runway is indicated by <SEL> and is displayed on the KORD DEPARTURES page, as shown in Figure 4–26.

```
10:58:27 z                              18 SEP 13
                  KORD DEPARTURES        1/1
      SIDS             RTE 1          RUNWAYS
     -NONE-                        <SEL>    32R

      EO SID
     -NONE-




     ................................................
     <INDEX                               ROUTE>
```

Figure 4–26
KORD DEPARTURES – RWY Selected

The selected departure runway is cross–checked with the GPS position to ensure the aircraft is on the selected runway. A caution–level EICAS message FMC RUNWAY DISAGREE is displayed when the following conditions are met:

- Takeoff Runway Disagree is enabled in the OPC
- Takeoff thrust is set
- Aircraft true heading is valid
- Groundspeed is valid and less than 80 knots
- Aircraft is on the ground
- An active flight plan exists and contains an origin runway
- Aircraft true heading is different from the selected departure true runway azimuth by more than 30° or the aircraft position is greater than 180 feet from the selected departure runway centerline.

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

To select a SID, select the correct 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 2L on page 1. A transition is selected by selecting the associated LSK and is indicated by <SEL>.

Airline–defined engine-out SIDs and all transitions for the selected runway are displayed under the EO SID header, when available, otherwise NONE is displayed. EO SIDs can be viewed before takeoff by line selecting the EO SID and selecting the LEGS page. EO SIDs are automatically selected during takeoff if an engine-out is detected and the flaps are not 0°. The modification can either be executed or erased. Engine failures on takeoff and climb are described in additional detail in Section 5, Takeoff and Climb.

ROUTE DISCONTINUITY

A ROUTE DISCONTINUITY, shown in line 3 in Figure 4–27, is created when no defined path exists between successive waypoints in a flight plan. Discontinuities can be created by deleting a waypoint, inserting a waypoint, or stringing a procedure.
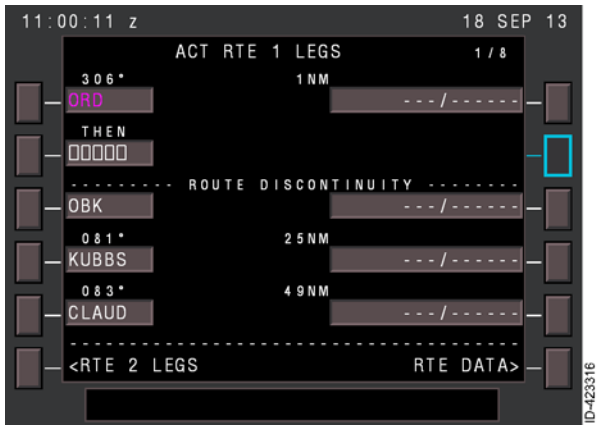
Figure 4–27
ROUTE DISCONTINUITY

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

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

Discontinuities can be cleared by entering the next waypoint after the route discontinuity into the scratchpad by line selecting the correct LSK. The LSK next to the discontinuity box prompt is then selected followed by the **EXEC** key to clear the route discontinuity.

ACTIVATING THE FLIGHT PLAN ROUTE

Selecting 6R (ROUTE) on the KORD DEPARTURES page, shown in Figure 4–26, displays the RTE 1 page shown in Figure 4–28.
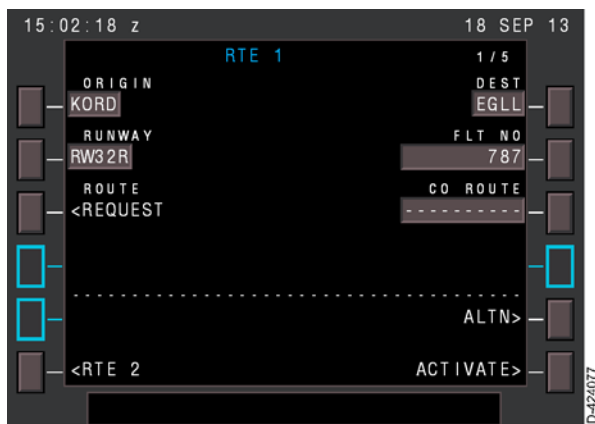
Figure 4–28
RTE 1 – Route Entry Complete

Selecting 6R (ACTIVATE), shown in Figure 4–28, after the route has been entered, lights the **EXEC** key and displays the ERASE prompt in 6L shown in Figure 4–29.

Figure 4–29
RTE 1 – Route Activation

Selecting the **EXEC** key activates the flight plan and changes the page title to ACT RTE 1 (or ACT RTE 2, as applicable), as shown in Figure 4–30.

NOTE: LNAV is available once the route is activated (with the aircraft greater than 50 feet in the air).
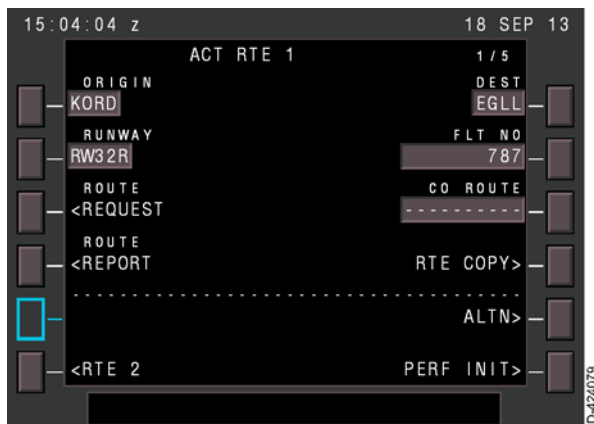
Figure 4–30
ACT RTE Page

When performance initialization is not complete (with the aircraft on the ground and the route not activated) the PERF INIT> prompt is displayed in 6R, as shown in Figure 4–30. Selecting 6R displays the PERF INIT page. After performance initialization is complete, TAKEOFF> is displayed in 6R on the active RTE pages (with the aircraft on the ground).

After the route has been activated, the RTE COPY prompt is displayed in 4R, as shown in Figure 4–30. Selecting 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, as shown in Figure 4–31.
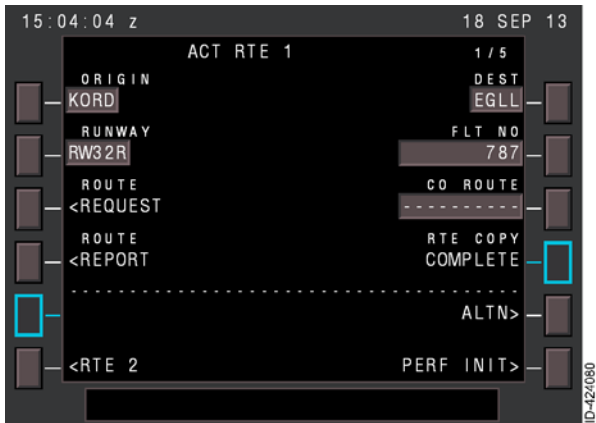
Figure 4–31
RTE COPY COMPLETE

PERFORMANCE INITIALIZATION

Once the flight plan has been activated and executed, the PERF INIT prompt is displayed in 6R on the RTE pages, as shown in Figure 4–31. Selecting 6R displays the PERF INIT page shown in Figure 4–32. This page is used to initialize the FMS performance calculations. Entered values on the PERF INIT page are cleared if electrical power is lost, when the engines are shutdown after flight, or after a database cycle.

**Figure 4–32
PERF INIT Page**

The PERF INIT page can also be displayed by Selecting 3L (PERF) on the INIT/REF INDEX page or by selecting the **INIT REF** key on the ground after the aircraft position has been initialized.

The PERF INIT page has autotabbing capabilities when enabled by the AMI. When data is entered into a field which has autotabbing enabled, the cursor automatically moves to the next correct field in the following order:

ZFW → RESERVES → CRZ ALT → COST INDEX → THRUST LIM

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). Manual entry in this field is not permitted.

   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.

- **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. Anytime after engine start the fuel flow values are invalid for more than 2 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 when 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 has been completed. Valid manual entries contain three or fewer numeric digits followed by an optional decimal and single digit.

  NOTES: 1.   Only manual entries can be deleted.

  2.   Box prompts indicate the aircraft sensing is not possible and a pilot-entry is required.

  INVALID ENTRY is displayed in the CDU help window when any of the following conditions are met:

  — Entry is not in a valid format
  — Entry which would result in a gross weight greater than the maximum gross weight in the performance database
  — Entry not within fuel weight range in the performance database.

  Figure 4–32 shows the 143.5 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). When a valid fuel quantity is displayed in 2L, entering ZFW in 3L results in the FMS calculating the gross weight and displays the result in 1L. Valid manual entries contain three numbers followed by an optional decimal point and single digit.

  INVALID ENTRY is displayed in the CDU help window when any of the following conditions are met:

  — Entry is not in a valid format
  — Entry which would result in a gross weight greater than the maximum gross weight in the performance database
  — Entry not within zero fuel weight range in the performance database.

  Values in 3L are not permitted to be deleted. INVALID DELETE is displayed in the CDU help window when an attempt is made to delete an entry in 3L.

TAKEOFF SPEEDS DELETED is displayed in the CDU help window when a ZFW value is entered after takeoff speeds have been accepted.

The ZFW value can be manually entered or uplinked. When a performance uplink is pending, uplinked values are displayed in small font next to the entered values in large font and are displayed as xxx.x/YYY.Y.

- **RESERVES (4L)** – The reserve fuel weight is displayed in 4L. Valid entries in 4L can contain a maximum of 4 digits and a decimal. Entries less than 100.0 may include a hundredths digits and entries less than 10.0 may include a thousandths digit. Entries with a hundredths or thousandths digit are rounded to the nearest tenth digit. The reserves weight is used in determining an insufficient fuel condition and in calculating performance predictions.

  The allowable entry range is determined by the performance database and entries that are not in this range result in INVALID ENTRY to be displayed in the CDU help window.

  NOTE: Entry is required to complete the preflight process.

  The RESERVES value can be manually entered or uplinked. When a performance uplink is pending, uplinked values are displayed in small font next to the entered values in large font and are displayed as xxx.x/YYY.Y.

  Values in 4L are not permitted to be deleted. INVALID DELETE is displayed in the CDU help window when an attempt is made to delete an entry in 4L.

- **<REQUEST (5L)** – Selecting 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, Flight Management Computer (FMC) Datalink, for more information.

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

- **CRZ ALT (1R)** – The desired cruise altitude can be entered in 1R by the pilot, from a company route, or by uplink. 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 permitted over an existing cruise altitude. An altitude entry greater than the maximum certified altitude is rejected and INVALID ENTRY is displayed in the CDU help window.

A cruise altitude entry in 1R is propagated to or from the CLB and CRZ pages and is changed by transitioning into the missed approach. The cruise altitude entry is cleared when the flight is complete.

Values in 1R are not permitted to be deleted. INVALID DELETE is displayed in the CDU help window when an attempt is made to delete an entry in 1R.

- **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 lower cost index results in minimum trip fuel operation, including cruise at maximum range cruise (MRC) 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. Entering a cost index within 10 NM of the top–of–descent, while in DES, not in the valid format, or not within the valid range is rejected and INVALID ENTRY is displayed in the CDU help window. 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, FMS Additional Information, Features, and Functions, for more information on the cost index.

  Values in 2R are not permitted to be deleted. INVALID DELETE is displayed in the CDU help window when an attempt is made to delete an entry in 2R.

- **FUEL FRZ TEMP/MIN FUEL TEMP (3R)** – When the MIN FUEL TEMP option is not enabled in the OPC, the FUEL FRZ TEMP header is displayed in small font and the fuel freeze temperature for a given fuel is displayed in 3R. When the MIN FUEL TEMP option is enabled in the OPC, the header displays MIN FUEL TEMP in small font and the minimum fuel operating temperature is displayed in 3R. The default value is from the AIRLINE POLICY page and is displayed in small font and may not be deleted.

  Pilot–entered or uplinked values are displayed in large font. Valid entries are -99 to -1 °C with the minus sign being required.

When MIN FUEL TEMP option is not enabled in the OPC and the actual fuel temperature is within 3 °C of the displayed value, the EICAS advisory message FUEL TEMP LOW is displayed.

NOTE: When the MIN FUEL TEMP OPC is enabled in the OPC and the actual fuel temperature is equal to the displayed value, the EICAS advisory message FUEL TEMP LOW Is displayed.

INVALID ENTRY is displayed in the CDU help window when an entry is made outside the valid range or not in the correct format. Deleting large font values is permitted and results in the display of small font default values. Deletion of small font values is not permitted and result in the display of the INVALID DELETE CDU help window message.

- **CRZ CG (4R)** – The cruise center of gravity (CG) is displayed in 4R. The cruise CG is used by the FMS to calculate maximum altitude and the maneuver margin to buffet. The default value is from the AMI database and cannot be deleted. The default value is displayed in small font.

    The default CG can be overwritten manually or uplinked to input the cruise CG. A pilot–entered CG is displayed in large font. When a PERF INIT uplink containing a cruise CG value is pending ACCEPT/REJECT, the cruise CG is displayed in small font. When accepted, the value is displayed in large font. Valid entries are between CG_{MIN} and CG_{MAX}, inclusive, from the aircraft database.

    INVALID ENTRY is displayed in the CDU help window when an entry is made outside the valid range or not in the correct format. Deleting large font values is permitted and results in the display of small font default values. Deletion of small font values is not permitted and result in the display of the INVALID DELETE CDU help window message.

- **STEP SIZE/ACCEPT (5R)** – STEP SIZE is displayed in 5R when a PERF INIT uplink is not pending ACCEPT/REJECT. When an PERF INIT uplink is pending ACCEPT/REJECT, ACCEPT> is displayed. Selecting of 5R when ACCEPT> is displayed makes pending uplink data permanent and results in the uplink data being treated as pilot–entered data.

    When STEP SIZE is displayed, the step size for the climb increment used for planning an optimum step climb profile is displayed in 5R. Valid entries are the step size in feet or I for ICAO. The default value is ICAO. Valid manual entries are 0 to 9000 in 1,000–foot increments.
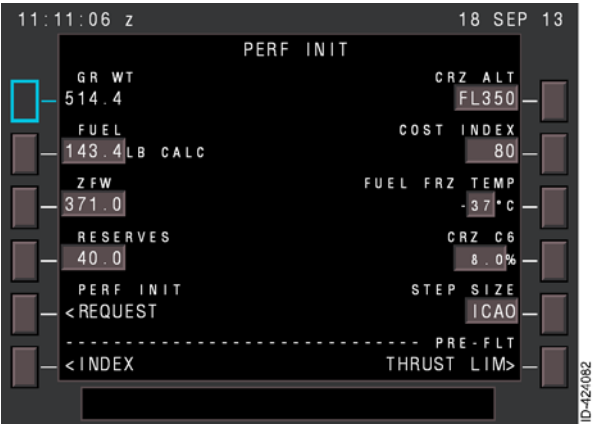
Entries outside of the allowable range or other than R or I displays the INVALID ENTRY CDU help window message. When the pilot–entered value is deleted, the default step size is displayed. Deletion of the default value is not permitted and results in the display of the INVALID DELETE CDU help message.

Data in 5R is propagated to and from the CRZ page. In–flight entries in 5R are not permitted. In–flight changes to the step size must be made on the CRZ page.

NOTE: When no step climbs are intended for the remainder of the flight, entering 0 for the step size is important to make performance calculations the most fuel efficient solution and make accurate fuel predictions. Otherwise, performance calculations assume the computed optimum steps are made, possibly resulting in non–conservative predictions of fuel at the destination.

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

Procedure 4–3 describes the steps to enter the flight plan performance information from on the PERF INIT page.

Step	Procedure 4–3 PERF INIT Entry
1	Enter 371 in the scratchpad and select 3L (ZFW).
2	Enter 40 in the scratchpad and select 4L (RESERVES).
3	Enter 350 in the scratchpad and select 1R (CRZ ALT).
4	Enter 80 in the scratchpad and select 2R (COST INDEX). The completed PERF INIT page is shown in Figure 4–33. **Figure 4–33** **PERF INIT Page – Complete**

THRUST LIMIT DATA

The THRUST LIM page shown in Figure 4–34, is used to select thrust modes, enter selected temperature for the assumed temperature derate function, entry of outside air temperature (OAT) when the air data system (ADS) is unable to provide it, and display the thrust limit for the selected mode. The THRUST LIM page is displayed by selecting the THRUST LIM prompt on the PERF INIT page, shown in Figure 4–33, or on the INIT/REF INDEX page.
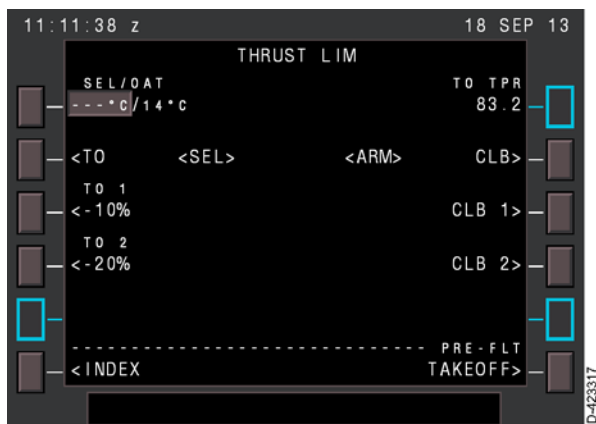
Figure 4–34
THRUST LIM Page

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 correct climb thrust limit mode when a takeoff thrust limit is selected.

The THRUST LIM page is described in the following paragraphs.

- **SEL/OAT (1L)** – The assumed temperature (SEL) for takeoff thrust (pilot–entered or uplinked) is displayed in 1L. Entry of an assumed temperature warmer than the OAT reduces takeoff thrust and displays D as part of the thrust reference mode. Valid entries are 0 to 99 Celsius (C) or 32 to 210 Fahrenheit (F) and are displayed in large font. Entries of one, two, or three characters followed by F displays the assumed temperature in Fahrenheit, otherwise the temperature displays in degrees Celsius.

Entries are permitted when all of the following conditions are met:

— The aircraft is on the ground with CAS less than 65 knots
— Dash prompts or large font temperature data is displayed in 1L
— The auto throttle is not engaged
— The thrust limit mode is takeoff
— The takeoff mode is not TO–B (take off bump).

The outside air temperature is displayed in either °C or °F. The OAT default display is in °C. When the assumed temperature is entered in °F, OAT is displayed in °F.

The assumed temperature thrust derate is not the same as the TO 1 and TO 2 fixed thrust derates in 3L and 4L. When TO 1 or TO 2 is selected and an assumed temperature is also entered, the thrust is further derated.

When an entry results in a greater than 25% reduction in thrust, the entered value is dialed back to a value that results in a 25% reduction.

Entering a temperature derate after the takeoff speeds have been selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

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

Entries in this field also change the assumed temperature (THRUST) in 2L TAKEOFF REF page.

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

Changes to the selected takeoff thrust limit mode after takeoff speeds have been selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

● **<TO 1**/**CON (3L)** – The TO 1 thrust limit mode in 3L is a percentage derate (when enabled). Manual derate entries are not permitted as the takeoff derate displayed in 3L is the takeoff derate in 2L (TO 1) on the AIRLINE POLICY 1/2 page, described in Section 15, FMS Additional Information, Features, and Functions. Takeoff thrust derate can be entered by an accepted uplink. <CON (max continuous thrust) is displayed when the takeoff thrust limit mode is not active.

Selection of the TO 1 rating after takeoff speeds have been selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

- **<TO 2 (4L)** – The TO 2 thrust limit mode in 4L is a percentage derate (when enabled). Manual derate entries are not permitted as the takeoff derate displayed in 4L is the takeoff derate in 2L (TO 2) on the AIRLINE POLICY 1/2 page, described in Section 15, FMS Additional Information, Features, and Functions. Takeoff thrust derate can be entered by an accepted uplink. <CON is displayed when the takeoff thrust limit mode is not active.

  Selection of the TO 2 rating after takeoff speeds have been selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

- **<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. When 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 enabled in the OPC. When the OPC option is not enabled, 3L, 4L, and/or 5L are blank.

  2. Takeoff datalink can automatically select a thrust limit mode.

  Selection of a new TO B rating after takeoff speeds have been selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

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

- **Takeoff Thrust Mode and TPR/N1 (1R)** – This field displays the selected takeoff thrust mode. The D– in front of the header line indicates that an assumed temperature derate is being used.
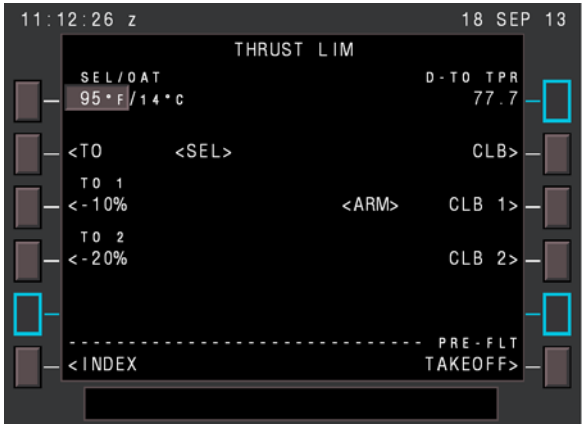
  When Rolls Royce engines are installed, turbine power ratio (TPR) is displayed in the header next to the selected takeoff mode. When displayed, the takeoff TPR calculated by the thrust management function (TMF) is displayed in the data field. When the engines are operated in the alternate mode, N1 is displayed in the header field instead and the takeoff N1 calculated by the TMF is displayed in the data field.

  When General Electric engines are installed, N1 is displayed in the header next to the selected takeoff mode. When displayed, the takeoff N1 calculated by the TMF is displayed in the data field.

  The header and data fields are blank if the TMF is invalid or there is no selected thrust limit mode.

- **CLB> (2R)** – Selecting 2R selects a full rated climb thrust limit. Selecting any of the climb LSKs overrides an automatic selection.

- **CLB 1> (3R)** – Selecting 3R selects a percentage derate (CLB 1) climb thrust limit. 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. Climb thrust derate can also be entered by an accepted uplink.

- **CLB 2> (4R)** – Selecting 4R selects a percentage derate (CLB 2) climb thrust limit. 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. Climb thrust derate can also be entered by an accepted uplink.

- **TAKEOFF> (6R)** – When thrust limit mode is active, TAKEOFF> is displayed in 6R. Selecting TAKEOFF displays the TAKEOFF REF page 1/2. This is the next page to be completed during the preflight.

Procedure 4–4 describes the steps to enter an example thrust limit mode on the THRUST LIM page.

Step	Procedure 4-4 Thrust Limit Entry
1	On the THRUST LIM page shown in Figure 4–34, select 2L to select the takeoff (TO) thrust limit.
2	Enter 95F in the scratchpad and select 1L. This enters 95 °F as the assumed temperature derate. The resulting display is shown in Figure 4–35.

Figure 4–35
THRUST LIM Page – Derate

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.
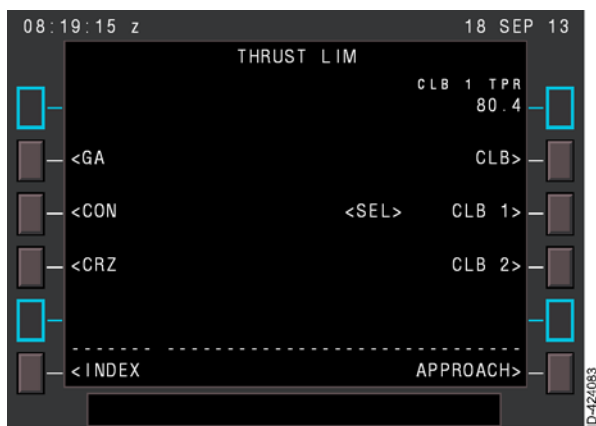
Figure 4–36
THRUST LIM Page – Airborne

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

- **<GA (2L)** – Selecting 2L selects the go–around thrust limit. The go–around thrust limit is automatically selected when flaps are out of up, flaps are extended to landing position, or glideslope is captured. The reference thrust limit is locked in GA when flaps are in landing position or glideslope is captured.

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

- **<CRZ (4L)** – Selecting 4L selects cruise thrust limit. When CRZ is the default thrust rating in cruise from the AMI (also designated on the AIRLINE POLICY page) the cruise thrust limit is automatically selected after the FMS mode transitions to top–of–climb.

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

TAKEOFF REF – TAKEOFF DATA UPLINK OPTION ENABLED

The following paragraphs describe the TAKEOFF REF pages when the Takeoff Data Uplink OPC option is enabled. The TAKEOFF REF pages when the Takeoff Data Uplink OPC option is not enabled is described later in this section. The TAKEOFF REF pages permit the pilot to manage takeoff performance.

TAKEOFF REF 1/2 Page

The TAKEOFF REF 1/2 page, shown in Figure 4–37, is used to display uplinked, manually entered, and EFB calculated takeoff data, takeoff thrust, takeoff speeds, and preflight FMS initialization status.
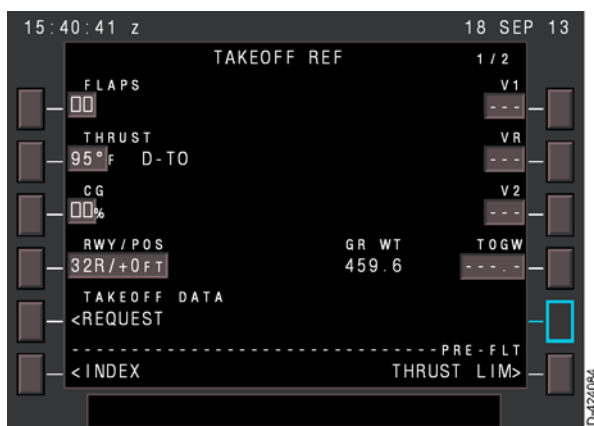
Figure 4–37
TAKEOFF REF 1/2 Page

The TAKEOFF REF page 1/2 is displayed by selecting any of the following:

- 5L on the INIT/REF INDEX page

- 4L on the FMC COMM page (when datalink option is installed)

- 6R on the THRUST LIM page (before takeoff)

- **INIT/REF** key when on the ground and a takeoff uplink is pending or preflight status is complete.

The TAKEOFF REF 1/2 page has autotabbing capabilities when enabled by the AMI. When data is entered into a field which has autotabbing enabled, the cursor automatically moves to the next field in the following order:

FLAPS → CG → V1 → VR → V2

The TAKEOFF REF page title changes to TAKEOFF REF UPLINK when a Takeoff Data Uplink is pending, accept/reject. When a Takeoff Data Uplink is pending, selection, entry, and deletion of data is not permitted and dashed prompts or entry boxes are removed until the uplink is accepted or rejected. When the Takeoff uplink is rejected, the status of each field reverts to that which existed before the uplink.

All data fields are frozen when airborne. Data fields not containing data and 5L (TAKEOFF DATA) are blank when airborne.

The TAKEOFF REF page 1/2 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 pilot–entry or datalink.

  Entering 5 when FLAPS 5 is the climb thrust reduction point displays INVALID ENTRY in the CDU help window. Entering or deleting a value after takeoff speeds have been accepted removes the takeoff speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window. Flap position is required for takeoff V_{SPEED} speed calculations. Entering a flap setting recalculates the stab trim value and deleting the flap setting blanks the stab trim value.

  Manual deletion of flap setting is permitted and returns the display to box prompts.

- **THRUST (2L)** – The assumed temperature for takeoff thrust (pilot–entered or uplinked) is displayed in 2L. Entry of an assumed temperature warmer than the OAT reduces takeoff thrust and displays D as part of the thrust reference mode. Valid entries are 0 to 99 Celsius (C) or 32 to 210 Fahrenheit (F). Entries of one, two, or three characters followed by F displays the assumed temperature in Fahrenheit, otherwise the temperature displays in degrees Celsius. Manual entries are only permitted while on the ground, the takeoff mode is not takeoff bump (TO B), a pending takeoff uplink does not exist, and a valid assumed temperature from the TMF does not exist.

  Entries in this field also change the assumed temperature (SEL) in 1L on the THRUST LIM page.

  NOTE: The assumed temperature thrust derate is not the same as the TO 1 and TO 2 fixed thrust derates in 3L and 4L on the THRUST LIM page. When TO 1 or TO 2 is selected and an assumed temperature is also entered, the thrust is further derated.

  The takeoff thrust mode is displayed to the right of the assumed temperature. When an assumed temperature reduction is active, the thrust mode is prefixed with D– to indicate a reduced value.

Entering or deleting an assumed temperature in 2L after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

Manual deletion of assumed temperature is permitted and returns the display to dashes.

- **CG TRIM (3L)** – The center of gravity and stabilizer trim (TRIM) data is displayed in 3L. Valid entry is within valid range from the aircraft database.

  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. The takeoff green band displayed on the stabilizer position indicator is also updated.

  Deletion of CG data is permitted and results in box prompts displayed and the Trim header and data field being removed.

- **RWY/POS (4L)** – The runway identifier and pilot-entered bias (shift) distance of the takeoff brake release point from the runway threshold or runway intersection are displayed in 4L. Values can be entered manually by the pilot or by uplink. The runway number automatically transfers from the RTE page. Runway entry does not change the runway entered on the RTE or DEPARTURES page.

  Valid runway identifiers entries are one to five alphanumeric characters for runways contained in the NDB for the origin airport. Valid formats are one or two numeric characters identifying the runway, optionally preceded by RW and followed by L, R, or C when the runway identifier in the NDB includes a suffix.

  When a runway identifier is displayed in 4L, it can be optionally followed by a position shift or runway intersection. A position shift (the distance that the aircraft is past the runway threshold) can be entered and is used for a position update at takeoff. The position update uses the exact lat/long position for the runway threshold, as stored in the NDB.

  Valid position shift entries when FT is displayed range from 0 to 99 followed by two zeros (00). Valid entries when M is displayed range from 0 to 30 followed by two zeros (00). The display of M or FT is determined by the metric runway OPC option. Position entries can be preceded by an optional minus (–) or plus (+) sign. Entries preceded by a minus sign indicate a longer takeoff distance is available. For example, an entry of –500FT indicates the takeoff will be initiated 500 feet before the runway threshold. Entries without an minus or plus sign are assumed to be positive. Entries must be preceded by a slash (/).

Valid runway intersection entries are one to three alphanumeric characters preceded by a slash (/). Runway intersection entries not found in the NDB are ignored and result in the display of the NOT IN DATA BASE CDU help message.

Deletion of a distance, intersection, or non–active runway is permitted and results in displaying the active runway when one exists or ---/--- when an active runway does not exist. Deletion of 4L when no distance, intersection, or non–active runway is displayed results in the display of the INVALID DELETE CDU help message.

Entering or deleting a value in 4L after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

- **<TAKEOFF DATA (5L)** – When datalink is available, <REQUEST is displayed in 5L. Selecting <REQUEST transmits a datalink request for takeoff data uplink and displays REQUESTING while the datalink request is in progress. <REJECT is displayed when a takeoff data uplink is pending. Selection of the <REJECT prompt returns the display to the previous data.

  When the datalink status is NO COMM, VOICE, or FAIL, DATA LINK is displayed in small font as the header, replacing the TAKEOFF DATA header. The associated datalink status (NO COMM, VOICE, or FAIL) is displayed in large font under the DATA LINK header.

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

- **V1, VR, and V2 (1R, 2R, and 3R)** – Takeoff V_{SPEEDS} are displayed in 1R, 2R, and 3R. Dashes are displayed when the required information is not entered or when the IRS is not aligned.

  Takeoff data comes from the EFB performance page and is sent as an uplink to the FMC when the pilot initiates Send to FMC from the EFB. The FMC displays the EFB–calculated V_{SPEEDS} based on gross weight, runway condition, derates, altitude, temperature, and other performance factors. EFB–calculated V_{SPEEDS} are displayed in small font.

  NOTE: EFB-calculated V_{SPEED} computations are inhibited from display when the Takeoff Speed Inhibit OPC option is enabled. V_1 computations are inhibited from display when the V_1 Inhibit OPC option is enabled. Manual V_{SPEED} entries are still permitted with either OPC option enabled. Valid entry range is between 80 and 300 inclusive.

  Pilot–entered speeds display in large font and replace uplinked speeds.

Pilot-entered or uplinked (EFB or AOC) takeoff speeds are limited to no less than the performance module-computed minimum V_1, V_R, and V_2 speeds. When a pilot-entered or uplinked takeoff speed is less than the corresponding minimum value, the respective MIN V1, MIN VR, or MIN V2 header is displayed along with the associated minimum value, as shown in Figure 4-38. In addition, V_R speeds less than the minimum V_1 are indicated by the display of MIN VR in the header line and the greater value of minimum V_1 or V_R is displayed in the data line.

NOTE: When the V_1 Inhibit OPC option is enabled, pilot-entered or uplinked V_1 entries continue to be limited to no less than the performance module-computed minimum V_1 speed.
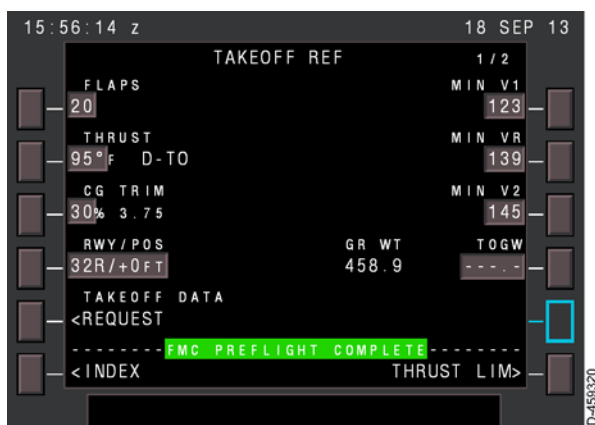
Figure 4-38
Minimum V_{SPEED}

If a pilot-entered or datalink V_{SPEED} is outside the valid range, INVALID ENTRY is displayed in the CDU help window.

The FMC performs a relative takeoff speed check to ensure $V_1 \leq V_R \leq V_2$. If a V_{SPEED} speed does not comply with the relative takeoff speed check, all V_{SPEEDS} are removed and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

A change to performance data results in existing V_{SPEEDS} being replaced with dashes and the CDU help window message TAKEOFF SPEEDS DELETED being displayed. Also, all V_{SPEEDS} are removed from the PFD and the PFD speed tape message **NO V SPD** is displayed.

Deletion of large font V$_{SPEEDS}$ is permitted and result in the display of dashes. Deletion of small font V$_{SPEEDS}$ or dashes is not permitted and result in the display of the INVALID DELETE CDU help window message. The 1R to 3R data fields are blanked 2 minutes after ground to air transition.

- **TOGW (4R)** – The takeoff gross weight is entered in 4R. Takeoff gross weight compensates for fuel burn during taxi.

  Valid entry is any weight within the allowable aircraft takeoff gross weight range (XXX.X). Entering a value after takeoff speeds are accepted removes the V$_{SPEEDS}$ and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

  Deletion of TOGW is permitted and results in returning to the default display (–––.–), removes the V$_{SPEEDS,}$ and displays TAKEOFF SPEEDS DELETED in the CDU help window. Deletion of the default display is not permitted and results in the display of the INVALID DELETE CDU help window message.

- **GR WT (4C)** – The gross weight from the PERF INIT page is displayed in 4C. The gross weight header and data fields are blank when a large font gross weight is not displayed on the PERF INIT page or when no uplinked zero fuel weight is pending.

- **ACCEPT> (5R)** – The data field in 5R displays ACCEPT> in large font when a takeoff data uplink message is pending. Selection of the ACCEPT> prompt results in the uplinked data being accepted and all remaining small font data being displayed in large font.

  When the active flight plan departure runway is not the same as the runway displayed in 4L, selection of the ACCEPT> prompt results in an automatic change of the active flight plan runway to that displayed in 4L. This also results in any incompatible departure procedures being dropped from the flight plan and the RUNWAY N/A FOR SID CDU help message being displayed.

  The header and data field are blank when airborne or when a pending uplink condition does not exist.

- **PRE–FLT (6R)** – The header in 6R displays PRE–FLT, as shown in Figure 4–39, until the required preflight data entries have been completed. Preflight pages requiring entries are displayed below the dashed line as prompts. When the aircraft is airborne, the PRE–FLT header line is replaced with dashes.

Figure 4–39
PRE–FLT Prompt

POS INIT is displayed in the data line after power–up while on the ground, and at least one IRU or AHRU is not in NAV mode and not in AUTONAV realign mode. Selecting POS INIT displays the POS INIT page.

ROUTE is displayed in the data line while on the ground, all IRUs and AHRUs are in NAV mode, and both routes are in the inactive state. Selecting ROUTE displays the RTE page.

PERF INIT is displayed in the data line while on the ground, all IRUs and AHRUs are in NAV mode, after a route is activated, and until gross fuel weight (or zero fuel weight), reserves, cost index, and cruise altitude are entered. Selecting PERF INIT displays the PERF INIT page.

THRUST LIM is displayed in the data line in all other situations. Selecting THRUST LIM displays the THRUST LIM page.

When all required preflight entries are complete and the aircraft is on the ground, the header line in row six displays FMC PREFLIGHT COMPLETE in white text with a green background, as shown in Figure 4–40. The header line FMC PREFLIGHT COMPLETE is displayed on the TAKEOFF REF, PERF INIT, and THRUST LIM pages.
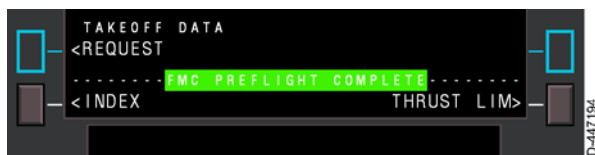
Figure 4–40
FMC PREFLIGHT COMPLETE

TAKEOFF REF 2/2 Page

The TAKEOFF REF 2/2 page displays uplinked and/or manually entered takeoff data. The TAKEOFF REF 2/2 page also provides access to alternate/standard uplinked takeoff data. Entries are required on TAKEOFF REF 2/2 before TAKEOFF REF 1/2 can be completed.

To display the TAKEOFF REF 2/2 page, shown in Figure 4–41, select the **NEXT PAGE** or **PREV PAGE** key when the TAKEOFF REF page 1/2 is displayed.
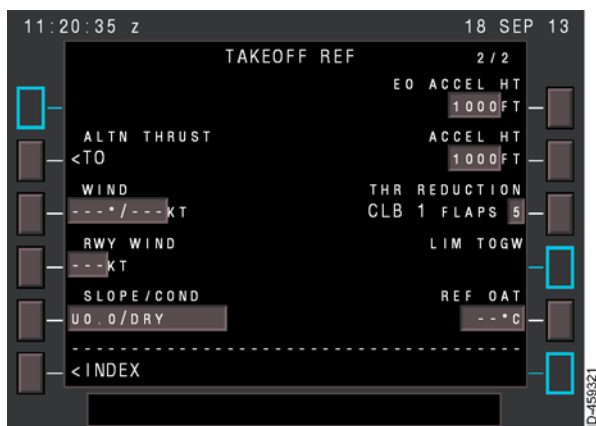
Figure 4–41
TAKEOFF REF 2/2 Page

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

- **ALTN THRUST, ALTN THR/FLAPS, STD THRUST, STD THR/FLAPS, ALTN THR/FLAP, STD THR/FLAP (2L)** – Header and data lines are displayed when pending uplinks exist and after acceptance until another runway is entered or propagated on the TAKEOFF REF 1/2 page in 4L. The header and data lines in 4L are blank in all other conditions.

  The following are possible header line displays and associated conditions for the display:
  — ALTN THR/FLAPS – Displayed when an alternate thrust and flap setting exists for the displayed STD THR/FLAPS takeoff/runway data
  — ALTN THRUST – Displayed when an alternate thrust setting exists and no alternate flap setting exists for the displayed STD THRUST takeoff/runway data
  — STD THR/FLAPS – Displayed when a standard thrust and flap setting exists for the displayed ALTN THR/FLAPS takeoff/runway data

> — STD THRUST – Displayed when a standard thrust setting exists and no standard flaps setting exists for the displayed ALTN THRUST takeoff/runway data.

The following are possible data line displays:

> — TO, TO/FLAPS
> — TO 1, TO1/FLAPS
> — TO 2, TO2/FLAPS
> — TO B, TOB/FLAPS
> — yy TO x (assumed temperature)
> — yy TO x /FLAPS.

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

> — 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 CDU help window.

- **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 are entered by the pilot or uplinked.

  Initial entry must include wind direction and speed separated by a slash (/). Subsequent entries can be wind direction or speed only. Speed only entries must be preceded by a slash. Valid directions are from 000 to 360°, with 000 and 360 displayed as 000. Valid speed entries range from 0 to 250 knots.

  Deletion of large font wind data is permitted and results in the default data being displayed.

  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 CDU help window.

- **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. Any pilot–entry clears the WIND line and returns the display to default dashes.

Entering a value after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

- **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.

  U0.0 is displayed in small font as the default slope. Valid runway slope entry is U for up or D for down followed by 0.0 through 2.0 in percent gradient. A pilot–entered or accepted uplink runway slope is displayed in large font. When only the runway slope is entered, a trailing slash (/) is not required. Entering a value after takeoff speeds are selected removes the speeds and TAKEOFF SPEEDS DELETED is displayed in the CDU help window.

  DRY is displayed in small font as the default runway condition. Valid runway condition entry is D (dry), W (wet), or S (wet skid runway). Entering W for wet displays WET. Entering D for dry displays DRY. Entering S for wet skid runway displays WET SK-R. A pilot–entered or accepted uplink runway conditions are displayed in large font. When runway condition is entered (either with or without a runway slope entry) a slash (/) must proceed the runway condition entry.

  When a pilot-entered runway condition is deleted, the default runway condition (DRY) is displayed in small font. The default value (DRY) is also displayed in small font on flight completion.

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

- **EO ACCEL HT (1R)** – The engine out acceleration height in 1R is the height above the airport where acceleration will start for flap retraction with an engine out. VNAV commands acceleration at this altitude or at first flap retraction.

  The small font default value is from the AMI file. Valid pilot–entries or accepted uplinked values are from 400 to 9,999 feet above the origin airport elevation and are displayed in large font. 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 AMI file. Valid pilot–entries or accepted uplinked values are from 400 to 9,999 feet above the origin airport elevation and are displayed in large font. Entry is optional for preflight completion.

- **THR REDUCTION (3R)** – The thrust reduction point in 3R is the altitude or flap setting at which reduction from takeoff thrust to armed climb thrust will automatically occur. The thrust reduction point is either an altitude or a flap position and the default value displayed is from the AMI.

  Valid thrust reduction altitudes are from 400 to 9,999 feet above the origin airport elevation. When a thrust reduction altitude exists in 3R, the altitude is followed by FT.

  Valid thrust reduction flap entries are 1 for FLAPS 1 and 5 for FLAPS 5. When a thrust reduction flap setting exits in 3R, FLAPS is displayed followed by the flap setting, as shown in Figure 4–41. When a manual entry makes the thrust reduction flaps and takeoff flaps the same, the takeoff flap entry on the TAKEOFF REF 1/2 page is automatically deleted and the TAKEOFF FLAP DELETED CDU help message is displayed.

  The armed climb thrust rating from the THRUST LIM page is displayed before the thrust reduction point. Possible armed climb thrust ratings are CLB, CLB1, and CLB2.

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

- **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. Manual entries results in the TAKEOFF SPEEDS DELETE CDU help window message being displayed and invalidate LIM TOGW in 4R.

  Deletion of large font values is permitted and result in the default display.

TAKEOFF REF – TAKEOFF DATA UPLINK OPTION NOT ENABLED

The following paragraphs described the TAKEOFF REF pages when the Takeoff Data Uplink OPC option is not enabled. The TAKEOFF REF pages when the Takeoff Data Uplink OPC option is enabled is described earlier in this section. The TAKEOFF REF page, shown in Figure 4–42, is used to display manually entered and FMS calculated takeoff data, takeoff thrust, takeoff speeds, and preflight FMS initialization status. The TAKEOFF REF page is limited to one page when the Takeoff Data Uplink option is not enabled, compared to two pages when the Takeoff Data Uplink option is enabled.
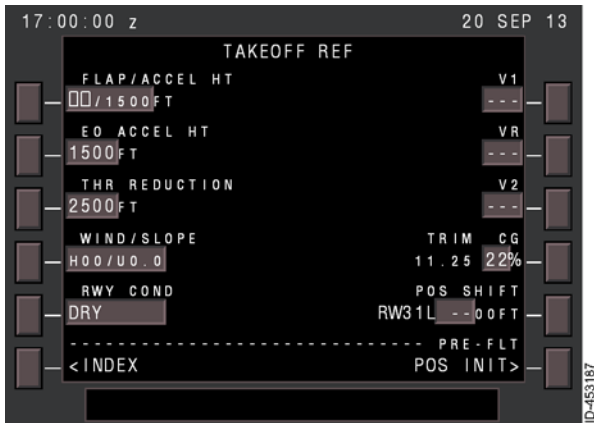
Figure 4–42
TAKEOFF REF Page

The TAKEOFF REF page with the Takeoff Data Uplink option not enabled is described in the following paragraphs:

- **FLAPS/ACCEL HT (1L)** – Valid flap entries are takeoff flap settings from the performance database and must be greater than the displayed 3L thrust reduction flap value. Flap entries do not require a trailing slash (/). Deletion of flap entries return the display to prompt boxes and blanks large font takeoff speeds. Deletion of flap entries also blanks TRIM CG header and data in 4R.

  Valid flap entries invalidate takeoff speeds displayed in 1R to 3R.

  The acceleration height in feet above the origin airport is displayed after the slash (/). VNAV commands acceleration at this altitude or at first flap retraction.

Valid acceleration height entries are 3– or 4–digit integers in the range of 400 to 9,999 feet above the origin airport elevation. The default acceleration height from the AMI is displayed in small font in feet. Pilot–entered acceleration height is displayed in large font. Acceleration height entries do not required a preceding slash (/).

Deletion is permitted when manual (large font) entries are displayed. Attempted deletion of default data results in the INVALID DELETE CDU help window message displayed.

- **EO ACCEL HT (2L)** – The engine out acceleration height is displayed in 2L. The default value from the AMI is displayed in small font. Pilot–entered values are displayed in large font and have a valid entry range of 400 to 9,999 feet above the origin airport elevation.

Deletion is permitted when manual (large font) entries are displayed. Attempted deletion of default data results in the INVALID DELETE CDU help window message displayed.

- **THR REDUCTION (3L)** – The thrust reduction point in 3R is the altitude or flap setting at which reduction from takeoff thrust to armed climb thrust will automatically occur. The thrust reduction point is either an altitude or a flap position and the default value displayed is from the AMI.

Valid thrust reduction altitudes are from 400 to 9,999 feet above the origin airport elevation. When a thrust reduction altitude exists in 3R, the altitude is followed by FT.

Valid thrust reduction flap entries are 1 for FLAPS 1 and 5 for FLAPS 5. When a thrust reduction flap setting exits in 3R, FLAPS is displayed followed by the flap setting. When a manual entry makes the thrust reduction flaps and takeoff flaps the same, the takeoff flap entry in 1L is automatically deleted and the TAKEOFF FLAP DELETED CDU help message is displayed.

The armed climb thrust rating from the THRUST LIM page is displayed to the right of the thrust reduction point. Possible armed climb thrust ratings are CLB, CLB1, and CLB2.

Entry is optional for preflight completion.

- **WIND/SLOPE (4L)** – The header displays WIND/SLOPE. The header and data are blank when the Takeoff Speed Inhibit OPC is enabled.

The default value for wind is H00 and slope is U0.0 and are displayed in small font.

Entry of a wind component and runway slope can be made in 4L. When both entries are made at the same time, a slash (/) must separate the two entries. When only the wind component is to be entered, no trailing slash (/) is required. When only the slope is to be entered, a preceding slash (/) is required. Pilot–entered values are displayed in large font.

Valid wind component entries are one- or two-digit integers preceded, optionally, by an H (for headwind) or T (for tailwind). When no direction indiction precedes the wind component, a headwind entry is assumed.

Valid runway slope entries are one- to three-digit entries in the range of 0.0 to 2.0, optionally, preceded by an U (for uphill) or D (for downhill). When no direction indication precedes the slope, uphill is assumed.

Entries and deletions of wind component and slope invalidate takeoff speeds in 1R to 3R.

- **RWY COND (5L)** – The runway condition is displayed in 5L. The runway condition on the TAKEOFF REF page with the Takeoff Data Uplink option not enabled functions the same way as the runway condition in 5L on the TAKEOFF REF 2/2 page previously described in this section.

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

- **V1, VR, and V2 (1R, 2R, and 3R)** – Takeoff V_{SPEEDS} are displayed in 1R, 2R, and 3R. Takeoff V_{SPEEDS} function the same way as takeoff V_{SPEEDS} on the TAKEOFF REF 1/2 page with the Takeoff Data Uplink option enabled, previously described in this section.

- **TRIM CG (4R)** – The center of gravity and stabilizer trim data is displayed in 5L. The center of gravity and stabilizer trim on the TAKEOFF REF page with the Takeoff Data Uplink option not enabled functions the same way as the trim CG in 3L on the TAKEOFF REF 1/2 page previously described in this section.

- **POS SHIFT (5R)** – The runway identifier and pilot–entered bias (shift) distance of the takeoff brake release point from the runway threshold are displayed in 5R. The runway number automatically transfers from the RTE page and is displayed in large font prefixed by RW. The position shift is used to update the FMS position on execution of an autothrottle takeoff.

When an active departure runway is available for display, the active departure runway is followed by two large font dashes (– –) followed by 00FT or 00M when the meters option for runway position shift is selected in the OPC.

Valid position shift entries when FT is displayed range from 0 to 99 followed by two zeros (00). Valid entries when M is displayed range from 0 to 30 followed by two zeros (00). Entries outside this range display the INVALID ENTRY CDU help window message.

Position entries can be preceded by an optional minus (–) or plus (+) sign. Entries preceded by a minus sign indicate a longer takeoff distance is available. For example, an entry of –500FT indicates the takeoff will be initiated 500 feet before the runway threshold. Entries without a minus or plus sign are assumed to be positive. Entries must be preceded by a slash (/).

Deletion of pilot–entered values displays the original two large font dashes (– –). Original large font dashes cannot be deleted. Data field 5R is blank when a departure runway does not exist in the active route.

- **PRE–FLT (6R)** – The header in 6R displays PRE–FLT, until the required preflight data entries have been completed. Preflight pages requiring entries are displayed below the dashed line as prompts. When the aircraft is airborne, the PRE–FLT header line is replaced with dashes.

  POS INIT is displayed in the data line after power–up while on the ground, and at least one IRU or AHRU is not in NAV mode and not in AUTONAV realign mode. Selecting POS INIT displays the POS INIT page.

  ROUTE is displayed in the data line while on the ground, all IRUs and AHRUs are in NAV mode, and both routes are in the inactive state. Selecting ROUTE displays the RTE page.

  PERF INIT is displayed in the data line while on the ground, all IRUs and AHRUs are in NAV mode, after a route is activated, and until gross fuel weight (or zero fuel weight), reserves, cost index, and cruise altitude are entered. Selecting PERF INIT displays the PERF INIT page.

  THRUST LIM is displayed in the data line in all other situations. Selecting THRUST LIM displays the THRUST LIM page.

  When all required preflight entries are complete and the aircraft is on the ground, the header line in row six displays FMC PREFLIGHT COMPLETE in white text with a green background. The header line FMC PREFLIGHT COMPLETE is displayed on the TAKEOFF REF, PERF INIT, and THRUST LIM pages.

Blank Page

5. Takeoff and Climb

INTRODUCTION

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

When the correct takeoff parameters are set, the FMC commands the selected takeoff thrust when the TO/GA button is selected. Immediately after takeoff, the autothrottle commands the thrust and the FMC targets a speed between V2+15 and V2+25.

LNAV and VNAV are normally armed before takeoff. When armed before takeoff, LNAV activates at 50 feet radio altitude (RA) and commands roll to fly the active route. VNAV activates at 400 feet above runway elevation and commands pitch to fly the climb profile.

When VNAV is engaged, the FMS automatically reduces takeoff thrust to the climb thrust limit on the THRUST LIM page. For the example flight scenario, the climb thrust is set at the thrust reduction altitude (1,000 feet AGL). When 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

The VNAV commanded speed is limited by the current aircraft configuration. At acceleration height or altitude capture below acceleration height, VNAV initially commands a speed 5 knots below the flap placard speed for the current flap setting. When flaps are retracted, VNAV commands the speed displayed on the SPD TRANS line.

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, provided they are greater than transition speed or flaps up maneuver speed.

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. The commanded speed is magenta.

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

When 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.

When an altitude conflict exists between the FMS target altitude and the MCP selected altitude, RESET MCP ALT is displayed in the CDU help window. 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.

When the aircraft is below both the VNAV profile target altitude and the MCP altitude in CLIMB, the VNAV guidance captures the lower of the two altitudes.

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 displayed by selecting 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 selected, the page for the active performance mode is displayed. Selecting the **PREV PAGE** or **NEXT PAGE** key displays the pages for the inactive performance modes.

The CLB page, shown in 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. When the aircraft reaches the speed transition altitude, the title changes to ACT ECON CLB (or the selected climb mode).

Figure 5–1
CLB Page

The CLB page title displays the type of climb and includes the following:

● CLB – Indicates no cruise altitude has been entered or cruise or descent is active.

● MOD CLB – Indicates a lateral or vertical modification is pending and engine out has not been selected and either no cruise altitude has been entered or cruise or descent is active.

● EO CLB – Indicates engine–out mode has been selected and either climb is not active or engine out is the first valid climb segment and performance initialization is not complete.

● ECON CLB – Indicates the first valid climb segment is an economy segment and performance initialization is not complete.

● XXXKT CLB – Indicates the first valid climb segment is a specified Mach segment and performance initialization is not complete.

● M.XXX CLB – Indicates the first valid climb segment is a specified Mach and performance initialization is not complete.

● ACT EO CLB – Indicates engine–out is the active flight mode with a minimum drag speed climb (EO SPD) selected.

● MOD EO CLB – Indicates a modified flight plan exists and either engine–out mode has been selected and cruise or descent is active or an engine–out minimum drag segment is active.

● ACT ECON CLB – Indicates climb is the active flight mode with an economy speed (ECON) selected.

● MOD ECON CLB – Indicates a modified active flight plan exists and climb is the active flight mode with an economy climb speed (ECON) selected.

● .XXX/XXX CLB – Indicates the first valid climb segment is a specified Mach/CAS schedule and performance initialization is not complete.

● ACT XXXKT CLB – Indicates climb is the active flight mode and any of the following are true:

— A specified CAS climb speed is selected

— Takeoff is the active flight mode with the aircraft altitude less than acceleration altitude. XXX is equal to the following prior to VNAV engagement:

● V2+15 for aircraft speed less than V2+15

- Aircraft speed when the aircraft speed is between V2+15 and V2+25
- V2+25 for aircraft speeds greater than V2+25.

XXX is equal to the following after VNAV engagement:

- Aircraft speed when the aircraft speed is between V2+15 and V2+25
- Aircraft speed at time of engine fail limited from V2 to V2+15.

— Engine failure has been detected, but not verified, during VNAV takeoff and the aircraft is above the flap retraction altitude and performance is initialized. XXX is equal to the maneuvering speed for flaps zero.

- MOD XXXKT CLB – Indicates a modified flight plan exists and climb is the active flight plan mode and any of the following are true:

  — A specified CAS climb speed is selected

  — Takeoff is the active flight mode with the aircraft altitude less than acceleration altitude. XXX is equal to the following prior to VNAV engagement:

  - V2+15 for aircraft speed less than V2+15
  - Aircraft speed when the aircraft speed is between V2+15 and V2+25
  - V2+25 for aircraft speeds greater than V2+25.

  XXX is equal to the following after VNAV engagement:

  - Aircraft speed when the aircraft speed is between V2+15 and V2+25
  - Aircraft speed at time of engine fail limited from V2 to V2+15.

  — Engine failure has been detected, but not verified, during VNAV takeoff and the aircraft is above the flap retraction altitude. XXX is equal to the maneuvering speed for flaps zero.

- ACT M.XXX CLB – Indicates climb is the active flight mode with a specified Mach climb segment selected.

- MOD M.XXX CLB – Indicates a modified flight plan exists and climb is the active flight mode with a specified Mach climb segment selected.

- EO XXXKT CLB – The first valid climb segment is an engine–out specified CAS climb and performance initialization is not complete.

- EO M.XXX CLB – The first valid climb segment is an engine–out specified Mach climb and performance initialization is not complete.

- ACT MCP SPD CLB – Indicates climb is the active flight mode with an MCP specified climb selected.

- MOD MCP SPD CLB –Indicates a modified flight plan exists and climb is the active flight mode with an MCP specified climb selected.

- ACT LIM SPD CLB – Indicates climb is the active flight mode and an envelope limited speed climb segment is active.

- MOD LIM SPD CLB – Indicates a modified flight plan exists and climb is the active flight mode and an envelope limited speed climb segment is active.

- MOD .XXX/XXX CLB – Indicates a modified flight plan exists and the first valid climb segment is a CAS/MACH schedule and performance initialization is not complete.

- ACT EO XXXKT CLB – Indicates engine–out climb is the active flight mode with a specified CAS climb speed selected.

- MOD EO XXXKT CLB – Indicates a modified flight plan exists and engine–out climb is the active flight mode with a specified CAS climb speed selected.

- ACT EO M.XXX CLB – Indicates engine–out climb is the active flight mode with a specified Mach climb segment selected.

- MOD EO M.XXX CLB – Indicates a modified flight plan exists and engine–out is the active flight mode with a specified Mach climb segment selected.

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.

  The cruise altitude is changed by two methods:

  1. 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.

  2. 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 selecting 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 EO SPD speed is displayed in this line. 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. EO SPD is displayed when the climb segment speed mode is engine–out minimum drag.

  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. Valid CAS values range from 100 to 400 (inclusive) and valid Mach values range from .100 to .900 (inclusive).

  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 333 knots and a Mach of .850.

- **SPD TRANS (3L)** – The default speed transition displayed in 3L is the speed/altitude value defined in the NAV database (NDB) for the origin airport. When a default transition does not exist in the NDB, the default value is from the AMI.

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

  Deletion of 3L is permitted when a speed transition is displayed and results in invalidating the climb speed transition segment of the vertical profile.

- **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. Speed entries must be between 100 and 400 knots (inclusive) and less than or equal to the specified CAS climb speed (when one exists). Altitude entries must be at or above the current aircraft altitude and below the cruise altitude.

  Deletion of 4L is permitted when a speed restriction is displayed and results in invalidating the climb speed restriction segment of the vertical profile.

The header and data field are only displayed when a cruise altitude exists, an engine out mode has not been selected, and performance has been initialized. Otherwise 4L is blank.

See Procedure 5–1, later in this section, for an example how to enter a speed restriction.

- **ECON, EO SPD, ALL ENG (5L)** – ECON is displayed when the climb speed is not ECON and engine out has not been selected. Selecting ECON changes the climb speed target in 2L to ECON and deletes the speed restriction in 4L when the restriction speed is greater than the economy CAS.

  EO SPD is displayed when engine out has been selected and engine out speed is not the current engine–out climb target speed. Selecting EO SPD changes the climb speed mode to EO.

  ALL ENG is displayed when an engine failure has been detected but not verified. Selecting ALL ENG changes the climb speed mode to the climb mode active prior to engine out detection.

  The data field is blank when ECON is the current climb target speed or when a cruise altitude is not displayed.

- **ERASE (6L)** – The ERASE prompt is displayed when a modified active, pending activation lateral, or pending activation VNAV only vertical profile is displayed. Selecting the ERASE prompt erases all pending flight plan modifications.

- **AT XXXXX/HOLD AT XXXXX (1R)** (Not shown in Figure 5–1) – The field is blank when no restriction exists. When a constrained leg exists, which is not a holding pattern leg, AT XXXXX is displayed in the header. When a constrained leg exists, which is a holding pattern leg, HOLD AT XXXXX is displayed in the header.

  The next waypoint speed and altitude constraint are displayed in 1R. FMC commanded speeds and altitudes are displayed in magenta. FMC commands the slower of the constraint speed or performance speed.

  Constraints can only be entered on the RTE LEGS page. Entering a constraint in 1R is not permitted. Deletion of 1R while a constraint is displayed is permitted and results in the deletion of the constraint from the lateral route resulting in a flight plan modification. Constrains can also be deleted on the RTE LEGS page.

- **ERROR (2R)** (Not shown in Figure 5–1) – The field is blank when no error exists. The ERROR header and associated data field is displayed when the following are true:

  — Performance predications are valid
  — 1R displays a constrained leg
  — The undershot error is predicted to be 200 feet or more low
  — The distance error is predicated to be 1 NM or more long
  — A climb waypoint constraint exists.

  When the ERROR header is displayed, the data field displays the low and long predications as XXXXLOYYLONG (for example 350LO 2LONG) where XXXX represents the undershoot error in feet and YY represents the distance error in NM.

  The undershoot error has a range of 200 through 9,999 feet, rounded to the nearest 10 feet. The distance error has a range of 1 through 99 NM rounded to the nearest 1 NM.

- **TRANS ALT (3R)** – The transition altitude is displayed in 3R in feet mean sea level (MSL). The power–up default is 18,000 feet. The default value can be overwritten by pilot–entry at any time.

  The transition altitude is automatically changed when a departure procedure with a stored transition altitude is executed and a pilot–entered value has not already be entered.

  When no transition altitude is associated with the departure procedure or when no departure procedure is entered, the transition altitude defaults to that defined in the NDB for the origin airport.

  The climb transition altitude returns to the default value of 18,000 feet after a long–term power interruption or flight completion.

- **MAX ANGLE/MAX ALT (4R)** – The header displays MAX ANGLE when performance has been initialized and the engine–out mode has not been selected. MAX ANGLE displays the current flaps up maximum angle climb speed. This speed can be copied into the scratchpad and entered in 2L to initiate a maximum angle climb. Entry is not permitted into this field. See Procedure 5–2, later in this section, for an example how to enter a maximum angle climb.

  The header displays MAX ALT when performance has been initialized and engine–out mode has been selected. MAX ALT displays the maximum engine out altitude. This altitude can be copied into the scratchpad and entered in 1L to change the cruise altitude. Entry is not permitted 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/ALL ENG (5R)** – The header displays ENG OUT when engine out mode has not been selected for the vertical profile or engine failure has been detected but not verified.

Selecting the ENG OUT prompt when climb is active and the ENG OUT maximum altitude is above the current altitude, results in a single engine minimum drag climb segment to the cruise altitude and a flight plan mod.

Selecting the ENG OUT prompt when climb is active, the aircraft is below the speed transition altitude, and the speed transition has not been deleted, results in a speed transition climb to the speed transition altitude and a flight plan mod.

Following the selection of the ENG OUT prompt, the cruise altitude is lowered to the engine out minimum drag cruise maximum altitude when that altitude is less than the current cruise altitude. When the current altitude is above the ENG OUT maximum altitude, the EO SPD D/D page is displayed. Selection of the ENG OUT prompt invalidates the speed restriction in 4L.

The header displays ALL ENG when performance has been initialized and engine out mode has been selected. Selecting 5R with the ALL ENG prompt displayed cancels the engine out mode and results in an economy mode with performance and guidance based on all engine operation.

● **CLB DIR> (6R)** (Not shown in Figure 5–1) – 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 FMC cruise altitude. Selecting CLB DIR and the **EXEC** key deletes all the climb constraints at waypoints between the current altitude and less than the MCP altitude. Altitude constraints at the MCP altitude are retained.

When the constraint to be deleted is a window constraint and only one of the two altitudes comprising the window constraint is below the MCP altitude, only that portion of the altitude window is deleted.

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

Procedure 5–1 describes the steps to enter a speed restriction.

Step	Procedure 5–1 Entering a Speed Restriction
1	To enter a speed restriction of 280 knots at 12,000 feet, enter 280/12000 in the scratchpad, as shown in Figure 5–2.

Figure 5–2
Entering a Speed Restriction

Step	Procedure 5-1 Entering a Speed Restriction (cont)
2	Select 4L to enter the speed restriction in the SPD RESTR field to create the modification, as shown in Figure 5-3. **Figure 5-3** **Entering a Speed Restriction – MOD**
3	Select the **EXEC** key to execute the modification. The resulting display is shown in Figure 5-4. **Figure 5-4** **Entering a Speed Restriction – ACT**

Procedure 5–2 describes the steps to enter a maximum angle climb.

Step	Procedure 5-2 Entering a Maximum Angle Climb
1	On the climb page, select 4R to copy 257 into the scratchpad, as shown in Figure 5–5. **Figure 5–5** **MAX ANGLE Entry**
2	Select 2L to enter this value as a selected speed. This creates a modification, as shown in Figure 5–6. **Figure 5–6** **MAX ANGLE Entry – MOD**

Step	Procedure 5–2 Entering a Maximum Angle Climb (cont)
3	Select the **EXEC** key to execute the modification. The resulting display is shown in Figure 5–7.

Figure 5–7
MAX ANGLE Entry – ACT

ENGINE FAILURE ON TAKEOFF AND CLIMB

If an engine failure occurs when the aircraft is at acceleration height or altitude capture below acceleration height, then VNAV commands an acceleration to flaps–up maneuver speed (limited by flap placard). When the **VNAV** key is selected, the ACT XXXKT CLB page is displayed, where XXX is the flaps–up maneuver speed. T/O ENGINE OUT is displayed in the CDU help window to advise an engine failure has been detected by the FMC.

If an engine failure occurs when the flaps are not 0° and an engine out standard instrument departure (EO SID) exists in the FMC database, then the EO SID is loaded as a flight plan modification. The modification can either be executed or erased.
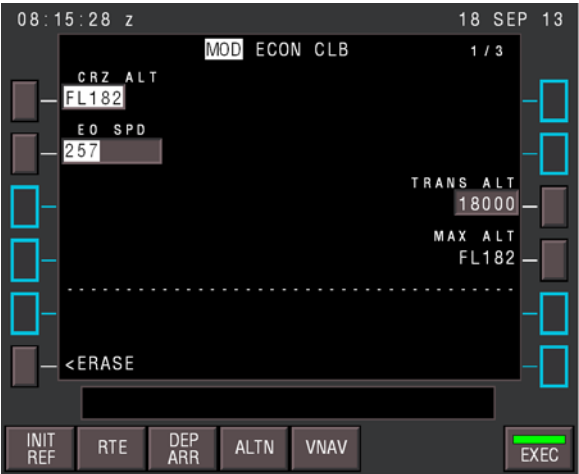
If an engine failure occurs when the aircraft has accelerated to the commanded flaps–up maneuver speed, then the thrust is automatically reduced from TO to CON (continuous) thrust. If an engine failure occurs above the thrust reduction point, the current climb thrust is maintained.

If engine failure occurs during a VNAV climb, the VNAV CLB page, shown in Figure 5–8, can be selected by the pilot to verify with the FMC an engine failure has occurred.

Figure 5–8
ENG OUT Prompt

Procedure 5–3 describes the step to verify an engine failure with the FMC.

Step	Procedure 5–3 Verify an Engine Failure
1	Select the ENG OUT prompt (5R). The ENG OUT prompt selects the engine out mode and creates a modification, as shown in Figure 5–9.

Figure 5–9
MOD ECON CLB Page

Step	Procedure 5–3 Verify an Engine Failure (cont)
2	Selecting the **EXEC** key executes the modification. The resulting display is shown in Figure 5–10.

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

Figure 5–10
ACT EO Page

CLIMB PROFILE

The normal default climb profile is a 250-knot climb to 10,000 feet, 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. When flaps are extended, the 250-knot climb is limited by the maximum speed permitted for flaps selected (LIM SPD CLB). The UNABLE NEXT ALT message is displayed when the aircraft cannot make the next defined constraint using the current mode, such as ECON.

Figure 5-11 illustrates a climb profile. In this example, the 18000A (AT OR ABOVE) constraint is not possible with ECON speed and the UNABLE NEXT ALT message is displayed when crossing the 6,000 feet constraint.
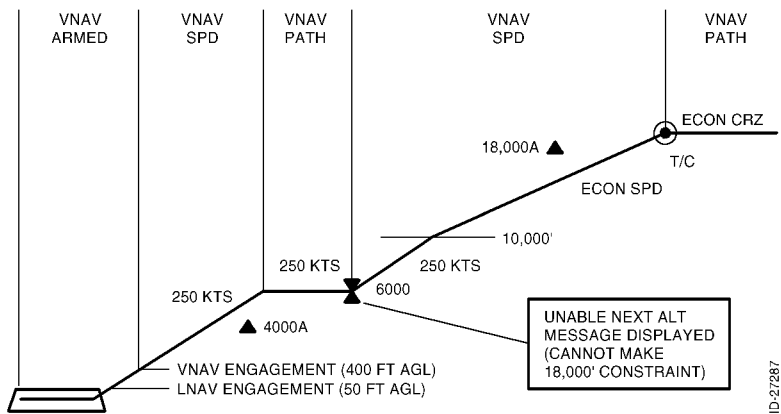
Figure 5-11
Climb Profile

CLIMB PERFORMANCE CHANGE

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

As an example, to climb at 320 knots, enter 320 in the scratchpad and select 2L to enter the modified speed. Selecting the **EXEC** key activates the new speed. The page title changes to ACT 320 KT CLB and the header line in 2L changes to SEL SPD, as shown in Figure 5–12.
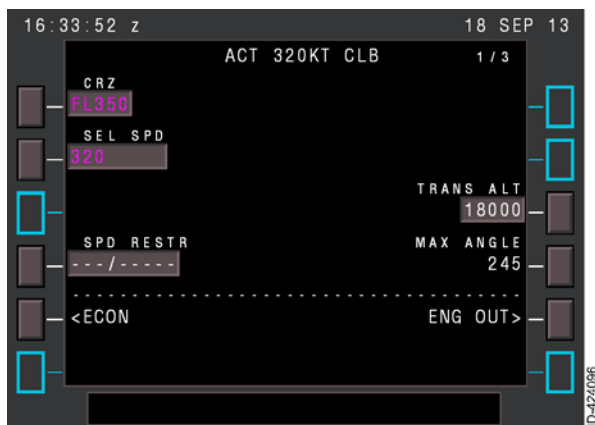
Figure 5–12
Climb Page – SEL SPD

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 RTE LEGS pages of an active route is the waypoint that the aircraft is navigating to. It is also referred to as the active waypoint. Selecting the **LEGS** key displays the ACT RTE LEGS page shown in Figure 5-13.
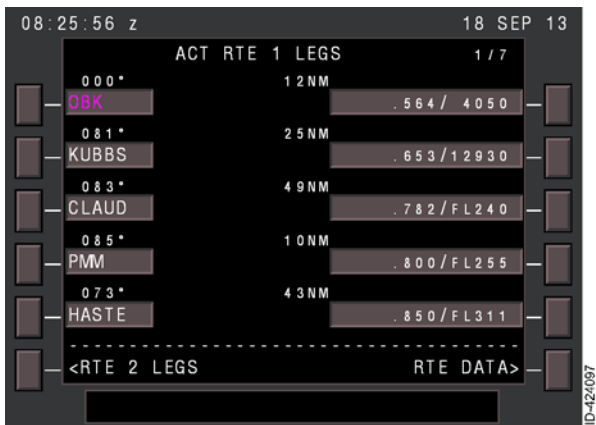
Figure 5-13
ACT RTE LEGS Page

The active waypoint in Figure 5-13 is OBK (Northbrook). The calculated distance-to-go to the active waypoint is 12 NM. This distance is dynamic. The FMS predicts the aircraft will cross over OBK at .564 Mach and 4,050 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.

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

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

Selecting RTE DATA in 6R displays the RTE DATA page. RTE DATA is displayed in 6R when the ND is in map mode. When the ND is in plan mode, a STEP prompt is displayed in 6R on the RTE LEGS page which cycles through the route segments.

Route Data

Each RTE LEGS page has a corresponding RTE DATA page, shown in Figure 5-14, that is displayed by selecting 6R (RTE DATA) on the RTE LEGS page. The RTE DATA page displays progress data for each waypoint on the RTE LEGS page.

Figure 5-14
RTE DATA Page

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

The RTE DATA page is described in the following paragraphs.

- **ETA (1L through 5L)** – The FMC-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 RTE LEGS page.

- **FUEL (1C through 5C)** – The FMC-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 selecting the associated right LSK. W next to the caret indicates that wind data has been entered for the waypoint.

- **<LEGS (6L)** – Selecting 6L displays the RTE LEGS page.

- **REQUEST> (6R)** – Selecting 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.

WIND PAGE

Selecting 3R (WIND) in Figure 5–14 displays the WIND page for CLAUD shown in Figure 5–15.
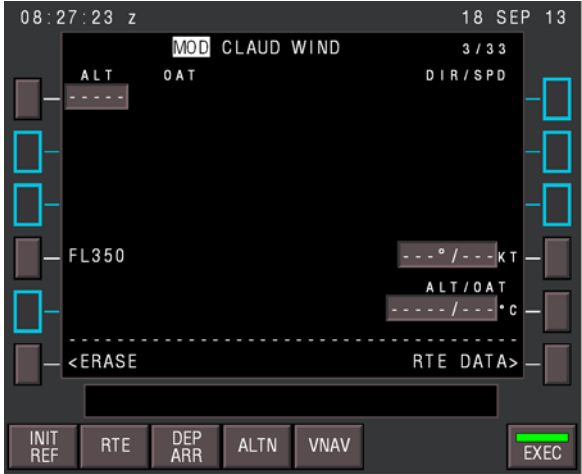
Figure 5–15
CLAUD WIND Page
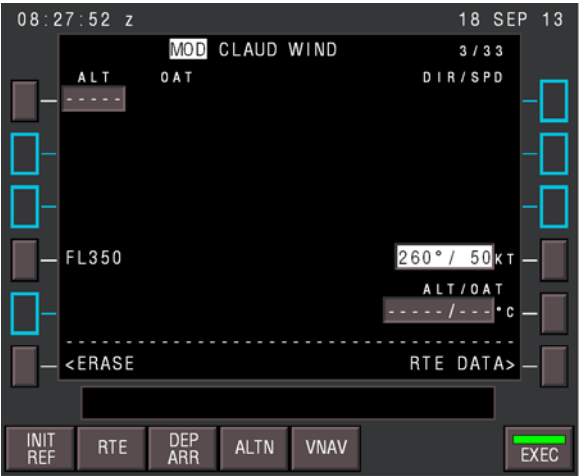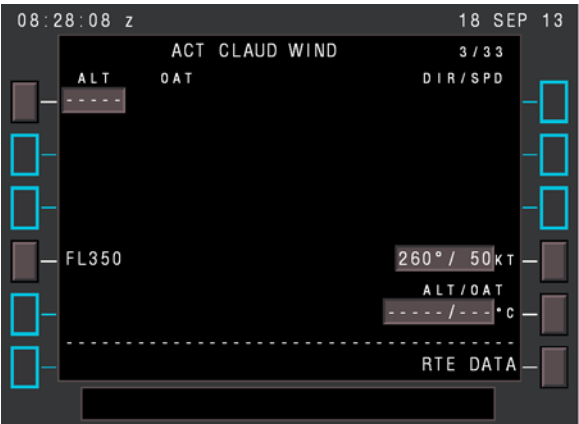
Forecast winds and temperatures at selected altitudes for specific waypoints can be entered on the WIND page to enhance VNAV performance and predictions.

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 when 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.

Procedure 5–4 describes the steps for entering winds at altitude. For this example, at the CLAUD intersection, wind is entered at FL350 as 260 degrees and 50 knots.
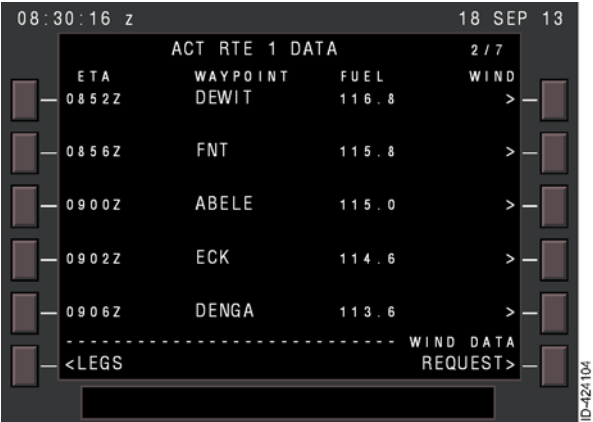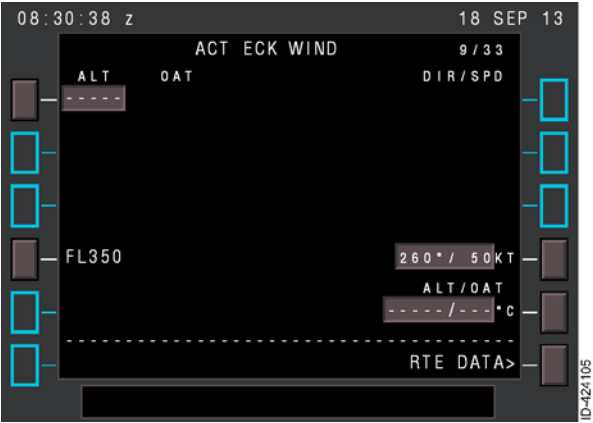
Step	Procedure 5–4 Altitude Wind Entry
1	To enter wind data for FL350, enter 350 in the scratchpad and select 1L. The resulting display is shown in Figure 5–16. **Figure 5–16 MOD CLAUD WIND – FL350**

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Takeoff and Climb
5-23

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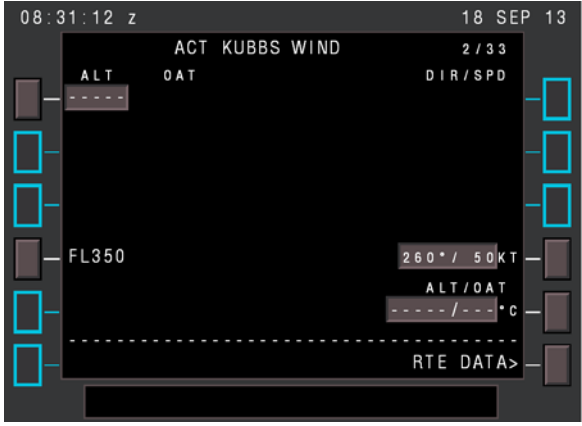
Step	Procedure 5–4 Altitude Wind Entry (cont)
2	Enter 260/50 in the scratchpad and select 4R. The resulting display is shown in Figure 5–17.

Figure 5–17
Wind Direction/Speed Entry

Step	Procedure 5–4 Altitude Wind Entry (cont)
3	Select the **EXEC** key. This activates the wind inputs, as shown in Figure 5–18.

Figure 5–18
ACT CLAUD WIND

The WIND page can also be used to check the propagated wind values. Procedure 5–5 describes the steps to check the propagated wind values for the waypoint PECK (ECK).

Step	Procedure 5-5 Checking Propagated Wind Values
1	Select 6R (RTE DATA) on the ACT CLAUD WIND page in Figure 5–18. The ACT RTE 1 DATA page shown in Figure 5–19 is displayed. The W at 3R indicates that wind data has been entered for CLAUD. ![ACT RTE 1 DATA Page screen] **Figure 5–19** **ACT RTE 1 DATA Page**

Step	Procedure 5-5 Checking Propagated Wind Values (cont)
2	Select the **NEXT PAGE** key to display the downpath waypoints, as shown in Figure 5-20. **Figure 5-20 ACT RTE 1 DATA – 2/7 Page**
3	Select 4R on to display the ACT ECK WIND page. The resulting display is shown in Figure 5-21. **NOTE:** The propagated wind at FL350 is displayed in small font in 4R (260°/50KT). **Figure 5-21 ACT ECK WIND**

Step	Procedure 5–5 Checking Propagated Wind Values (cont)
4	To check backward wind propagation to the waypoints between CLAUD and the aircraft present position, select 6R (RTE DATA) on the ACT ECK WIND page.
5	Select the **PREV PAGE** key to display the ACT RTE 1 DATA page 1/7.
6	Select 2R to display the WIND page for KUBBS, shown in Figure 5–22. **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 (260°/50KT). **Figure 5–22** **ACT KUBBS WIND Page**

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

- When 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 5L are not permitted.

- 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.

- The altitude on a wind page must 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.

- When 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 proceeded by an altitude and a slash (/). OAT entries range from –99 to 60, inclusive.

- 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.

- When waypoint OAT entries are not made, standard daytime temperatures are used.

Climb Airspeed/Altitude Constraints

When vertical altitude constraints are entered or deleted during the climb phase of flight, the FMC 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 FMC 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

Specified constraints can be entered 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 feet. At or below 15,000 feet is inserted in the flight plan as a constraint by entering 15000B in the scratchpad and selecting 2R (KUBBS). After this is done, the modification must be executed by selecting the **EXEC** key. The resulting display is shown in Figure 5–23.
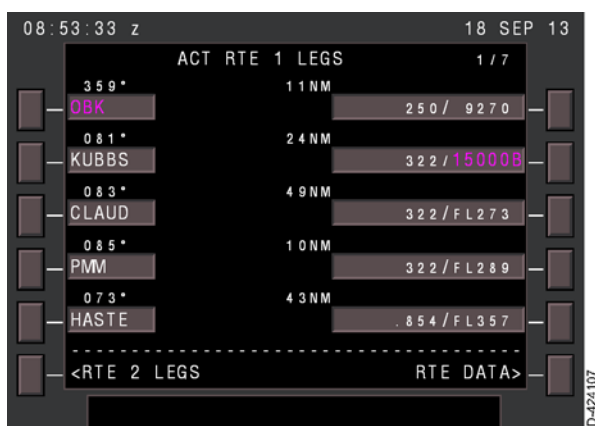
Figure 5–23
Altitude Constraint Entry

An AT constraint is entered using only the altitude number (no A or B suffix). A block altitude constraint in a climb is entered using the lower altitude constraint first followed by an A, then the higher altitude constraint followed by a B. For example, a block altitude constraint between FL210 and FL230 during a climb is entered as 210A230B. The reverse order is used for a descent.

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. When in a climb and a constraint is entered with an altitude below the aircraft, the entry is accepted and, when 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 feet, and once the aircraft sequences KUBBS, continues climbing to FL350.

AIRSPEED CONSTRAINTS

Airspeed constraints can be inserted 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 permitted), and select the right LSK for the constrained waypoint, and then select 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 permitted and INVALID ENTRY is displayed in the CDU help window.

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 can be entered on the RTE LEGS pages and RTE HOLD pages (for holding patterns). Constraints associated with an entered departure or arrival procedure are inserted into the route when 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 can also delete constraints in a route.

- Entry format is important when entering both an airspeed and an altitude constraint. Entries 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 can 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.

- Climb airspeed entries are only permitted in three-digit CAS format from 100 to 400 knots. Valid entries for cruise speed targets are only permitted in Mach and range from .400 through .990, inclusive, followed by a slash. Other possible cruise speed targets are E for economy, L for long–range cruise, and R for RTA, followed by a slash. Constant cruise speed segments are described in detail in Section 6, Cruise.

- Altitude entries of less than 1,000 feet must be preceded with zeros. A minimum entry of at least four digits is required (i.e., 800 feet is entered as 0800). Negative altitude entries must be entered as –NNNN, (minimum of –1,000 feet). Altitude constraint entries must be lower than the CRZ ALT (they can be equal to the CRZ ALT only when 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 CDU help window 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 when an altitude only constraint is entered.

When 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.
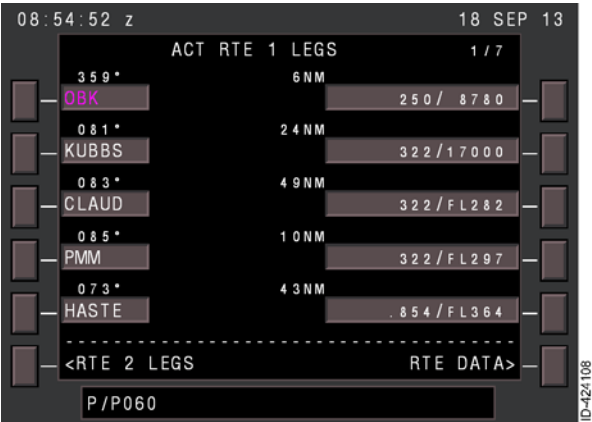
Constraints can be deleted with the **DEL** key. Dashes, boxed, predicted values, and altitude terminations cannot be deleted and INVALID DELETE is displayed in the CDU help window. Deleting a constraint displays dashes in the constraint field. The dashes are then replaced by new predicted values.
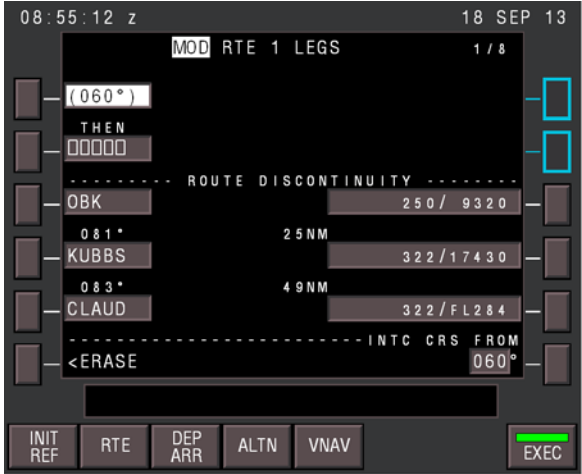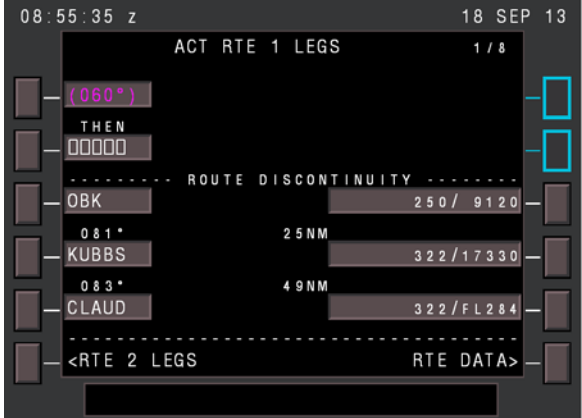
Rules for airspeed/altitude constraints in the CRUISE, DESCENT, and APPROACH flight phases are described in the proper sections.

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.

Procedure 5–6 describes how to intercept a course using the present/position (P/P) feature.

Step	Procedure 5–6 Intercepting Course Using Present/Position Feature
1	Enter P/P (for present position) and the outbound course in the scratchpad. For this example, enter P/P060 in the scratchpad, as shown in Figure 5–24.

Figure 5–24
Present Position Entry

Step	Procedure 5-6 Intercepting Course Using Present/ Position Feature (cont)
2	Select 1L. The resulting display is shown in Figure 5–25.

Figure 5-25
Present Position – MOD

Step	
3	Selecting **EXEC** key displays Figure 5–26. 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.

Figure 5-26
Intercept With 060 Course

Step	Procedure 5-6 Intercepting Course Using Present/ Position Feature (cont)
4	Complete the remaining steps to comply with the ATC clearance to intercept the airway and proceed on course to KUBBS. Select 4L to downselect KUBBS to the scratchpad.
5	Select 2L to enter KUBBS into the box prompts, as shown in Figure 5–27.
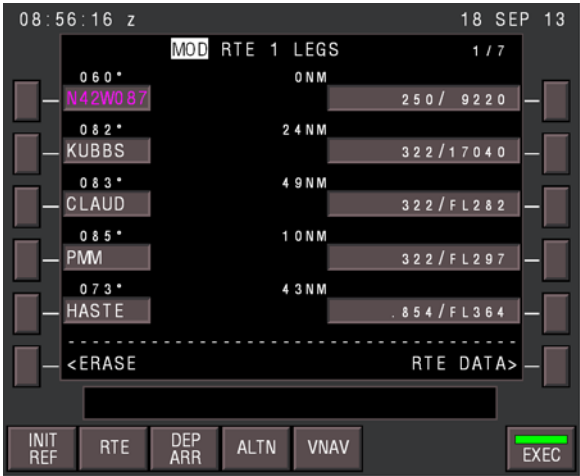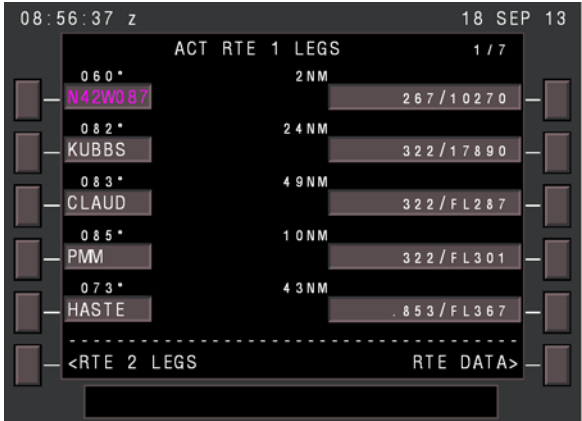
Figure 5–27
Present Position Waypoint

Step	Procedure 5-6 Intercepting Course Using Present/Position Feature (cont)
6	Selecting the **EXEC** key displays Figure 5-28.

Figure 5-28
Latitude/Longitude – Active Waypoint

The FMS creates a waypoint latitude/longitude at the intercept point on the airway inbound to KUBBS. The route discontinuity was removed with the previous steps.

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Takeoff and Climb

5-35

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6.   Cruise

INTRODUCTION

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 can 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 selecting the **VNAV** key when the FMS is in the cruise phase. When the cruise phase is inactive, the CRZ page is page 2/3 of the vertical navigation pages and is displayed by selecting either the **PREV PAGE** or **NEXT PAGE** key after the **VNAV** key has been selected.

The cruise page is automatically selected when the FMS transitions from climb to cruise when 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. The cruise page gives a way to evaluate the effect of fuel and time to destination with changes (MODs) in the cruise mode or the cruise altitude as well as changes in the lateral flight plan.

To display the cruise page, shown Figure 6–1, select the **VNAV** key after the FMS has transitioned to the cruise flight phase.

```
09:04:57 z                          18 SEP 13
                    ACT ECON CRZ         2/3
         CRZ ALT                     STEP TO
         FL350                        FL390
         ECON SPD                          AT
         .854                    0912z/  56NM

                               EGLL ETA/FUEL
                                 1740z/ 39.3
         STEP           OPT    MAX    RECMD
         ICAO          FL382  FL390  FL390
         ...........................
                                    ENG OUT>

        <RTA PROGRESS                   LRC>
```
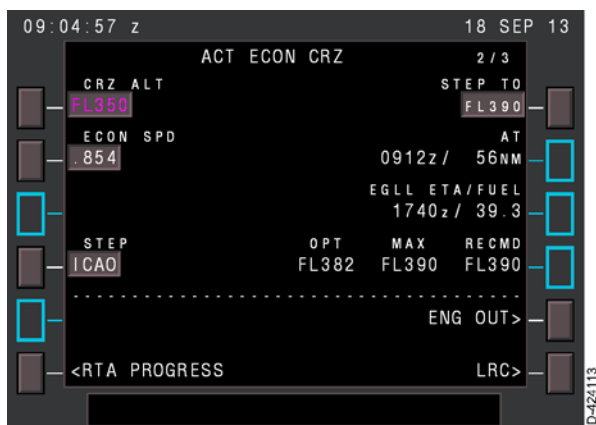
**Figure 6–1
ACT ECON CRZ Page**

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 when controlling to a fixed speed and M.XXX is displayed when controlling to a fixed Mach.

- ECON CRZ is displayed when the speed is based on cost index.

- ECON CRZ CLB or CRZ DES is displayed when cruise climb or descent with ECON is selected.

- LRC CRZ is displayed when long–range cruise is selected.

- LRC CRZ CLB or DES is displayed when cruise climb or descent with LRC is selected.

- RTA CRZ is displayed when required time of arrival (RTA) cruise is selected.

- RTA CRZ CLB or DES is displayed when cruise climb or descent with RTA is selected.

- MCP SPD CRZ is displayed when speed intervention is selected on the MCP.

- EO CRZ is displayed when engine out mode is selected. CO CRZ is displayed when a company specified engine out cruise speed is selected.

- EO D/D is displayed if engine out mode is selected with the current aircraft altitude is greater than the maximum altitude for engine out performance.

- LRC D/D (drift down) is displayed if engine out mode is with LRC is selected.

- EO LRC CRZ is displayed after descending to engine out maximum altitude.

- LIM SPD CRZ is displayed when an envelope limited cruise speed is active.

- LIM SPD CRZ CLB or DES is displayed when cruise climb or descent with an envelope limited cruise speed is active.

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.

  Changing the MCP altitude and pushing the altitude selector enters the MCP altitude as the active cruise altitude, without creating a modification.

  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 CDU help window. When a cruise altitude is entered that is greater than the performance computed maximum altitude (including engine out conditions), the entry is accepted and MAX ALT FLXXX is displayed in the CDU help window.

  NOTE: A cruise altitude entry above the maximum altitude deletes the fuel predictions on the PROGRESS page 1/4 for all waypoints in the flight plan. However, entering a waypoint other than a flight plan waypoint in 3L on the PROGRESS page 1/4 displays time and fuel predictions direct to the waypoint, 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.

When transitioning into a missed approach, the highest altitude constraint in the missed approach procedure is automatically entered as the new cruise altitude.

- **Speed Line (2L)** – The cruise speed target for the current leg of the cruise flight phase is displayed in 2L. The target speed or Mach is displayed in magenta. The header line displays ECON SPD when the speed mode is economy cruise. 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. RTA id displayed when the speed mode when an RTA time and fix is entered on the RTA PROGRESS page.

  EO SPD is displayed when the speed mode is engine out minimum drag cruise speed. 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.

  The data field displays three dashes when economy or RTA is the cruise mode and performance initialization is not complete. The header field is blank when no cruise altitude is displayed in 1L or descent is the active flight mode.

- **TPR/N1 (3L)** – The header line displays TPR when Rolls Royce engines are installed. The header line displays N1 when General Electric engines are installed. The target TPR 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 cruise is not the active flight mode.

- **STEP SIZE (4L)** – The step size for the climb increment used for planning an optimum step climb profile is displayed in 4L. The default step climb is displayed as ICAO. The pilot can enter step size as 0 or a four–digit multiple of 1000 between 1,000 and 9,000. Deletion of a manual entry defaults back to ICAO. The step size value is propagated from the PERF INIT page.

  When no step climbs are intended for the remainder of the flight, entering 0 for the step size is important to make performance calculations the most fuel efficient solution and make accurate fuel predictions. Otherwise, performance calculations assume the computed optimum steps are made, possibly resulting in non–conservative predictions of fuel at the destination.

  NOTE: When step climbs are displayed, the FMS fuel predictions are based on the step climbs made at the correct points.

- **ECON, RTA/ECON, or CO SPD (5L)** (Not shown in Figure 6–1) – The ECON prompt is displayed when an RTA waypoint is not in the flight plan and economy is not the cruise speed target. The ECON prompt selects economy cruise speed and ECON SPD is displayed in 2L.

  The RTA/ECON prompt is displayed when an RTA waypoint is in the flight plan and RTA is not the cruise speed target. The RTA/ECON prompt selects the RTA speed mode and displays the ECON prompt.

  The CO SPD prompt is displayed when an engine out has been selected and the company policy engine out speed is not the cruise speed. The CO SPD prompt selects the company policy engine out defined cruise speed defined in the AMI.

  The 5L data field is blank when a cruise altitude has not been entered or descent is the active flight plan mode.

- **EO SPD/ERASE/RTA PROGRESS (6L)** (Not shown in Figure 6–1) – The EO SPD prompt is displayed when engine out has been selected and engine out minimum drag is not the current cruise speed. Selecting the EO SPD prompt changes the cruise speed mode to engine out minimum drag and results in a flight plan modification.

  The ERASE prompt is displayed in 5L when a vertical or lateral flight plan modification is pending. Selecting the ERASE prompt erases the pending modification.

  The RTA PROGRESS prompt is displayed when a modified active or pending active route does not exist and engine out SEL SPD, engine out CO SPD, or engine out LRC is not active. Selecting the RTA PROGRESS prompt displays the RTA PROGRESS 3/4 page.

- **STEP TO (1R)** – An altitude can be entered for step climb evaluation and the FMC displays the results on this page and the PROGRESS page.

  When the step size is ICAO, the STEP TO altitude is the next higher altitude above the OPT altitude (displayed in 4C) corresponding to the direction of flight.

  When the step size is an altitude increment, the STEP TO altitude is the next higher above the OPT altitude calculated by adding the STEP SIZE increment to the FMC CRZ ALT.

  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. Pilot–entry is not permitted when a step altitude has been entered on the RTE LEGS page, an altitude entry is less than or equal to the cruise altitude, or when the step size in 4L is 0.

This field is blank when there is no active flight plan, within 200 NM of the top–of–descent point, within 500 NM of the destination, or an engine out driftdown is in progress. The field is also blank when 0 has been entered in 4L (STEP SIZE).

Step to altitudes can also be entered at waypoints on the RTE LEGS page by entering the step altitude followed by S in the scratchpad (for example, 19000S) and selecting right field of the corresponding waypoint and selecting the **EXEC** key. These altitudes can be higher or lower than the cruise altitude.

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, shows a cruise altitude of FL350 (1L) selected at takeoff and an OPTIMUM ALTITUDE of FL382 (4C). The STEP TO altitude is FL390 (1R).

- **AT, AVAIL AT, TO T/D, TO FLXXX, (2R)** – AT is displayed in the header when an altitude is displayed in 1R which is not derived from a specified step point. When AT is displayed in the header, the estimated time of arrival (ETA) and distance–to–go (DTG) to the optimum step point are displayed in 2R. NOW is displayed in the data field when a recommended step to point has passed. NONE is displayed in the data field when the step climb computation has determined that an optimum step climb does not exists.

  The header displays AVAIL AT when the next step altitude has been propagated from a step altitude entry on the RTE LEGS page and the step to the specified altitude cannot take place within 5 NM of the associated flight plan fix due to thrust or buffet limit. ETA and DTG to the point at which the step altitude in 1R can be achieved is displayed in the data fields. NOW is displayed in the data field when a recommended step to point has passed. NONE is displayed in the data field when the step climb computation has determined that an optimum step climb is not advisable.

  The header displays TO T/D within 200 NM of the top–of–descent point or within 500 NM from the destination. ETA and DTG are displayed in the data field which represent time and distance to the top–of–descent.

  The header displays TO FLXXX, where XXX represents the cruise flight level, when engine out driftdown is the active flight mode, the aircraft is more than 200 NM from the TOD and more than 500 NM from the destination, predications to the level at point are valid and an active flight plan exists. ETE and DTG to the level at point are displayed in the data field.

The header and data fields are blank when the cruise altitude has not been entered or descent is the active flight mode.

- **Destination ETA/FUEL (3R)** – The ETA 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. When there are planned steps on the RTE 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.

    ETA/FUEL W/MOD is displayed when a route modification is pending.

- **OPT Altitude (4C)** – 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.

    NOTE: The header and data fields are blank when RTA is the CRZ target speed.

- **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.

    NOTE: The header and data fields are blank when RTA is the CRZ target speed.

- **RECMD (4R)** – The recommended cruise flight level in 4R takes into account wind when computing cost to cruise and provides information to the flight crew to make a decision to make a step climb or step descent.

    The recommended flight level can be any flight level in the present step altitude schedule up to the maximum altitude and down to 9,000 feet below the current FMS cruise altitude.

    NOTE: The header and data fields are blank when RTA is the CRZ target speed.

- **ENG OUT/ALL ENG > (5R)** – ENG OUT is displayed when performance has been initialized and engine out mode has not been selected for the vertical profile. Selecting the ENG OUT prompt results in a flight plan MOD until the **EXEC** key is selected.

  During cruise, selecting the ENG OUT prompt and selecting the **EXEC** button results in the following:

  — Lowers the cruise altitude to the engine–out minimum drag cruise maximum altitude when that altitude is less than the cruise altitude. The cruise altitude is displayed in magenta.

  — Displays the LRC D/D page when the current altitude is above the ENG OUT maximum altitude.

  — Selects the engine–out minimum drag climb speed (EO SPD) as the cruise speed and displays the EO SPD in magenta.

  — Changes the cruise mode and altitude based on aircraft position relative to the engine–out minimum drag speed and long–range cruise maximum altitudes.

  — Deletes all cruise speed targets from the active route.

  NOTE: Selecting the ENG OUT prompt during a descent has no effect on the cruise altitude or cruise mode.

  ALL ENG is displayed when performance has been initialized and engine–out mode has been selected for the active vertical profile. Selecting the ALL ENG prompt and the selecting **EXEC** key results in a transition to economy cruise mode.

- **LRC> (6R)** – Selecting the LRC prompt and selecting the **EXEC** key results in changing the cruise speed mode to long–range cruise or engine–out long–range cruise, dependent on whether engine–out mode has been selected. Selecting the LRC prompt results in a flight plan MOD until the **EXEC** key is selected.

  The LRC prompt is not displayed when a cruise altitude has not been entered or when descent is the active flight mode.

Engine Failure En Route

Engine out VNAV guidance is displayed on the EO CRZ or EO D/D page, shown in Figure 6–2. Engine out FMC–calculations for cruise altitude, speed, and optimum and maximum engine out altitudes are displayed on this page. Engine out data is also available with both engines operating by selecting the ENG OUT prompt (5R) on the CRZ page followed by the **EXEC** key.
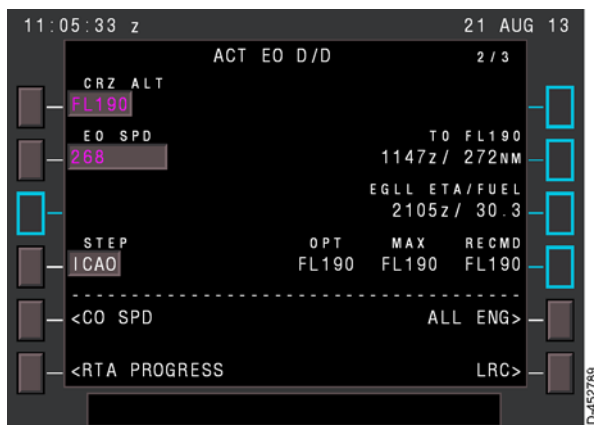
Figure 6–2
ACT EO D/D Page

When above the maximum engine out cruise altitude, VNAV calculates engine out guidance for driftdown (EO D/D). The EO D/D page changes to EO CRZ when reaching the engine out cruise altitude.

As the airplane gross weight decreases, the maximum altitude increases. A step climb may be possible under these conditions. Subsequent engine out cruise climb or descent is accomplished the same as two–engine cruise climb or descent.

The engine out page is described in the following paragraphs:

● **CRZ ALT (1L)** – The altitude from the MAX ALT line (4R) is displayed when the current cruise altitude is above the MAX ALT. Manual entry of an altitude above the maximum engine out altitude results in MAX ALT FLXXX being displayed in the CDU help window. Valid entries are the same as the all engine cruise page.

● **EO SPD (2L)** – The engine out target speed or Mach is displayed in magenta. Manual entries are permitted and valid entries are the same as the all engine cruise page. Manual entries display SEL SPD in the header and selecting any speed displays the EO SPD prompt in 6L.

- **CO SPD (Company Speed) (5L)** – Selecting the CO SPD prompt modifies the page with company speed and engine out data from the Airline Policy page.

- **OPT MAX RECMD (4C and 4R)** – The optimum, maximum, and recommended engine out altitudes are displayed in 4C and 4R under the OPT, MAX, and RECMD headers. OPT displays the optimum altitude based on the aircraft gross weight and speed displayed on the speed line.

  MAX displays the maximum cruise altitude based on the current gross weight, engine out operation, selected speed, disregarding any altitude or speed constraints, and a climb rate of 100 feet per minute.

  RECMD displays the most economical altitude to fly based on aircraft gross weight and cruise winds.

- **ALL ENG (5R)** – Selecting the ALL ENG prompt displays a MOD XXX CRZ page with performance based on both engines operating. Selecting the **EXEC** key permits subsequent selection of two engine economy VNAV modes.

- **LRC (6R)** – Selecting the LRC prompt enables engine out long–range cruise. The LRC prompt is displayed when EO, CO SPD, or SEL SPD is the active speed mode.

Route Copy

The route copy function permits 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, shown in Figure 6–3, 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 in 1L. Selecting the RTE COPY prompt copies the active route into the alternate route and replaces the RTE COPY prompt with RTE COPY COMPLETE.
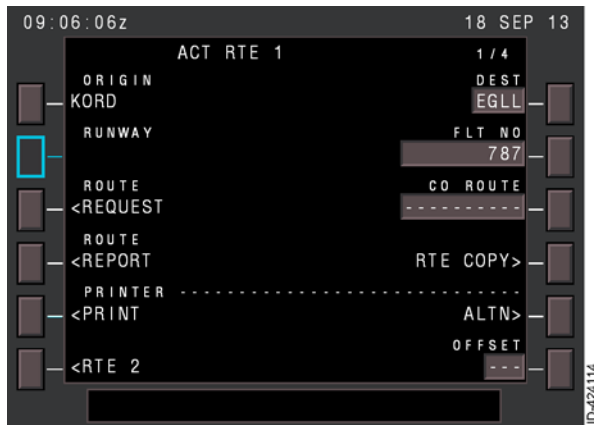
Figure 6–3
Copying the Route

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.

Selecting 4R (RTE COPY), shown in Figure 6–3, copies the active route into the alternate route. Figure 6–4 shows the route copy complete at 4R (RTE COPY COMPLETE).

Figure 6–4
Route Copy – Complete

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

- **RTE COPY> (4R)** – Selecting 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)** – RTE 1 is displayed on the ACT RTE 2 page and RTE 2 is displayed on the ACT RTE 1 page. Selecting 6L on the ACT RTE page displays the copied route on the correct page (RTE or RTE 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:

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

- When the original fix is a latitude/longitude waypoint, then a new latitude/longitude waypoint is created abeam the original point.

- When the original fix is a PBD, a new PBD is created abeam the NAV database fix of the original PBD.

- When the original fix was a latitude/longitude reporting point, the latitude/longitude 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).

When an abeam waypoint is within 100 NM of the original waypoint, previously entered wind for a specified altitude are retained. However, altitude or speed constraints are not retained for the created abeam waypoints.

Abeam waypoints are not generated when the distance from the original waypoint to the abeam waypoint is more than 700 NM, except for the recreating of latitude/longitude reporting points. The abeam distance limit exceedance for a given waypoint does not result in waypoints downstream to be ignored when they meet the distance requirement.

Abeam waypoints are created starting at the first waypoint to the last waypoint up to but not including the missed approach point.
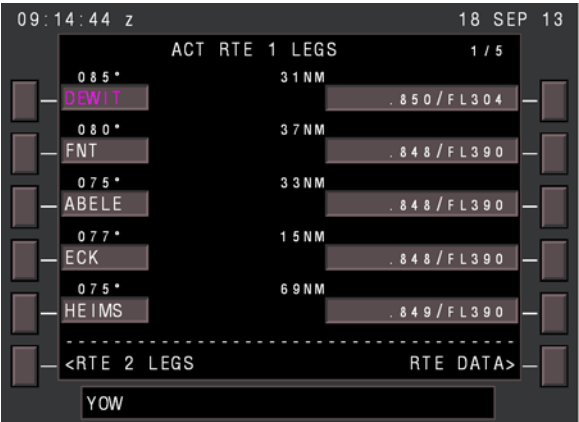
The abeam point function is accessed after a direct-to entry. Figure 6-5 shows the aircraft location on the active route for the flight from KORD to EGLL. The ACT RTE 1 LEGS page shows the aircraft 40 NM from the active waypoint **HASTE**.
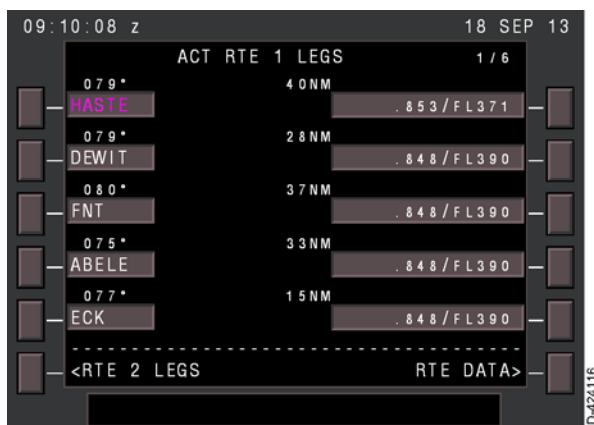
Figure 6-5
ACT RTE 1 LEGS Page

ATC has issued a clearance, from over HASTE cleared direct to OTTAWA (YOW). Procedure 6-1 describes the steps in creating abeam waypoints.

Step	Procedure 6-1 Abeam Point
1	Select the **NEXT PAGE** key to display the ACT RTE 1 LEGS 2/6 page.
2	Select 3L (YOW) to copy YOW into the scratchpad.
3	Select the **PREV PAGE** key to display the ACT RTE 1 LEGS 1/5 page, as shown in Figure 6-6. **Figure 6-6 ACT RTE 1 LEGS 1/5 Page**
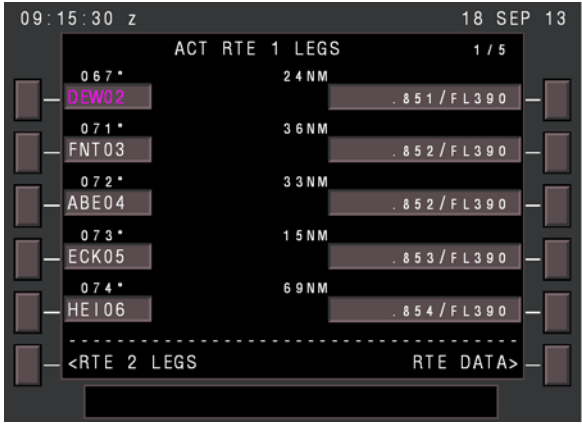
Step	Procedure 6–1 Abeam Point (cont)
4	Select 1L to copy YOW into the TO waypoint field. The ABEAM PTS prompt is displayed in 4R, as shown in Figure 6–7.

Figure 6-7
MOD RTE 1 LEGS – ABEAM PTS

Step	Procedure 6–1 Abeam Point (cont)
5	Selecting 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. 4R changes to ABEAM PTS SELECTED, as shown in Figure 6–8, and the **EXEC** key lights. **Figure 6–8** **ABEAM PTS SELECTED**

Step	Procedure 6-1 Abeam Point (cont)
6	Select the **EXEC** key to create the abeam points. After the direct-to function has been executed, the abeam points are inserted into the active route, as shown in Figure 6-9.

Figure 6-9
ACT RTE 1 LEGS – Abeam Waypoints

Direct-To/Intercept Course

Direct-to flight plan entries permit 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, modified active route, or not part of the active flight plan.
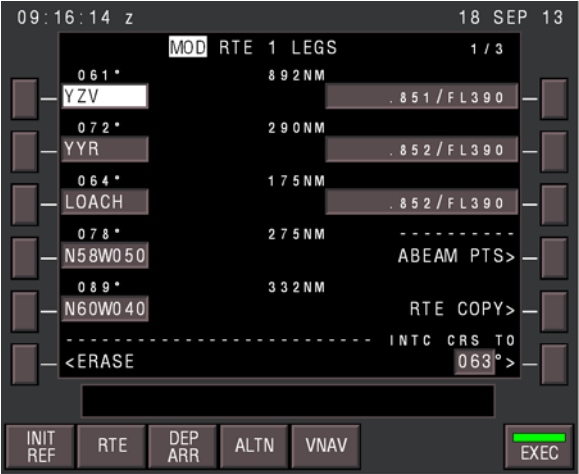
DIRECT-TO
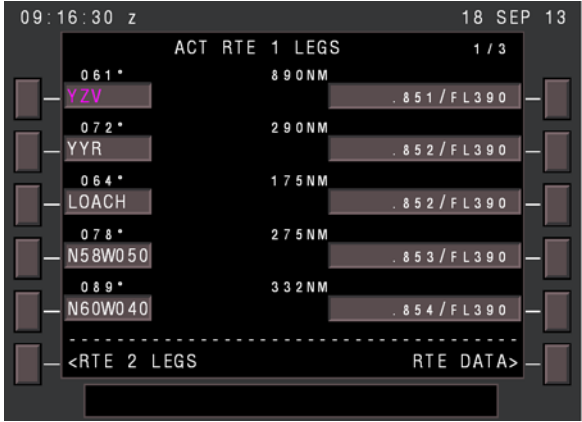
A direct-to is done by entering the desired fix in 1L on the first ACT RTE LEGS page or MOD RTE LEGS page. The following can be entered in 1L:

- 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.

Procedure 6–2 describes the steps to enter a direct–to to SEPT–ILES (YZV).

Step	Procedure 6–2 Direct–To Modification
1	Enter YZV in the scratchpad and select 1L. The resulting display is shown in Figure 6–10. The direct–to waypoint (YZV) with the inbound course (°061) is displayed in 1L. The ERASE prompt is displayed in 6L to erase the pending modification, when desired.

Figure 6–10
Direct–To YZV – Modification
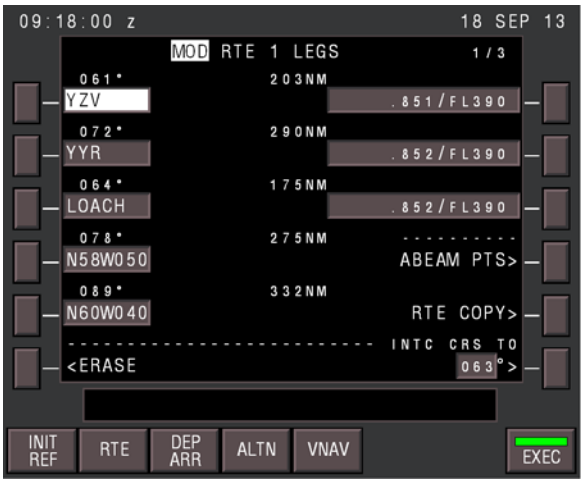
Step	Procedure 6–2 Direct–To Modification (cont)
2	Select the **EXEC** key to execute the modification. The resulting display is shown in Figure 6–11.

Figure 6–11
Direct–To YZV – Active

D201207000032
REV 0   Mar 2014

Cruise
6-19
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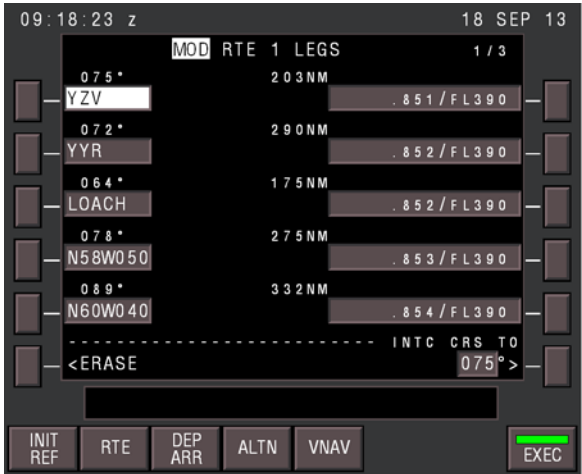
INTERCEPT COURSE TO

Creating an intercept course to a particular fix is similar to performing a direct–to. A fix is entered into 1L on the first ACT RTE LEGS page or MOD RTE LEGS page. When 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 6–12). When the fix is offpath, box prompts are displayed in 6R. When desired, an intercept course can be entered in 6R (overwriting the displayed value or into the box prompts).
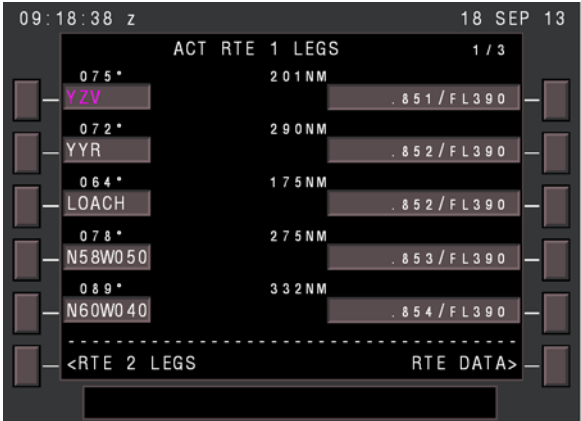
When the modification is executed, the aircraft captures the intercept leg (when LNAV is engaged and the current aircraft track crosses the intercept leg). The course displayed in the header line in 1L is the course required to follow a great circle path that intercepts the fix at the selected course. When the current track does not cross the intercept leg, NOT ON INTERCEPT HEADING is displayed in the CDU help window.

Procedure 6–3 describes the steps to intercept a course of 075° from a position west of waypoint YZV (SEPT–ILES).

Step	Procedure 6–3 Fly Heading to Intercept Course
1	Enter YZV in the scratchpad and select 1L. The resulting display is shown in Figure 6–12. The current course to the waypoint entered in 1L is displayed in 6R (063°). **Figure 6–12** **MOD RTE 1 LEGS – INTC CRS TO**

Step	Procedure 6–3 Fly Heading to Intercept Course (cont)
2	Enter 075 in the scratchpad and select 6R. The resulting display is shown in Figure 6–13. **NOTE:** When 6R is selected, the ABEAM PTS prompt and the RTE COPY prompt are removed. **Figure 6–13** **MOD RTE 1 LEGS – Intercept Course**

D201207000032   *Cruise*
REV 0   Mar 2014   *6-21*
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Step	Procedure 6-3 Fly Heading to Intercept Course (cont)
3	Select the **EXEC** key to execute the modification. The resulting display is shown in Figure 6–14.

Figure 6–14
ACT RTE 1 LEGS – 075° Course

INTERCEPT COURSE FROM

The steps to create an intercept course from a waypoint are similar to selecting an intercept course to a waypoint. An intercept course can be created outbound from a waypoint in the NDB or from a present position. When a waypoint and course are entered in the active waypoint line, INTC CRS FROM is displayed in 6R.

As an example to fly an intercept course of 075 from the VZV waypoint, enter a waypoint and course as 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, when 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 general information about the progress of the flight. There are four PROGRESS pages (PROGRESS 1/4, PROGRESS 2/4, RTA PROGRESS 3/4, and RNP PROGRESS 4/4).

PROGRESS 1/4 Page

To display the PROGRESS 1/4 page, shown in Figure 6–15, select the **PROG** key, or select the **PREV PAGE** key when the PROGRESS 2/4 page is displayed, or select the **NEXT PAGE** key when the RNP PROGRESS 4/4 page is displayed.
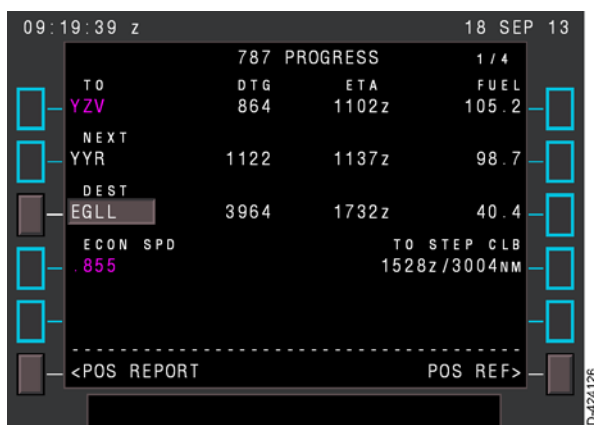
**Figure 6–15
PROGRESS 1/4 Page**

The title of the PROGRESS 1/4 page displays the company flight number from 2R of the RTE 1 page. The PROGRESS 1/4 page 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 Waypoint Information (Line 3)** – 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. When 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. When this is done, the DEST label is replaced by EN ROUTE WPT and predicted information shown is based on the current route. When 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.

  A waypoint that does not exist in the flight plan, other than an along track waypoint or a latitude/longitude crossing waypoint, can be entered over the displayed destination. When this is done, the DEST label is replaced with DIR TO FIX. The predicted information is then based on flying direct to that waypoint.

  Manual entries are returned to the destination using the **DEL** key or by changing all CDU displays from the PROGRESS 1/4 page.

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

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

  — LRC SPD – Long–range cruise speed

  — ECON SPD – Economy speed

— SEL SPD – Manually entered speed on the CDU or the VNAV speed target is the maneuvering speed for flaps zero

— 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

— RTA SPED – RTA speed is active

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

- **<POS REPORT (6L)** – Selecting 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) – Displayed when climb is active

  — STEP CLB (Step climb) – Displayed when cruise is active and step climb information is displayed in 2R on the CRZ page

  — T/D (Top–of–descent) – Displayed when cruise is active and the aircraft is within 200 NM of the top–of–descent or within 500 NM of the destination

  — E/D (End–of–descent) – Displayed when descent is active

  — LEVEL AT – Displayed when the active guidance/performance mode is driftdown (D/D).

  The information in 4R always applies to the active route. When the header line is TO STEP CLB or TO T/D and the aircraft is past that profile point, NOW is displayed. When 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)** – Selecting 6R displays the POS REF page.

D201207000032

REV 0   Mar 2014

Cruise

6-25

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PROGRESS 2/4 Page

The PROGRESS 2/4 page displays wind information, tracking errors, airspeed, temperature, and fuel information, and permits the pilot to choose the fuel information source if there is a discrepancy.

To display the PROGRESS 2/4 page, shown in Figure 6–16, select the **NEXT PAGE** key when the PROGRESS 1/4 page is displayed or select the **PREV PAGE** key when the RTA PROGRESS 3/4 page is displayed.
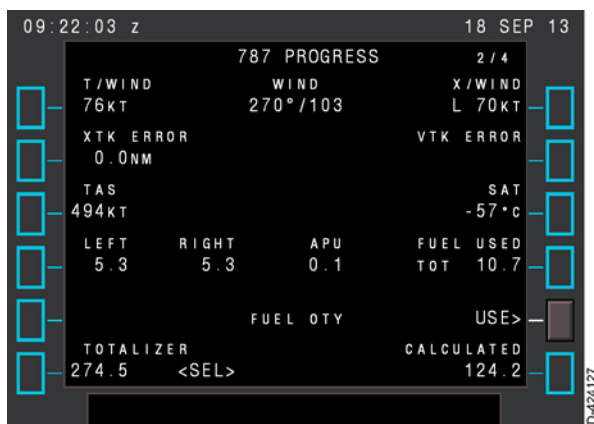
Figure 6–16
PROGRESS 2/4 Page

The title of the PROGRESS 2/4 page displays the company flight number from 2R of the RTE 1 page. The PROGRESS 2/4 page 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 data line line.

    NOTE: The H/WIND and T/WIND values 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.

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

- **FUEL USED (Line 4)** – The total fuel used by the two engines and the APU is displayed in 4C. The fuel consumed by the left and right engine and APU are as sensed by the fuel flow meters. The data lines are blank when a valid fuel flow does not exist.

  The total fuel used is displayed under and to the right of the FUEL USED TOT header. The total fuel used is the sum of both the left and right engines and APU (when APU fuel used is valid). If either the left or right engine fuel used become invalid, the data line in 4R is blank.

  NOTE: The data line does not blank if the APU fuel used is invalid.

- **<USE and USE> (Line 5)** – The USE prompt in 5L and 5R permit the pilot to select either the TOTALIZER or CALCULATED fuel quantity for performance calculations. <SEL> is displayed in line 6 next to the fuel quantity being used. The USE prompt is not displayed if either the totalizer or at least one fuel sensor is detected as failed.

- **TOTALIZER (6L)** – The totalizer fuel quantity is displayed in 6L. The totalizer fuel quantity is blank when the fuel quantity is manually entered on the PERF INIT page in 2L. The header and data are removed from display if data is invalid on the ground or is invalid in the air for more than 2 minutes.

- **VTK ERROR (2R)** – The vertical track error above or below the vertical path is displayed in 2R. A plus sign (+) means the aircraft is above path and a minus sign (–) means the aircraft is below the vertical path. If the vertical track error is invalid or both routes are inactive, then this field is blank.

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

- **CALCULATED (6R)** – Before engine start, at engine shut down, and after fuel jettisoning, 6R displays fuel quantity calculated by the totalizer. After engine start, 6R displays the FMC calculated fuel quantity remaining. The FMC calculated fuel quantity is decreased by using the fuel flow sensing system (FUEL USED).

  When a manual fuel quantity entry is made on the PERF INIT page in 2R, the manual entry becomes the initial value of total fuel quantity.

  The header and data are removed from display if data is invalid on the ground or is invalid in the air for more than 2 minutes.

RTA PROGRESS 3/4 Page

The RTA PROGRESS 3/4 page permits the pilot to enter a waypoint with a required time of arrival (RTA). When this entry is made before takeoff, the FMS calculates the recommended takeoff time. When 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 3/4 page, select the **NEXT PAGE** key when the PROGRESS 2/4 page is displayed or select the **PREV PAGE** key when the PROGRESS 4/4 page is displayed. The RTA PROGRESS 3/4 page is also accessed by selecting the RTA PROGRESS prompt in 6L on the ACT CRZ page. The RTA PROGRESS 3/4 page, when it is first accessed, is shown in Figure 6–17.

Figure 6-17
RTA PROGRESS Page

The RTA PROGRESS 3/4 page is described in the following paragraphs:

- **FIX (1L)** – The 1L data field displays boxes when an active, modified active, or pending activation route exists, no RTA fix exists, and an engine out has not been selected for the displayed route. Valid entries are any waypoint prior to the missed approach in the pending activation, modified active, or active flight plan. Entries are made by the pilot or datalink.

  Waypoints defined by coordinates must be down selected to the scratchpad and then selected to 1L. When the RTA waypoint is contained more than once in the route, sequencing or otherwise removing the first occurrence of the waypoint terminates the RTA.

  The RTA fix is deleted when the RTA fix is no longer in the flight plan. Valid entries, when an RTA time and fix are displayed, invalidates the existing RTA time and results in a modified active flight plan.

  Deletion of an RTA fix, when an RTA time does not exist, removes the RTA fix and does not result in a modified active flight plan. Deletion of an RTA fix, when an RTA exists, deletes the RTA time and fix and results in a modified active flight plan. Deletion of a RTA fix results in any existing RTA cruise speed targets, on the LEGS page, changing to ECON cruise speed targets.

- **RTA SPD (2L)** – The RTA SPD header is displayed when a fix is entered in 1L and a RTA is entered in 1R. When an RTA is entered in 1R, 2L displays the calculated speed required to reach the waypoint at the entered RTA, as shown in Figure 6-18. This data cannot be changed by the pilot. The RTA speed is shown in magenta when the RTA speed is the current target speed.

Figure 6-18
RTA PROGRESS Page With Pilot-Entered RTA

- **SPD SEGMENT (3L) (Not Shown In Figure 6-18)** – The speed segment data field displays the start and end point of the next cruise speed segment. The displayed speed segment changes anytime a waypoint that has a specified cruise speed target is sequenced. The header and data field are blank when anytime the aircraft is on the ground or when airborne and no down path cruise speed targets exist.

- **MAX SPD (5L)** – The maximum speed is displayed in 5L. The FMS uses this speed in calculating whether or not it can make the RTA constraint. The default value is .850. Valid entries range from .100 to .990. Attempted deletion of the default MAX SPD is not permitted and results in the display of the INVALID DELETE in the CDU help window. Deletion of a pilot-entered value returns to the default value of .850. When an RTA is active, valid entry or deletion of the MAX SPD results in the recalculation of the performance predictions.

- **<ERASE (6L)** – Selecting 6L erases the modified or pending RTA constraint.

- **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. 1R is blank when a valid RTA fix does not exist in 1L. Valid entries are of the following combinations where HH is in the range of 00 to 23, MM.M is in the range of 00.0 to 59.9, and the suffix X is an optional character suffix with valid values of A or B.

  — HHMM.M
  — HHMM.MX
  — HHMM
  — HHMMX
  — HHMM.
  — HHMM.X

  Entries without an A or B suffix indicate an AT time. Entries suffixed by an A indicate the RTA time is an AT or AFTER time. Entries suffixed by a B indicate the RTA time is an At or BEFORE time.

  Valid RTA time entries result in any existing ECON cruise speed targets on the LEGS page prior to the RTA fix changing to RTA cruise speed targets. Valid RTA deletions result in any existing RTA cruise speed targets on the LEGS page changing to ECON cruise speed targets.

  When the entered waypoint cannot be reached at the entered RTA, UNABLE RTA is displayed in the CDU help window. Entry is not permitted when 1R is blank.

- **ALT/ETA (2R)** – The predicted altitude and ETA for the waypoint entered in 1L are displayed in 2R. 2R is blank when a valid RTA fix does not exist in 1L.

- **T/O, RECMD T/O, END (3R)** – The header displays T/O when on the ground and a performance computed takeoff time is not displayed in 3R. When an RTA is entered at 1R, the T/O header is replaced with RECMD T/O and the recommended takeoff time field is displayed in 3R while the aircraft is on the ground. The recommended takeoff time in Zulu is displayed when the performance computed takeoff time is valid and later than or equal to the current time. When a pilot–entered takeoff time does not exist and the current time is later than the performance computed takeoff time, the 3R data field displays NOW.

  When airborne and no down path cruise speed targets exist, line 3R is blank. When airborne and a down path cruise speed target exists, the header field displays END. When airborne and one down path cruise speed target exists, the data field displays T/D in large font. When airborne and two down path cruise speed targets exist, the 3R data field displays the second cruise speed target and waypoint identifier (the first cruise speed target is displayed in 3L).

- **PRIOR RTA > (6R)** – When a prior RTA fix and time exist, PRIOR RTA is displayed in the data field. When prior RTA data does not exist or an engine out has been selected, the 6R data field is blank. Selecting 6R when PRIOR RTA is displayed results in restoring the previous RTA fix and time.

  Prior RTA fix and time are available when either of the following are met:

  — A CRZ speed mode other than ENG OUT has been selected while the RTA is active
  — Deletion and execution of the RTA fix on the RTA PROGRESS page.

  Prior RTA data is not available when any of the following conditions are met:

  — The prior RTA fix is sequenced
  — The prior RTA prompt has been selected
  — The prior RTA fix no longer exists in the displayed flight plan
  — A new RTA fix and time have been entered.

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

RNP PROGRESS 4/4 Page

The RNP PROGRESS 4/4 page permits the pilot to enter lateral and vertical RNP values. The RNP PROGRESS 4/4 page displays status information pertinent to RNP operations such as the status of approach RNP.

To display the RNP PROGRESS 4/4 page, select the **NEXT PAGE** key when the RTA PROGRESS 3/4 page is displayed or select the **PREV PAGE** key when the PROGRESS 1/4 page is displayed. The RNP PROGRESS 4/4 page, when it is first accessed, is shown in Figure 6–19.

Figure 6–19
RNP PROGRESS Page

The RNP PROGRESS 4/4 page is described in the following paragraphs:

● **Waypoint Identifier (1L)** – The active waypoint is displayed in 1L. The active waypoint is the same as the value from 1L of the RTE 1 LEGS page.

The leg segment is displayed above the waypoint identifier. Courses are displayed in magnetic or true. Arcs display the distance in NM and arc turn direction, for example 12 ARC R. Heading leg segments are displayed as xxx° HDG. Track leg segments are displayed as xxx° TRK. HOLD AT, PROC TURN, or PROC HOLD may also be displayed in the leg segment field. Dashes are displayed when the course is undefined.

- **RNP/ACTUAL (2L)** – The RNP for the phase of flight and the actual position accuracy are displayed in 2L. The RNP/ACTUAL values are the same as POS REF 2/4 page in 5L. Pilot–entry is permitted to change the default RNP value. Pilot–entered values do not require a trailing slash (/). Actual position accuracy is a display–only value and pilot modification is not permitted. Manually entered RNP values are propagated to the POS REF 2/4 page 5L RNP/ACTUAL and vice versa.

- **XTK ERROR (3L)** – The magnitude of crosstrack error from the active route in NM is displayed in 3L. The direction left (L) or right (R) of the active route is displayed before the magnitude of crosstrack error. The crosstrack error is displayed to the nearest 1/100 NM. Crosstrack errors greater than 99.99 NM are displayed as 99.99 NM.

- **RNP (APPROACH) (6L)** – The smallest RNP for the approach procedure (including missed approach) loaded in the active flight plan is displayed in 6L when a pilot–entered RNP does not exist. When a pilot-entered RNP exists (2L displayed in large font), the manually entered RNP is displayed in large font in 6L.

  When a pilot–entered RNP does not exist and an RNP value for the approach does not exist in the navigation database (when an approach is loaded), the default RNP value for the approach navigation flight phase is displayed in small font.

  RNP values from 0.01 to 9.99 are displayed with a resolution of 1/100 NM. RNP values from 10.0 to 99.9 are displayed with a resolution of 1/10 NM.

  Pilot–entry in this field is not permitted.

- **Distance–To–Go (1C)** – The distance–to–go to the next waypoint is displayed in this field.

- **Speed/Altitude (1R)** – The predicted speed and altitude which the aircraft will cross the active waypoint is displayed in 1R. The speed and altitude is the same from RTE 1 LEGS page in 1R. The predicted values are displayed in small font when no restrictions have been specified.

  The FMC computed glidepath for the approach is displayed above the speed/altitude field.

- **VERT RNP/ANP (2R)** – The current default vertical RNP and actual navigation performance (ANP) values are displayed in 2R in small font when a pilot–entered vertical RNP does not exist.

Pilot–entered vertical RNP values can be made in 2R and are displayed in large font with a valid entry range of 10 to 999. Pilot–entered values do not require a trailing slash (/). If an entry outside the valid range is made, INVALID ENTRY is displayed in the CDU help window. Pilot–entered vertical RNP values are cleared at flight completion.

When a pilot–entered vertical RNP is deleted, the default vertical RNP value is displayed. If an attempt is made to delete the default vertical RNP value, INVALID DELETE is displayed in the CDU help window and the default vertical RNP value remains.

The vertical ANP value is displayed after the slash (/) with a value range of 1 to 999. If the vertical ANP value is invalid, no vertical ANP value is displayed and the ANP display area is blanked. Vertical ANP is a display only value and pilot–modification is not permitted.

VERIFY VERT RNP ENTRY is displayed in the CDU help window when all of the following conditions are met:

— The vertical ANP is valid
— A manual vertical RNP entry is made
— The manually entered vertical RNP value is greater than the current default vertical RNP or the manually entered vertical RNP value is less than the vertical ANP.

- **VTK ERROR (3R)** – The vertical track error from the FMC–computed glidepath is displayed in 3R. 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 the vertical track error is invalid or both routes are inactive. The vertical track error displayed is the same from the PROGRESS 2/4 page in 2R.

- **VERT RNP (APPROACH) (6R)** – The VERT RNP value displayed in 2R is displayed in 6R followed by FT. A default VERT RNP value is displayed in small font and a pilot–entered VERT RNP value is displayed in large font. Pilot–entry in this field is not permitted as 6R only displays VERT RNP values from 2R.
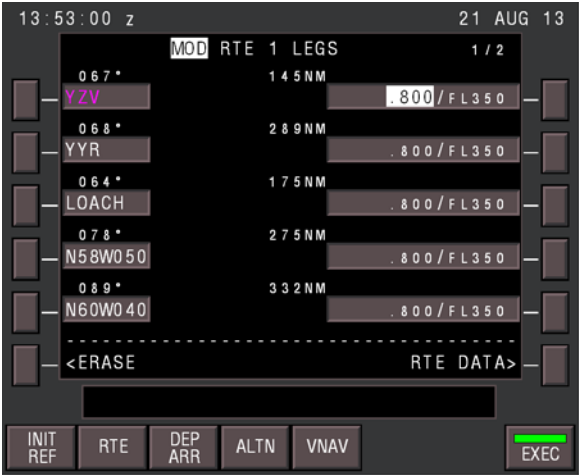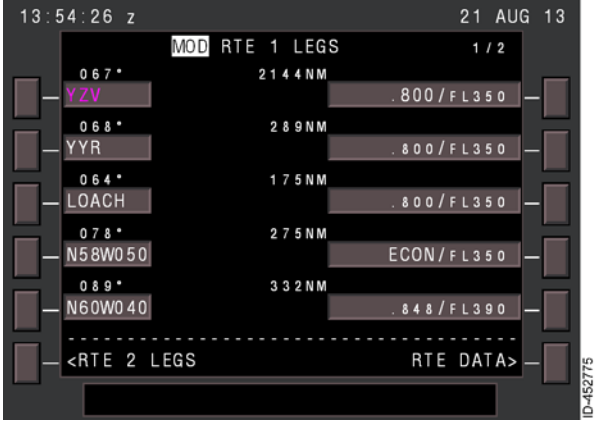
CRUISE SPEED SEGMENT

The cruise speed segment function permits the pilot to enter a target speed to be flown for a defined portion of the flight plan in the CRUISE phase. Multiple cruise speed segments are possible, either adjacent to each other or scattered throughout the CRUISE phase.

Cruise speed targets are enterable only after the last climb constraint or before the first descent constraint. Cruise speed targets can be entered in Mach with a valid entry range from .400 to .990, inclusive. Entered cruise speed targets required a trailing slash (/). Cruise speed targets can also be entered for the follow cruise modes:

● Economy cruise by entering ECON/ or E/

● Long–range cruise by entering LRC/ or L/

● Required time of arrival by entering RTA/ or R/.

Procedure 6–4 describes the steps to enter a constant cruise speed segment. For the sample flight from KORD to EGLL, the desired cruise speed is .800M from YZV to N58W050. After N58W050 the described cruise speed is economy (ECON).

Step	Procedure 6–4 Constant Cruise Speed Segment
1	On the ACT RTE 1 LEGS page, enter .800/ in the scratchpad and select 1R. The resulting display is shown in Figure 6–20.

Figure 6–20
Cruise Speed Segment – .800

Step	Procedure 6–4 Constant Cruise Speed Segment (cont)
2	Enter ECON/ in the scratchpad, select 4R, and select the **EXEC** key. The resulting display is shown in Figure 6–21.

Figure 6–21
Cruise Speed Segment - ECON

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 then either pushing the altitude knob or entering the step altitude on the CRZ page and executing the modification. 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.   When the planned or optimum steps are not made, 0 (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, Wind Entry and Use.

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 or step interval but cannot exceed the maximum altitude at the step point. Figure 6–22 shows an optimum step cruise profile for the flight scenario from KORD to EGLL.
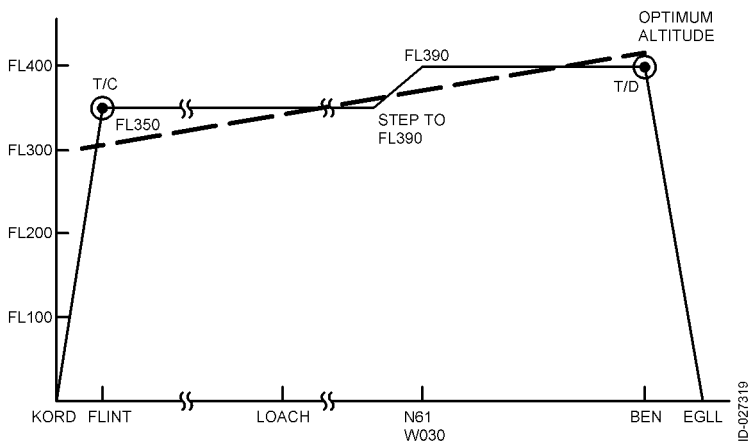
Figure 6–22
Optimum Step Cruise Profile

Predicted optimum step altitudes are displayed on the RTE LEGS page. The distance and ETA to the next step point is displayed on the VNAV CRZ or PROGRESS 1/4 page. The calculated step point (displayed with a green circle and 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.

Planned Steps

Planned steps permit the pilot to specify step altitudes at flight plan waypoints. Pilot–entry of a step altitude on the VNAV CRZ or RTE LEGS page overrides the FMC step climb predictions for the next predicted step. The FMC resumes normal step altitude predictions after a step climb to the manually entered altitude is predicted. Entry of a planned step altitude on the RTE LEGS page overrides a STEP TO entry made on the VNAV CRZ page. The pilot–entered planned step is displayed on the ND.

When a step size of zero (0) is entered on the CRZ page or PERF INIT page and a planned step (or steps) is manually entered, performance predictions are made using the manually entered step (or steps) at the specified waypoint.

Planned steps, like optimum steps, are advisory and can be initiated setting the step altitude in the MCP altitude window and then either pushing the altitude knob or entering the step altitude on the CRZ page and executing the modification.

NOTE: The MCP altitude is always respected. If the planned step altitude is changed on the CRZ page and the change is executed without changing the MCP to a higher altitude first, the aircraft will not climb.

When the last step is a step down, that step is maintained until the descent profile is intersected. When the last step is a step down and the step size specified on the PERF INIT or CRZ page is zero (0), predictions along the remainder of the flight plan are made assuming continued flight at the final step altitude.

A planned step point is made on the RTE LEGS page by entering the step altitude followed by S on right side of the CDU at the desired step point. The flight from KORD to EGLL requires a step climb to FL390 at N61W030. Procedure 6–5 describes the steps to input a step climb entry.

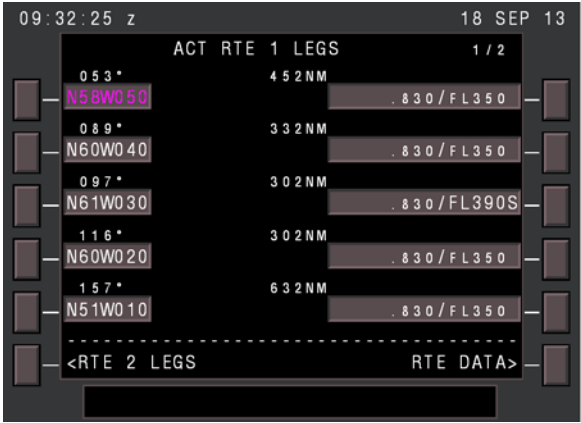| Step	Procedure 6–5 Step Climb Entry
1	On the ACT RTE 1 LEGS page, enter /390S in the scratchpad and select 3R.
2	Select the **EXEC** key to execute the modification. The resulting display is shown in Figure 6–23.

Figure 6–23
Step Climb Entry

For the flight from KORD to EGLL, the FMS calculates a step climb from FL350 to FL390 at N61W030. Figure 6–24 shows the planned step cruise profile for the flight scenario.
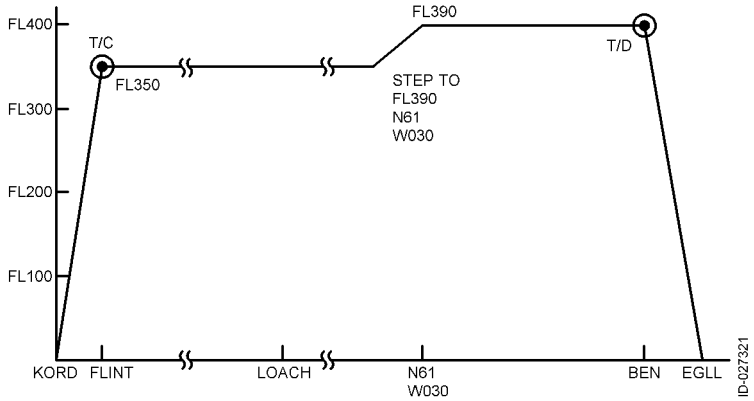
Figure 6–24
Planned Step Cruise Profile

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, shown in Figure 6-25. The OFFSET prompt is displayed only with the aircraft airborne and not on a SID, STAR, or transition.
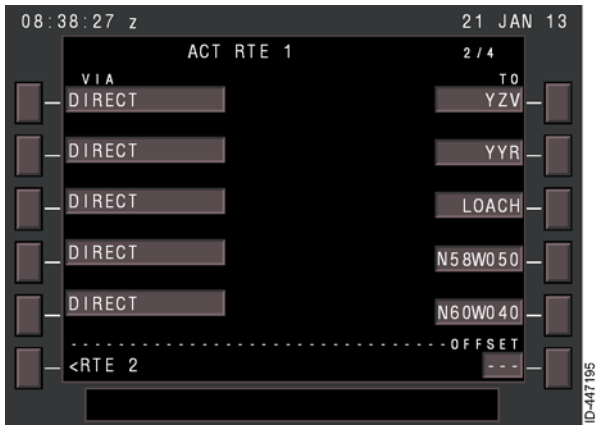
Figure 6-25
ACT RTE 1 – OFFSET

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 when airborne and not flying a SID, STAR, or transition. The offset entry propagates through the remaining flight plan up to any of the following:

- The end-of-route waypoint
- A discontinuity
- The start of a STAR transition, STAR, approach transition, 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 CDU help window.
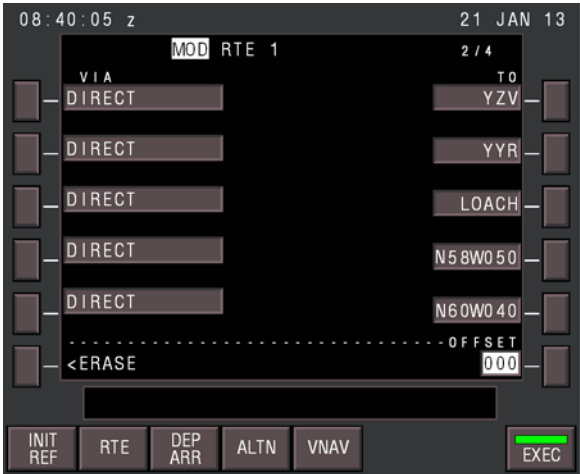
A valid entry is L (left) or R (right) for the direction of the offset followed by the distance of the offset in NM. An entry of zero (0) is permitted when a non–zero value is displayed and results in the offset being canceled. Deletion of an offset in 6R is also permitted when a non–zero value is displayed and results in the offset being canceled.
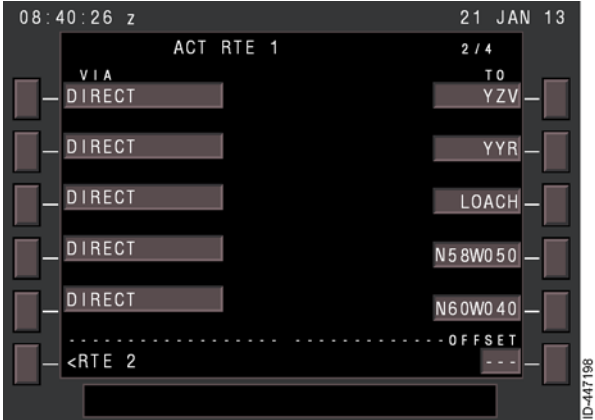
Procedure 6–6 describes the steps to enter an offset of 20 NM to the right for the flight from KORD to EGLL.

Step	Procedure 6-6 Offset Entry
1	On the ACT RTE 1 page, enter R20 in the scratchpad and push 6R. The resulting display is shown in Figure 6–26. The modified offset is displayed on the ND as a dashed white line. **Figure 6-26** **ACT RTE 1 – OFFSET**
2	Push the **EXEC** key.

When executed, the offset is displayed on the ND as a dashed magenta line. The offset is flown with a 30° entry and exit and is shown on the ND.

An active offset can be canceled by pushing the **DEL** key, and then 6R, and the **EXEC** key. Entering 000, L0, 0, or R0 in 6R, or entering a direct–to also cancels the offset. Procedure 6–7 describes the steps to cancel the offset in the sample flight plan.

Step	Procedure 6-7 Cancelling an Offset Entry
1	Enter 000 in the scratchpad and push 6R. The resulting display is shown in Figure 6–27.

Figure 6-27
OFFSET – MOD

Step	Procedure 6-7 Cancelling an Offset Entry (cont)
2	Push the **EXEC** key to execute the modification. The resulting display is shown in Figure 6–28.

Figure 6-28
ACT RTE 1 – OFFSET Removed

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.

ACT RTE LEGS Page – HOLD AT Function

The HOLD AT function in line 6 on the ACT RTE LEGS page, shown in Figure 6–29, permits the pilot to initiate a holding pattern at a fix on path, at the current aircraft position, or any other geographical point.
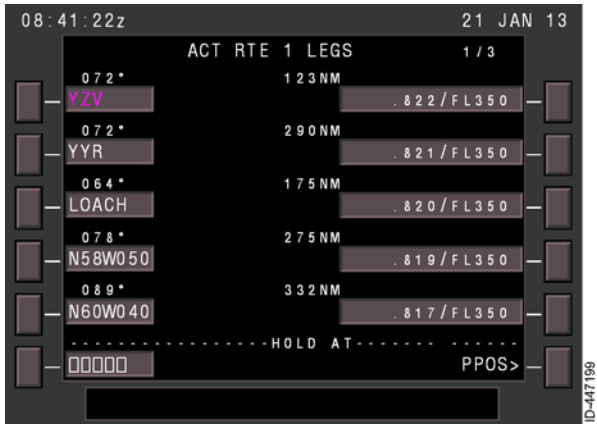

Figure 6–29
ACT RTE LEGS Page – HOLD AT

HOLD AT is displayed by pushing the **HOLD** key (when the route does not contain a holding pattern) or by selecting the NEXT HOLD prompt in 6L on the ACT RTE HOLD page (when the route contains a holding pattern).

The fields associated with the hold function on the ACT RTE LEGS page are described in the following paragraphs:

● **HOLD AT (6L)** – The waypoint to be used as the holding fix is entered in 6L. 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. When a waypoint is entered in 6L, the MOD RTE HOLD page is displayed.

Valid entries in 6L consist of the following:

— Published waypoint
— Airport
— NAVAID

— Non–directional beacon (NDB)
— Place bearing distance (PBD)
— Place bearing/place bearing (PB/PB)
— Any flight plan waypoint except a latitude or longitude reporting point
— Runway extension fix
— A final approach fix (FAF) already displayed in the flight plan
— Latitude/longitude waypoint.

When an entered fix is not contained in the flight plan, HOLD AT XXXXX is displayed in the CDU help window, where XXXXX is the name of the entered fix. When a hold is given at a fix not in the flight plan, the HOLD AT XXXXX can be line selected into the flight plan to choose where hold is to occur in sequence with the other flight plan waypoints.

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 X HOLD.

NOTE: The aircraft cannot enter a pre-planned holding pattern when on an offset path.

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

NOTE: Selecting the PPOS while on an offset path deletes the offset path and inserts a ROUTE DISCONTINUITY between the present position HOLD AT waypoint and the TO waypoint in the flight plan.

MOD RTE HOLD Page

The MOD RTE HOLD page, shown in Figure 6–30, 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 become effective on the next crossing of the holding fix.

Figure 6–30
MOD RTE HOLD Page

The MOD RTE HOLD page is displayed when a valid holding fix is entered into the HOLD AT prompt in 6L or when PPOS is selected in 6R on the RTE LEGS page, shown in Figure 6–29.

The MOD 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 MOD RTE HOLD page but can be deleted on the RTE LEGS page. When the hold is in the modified state (MOD in page title), the fix is displayed in white reverse video, as shown in Figure 6–30. When the hold is active, the fix is displayed in magenta, as shown in Figure 6–31.

- **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 radial, 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 in Table 6–1.

Deletions are not permitted for this field. Entries in the QUAD/RADIAL prompts changes the INBD CRS value in 3L.

Table 6–1 lists the quadrant boundaries.

Table 6–1
Quadrant Boundaries

Quadrant	Boundary Radials
N	From 338° to 22°
NE	From 23° to 67°
E	From 68° to 112°
SE	From 113° to 157°
S	From 158° to 202°
SW	From 203° to 247°
W	From 248° to 292°
NW	From 293° to 337°

When the hold is in the modified state, the entered quadrant and radial are displayed in white reverse video. When the hold is active, the quadrant and radial are displayed in magenta.

● **INBD CRS/DIR (3L)** – The inbound course and turn direction are displayed in 3L. Valid entries for the course are three–digit bearings with an option to be 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 3L 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.

When the hold is in the modified state, the entered inbound course and turn direction are displayed in white reverse video. When the hold is activated, the inbound course and turn direction are displayed in magenta.

T is displayed after the inbound course when mag/true reference is true north. When mag/true reference is magnetic north, only the inbound course digits are displayed.

- **LEG TIME (4L)** – Leg time and leg distance (in 5L) are mutually exclusive. Entering a value in one erases the value in the other. The length of the inbound leg of the pattern is specified in minutes in 4L. The default leg time is 1.0 minute at or below 14,100 feet and 1.5 minutes above 14,100 feet. The default time can be changed by the pilot. Valid leg time range from 0.1 to 9.9 inclusive. The FMS defaults to leg time (blank LEG DIST) on initial display.

  The altitude used to determine the leg time is as follows:

  — Prior to the hold becoming the active leg, the altitude predicted for the aircraft to arrive at the holding fix is used for computing the default leg time. When the predicted altitude is unknown, a default leg time of 1 minute is used.

  — When the next leg is a hold other than a Procedure Hold (HA or HM leg), the MCP altitude is used for computing the default leg time when the MCP altitude would constrain VNAV in a climb or descent.

  — When the hold is the active leg, the default leg time is based on the actual aircraft altitude. The actual aircraft altitude is continuously determined.

  When 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.

  When the hold is in the modified state, the entered leg time is displayed in white reverse video. When the hold is active, the leg time is displayed in magenta.

- **LEG DIST (5L)** – Leg distance and leg time (in 4L) are mutually exclusive. Entering a value in one erases the value in the other. 5L displays dashes unless an entry is made or a value is inserted from the NAV database stored procedure. When leg distance is entered, dashes are displayed in the LEG TIME field (4L). Valid leg distance range is from 0.1 to 99.9 NM.

  When the hold is in the modified state, the entered leg distance is displayed in white reverse video. When the hold is active, the leg distance is displayed in magenta.

- **<ERASE (6L)** – The ERASE prompt is displayed when a modified active or pending activation route exists. When a hold does not exist, selecting the ERASE prompt deletes any pending vertical and/or lateral modifications and displays the RTE HOLD AT page. When a hold exists, selecting the ERASE prompt displays the ACT RTE HOLD page.

- **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 when a holding target altitude has not 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.

  Valid entry in 1R is three digits (range from 100 to 400) and a trailing slash (/) for SPD. Valid entry in 1R for TGT ALT range from three to five digits for TGT ALT preceded by an optional slash. The maximum altitude entry is cruise altitude (if it exists), otherwise the maximum certified altitude. Entries in 1R must be in one of the following formats:

  — Speed constraint: SPD/

  — Speed/target altitude constraint: SPD/ALT, SPD/ALTA, or SPD/ALTB (A for above or B or below)

  — Speed/target altitude window constraint: SPD/ALTAALTB or SPD/ALTBALTA

  — Target altitude constraint: ALT, /ALT, ALTA, /ALTA, ALTB, or /ALTB

  — Target altitude window constraint: ALTAALTB, /ALTAALTB, ALTBALTA, or /ALTBALTA

  — Planned step: ALTS or /ALTS.

  Deletion of the holding altitude is permitted on the HOLD or RTE LEGS page when the entry is equal to or less than the cruise altitude.

  When no constraint is specified for the holding pattern and the predicted altitude at the hold waypoint is determined to be the cruise altitude, then the hold is at the cruise altitude. When the cruise altitude is subsequently changed, the cruise holding altitude is also changed.

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

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

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

  When hold modification is pending, an entered EFC time is displayed in white reverse video.

- **HOLD AVAIL (4R)** – The predicted holding time available before the aircraft must exit the hold to reach the destination (with the required fuel reserves from the PERF INIT page) is displayed in 4R. When 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.

  5R is downselectable to the scratchpad, however entry in 5R is not permitted.

  The best speed is displayed in magenta when the hold is the active leg and the speed is the FMS speed target.

  NOTE: This speed can exceed ICAO limit speed.

ACT RTE HOLD Page

When the hold is executed (**EXEC** key pushed with the MOD RTE HOLD page displayed), the page title changes to ACT RTE HOLD, as shown in Figure 6–31. In this example, a present position hold is selected and the present position becomes the hold fix (N43W084 shown in 1L).
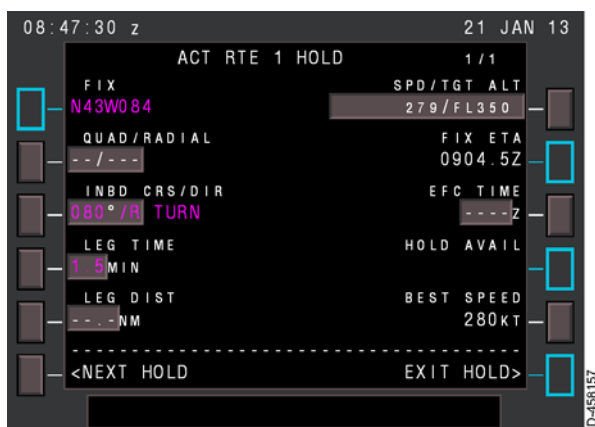
Figure 6–31
ACT RTE HOLD Page

The ACT RTE HOLD page is displayed by selecting the **HOLD** key on the CDU when one or more holding patterns exist in the route. When the hold is the next LNAV event, the active commands are displayed in magenta. The holding parameters can be changed on this page.

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 when the route is not in the modified state. Selecting the NEXT HOLD prompt displays an additional HOLD AT function on the ACT RTE LEGS page.

- **EXIT HOLD> (6R)** – The EXIT HOLD prompt is displayed in 6R when 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 in white reverse video. This lights the **EXEC** key and selecting the **EXEC** key display EXIT ARMED, as shown in Figure 6–32. The aircraft is routed to the holding fix by way of the inbound course and continued flight along the active route. Lateral guidance continues to fly the hold and exits the hold when sequencing the waypoint. The pattern is shortened when EXIT is ARMED while flying turn number 1, or the first turn after crossing the holding fix.

Figure 6–32
ACT RTE HOLD – EXIT ARMED

EXIT ARMED is displayed in 6R when 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.

The hold may also be exited on the ACT RTE LEGS page by deleting or bypassing the HOLD AT waypoint which results in LNAV to command a direct to the next waypoint.

The FMC automatically commands an exit from the following holding patterns:

- Fix Terminated Holds (HF) – Fix terminated holds are normally for instrument approach holding patterns designed as a course reversal instead of a procedure turn. The airplane exits the hold when arriving at the holding fix inbound. Fix terminated holds display PROC HOLD above the holding fix on the ACT RTE LEGS page. The RTE HOLD page is not accessible for HF holds.

- Altitude Terminated Holds (HA) – Altitude terminated holds are normally for holding patterns in SIDs in which the airplane exits the hold after reaching an altitude. Altitude terminated holds display HOLD AT above to the holding fix on the ACT RTE LEGS page. The RTE HOLD page is not accessible for HA holds.

Holding patterns are described in additional detail in Section 10, Advanced Flight Planning.

> **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.**

FIX INFO PAGE

The FIX INFO pages permit the pilot to 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. The bearing data is magnetic or true depending on the aircraft location. Refer to Polar Operations in Section 10, Advanced Flight Planning, for more information.

The FIX INFO page, shown in Figure 6–33, is displayed by selecting the **FIX** key on the MCDU. A total of four FIX INFO pages are available.

NOTE: Pushing the **NEXT PAGE** key permits the pilot to select three radials and/or distances and a point abeam from a second fix and a second ETA-ALT entry.
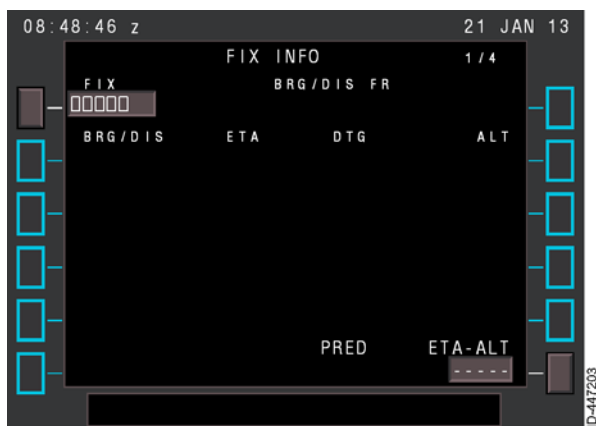
Figure 6–33
FIX INFO Page

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 (PB/PB), along track waypoint airway intersection, Reporting Point waypoints that are found in any route, as well as LAT/LON, PBD or PB/PB 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.

The FIX INFO page is described in the following paragraphs:

- **FIX (1L)** – Valid entries in 1L are waypoints, NAVAIDs, NDBs, airports contained in the NAV database, LAT/LON, PBD, PBPB, along track waypoints, airway intersections, and reporting points.

  A new fix can be entered over the existing fix. The fix is erased by selecting the ERASE FIX prompt in 6L or by selecting the **DEL** key and upselecting it to 1L. When the FIX in 1L is deleted, all data from the FIX INFO page is cleared, except for any entry in 6R.

Selection of 1L when a navigation database waypoint, NAVAID, NDB, or airport identifier is displayed results in the fix identifier being displayed in the scratchpad. Selection of 1L when a LAT/LON, airway intersection, or reporting point results is displayed in the full expansion of the fix being displayed in the scratchpad in the standard LAT/LON format. Selection of 1L when a PBD, PBPB, or along track waypoint is displayed results in the full expansion of the fix being displayed in the scratchpad in the standard PBD entry format.

When the entry in 1L is a PBD or PBPB waypoint that is not found in any active route and the parent fix identifier contains three or more characters, the resulting fix is displayed as the first three characters of the parent fix identifier followed by a dash and suffixed by a single digit corresponding to the FIX INFO page number (for example PXR/180/50 on FIX INFO page 3/4 would be displayed as PXR–3).

NOTE: When the parent fix identifier contains two or less characters, the resulting fix is displayed as the parent fix identifier followed by a dash and sufficed by a single digit corresponding to the FIX INFO page number (for example NN–2).

- **BRG/DIS (2L through 4L)** – Bearing and/or distance (BRG/DIS) references can be entered into 2L through 4L. 2L through 4L are blank until a fix is entered in 1L. After a fix is entered, dashes are displayed (–––/–––) until an entry is made.

  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. When only a bearing is entered, no trailing slash (/) is required.

  Entered distances must be preceded with a slash (/). Valid distance range is between 0 to 9999 inclusive.

  Deletion of entered data returns the displays to the default dashes (–––/–––). Attempted deletion of default dashes displays the INVALID DELETE CDU help window message.

  When the fix displayed in 1L is either a database waypoint, along track waypoint, PBD, or PBPB waypoint that is contained in any route, selecting 2L through 4L results in the fix identifier displayed in 1L being copied into the scratchpad followed by the bearing and distance corresponding to the selected bearing/distance field.

  NOTE: Downselecting 2L through 4L into the scratchpad is not permitted when only a bearing or distance is displayed in 2L through 4L (flight path not intercepted).

When the entered distance circle intersects the active flight plan, the intersecting radial is displayed in small font before the slash. Valid intersections for an entered bearing are 9,999 NM or less.

When only a distance is entered that does not intercept the active flight plan, the distance is displayed and the bearing is blank. When only a bearing is entered which does not intercept the active flight plan, the bearing is displayed and the distance is blank. When radial lines or distance circles intersect the active flight path, the ETA, DTG (distance along the flight path to the intersection), and ALT (estimated altitude at the intersection) are displayed to the right of BRG/DIS.

NOTE: When the distance circle intersects the active route, the closest of the 2 intersections is displayed.

When radial lines or distance circles do not intersect the active flight path, the ETA, DTG, and ALT fields are blank.

NOTE: When a bearing and distance are entered together, the active flight path is not intersected, therefore the ETA, DTG, and ALT fields are blank.

Entry of a bearing displays a radial line on the ND. Entry of a distance displays a distance circle on the ND. Entry of a bearing and distance defines a point that is displayed on the ND.

Line selection of any of the intersection points into the scratchpad for subsequent entry into the flight plan result in the distance value being displayed to the nearest tenth with the format of place/bearing/distance.

● **<ABEAM (5L)** – 5L is blank when an entry in 1L has not been made, a fix is entered in 1L however, no active route exists, or when the fix in 1L is not contained in the NAV database.

When an entered fix in 1L exists in the NAV database and an active route exists, ABEAM is displayed in large font in 5L. Selecting 5L displays the bearing and distance from the fix perpendicular to the nearest intersection on the flight plan path. Selecting ABEAM also displays distance along the path to the abeam point, ETA, and altitude at that point. When the ABEAM prompt is selected and an abeam intersection exists, ABEAM is displayed in small font.

When an abeam point to the active or active offset flight path cannot be found, INVALID ENTRY is displayed in the CDU help window.

A valid intersection can be downselected to the scratchpad as a PBD waypoint to insert into the route. Deletion of 5L when data is displayed results in the return of the <ABEAM prompt.

- **<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 when a fix has not been entered in 1L.

- **2C through 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.

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

- **BRG/DIS FR (1C/1R)** – The bearing and distance from the fix in 1L is displayed in 1R.

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

- **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.

  When an active route exists, dashes (–––––) are displayed in 6R until an entry is made. A valid ETA entry is a four-digit time value followed by Z. The estimated aircraft position at the entered time is calculated and the distance to the position is displayed to the left of the entered time. The entered time is displayed next to the profile circle on the ND.
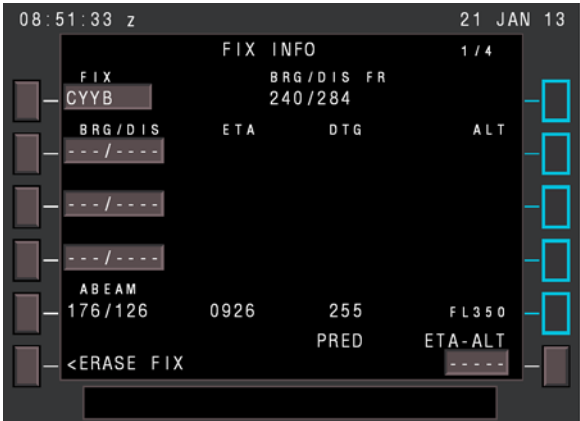
  NOTE: Z is used by the FMC to distinguish between altitude and time.
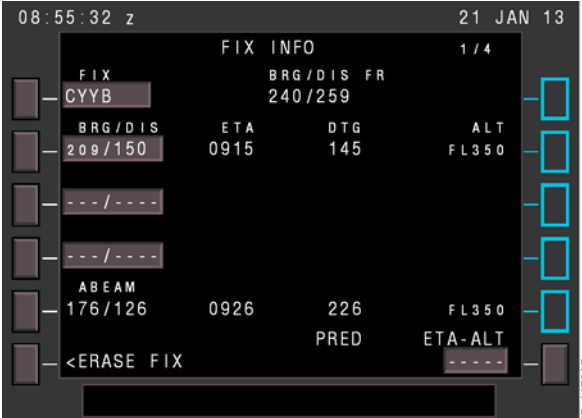
  A valid altitude entry is a three– to five-digit value in standard altitude format. The estimated aircraft position at the entered altitude is calculated and the distance to the position is displayed to the left of the entered altitude.

  For either ETA or altitude entries, when 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.

  When an active route does not exist, 6R is blank.

For the sample flight from KORD to EGLL, the BRG and DIS when the aircraft is abeam North Bay (CYYB) is desired. The ETA, DTG, and ALT when the aircraft is 100 NM away, crossing the 180 bearing of CYYB, and the point along the flight path where the aircraft will be at 2100Z is also desired. Procedure 6–8 describes the steps to determine this information.

Step	Procedure 6–8 Fix Info Page Data
1	Push the **FIX** key to display the FIX INFO page.
2	Enter CYYB in the scratchpad and push 1L. The BRG and DIS to CYYB is displayed.
3	Push 5L (ABEAM). The resulting display is shown in Figure 6–34. The BRG and DIS (176/126) from CYYB perpendicular to the nearest intersection on the flight plan path is displayed in 5L. Also, the ETA (0926), DTG along the path to the abeam point (255), and ALT at that point (FL350) is displayed.

Figure 6–34
FIX INFO - ABEAM

Step	Procedure 6–8 Fix Info Page Data (cont)
4	To determine the ETA, DTG, and ALT when the aircraft is 150 NM away from CYYB, enter /150 in the scratchpad and push 2L. The resulting display is shown in Figure 6–35. The predicted ETA (0915), the DTG (145), and ALT (FL350) are displayed in 2C to 2R.

Figure 6–35
FIX INFO – DIS

Step	Procedure 6–8 Fix Info Page Data (cont)
5	To determine the ETA, DTG, and ALT when the aircraft crosses the 180 degree bearing from CYYB, enter 180 in the scratchpad and push 3L. The resulting display is shown in Figure 6–36. The predicted ETA (0925), the DTG (213), and ALT (FL350) are displayed in 3C to 3R.
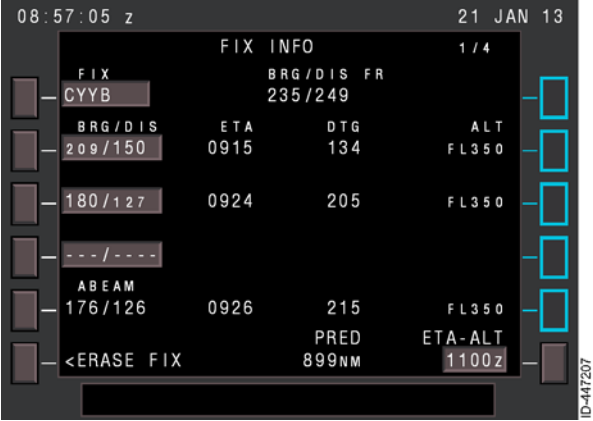
Figure 6–36
FIX INFO – BRG

Step	Procedure 6–8 Fix Info Page Data (cont)
6	To determine the predicted point in the flight plan where the aircraft will be at 1100Z, enter 1100Z in the scratchpad and push 6R. The resulting display is shown in Figure 6–37. In this example, the predicted point in the flight plan where the aircraft will be at 1100Z is 899 NM from the current location.

Figure 6-37
FIX INFO – PRED ETA

REF NAV DATA PAGE

The REF NAV DATA page, shown in Figure 6–38, displays data for any selected waypoint, NAVAID, airport, and destination runway in the NAV database or flight plan route. The page is also used to inhibit specific NAVAIDs for position updating and to inhibit VOR/DME position updating.
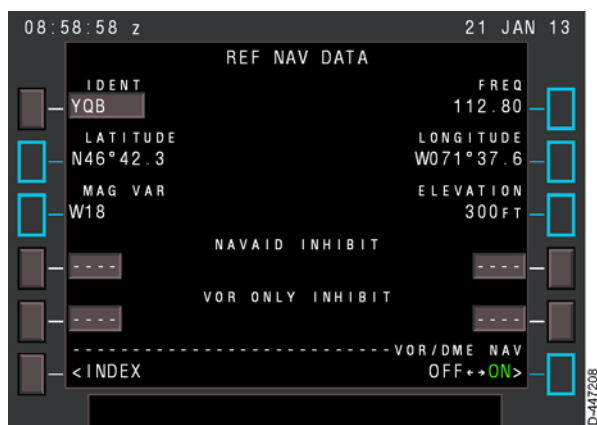
Figure 6–38
REF NAV DATA Page

The REF NAV DATA page is accessed from the INIT REF INDEX page. The REF NAV DATA page is displayed by pushing the **INIT REF** key, pushing 6L (INDEX) on the INIT REF page, and then pushing 1R (NAV DATA) on the INIT REF INDEX page.

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. When the entry is in the NAV database, data for the entry is displayed. When the entry is not in the NAV database, NOT IN DATABASE is displayed in the CDU help window.

   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 permitted.

● **LATITUDE and LONGITUDE (Line 2)** – 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. The display format of the magnetic variation is a large font E or W followed by a one– or two–digit magnitude of variation. Zero variation is displayed as E0.

  When 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.

- **NAVAID INHIBIT (Line 4)** – Initially, dashes are displayed in 4L and 4R. The pilot can inhibit up to two VORs, VOR/DMEs, VORTACs, or DMEs contained in the NAV database, from FMS radio updating. Either desired NAVAID inhibit can be entered in 4L or 4R.

  When 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, after a long–term power interrupt, or when the RAD NAV INHIBIT in 6R is selected ON.

  NOTE: NAVAIDs 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, or when the RAD NAV INHIBIT in 6R is selected ON or VOR.

  NOTE: VORs entered in these fields are not inhibited from route tune, manual tune, or procedure tune capability. When 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.

- **FREQ (1R)** – When the identifier in 1L represents a NAVAID, the NAVAID frequency is displayed in 1R.

- **ELEVATION (3R)** – The elevation of the NAVAID, airport (reference point), or runway threshold entered in 1L is displayed in 3R. When the identifier in 1L is for a waypoint, this field is blank.

- **VOR/DME NAV (6R)** – Pushing 6R toggles the VOR/DME navigation inhibit mode between ON and OFF. The selected state is displayed in large green font and the non–selected states are displayed in small white font.
  — ON – Enables VOR/DME updating of the FMC
  — OFF –Inhibits VOR/DME updating of the FMC. Selecting OFF displays ALL in the data fields of 5L and 5R.

  All inhibits are cleared on flight completion. The toggle state in 6R is retained over warm starts, cold starts, and initialized to ON at flight completion. Selection is also displayed on POS REF page 3/4.

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 permit the pilot to select the desired NAV database fix.

As an example, to display the SELECT DESIRED WPT page for NAV database components with the identifier NM, enter NM in the scratchpad and push 1L on the REF NAV DATA page. The resulting display is shown in Figure 6–39.
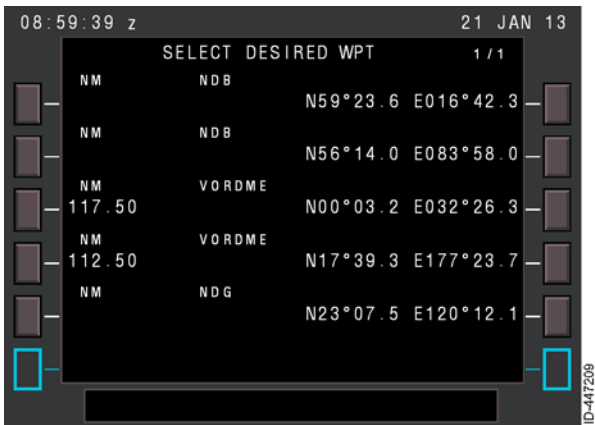
Figure 6–39
SELECT DESIRED WPT Page

When the SELECT DESIRED WPT page is displayed as a result of a non–direct or intercept flight plan modification (i.e., entering a waypoint into the flight plan), the displayed list is sorted based on proximity to the lat/lon of the waypoint preceding the entered fix identifier. When the SELECT DESIRED WPT page is displayed as a result of performing a direct or intercept flight plan modification, REF NAV DATA entry, PROGRESS page 1 entry, FIX INFO entry, VNAV DES vertical bearing entry, OFFPATH DES entry, or select waypoint plan mode function, the displayed list is sorted based on proximity to the current aircraft position.

Displayed fixes are generally displayed by increasing distance from the aircraft. However, when the entry is made on the RTE or RTE LEGS pages (i.e., when entering a waypoint into the flight plan), the fixes are displayed by increasing distance from the waypoint in the RTE or RTE LEGS page which comes before the entered fix identifier.

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.

When more than six non-unique identifiers exist, the remaining fixes are accessed by pushing the **NEXT PAGE** or **PREV PAGE** key. When the page is exited before a fix is selected, no fix is selected.

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
  — WAYPOINT
  — ILSDME
  — VOR
  — VORTAC
  — TACAN
  — LOC
  — DME
  — VORDME
  — GLS
  — ILSDME
  — ILSTACAN

— IGS

— IGSDME

— IGSTACAN

When the fix is a NAVAID, the frequency is displayed in the data line in 1L through 6L.

- **Position (1R through 6R)** – The position of each fix is displayed in 1R through 6R.

DESCENT FORECAST PAGE

The DESCENT FORECAST page, shown in Figure 6–40, is used to enter forecast values of specific parameters to more accurately define the computed descent profile. The forecast values may also be uplinked. The DESCENT FORECAST page is displayed by pushing the **VNAV** key, pushing the **NEXT PAGE** key to display the DES page 3/3, and then pushing 5R (FORECAST).

Figure 6–40
DESCENT FORECAST Page

All data fields are initially cleared except the TRANS LVL field. 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 (when 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. Pilot–entered values are cleared after flight completion or when the destination airport is changed.

- **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 permitted (only one wind entry can be made for a given altitude).

  When one of the altitudes in 2L through 5L is deleted, the fields in that line default to dashes.

- **<REQUEST/LOAD (6L)** – When datalink status is READY, the REQUEST prompt is displayed in 6L. Selecting REQUEST transmits a datalink request for descent wind data. Following the selection of REQUEST, REQUESTING is displayed until acknowledgment has been received. After network acknowledgement, REQUEST is displayed followed by small font SENT.

  LOAD is displayed, followed by small font FORECAST UPLINK, when descent forecast uplink data is pending. Selecting the LOAD prompt results in validation and loading of descent forecast information and initiation of a downlink response.

- **TAI/ON ALT (1R)** – An altitude below which the use of engine bleeds is expected to commence can be entered in the thermal anti–ice field. The FMC performance function uses the thermal anti–ice (TAI) altitude to make adjustments in the descent profile for a more cost-effective and accurate descent. When 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. When only wind direction is entered, it must be followed by a slash (/). When only a wind speed is entered, a preceding slash (/) is optional.

- **DES/PURGE> (6R)** – DES is displayed when a descent forecast uplink data is not pending. Selecting DES displays the DES page.

  PURGE is displayed when a descent forecast uplink data is pending. Selecting PURGE results in clearing the pending descent forecast and initiate a downlink response. Selecting PURGE also clears the LOAD prompt in 6L.

ALTITUDE INTERVENTION

Altitude intervention is the function of incorporating the MCP altitude window and knob-push operation with the FMC VNAV flight planning for heads-up operation. For CRUISE, altitude intervention permits the pilot to raise or lower the current cruise altitude without using the CDU and without confirmation using the **EXEC** key.

Cruise Altitude Modification

When 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.

When the MCP altitude is set to an altitude below the current cruise altitude (more than 50 NM from the top–of–descent point), pushing the altitude selector results in the cruise altitude to be set to the MCP altitude and the airplane to descend to the new altitude. The autothrottle sets a calculated thrust value for an approximate 1,250 fpm descent.

Setting an altitude below the current altitude in the MCP altitude and pushing the altitude selector activates the DES NOW function when the aircraft is within 50 NM of the top of descent or when the MCP altitude is set below the highest descent altitude constraint in the VNAV profile.

When the MCP altitude is set below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by the flight crew in these instances.

7.   Descent

INTRODUCTION

The FMC 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 terminates at the start of the approach phase. The start of the approach phase is described in Section 8, Approach.

The descent path is calculated starting at the end-of-descent and going backwards to the cruise altitude. The descent vertical path to the first constraint is based on altitude and speed constraints, FMC cruise and DESCENT FORECAST page winds, off-idle thrust, speedbrakes retracted, predicted use of anti-ice.

The FMC creates a deceleration segment at the top-of-descent point when the cruise speed is greater than the descent speed. When 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 Mach/CAS (based on Cost Index) descent where the path is constructed for an optimal descent speed, subject to defined airspeed/altitude constraints. The second type is a manually entered Mach/CAS descent where the path is constructed to fly the pilot-entered speed, still subject to defined airspeed/altitude constraints.

NOTE: VNAV does not command an economy target speed greater than V_{MO}/M_{MO} minus 16 knots or a pilot-entered speed greater than V_{MO}/M_{MO} minus 11 knots.

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 FMC default is a speed transition of 240 knots (a 10-knot buffer so as not to exceed 250 knots) below 10,000 feet. The aircraft decelerates to 240 knots when reaching the intermediate deceleration point prior to 10,000 feet.

Descent path segments after the first altitude constraint are constructed as straight line point to point segments. The FMC commands additional thrust when the VNAV path segment is too shallow to be flown at IDLE thrust.

The FMC continuously updates the correct deceleration distance from the destination to slow to approach speeds.

DESCENT PAGE

The descent page is displayed by selecting the **VNAV** key when the DESCENT mode is active. When the DESCENT mode is inactive then the DES page 3/3 (of the vertical navigation pages) is displayed by selecting the **NEXT PAGE** or **PREV PAGE** key after selecting the **VNAV** key. The descent page is also displayed by selecting 6L (DES) on the OFFPATH DES page or 6R (DES) on the DESCENT FORECASTS page.

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 6.7 NM before the top–of–descent.
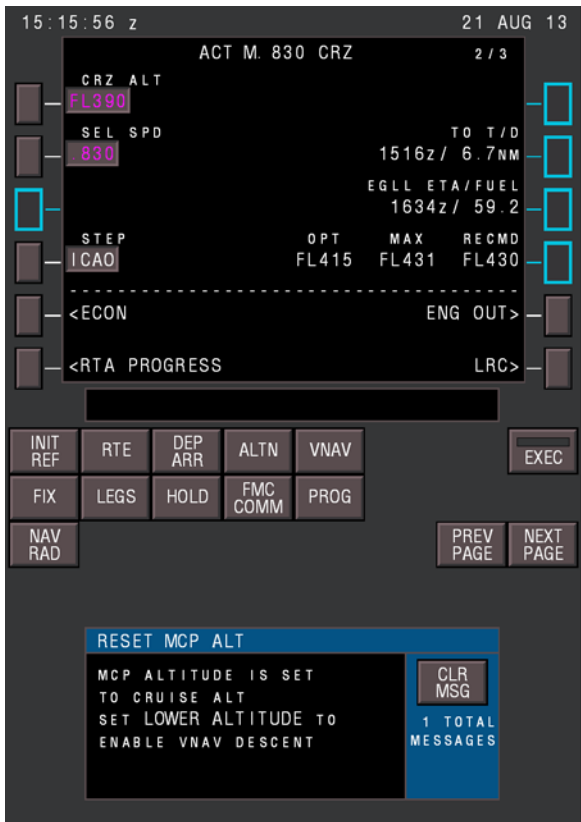
Figure 7–1
ACT CRZ Page

The CDU help window message RESET MCP ALT, as shown in Figure 7–1, is displayed 2 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 shown in Figure 7–2.
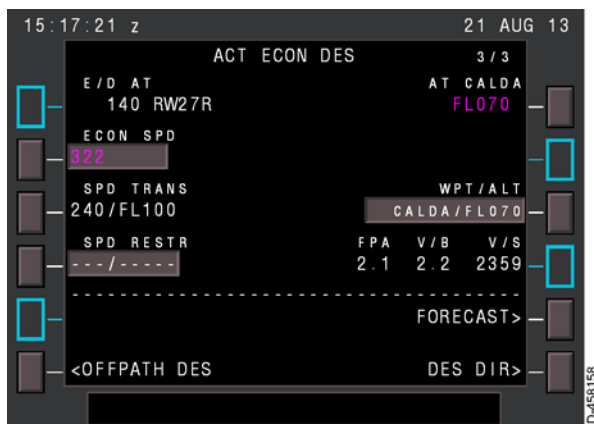
Figure 7–2
ACT ECON DES Page

The page title includes ECON when VNAV economy speed mode is selected. Fixed speed descents modify the title.

The page title displays the type of descent and includes the following:

- DES – Indicates no cruise altitude has been entered or no descent constraint exists in the vertical profile.

- MOD DES – Indicates a lateral or vertical modification is pending and either no cruise altitude has been entered or no descent constraint exists in the vertical profile.

- ECON DES – Indicates that the speed is based on a cost index.

- XXXKT DES – Indicates a specified CAS is the mode of the first descent segment and climb or cruise is the active flight mode or performance initialization is not complete.

- M.XXX DES – Indicates a specified Mach is the mode of the first descent segment and climb or cruise is the active flight mode or performance initialization is not complete.

- .XXX/XXX DES – Indicates a specified Mach/CAS schedule is the mode of the first descent segment and climb or cruise is the active flight mode or performance initialization is not complete.

- ACT ECON DES – Indicates descent is the active flight mode with an economy descent speed selected.

- MOD ECON DES – Indicates a modified flight plan exists and descent is the active flight mode with and economy speed selected.

- ACT XXXKT DES – Indicates descent is the active flight mode with a specified CAS descent speed selected.

- MOD XXXKT DES – Indicates a modified flight plan exists and descent is the active flight plan mode with a specified descent speed selected.

- ACT M.XXX DES – Indicates descent is the active flight mode with a specified Mach descent segment selected.

- MOD M.XXX DES – Indicates a modified flight plan exists and descent is the active flight mode with a specified Mach descent segment selected.

- ACT END OF DES – Indicates descent is the active flight mode and the aircraft has sequenced the end–of–descent constraint.

- MOD END OF DES – Indicates a modified flight plan exists and descent is the active flight mode and the aircraft has sequenced the end–of–descent constraint.

- ACT MCP SPD DES – Indicates descent is the active flight mode with an MCP specified descent selected.

- MOD MCP SPD DES –Indicates a modified flight plan exists and descent is the active flight mode with an MCP specified descent selected.

- ACT LIM SPD DES – Indicates descent is the active flight mode and an envelope limited speed descent segment is active.

- MOD LIM SPD DES – Indicates a modified flight plan exists and descent is the active flight mode and an envelope limited speed descent segment is active.

- MOD .XXX/XXX DES – Indicates a modified flight plan exists and the first valid descent segment is a specified Mach/CAS schedule and climb or cruise is the active flight mode or performance initialization is not complete.

The DES page is described in the following paragraphs:

- **E/D AT (1L)** – The end–of–descent point in 1L displays the altitude and waypoint with the lowest altitude constraint propagated from the RTE LEGS page. The end–of–descent point is displayed when a descent constraint is contained in the lateral route or when the aircraft has sequenced the end–of–descent waypoint. Figure 7–2 shows the descent ending at 140 feet for RWY 27R at EGLL.

The altitude is displayed in magenta when it becomes the FMC altitude target. The waypoint is displayed in magenta when the end–of–descent waypoint becomes the active waypoint.

When a descent constraint does not exists in the lateral route and the aircraft has not sequenced the end–of–descent waypoint, the page is blank with DES as the page title. When the end-of–descent constraint is a window constraint, the lower altitude is displayed with an A suffix. The altitude can be followed by A for AT OR ABOVE, B for AT OR BELOW.

- **ECON SPD**/**SEL SPD (2L)** – ECON SPD is displayed in the header line when economy descent speed is selected. SEL SPD is displayed in the header line when a pilot–entered CAS speed or Mach number is entered.

  The data field displays the speed of the active or first descent target speed in large font. The speed can be a Mach, CAS, or CAS/Mach schedule. ECON SPD is based on cost index.

  Data may be entered into 2L data field using any of the following methods:
  — Crew entry from the scratchpad
  — Propagation of a speed entered on the OFFPATH DESCENT page
  — Entry of an RTA time on the RTA PROGRESS page
  — Selection of PRIOR RTA prompt on the RTA PROGRESS page.

  The aircraft flies the constraint speed or the current performance speed, whichever is less.

  When CAS and Mach values are displayed simultaneously, only the active FMC target value is displayed in magenta. Normally in descent, the Mach value is magenta until transitioning the CAS/Mach transition point, at which time the CAS value becomes magenta.

  A CAS or CAS/Mach entry with a CAS less than or equal to the descent speed transition or descent speed restriction results in blanking the speed transition an/or speed restriction data (3L and/or 4L) and deleting those speed segments from the descent profile.

  NOTE: A Mach only entry is not compared to the speed transition or speed restriction speed.

  The data field displays dashes when the performance initialization is not complete. The header and data fields are blank when no cruise altitude is contained in the vertical profile or there are no descent constraints contained in the lateral route and the airplane has not sequenced the end–of–descent waypoint.

Figure 7–2 shows an ECON speed of 322 knots 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. When a default speed does not exist in the NAV database for the destination airport, the speed transition defined in the AMI becomes the default.

  Figure 7–2 shows a speed transition of 240 knots at FL100 at this stage of the descent into London.

  When the aircraft is below the speed transition altitude, this field is blank. Deleting this field results in the aircraft flying an economy or selected speed when not limited by a waypoint constraint or speed restriction. Speed is displayed in magenta when it is the FMC speed target.

- **SPD RESTR (4L)** – The header field displays SPD RESTR when an end–of–descent constraint exists in 1L and performance has been initialized, otherwise the header is blank. Speed restrictions at altitudes higher than the end–of–descent altitude and not associated with specific waypoints can be manually entered on this line. Pilot–entered speed restrictions are displayed in large font.

  The data field contains the restriction speed followed by the speed restriction altitude. The speed restriction is displayed in 4L when a valid speed restriction has been entered and the speed restriction altitude has not been crossed. Dashes are displayed when no speed restriction has been entered or when transitioning the speed restriction segment. When transitioning the speed restriction segment, the speed restriction is propagated to 2L as a SEL SPD mode.

  The altitude must be below the cruise altitude and above the end–of–descent constraint in 1L. When no climb segment exists in the vertical profile, the altitude entry must be at or below the current aircraft altitude. The airspeed must be less than or equal to the specified CAS descent speed, if one exists. Mach entries are not accepted Speed restriction entries that conflict with the speed transition results in the speed transition displayed in 3L to be blank.

  Deletion of the descent speed restriction results in redisplaying the descent speed transition when the speed transition has not been sequenced or deleted and the descent speed restriction altitude is below the cruise altitude and above the end–of–descent constraint in 1L. Speed is displayed in magenta when it is the FMS target speed.

- **<ECON (5L)** – ECON is displayed when ECON is not the current descent mode target speed. Selecting 5L when ECON is displayed results in changing the descent speed mode to ECON. When ECON is the current FMC DES target speed, the data line is blank.

  NOTE: Selection of ECON deletes the speed restriction in 4L when the restriction speed is greater than the economy CAS speed.

- **<OFFPATH DES/ERASE (6L)** – ERASE is displayed when a flight plan modification is pending. OFFPATH DES is displayed when ERASE is not displayed.

  Selecting ERASE results in erasing all pending flight plan modifications. Selecting OFFPATH DES displays the OFFPATH DES page (described later in this section).

- **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).

  When the constraint speed is higher than the current performance mode, the guidance will control to the performance speed.

  Speed and/or altitude are displayed in magenta when they are the FMC target values. This field is blank when no constraint exists.

- **WPT/ALT and FPA, V/B, and V/S (3R and 4R)** – Flight path angle (FPA), vertical bearing (V/B), and vertical speed (V/S) are displayed in 4R to the waypoint and altitude displayed in 3R. The data field in 3R defaults to the waypoint and altitude in 1R. The pilot can enter any waypoint in the active or nonactive route (including latitude/longitude reporting points), or any waypoint in the NAV database into 3R. When a waypoint and altitude are to be entered at the same time, a slash (/) must separate the two. A waypoint or altitude can be entered individually and do not require a preceding or trailing slash (/).

  Vector waypoints are not accepted as manual entries. When no pilot–entry exists and no altitude constraint exists on a Vector waypoint in the route, the default entry is the first waypoint with a constraint following the Vector waypoint. When an altitude constraint exists on a Vector waypoint, normal WPT display rules apply. When a Vector waypoint is followed by a DISCONTINUITY, dashes are displayed in 3R.

The current aircraft flight path angle is displayed under the FPA header. The vertical bearing and vertical speed calculated to fly directly to the waypoint and altitude in 3R, without regard to the current lateral or vertical flight plan path, are displayed in 4R under the V/B and V/S header. These display fields are listed in the following:

— FPA – The current flight path angle of the aircraft in degrees is displayed during a descent. The FPA readout is removed when the descent FPA is less than .02 degrees or in a climb. When the descent FPA is between .02 and .05 degrees inclusive, the FPA readout displays 0.0. When the descent FPA is greater than .05 degrees, the FPA is displayed in large font in tenth increments.

— V/B – The vertical bearing in degrees calculated to get from the current position to the waypoint and altitude displayed in 3R. The V/B readout blanks when a waypoint and altitude are not displayed in 3R.

— V/S – The vertical speed in feet–per–minute calculated to get from the current position to the waypoint and altitude displayed in 3R. The V/S readout blanks when a waypoint and altitude are not displayed in 3R.

● **FORECAST> (5R)** – Selecting 5R displays the DESCENT FORECAST page.

● **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 a 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. Selecting the **EXEC** key deletes all descent constraints above the MCP altitude window. Altitude constraints at the MCP altitude are retained. The last descent constraint is not affected by the DES DIR prompt selection, regardless of MCP altitude. When the constraint to be deleted is a window constraint and only one of the two altitudes is above the MCP altitude, only that portion of the altitude window constraint is deleted. Speed and altitude constraints not associated with a waypoint are not affected. Constraints on an approach procedure, including the constraint on a common waypoint between the approach procedure and approach transition are retained.

NOTE: The pilot can also initiate a direct descent with the MCP altitude knob. When the MCP altitude knob is lowered below one or more descent constraints, each push of the altitude knob will delete the next constraint above the MCP altitude window. Altitude constraints lower than the MCP altitude cannot be deleted using the altitude knob. The final descent constraint cannot be deleted with the MCP altitude knob.

An example where the DES DIR prompt is executed at 10,000 feet during a decent with an altitude constraint at 6,000 and 4,000 feet and the MCP set to 4,000 feet is shown in Figure 7–3. VNAV recalculates the path with the 6,000 constraint removed and then controls to the new path to the altitude constraint at the MCP.
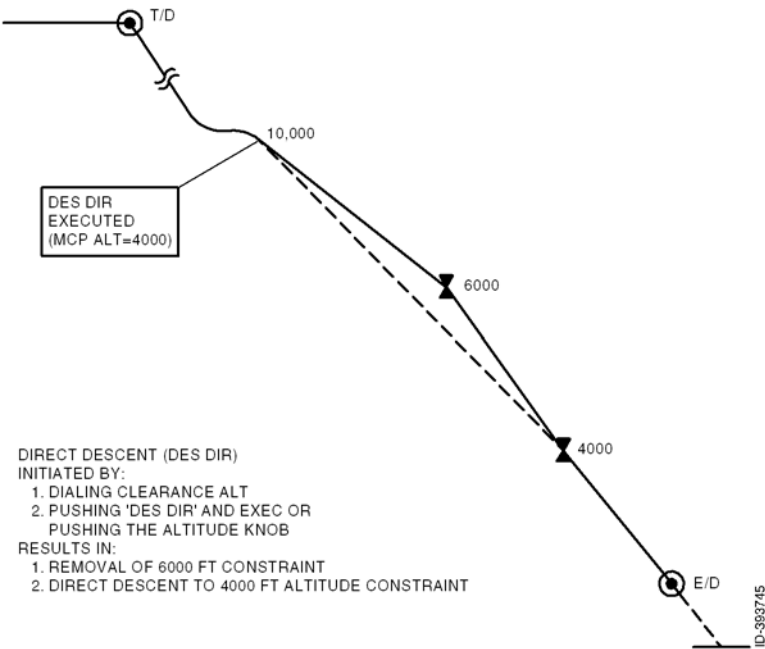
Figure 7–3
Descend Direct Vertical Path

— **DES NOW>** – The DES NOW prompt is displayed when the descent phase in not active.

Selecting the DES NOW prompt lights the EXEC light. Selecting the **EXEC** key (or lowering the MCP altitude and pushing the knob) 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 1,250 fpm descent rate (approximately) until reaching the calculated path. The autothrottles go into throttle hold mode on reaching the 1,250 fpm descent rate to let the pilot re-adjust the throttles to change the rate of descent. On intersecting the original descent path, the vertical guidance function captures the calculated vertical path for the selected descent mode.
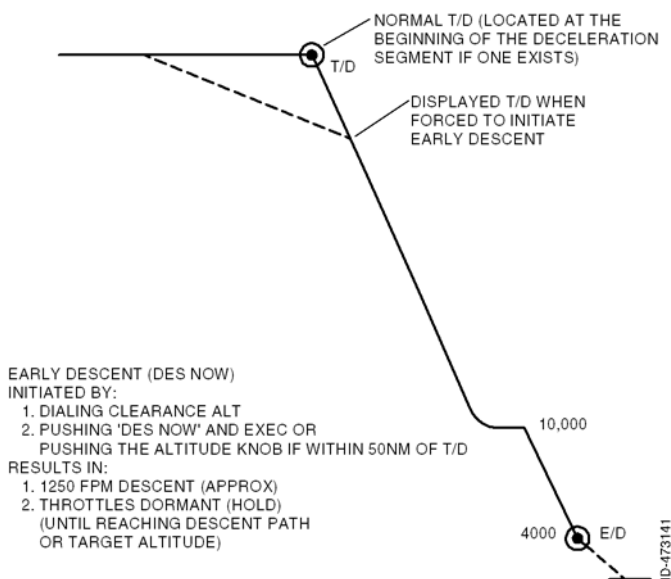
Figure 7-4
Descend Now Vertical Path

OFFPATH DES PAGE

The OFFPATH DES page enables the pilot to 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.

The OFF PATH DES page, shown in Figure 7–5, is displayed by selecting 6L on the descent page.
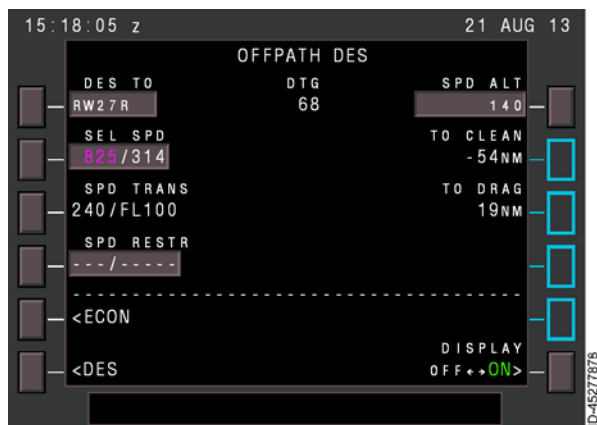
Figure 7–5
OFFPATH DES Page

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, with the exception of along track waypoints and LAT/LON crossing points. Deletion of an entered waypoint in 1L results in the display of box prompts or the next descent constraint. Deletion of a waypoint that was not crew–entered is not permitted.

  When the aircraft altitude is within 150 feet of the waypoint in 1L, the display defaults to the new end–of–descent point from the descent page, or to box prompts when one does not exist. Pilot entries do not propagate to the DES page.

  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. Boxes are displayed in this field when a manual waypoint entry is deleted. Altitude my be optionally preceded by a speed and a slash (/). Speed entries are permitted in the range of 100 to 400, inclusive.

- **Speed Line (2L)** – ECON SPD or SEL SPD is displayed in the header line in 2L with the correct speed in the data field. Mach and/or airspeed can be entered. The data field displays the speed constraint at the end–of–descent point propagated from the DES page in small font, when no manual entry exists and an end–of–descent waypoint exists. A pilot–entered speed results in the header line to change to SEL SPD. When SEL SPD is displayed, an ECON prompt is displayed in 5L. When the displayed speed is the current FMC speed target, then speed in 2L is displayed in magenta. Valid entries are propagated to the DES page.

- **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. When deleted, this field and header line are blank on both pages and the EXEC light is lit. When deleted, the speed transition is only redisplayed by entering a new cruise altitude above the NAV database stored altitude. Deleting the speed transition results in the aircraft flying ECON or selected speed if not limited by a waypoint constraint or speed restriction. When the displayed speed is the current FMC speed target, then speed in 3L is displayed in magenta.

  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 lower than the cruise altitude and higher than the end–of–descent altitude. Speed entries must be less than or equal to the first speed restriction in the descent. 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 and performance initialization is complete. When the displayed speed is the current FMC speed target, then the speed in 4L is displayed in magenta.

- **<ECON (5L)** (Not shown in Figure 7–5) – An ECON prompt is displayed in 5L when SEL SPD is displayed in 2L. Selecting the ECON prompt changes the speed mode from SEL SPD to ECON.

- **<DES/ERASE (6L)** – DES is displayed in 6L when a modification is not pending. Selecting DES displays the DESCENT page. ERASE is displayed in 6L when a modification is pending. Selecting ERASE deletes the pending modification.

- **TO CLEAN (2R)** – The direct–to distance from the aircraft to the clean idle descent path is displayed in 2R. Pilot–entry is not permitted, this is a display on field. CLEAN represents the energy circle with no speed brakes, flaps, or gear down that permits 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 54 NM.

  The data field in 2R is blank when an end–of–descent point or constraint does not exist, performance is not initialized, or the aircraft position is not valid.

- **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.

  A negative distance is indicated when the aircraft has passed the drag circle and a drag descent is no longer possible. The drag circle represents the energy circle with full speed brakes applied, no flaps or gear extended that permits 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, an end–of–descent constraint exists, performance is initialized, and the aircraft position is valid. 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)** – Selecting 6R toggles the clean and drag circles on and off the associated ND. The drag circle does not display until the aircraft position is inside of the clean circle. 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, shown in Figure 7–6, 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.
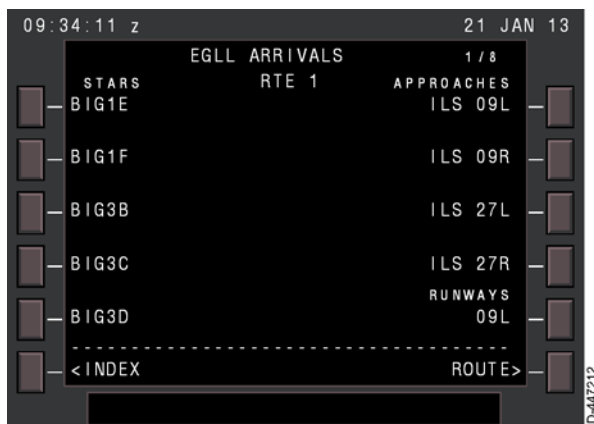
Figure 7–6
ARRIVALS Page

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 selected 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.

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 selecting 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/PROF DES (1L)** – The STARS are listed for the departure or arrival airport. Profile descents are displayed below STARS under the PROF DES title line. When NONE is displayed, no STARS are in the NAV database for that airport. When an approach is selected, only STARS compatible with the selected approach are displayed.

Selecting the associated LSK selects a STAR or PROF DES. Once a STAR or PROF DES 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.

- **TRANS (2L)** (Shown in Figure 7–10) – The STAR transitions for a selected STAR are displayed in the left data fields beginning in 2L after a STAR has been selected. A transition is selected by selecting the associated LSK. The selected STAR transition is indicated by <SEL> next to it.

- **<INDEX/ERASE (6L)** – Selecting 6L displays the DEP/ARR INDEX page which provides arrival/departure date for any other airport in the navigation database. INDEX is displayed when a pending modification does not exist.

  ERASE is displayed when a pending modification exists for the displayed route and an active route already exists. Selecting the ERASE prompt deletes any selections made on the ARRIVALS page since the last **EXEC** key selection.

- **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. When a STAR is selected, only runways compatible with the selected STAR are displayed. An approach is selected by selecting the associated LSK. The selected approach is then indicated by <SEL> or <ACT> next to it.

  Selection and execution of an ILS approach autotunes the ILS receivers and displays the course. Selection of a back course approach autotunes the ILS and displays the front course.

- **Glideslope (G/S) (2R)** (Shown in Figure 7–10) – G/S is displayed when a localizer based approach (ILS, IGS, LOC, BAC, LDA, and SDF) is in the currently displayed, selected, or active flight plan. The glideslope permits the FMC to compute a glidepath when ILS glideslope is not available. The selected state (On or OFF) is displayed in large green font. The default state is ON for ILS or IGS approaches. The default state is OFF for LOC, BAC, LDA, and SDF approaches.

- **TRANS (3R)** (Shown in Figure 7–10) – The approach transitions for a selected approach are displayed in the right data fields beginning in 3R after an approach has been selected. A transition is selected by selecting the associated LSK. The selected approach transition is indicated by <SEL> next to it. When a transition is not selected, the FMC displays a straight–in approach starting at a waypoint 4 to 8 miles outside of the FAF.

- **ROUTE/Approach Intercept> (6R)** – ROUTE is displayed when an arrival runway or procedure is not selected or not in the active flight plan. Selecting ROUTE displays the correct RTE page (MOD RTE, ACT RTE, or RTE 1).

  An approach intercept fix is displayed in 6R (shown in Figure 7–8) 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. Selecting 6R selects the intercept leg to the approach fix or runway.

  After selecting the approach intercept fix in 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 RTE LEGS page displays the routing with the approach intercept fix waypoint as the active waypoint. 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.

  For runway only selections, the intercept course is the same as the NAV database runway heading.
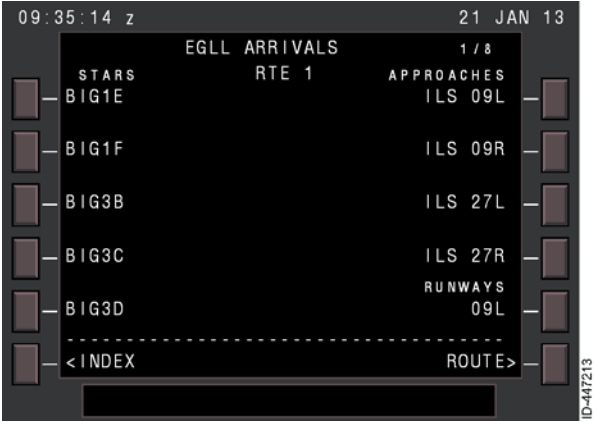
  The RTE COPY and ABEAM waypoint prompts are not displayed on the RTE LEGS page after selecting the APPROACH INTC prompt. Any previously existing flight plan waypoints are deleted.

  This field is blank when no arrival runway or procedure has been selected, or if none exists in the active flight plan. The field is also blank when the airport on the displayed ARRIVALS page does not match the selected approach.

  NOTE: When 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.

Procedure 7–1 describes the steps to enter the approach in the sample flight plan.

Step	Procedure 7-1 Loading Approach
1	Select the **DEP ARR** key to display the ARRIVALS page for EGLL shown in Figure 7–7. <div align="center">

```
09:35:14 z                          21 JAN 13
              EGLL ARRIVALS           1/8
                   RTE 1
         STARS              APPROACHES
      ─ BIG1E                  ILS 09L ─

      ─ BIG1F                  ILS 09R ─

      ─ BIG3B                  ILS 27L ─

      ─ BIG3C                  ILS 27R ─
                             RUNWAYS
      ─ BIG3D                     09L ─
      - - - - - - - - - - - - - - - - - - -
      ─ <INDEX                  ROUTE> ─
```

Figure 7-7
EGLL ARRIVALS Page</div> |

Step	Procedure 7-1 Loading Approach (cont)
2	Select 4R on the EGLL ARRIVALS page to select the ILS approach to RWY27R at EGLL. <SEL> is displayed inboard of the selection and the other options within the approach category are removed from the list. Figure 7-8 shows the resulting display.

Figure 7-8
EGLL ARRIVALS Page - ILS27R Selected

Step	Procedure 7–1 Loading Approach (cont)
3	The clearance from ATC for approach to EGLL is the BNN1D STAR and BNN transition. To select the BNN1D STAR, select the **NEXT PAGE** key to display the EGLL ARRIVALS 2/8 page shown in Figure 7–9. **Figure 7–9** **EGLL ARRIVALS 2/8 Page**
4	Select 2L to select the BNN1D STAR. The resulting display is shown in Figure 7–10. **Figure 7–10** **EGLL ARRIVALS – STAR and Transition Selected**

Step	Procedure 7–1 Loading Approach (cont)
5	Select 5R to select the BNN transition. The resulting display is shown in Figure 7–11. **Figure 7–11** **EGLL ARRIVALS**
6	Select the **EXEC** button to execute the approach. When the modification is executed, <SEL> changes to <ACT>, as shown in Figure 7–12. **Figure 7–12** **EGLL ARRIVALS Activated**

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 visual flight rules (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 FMC–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 on compatibility with obstacle clearance limits or procedural requirements. The VFR APPR prompt, shown in Figure 7–13, is displayed in 2R when a runway is selected without an approach which has a VFR approach enabled in the NAV database.
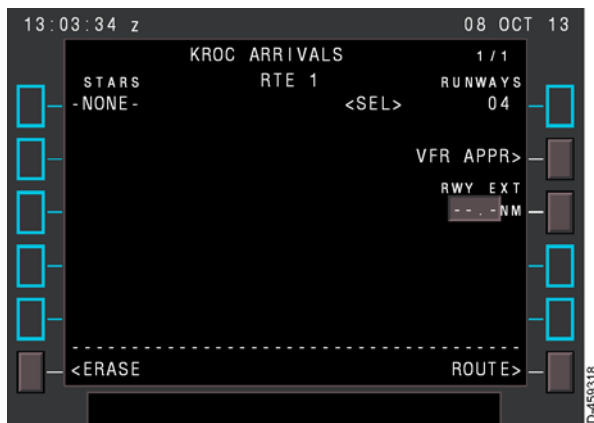
Figure 7–13
VFR Approaches

Selecting the VFR APPR prompt results in the following:

- VFR is displayed in the 1R data field

- The default runway extension value of 8 NM is displayed in the 3R data field (pilot–entry is not permitted)

- FPA is displayed in the 4R header field and the default flight path angle of 3.0° is displayed in the 4R date field (pilot–entry is permitted).

LNAV and/or VNAV guidance to the entered runway is created as an aid to the pilot during a VFR approach. The FMC 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 2,000 feet 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 2,000 feet 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 7–14.
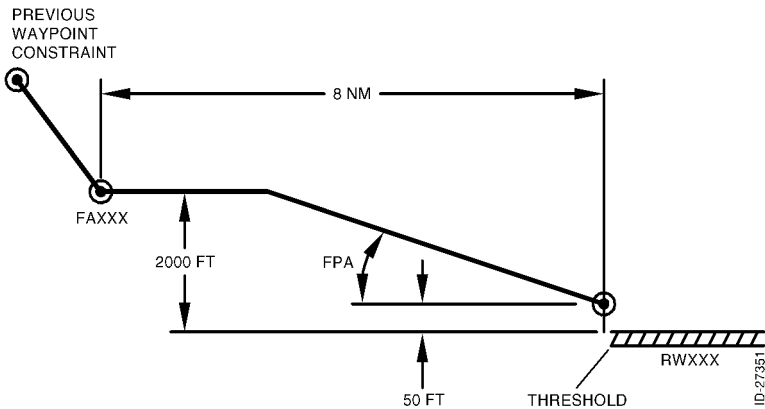
Figure 7–14
VFR Approach Profile

Guidance is generated to arrive at the final approach fix at a speed of 170 knots, 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.

Runway Extension

A runway extension distance can be entered into 3R on the destination airport ARRIVALS page shown in Figure 7–15. 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 FMC creates a flight plan fix along the runway centerline at the entered distance. The fix is named RXYY, where YY is the designated runway (for example RX10).
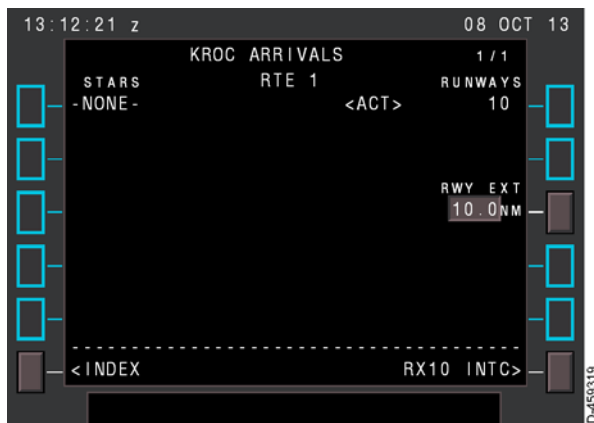
Figure 7–15
Runway Extension

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.

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. When 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 (when enabled) is available for GPS approaches. The FMC 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 (normally 50 feet 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 (when available) is displayed on the RTE LEGS page. When a vertical angle for any other approach leg is defined, the vertical angle is also displayed on the RTE LEGS page. The vertical angle for the GPS approach is preceded by glide path (GP) in the right side of the header line for the associated waypoint, as shown in 2R in Figure 7–16.

NOTE: The pilot cannot change the vertical angle value from the NAV database.
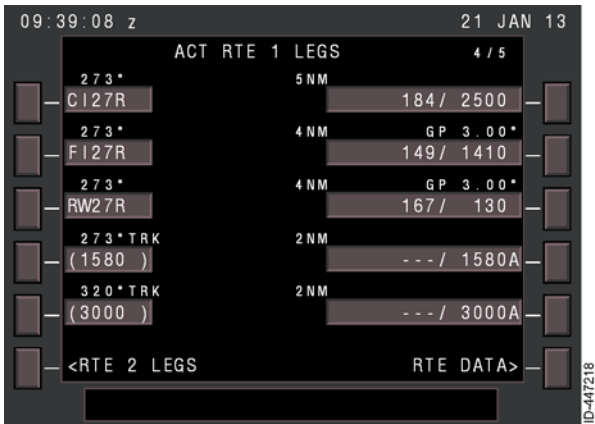
Figure 7–16
Vertical Angle on RTE LEGS Page

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. When 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 FMC 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 be line up with the runway centerline.

NOTE: Vertical guidance is not available for NDB approaches.

The FMC does not automatically tune the procedure specified NAVAID for NDB approaches. The NAVAID must be tuned manually.

DESCENT PROFILE

The FMC creates the descent path with a deceleration at the speed transition altitude (typically 250 knots below 10,000 feet). VNAV plans a speed target 10 knots below the transition speed to allow for unknown tailwinds. The pilot can change the default descent profile by entering any speed and/or altitude restrictions required to meet ATC clearances.

When 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 7–17 shows a descent profile.
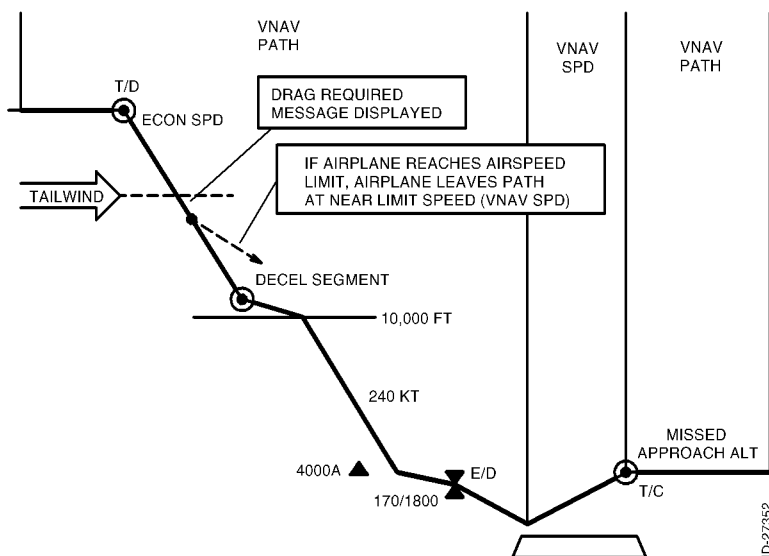
Figure 7–17
Descent Profile

ALTITUDE INTERVENTION

Altitude intervention incorporates the MCP altitude window and knob with the FMC VNAV flight planning for headsup operation. For descent, altitude intervention lets the pilot delete constraints, perform altitude level offs, and resume descent.

Cruise Descent

Setting an altitude below the current cruise altitude in the MCP altitude window and pushing the altitude selector (more than 50 NM from top of descent point) results in the cruise altitude to be set to the MCP altitude and the airplane to descend to the new cruise altitude. The CRZ page displays ACT ECON CRZ DES. When the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by the pilot.

NOTE: Setting an altitude below the current cruise altitude in the MCP altitude window and pushing the altitude selector (within 50 NM from top of descent point) results in an early descent and capture of the descent path. This is described earlier in this section under the DES NOW prompt.

Constraint Deletion

When 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.

NOTE: Deletion of an altitude constraint which is part of an approach procedure, including the one common to the approach and approach transition, by pushing the MCP altitude knob is inhibited. Also, deletion or modification of an altitude constraint on a hold fix that is part of the approach procedure, including the waypoint common with the selected transition, by pushing the MCP altitude knob is inhibited. However, modifications can be made on RTE LEGS page.

Altitude Level Off and Resuming Descent

When the MCP altitude 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 MCP to a lower altitude and pushing the altitude knob on the MCP.

Blank Page

8.   Approach

INTRODUCTION

The FMC ON APPROACH flight phase begins when any of the following conditions are met:

- The DESCENT phase is active and the flaps are moved from 0 degrees

- The first waypoint of the active approach is sequenced

- When the runway or missed approach point is the active waypoint and the distance to go to the runway is less than 25 NM

- When on a direct–to intercept course to the active waypoint, the active bottom of descent constraint is lower than the destination airport elevation plus 500 feet, and the distance to go to the destination airport is less than 12 NM.

The ON APPROACH phase may be delayed if the crew manually inserts, bypasses, or deletes an approach waypoint on the LEGS page.

VNAV guidance can be used to transition onto an ILS or GLS approach or fly an approach other than ILS or GLS. When ON APPROACH flight phase is active, the following describes the path capture, pitch control, and thrust modes when the aircraft is above, below, or on path:

- Above Path – Path capture is enabled, pitch control is speed–on–elevator, and thrust mode is idle.

- Below Path – Path capture is enable, pitch control is path–on–elevator, and thrust mode request is speed–on–throttles.

- On Path – Pitch control is path–on–elevator and thrust mode is the correct performance calculated thrust setting for the current vertical segment of the descent path if the flaps are less than 1. When flaps are 1 or greater, thrust mode is speed–on–throttles.

When ON APPROACH phase is active, the following feature are available:

- The MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current aircraft altitude, VNAV continues to command a descent.

- VNAV remains in VNAV PTH and follows the descent path unless the aircraft accelerates to within 5 knots of the current flap placard speed and the aircraft rises more than 150 feet above the path. In this case, VNAV PTH changes to VNAV SPD.

- When a glidepath angle is specified for one or more legs on the approach, the glidepath angle is displayed on the RTE LEGS page and VNAV provides VNAV PTH guidance at the displayed angle. When sequencing a waypoint prior to a descent leg specified by a glidepath angle, VNAV commands level flight until the airplane intercepts the descent path.

The FMC ON APPROACH flight phase ends when TO/GA is selected, the aircraft lands, or when the aircraft flies beyond the last waypoint in the approach, either the missed approach point or runway. The VNAV page title changes from ACT xxxxx DES to ACT END OF DES.

APPROACH REF PAGE

The APPROACH REF page, shown in Figure 8–1, displays planning data and approach reference speed selection. The APPROACH REF page is displayed by selecting the **INIT REF** key when the aircraft is airborne and CLB mode is not active, selecting APPROACH from the INIT/REF page, or selecting APPROACH from the THRUST LIM page.
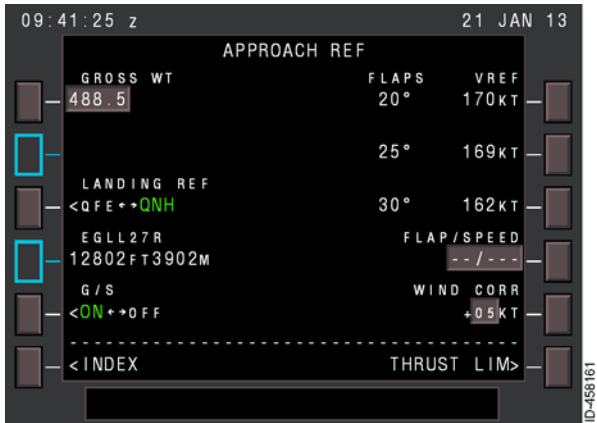
Figure 8–1
APPROACH REF Page

The APPROACH REF page is described in the following paragraphs:

- **GROSS WT (1L)** – The gross weight in 1L is the instantaneous FMC–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.

  NOTE: When both component identifications (CIDs) are displaying the APPROACH REF page, both pages must be exited for the manually entered gross weight to be replaced.

  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. Valid entry is either two or three numeric digits optionally followed by a decimal point and a single tenths digit. Valid range is as defined in the performance database. Permanent changes to gross weight result in recalculation of all performance data and can only be made on the PERF INIT page.

  Box prompts are displayed when gross weight is not available from the FMC.

  The weight is displayed in thousands of pounds or thousands of kilograms, depending on the OPC option.

- **LANDING REF (3L)** – Selecting 3L toggles the landing reference between queens field elevation (QFE) and sea level standard atmosphere pressure (QNH) when not in CLB flight phase and BARO is not set to STD. The active mode is displayed in large green font and the inactive mode is displayed in small white font.

  Selecting QFE sets the cabin pressurization schedule and the destination landing altitude indication to zero altitude. With QFE selected and CLIMB phase is active, changing the barometric setting from QFE to STD results in the landing reference to toggle from QFE to QNH and the green color on the PFD altitude tape is removed. When changing the barometric setting from STD to QFE, the PFD altitude tape background color changes to green.

  When the QFE/QNH option is not enabled, 3L is blank and non–operational.

- **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.

Following a change of destination or execution of a divert, the length of the new destination runway 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 feet long or 3,902 meters long.

NOTE: The pilot cannot enter or clear any data from 4L and this field is cleared when the flight is complete.

- **Glideslope (G/S) (5L)** – G/S is displayed when a localizer–based approach (ILS, IGS, LOC, BAC, LDA, and SDF) is in the currently displayed, selected, or active flight plan. The glideslope permits the FMC to compute a glidepath (G/P) when ILS glideslope is not available (LOC, BAC. LDA, and SDF). The selected state (ON or OFF) is displayed in large green font. The default state is ON for ILS or IGS approaches. The default state is OFF for LOC, BAC, LDA, and SDF approaches.

  The header and data field are blank when a LOC–based approach is not in the active flight plan.

- **<INDEX (6L)** – Selecting 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 (a gross weight is necessary for V_{REF} speed calculations). The data fields of 1R through 3R are blank if the corresponding V_{REF} speed from the performance database do not exist for a given flap setting.

  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.

  The V_{REF} speed is displayed on the PFD. Deleting a pilot–entered value displays dashes in 4R and removes the V_{REF} data from the PFD.

To enter 30° of flaps and 162 knots for landing, select 3R to copy the values shown at 3R to the scratchpad. Selecting 4R selects the scratchpad values to the FLAP/SPEED field, as shown in Figure 8–2.
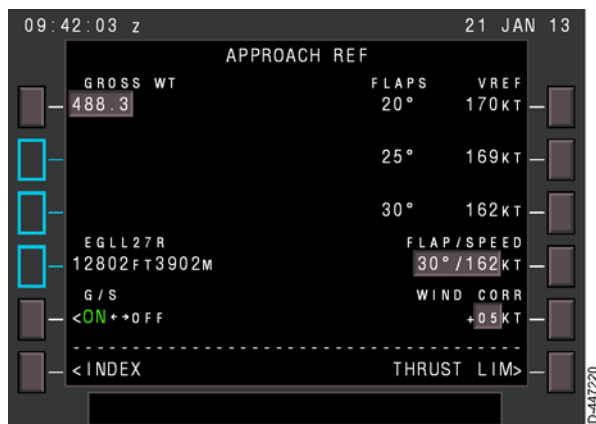
Figure 8–2
APPROACH REF – FLAP/SPEED

- **WIND CORR (5R)** – +05KT is displayed in small font by default when a manual wind correction has not been entered. Valid manual entry range is 0 to 20, inclusive. Deletion of a manual entry returns the display to the default value.

- **THRUST LIM (6R)** – Selecting 6R displays the THRUST LIMIT page.

RADIO TUNING

The radio tuning function can be handled automatically by the FMC, 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. In the unlikely event that an unrecoverable loss of all displays or loss of all three FMCs occurs, radio tuning is handled by the tuning and control panel (TCP). Additional information on backup radio tuning procedures is described in Section 13, FMS Backup Navigation, Controls, and Display Functions.

NAV RADIO PAGE

The NAV RADIO page, shown in Figure 8–3, provides tuning control capability and tuning status display of VOR, ADF, ILS, and GLS receivers. The NAV RADIO page is displayed by selecting **NAV RAD** key.

Figure 8–3
NAV RADIO Page

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 or TACAN associated NAVAID station identifiers, VOR/DME frequencies, frequency/course, or identifier/course entries. Manual entry results in a request for the corresponding VOR and DME receivers to be manually tuned.

  Valid frequency/course entries consists of a frequency between 108.0 to 117.95 (in increments of 0.05) followed by a slash (/) and a three–digit course entry in the range of 000 to 360. The entered course data is displayed in 2L or 2R.

  Valid identifier/course entries consist of a valid identifier followed by a slash (/) and a three–digit course entry in the range of 000 to 360. The entered course data is displayed in 2L or 2R.

  When more than one NAVAID record is found in the NAV database that corresponds to an entered identifier in 1L or 1R, the closest NAVAID to the current aircraft position is used.

An entry in 1L or 1R tunes the associated DME frequency in the respective radio. These fields display frequency, identifiers, and the tuning status. All tuning status symbols are displayed in small font. 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. Deleting a manual tuned frequency and/or station clears the corresponding VOR course and reverts the corresponding channel to autotuning.

— P (procedure autotuning) – The FMC selects NAVAIDs required for approach or departure procedure guidance.

— R (route autotuning) – The FMC–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 FMC a NAVAID for best position orientation.

● **CRS/RADIAL (Line 2)** – The VOR course and radial for the selected VORs are displayed in line 2. VOR course is displayed in green and radials are displayed in white. Valid manual entries for course are in the range of 000 to 360.

A course is autoselected 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 when in autotune (A). Deletion of 2L or 2R when a manually entered course is displayed results in dashed being displayed.

When a valid VOR identifier does not exist in line 1, the VOR course data in line 2 is blank.

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. Radial entries or deletions are not permitted.

● **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. The ADF frequency is displayed in cyan and the status is displayed in white.

Valid entry range is 190.0 to 1750.0 inclusive in increments of 0.5, followed by an A (ANT), B (BFO), or none, which defaults to ADF mode. A valid frequency can be entered over existing ADF frequencies or when dashes are displayed.

When the current mode is BFO or ADF, A can be entered without a frequency to change the mode to ANT. When the current mode is ADF or ANT, B can be entered without a frequency to change the mode to BFO. Deletion of 3L or 3R while in manual ADF, ANT, or BFO mode results in the display of the frequency only (ANT or BFO deleted).

NOTE: ADF frequencies are not tuned automatically and must be entered manually.

When the ADF Left Not Tuning OPC option is enabled, the header and data field in 3L are blank. When the ADF Right Not Tuning OPC option is enabled, the header and data field in 3R are blank. Tuning capability of the ADF through the CDU is disabled when the associated ADF Not Tuning OPC option is enabled.

- **ILS – GLS (4L)** – ILS and GLS tuning information is displayed in 4L. Valid entries are an ILS frequency and front course (XXX.XX/YYY), front course with frequency already entered (/YYY), or GLS channel (XXXXX) in the range of 20000 to 99999.

  The ILS and GLS receivers operate in FMC autotune or manual tuning modes. The FMC autotunes the ILS frequency/course or the GLS channel depending on the approach selected in the flight plan.

  The aircraft position determines the following operating modes:

  — PARK – Indicates the ILS or GLS is not being used and is not tuned. Displayed when electrical power is first applied and when more than 200 NM from top–of–descent or less than half way to the destination (whichever is closer to the destination).

  — XXX.XX/YYY PARK – Indicates the ILS is tuned for the selected approach but is not being used. ILS frequency (XXX.XX), front course (YYY), and PARK are displayed when an ILS, LOC, back course, or GLS approach procedure is part of the active flight plan and when less than 200 NM from top–of–descent or more than half way to the destination (whichever represents the lesser distance to the destination). The pilot can line select the frequency and front course (small font) into 4L to manually tune the ILS (large font).

— A – Indicates autotuning under FMC control for approach guidance. ILS frequency and front course are displayed followed by an A when an ILS, LOC, back course, or GLS approach procedure is part of the active flight plan and 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.

> **NOTE:** Autotuning is inhibited for 10 minutes after takeoff, unless a change in the destination runway has been made.

— M – Indicates the ILS or GLS is manually tuned.

Autotuning does not override manual tuning. Deleting a manually tuned frequency permits 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 feet radio altitude (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 takeoff/go–around (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 1,500 feet RA.

● **PRESELECT (Line 6)** – 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 correct field on the NAV RADIO page. Valid entries are any valid tuning entry.

GO-AROUND MODE

Go-around mode is activated manually using either **TOGA** button or can be automatically activated when a go-around is manually flown.

Go-around mode is activated manually during approach using either **TOGA** button when the flaps are set at other than 0° or glideslope approach mode is engaged. On the detection of go-around mode when the active flight phase is descent or end of descent, the flight phase transitions to active climb and the following occur:

● Any remaining descent constraints in the vertical profile are deleted (the waypoints are retained in the active flight plan).

● The greater of the MCP altitude or the missed approach altitude is loaded as the cruise altitude into the active flight plan.

The lateral flight plan remains unaffected. When a missed approach exists in the active flight plan, all climb constraints are retained. Normal VNAV functionality in active climb or cruise flight phase is available when the **VNAV** button is selected.

During a go-around, the pitch and roll modes change to TO/GA and the autothrottle mode annunciator changes to THR when the **TOGA** button is pushed once. When the **TOGA** button is pushed twice, the autothrottle mode annunciator changes to THR REF.

When the cruise phase is active, the speed target is the most restrictive of speed transition, best hold speed, or ECON cruise (above speed transition altitude).

Automatic Go-Around Mode Detection

Go-around mode is normally activated using either **TOGA** button. If a **TOGA** button is not pushed during a go-around, automatic go-around mode detection occurs when the following conditions are met:

● MCP altitude is greater than current aircraft altitude.

● Rate of climb is 600 FPM or greater.

● Flaps have been retracted from landing position.

— When flaps are extended 20 degrees during approach, flaps are considered retracted from landing position when the current flap position is less than 11.8 degrees.

— When flaps are extended 25 degrees or greater during approach, flaps are considered retracted from landing position when the current flap position is less than 21.8 degrees.

Automatic LNAV Arm/Engagement

When go–around mode is selected using either **TOGA** button, LNAV is automatically armed. LNAV is engaged at 50 feet AGL when the autopilot is disengaged and at 200 feet AGL when the autopilot is engaged.

Automatic LNAV transition during a go–around occurs when the following conditions are met:

- The normal required conditions for LNAV to engage are met.
- The flight plan contains a leg after the destination runway or after the missed approach point when the approach has no runway.

  NOTE: Route discontinuities after the missed approach point will prevent the TO/GA to LNAV function from engaging.

- Flaps are set greater than 0°.

Blank Page

9.   Alternate Airport Pages

INTRODUCTION

The alternate airport pages are used to select alternate airports, display data about the alternate airport, and initiate a diversion to an alternate airport.

ALTERNATE 1/2 PAGE

The ALTN page, shown in Figure 9–1, is used to view the alternates available along the route of flight. The ALTN page is displayed by selecting 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.
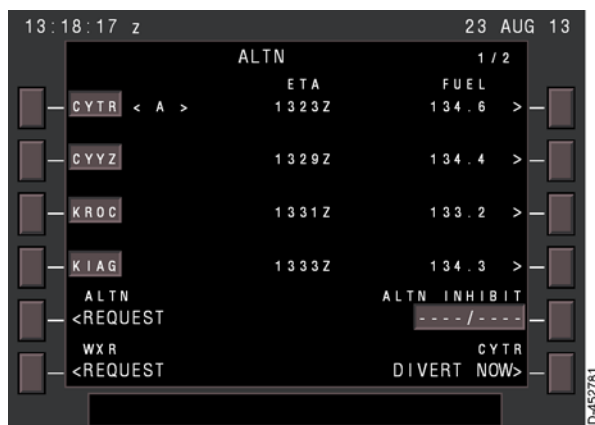
Figure 9–1
ALTN 1/2 Page

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. Alternate airport are displayed on the ND in cyan when within the displayed map range. The letter A inside the airport symbol identifies the airport as one of the alternates shown on ALTN page 1/2. In map mode, the selected airport displays at all times. In plan mode, or map mode with APRT selected, all four alternates shown on ALTN page 1/2 are displayed. When 1280 NM map range is selected, alternates out of the map range are displayed as directional arrows with the ICAO identifier and distance in NM.

ALTN page 1/2 is described in the following paragraphs:

- **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.

  Alternate airports selected from the NAV database are restricted to those airports which have a runway longer than a minimum runway length specified in the AMI. Any alternates displayed in the ALTN INHIBIT field (5R) are not included in the alternates automatically selected by the FMC.

  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 9–1. 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).

  Manual entries must be an airport in the NAV database. When 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.

  Alternates can be uplinked by the way of a company preferred alternates list (ALTN REQUEST in 5L). A pending company preferred alternates uplink removes the previously displayed alternates from the page. When the uplink contains less than four airports, the remaining fields are blank. Acceptance of company preferred alternates uplink results in the display of the alternates in large font. When a priority is included in the uplink, the priority number is displayed to the left of the airport identifier.

  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)** – Selecting 5L transmits a datalink request for a preferred list of alternates (up to four). Uplinked airports are displayed in order of ETA but can be assigned a priority number by the transmitting site. The CDU help window message ALTN UPLINK is displayed when the alternate airport data arrives.

- **<WXR REQUEST/REJECT/ERASE (6L)** – WXR REQUEST is displayed when no alternate weather data request has been initiated and datalink status is ready. Selecting WXR REQUEST transmits a datalink request for alternate airport weather information. Uplinked weather is sent to the flight deck printer.

  REJECT is displayed when a company preferred alternate uplink is pending. Selecting REJECT results in returning all field to the pre–uplinked state and initiates a downlink response.

  ERASE is displayed when a pending flight plan modification is created when a pending company preferred alternate uplink does not exist. Selecting ERASE results in erasing any pending modifications.

- **ETA (1C through 4C)** – The ETA is displayed for each of the alternates in 1C through 4C. The ETA is calculated based on the routing, altitude, and speed displayed on the XXXX ALTN page. 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/ALTN Page Access Prompt (1R through 4R)** – The predicted arrival fuel is displayed for each alternate airport in 1R through 4R in thousands of pounds or kilograms (depending on option). The fuel display is blank when the aircraft is on the ground.

  The XXXX ALTN page access prompt is displayed as a large font > to the right of the predicted arrival fuel display. Selection of 1R through 4R displays the associated XXXX ALTN page, where XXXX is the alternate airport name.

- **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. Airports must be separated by a slash (/) when 2 are entered at the same time.

- **DIVERT NOW/ACCEPT> (6R)** – DIVERT NOW is displayed when a pending company preferred alternate uplink or pending alternate inhibit uplink does not exist. Selecting DIVERT NOW 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 DIVERT NOW is selected, the MOD XXXX ALTN page for the selected alternate is automatically displayed.

  The following occurs when executing the diversion:

  — 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

  — When a descent path exists, deletes all descent constraints (DESCENT PATH DELETED is displayed in the CDU help window when DIVERT NOW is selected).

  ACCEPT is displayed when a company preferred alternate uplink is pending. Selecting ACCEPT results in the company preferred alternated uplink data or alternate inhibit uplink data being displayed in large font and initiates a downlink response.

ALTERNATE LIST 2/2 PAGE

The ALTN LIST 2/2 page, shown in Figure 9–2, is displayed by selecting the **NEXT PAGE** or **PREV PAGE** key when the ALTN 1/2 page is displayed.

Figure 9–2
ALTN LIST 2/2 Page

The ALTN 2/2 LIST page 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.

The ALTN LIST 2/2 page is described in the following paragraphs:

- **Alternate Airport List (Lines 1 through 4)** – The four lines display up to five alternate airports on each line. Up to 20 airports that can be used as alternates. The alternates displayed on the ALTN 1/2 page can be manually selected from this list when preferred uplinked airports do not use all four selections.

- **ALTN LIST REQUEST (5L)** – Selecting the ALTN LIST REQUEST prompt in 5L transmits a datalink request for an alternate airport list uplink. The alternate list is uplinked directly to this page. No manual entries are permitted on this page. Manual airport entries can only be entered on the ALTN 1/2 page.

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

- **ALTN LIST PURGE (5R)** – The entire alternate list can be deleted by selecting the ALTN LIST PURGE prompt in 5R. When ALTN LIST PURGE prompt is selected, a CONFIRM prompt is displayed. Selecting CONFIRM deletes all current airports from the alternate airport list.

XXXX ALTN PAGES

Each of the 4 alternate airports displayed on the ALTN 1/2 page has a related XXXX ALTN page. The XXXX ALTN page, shown in Figure 9–3, displays specific information about alternate airports, the route used for a diversion, and the conditions on which the ETA and fuel calculations are based on. All data on the page is related to the alternate airport displayed in the page title.

Figure 9–3
XXXX ALTN Page

The XXXX ALTN pages are displayed by selecting 6R (DIVERT NOW) on the ALTN 1/2 page or by selecting the > prompt next to the desired alternate on the ALTN 1/2 page.

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 as DIRECT, OFFSET, and 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.

  — **DIRECT TO (1L)** – Selecting 1L selects a direct route from the aircraft present position to the airport. All flight plan waypoints are deleted.

— **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. Flight plan waypoints are retained.

— **OVERHEAD (3L)** – Selecting 3L and selecting the **EXEC** key creates an overhead diversion that constructs a flight path that retains the active flight plan to the OVERHEAD fix and then creates a path directly to the alternate airport.

The default OVERHEAD fix is the active waypoint. The default OVERHEAD can be changed by the pilot by entering any waypoint in the active or modified flight plan. A pilot–entered OVERHEAD fix is displayed in large font.

When a hold is associated with the OVERHEAD fix, the hold is retained and is followed by the leg to the alternate airport.

- **<ALL ENG/ENG OUT (5L)** – ALL ENG is displayed when the engine out mode has been selected for the vertical profile. Selecting ALL ENG results in an all engine vertical profile for the modified flight plan.

ENG OUT is displayed when the engine out mode has not been selected for the vertical profile. Selecting ENG OUT results in a single engine minimum drag profile for the modified flight plan.

- **ALTN/ERASE (6L)** – ALTN is displayed when no pending modification exists. Selecting ALTN displays the ALTN 1/2 page.

ERASE is displayed when a pending modification exists. Selecting ERASE erases any pending modification or changes made to this page while a modification is pending.

- **ALT (1R)** – The advisory cruise altitude that is used for ETA and arrival fuel calculations is displayed in 1R. Valid entry is any altitude or flight level. Entries are made manually or by uplink. Entry of an ALT value in 1R is propagated to all alternates and display on each ALTN page. The default value is from the AMI and displayed in small font. When an AMI value does not exist, the default value is the FMC computed all engine or engine out diversion altitude in small font.

- **SPD (2R)** – The speed that is used for ETA and arrival fuel calculations is displayed in 2R. Entries are made manually or by uplink. Entry of an SPD value in 2R is propagated to all alternates and displayed on each ALTN page. Valid entries can be any of the following:

  — CAS value in the range of 100 to 400

  — Mach value in the range of 0.100 to 0.990

  — LRC (long-range cruise), ECON (economy), EO (engine out), EOLRC (engine out long-range cruise), CO (company speed).

  The header displays LRC, ECON, EO, EOLRC, or CO following a pilot-entry of the associated speed mode. The header displays EO when a CAS or MACH value is entered while in modified or active engine out mode. The header displays SPD when a CAS or MACH value is entered while in active or modified all engine mode.

  The default value is from the AMI and is displayed in small font. When an AMI value does not exist, the default value is the FMC computed all engine or engine out diversion altitude in small font.

- **WIND (3R)** – The predicted average wind for the divert route is displayed in 3R. Valid entry is a manual direction in degrees and a speed in knots from 0 to 250 or by uplink. A wind entry in 3R for any alternate applies to that alternate only. The default display is dashes when no valid data exists and a company preferred alternate uplink is not pending.

- **ALT/OAT (4R)** – The OAT for a specified altitude is displayed in 4R. Valid entry is an altitude in the standard altitude format and range followed by a slash and a one- to three-digit OAT temperature in °C between –99 and 60. An ALT/OAT entry for any alternate applies to that alternate only. The default display is dashes when no valid data exists and a company preferred alternate uplink is not pending.

- **ETA/FUEL (5R)** – The calculated airport ETA and arrival fuel based on the selected route, altitude, and speed are displayed in 5R. The displayed values in 5R are the same as those displayed in the center fields on the ALTN page. If the fuel prediction for the alternate is less than zero, UNABLE FUEL is displayed in large font. UNABLE ALT is displayed in large font when the entered altitude for an individual alternate is above the calculate maximum for that alternate or if the aircraft would not reach the altitude before reaching the TOD point. If UNABLE FUEL and UNABLE ALT conditions both exist at the same time, UNABLE ALT is displayed.
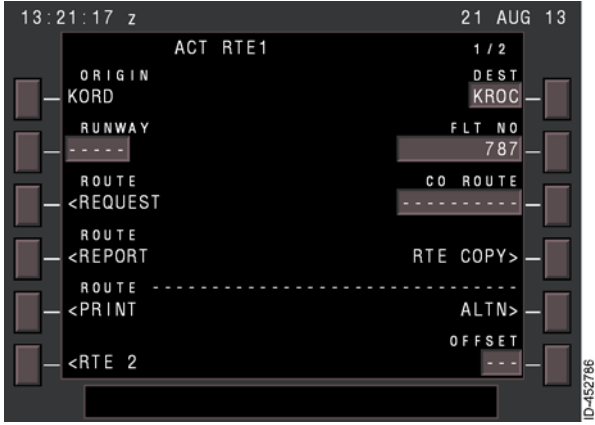
- **DIVERT NOW> (6R)** – This prompt is the same as on the ALTN 1/2 page (described earlier in this section).

    NOTE: After a diversion is executed, the XXXX ALTN page is not updated until the XXXX ALTN page is exited on all CDUs.

Procedure 9–1 describes the steps to select an overhead route to the waypoint AMERT and then to the alternate KROC.

Step	Procedure 9–1 Selecting an Overhead Route
1	ARMET is the active waypoint and is the default OVERHEAD fix. Select 3L to select OVERHEAD on the KROC ALTN 2/4 page. <SEL> is displayed in 3L, as shown in Figure 9–4. NOTE: The default OVERHEAD waypoint can be changed by the pilot by entering any waypoint in the active or modified flight plan. **Figure 9–4** **ALTN Page - OVERHEAD**

Step	Procedure 9-1 Selecting an Overhead Route (cont)
2	Select 6R to select the diversion. The prompt in 6R changes to SELECTED and the page title changes to MOD KROC ALTN, as shown in Figure 9-5.

Figure 9-5
DIVERT - SELECTED

Step	
3	Select the **EXEC** key to execute the diversion. <ACT> is displayed in 3C, as shown in Figure 9-6, to indicate the active route option.

Figure 9-6
ACT ALTN Page

Step	Procedure 9–1 Selecting an Overhead Route (cont)
4	Executing the diversion to KROC changes the destination in the active route to KROC. This is shown on the ACT RTE 1 page shown in Figure 9–7.

Figure 9–7
ACT RTE 1 Page

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10. Advanced Flight Planning

INTRODUCTION

This section covers the following:

- Creating waypoints

- FMC 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 (PBD)

- Place bearing/place bearing (PB/PB)

- Along track

- Latitude/longitude

- Course intersection.

Generally, waypoints are entered in the scratchpad, then moved to the desired location by selecting 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 CDU help window. When the pilot tries to enter a waypoint that refers to an identifier that is not in the NAV database, NOT IN DATABASE is displayed in the CDU help window.

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 distance (in miles) for the newly defined waypoint. The created waypoint is then inserted into the route. For example, entering ELN/25 creates an along track waypoint 25 NM after ELN on the present route, and entering ELN/−30 creates an along track waypoint 30 NM before ELN on the present route. The distance entered 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 latitude/longitude waypoints.

Latitude/Longitude Waypoints

Latitude/longitude 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 7-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.

Interval latitude or longitude waypoints are entered as a latitude or longitude followed by a dash, then the desired increment for the multiple interval waypoints. For example, entering W060-10 adds waypoints starting at W060 in 10-degree increments from that point to the destination. The latitude or longitude reporting waypoints are entered on a RTE LEGS page by entering the interval waypoint into the scratchpad and upselecting to the line before the first desired waypoint. This entry can be made on any waypoint along the route that exists prior to the occurrence of the beginning latitude or longitude.

Airway Crossing Fixes

Airway crossing fixes are entered as a 5-character waypoint name (when a waypoint exists at the intersection) or by entering consecutive airways on the RTE page. When 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.

Table 10–1
Pilot Waypoint Construction

Type of Waypoint	CDU Page	Valid Entry	Invalid Entry	Examples
NAV database waypoint	RTE or RTE LEGS	NAVAID, airport, waypoint, runway	Waypoint not in database	NAVAID: BAE, TOTNB Airport: ASSY Waypoint: AUGER Runway: RW30R
Place bearing/distance	RTE or RTE LEGS	NAVAID, waypoint	Runway fix, LOM, MM, lat/long	DEN090/70 OBK274/61
Place bearing/place bearing	RTE or RTE LEGS	NAVAID, waypoint	Lat/long, distance greater than 700 NM from either fix	ORD125/CGT097 FSO360/CCR090
Latitude/longitude	RTE or RTE LEGS	Lat/long with leading zeros (required)	When lat or long contains minutes, both lat and long must have trailing zeros	N45W165 N3728.0W13309.0 N3750.0W12500.0
Along track waypoint	RTE LEGS	Waypoint must exist on RTE LEGS page. (–) is prior to waypoint	Cannot coincide or extend beyond another existing waypoint	SFO/–35 DEN/30
Crossing latitude or longitude	RTE LEGS	Route that crosses entered latitude or longitude	Route does not cross entered latitude or longitude	W123, N05
Interval latitude or longitude	RTE LEGS	Route that crosses latitude or longitude followed by a dash (–) and interval in degrees.	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

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:

1. Passing an altitude

2. Flying a heading to a radial

3. Flying a heading to DME distance

4. Intercepting a course

5. Heading vectors.

Altitude and course intercept conditional waypoints are displayed on the CDU inside parentheses ( ).

LNAV will fly the VECTORS leg while it remains active. The VECTORS leg will sequence (go inactive) when LNAV is disengaged (i.e., when HDG HLD or HDG SEL is active) or when the pilot activates another waypoint (i.e., when direct–to another point is selected).

Figure 10–1 shows different types of conditional waypoints.
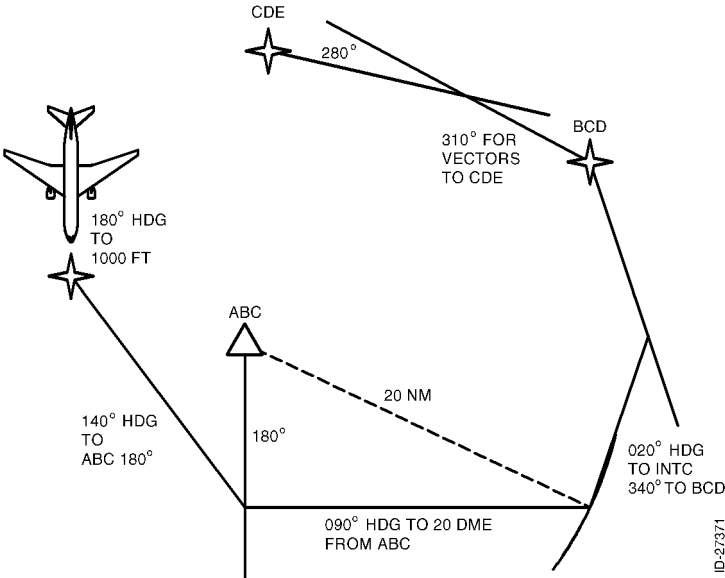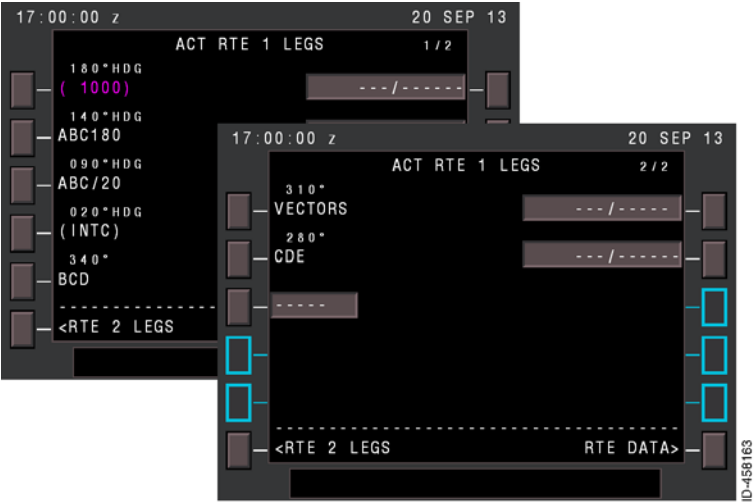
Figure 10–1
Conditional Waypoints

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.

For airports with more than one approach to the same runway, the two–letter prefix may change to enable different identifiers for the same waypoint. The first letter identifies the type of fix and the second identifies the type of approach as follows:

- I( ) – Initial approach fix
- D( ) – Minimum descent altitude
- T( ) – Touch down point
- R( ) – Runway centerline intercept
- C( ) – Final approach course fix
- F( ) – Final approach fix
- P( ) – Missed approach point
- ( )I – ILS

D201207000032   *Advanced Flight Planning*
REV 0   Mar 2014   10-7
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- ( )L – Localizer only
- ( )B – Back course ILS
- ( )D – VOR/DME
- ( )V – VOR only
- ( )S – VOR with DME points
- ( )N – NDB
- ( )Q – NDB with DME points
- ( )T– TACAN
- ( )R – RNAV.

Table 10–2 lists the FMC abbreviations combinations that can be used with the runway number when multiple approaches exist to that runway (parentheses after the waypoint type are included to compare with abbreviations previously listed). 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.
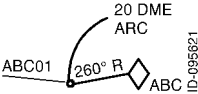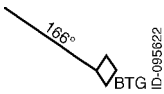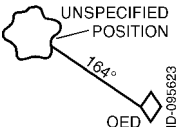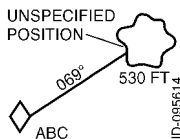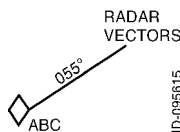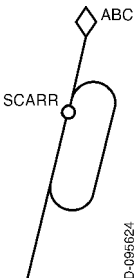
Table 10–2
FMC Abbreviations for Runways With
Multiple Approaches

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
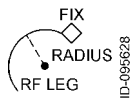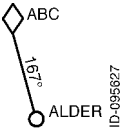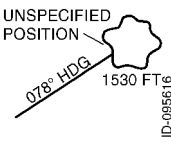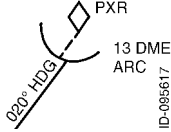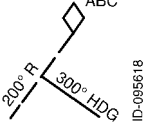
Navigation Leg Types

Table 10–3 lists the different types of flight plan legs that are displayed on the CDU and ND during a typical flight.
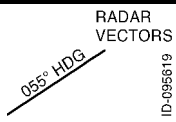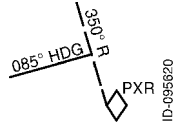
Table 10–3
Navigation Leg Types

Legs	Example	Description	CDU	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 can 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

Table 10-3 (cont)
Navigation Leg Types

Legs	Example	Description	CDU	Condition
IF	SEA	Initial fix	- - -° SEA	Leg is ignored if created by the NAV database. Leg is inserted as a route discontinuity if created manually.
PI		Procedure turn	PROC TURN (INTC)	Tuned NAVAID required. Always followed by a CF leg.
RF	FIX RADIUS RF LEG	Constant radius turn between two database fixes, lines tangent to the arc, and a center fix.	DD ARC WPT	No required NAVAID.
TF	ABC 167° ALDER	Track between two fixes	167° ALDER	Direct to fix, fix to fix, or in-tercept to fix. No required NAVAID.
VA	UNSPECIFIED POSITION 078° HDG 1530 FT	Heading to an altitude	078° HDG (1530)	Tuned NAVAID can be required.
VD	PXR 13 DME ARC 020° HDG	Heading to a DME distance	020° HDG PXR/13	Heading to a DME arc. Tuned NAVAID required.
VI	ABC 200° R 300° HDG	Heading to a course intercept	300° HDG (INTC)	Heading to an intercept leg. Tuned NAVAID can be required.

Table 10‑3 (cont)
Navigation Leg Types

Legs	Example	Description	CDU	Condition
VM	RADAR VECTORS 055° HDG ID-095619	Heading to a manual termination	055° HDG **VECTORS**	Tuned NAVAID can be required.
VR	350° R 085° HDG PXR ID-095620	Heading to a VOR/DME radial	085° HDG **PXR350**	Tuned NAVAID required.

LNAV WAYPOINT IDENTIFIERS

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display. NOT IN DATABASE is displayed in the CDU help window when 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.

FMC–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 previous 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

When 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 can be accomplished 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 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.

FMC Polar Operations

The FMC automatically begins polar operation when the calculated aircraft position enters a polar region. All information from the FMC to the flight displays is referenced to true north while in these regions. Figure 10–2 displays the Polar Regions.
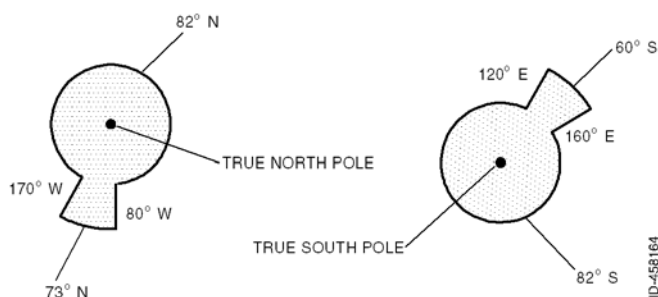
Figure 10–2
Polar Regions

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.

The current GRID heading displays near the top of both NDs when the airplane is North of 70 °N or South of 70 °S.

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.

RTE 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 shown in Figure 10–3.
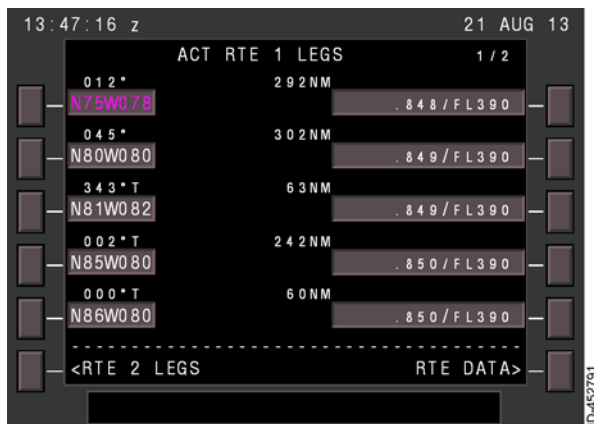
Figure 10–3
RTE LEGS – Magnetic vs True

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 that is bounded by N73°, N82°, W80°, and W170° shown in 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 TRUE 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 commands an unwanted turn. LNAV is the preferred roll mode.

GPS FAILURE IN POLAR NAVIGATION

Loss of both GPS units results in an increased actual navigation performance (ANP) and possible display of the NAV UNABLE RNP message, but this normally would not prevent polar operation.

IRS FAILURE IN POLAR NAVIGATION

The inertial reference system (IRS) 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 IRS does fail, the non–normal checklist provides the crew with inoperative items and necessary crew actions.

If the IRS fails in a polar region, the EICAS advisory message NAV INERTIAL SYS displays and all autopilot and AFDS roll modes fail. When heading information is restored by entry of a reference heading on the POS INIT page, HDG SEL and HDG HOLD roll modes are restored. GPS continues to provide navigation data to the FMC and active route information displays on the ND. When operating in this degraded mode, heading on the POS INIT page may be referenced to magnetic, true, or grid heading. The heading display drifts significantly under these conditions. Periodic updating of the heading reference on the POS INIT page should be accomplished at least every 10 minutes.

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 IRS failure, flight crews should plan a raw data approach.

HOLDING PATTERNS

This section describes holding patterns and how the FMC calculates a holding pattern. Creating and modifying holds and holding pattern guidance is described in detail in Section 6, Cruise.

Holding Pattern Types

There are three types of holding patterns used as legs in a flight plan. The main difference between them is how they are terminated.

● **Holding Pattern to a Fixed Waypoint (HF)** – A fixed waypoint hold terminates when the aircraft first sequences the holding fix after the hold becomes active. The aircraft makes one circuit in the hold or of the entry procedure (teardrop, parallel), then exits automatically along the route of flight.

● **Holding Pattern with an Altitude Termination (HA)** – This hold termination is dependent on the altitude specified in the flight plan, and is most often used when terrain is a consideration during the CLIMB phase. When the aircraft reaches or exceeds the altitude specified in the flight plan before the HA leg is active, the aircraft does not enter the hold. When the specified altitude is reached while in the hold, the hold is terminated when the aircraft next crosses the fix, and the flight plan route is continued. When the EXIT HOLD prompt is selected for an HA holding pattern and the aircraft is active in the first turn or the outbound leg, the holding pattern is truncated by shortening the outbound leg.

● **Holding Pattern with a Manual Termination (HM)** – This hold is terminated manually when the EXIT HOLD prompt is selected. When the EXIT HOLD prompt is selected for an HM holding pattern and the aircraft is active in the first turn or the outbound leg, the holding pattern is truncated by shortening the outbound leg.

HF and HA holds are from the NAV database and are normally procedure specified or necessary due to flight conditions. The pilot cannot enter HF or HA holds into the flight plan. The pilot can delete HF or HA holds, when desired. Manual holds are pilot–entered holding patterns and are the type most often used. Manual holds can be entered at any waypoint, including the FROM waypoint (present position hold).

When a direct-to is executed while in any type of hold, the FMC exits the hold immediately.

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Advanced Flight Planning
10-19

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FIX TERMINATED HOLD (HF)

Fix terminated holds can occur in any flight phase but normally occur in descent. A fix terminated hold consists of only one turn (or partial turn) around the pattern. The FMC exits the hold when the aircraft crosses the hold fix the first time after entering the hold. There is no annunciator to alert the pilot when the hold is terminated. The RTE HOLD page is not accessible for HF holds.

Fix terminated holds display PROC HOLD above the holding fix on the ACT RTE LEGS page, as shown in 3L in Figure 10–4.
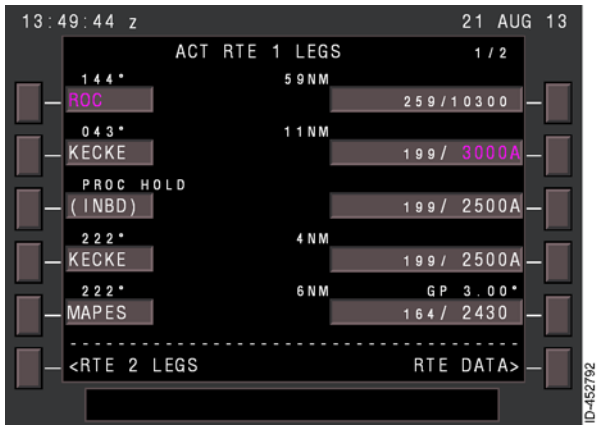
Figure 10–4
PROC HOLD

ALTITUDE TERMINATED HOLD (HA)

Altitude terminated holds contain an AT OR ABOVE altitude constraint. Altitude terminated holds only occur in climb and the aircraft stays in the holding pattern until the AT OR ABOVE constraint is met. Altitude terminated holds display HOLD AT above to the holding fix on the ACT RTE LEGS page.

When the aircraft is at or above the specified altitude before reaching the holding fix, the hold is not flown.

During the hold, when the altitude constraint is met, the FMC 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 hold is manually terminated by selecting the EXIT HOLD prompt on the HOLD page and selecting the **EXEC** key. When selected, the FMC 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.

Manually terminated holding patterns display HOLD AT above the holding fix, as shown in 5L on the ACT RTE LEGS page in Figure 10–5.
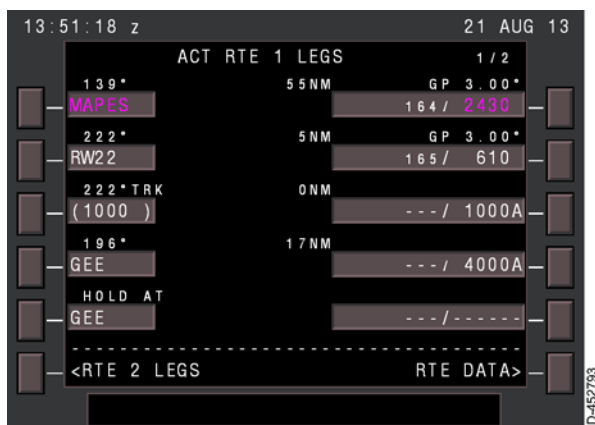
Figure 10–5
HOLD AT on ACT RTE LEGS Page

Creating and Modifying Holding Patterns

Manual holds are created on the ACT RTE LEGS HOLD AT page. Holds are modified on the MOD RTE HOLD page. When a hold does not exist in the flight plan, selecting the **HOLD** key displays the ACT RTE LEGS HOLD AT page, shown in Figure 10–6. The pilot can specify a desired fix for the hold by entering the fix in 6L or select a present position hold by selecting 6R (PPOS).
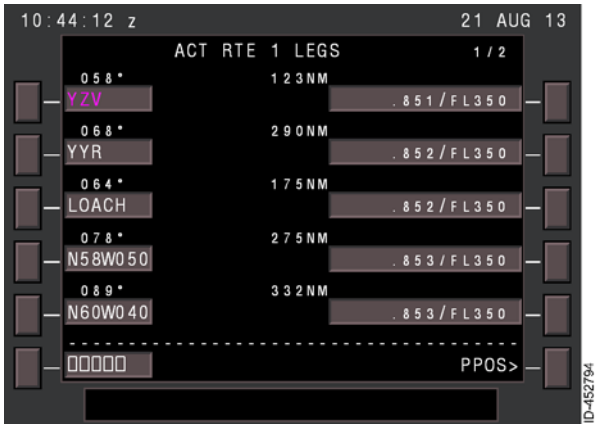
Figure 10-6
ACT RTE LEGS HOLD AT Page

When one or more holds exist in the flight plan, selecting the **HOLD** key displays the ACT RTE HOLD page shown in Figure 10–7. The ACT RTE HOLD page displays the nearest hold in the flight plan. The ACT RTE LEGS HOLD AT page is displayed by selecting 6L (NEXT HOLD) on the ACT RTE HOLD page. When more than one hold exists, the next nearest hold in the flight plan is displayed by selecting the **NEXT PAGE** key.
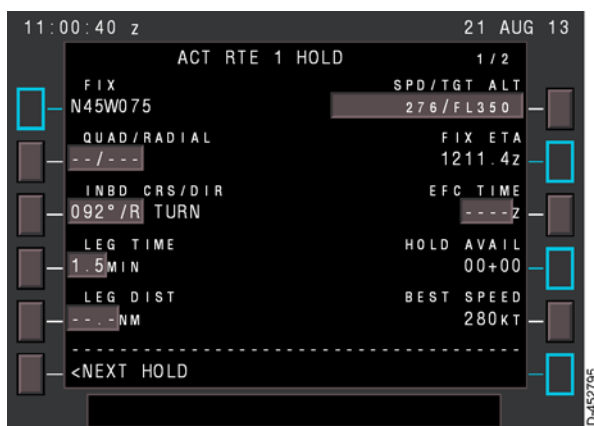
Figure 10–7
ACT RTE HOLD Page

Holding Patterns on the ND

Two types of symbols are displayed 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 can change when crossing the holding fix and is especially true of the first holding fix crossing during DESCENT holding patterns without a deceleration segment.

When the map range is 80 NM or less and the holding entry segment is the active leg or the next active leg, the holding pattern entry is displayed on the ND. The holding pattern entry is removed from display when the holding pattern entry segment is sequenced and the holding pattern is the active leg.

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). When the FMC performance function is initialized, 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. When the FMC performance function is not initialized, the speed used is the true airspeed from the air data reference system (ADRS), 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 FMC holding command speed, plus the absolute magnitude of the wind vector. The FMC holding command speed is determined according to the following:

- When speed intervention is being used, the FMC command speed is the MCP speed.

- Otherwise, when a constraint speed is entered 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 FMC computed best hold speed limited by V_{GMIN} is used.

  NOTE: When the holding pattern is entered initially in DESCENT, the FMC command speed can be the active descent speed (for example, ECON speed) when 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. Strong winds or airspeed in excess of FAA or ICAO entry speeds may results in the airplane flying out the protected airspace.

When 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 FMC 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 (when the FMC performance function is not initialized).

Deceleration Segments

The FMC calculates a deceleration distance so the aircraft can then achieve the FMC–holding command speed at the start of the holding pattern or procedure hold entry. When in DESCENT, this deceleration distance is calculated as part of the descent path.

Holding Pattern Entry Types

The aircraft must cross the holding fix before the FMC generates guidance commands to enter the hold. The FMC uses three types of holding pattern entry:

- Parallel
- Teardrop
- Direct entry.

The type of entry is determined by the aircraft track (not heading or direction from which the active route approaches) when crossing the holding fix. The holding entry path is displayed on the ND. Figure 10–8 shows the various holding entry sectors.
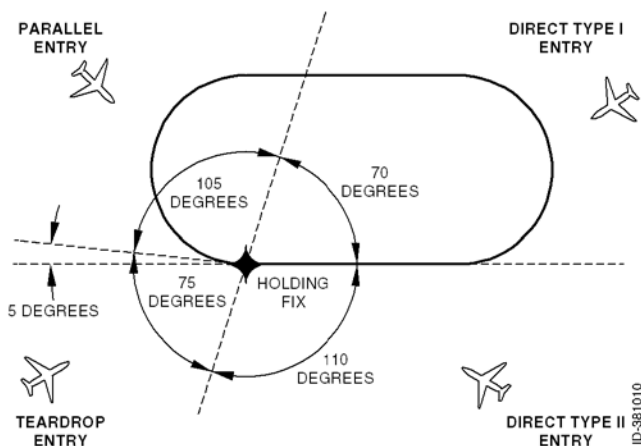
Figure 10–8
Holding Entry Sectors

Holding pattern entries are designed to keep the aircraft within the bounds of the racetrack pattern. At the start of the holding pattern entry, the holding fix may be treated as a fly–by waypoint. Remaining within the prescribed holding airspace required the airplane to be at holding airspeed at the holding fix.

The airplane flies the initial outbound leg as a computed distance from the holding fix. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active.

PARALLEL HOLD ENTRY

Parallel entries are constructed with a leg parallel to the inbound course and a 180° turn towards the holding fix, as shown in Figure 10–9. 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.
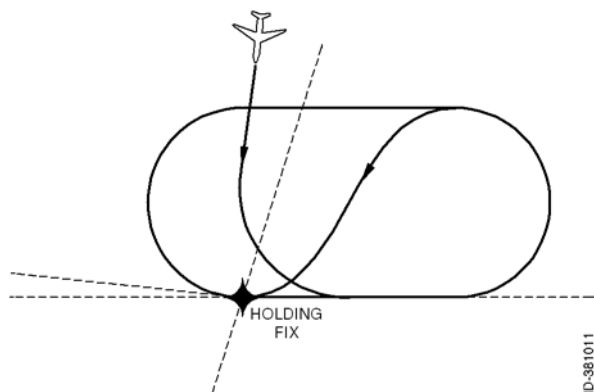
Figure 10-9
Parallel Entry Path

To permit construction of a continuos entry path, the hold entry leg parallel to the inbound course may be extended by the FMC, as required, to permit the aircraft to cross the holding fix inbound.

TEARDROP HOLD ENTRY

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, as shown in Figure 10–10. The distance of the teardrop leg is 2.95 times the turn radius. After the turn, LNAV captures the inbound course.

NOTE: The dividing line between a teardrop and parallel entry is offset 5° so that an entry flown approximately along the reciprocal of the inbound course always selects a teardrop entry.
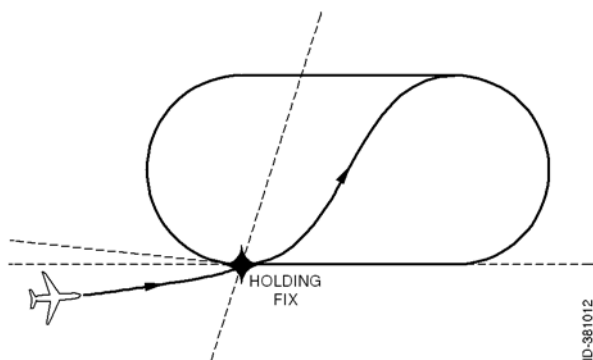
**Figure 10–10
Teardrop Entry Path**

DIRECT HOLD ENTRIES

Direct entries are constructed in two types, Type I and Type II. When a Type I direct holding entry is determined, the aircraft crosses the holding fix and intercepts a circular arc of the computed holding radius until an extension of the outbound leg of the computed holding fix is intercepted, as shown in Figure 10–11.
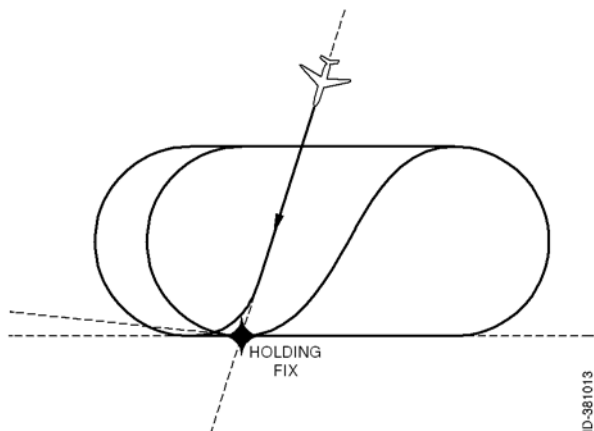
Figure 10–11
Direct Entry Path – Type I

When a Type II direct entry is determined, the aircraft crosses the holding fix until beginning a turn to intercept the outbound leg of the calculated holding pattern, as shown in Figure 10–12.
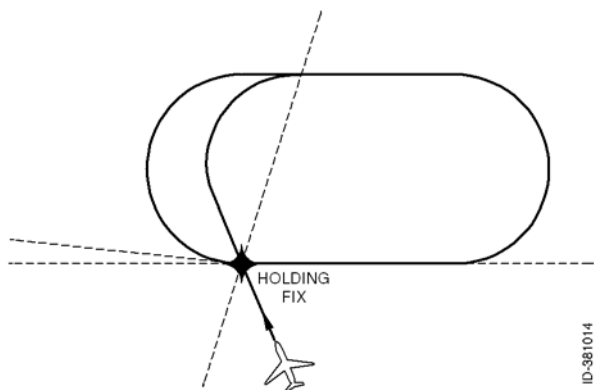
Figure 10–12
Direct Entry Path – Type II

Holding Pattern Guidance

The geometry of the holding pattern, shown in Figure 10–13, 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.
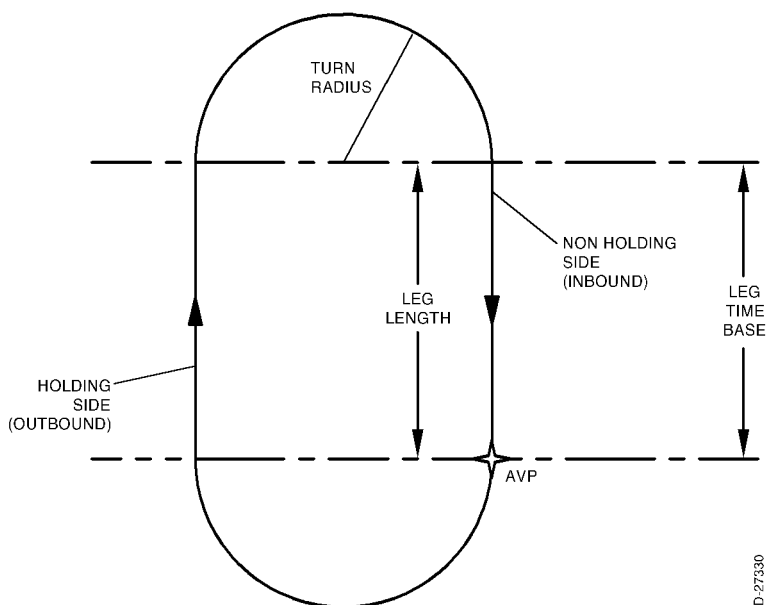
Figure 10–13
Holding Pattern Geometry

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

HOLDING PATTERN GUIDANCE IN CLIMB

During the Climb phase, the FMC 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 permitted in the Climb phase.

Altitude Terminated Holds in Climb

For altitude terminated holding patterns, the hold is flown until the AT OR ABOVE constraint is met. When 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

When the hold is constrained by an AT OR BELOW constraint, the FMC climbs until reaching the constraint or the MCP altitude, whichever is lower. When the aircraft is already above the constraint or the MCP altitude when VNAV is engaged, the FMC levels off at the current aircraft altitude.

When the hold is constrained by a window constraint, the FMC climbs until reaching the upper altitude constraint or the MCP altitude, whichever is lower. When the aircraft is already above the upper altitude constraint or the MCP altitude when VNAV is engaged, the FMC levels off at the current aircraft altitude.

When the hold is constrained by an AT OR ABOVE constraint, the FMC climbs until reaching the cruise altitude, the next AT constraint, the next AT OR BELOW constraint, or the MCP altitude, whichever is lowest.

When the hold is not constrained, the FMC 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 permitted in CRUISE. The hold is always at the cruise altitude and all types of altitude constraints are permitted but cannot be above the cruise altitude. When a hold constraint below the cruise altitude is entered, the FMC enters the Descent flight phase.

HOLDING PATTERN GUIDANCE IN DESCENT

While flying in the Descent flight phase, the FMC 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 permitted in Descent.

The following assumes the MCP altitude is set below the descent path altitude and all constraint altitudes. While in Descent, the FMC always captures the MCP altitude when descending from above the MCP altitude and levels off at the current aircraft altitude when VNAV is engaged when the aircraft is below the MCP altitude.

When the hold is constrained by an AT OR BELOW constraint, the FMC descends until reaching the constraint or the descent path altitude, whichever is lower. When the aircraft is already below the constraint and the descent path altitude when VNAV is engaged, the FMC levels off at the current aircraft altitude.

When the hold is constrained by a window constraint, the FMC descends until reaching the lower altitude constraint or the descent path altitude, whichever is higher. When the aircraft is already below the lower altitude constraint when VNAV is engaged, the FMC levels off at the current aircraft altitude. When the aircraft altitude at the hold fix is above the upper altitude, the FMC descends until reaching the upper altitude constraint.

When the hold is constrained by an AT OR ABOVE constraint, the FMC descends until reaching the constraint altitude or the descent path altitude, whichever is higher. When the aircraft is already below the constraint when VNAV is engaged, the FMC levels off at the current aircraft altitude. When the hold is not constrained, the FMC descends until reaching the descent path altitude. When the aircraft is already below the descent path altitude when VNAV is engaged, the FMC levels off at the current aircraft altitude.

Holding Pattern Exit Transition

A holding pattern is exited by selecting the EXIT HOLD prompt during a hold or selecting a direct-to any fix.

When the EXIT HOLD prompt is selected for an HA or HM holding pattern and the aircraft is active in the first turn or the outbound leg, the holding pattern is truncated by shortening the outbound leg. The shortened outbound leg is created long enough to permit a curved path transition back to the holding fix, as shown by a dashed line in Figure 10-14.
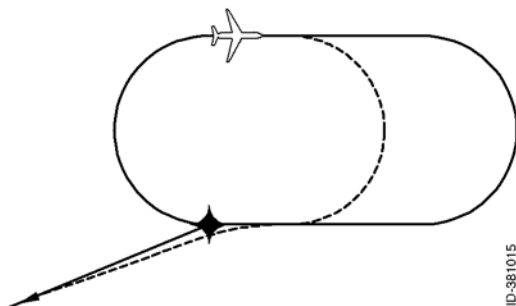
Figure 10-14
Holding Pattern Exit

When the aircraft is on turn 2 of the holding pattern (turning inbound) or on the inbound leg, the holding pattern is unable to be truncated as the most direct path to the holding fix is already active. The aircraft continues on the normal holding pattern path until sequencing the holding fix.

The holding pattern is truncated for direct hold entries and established holding patterns. When the EXIT HOLD prompt is selected during a teardrop or parallel holding entry, the entry is flown completely and the hold is exited when approaching the holding fix.

11. Flight Management Computer (FMC) Datalink

INTRODUCTION

The onboard communications system facilitates two-way datalink communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the aircraft communications system to a receiver on the ground. Information can be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink. Data is transmitted from a ground station for input to the FMC. 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 and manual and automatic uplinks. Takeoff datalink is an OPC option.

MANUAL DOWNLINKS

Downlink requests for data can be initiated by selecting the REQUEST prompt. The REQUEST prompt (as configured by the airline) may be displayed on the PERF INIT, TAKEOFF REF (systems with the takeoff datalink option only), DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages, shown in Figure 11–1.
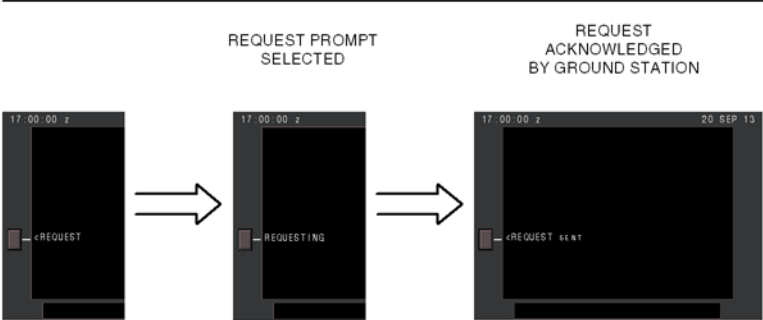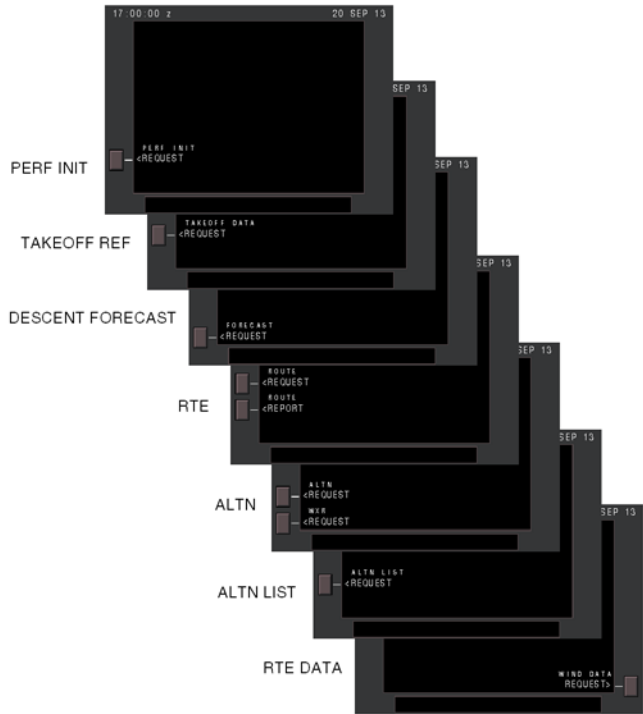
Figure 11–1
FMC Datalink Requests

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. Radios supporting datalink operations can be reconfigured by the crew with the MFD COMM function.

Figure 11-2
FMC Datalink Status

The status messages are as follows:

- **FAIL**

  — The data communications management function is inoperative, or

  — All the data radios have failed.

- **NO COMM** – The data radios are operational but 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

Data can be uplinked from the airline dispatcher directly to the PERF INIT, TAKEOFF REF (systems with the takeoff datalink option only), 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 help window message and with an UPLINK label above the correct COMM page prompt.

When there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the COMM page is not displayed.

For systems with the takeoff datalink option, 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).

Figure 11–3 shows the FMC datalink uplink message flow.
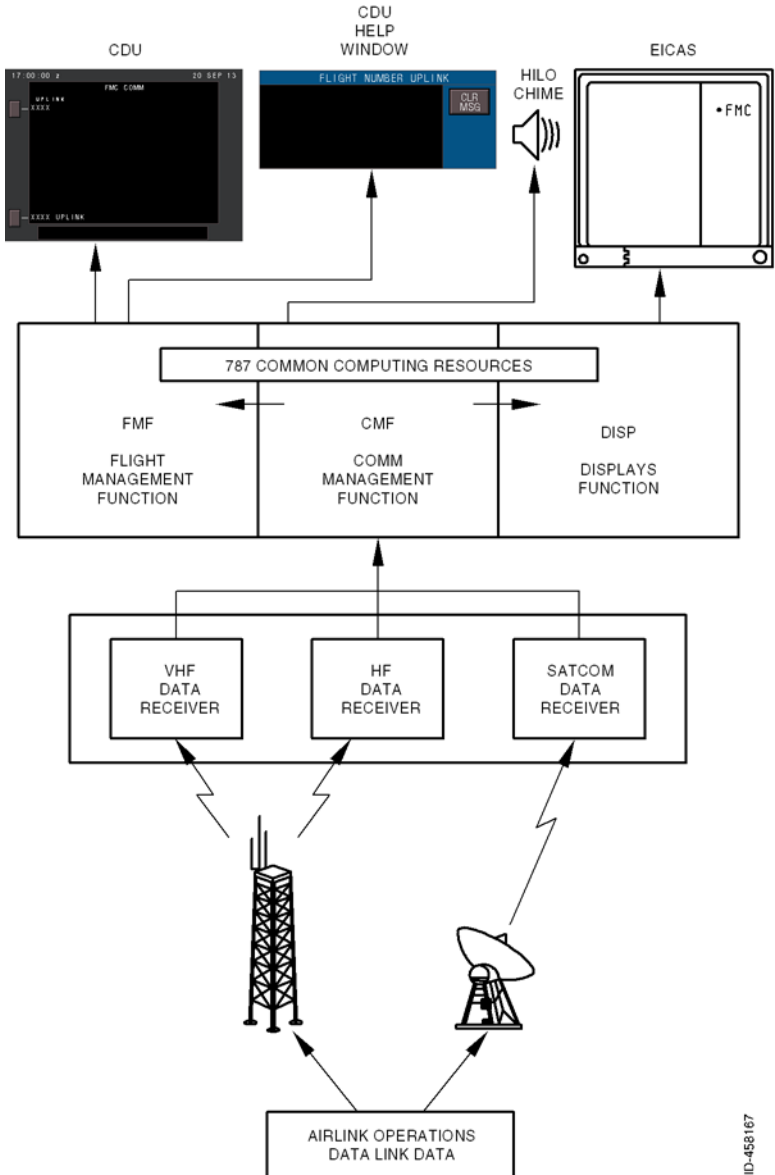
**Figure 11–3
FMC Datalink Uplinks**

Processing Uplinks – Accept/Reject

After receiving uplinked data, the ACCEPT and REJECT prompts are displayed on the PERF INIT, TAKEOFF 1/2 (systems with the takeoff datalink option only), and ALTN 1/2 pages, as shown in Figure 11–4.
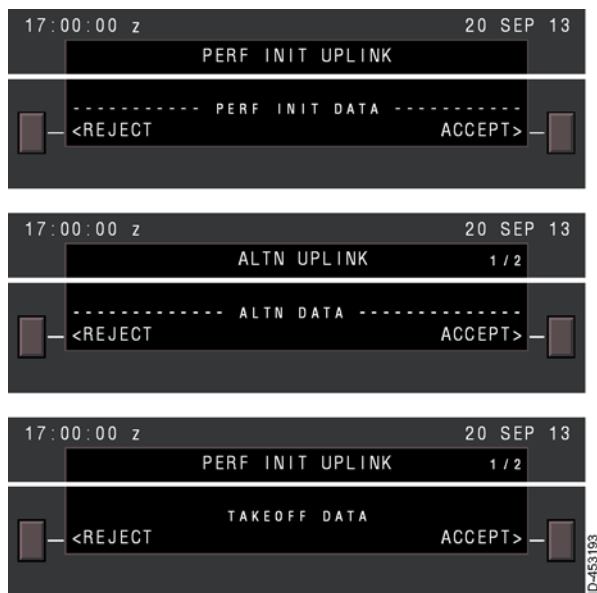
Figure 11-4
Accept/Reject Prompts

NOTE: The TAKEOFF DATA ACCEPT and REJECT prompts shown in Figure 11–4 are only displayed for systems with the takeoff datalink option.

The CDU help window displays PERF INIT UPLINK, TAKEOFF INIT UPLINK, TAKEOFF DATA LOADED, ALTN UPLINK, or ALTN INHIBIT UPLINK after the associated uplinked data is received.

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 CDU help window 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 CDU help window 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 11–5. 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.
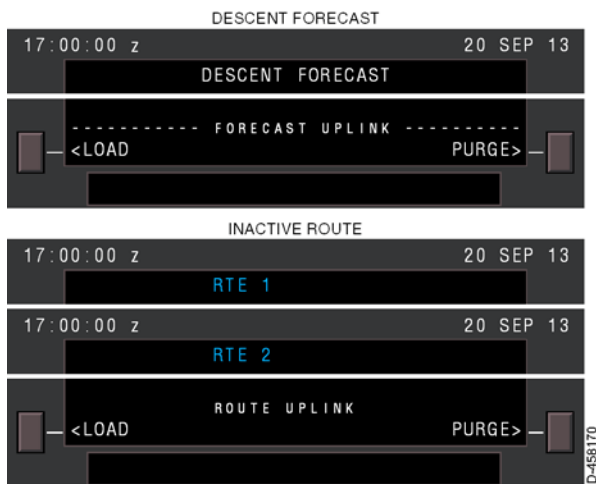
Figure 11–5
Load/Purge Prompts

The CDU help window displays DES FORECAST UPLINK READY or ROUTE X UPLINK READY after the uplinked data is received.

Selecting LOAD:

● Loads uplinked data into FMC for display

● Clears CDU help window 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 CDU help window 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 11-6, and the ERASE prompt is displayed.
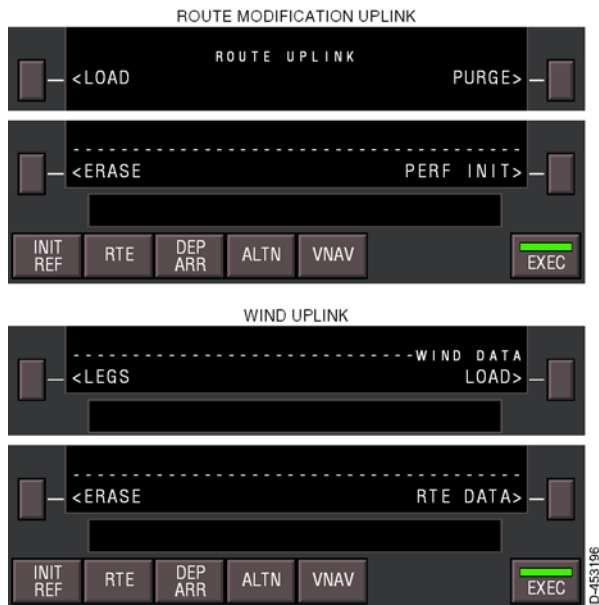
Figure 11-6
Load/Execute – Erase Prompts

The CDU help window displays ROUTE X UPLINK READY or WIND DATA UPLINK READY after the uplinked data is received.

Selecting LOAD:

- Loads uplinked data into FMC for display

- Clears CDU help window message

- Uplinked data modifies previous data

- Page title displays MOD

- ERASE prompt is displayed

- EXEC key lights.

Selecting 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 without flight crew action. The list of 20 alternates automatically loads into the ALTN LIST page without flight crew action.

The CDU help window messages FLIGHT NUMBER UPLINK or ALTERNATE LIST UPLINK remain in the CDU help window until the correct CDU page is selected, as shown in Figure 11-7.
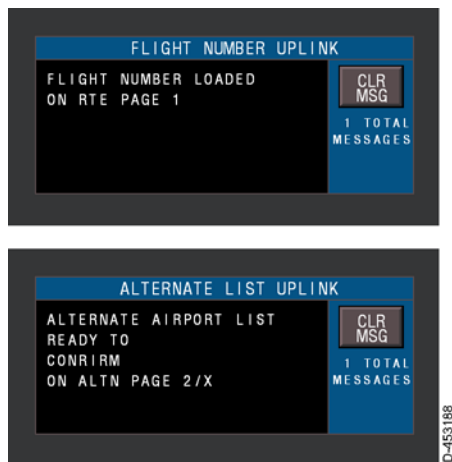
Figure 11-7
Automatic Uplinks

FMC COMM PAGE

The general datalink status and message uplink status are displayed on the FMC COMM page. Page prompts on the FMC COMM page access pages that display other datalink information.

To FMC COMM page, shown in Figure 11−8, is displayed by selecting the **FMC COMM** key.
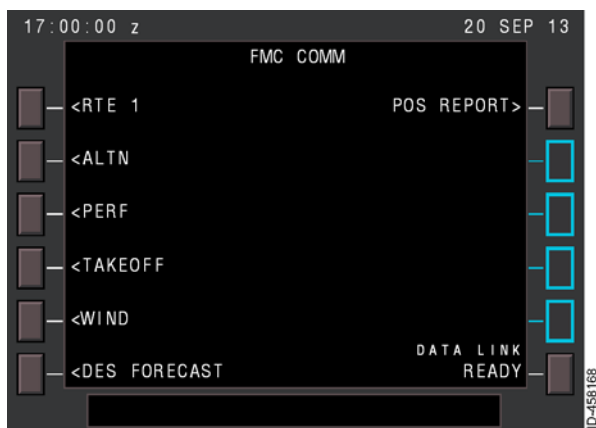
Figure 11−8
FMC COMM – With Takeoff Option

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.

For systems without the takeoff datalink option, the TAKEOFF prompt is not displayed.

Selecting an LSK displays the associated page.

UPLINK STATUS

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 11–9. Preprocessing of uplinks ensures that all of the necessary data is available for display when the uplink message is selected.
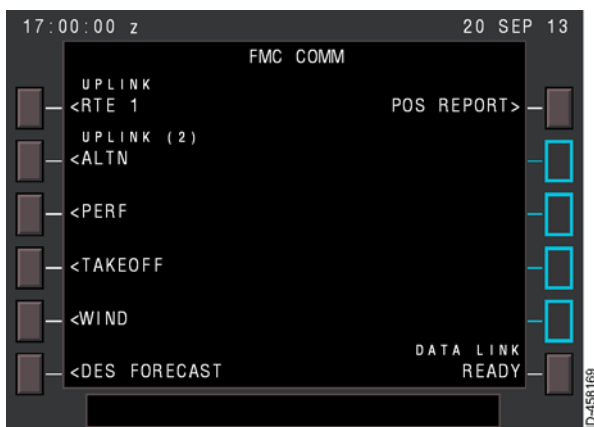
Figure 11–9
Uplinks – With Takeoff Option

For systems without the takeoff datalink option, the TAKEOFF prompt, shown in Figure 11–9 in 4L, is not displayed.

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.

- For systems with the takeoff datalink option, 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.
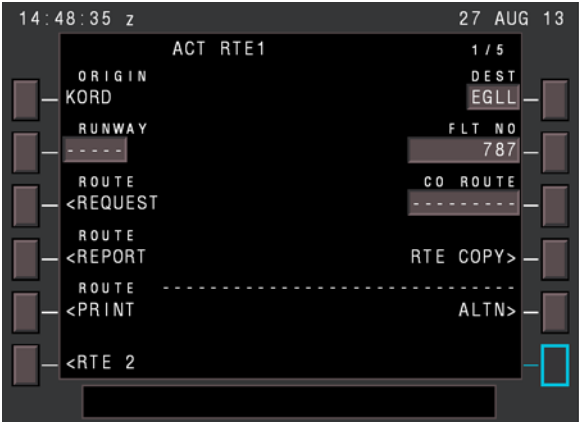
The EICAS message •**FMC** is displayed when any uplink message is pending.

FMC DATALINK REPORTS

FMC datalink reports are sent for the route (RTE) and the position report (POS REPORT) when the correct LSK is selected.

Route Report

Procedure 11-1 describes the steps to downlink a route report.

Step	Procedure 11-1 Downlink a Route Report
1	Select the **FMC COMM** key to display the FMC COMM page.
2	Select 1L (RTE 1) on the FMC COMM page to display the FMC COMM RTE page shown in Figure 11-10. **Figure 11-10** **RTE 1 – REPORT**
3	Select 4L (ROUTE REPORT) to downlink the active route to the company.

Position Report

Procedure 11–2 describes the steps to downlink a position report.

Step	Procedure 11–2 Downlink a Position Report
1	Select the **FMC COMM** key to display the FMC COMM page.
2	Select 1R (POS REPORT) on the FMC COMM page to display the 787 POS REPORT page shown in Figure 11–11.

Figure 11–11
POS REPORT

Step	Procedure 11–2 Downlink a Position Report
3	Select 6R (REPORT) to downlink the position report to the company. When the report is being sent, the REPORT prompt changes from REPORT to REPORTING to REPORT SENT.

Blank Page

12. Wind Entry and Use

INTRODUCTION

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:

- Select the RTE DATA prompt (6R) on any RTE LEGS page.

- Select 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.
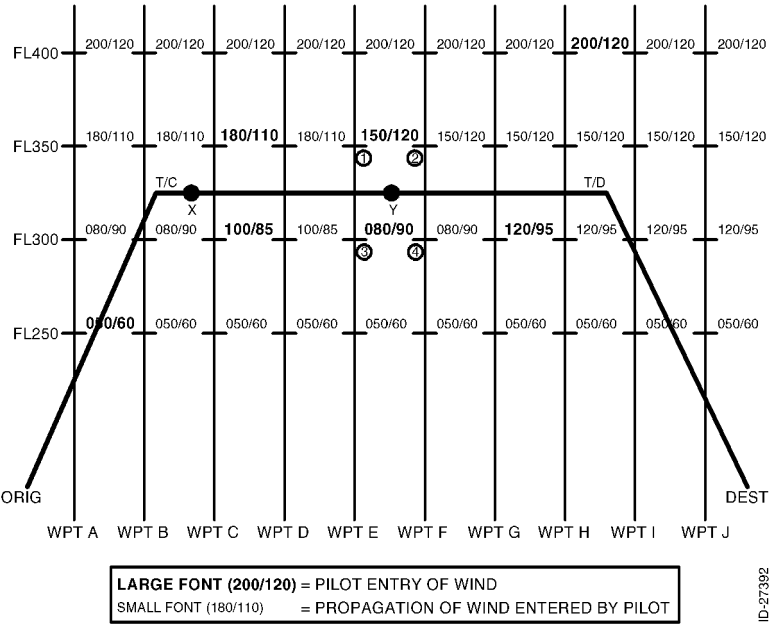
Figure 12-1
Entry and Propagation of Winds in CLIMB and
CRUISE Flight Phase

- **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 FMC interpolates the winds from the nearest known values to determine the wind at the desired point. For example, when the FMC 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. When all forecast wind entries are above the cruise altitude, the FMC 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. When all forecast wind entries are below the cruise altitude, the FMC 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. Selecting 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. When the destination altitude is not defined (for example, when no destination is specified), zero altitude is used.

Effect of Flight Plan Modifications on Wind Propagation

The following paragraphs describe deleting and adding waypoints.

DELETING WAYPOINTS

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. When waypoint A, shown in Figure 12–1, is deleted, the wind on the remaining waypoints would be unchanged.

When a waypoint containing wind entries for certain flight levels is deleted, but other wind entries for those flight levels are in the wind profile, the wind propagation is revised. The other wind entries for those flight levels are used to determine the revised propagation. When waypoint E, shown in Figure 12–1, is deleted, the wind propagation is redistributed, as shown in Figure 12–2.
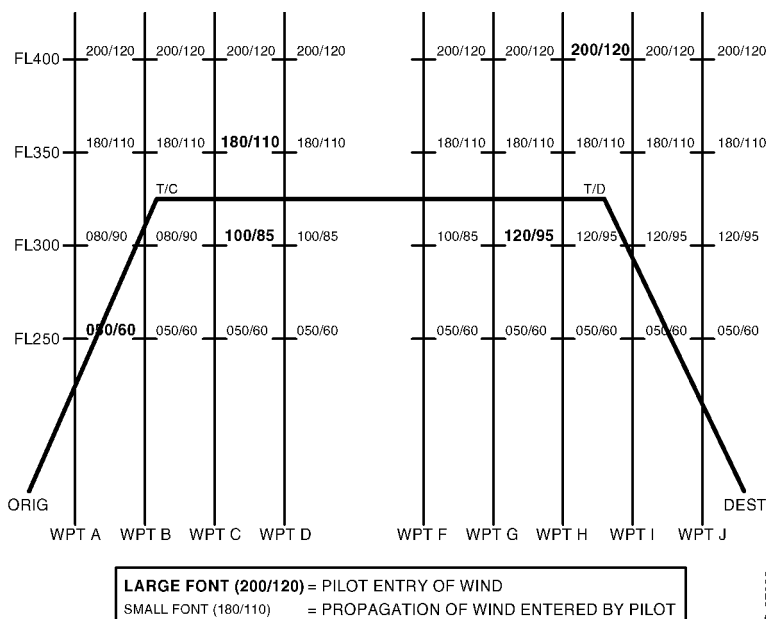
Figure 12–2
Effect of Flight Plan Changes on Wind Propagation

When waypoint E is deleted, the entered wind at FL350 for waypoint C is propagated to waypoint F, G, H, I, and J. Also, the entered wind at FL300 for waypoint C is propagated to waypoint F.

The B787 FMC software retains wind propagation on all waypoints as waypoints are sequenced. For example, when the aircraft has passed waypoints A and B when waypoint E is deleted, the wind on the remaining waypoints is unchanged.

ADDING WAYPOINTS

When waypoints are added to the flight plan, the added waypoints comply with the wind propagation rules outlined previously. For example, when 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 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 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. When the abeam waypoint is more than 99 NM from the original waypoint, the winds for the abeam waypoint are deleted.

Mixing Measured Winds With FMC Propagated/ Forecast Winds

The FMC 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 FMC uses 100% of the measured wind vector at the aircraft position. At 200 NM in front of the aircraft the FMC uses 50% of the measured wind vector and 50% forecast wind. At distances over 200 NM in front of the aircraft, the FMC uses successively less measured wind until the wind used is almost 100% forecast wind.
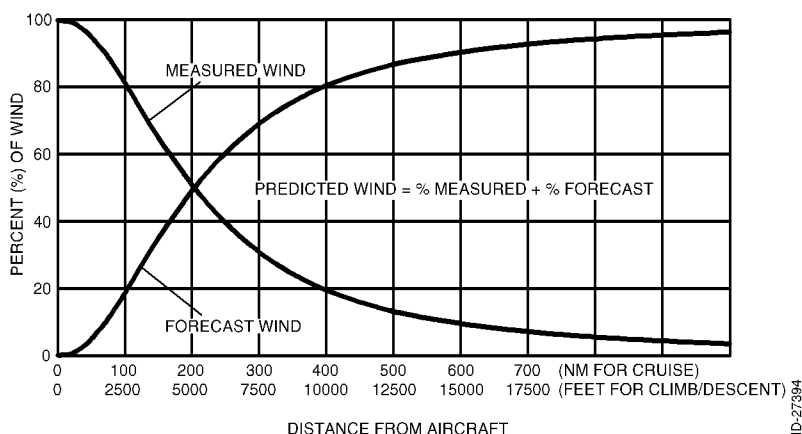
Figure 12–3
Mixing of Measured Wind With FMC Propagated/Forecast Winds

In the CLIMB and DESCENT flight phases, the wind is mixed the same way except the equal weight distance is 5,000 feet rather than 200 NM and the DISTANCE FROM AIRCRAFT units are feet rather than nautical miles.

STEP CLIMBS

The FMC–calculated step climb points are based on the aircraft optimum altitude so that the optimum cruise profile matches the optimum altitude profile, as shown in Figure 12–4. The FMC 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 FMC 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 FMC calculates fuel and ETA predictions. These predictions also assume all FMC–calculated and pilot–entered step climbs are completed on schedule. If a step point is passed without executing the step, the FMC fuel and ETA predictions are calculated assuming the step climb is initiated immediately.
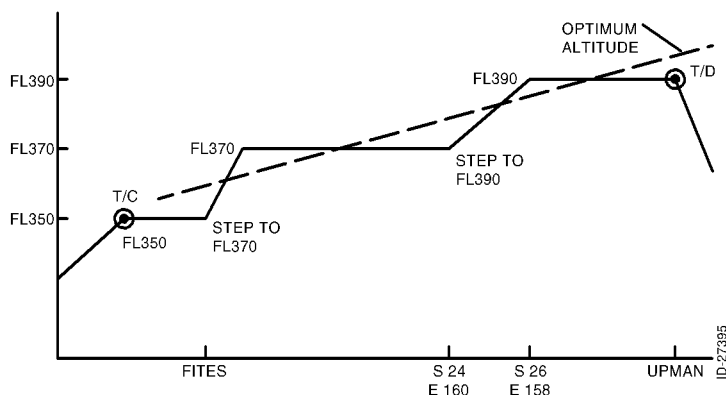
Figure 12–4
Optimum Vertical Flight Path

Step climb sizes can be changed on the PERF INIT page (when on the ground and no PERF INIT datalink is pending ACCEPT/REJECT) or VNAV CRZ page. Available step climb sizes are ICAO or pilot–entered values. When ICAO is selected, step climbs are given in 4,000 feet increments. When pilot–entered values are used, the value entered by the pilot determines what step size is used. Valid pilot entries are 0 to 9000 in 1,000–foot increments.

Using the Step Climb Feature to Evaluate Wind Trade

Figure 12-5 shows an example of a RTE LEGS page for an FMC 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.
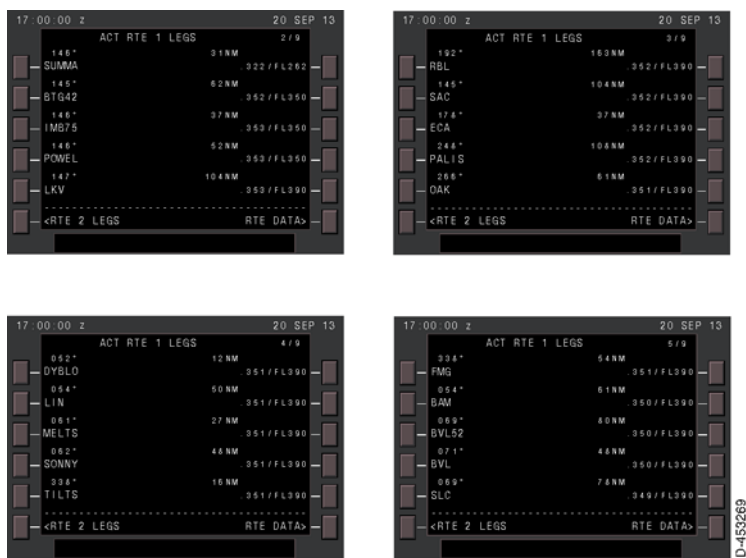
Figure 12-5
RTE LEGS Pages for Wind Trade Step (Step Climb) Example

Initially, no winds are entered and the FMC predicts destination ETA of 0633Z and fuel at destination of 14,200 lbs. The FMC 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 FMC predicts a destination ETA of 0648Z and fuel at destination of 9,500 lbs. But keep in mind, the FMC is basing these predictions on the assumption the step climb to FL390 is completed.

To do a wind trade calculation to see the FMC predictions if the aircraft stays at FL350, enter a STEP SIZE of zero on the CRZ page and let the FMC calculate the destination ETA and fuel remaining. With a step size of zero, the FMC step climb predictions are disabled and the FMC 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 FMC 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 previously except the headwind is at FL350, the tailwind is at FL390, and the initial cruise altitude is 37,000 feet. In this case, the FMC 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 FMC. There is no reason to execute the flight plan modification, since the FMC 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 FMC 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 feet 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 FMC can be used to plan and evaluate wind trade steps. When changing step size values, the FMC does not temporarily blank the speed/flight level predictions on the RTE 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 RTE 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 shown 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 are when a single average wind is entered.

13. FMS Backup Navigation, Controls, and Display Functions

INTRODUCTION

This section describes the backup EFIS and display select panel controls as well as the alternate NAV alternate radio pages.

ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS) CONTROL PANEL AND DISPLAY SELECT PANEL (DSP)

The EFIS/DSP systems display, shown in Figure 13–1, provides an alternate way to control the functions of the EFIS control panel and the DSP. To display the EFIS/DSP systems display, select the EFIS/DSP tab on the systems MFD.

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/DSP systems display is shown in Figure 13–1.
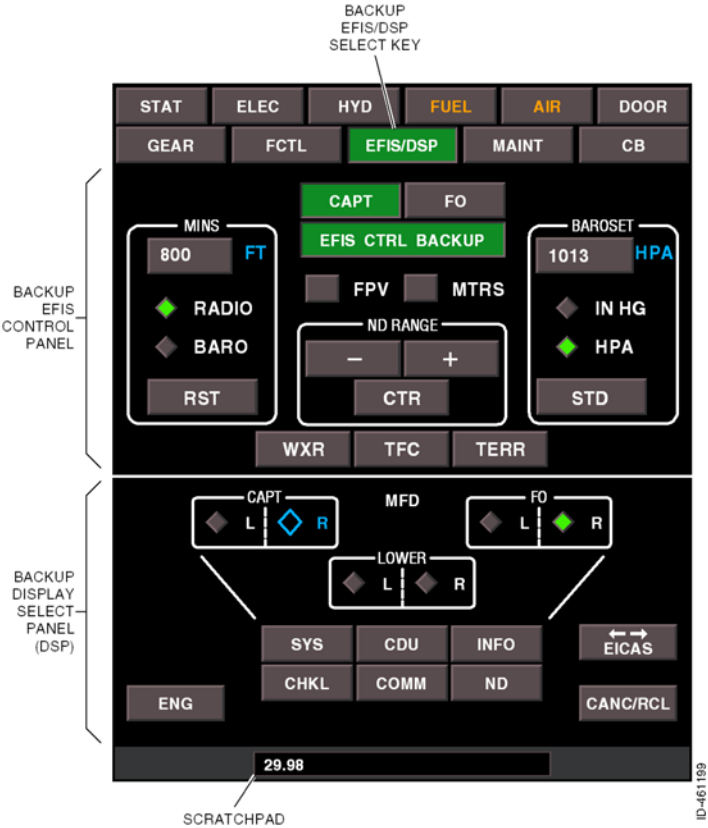
Figure 13–1
EFIS/DSP Tab

The EFIS/DSP tab is divided into two sections; backup EFIS controls and backup DSP controls. The following paragraphs describe the backup EFIS controls and backup DSP controls.

Backup EFIS Controls

The backup EFIS controls are described in the following paragraphs.

- **CAPT/FO** – Permits selection of the CAPT side or FO side EFIS/DSP backup controls. When **CAPT** is selected, the captain side backup EFIS/DSP controls are enabled. When **FO** is selected, the first officer side backup EFIS/DSP controls are enabled. The selected EFIS/DSP control panel side is displayed in green.

● **EFIS CTRL BACKUP** – Toggles EFIS backup controls between enabled and disabled. The **EFIS CTRL BACKUP** button is displayed in gray when disabled and green when enabled. The default is disabled. The EFIS backup controls are not editable until the **EFIS CTRL BACKUP** is enabled. When the **EFIS CTRL BACKUP** is not enabled, the EFIS control fields are displayed in cyan and are not editable, as shown in Figure 13–2.
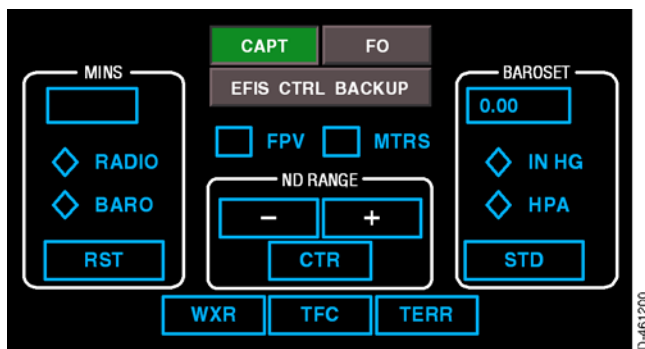
Figure 13–2
Disabled EFIS Backup Controls

● **MINS** – The MINS field displays the active approach minimum setting in feet (FT). Manual entries can be made when the cursor is over the MINS field by entering the desired entry using the MFK and then pushing the **ENTER** button the MFK or CCD. Valid RADIO entries are from –1 to 999 and valid barometric (BARO) entries are from –100 to 15000.

Toggling between RADIO and BARO is accomplished using the cursor to highlight the desired setting and pushing the **ENTER** key on the CCD or MFK. The active selection is displayed with a green diamond.

Selecting the **RST** key resets the approach alert on the respective PFD. This alert is normally reset by pushing the **RST** knob on the electronic flight instrument system control panel (EFIS CP).

● **FPV** – Selecting the FPV checkbox selects the flight path vector on the PFD on.

● **MTRS** – Selecting the MTRS checkbox selects meters to be displayed (in addition to feet) above the normal altitude display on the respective PFD.

● **BAROSET** – The backup altimeter setting is displayed under the BAROSET header. The default value is the last barometer setting received from the EFIS control panel.

Manual entries can be made when the cursor is over the BAROSET field by entering the desired entry on the MFK and pushing the **ENTER** key on the MFK or CCD. Valid entries are in inches of mercury or hectopascals. Valid inches of mercury entry is between 22.00 and 32.00 and valid hectopascals entry is a three– or four-digit entry between 745 and 1083. Valid entries are displayed with the units determined by the entry. IN HG is displayed for inches of mercury and HPA is displayed for hectopascals. Inches or hectopascals are toggled using the cursor to select either IN HG or HPA.

Selecting the **STD** key selects the standard barometric setting (29.92 IN HG or 1013 HPA) for the PFD barometric reference. If STD is displayed on the PFD, selecting the **STD** key selects the preselected barometric setting. This is normally selected by pushing the **STD** knob on the EFIS CP.

● **ND RANGE** – The minus (**–**) or plus (**+**) 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 **CTR** button toggles the centered (compass) and expanded displays.

● **WXR/TRFC/TERR** – The **WXR**, **TRFC**, **TERR** keys display selected detailed ND and mini–map data and can be selected simultaneously. The **WXR** key toggles weather radar information. The **TERR** key toggles EGPWS terrain information. The **TRC** key toggles air traffic information on the ND.

    NOTE: For air traffic to be displayed, the Mode S selector must be in either TA or TA/RA.

Backup Display Select Panel (DSP) Controls

The backup DSP controls are described in the following paragraphs.

● **MFD** – The CAPT (L/R), FO (L/R), and LOWER (L/R) prompts display which MFD control is active. The active MFD is displayed as a green diamond while the inactive MFDs are displayed as gray diamonds. A cyan diamond indicates which display is currently displaying EICAS information. The EICAS display cannot be selected for MFD control as the EICAS page must be displayed at all times. The active MFD can be changed by using the cursor to select the desired MFD and pushing the **ENTER** button on the MFK or CCD. When the desired MFD is displayed with a green diamond, the display buttons, discussed in the following paragraphs, can be used to alternate the desired display.

The following is a list of the display buttons:

— **SYS** – Toggles system synoptics and maintenance information on the selected display.

— **CDU** – Toggles the control display unit on the selected display.

— **INFO** – Toggles the airport map database on the selected display.

— **CHKL** – Toggles the checklist on the selected display.

— **COMM** – Toggles the communications display on the selected display.

— **ND** – Toggles the navigation display on the selected display.

● The **EICAS** key toggles the EICAS display between CAPT and FO sides.

● The **ENG** key toggles secondary engine information on the EICAS display.

● The **CANC**/**RCL** key toggles caution and advisory messages on the EICAS display. When these messages are displayed, selecting the **CANC**/**RCL** key 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).

● **Scratchpad** – The scratchpad is displayed at the bottom of the EFIS/DSP page. MINS or BAROSET data entered by the pilot are first displayed in the scratchpad before being entered into the correct data field. Data in the scratchpad is removed by pushing the **CLR** key on the MFK.

ALTERNATE NAVIGATION

In the unlikely event that an unrecoverable loss of all displays or loss of all three FMCs occur, a backup navigation capability is available through the tuning and control panel (TCP), shown in Figure 13–3. Under normal power conditions, selecting the **NAV** key on any of the three TCPs access the alternate navigation capability. When on standby power, only the left (Captain's) TCP is available for alternate navigation. Back–up navigation information is displayed on the TCPs and integrated standby flight display (ISFD) enabling the crew to safely land at the nearest suitable airport.

Figure 13–3
Tuning Control Panel (TCP)

When alternate navigation is in use, LNAV and VNAV are not available. Autopilot and autothrottles may be available.

The TCPs do not have a performance or navigation database. A single waypoint can be manually entered on the ALTN NAV page.

The alternate navigation system operates from two TCP pages: ALTN NAV and ALTN NAV RADIO. The two pages are described in the following paragraphs.

ALTN NAV Page

The ALTN NAV page, shown in Figure 13–4, is displayed by pushing the **NAV** button on the TCP. The ALTN NAV page provides a stand alone single waypoint navigation capability. Once the waypoint latitude and longitude have been entered at 2L and 2R, flight progress information to the waypoint is then displayed. The waypoint must be manually updated as required.
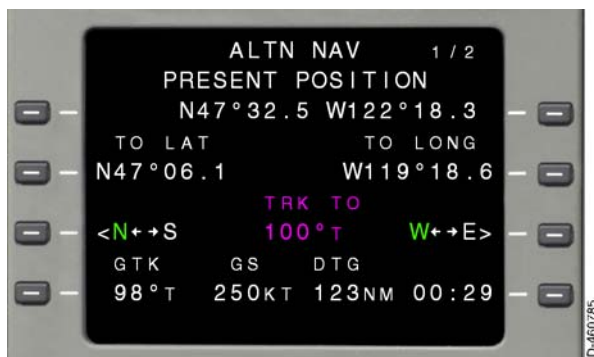
Figure 13–4
ALTN NAV Page

The ALTN NAV page is described in the following paragraphs:

- **PRESENT POSITION (Line 1)** – The current left integrated navigation receiver (INR) latitude and longitude is displayed to the nearest tenth of a minute.

- **TO LAT (2L)** – A TO latitude can be entered into the scratchpad and then line selected to 2L. Only the latitude in degrees and minutes can be entered in DDMM.M format. North or South latitude can be selected in 3L.

- **North/South Selection Key (3L)** – North or South latitude can be toggled by pushing LSK 3L. The selected latitude is displayed in green font. The default is the current latitude hemisphere.

- **GTK and GS (4L)** – The current left INR true ground track is displayed under the GTK header in 4L to the nearest whole degree. The current left integrated navigation receiver true groundspeed to the nearest whole knot is displayed under the GS header.

- **TO LONG (2R)** – A TO longitude can be entered into the scratchpad and then line selected to 2R. Only the longitude in degrees and minutes can be entered in DDMM.M format. West or East longitude can be selected in 3R.

- **West/East Selection Key (3R)** – West or East longitude can be toggled by pushing LSK 3R. The selected longitude is displayed in green font. The default is the current longitude hemisphere.

- **DTG and TTG (4R)** – The distance to go from the current aircraft position to the entered latitude/longitude is displayed under the DTG header in NM. The accuracy is better than or equal to 10 NM. The time to go from the current aircraft position to the entered latitude/longitude is displayed under the TTG header in hours and minutes format (HH:MM). The accuracy is better than or equal to 1 minute.

ALTN NAV RADIO Page

The ALTN NAV RADIO page, shown in Figure 13–5, is displayed by pushing the **NAV** button on the TCP and then the **NEXT PAGE** button. The ALTN NAV RADIO page provides an alternate means of tuning the ILS frequency and course or GLS channel into the left integrated navigation receiver (INR). Left side ILS or GLS deviations are then displayed on the ISFD.

Figure 13-5
ALTN NAV RADIO Page

When alternate navigation is selected on, the EICAS advisory message TCP ALTN NAV is displayed. It is possible to have the left and right ILS or GLS tuned to different frequencies/channels. Ensure the correct ILS frequencies or GLS channels are tuned for the approach being flown. The PFD approach data block always displays the tuned ILS frequency or GLS channel or the received ident for the on-side system.

The ALTN NAV RADIO page is described in the following paragraphs:

- **ILS–GLS (1L)** – ILS or GLS tuning information is displayed in 1L. Valid ILS frequency format is NNN.NN and valid GLS channel format is NNNNN. Valid ILS frequency or GLS channel is entered into the scratchpad and then line selected to 1L. The default is the most recently tuned ILS frequency or GLS channel, when available. The tuning information is displayed in cyan when inactive and white when active.

- **COURSE (2L)** – The ILS course is displayed in 2L. The ILS course is entered into the scratchpad and then line selected to 2L. The default is the most recently tuned ILS course, when available. The course is displayed in cyan when inactive and white when active. 2L is not used when a GLS channel has been entered in 1L.

- **CTRL (1R) –** Backup navigation tuning is toggled ON and OFF by pushing 1R (CTRL). When selected ON, the following occurs:

  — ON is displayed in large green font
  — ILS–GLS and course is displayed in white
  — ILS frequency and course or GLS channel may be tuned into the left INR
  — The EICAS advisory message TCP ALTN NAV is displayed
  — ISFD displays left INR ILS or GLS deviations.

  When selected OFF, the following occurs:

  — OFF is displayed in large green font
  — ILS–GLS and course is displayed in cyan
  — ILS and GLS may not be tuned from the ALTN NAV RADIO page
  — The EICAS advisory message TCP ALTN NAV is removed
  — ISFD displays left INR ILS or GLS deviations.

Blank Page

14. Flight Management Computer (FMC) Messages

INTRODUCTION

FMC messages indicate when a condition exists that degrades the operation of the system, data input errors, or datalink status. The messages are categorized as follows:

- Alerting messages

- Communications messages

- Advisory messages

- Entry-error advisory messages.

Some CDU help window messages clear automatically when the condition is removed. Others, such as INVALID ENTRY, must be manually cleared using the **CLR MSG** key. The messages are displayed in the CDU help window according to priority. Lower priority messages replace displayed messages as the **CLR MSG** key is selected or the condition is corrected.

NOTE: CDU help window message which must be cleared using the **CLR MSG** key, are only shown once, and will not be incremented.

Most CDU help window messages display on both CDUs. Others, such as INVALID DELETE and INVALID ENTRY, only display on the onside CDU.

Alerting messages result in FMC MESSAGE being displayed on the EICAS display. Communications messages results in the communications message •**FMC** being displayed on the EICAS display. Clearing the message or correcting the condition cancels the message.

FMC ALERTING MESSAGES

FMC alerting messages:

● Are displayed in the CDU help window

● Display FMC MESSAGE on the EICAS display.

Some CDU help window messages clear automatically when the condition is removed. Others must be manually cleared using the **CLR MSG** key. Table 14–1 lists FMC operational messages.

Table 14–1
Operational Messages

Help Window Title	Condition	Help Window Text
ALIGNMENT REINITIATED	IRU 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.	IRS ALIGNMENT FAILED – AUTOMATICALLY RESTARTED
CHECK ALT TGT	VNAV is selected when the aircraft is between the MCP window altitude and the VNAV target altitude. VNAV holds level flight.	VNAV TARGET ALTITUDE AND MCP ALTITUDE DISAGREE RESET MCP OR MODIFY VNAV ALTITUDE TARGET
CHECK AIRLINE POLICY	After loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the loaded value and notifies the flight crew of the differences. This is a maintenance function. **NOTE:** Once the CDU help window message is displayed and is cleared, it is not redisplayed again for that load.	INVALID AMI VALUE(S) VERIFY AMI

Table 14-1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
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.	ALL DESCENT CONSTRAINTS DELETED ERASE MOD OR ENTER NEW CONSTRAINT
DISCONTINUITY	LNAV active and the route is not defined after 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.	LNAV IN HEADING HOLD MODIFY ACTIVE WAYPOINT
DRAG REQUIRED	VNAV active and aircraft is unable to maintain tracking of precomputed nominal descent path and stay within speed tolerances. Additional drag and/or less thrust required to maintain the VNAV descent path.	UNABLE TO MAINTAIN VNAV DESCENT SPEED EXTEND SPEEDBRAKES AS REQUIRED
END OF OFFSET	LNAV active and 2 minutes prior to end of active route offset. AFDS maintains last heading if active route offset overflown.	APPROACHING END OF OFFSET MODIFY FLIGHT PLAN TO CONTINUE OFFSET

Table 14‑1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
END OF ROUTE	Aircraft sequenced the last waypoint in the RTE. AFDS maintains last heading.	PASSING LAST WAYPOINT IN ACTIVE ROUTE MODIFY ROUTE
ENTER INERTIAL POSITION	The flight crew-entered present position did not pass one of the IRU comparison checks, or the IRU is ready to transition to NAV mode and has not received a present position. The **CLR MSG** key must be used to remove this message.	INERTIAL REFERENCE SYSTEM REQUIRES POSITION TO COMPLETE ALIGNMENT ENTER POSITION ON POS INIT 1/4
FMC APP MODE UNAVAIL‑GP	The final approach angle check has failed.	SELECTED APPROACH HAS NO GLIDE PATH ANGLE CONFIRM APPROACH SELECTION
FMC APP MODE UNAVAIL‑QFE	Attempting to use IAN procedures while QFE landing reference enabled.	FMC APPROACH GUIDANCE NOT AVAILABLE WITH QFE SELECTED
FMC APP/TUNE DISAGREE	An approved approach is in the active flight plan and all ILS/GLS tuning is parked, G/S OFF selected, or an ILS/GLS tuning error occurs. QFE must not be selected with G/S armed or engaged and must be within 50 NM from TOD, 150 NM direct distance from MAP, or in DESCENT mode.	LANDING SYSTEM TUNING NOT COMPATIBLE WITH SELECTED APPROACH CHANGE APPROACH OR DELETE LANDING SYSTEM TUNING

Table 14‑1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
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 IRU inertial position by more than 6 NM	VALID IRS POSITION DISAGREES WITH ACTIVE ORIGIN AIRPORT POSITION VERIFY INERTIAL POSITION OR ORIGIN AIRPORT
INSUFFICIENT FUEL	A change in flight conditions occur or a change in the route is made which results in the computed fuel burn to exceed the total fuel‑on‑board, less reserves.	MODIFICATION REQUIRES MORE FUEL THAN AVAILABLE REVIEW MOD
LIMIT ALT XXXXX or LIMIT ALT FLXXX	The crew or FMC selected altitude is greater than the VNAV limit altitude.	SELECTED ALTITUDE IS ABOVE VNAV ALTITUDE LIMIT MODIFY CRUISE ALTITUDE OR VNAV TARGET SPEED
NAV DATA OUT OF DATE	The clock calendar date exceeds the active NAV database valid calendar cycle.	CURRENT DATE NOT IN DATA BASE RANGE SELECT NEW DATA BASE ON IDENT PAGE
NAV INVALID-TUNE XXXX	RNAV or VOR approach procedures require a specific NAVAID tuned. It is either not tuned or a valid signal is not being received.	APPROACH NAVAID NOT TUNED VERIFY NAV RADIO PAGE TUNING

Table 14-1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
NO ACTIVE ROUTE	No active FMC lateral route is available and LNAV is selected on the MCP.	LNAV NOT AVAILABLE ACTIVATE AND EXECUTE ROUTE
PREDICTIONS UNAVAILABLE	FMC performance predictions are not available for remainder of flight.	PERFORMANCE PREDICTIONS INHIBITED FOR DURATION OF FLIGHT MAINTENANCE REQUIRED
RESET MCP ALT	Displayed 2 minutes before the top of descent point with VNAV active and MCP not set to altitude below cruise altitude.	MCP ALTITUDE IS SET TO CRUISE ALT SET LOWER ALTITUDE TO ENABLE VNAV DESCENT
RTA FIX DELETED	RTA fix has been deleted from the modified flight plan.	MODIFICATION DELETES EXISTING RTA FIX TO RETAIN RTA ERASE MOD
TAKEOFF FLAPS DELETED	Deletion of entered thrust reduction flap value results in invalidating takeoff flap setting. **NOTE:** The display of this message will suppress the display of the TAKEOFF SPEED DELETED message.	DELETION OF ENTERED THRUST REDUCTION INVALIDATED TAKEOFF FLAPS ENTER VALID TAKEOFF FLAPS

Table 14-1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
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, or pilot-entered values do not comply with the relative takeoff speed check. The crew must reselect proper V_{SPEEDS}.	When the datalink option is disabled, the help window displays: SPEEDS DELETED DUE TO CHANGE IN TAKEOFF CONDITIONS ON THE FMC ENTER SPEEDS ON TAKEOFF REF PAGE When the datalink option is enabled, the help window displays: SPEEDS DELETED DUE TO CHANGE IN TAKEOFF CONDITIONS ON THE FMC ENTER SPEEDS ON TAKEOFF REF PAGE 1/2
THRUST REQUIRED	VNAV active, autothrottle is not engaged, and additional thrust required to track VNAV descent path and maintain speed.	UNABLE TO MAINTAIN VNAV DESCENT SPEED ADD THRUST OR ENGAGE AUTOTHROTTLE
T/O ENGINE OUT	Engine failure detected but not verified during VNAV takeoff. Aircraft is above flap retraction altitude with performance initialized.	FMC HAS DETECTED AN ENGINE FAILURE SELECT ENG OUT> TO CONFIRM SELECT <ALL ENG TO CANCEL

Table 14-1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
UNABLE FLXXX AT RTA FIX	Predicted crossing altitude at RTA fix is less than FLXXX, but the predicted ETA is within tolerance.	VNAV WILL NOT ATTAIN ALTITUDE AT RTA FIX RTA TIME WILL BE MET REVIEW RTA CONDITIONS
UNABLE NEXT ALT	VNAV is not used to meet the next climb restriction altitude.	NEXT CLIMB CONSTRAINT NOT ATTAINABLE REVISE CLIMB SPEED OR MODIFY CONSTRAINT
UNABLE TO SEND MSG	Aircraft is unable to transmit downlink message as commanded by crew or aircraft is unable to automatically send message at required time for planned event.	TEMPORARY COMMUNICATION SYSTEM INTERRUPT RESEND MESSAGE
VERIFY RNP-PROG 4/X	The default RNP has changed due to a change in flight phase and the crew has previously entered a larger RNP value than the default on PROG page 4/X.	ENTERED VALUE GREATER THAN DEFAULT RNP OR LESS THAN ANP CONFIRM RNP - RNP PROGRESS PAGE 4
VERIFY VERT RNP-PROG 4/X	The default Vertical RNP has changed due to flight phase and the crew has previously entered a larger RNP value than the default vertical RNP on PROG page 4/X.	ENTERED VALUE GREATER THAN DEFAULT VERTICAL RNP OR LESS THAN VERTICAL ANP CONFIRM VERTICAL RNP - RNP PROGRESS PAGE 4

Table 14‑1 (cont)
Operational Messages

Help Window Title	Condition	Help Window Text
VIA OFFSET INVALID	Flight conditions invalidate the pending alternate airport diversion with the entered OFFSET.	OFFSET ROUTING IS NO LONGER VALID FOR THE SELECTED ALTERNATE

FMC COMMUNICATIONS MESSAGES

FMC communications messages:

* Are displayed in the CDU help window

* Results in the EICAS communications message (FMC) to be displayed

* Sound the communications aural chime (high‑low).

Table 14‑2 lists FMC communications messages.

Table 14‑2
Communications Messages

Help Window Title	Condition	Help Window Text
ALTN UPLINK	Up to four company-preferred alternate airports and associated data has been received and is available for preview on the ALTN page.	ALTERNATE AIRPORT DATA READY TO ACCEPT OR REJECT ON ALTN PAGE 1/X
ALTN INHIBIT UPLINK	A company list of up to two alternate airports that is inhibited from automatic selection and display on the ALTN page has been received and is available for preview on the ALTN page.	INHIBITED ALTERNATE AIRPORT LIST READY TO ACCEPT OR REJECT ON ALTN PAGE 1/X

Table 14‑2 (cont)
Communications Messages

Help Window Title	Condition	Help Window Text
ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.	ALTERNATE AIRPORT LIST READY TO CONFIRM ON ALTN PAGE 2/X
FLT NUMBER UPLINK	A new flight number has been received and is available on the RTE page 1/X.	FLIGHT NUMBER LOADED ON RTE PAGE 1
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.	CANNOT USE LOADED RUNWAY/ INTERSECTION FOR TAKEOFF UNDER CURRENT CONDITIONS
PARTIAL ROUTE X UPLINK	A new route has been uplinked to the FMC but a portion of the route could not be loaded.	SOME ROUTE DATA REJECTED REVIEW LOADED DATA ON RTE PAGE EXECUTE OR ERASE
PERF INIT UPLINK	Performance initialization data has been received and is available for preview on the PERF INIT page.	PERFORMANCE DATA READY TO ACCEPT OR REJECT ON 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.	FLIGHT PLAN IS READY TO LOAD OR PURGE ON RTE PAGE
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.	FLIGHT PLAN LOADING PLEASE WAIT

Table 14–2 (cont)
Communications Messages

Help Window Title	Condition	Help Window Text
TAKEOFF DATA LOADED	The crew has entered a new runway on the TAKEOFF REF page, which matches a runway from a previous takeoff uplink; or the crew has selected a different takeoff thrust on the THRUST LIM page; or the crew has selected alternate takeoff thrust on the TAKEOFF REF page 2/2. Data displayed on the TAKEOFF REF page along with the ACCEPT> <REJECT prompts.	RUNWAY OR THRUST SETTING CHANGED TAKEOFF DATA READY TO ACCEPT OR REJECT ON TAKEOFF REF PAGES
TAKEOFF DATA UPLINK	An uplink that contains takeoff data matching the runway on the takeoff page is available for preview on the TAKEOFF REF 1/2 and 2/2 pages and THRUST LIM page.	TAKEOFF DATA READY TO ACCEPT OR REJECT ON TAKEOFF REF PAGES
WIND DATA READY	Wind data has been received and is available for loading into the active route on the RTE DATA page.	LOAD ON RTE DATA PAGE

FMC ADVISORY MESSAGES

FMC advisory messages are displayed in the CDU help window. Table 14–3 lists FMC advisory messages.

Table 14–3
Advisory Messages

Help Window Title	Condition	Help Window Text
ATC RTE CLEARANCE UPLINK	A new ATC route clearance has been uplinked and has passed the pre–check.	SELECT LOAD FMC TO MODIFY RTE
DELETE	The **DEL** key was pushed.	None, DELETE message displayed in scratchpad.
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.	None, message displayed in scratchpad.
INVALID ALTN UPLINK	A company-preferred list of alternate airports and associated alternate data has been received but the data is invalid and cannot be displayed.	ALTERNATE AIRPORT DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received but the data is invalid and cannot be displayed.	ALTERNATE AIRPORT LIST UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID FLT NO UPLINK	A new flight number has been received but the data is invalid and cannot be displayed.	FLIGHT NUMBER UPLINK REJECTED DUE TO FAILED ERROR CHECK

Table 14–3 (cont)
Advisory Messages

Help Window Title	Condition	Help Window Text
INVALID FORECAST UPLINK	Descent forecast data has been received but the data is invalid and cannot be displayed.	FORECAST DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID PERF INIT UPLINK	Performance initialization data has been received but the data is invalid and cannot be displayed.	PERFORMANCE DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID ROUTE UPLINK	A new flight plan route or modification to the active flight plan route has been received but the data is invalid and cannot be displayed.	FLIGHT PLAN UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID SUPP DATA UPLINK	Uplinked supplemental navigation database is rejected due to exceeding database size or rejected due to bad data.	NAV DATA BASE CAPACITY EXCEEDED or REJECTED DUE TO MESSAGE ERROR
INVALID TAKEOFF UPLINK	Takeoff data for up to 6 runways or runway-intersection pairs has been received but the data is invalid and cannot be displayed.	TAKEOFF DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID WIND DATA UPLINK	En route wind data has been received but the data is invalid and cannot be displayed.	WIND DATA UPLINK REJECTED DUE TO MESSAGE ERROR
MAX ALT XXXXX or MAX ALT FLXXXXX	Entered altitude would result in cruise altitude to be greater than maximum altitude.	MAX ALT XXXXX CRUISE ALTITUDE GREATER THAN MAX ALTITUDE MODIFY CRUISE ALTITUDE OR CRUISE SPEED

Table 14‑3 (cont)
Advisory Messages

Help Window Title	Condition	Help Window Text
MIN VSPEEDS UNAVAILABLE	The takeoff speed computation algorithm is unable to compute takeoff speeds because of conditions which are not supported by the flight manual or takeoff speed computation algorithm.	FMC UNABLE TO COMPUTE MINIMUM VSPEEDS FOR CURRENT CONDITIONS VERIFY VSPEEDS
NON WGS‑84 AIRPORT	Navigation database indicates the origin or destination airport is not surveyed to a WGS‑84 equivalent datum. Displays on the ground while in preflight or takeoff mode and an active flight plan exists with a departure runway selected from the origin airport. Displays in the air when an approach procedure is active into the destination airport and the aircraft is more than half way to destination or 200 NM from destination. The **CLR MSG** key must be used and the condition must no longer be present to remove this message.	When departure airport is not WGS‑84: DEPARTURE RUNWAY NOT SURVEYED TO GPS STANDARD RUNWAY DISAGREE EICAS CAUTION NOT AVAILABLE FOR TAKEOFF When destination airport is not WGS‑84: DESTINATION AIRPORT NOT SURVEYED TO GPS STANDARD DISABLE GPS UPDATING FOR APPROACH UNLESS OTHER PROCEDURES ARE APPROVED
RESET MCP APP MODE	A change in the expected approach or G/S ON/OFF is made with an approach mode armed or engaged.	CHANGE IN SELECTED APPROACH RESET APPROACH MODE FOR VALID DATA

Table 14–3 (cont)
Advisory Messages

Help Window Title	Condition	Help Window Text
SUPP DATA LOADING	Data is being loaded into the FMC supplemental NAV database.	AOC SUPPLEMENTAL NAV UPLINK BEING LOADED PLEASE WAIT
SUPP DATA UPLINK	Supplemental NAV database uplink has completed loading.	LOAD SUCCESSFUL
UNABLE CRZ ALT	Performance predicts a zero cruise time at the entered cruise altitude.	COMPUTED TOP OF DESCENT IS BEFORE TOP OF CLIMB CONFIRM CRUISE ALTITUDE
UNABLE TO LOAD CLEARANCE	ATC clearance contains invalid data or requires an active route.	CDU help window text varies and is specific to entry error made. The following is possible text: FLIGHT PLAN MODIFICATION IN PROGRESS EXECUTE OR ERASE MOD TO LOAD CLEARANCE NO ACTIVE ROUTE ACTIVATE RTE 1 OR RTE 2 ATC CLEARANCE INCLUDES INVALID DATA CONTACT ATC

Table 14‑3 (cont)
Advisory Messages

Help Window Title	Condition	Help Window Text
XXXXXXX – MAX ALT FLXXX or XXXXXXX – MAX ALT XXXXX	Predicted altitude at a waypoint with a cruise speed segment or RTA will be above maximum altitude.	ALTITUDE PREDICTED AT <XXXXXXX> IS ABOVE MAXIMUM ALTITUDE FOR PLANNED CRUISE SPEED CONFIRM PLANNED CRUISE SPD

FMC ENTRY ERROR MESSAGES

FMC entry error messages:

- Are displayed in the CDU help window

- Must be removed by selecting the **CLR MSG** key or for some messages enter a corrected entry on the CDU to clear the message.

Table 14–4 lists FMC entry error messages.

Table 14–4
Entry Error Messages

Help Window Title	Condition	Help Window Text
APP TUNE INHIBITED–MCP	ILS or GLS tuning is inhibited with autopilot engaged, approach switch (on MCP) selected and localizer or glideslope captured; and crew attempts to enter and execute a new runway or approach; or crew attempts to enter a new ILS frequency or GLS channel on the NAV RADIO page.	DISENGAGE A/P AND FLIGHT DIRECTOR TO ENABLE LS TUNING

Table 14–4 (cont)
Entry Error Messages

Help Window Title	Condition	Help Window Text
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.	ACTIVE ROUTE REVERSES DIRECTION AT THE FINAL APPROACH WAYPOINT MODIFY ROUTE TO FA FIX
ENG OUT SID MOD	An engine failure is sensed after takeoff before the flaps are fully retracted. The FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.	ENGINE OUT DETECTED EO DEPARTURE ROUTE LOADED EXECUTE TO COMPLY
IN NAV DATA BASE	Attempted entry into SUPP NAV DATA airport waypoint or NAVAID field already in NDB.	ENTERED IDENTIFIER ALREADY EXISTS IN NAV DATA BASE REVISE ENTERED IDENTIFIER
INVALID DELETE	Deleting the selected data is not permitted.	SELECTED LINE CAN NOT BE DELETED
INVALID ENTRY	Attempted entry of data into a CDU field and the data is not properly formatted for that field.	CDU help window text varies and is specific to entry error made.
INVALID ENTRY – RTA ACTIVE	Attempted entry of ECON/ or E/ on the ACT RTE LEGS page to terminate a constant speed cruise segment, when an active RTA exists down path in the flight plan.	DELETE RTA TO ENABLE SPEED ENTRY OR TO RESUME RTA ENTER R/ OR RTA/
NO OFFSET AT LEG XXXXXXX	Entered start or end of offset waypoint is not valid.	ENTERED OFFSET START WAYPOINT NOT VALID FOR OFFSET CONFIRM OFFSET START

Table 14-4 (cont)
Entry Error Messages

Help Window Title	Condition	Help Window Text
NOT IN DATA BASE	The required data is not found in the route or the NAV database.	CDU help window text varies and is specific to item not found.
NOT IN FLIGHT PLAN	Entered start of offset waypoint is not in flight plan.	OFFSET START WAYPOINT CORRECT FORMAT BUT NOT IN CURRENT FLIGHT PLAN
OFFSET DELETED	Flight plan modification deleted start of offset waypoint.	CONFIRM MODIFICATION OR ENTER NEW OFFSET ON LATERAL OFFSET PAGE
OFFSET ENDS ABEAM YYYYYY	A flight plan change or crew entered waypoint results in the FMC being unable to construct or maintain the desired offset. Offset will end at abeam YYYYYYY.	CDU help window text varies and is specific to type of offset error occurring.
ROUTE FULL	The route is filled to the allowable capacity.	WAYPOINT STORAGE CAPACITY HAS BEEN REACHED MODIFY ROUTE
RUNWAY N/A FOR SID	The selected runway is not compatible with the selected departure.	RUNWAY CANNOT BE USED WITH ENTERED DEPARTURE PROCEDURE CONFIRM RUNWAY

Table 14-4 (cont)
Entry Error Messages

Help Window Title	Condition	Help Window Text
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.	DELETION OF ENTERED THRUST REDUCTION INVALIDATED TAKEOFF FLAPS ENTER VALID TAKEOFF FLAPS
T/O ENGINE OUT	An engine failure has been detected but not verified during a VNAV takeoff while above the flap retraction altitude and performance initialized.	FMC HAS DETECTED AN ENGINE FAILURE SELECT ENG OUT> TO CONFIRM SELECT <ALL ENG TO CANCEL
STANDBY ONE	The FMC requires more than 4 seconds to display data.	FMC PROCESSING LAST ENTRY PLEASE WAIT
SUPP DATA BASE FULL	Supplemental NAV database is full, entry not accepted.	ENTRY EXCEEDED SUPP NAV DATA BASE CAPACITY
UNABLE FLIGHT PLAN ENTRY	Attempted flight plan entry is incompatible with loaded navigation database.	ENTRY NOT ACCEPTED WITH CURRENT NAV DATA BASE CHANGE IDENTIFIER
UNABLE TO OFFSET	Entered offset not flyable.	SELECTED OFFSET NOT FLYABLE REVISE OFFSET DATA
UNABLE TO SEND MSG	The selected datalink message cannot be transmitted.	TEMPORARY COMMUNICATION SYSTEM INTERRUPT RESEND MESSAGE

Table 14‑4 (cont)
Entry Error Messages

Help Window Title	Condition	Help Window Text
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 performance (ANP).	ENTERED VALUE GREATER THAN DEFAULT RNP OR LESS THAN ANP CONFIRM RNP
VERIFY VERT RNP ENTRY	Entered vertical RNP value is greater than the default vertical RNP for the current flight phase, or less than the present ANP.	ENTERED VALUE GREATER THAN DEFAULT VERTICAL RNP OR LESS THAN VERTICAL ANP CONFIRM VERTICAL RNP

15. FMS Additional Information, Features, and Functions

INTRODUCTION

This section describes in detail the use of cost index and how the cost index is calculated for airline use. This section also describes the maintenance CDU pages and how they are accessed.

COST INDEX

The FMC 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, when it costs $1,200 per hour for flying time and 10 cents per pound for fuel, the cost index is 120.

When the cost of fuel increases to 20 cents per pound the cost index is 60. The aircraft would fly slower to save fuel.

When in the example, flying time per hour increased to $1,500 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 their 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.

When 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 required, to better fit the route segment.

Cost index is only associated with ECON speed mode. When flying ECON speed, cost index can vary the speed slightly due to changing wind conditions. This is a normal function of cost index since the 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, shown in Figure 15–1, is displayed by selecting 6R (MAINT) on the INIT/REF INDEX page.
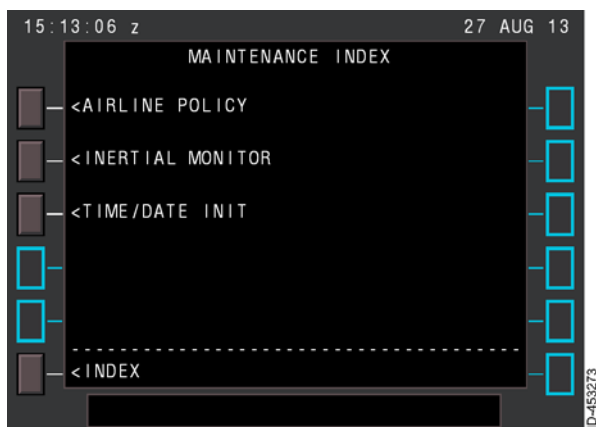
Figure 15–1
MAINTENANCE INDEX Page

The MAINTENANCE INDEX page has prompts for pages that are normally used only on the ground. These pages permit maintenance personnel examine the AIRLINE POLICY pages and evaluate IRU integrity.

Selecting 1L (AIRLINE POLICY) or 2L (INERTIAL MONITOR) displays the associated maintenance page. Selecting 3L (TIME/DATE INIT) displays the TIME/DATE INIT page, which permits manual entry of date and time when GPS is not available. Selecting 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 modifiable information (AMI) file and the operational configuration (OPC) file. The FMC first references this file for data values before computing FMC default values. These pages are not normally used by the flight crew.

To display the AIRLINE POLICY 1/2 page, shown in Figure 15–2, select 1L (AIRLINE POLICY) on the MAINTENANCE INDEX page.
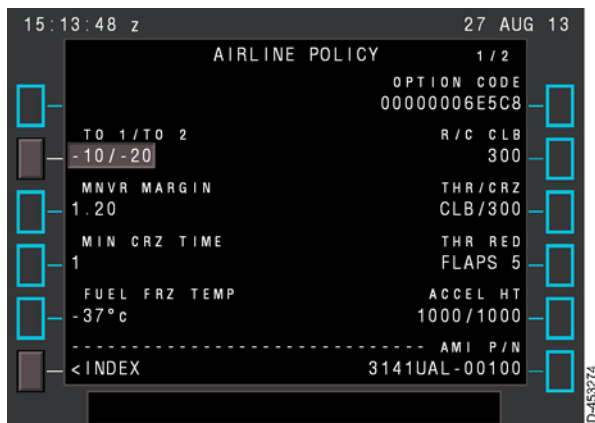
Figure 15–2
AIRLINE POLICY 1/2 Page

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 when the takeoff derate option is enabled. The default AMI value is displayed when one exists, otherwise the flight management computer function (FMCF) value is displayed. Either default value is displayed in small font. INVALID DELETE is displayed in the CDU help window when an attempt is made to delete the default value.

Valid pilot–entry range is 0 to the max derate percentage value specified in the operation program data (OPD) with a maximum of 3 characters (entering a minus sign is optional). Pilot–entered and default values are displayed in large font. A slash (/) is required when both derates are entered together. When only takeoff derate 2 is entered, a slash (/) must precede the entry. Deletion of pilot–entered values display the AMI or FMCF default values and invalidate large font takeoff speeds. Entry or deletion of large font values result in the recomputation of small font takeoff speeds.

Entered data is retained after warm starts, cold starts, and flight completion.

When the takeoff derate option is not enabled, the header and data fields are blank.

- **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. The AMI value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF default value is displayed in small font. Pilot–entry is not permitted.

- **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. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

- **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 or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

  The fuel freeze temperature/minimum fuel temperature is displayed on the PERF INIT page.

- **<INDEX (6L)** – Selecting 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. Pilot–entry is not permitted.

- **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 AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

- **THR/CRZ (3R)** – The default thrust limit set by the FMC at cruise altitude capture is displayed in this field. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

  The second entry in 3R (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).

- **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 AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

- **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. The AMI default value is displayed in large font. Engine out acceleration height is displayed to the left of the slash (/) and the all engine acceleration height is displayed to the right of the slash. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. Pilot–entry is not permitted.

  The ACCEL HT value is propagated to the TAKEOFF REF 2/2 page.

- **AMI P/N (6R)** – The AMI part number is displayed in 6R.

To display the AIRLINE POLICY 2/2 page, shown in Figure 15-3, select the **NEXT PAGE** key when the AIRLINE POLICY PAGE 1/2 is displayed.
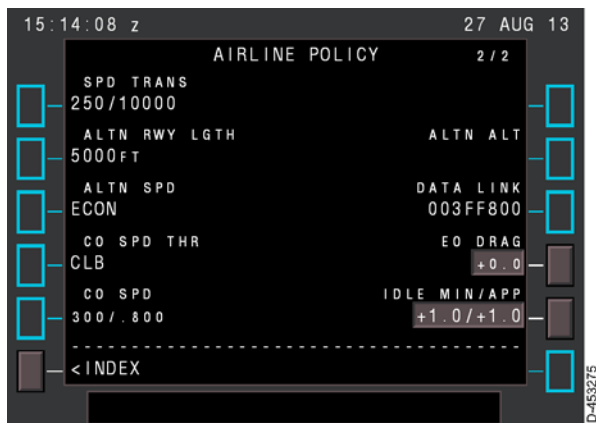
Figure 15-3
AIRLINE POLICY 2/2 Page

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. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed. Pilot-entry is not permitted.

- **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. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed. Pilot-entry is not permitted.

- **ALTN SPD (3L)** – The default cruise speed mode in 3L is the speed schedule for alternate cruise predictions. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed. Pilot-entry is not permitted.

- **CO SPD THR (4L)** – The company speed thrust rating in 4L is the thrust rating to be used when company speed is active. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed. Pilot–entry is not permitted.

- **CO SPD (5L)** – The company speed (in CAS) in 5L is used in the engine out mode. The AMI default value is displayed in large font. If the AMI value is invalid or not loaded, the FMCF value is displayed in small font. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed. Pilot–entry is not permitted.

- **<INDEX (6L)** – Selecting 6L displays the MAINTENANCE INDEX page.

- **SPD RESTR (1R)** – The default speed restriction and altitude are displays in 1R. The AMI default value is displayed in large font when valid. 1R is blank when no AMI default value exists or the AMI value is invalid. Pilot–entry is not permitted.

- **ALTN ALT (2R)** – The alternate altitude in 2R is the default advisory altitude used in alternate flight plan predictions. The AMI default value is displayed in large font when valid. 2R is blank when no AMI default value exists or the AMI value is invalid. Pilot–entry is not permitted. If the AMI values are invalid the CHECK AIRLINE POLICY CDU help message is displayed.

- **DATA LINK (3R)** – The AMI datalink option code is displayed in 3R. The AMI datalink option code is displayed in large font. If no AMI is loaded, the 3R data field displays the FMCF default datalink option code in small font. 3R data and header fields are blank when the data link option code is not enabled.

- **EO DRAG (4R)** – The default engine out drag factor is displayed in 4R in small font. Manual entries are permitted within the range of –9.9 to +9.9 and are displayed in large font.

- **IDLE MIN/APP (5R)** – The default minimum idle thrust descent factor is displayed in small font. Manual entries are permitted within the range of –5.0 to +5.0 and are displayed in large font.

INERTIAL MONITOR Page

To display the INERTIAL MONITOR page, shown in Figure 15-4, select 2L (INERTIAL MONITOR) on the MAINTENANCE INDEX page. The INERTIAL MONITOR page is used to display radial position error (RPE), groundspeed, time in NAV (TIN), and draft rate for the left and right inertial reference unit (IRU). Display of data from attitude and heading reference units (AHRUs) are not included.
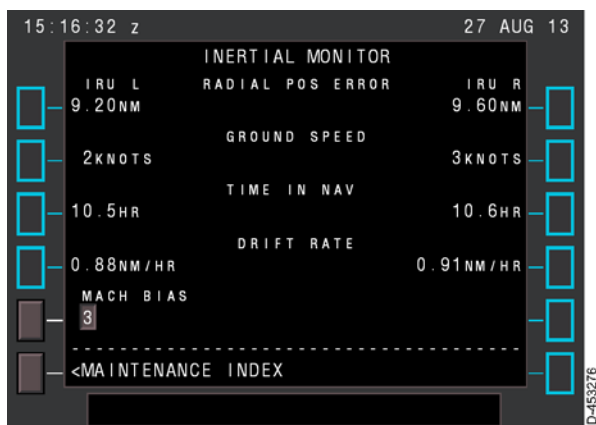
Figure 15-4
INERTIAL MONITOR Page

Following an air-to-ground transition, if an IRU is in stationary align mode when the parking brake is set, the data fields in 1L thru 4L and 1R thru 4R are blank.

The INERTIAL MONITOR page is described in the following paragraphs.

- **RADIAL POS ERROR (Line 1)** – The RPE value for IRU L is displayed in 1L and the RPE value for IRU R is displayed in 1R. The RPE value compares the last FMC position to the IRU sensor the first time the parking brake is set following an air-to-ground transition. When a valid RPE value does not exist for an IRU, the data field for the associated IRU is blank.

- **GROUND SPEED (LINE 2)** – When a valid groundspeed exists the first time the parking brake is set following an air-to-ground transition, the value is displayed in knots in 2L and 2R. When a valid groundspeed does not exist for an IRU, the data field for the associated IRU is blank.

- **TIME IN NAV (LINE 3)** – When a valid time in NAV exists the first time the parking brake is set following an air–to–ground transition, the value is displayed in hours in 3L and 3R. When a valid time in NAV does not exist for an IRU, the data field for the associated IRU is blank.

- **DRIFT RATE (LINE 4)** – When a valid drift rate exists, the value is displayed in nautical miles per hour (NM/HR) 4L and 4R. The drift rate is computed using the displayed RPE value and TIN value for the associated IRU. If either the RPE or TIN values are not displayed, the draft rate is invalid.

- **MACH BIAS (5L)** – The Mach bias is used by the IRU to modify the sensed Mach output. Small sensor errors are possible and vary from aircraft to aircraft. Entering a Mach Bias increases the accuracy of performance data based on aircraft sensors.

  The possible value range is an integer between 0 and 5. Deletion of 5L when data is displayed results in the deletion of the displayed Mach bias and results in setting the delta Mach bias parameter to 000. Dashes are displayed when a valid Mach bias does not exist.

- **<MAINTENANCE INDEX (6L)** – Selecting 6L displays the MAINTENANCE INDEX page.

TIME/DATE INIT Page

To display the TIME/DATE INIT page, shown in Figure 15–5, select 3L (TIME/DATE INIT) on the MAINTENANCE INDEX page. The MAINTENANCE INDEX page permits maintenance personnel the ability to manually enter a date and time to be sent to the CCS clock when no system time (GPS time) is available.
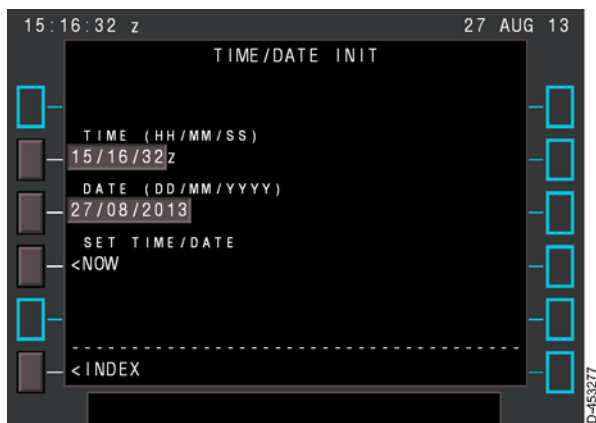
Figure 15–5
TIME/DATE INIT Page

The MAINTENANCE INDEX page is described in the following paragraphs:

- **TIME (HH/MM/SS) (2L)** – Entry of time in 2L is enabled when on the ground on the GPS time is not valid. When the GPS time is valid, the data field in 2L is blank.

- **DATE (DD/MM/YYYY) (3L)** – Entry of a date in 3L is enabled when on the ground on the GPS date is not valid. When the GPS date is valid, the data field in 3L is blank.

- **SET TIME/DATE (4L)** – <NOW is displayed in the data field of 4L when GPS date and time are invalid and data fields 2L and 3L display manually entered values of time and date. Selecting the <NOW prompt results in the time and date in data fields 2L and 3L being sent to the CCS clock time and date. Selecting the <NOW prompt clears the time and date values displayed in 2L and 3L. The data field in 4L is blank when the GPS date and time are valid or when dashes are displayed in 2L and 3L.

Acronyms and Abbreviations

Acronyms and abbreviations used in this guide are defined as follows:

TERMS	DEFINITION
A	at or above, autotuning
ACCEL	acceleration
ACT	activated
ADF	automatic direction finder
ADRS	air data reference system
ADS	air data system
AEDB	Aero Engine Database
AF	arc to fix
AFDC	autopilot flight director computer
AFM	Airplane Flight Manual
AGL	above ground level
AHRU	attitude and heading reference unit
ALT	altitude
ALTN	alternate
AMI	airline modifiable information
ANP	actual navigation performance
AOG	aircraft-on-ground
AP	autopilot
APRT, ARPT	airport
ARR	arrival
ATC	air traffic control
ATZ	aerodrome traffic zone
AUTO	automatic
AUX	auxiliary
AVAIL	available
B	below
BARO	barometer
BAT	battery
BM	back course marker
BRG	bearing
BRG/DIST	bearing/distance
C	Celsius, center

TERMS	**DEFINITION**
CALC	calculated
CANC	cancel
CAPT	captain
CAS	calibrated airspeed
CCD	cursor control device
CCR	common computing resource
CCS	common core system
CDU	control display unit
CF	course fix, course to a fix
CG	center of gravity
CHKL	checklist
CI	cost index
CID	component identification
CLB	climb
CLR	clear
CO	company
COMM	communication
CON	continuous
CRS	course
CRZ	cruise
CRZ CLB	cruise climb
CTA	controlled area
CTR	controlled zone
D	down, downhill, dry
D/D	drift down
DEL	delete
DEP	departure
DEP ARR, DEP/ARR	departure arrival
DES	descent
DEST	destination
DF	direct to fix
DIR	direct, direction
DIS, DIST	distance
DME	distance measuring equipment

TERMS	**DEFINITION**
DP	departure procedure
DSP	display select panel
DSPL	display
DTG	distance-to-go
DU	display unit
E	East
E/D	end-of-descent
ECON	economy
ECON CLB	economy climb
ECON DES	economy descent
EFB	electronic flight bag
EFC	expect further clearance
EFIS	electronic flight instrument system
EFIS CP	electronic flight instrument system control panel
EICAS	engine indication and crew alerting system
ENG	engine
EO	engine out
EOLRC	engine out long-range cruise
EPR	engine pressure ratio
ETA	estimated time of arrival
EXEC	execute
F	Fahrenheit
FA	fix to an altitude, VFR approach fix
FAA	Federal Aviation Administration
FAF	final approach fix
FD	flight director
FF	fuel flow, final approach fix
FIR	flight information region
FL	flight level
FLT	flight
FLT NO	flight number
FM	fix to a manual termination, flight management
FMA	flight mode annunciator
FMC	flight management computer

TERMS	**DEFINITION**
FMCF	flight management computer function
FMF	flight management function
FMS	flight management system
FO	first officer
fpm	feet per minute
FPV	flight path vector
FR	from
FREQ	frequency
FRZ	freeze
ft, FT	feet
FTS	Flight Technical Services
G/A, GA	go–around
G/P, GP	glide path
G/S	glideslope
GCC	Global Customer Care
GLS	GPS landing system
GPS	global positioning system
GR WT	gross weight
GS	groundspeed
GTK	ground track
H, H/WIND	headwind
HA	holding to an altitude, holding pattern with an altitude termination
HDG	heading
HF	holding pattern to a fixed waypoint, holding to fix
HIL	horizontal integrity limit
HLD	hold
HM	holding pattern with a manual termination
HT	height
IAF	initial approach fix
ICAO	International Civil Aviation Organization
IDENT	identification
IF	initial fix, initial fix approach
ILS	instrument landing system
IM	inner marker

TERMS	**DEFINITION**
IN HG	inches of mercury
INBD	inboard, inbound
INFO	information
INIT	initialize
INIT REF	initialize reference
INR	integrated navigation radio
INTC	intersection
IRS	inertial reference system
IRU	inertial reference unit
ISFD	integrated standby flight display
kgs	kilograms
L	left, left crosswind
lat, LAT	latitude
LAT/LON	latitude/longitude
lbs	pounds
LGTH	length
LIM	limit
LNAV	lateral navigation
LOC	localizer
LON, long	longitude
LRC	long–range cruise
LSK	line select key
LVL	level
LWR	lower
M	magnetic, manual tuning
MA	missed approach
MAG	magnetic
MAX	maximum
MCDU	multifunction control display unit
MCP	mode control panel
MD	minimum descent
MFD	multifunction display
MFK	multifunction keyboard
MIN, MINS	minimum(s)

TERMS	DEFINITION
MLS	microwave landing system
MM	middle marker
M_{MO}	maximum operating mach
MNVR	maneuver
MOD	modification
MRC	maximum range cruise
MSG	message
MSL	mean sea level
MTRS	meters
N	North
N/A	not available
NAV	navigation
NAV RAD	navigation radio
NAVAID	navigational aid
ND	navigation display
NDB	navigation database, non–directional beacon
NE	Northeast
NM	nautical miles
NW	Northwest
OAT	outside air temperature
OEM	original equipment manufacturer
OM	outer marker
OP	operational
OPC	operational program configuration
OPD	operation program data
OPT	optimum
ORIG	original
P	procedure autotuning
P/N	part number
P/P	present/position
PB/PB	place bearing/place bearing
PBD	place/bearing/distance
PERF	performance
PFD	primary flight display
PI	procedure turn to an intercept

TERMS	**DEFINITION**
POS	position
PPOS	present position
PRED	predict
PREV	previous
PROG	progress
PTH	path
QFE	queens field elevation
QNH	sea level standard atmosphere pressure
QUAD	quadrant
R	right,
	right crosswind,
	route autotuning
R/C	rate–of–climb
RA	radio altitude
RAD	radio
RCL	recall
RECMD	recommended
REF	reference
RESTR	restriction
RMA	return material authorization
RNP	required navigation performance
RPE	radial position error
RST	reset
RTA	required time of arrival
RTE	route
RW, RWY	runway
RX	runway extension fix
S	South,
	skid
S/C	step climb
SAT	static air temperature
SE	Southeast
SEL	select
SEL CAS	selected CAS
SEL MACH	selected Mach
SID	standard instrument departures
SP	space

TERMS	DEFINITION
SPD	speed
SPD RESTR	speed restriction
STA	station
STAR	standard terminal arrival
STD	standard
SW	Southwest
SYS	system
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 airspeed
TCP	tuning and control panel
TD	touchdown
TERR	terrain
TF	track between two fixes
TGT	target
THR	thrust
THR REF	thrust reference
TIZ	traffic information zone
TMA	terminal area
TMF	thrust management function
TO	takeoff
TO/GA, TOGA	takeoff/go–around
TOC	Technical Operations Center
TOGW	takeoff gross weight
TOT	total
TPR	turbine power ratio
TRANS	transitions
TRFC	traffic
TRK	track
TRU	true
TTG	time–to–go
U	up, uphill
UIR	upper flight information region

TERMS	**DEFINITION**
UTC	universal time coordinated
V/B	vertical bearing
V/S	vertical speed
VAR	variation
VERT	vertical
VFR	visual flight rules
VHF	very high frequency
VIA	versatile integrated avionics
V_{MO}	maximum operating velocity
VNAV	vertical navigation
VOR	VHF omnidirectional radio range
VORTAC	combined VOR and TACAN stations
V_{REF}	reference speeds
VTK	vertical track
W	West, white, wet
WPT	waypoint
WT	weight
WXR	weather
XTK	crosstrack
ZFW	zero fuel weight

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Index

Index (cont)

Index (cont)

Index (cont)

Index (cont)

Index (cont)

G

H

Index (cont)

Index (cont)

Index (cont)

Index (cont)

Index (cont)

U

V

W

Index (cont)

X

Blank Page