

# **'767 Captain' FLIGHT MANUAL**

## **PART V – Flight Management System**

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## ABOUT THIS MANUAL

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The '767 Captain' FLIGHT MANUAL is organized into five Parts.  
Each Part is provided as a separate Acrobat® PDF document:

Click START > Programs > Captain Sim > 767 Captain >

- **Part I – User's Manual**
- **Part II – Aircraft Systems**
- **Part III – Normal Procedures**
- **Part IV – Flight Characteristics and Performance Data**
- **Part V – Flight Management System** - this document.

Adobe Acrobat® Reader Required

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THIS MANUAL PROVIDES ADDITIONAL INFORMATION ONLY, WHICH IS NOT AVAILABLE ON THE WEB SITE.

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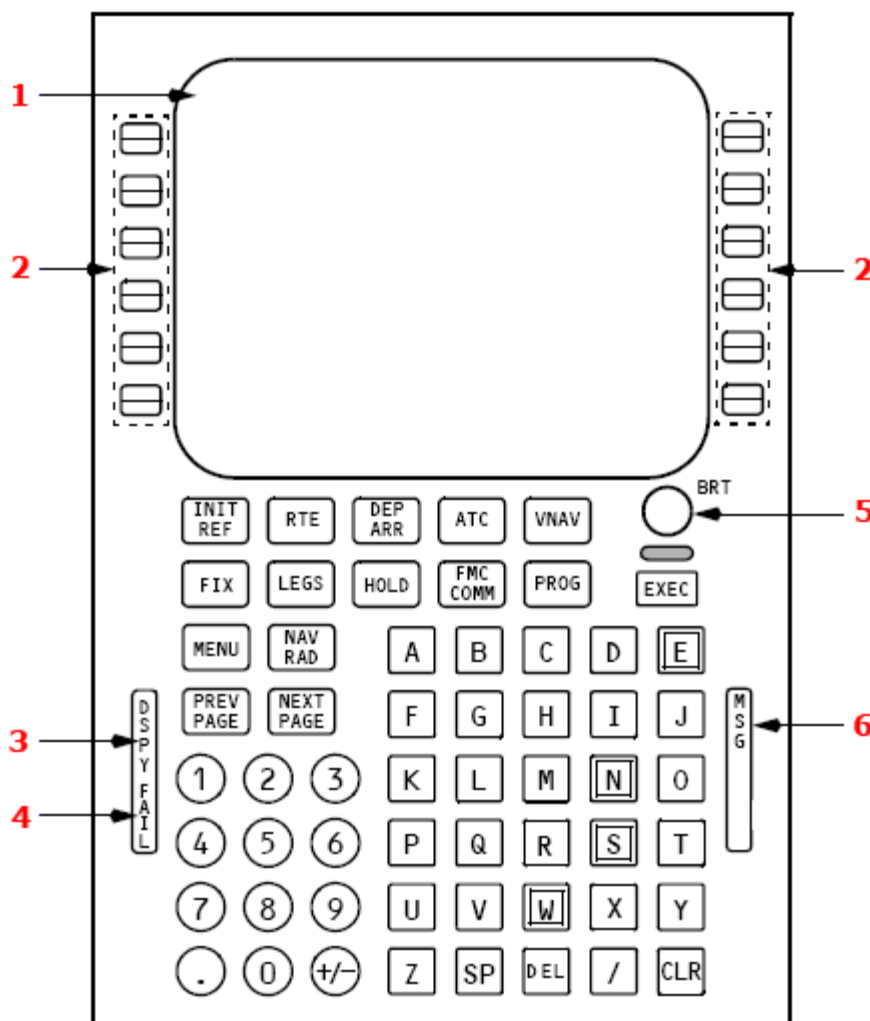
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**DO NOT USE FOR FLIGHT****Section 1: FLIGHT MANAGEMENT, NAVIGATION CONTROLS AND INDICATORS****FLIGHT MANAGEMENT SYSTEM CONTROL DISPLAY UNIT (CDU)****1. Control Display Unit (CDU) Display**

Displays FMS data pages.

**2. Line Select Keys**Push

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is displayed in scratchpad.

**3. Display (DSPY) Light**

Illuminated (white) -

- when RTE page 3 or greater, RTE LEGS page 2 or greater, RTE DATA page 2 or greater is displayed
- when airplane is not in holding pattern displayed on HOLD page
- when modification is in progress, and any RTE, RTE LEGS, RTE DATA, HOLD, or VNAV page is displayed.

**4. FAIL Light**

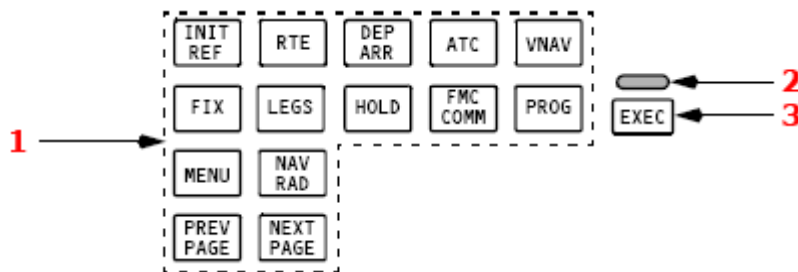
Illuminated (amber) - fault detected in related FMC

**5. Brightness Control**

Rotate - controls display brightness.

**6. Message (MSG) Light**

Illuminated (white) - scratchpad message is displayed.

**FUNCTION AND EXECUTE KEYS****1. CDU Function Keys**

Push-

- INIT REF - displays page for data initialization or for reference data
- RTE - displays page to input or change origin, destination, or route
- DEP ARR - displays page to input or change departure and arrival procedures
- VNAV - displays page to view or change vertical navigation path data
- FIX - displays page to create reference points on HSI map
- LEGS-
  - displays page to evaluate or modify lateral and vertical route data
  - displays page to control HSI PLAN mode display
- HOLD - displays page to create holding patterns and show holding pattern data
- PROG - displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU - displays page to choose subsystems controlled by CDU
- NAV RAD — displays page to monitor or control VOR tuning
- PREV PAGE - displays previous page of related pages (for example, LEGS pages)
- NEXT PAGE - displays next page of related pages.

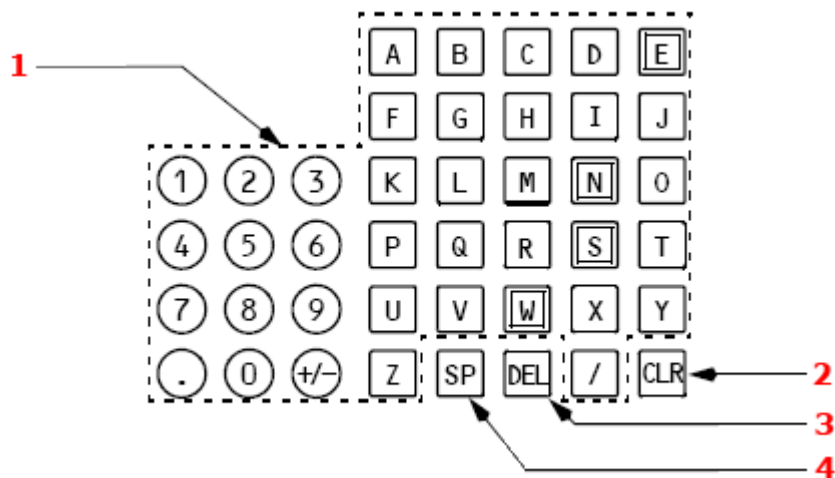
**2. Execute Light**

Illuminated (white) - active data is modified but not executed.

**3. Execute (EXEC) Key**

Push-

- makes data modifications) active
- extinguishes execute light.

**ALPHA/NUMERIC AND MISCELLANIOUS KEYS****1. Alpha/Numeric Keys**

Push-

- puts selected character in scratchpad
- Slash (/) key - puts "/" in scratchpad
- Plus Minus (+/-) key - first push puts "-" in scratchpad. Subsequent pushes alternate between "+" and "-".

**2. Clear (CLR) Key**

Push-

- clears last scratchpad character
- clears scratchpad message.

Push and hold - clears all scratchpad data.

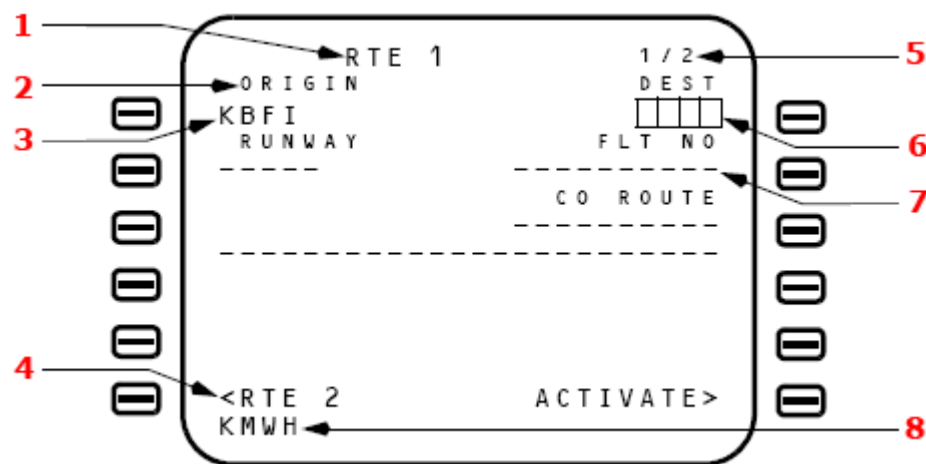
**3. Delete (DEL) Key**

Push - puts "DELETE" in scratchpad.

**4. Space (SP) Key**

Push - puts space in scratchpad



**DO NOT USE FOR FLIGHT****CDU PAGE COMPONENTS****1. Page Title**

Subject or name of data displayed on page.

ACT (active) or MOD (modified) shows whether page contains active or modified data.

**2. Line Title**

Title of data on line below.

**3. Line Data**

Displays -

- data
- entry field
- prompts

**4. Prompts**

Caret "<" or ">" indicates a prompt.

Push - selects indicated information, mode, or page.

**5. Page Number**

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

**6. Boxes**

Data input is mandatory.

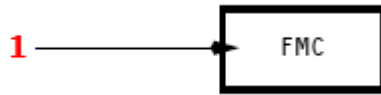
**7. Dashes**

Data input is optional. The data is not mandatory.

**8. Scratchpad**

Displays messages, alphanumeric entries or line selected data.

## FMC ANNUNCIATOR LIGHT



### 1. FMC Annunciator Light

Illuminated (amber) -

- CDU is displaying an operationally significant message in the scratchpad.
- pushing CDU CLR key extinguishes the light and clears the scratchpad message.

**Section 2: FLIGHT MANAGEMENT SYSTEM DESCRIPTION****INTRODUCTION**

The flight management system (FMS) aids the flight crew with navigation, in-flight performance optimization, automatic fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help in flying efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting systems to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios for position updating. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Cruise altitudes and crossing altitude restrictions are used to calculate VNAV commands.

**FLIGHT MANAGEMENT COMPUTER (FMC)**

The heart of the flight management system is the flight management computer.

The FMC uses flight crew-entered flight plan data, airplane systems data, and data from the navigation database to calculate airplane present position and generate the pitch, roll, and thrust commands necessary to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route data are sent to the HSIs. The EFIS control panels are used to select the data to be displayed on the HSIs. The mode control panel selects the autothrottle, autopilot, and flight director operating modes.

The FMC is certified for area navigation when used with navigation radio and/or GPS updating.

The FMC and CDU are used for enroute and terminal area navigation, RNAV approaches, and as a supplement to primary navigation means when conducting other types of nonprecision approaches.

**CONTROL DISPLAY UNITS (CDUS)**

CDU is used to control the FMC.

**Section 3: FLIGHT MANAGEMENT SYSTEM OPERATION**

When first powered, the FMS is in the preflight phase.

As a phase is completed, the FMS changes to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete

**PREFLIGHT**

During preflight, flight plan and load sheet data are manually entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet data provide performance data to initialize VNAV.

Required preflight data consists of:

- initial position
- route of flight
- performance data
- takeoff data

Optional preflight data includes:

- navigation database selection
- route 2
- SID
- STAR

Each required or optional data item is entered on specific preflight pages.

Preflight starts with the IDENT page. If the IDENT page is not displayed, it can be selected with the IDENT prompt on the INIT/REF INDEX page. Visual prompts help the flight crew select necessary CDU preflight pages. Preflight pages can be manually selected in any order.

After the necessary data on each preflight page is entered and checked, push the lower right line select key to select the next preflight page. When ACTIVATE is selected on the ROUTE page, the execute (EXEC) light illuminates. Push the EXEC key to make the route active.

Use the departure/arrival (DEP/ARR) page to select a standard instrument departure (SID). Selection of the SID may cause a route discontinuity in the flight plan. The modification must be connected to the existing route and executed. This can be accomplished on the ROUTE or LEGS page.

When all required preflight entries are complete, PRE-FLT COMPLETE is displayed on the TAKEOFF REF page.

**TAKEOFF**

The takeoff phase starts with engagement of takeoff thrust on the MCP and extends to the thrust reduction altitude where climb thrust is normally selected.

**CLIMB**

The climb phase starts at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C is the position where the airplane reaches the cruise altitude entered on the PERF INIT page.

**CRUISE**

The cruise phase starts at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

**DESCENT**

The descent phase starts at the T/D point or when the VNAV descent page becomes active. The descent phase extends to the start of the approach phase.

**APPROACH**

The approach phase starts when intercepting the first leg of a published approach selected from the ARRIVALS page.

**OPERATIONAL NOTES**

When operating in the LNAV and VNAV modes, system operation must be monitored for unwanted pitch, roll, or thrust commands. If unwanted operation is noticed, roll and pitch modes other than LNAV and VNAV must be selected.

The system must be carefully monitored for errors following:

- activation of a new data base
- power interruption
- IRS failure.

When operating far off the route, the FMC may not sequence the active waypoint when the airplane passes abeam the waypoint.

LNAV can only capture the active leg. It cannot capture an inactive leg in the active route. The DIRECT TO procedures can be used to create an active leg for capture.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) use the first waypoint in the route.

When entering airways in a route page, the start and end waypoints must be in the data base. Otherwise, the route segment must be entered as a DIRECT leg.

**TERMINOLOGY**

The following paragraphs describe FMC and CDU terminology.

**Active** - flight plan data being used to calculate LNAV or VNAV guidance commands.

**Activate** - the procedure to change an inactive route to the active route for navigation. It is a two step procedure.

- select the ACTIVATE prompt
- push the execute (EXEC) key.

**Altitude constraint** - a crossing restriction at a waypoint.

**Delete** - using the delete (DEL) key to remove FMC data and revert to default values, dash or box prompts, or a blank entry.

**Econ** - a speed schedule calculated to minimize operating cost. The economy speed is based on the cost index. A low cost index causes a lower cruise speed. Maximum range cruise or the minimum fuel speed schedule may be obtained by entering a cost index of zero. This speed schedule ignores the cost of time.

A low cost index may be used when fuel costs are high compared to operating costs.

A minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds.

**Enter** - put data in the CDU scratchpad and line select the data to the applicable location. New characters can be typed or existing data can be line selected to the scratchpad for entry.

**Erase** - remove entered data, which has resulted in a modification, by selecting the ERASE prompt.

**Execute** - push the illuminated EXEC key to make modified data active. Inactive - data not being used to calculate LNAV or VNAV commands. Initialize - entering data required to make the system operational.

**Message** - FMC information displayed in the scratchpad.

**Modify** - to change active data. When a modification is made to the active route or performance mode, MOD displays in the page title, ERASE displays next to line select key 6 left, and the EXEC key illuminates.

**Prompt** — CDU symbol that aids the flight crew in accomplishing a task. Prompts can be boxes, dashes, or symbols (< or >) to remind the flight crew to enter or select data.

**Select** - pushing a key to obtain the necessary data or action, or to copy selected data to the scratchpad.

**Speed restriction** - an airspeed limit associated with a specified altitude entered by the flight crew.

**Speed transition** - an airspeed limit associated with a specified altitude entered by the FMC.

**Waypoint** - a point on the route or in the navigation database. It can be a fixed point such as a latitude and longitude, VOR or ADF station, or an airway intersection. A conditional waypoint is not associated with a land reference; it is based on a time or altitude requirement. An example of a conditional waypoint is "when reaching 1000 feet".

## **LATERAL NAVIGATION (LNAV)**

LNAV provides steering commands to the next waypoint or the selected route intercept point. When selected after takeoff, LNAV engages when laterally within 2.5 nautical miles of the active route leg. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC data base is entered into the active route, the FMC commands a heading, track, to comply with the procedure.

### **WAYPOINTS**

Waypoint (navigation fix) identifiers display on the CDU and HSI.

The CDU message NOT IN DATABASE is displayed if a manually entered waypoint identifier is not in the data base. The waypoint can still be entered as a latitude/longitude, place-bearing/distance or a place-bearing/place-bearing waypoint.

FMC-generated waypoints contain a maximum of five characters assigned according to the following rules.

### **NAVAID WAYPOINTS**

VHF - waypoints located at VHF navaids (VOR/DME/LOC) are identified by one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC- LAX
- TyndallTACAN-PAM
- Riga Engure, Latvia - AN.

NDB - waypoints located at NDBs are identified by use of the station identifier. Example: FORT NELSON, CAN - YE.

### **FIX WAYPOINTS**

Waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

**LONG WAYPOINT NAMES**

Waypoints with more than five characters are abbreviated using the following rules sequentially until five characters remain. For double letters, one letter is deleted. Example:

- KIMMEL becomes KIMEL

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Example:

- BAILEY becomes BAILY

The next rule abbreviates names even further. Apply the previous rule, then delete consonants from right to left. Example:

- BRIDGEPORT becomes BRIDGPRT then BRIDT

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

**UNNAMED WAYPOINTS**

If an unnamed turn point, intersection, or fix is collocated 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 collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints 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 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID - DISTANCE - IDENT):

- INW-18-INW18
- CSN-106-06CSN

Waypoint located at unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points are identified by the three-letter airspace type identification followed by a two-digit sequence number. Example:

- FRA01

Unnamed oceanic control area reporting points in the northern hemisphere use the letters N and E, while points 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.

Placement 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° and is the third character if the longitude is 100° or greater.

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. Examples:

- |                            |                             |
|----------------------------|-----------------------------|
| • N50° W040° becomes 5040N | • S52° W075° becomes 5275W  |
| • N75° W170° becomes 75N70 | • S07° W120° becomes 07W20  |
| • N50° E020° becomes 5020E | • S50° E020° becomes 5020S  |
| • N06° E110° becomes 06E10 | • S06° E110° becomes 06S10. |

**PROCEDURE ARC FIX WAYPOINT NAMES**

Unnamed terminal area fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles and so forth. Example:

- EPH252°/24 = D252X

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified by the station identifier and the DME radius. Example:

- CPR338°/29 = CPR29

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character.

Examples:

- CPR134°/29 = CP29A
- CPR1900 /29 = CP29B

### **PROCEDURE FIX WAYPOINTS**

Waypoints located at unnamed runway-related fixes are identified by adding a two-letter prefix to the runway number.

Examples: CF04, RW18L.

Unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page.

Airport reference points are identified by the ICAO identifier.

### **DUPLICATE WAYPOINTS**

Application of the abbreviation rules may create identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude, longitude, and the type of facility or waypoint of all the waypoints with the same identifier. Select the latitude/longitude of the correct waypoint to enter the correct waypoint on the original page.

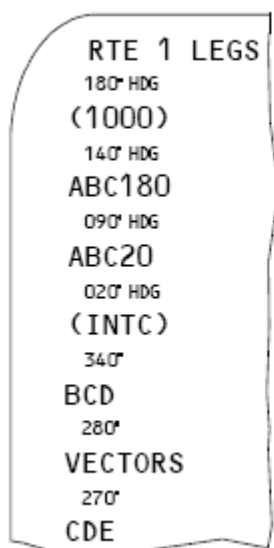
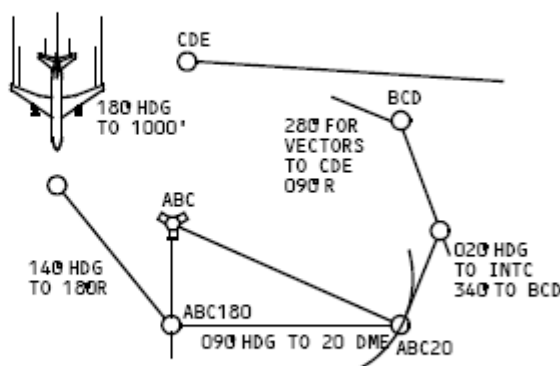
### **CONDITIONAL WAYPOINTS**

Conditional waypoints may be displayed in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically-fixed position. The types of conditions are:

- climb/descent through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vectors to a course or fix.

Altitude and course intercept conditional waypoints display on the CDU inside (parenthesis) marks. The diagram below shows conditional waypoints.



**DO NOT USE FOR FLIGHT****EXAMPLE:****MEANING:**

**Note:** All waypoints except BCD and CDE are examples of conditional waypoints.

**MANUALLY ENTERED LATITUDE/ LONGITUDE WAYPOINTS**

Pilot defined waypoints entered as a latitude and longitude are shown in a seven-character format. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displays as N47W008
- N47° 15.4' W008° 3.4' is entered as N4715.4W00803.4 and displays as N47W008.

**MANUALLY ENTERED PLACE-BEARING/DISTANCE OR PLACE-BEARING/PLACE-BEARING WAYPOINTS**

Waypoints entered as a place-bearing/distance or place-bearing/place-bearing are identified by the first three characters of the entry followed by a two-digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

The two digit sequence numbers reserved for RTE1 are 01 through 49. The two digit sequence numbers reserved for RTE2 are 51 through 99.

**MANUALLY ENTERED AIRWAY CROSSING WAYPOINTS**

Airway crossing fixes are entered as a five character waypoint name or by entering consecutive airways on the ROUTE page. In the latter case, the display is an X followed by the second airway name. Example: entering J70 on the VIA line of the ROUTE page causes box prompts to display opposite on the same line. Leaving the box prompts empty and entering J52 on the next VIA line, directly below J70, causes the FMC to calculate the intersection of the two airways and replace the boxes with the waypoint identifier, XJ52.

## HSI MAP DISPLAYS

The route is displayed on the HSI in MAP, and PLAN modes. The display color and format represent the following status:

- an inactive route is displayed as a cyan dashed line
- an activated, but not yet executed route, is displayed as a white dashed line
- the active route is displayed in magenta
- modifications to an active route are shown as dashed white lines
- modified waypoints are displayed in white

The HSI displays the FMC position at the apex of the airplane symbol. All HSI map data displays relative to this apex.

## VERTICAL NAVIGATION (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

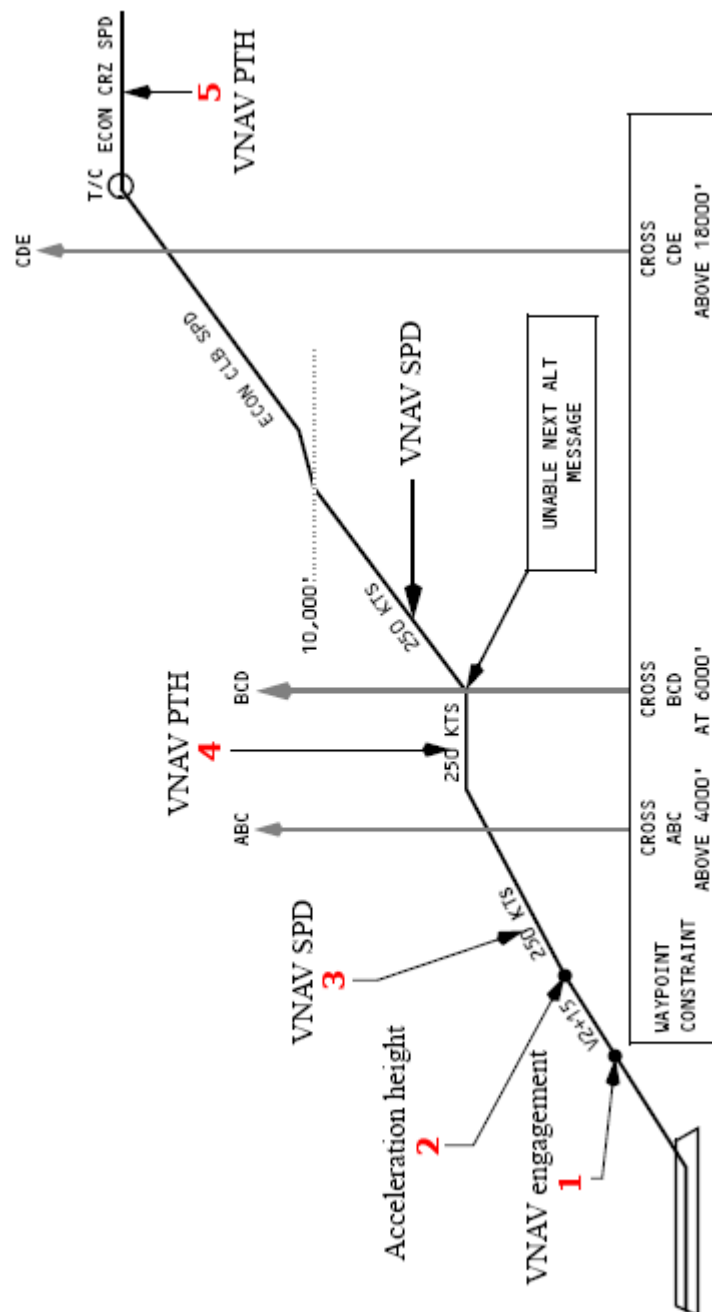
### **SPEED/ALTITUDE CONSTRAINTS**

VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Values entered as part of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and are displayed in small font.

Waypoints can have altitude or airspeed/altitude constraints. Speed constraint entries require an altitude constraint at the same waypoint. All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (example: 220A240B or 240B220A).

**DO NOT USE FOR FLIGHT****TAKEOFF AND CLIMB****1. Takeoff**

The takeoff (TO) pitch mode is used for the takeoff and initial climb. VNAV is normally engaged at 1000 feet and pitch guidance continues to maintain the target airspeed.

During takeoff the target airspeed is between  $V_2 + 15$  and  $V_2 + 25$  knots. When VNAV is engaged the FMC airspeed is set to the target airspeed.

When VNAV is engaged (above 400 feet) the thrust reference changes to climb.

## **2. Acceleration Height**

At the acceleration height, flap retraction, or AFDS altitude capture before acceleration height, VNAV commands an airspeed increase to 250 knots or the speed transition associated with the origin airport, limited by configuration

## **3. VNAV Climb**

The VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

## **4. Climb Constraints**

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed.

## **5. Top of Climb (T/C)**

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C point is displayed on the map as a green circle with the label T/C.

## **CRUISE**

At cruise altitude, the FMC commands economy cruise speed or the pilot entered speed until reaching the top-of-descent (T/D) point. Alternate cruise speed is flight crew entered speed.

If the cost index is set to zero the FMC commands maximum range cruise speed. Cost index modifications are allowed until within ten miles of the top of descent.

## **CRUISE CLIMB**

When VNAV is engaged, resetting the MCP to an altitude higher than the current cruise altitude causes the new altitude to be displayed in the scratchpad of the CDU. The altitude can then be entered on the CRZ ALT line on the cruise page. When the modification is executed the airplane will climb to the new cruise altitude. The CRZ page displays ACT ECON CRZ CLB.

## **STEP CLIMB**

Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size entered on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise. Flight crew entry of a step altitude on the CRZ page overrides the FMC step climb predictions.

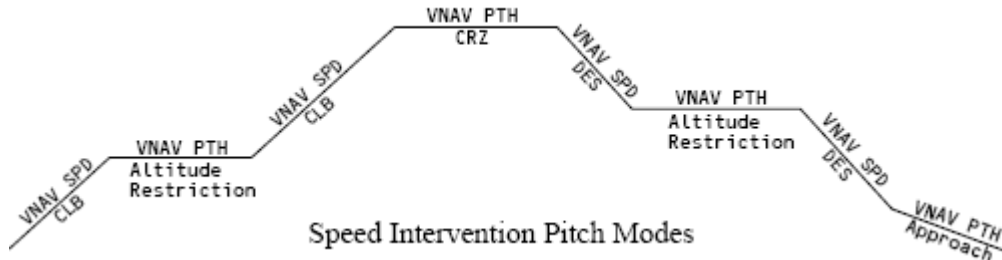
Predicted step altitudes are displayed on the RTE LEGS page. The distance and ETA to the next step point is displayed on the CRZ and progress pages. Step points are displayed on the HSI map with a green circle and S/C label.

## **CRUISE DESCENT**

The new cruise altitude can be entered on the cruise page. When the modification is executed the CRZ page displays ACT ECON CRZ DES.

**DO NOT USE FOR FLIGHT****Note**

A cruise descent will not provide speed adjustments to comply with speed restrictions or transition altitude speeds. Transition or speed restrictions must be maintained by flight crew action.

**MODE CONTROL PANEL SPEED INTERVENTION**

With VNAV engaged, pushing the IAS MACH selector enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

The above illustration shows VNAV mode for each phase of flight during speed intervention.

In VNAV PTH mode, thrust controls speed; in VNAV SPD mode, pitch controls speed.

In a path descent, VNAV PTH changes to VNAV SPD during speed intervention. In all other phases, the pitch mode remains the same.

In approach phase (see Approach topic this section), during speed intervention, pitch mode remains in VNAV PTH and the vertical path is maintained regardless of IAS MACH selector changes.

**DESCENT**

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point.

An E/D point is created by the FMC when an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan. During cruise, an E/D point is also created when an altitude constraint less than cruise altitude is added to a downstream waypoint on the LEGS page.

The FMC calculates the top of descent (T/D) point after the E/D is entered. T/D is the point where the cruise phase changes to the descent phase. The T/D is displayed on the HSI as a green circle with the label T/D. The descent path starts at the T/D and includes any waypoint altitude/airspeed constraints.

The path to the first altitude constrained waypoint is based on:

- idle thrust
- speedbrakes retracted
- predicted use of anti-ice
- applicable target speed

Descent path segments after the first altitude constrained waypoint are constructed as straight line point-to-point segments from one altitude constraint to the next.

The airspeed used to determine the descent path is the existing VNAV cruise airspeed, normally economy Mach/CAS (based on Cost Index), and any additional descent airspeed constraints. Waypoints with an airspeed constraint must also have an altitude constraint. Airspeed constraints after the first altitude constrained waypoint are treated as speed limits (e.g. at or below the speed constraint)

With the MCP altitude set below the current airplane altitude and at the T/D point, the FMC commands idle thrust and the AFDS pitches down to track the vertical descent path. AFDS pitch maintains the vertical descent path while the angle of the descent path is calculated by the FMC to maintain the descent airspeed (at idle thrust), normally economy descent Mach/CAS.

**DO NOT USE FOR FLIGHT**

If the airplane passes the T/D point and the window altitude has not been set lower, or if the airplane levels at an MCP altitude not in the FMC descent profile, ALT HOLD annunciates. To reinitiate/continue the descent, the MCP altitude must be reset and VNAV re-engaged.

When a speed transition altitude is included in the descent path (typically 250 kts below 10,000 ft), the descent path angle shallows temporarily to slow to the transition altitude airspeed. Below the speed transition altitude, the descent path angle increases to maintain a target speed 10 kts below the transition speed (typically 240 kts) to allow for unforecast tailwinds.

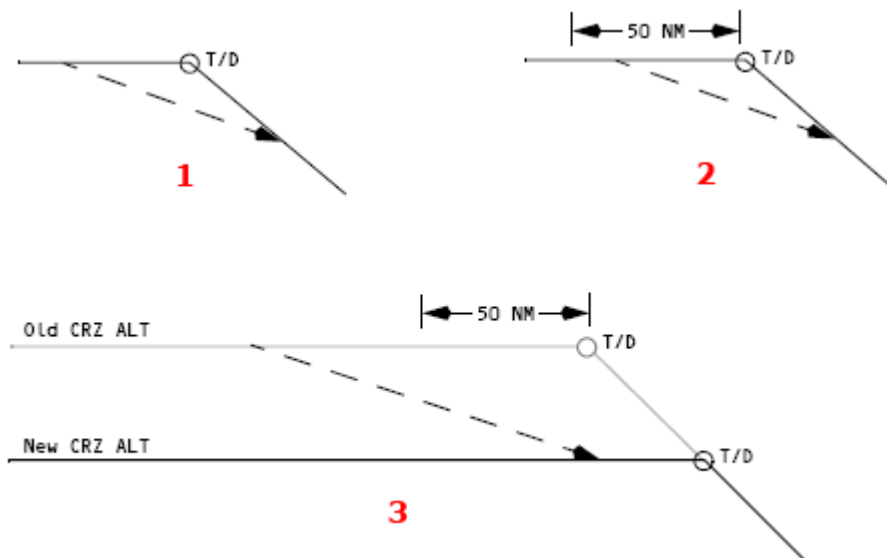
Final deceleration is commanded to arrive at the final approach fix or the outer marker at 170 kts. It is the flight crew's responsibility to extend flaps as appropriate when the final deceleration segment to 170 kts is initiated by VNAV.

**Note**

Adding, deleting or revising altitude constraints after VNAV enters the descent mode causes a recalculation of the descent path by the FMC. This may cause VNAV to revert to speed reversion mode (VNAV SPD) if the newly calculated path is above or below the old path far enough so as to prevent the path from remaining captured.

**EARLY DESCENT**

An early descent is initiated by forcing the FMC into the descent phase before reaching the top of descent point. VNAV commands a descent at a reduced descent rate until the idle descent path is intercepted.

**1. DES NOW**

Use the DES NOW prompt on the DES page. VNAV starts an early descent and captures the idle descent path.

**2. Within 50 NM of Top of Descent Point**

Use the MCP altitude selector to start an early descent. Within 50 NM of the top of descent point, VNAV starts an early descent and captures the idle descent path.

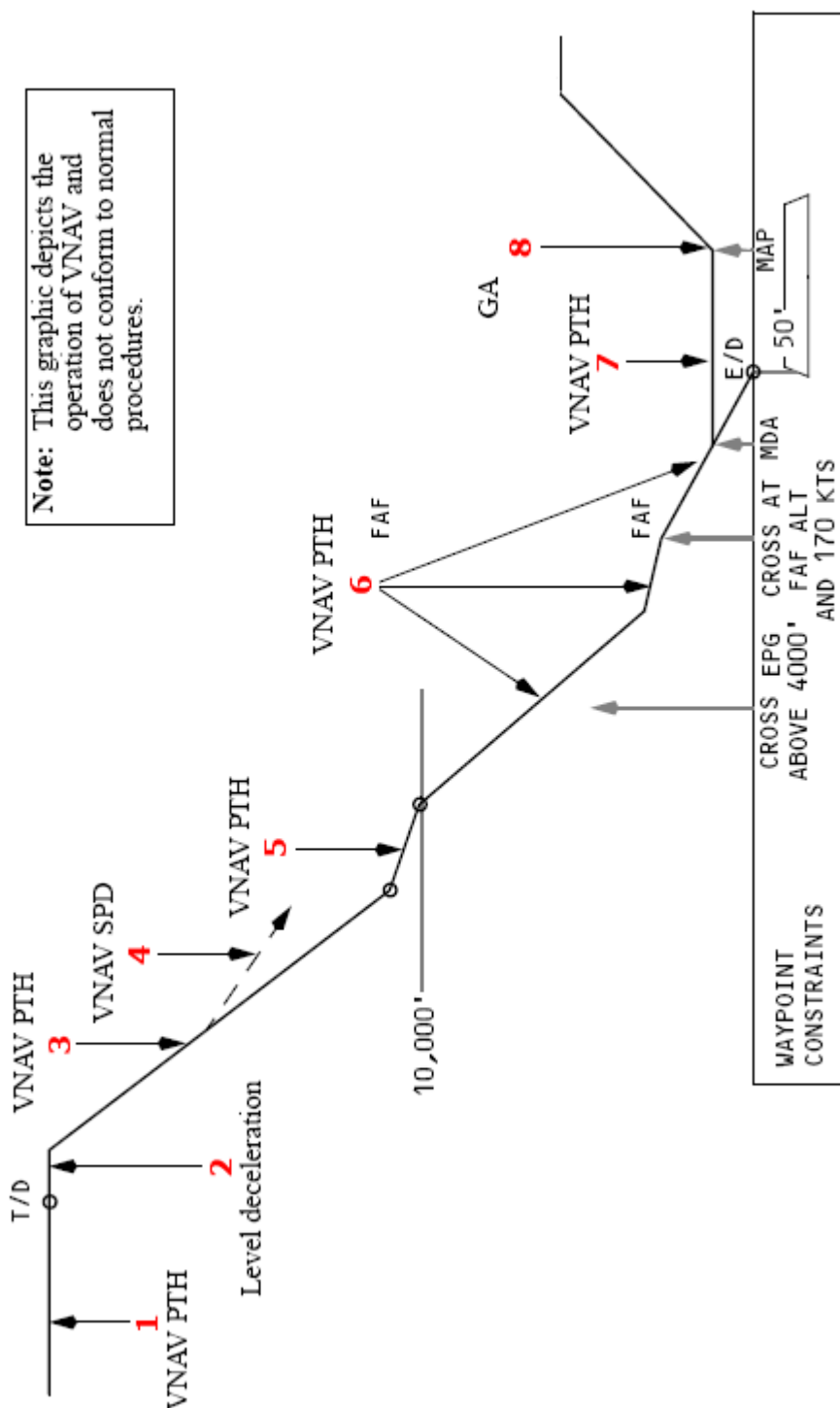
**3. More than 50 NM from Top of Descent Point**

Enter a new cruise altitude to start a cruise descent. If the distance from the top of descent is more than 50 NM, VNAV begins a cruise descent to the new cruise altitude and the new T/D is displayed.

Monitor the descent profile to ensure the new cruise altitude is reached before T/D.

**DO NOT USE FOR FLIGHT****APPROACH**

VNAV will fly the computed descent path to the E/D point altitude if the MCP altitude is set at or below the E/D point altitude. However, it is the responsibility of the flight crew not to descend below the MDA of the approach being flown until adequate visual contact is achieved.

**CRUISE AND DESCENT PROFILE (NONPRECISION APPROACH)**

**1. Cruise**

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

**2. Level Descent Phase**

After top of descent, FMC is in descent mode, VNAV decreases airspeed to ECON descent speed, maintains altitude in VNAV PTH.

**3. Descent**

Upon reaching descent speed, VNAV descends in VNAV PTH at ECON descent speed.

**4. Speed Limit Protection**

If a tailwind causes the airplane to accelerate the DRAG REQUIRED scratchpad message will be displayed. If the speedbrakes are not deployed, the pitch mode will change to VNAV SPD and depart the path before the speed reaches the limit.

**5. Speed Restriction Deceleration**

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

**6. Descent and Approach**

When at restricted speed, VNAV descends and starts approach in VNAV PTH at commanded speed.

**7. Minimum Descent Altitude**

When the MDA is reached with VNAV engaged the airplane will maintain the MDA altitude in VNAV PTH. If the missed approach point is crossed without selecting GA, VNAV will maintain the missed approach point altitude until GA is selected.

**8. Go-Around (GA)**

The missed approach go-around is commenced by pushing a Go-Around switch. Pushing a Go-Around switch sets go-around thrust.



**DATA ENTRY RULES****ALTITUDE ENTRY**

Altitudes can be entered into the FMC as three digit (XXX), four digit (XXXX), five digit (XXXXX), or flight level (FLXXX) numbers. The FMC displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (XXX, FLXXX) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008; displays as 800
- 1,500 feet is entered as 015 or FL015; displays as 1500
- 11,500 feet is entered as 115 or FL115; displays as FL115
- 25,000 feet is entered as 250 or FL250; displays as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (XXXX) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050; displays as 50
- 835 feet is entered as 0835; displays as 840
- 1,500 feet is entered as 1500; displays as 1500
- 8,500 feet is entered as 8500; displays as 8500
- 9,994 feet is entered as 9994; displays as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet

Examples of five (XXXXX) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050; displays as 50
- 835 feet is entered as 00835; displays as 840
- 1,500 feet is entered as 01500; displays as 1500
- 8,500 feet is entered as 08500; displays as FL085
- 9,995 feet is entered as 09995; displays as FL100
- 11,500 feet is entered as 11500; displays as FL115
- 25,000 feet is entered as 25000; displays as FL250.

Negative altitude entries are allowed to -1000 feet.

**AIRSPPEED ENTRY**

Airspeeds can be entered into the FMC as calibrated airspeed (CAS) or Mach number (M). CAS is entered as three digits (XXX) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

**DATA PAIRS**

Many CDU pages display data in pairs separated by a slash "/." Examples of these pairs include wind direction/speed and waypoint airspeed/altitude constraints. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an INVALID ENTRY message.

## **Section 4: FLIGHT MANAGEMENT COMPUTER**

### **FMC DATABASES**

The FMC contains two databases:

- performance database
- navigation database

The performance database supplies all the necessary performance data to the flight crew. It supplies the FMC with the necessary data to calculate pitch and thrust commands. All necessary data can be shown on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

The navigation database includes most data usually found on navigation charts. This data can be shown on the CDU or HSI. The database contains:

- the location of VHF navigation aids
- airports
- runways
- other airline selected data, such as SIDs, STARs, approaches, and company routes
- transition altitudes.

### **THRUST MANAGEMENT**

The autothrottle is controlled by the thrust management computer. When VNAV is engaged, the FMC controls the autothrottle by setting the command speeds and thrust reference modes on the thrust management computer.

When VNAV is not engaged, the thrust management is controlled by the flight crew as part of the AFDS system.

**Section 5: FMC PREFLIGHT****INTRODUCTION**

FMC preflight is required before flight.

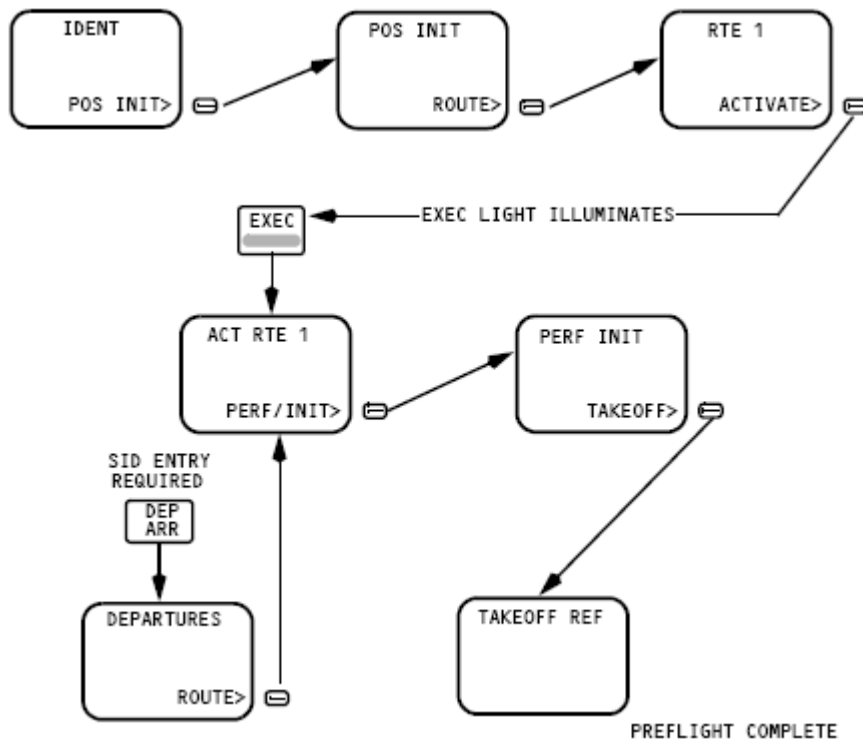
Completion of the FMC preflight requires data entry in all minimum required data locations. Additional entry of optional preflight data optimizes FMC accuracy.

**PREFLIGHT PAGE SEQUENCE**

The usual FMC power-up page is the identification page. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- ROUTE page
- DEPARTURES page (no automatic prompt)
- performance initialization (PERF INIT) page
- takeoff reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

**MINIMUM PREFLIGHT SEQUENCE**

During preflight, a prompt in the lower right directs the flight crew through the minimum requirements for preflight completion. Selecting the prompt key displays the next page in the flow. If a required entry is missed, a prompt on the TAKEOFF page leads the flight crew to the preflight page missing data.

Airplane inertial position is necessary for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route data is origin and destination airports, and a route leg.

Performance data requires the airplane weight and cruise altitude.

Takeoff data requires a flap setting.

### **SUPPLEMENTARY PAGES**

Supplementary pages are sometimes required, these pages have no prompts and interrupt the usual sequence. Discussions of each page includes methods to display the page.

When the route includes SIDs and STARs, they can be entered using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed and the route is modified on the ROUTE and RTE LEGS pages. Speed/altitude restrictions are entered and removed on the RTE LEGS page. The RTE LEGS page is described in the FMC Cruise section.

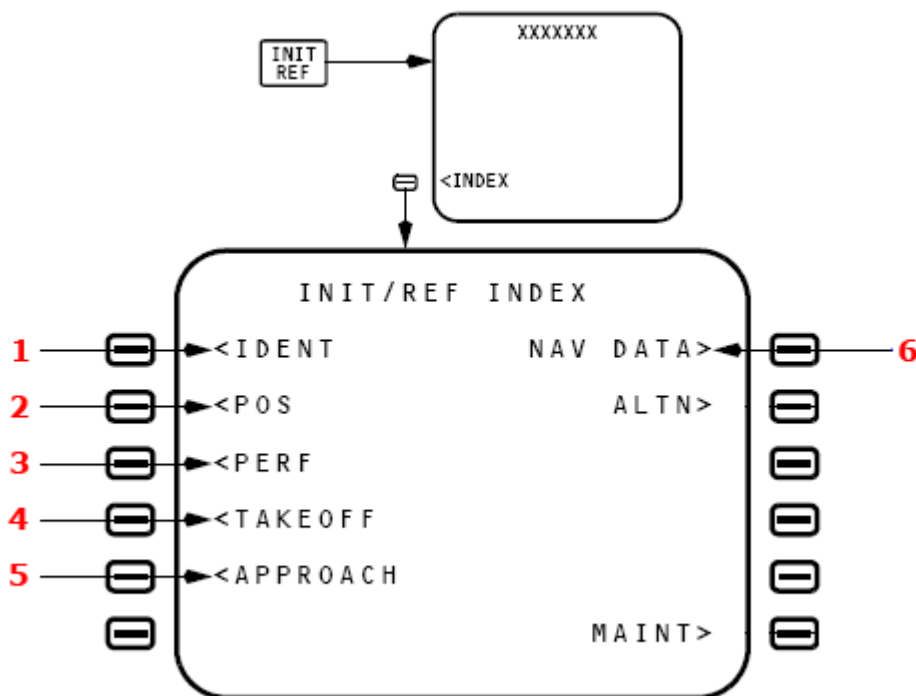
Waypoint, navaid, airport, and runway data is referenced on the REF NAV DATA page. The REF NAV DATA page is described in the FMC Cruise section.

## **PREFLIGHT PAGES - PART 1**

The preflight pages are presented in the sequence used during a typical preflight.

### **INITIALIZATION/REFERENCE INDEX PAGE**

The initialization/reference index page allows manual selection of several FMC pages. It gives access to most of the pages used during preflight.



#### **1. Identification (IDENT)**

The IDENT page is the first page in the preflight sequence.

**DO NOT USE FOR FLIGHT****2. Position (POS)**

The POS INIT page is used for IRS initialization.

**3. Performance (PERF)**

The PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

**4. TAKEOFF**

The TAKEOFF REF page is used to enter takeoff reference data and V speeds.

**5. APPROACH**

The APPROACH REF page is used for entry of the approach VREF speed.

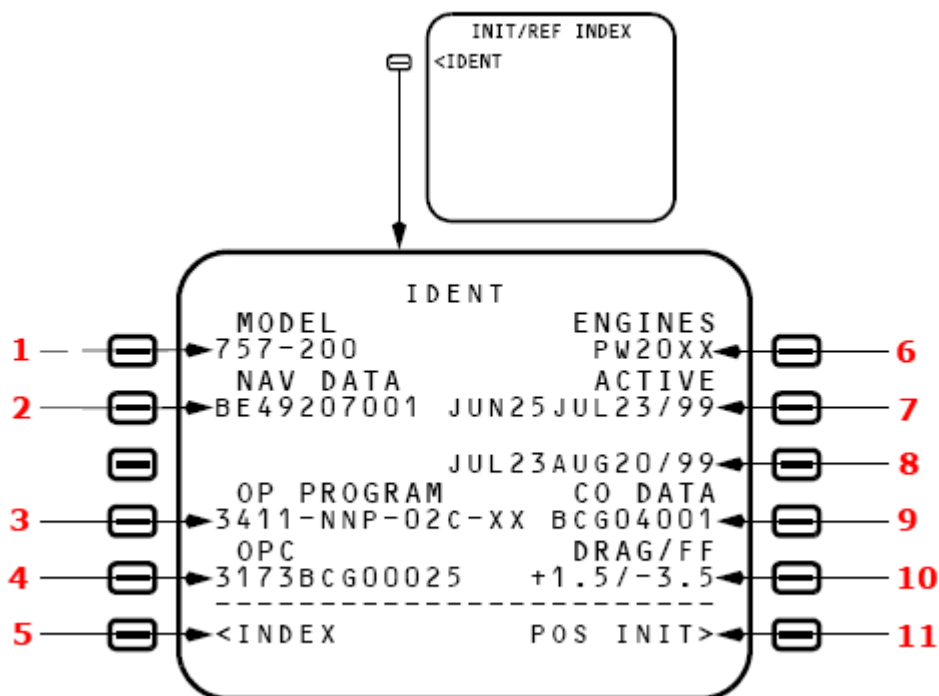
**6. Navigation (NAV) DATA**

The REF NAV DATA page is used to access data on waypoints, navaids, airports, and runways. The REF NAV DATA page is accessible only from this page.

**IDENTIFICATION PAGE**

Most of the data on this page is for flight crew verification. Active date and drag/fuel flow can be modified.

The flight crew verifies FMC data, selects the current navigation database, and checks or modifies drag and fuel flow factors on the identification page.

**1. MODEL**

Displays the airplane model from the FMC performance database.

## **2. Navigation (NAV) DATA**

Displays the navigation database identifier.

## **3. Operating (OP) PROGRAM**

Displays the operating program identifier.

## **4. Operating Program Configuration (OPC) Part Number**

Displays the Operational Program Configuration part number.

## **5. INDEX**

Push - displays the INIT/REF INDEX page.

## **6. ENGINES**

Displays the engine model from the FMC performance database.

## **7. ACTIVE**

Displays the effectivity date range for the active navigation database.

The active navigation database can be replaced with the inactive database while on the ground.

Changing the navigation database removes all previously entered route data.

## **8. Inactive Date Range**

Displays the effectivity date range for the inactive navigation database. May be line selected to the scratchpad and inserted to the ACTIVE line while on the ground.

## **9. Company (CO) DATA**

Displays the last eight characters of the Airline Modifiable Information (AMI) part number.

## **10. DRAG/Fuel Flow (FT) Factors**

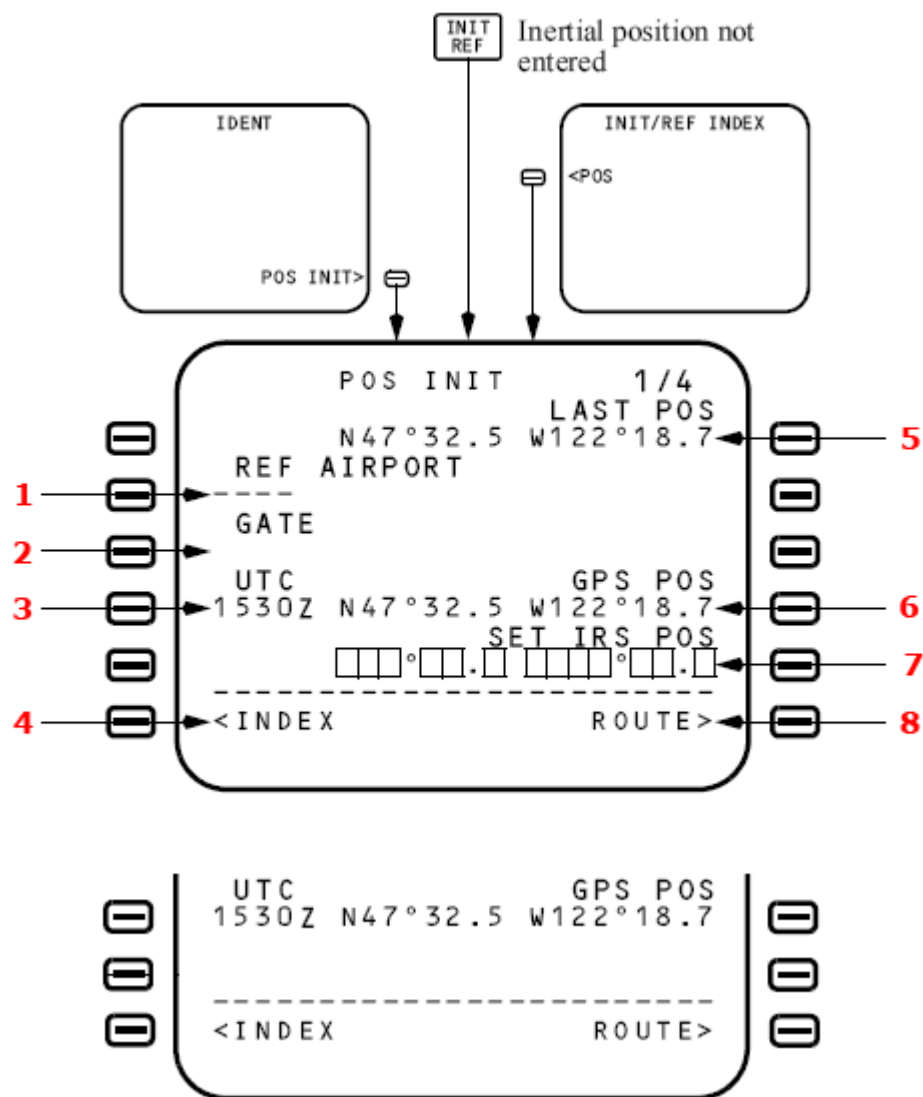
Displays the airplane drag and fuel flow correction factors.

## **11. Position Initialization (POS INIT)**

Push - displays the POS INIT page.

**DO NOT USE FOR FLIGHT****POSITION INITIALIZATION PAGE**

The position initialization page allows entry of airplane present position for IRS alignment. This page is also used to enter the heading when an IRS is in the ATT mode.

**1. Reference Airport (REF AIRPORT)**

Entry of the reference airport displays the airport latitude/longitude. Optional entry.

Valid entries are ICAO four letter airport identifiers.

Removes previous GATE entry.

Entry blanks when airborne.

**2. GATE**

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after reference airport entered.

### **3. Coordinated Universal Time (UTC)**

UTC -

- displays time from captain's clock when operative; otherwise, displays time from first officer's clock
- hours set by entering desired hour reference
- minutes set by resetting appropriate pilot's clock.

### **4. INDEX**

Push - displays the INIT/REF INDEX page.

### **5. Last Position (LAST POS)**

Displays the last FMC calculated position.

### **6. GPS Position (GPS POS)**

Displays the GPS present position. During preflight, the GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

### **7. Set IRS Position (SET IRS POS)**

The set inertial position entry is required to initialize the IRS. Select the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or a manual entry to initialize the IRS.

If an entry is not made before the IRS completes the initial alignment, the scratchpad message ENTER IRS POSITION is displayed.

If the manually entered position fails the IRS internal check, the scratchpad message ENTER IRS POSITION is displayed.

The manually entered position is also compared with the FMC origin airport position. If the entered position is not within 6 NM of the FMC origin airport position, the scratchpad message IRS POS/ORIGIN DISAGREE is displayed.

Blanks when the IRS changes from the alignment to the navigation mode.

### **8. ROUTE**

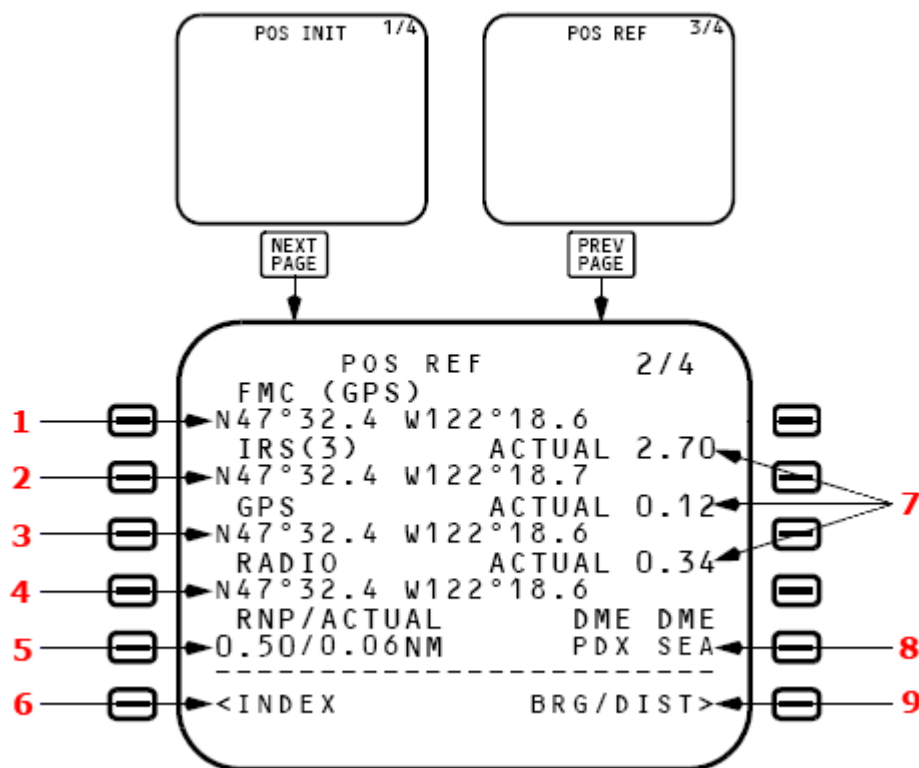
Push - displays the ROUTE page.



**POSITION REFERENCE PAGES****POSITION REFERENCE PAGE 2/4**

Position reference page 2 simulates displays positions calculated by the FMC, IRS, GPS, and radio navigation receivers. The FMC position can be updated to IRS, GPS, or radio position on this page.

Positions are displayed as the latitude/longitude calculated by the individual systems. When BRG/DIST is selected the IRS, GPS, and radio positions are shown as bearing and distance from the FMC position.

**1. FMC Position and Source**

The source used by the active FMC for position data is displayed next to the FMC line title. In the example, the FMC uses LGPS for position data.

Displays the FMC calculated latitude/longitude.

Identifies the source for calculating the FMC position:

- GPS - position calculated from GPS and inertial position data
- IRS - position calculated from inertial position data only
- RADIO — position calculated from navigation radio and inertial position data
- LOC-GPS - position is calculated from localizer, GPS and inertial data
- LOC-RADIO - position is calculated from localizer, navigation radio and inertial data
- LOC - position is calculated from localizer and inertial data.

**2. IRS**

Displays latitude/longitude position or the bearing and distance from the FMC position determined by the IRS. If the displayed position is derived from all three IRSs, (3) is displayed. If the position is from a single IRS then (L), (C), or (R) is displayed to indicate which IRS position is displayed.

### **3. GPS**

Displays latitude/longitude position or the bearing and distance from the FMC position determined by the GPS.

### **4. RADIO**

After airborne, displays latitude/longitude position or the bearing and distance from the FMC position determined by navigation radios.

### **5. Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)**

Displays the RNP and actual navigational performance (ACTUAL) of the FMC.

#### **Note**

The FMC stops GPS updating if GPS data accuracy degrades due to satellite availability or unfavorable geometry. Subsequently, the FMC receives updates from another system.

### **6. INDEX**

Push - displays the INIT/REF INDEX page.

### **7. ACTUAL**

Displays actual navigation performance (ANP) of the IRS, GPS and navigation radios.

### **8. Radio Update Station(s)/Mode**

Displays radio station identifiers.

Position update mode is indicated in the line title:

- DME DME
- VOR DME

Line and title are blank when no radio position is computed.

### **9. Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)**

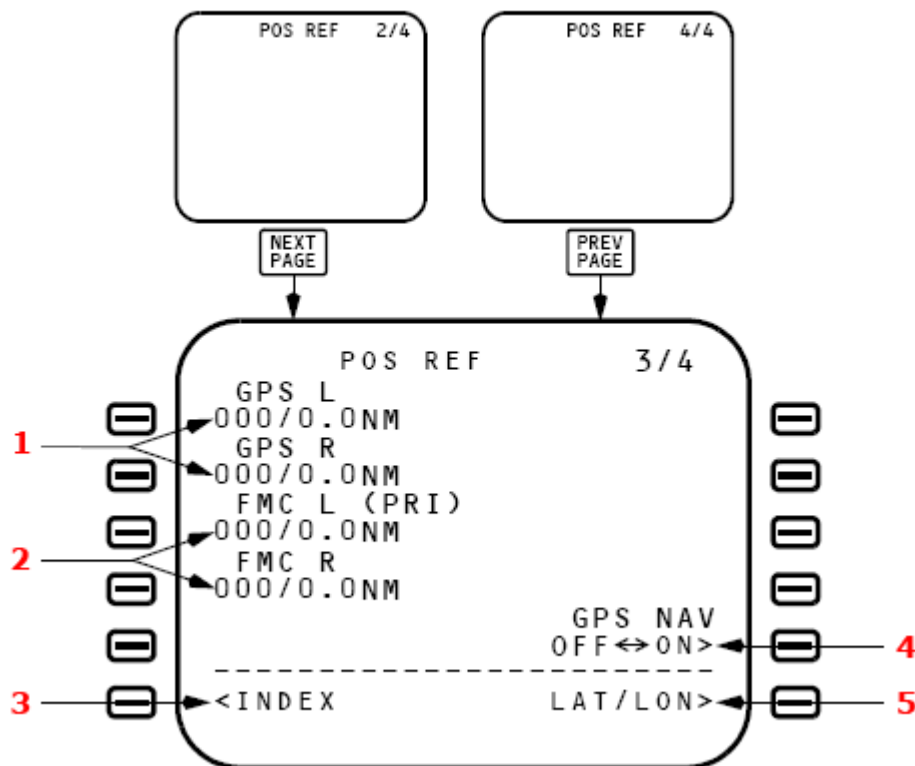
Push - alternates position data format between bearing/distance or latitude/longitude.

The page illustration is shown in the latitude/longitude display format. Latitude/longitude format displays are actual position. Bearing/distance display is relative to the FMC position.

**POSITION REFERENCE PAGE 3/4**

On position reference page 3, the flight crew can observe the calculated positions from the left and right GPS receivers and the left and right FMC calculations. This page also allows the flight crew to enable or disable GPS position updates.

This page can display the bearing/distance or latitude/longitude format. The bearing/distance format displays the positions relative to the active FMC position on the POS REF 2/4 page. In the example, both the left and right GPS agree with the left FMC position.

**1. GPS Left (L) and GPS Right (R)**

Displays the left and right GPS positions.

**2. FMC Left (L) and FMC Right (R)**

Displays the left and right FMC calculated position.

Primary (PRI) is displayed in line title of the FMC that is the navigation master.

**3. INDEX**

Push - displays the INIT/REF INDEX page.

**4. GPS Navigation (NAV)**

Push - alternately selects GPS NAV ON (enabled) and OFF (disabled).

OFF - GPS position data is not available to the FMC. OFF displays in large letters; ON displays in small letters.

**DO NOT USE FOR FLIGHT**

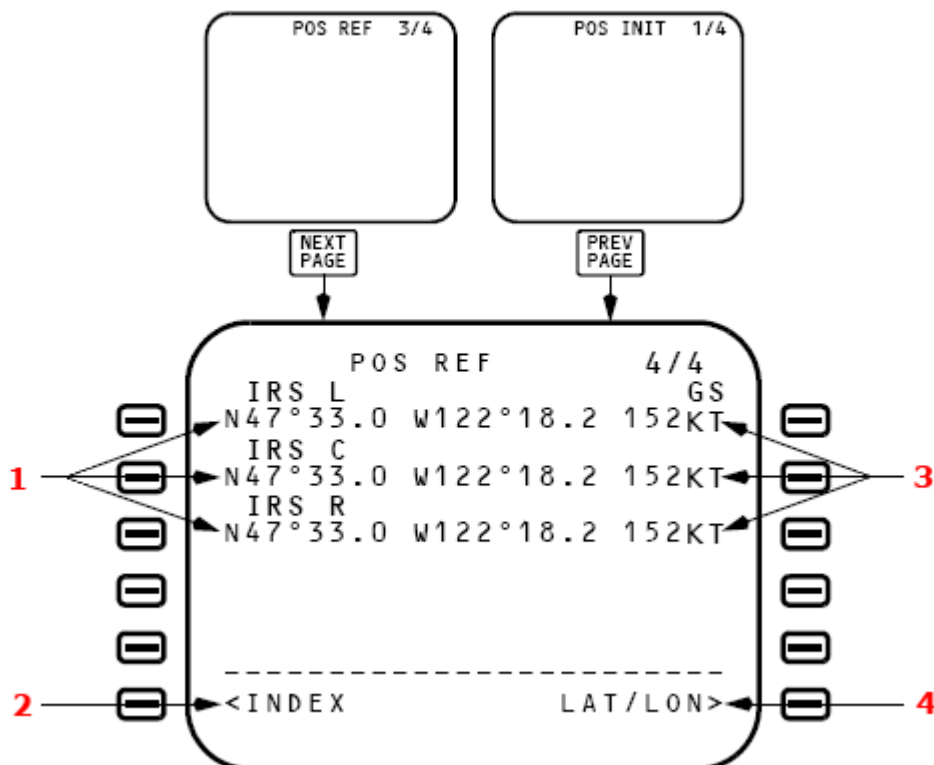
ON - GPS position data is available to the FMC. ON displays in large letters; OFF displays in small letters.

### 5. Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)

Push - alternately changes the display of position data on POS REF 2/4,3/4, and 4/4 to latitude/longitude format or bearing/distance format.

The page illustration is shown in the bearing/distance display mode.

#### **POSITION REFERENCE PAGE 4/4**



On position reference page 4, the calculated positions and ground speeds from the left, center and right IRS are displayed. Positions can be displayed in the bearing/distance or latitude/longitude format.

#### **1. IRS L, C, and R**

Displays the position of the Left, Center, and Right IRS. Positions can be displayed in latitude longitude or as bearing and distances from the FMC position.

#### **2. INDEX**

Push - displays the INIT/REF INDEX page.

#### **3. Ground Speed (GS)**

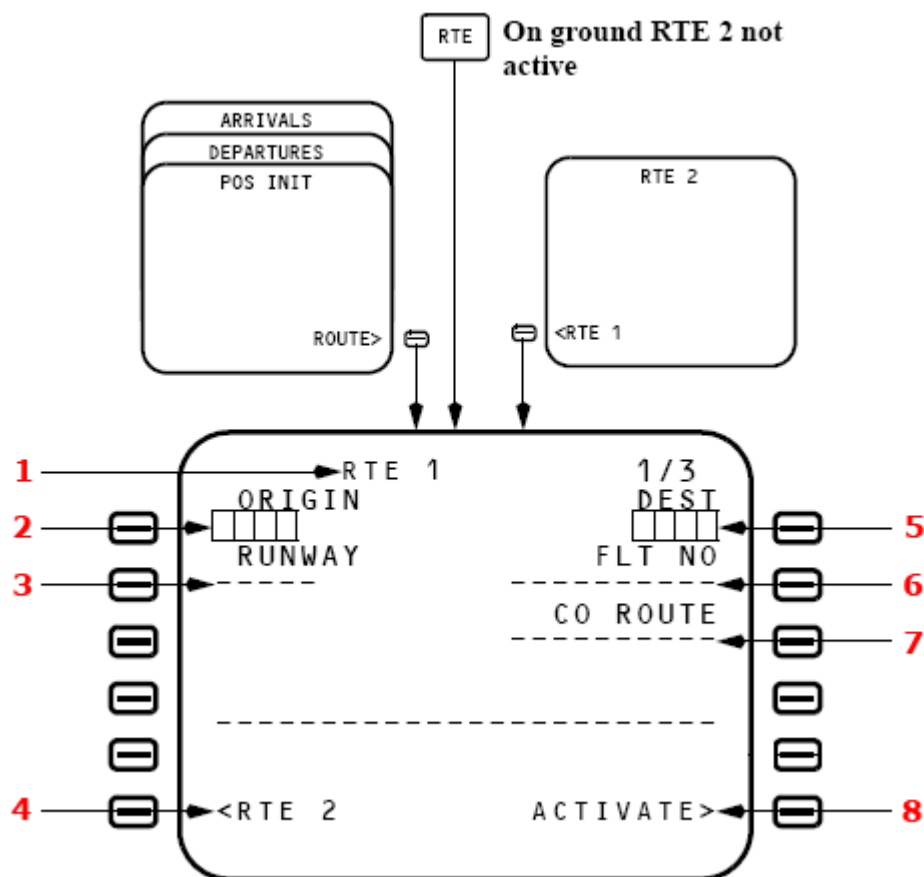
Displays the ground speed calculated by each IRS. The displayed values are frozen when the engines are shut down after flight until power is removed.

**4. Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)**

Push - alternately changes the displayed position between latitude/longitude format and bearing/distance format. When the display is in the bearing/distance format the prompt displays LAT/LON>.

**ROUTE PAGE**

Two routes (RTE 1 and RTE 2) can be stored and displayed in air traffic control format. The first route page displays origin and destination data. Subsequent route pages display route segments between waypoints or fixes. Having two routes allows management of alternate or future routes while leaving the active route unmodified. RTE 2 has an identical page structure as RTE 1.

**ROUTE PAGE 1/X**

On the real aircraft, selecting this prompt sends a datalink route request. In the simulated FMC this prompt opens the SELECT CO RTE page listing all previously saved routes. You can navigate the list pages using the NEXT PAGE and PREV PAGE keys. Selecting any route from the list loads this route into the FMC.

The FLTSIM FPLS on the bottom of SELECT CO RTE page opens IMPORT FS FPL page. This page lists all flight plans (.FPL files) created and saved by the Flight Simulator built-in flight planner. Selecting any entry imports the corresponding flight plan waypoints into the FMC.

**1. Page Title**

Preceded by ACT when the route is active, and by MOD when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title. The minimum number of route pages is 2.

## 2. ORIGIN

Entry:

- must be a valid ICAO identifier in the navigation database
- made automatically when a company route is entered
- enables direct selection of departure and arrival procedures
- required for route activation
- inhibited in-flight for active route.

Entry on the ground deletes existing route.

## 3. RUNWAY

Enter the applicable runway for the origin airport. Runway must be in the navigation database.

Entry:

- is optional
- causes MOD to display in the title if route is active
- can be selected on the DEPARTURES page

## 4. Route (RTE) 2

Push - displays the RTE 2 page 1/x.

Allows access to an inactive route for entry, modification or activation.

Inactive route modifications:

- do not alter the active route
- do not change the inactive RTE page title.

Prompt changes to RTE 1 when RTE 2 is displayed.

## 5. Destination (DEST)

Entry:

- must be a valid ICAO identifier in the navigation database
- made automatically when a company route is entered
- required for route activation
- displays MOD in page title if entered in an active route.

## 6. Flight Number (FLT NO)

Enter the company flight number.

Entry:

- optional for activation of the route
- limited to 10 characters
- included in the PROGRESS page title
- propagated to RTE 2 page
- deleted at flight completion.

## 7. Company Route (CO ROUTE)

A previously saved route can be loaded from file by entering the company route identifier.

An entry is optional for activation of the route. Valid entry is any previously saved company route name. If the name isn't found among the saved routes, the scratchpad message NOT IN DATABASE is displayed.

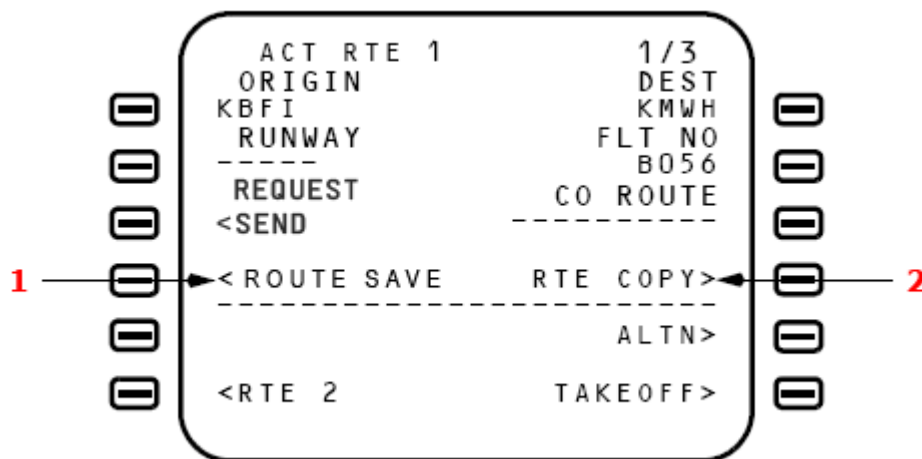
Entry of a new company route replaces the previous route.

**8. ACTIVATE**

Push the ACTIVATE key to arm the route and illuminate the execute light. When the EXEC key is pushed, the route becomes active, ACT is displayed in the title, and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Activation of a route is required for completion of the preflight. ACTIVATE is always displayed on the inactive route pages. After route activation, the ACTIVATE prompt is replaced by:

- PERF INIT, when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete.

**MORE ROUTE PAGE PROMPTS FOR AN ACTIVE ROUTE****1. ROUTE SAVE**

Selecting ROUTE SAVE prompt allows you to save the currently entered route in a file as a company route. Such saved route can be recalled at a later time by using CO ROUTE or REQUEST SEND prompts. All routes saved to .../Captain\_Sim/navigation/routes.

**2. Route Copy (RTE COPY)**

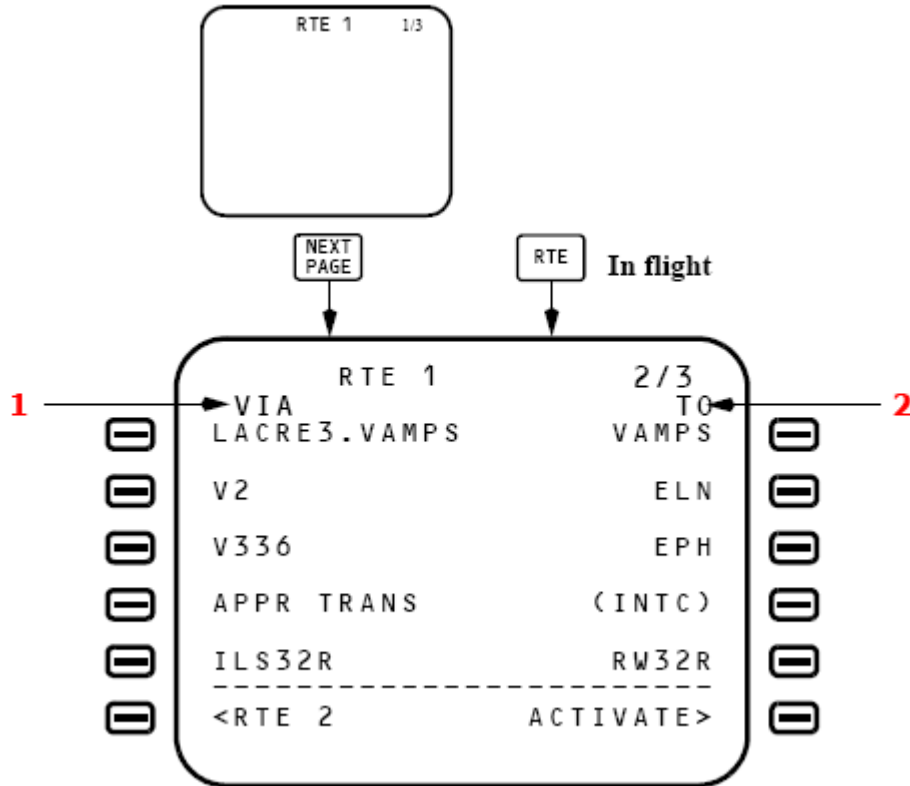
Push - copies the entire active route into the inactive route.

Displayed only on the active route page.

Displays COMPLETE after the route is copied.

**ROUTE PAGE 2/X**

The subsequent route pages 2/X through X/X, display route segments in air traffic control format. Route segments are defined as direct routing, airways, or procedures with start and end points such as waypoints, fixes, navaids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.

**1. VIA**

The VIA column displays the route segment to the waypoint or termination in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination. Enter an airway in the VIA column and boxes display in the TO column. DIRECT is entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the previous TO waypoint, or
- intersect the previous VIA route segment.

Dashes change to DIRECT if the TO waypoint is entered first.

Dashes are displayed for the first VIA beyond the end of the route.

Invalid VIA entries result in the scratchpad message INVALID ENTRY.

Invalid VIA entries are:

- airways routes which do not contain the TO waypoint of the previous line or
- airways that do not intersect the previous airway
- airways or company routes that are not in the navigation database.

The start and end waypoints determine whether the entered airway 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 start point of the next route segment or a route discontinuity is created between the segments.



Entering an airway on the first VIA line of page 2 initiates an airway intercept and boxes are displayed in the first TO line. When a waypoint is entered in the boxes the airway and waypoint are moved down to the second line. The FMC enters a waypoint in the first TO line which is the first waypoint on the airway segment closest to the airplane position.

Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one airway to the next. The FMC created waypoint is displayed as the TO waypoint for the first airway.

LACRE3 .VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 and V336 are examples of airway entries.

APP TRANS is an example of a STAR selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

## **2. TO**

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway displays DIRECT in the VIA column.

Boxes indicate data input is required to complete the route segment definition.

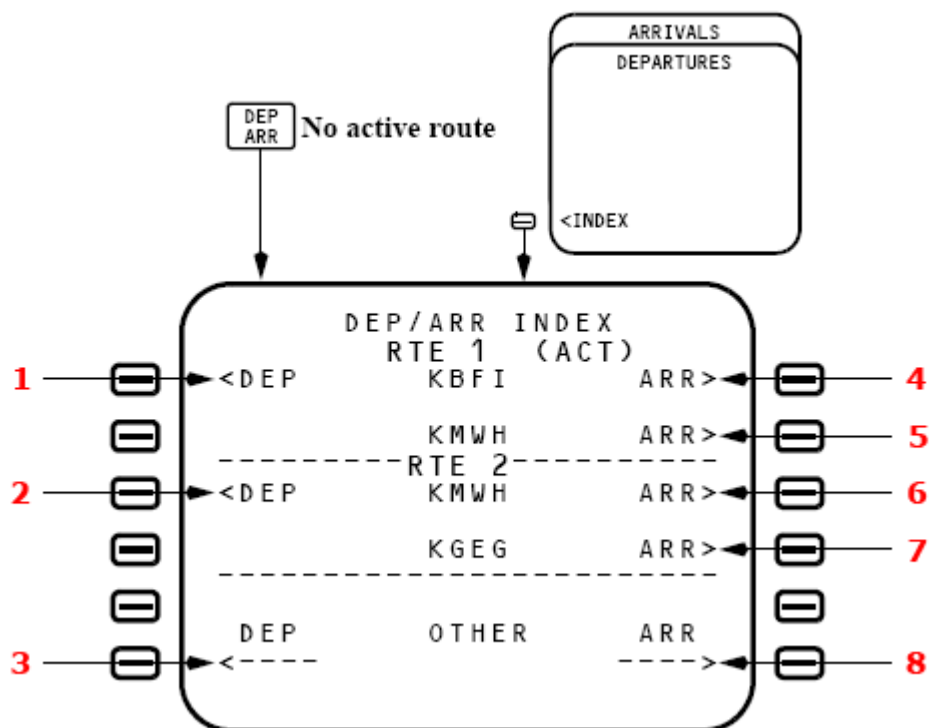
Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

Valid waypoint entries for airways are waypoints or fixes on the airway. Dashes display on the first TO waypoint after the end of the route.

**PREFLIGHT PAGES - PART 2****DEPARTURE/ARRIVAL INDEX PAGE**

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival data for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.

**1. Departure (DEP) - Route 1**

Push - displays the departure page for route 1 origin airport.

**2. Departure (DEP) - Route 2**

Push - displays the departure page for route 2 origin airport.

**3. Departure (DEP) - Other**

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allow display of departure data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

**4. Arrival (ARR) - Route 1 Origin**

Push - displays the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn-back situation.

**DO NOT USE FOR FLIGHT****5. Arrival (ARR) - Route 1 Destination**

Push - displays the arrival page for route 1 destination airport.

**6. Arrival (ARR) - Route 2 Origin**

Push — displays the arrival page for route 2 origin airport. Origin airport arrivals selection is used during a turn-back situation.

**7. Arrival (ARR) - Route 2 Destination**

Push - displays the arrival page for route 2 destination airport.

**8. Arrival (ARR) - Other**

Displays the arrival page for the airport entered in this line through the scratchpad.

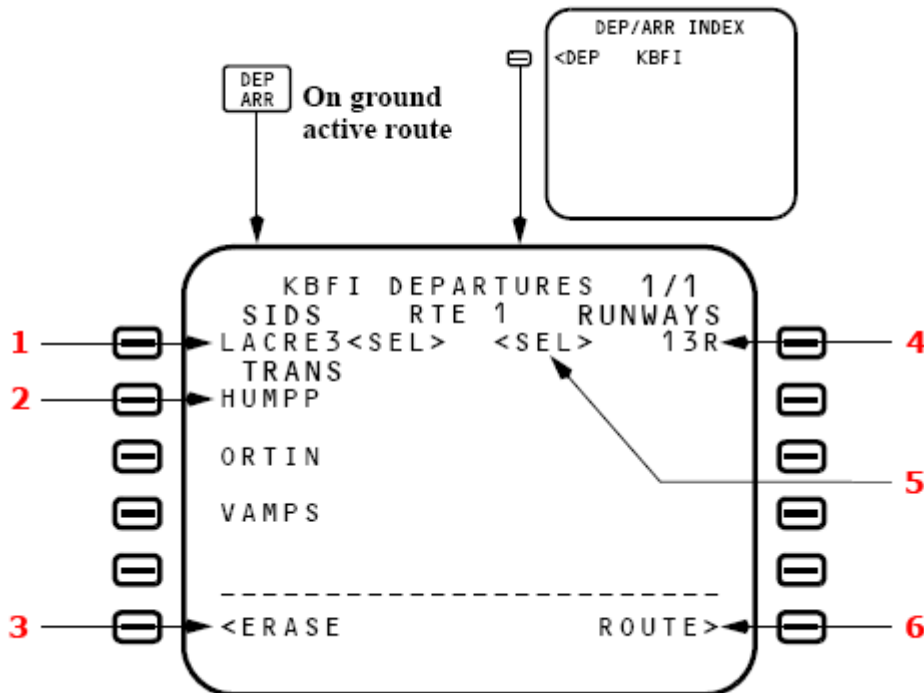
ARR prompt for OTHER allow display of arrival data about airports that are not an origin or destination.

The data can be viewed but cannot be selected because the airport is not on the route.

**DEPARTURES PAGE**

The departures page is used to select the departure runway, SID, and transition for the route origin airport.

The departures page for the inactive route displays when the DEP ARR function key is pushed with an inactive RTE or RTE LEGS page is displayed.

**1. Standard Instrument Departures (SIDS)**

Displays a list of SIDS for the airport.

Push-

- selects SID for use in the route
- other SIDs no longer display and transitions for the selected SID display

- runways for selected SID remain and others no longer display.

## **2. Transitions (TRANS)**

Displays transitions compatible with the selected SID.

Push-

- selects transition for entry in the route
- other transitions no longer display.

## **3. ERASE or INDEX**

Erase displays when a route modification is pending. INDEX displays when no route modification is pending.

ERASE push - removes selections not executed and displays the entire departure page. Other vertical or lateral modifications will be erased also.

INDEX push - displays the DEP/ARR INDEX page.

## **4. RUNWAYS**

Displays a list of runways for the selected airport.

The runway selected on the RTE 1/X page displays as <SEL> or <ACT>.

Push-

- selects runway for use in the route. All other runways no longer display
- SIDs associated with selected runway remain, all others no longer display
- subsequent change of a runway deletes departure procedures previously selected.

## **5. <SEL>, <ACT>**

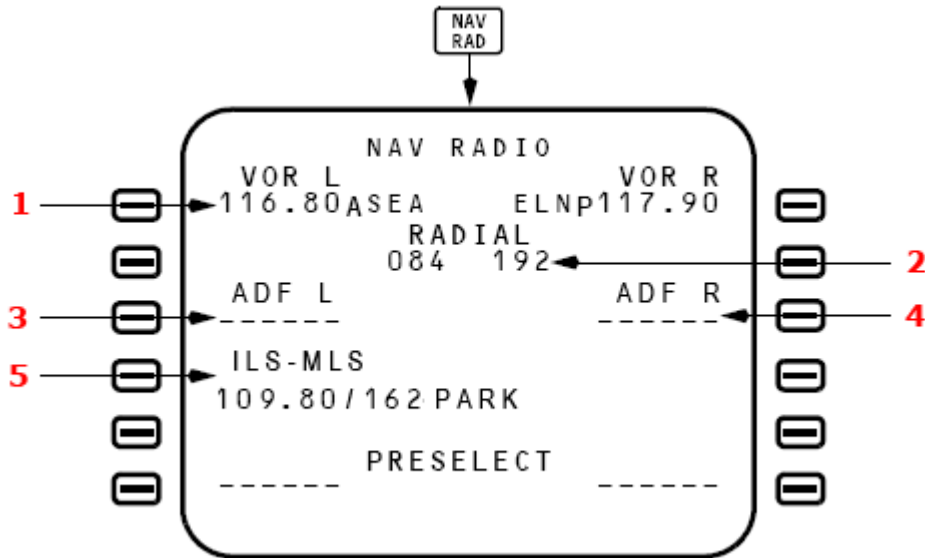
Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>. Executing a modification or leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

## **6. ROUTE**

Push - displays the related RTE page.

**DO NOT USE FOR FLIGHT****NAVIGATION RADIO PAGE**

VOR navigation radios are normally autotuned by the FMC. The NAV RADIO page displays the tuned VOR frequencies, identifiers, tuning status and current radial for both VOR receivers. The VORs can be remotely tuned from this page.

**1. VOR Frequency and Tune Status**

The tuning status is displayed adjacent to left and right VOR frequencies. Entry of a frequency or identifier remotely tunes a VOR. The FMC autotunes VORs and their related DMEs for procedure flying and radio positions. The tuning status displays are:

- A (autotuning) — FMC selects a navaid for best position orientation
- P (procedure autotuning) - FMC selects nav aids for approach or departure procedure guidance
- R (remote tuning) — VOR frequency or identifier has been entered by the flight crew on the NAV RADIO page.
- M (manual) - VOR is manual-tuned using the VOR control panels on the glareshield. Manual—tuning takes priority over FMC autotuning.

Valid entries:

- VOR or non-ILS DME identifier
- VOR frequency (XXX.X or XXX.XX)

The identifier and frequencies are green and tuning status is white.

**2. RADIAL**

Displays the current radial from the left and right VOR stations to the airplane.

**3-4. ADF Frequency****5. ILS Frequency and Course**

The ILS receivers operate in the automatic or manual tuning mode. The FMC commands the frequency and course selection in the automatic mode. When the ILS is not necessary, the FMC sets the ILS to PARK.

Airplane position on the route determines the ILS operating mode. The operating mode displays are:

- PARK - The ILS is not being used and is not tuned
- XXX.XX/YYY PARK - The ILS is tuned for the selected approach but is not being used
- "A" indicates autotuning under FMC control for approach guidance.
- "M" indicates the ILS is manually tuned.

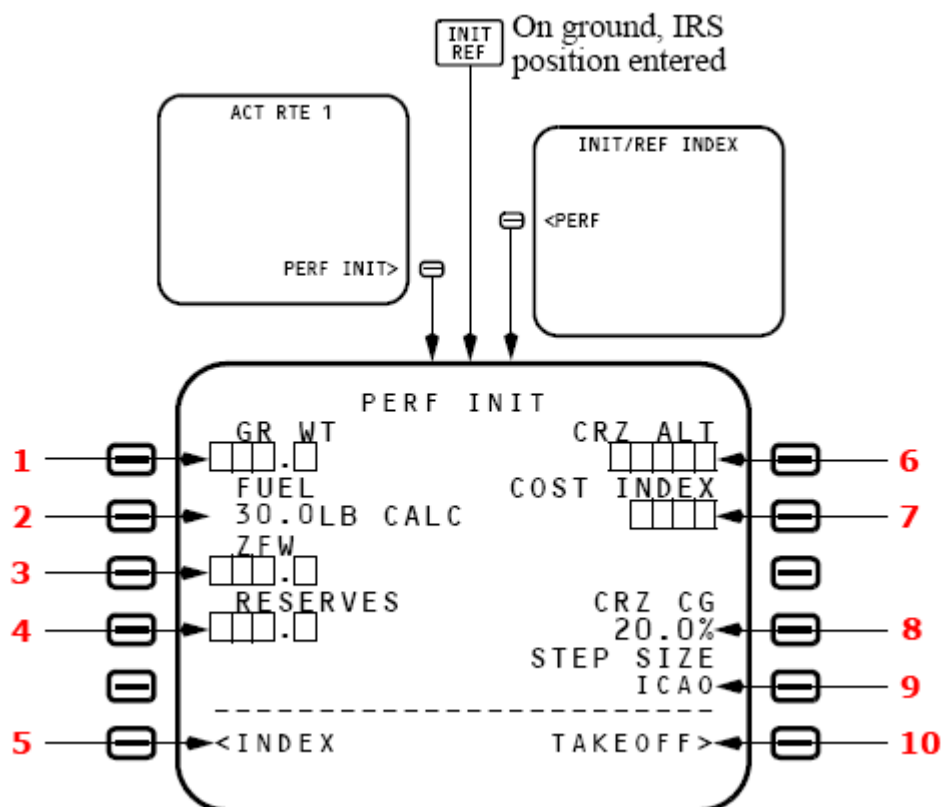
**DO NOT USE FOR FLIGHT**

ILS manual tuning requires entry of a frequency and course.

NOTE: due to Flight Simulator limitations, entering an ILS frequency also tunes the VOR L radio to the same frequency. This also happens when the ILS is autotuned. The VOR L tune status indicates P (procedural autotuning) in this case.

### **PERFORMANCE INITIALIZATION PAGE**

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This data is required for VNAV operation.



#### **1. Gross Weight (GRWT)**

Airplane gross weight can be entered by the flight crew or calculated by the FMC after entry of zero fuel weight.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

Entering the zero fuel weight first displays calculated gross weight.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

#### **2. FUEL**

Fuel on board displays when the fuel totalizer calculations are valid. The source for the display is included in the line:

- CALC (calculated) - fuel quantity is from FMC calculations.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

### **3. Zero Fuel Weight (ZFW)**

Normally, ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

Calculated zero fuel weight displays when airplane gross weight is entered first and fuel on board is valid.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

### **4. RESERVES**

Valid entry is thousands of pounds with a decimal (hundreds) optional.

### **5. INDEX**

Push - displays the INIT/REF INDEX page.

### **6. Cruise Altitude (CRZ ALT)**

Cruise altitude can be entered by the flight crew or from a company route.

Entered value is displayed on the CLB and CRZ pages.

### **7. COST INDEX**

Cost index is used to calculate ECON climb, cruise, and descent speeds. Larger values increase the ECON cruise speed. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route.

Valid entries are 0 to 9999.

### **8. Cruise Center of Gravity (CRZ CG)**

Used by FMC to compute maximum altitude and maneuver margin to buffet.

Displays default center of gravity in small font.

A flight crew entered value displays in large font.

### **9. STEP SIZE**

Displays the climb altitude increment used for planning the optimum climb profile.

Default value is ICAO which provides a 2000 foot step below FL290 and a 4000 foot step above FL290.

Valid manual entries are 0 to 9000 in 1000 foot increments.

In-flight entries are inhibited. In-flight step size changes are made on the CRZ page.

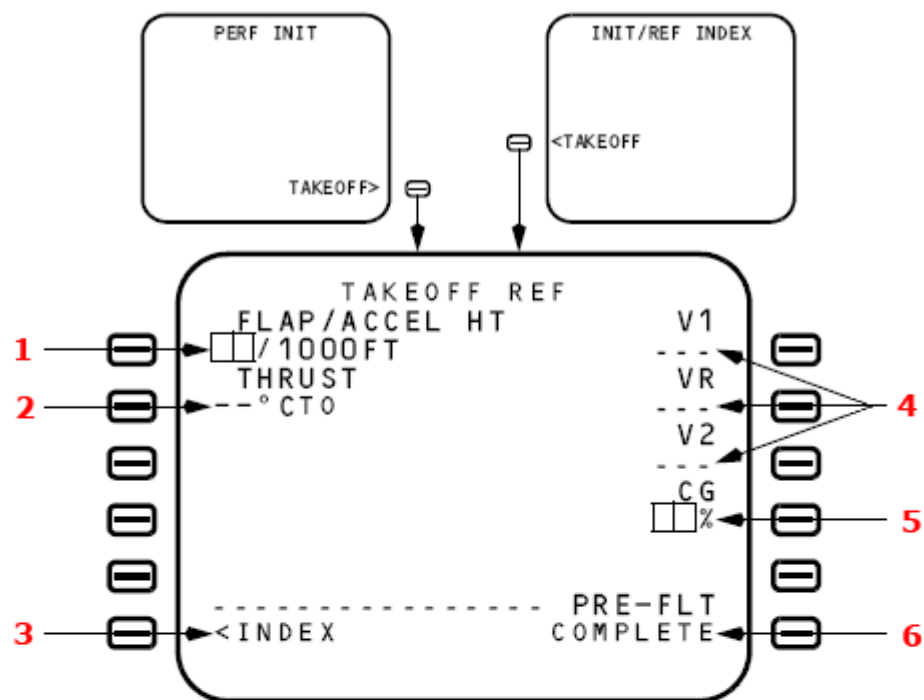
For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

### **10. TAKEOFF**

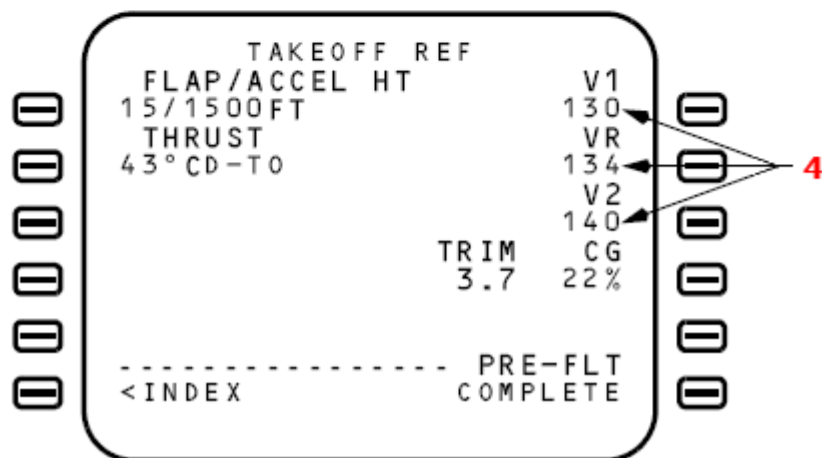
Push - displays the TAKEOFF REF page.

**DO NOT USE FOR FLIGHT****TAKEOFF REFERENCE PAGE**

The takeoff reference page allows the input of the final performance data required for takeoff. Entries on the takeoff reference page complete the normal FMC preflight. If any required preflight data has been omitted, prompts are displayed to access the page where data is missing.



CDU following entry of TO flaps, V speeds and CG.

**1. Flap/Acceleration Height (FLAP/ACCEL HT)**

Enter a valid takeoff flap setting.

Entry of a value after takeoff speeds are entered removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

ACCEL HT displays the acceleration height in feet above the origin airport. VNAV commands acceleration at this altitude or at first flap retraction.



Default value is from the AMI.

Valid flight crew entries are from 400 to 9999 feet above the origin airport elevation.

## **2. THRUST**

Initially displays dashes and the thrust reference mode.

If an assumed temperature value is entered on the thrust management control panel, the entered temperature is displayed here.

Valid flight crew entries are from 0 to 99 (°C) or 32F to 21 OF (°F). The entered value is displayed on EICAS.

Entry of a value after takeoff speeds are entered removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

## **3. INDEX**

Push - displays the INIT/REF INDEX page.

## **4. V Speeds**

Dashes are displayed before speeds are entered and when speeds have been deleted.

If performance data is changed after speeds are entered, the speeds are deleted, dashes are displayed, and the scratchpad message TAKEOFF SPEEDS DELETED is displayed.

## **5. TRIM, Center of Gravity (CG)**

Valid entry is CG within the valid range.

After the CG is entered, the FMC calculates and displays the stabilizer takeoff trim setting to the left of the CG entry

## **6. Pre-Flight (PRE-FLT) Status**

Displays COMPLETE if all required pre-flight entries have been made.

Displays a prompt to access a pre-flight page where further entries are required if pre-flight is not complete.

**Section 6: FMC TAKEOFF AND CLIMB****INTRODUCTION**

The takeoff phase of flight starts with the selection of takeoff thrust at the start of the takeoff roll.

The takeoff mode of the autoflight system provides flight director guidance until LNAV and VNAV are engaged after takeoff. Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase changes to the climb phase when climb thrust and VNAV are engaged. The climb phase continues to the top of climb point, where the cruise phase starts.

**TAKEOFF PHASE**

When changes are made to the departure runway and SID, the DEPARTURES and TAKEOFF REF pages must be modified to agree. The modified data are entered the same as during preflight.

During takeoff, the autothrottle commands the selected thrust and the autoflight system provides pitch and roll commands through the flight director.

FMC roll commands are provided when LNAV is engaged.

**CLIMB PHASE**

When climb thrust and VNAV are engaged the FMC provides pitch commands to maintain the climb speed until the acceleration height is reached. At the acceleration height the FMC commands acceleration to 250 knots.

The VNAV commanded speed is limited by the airplane configuration. At acceleration height, VNAV commands a speed 5 knots below the flap placard speed.

Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until reaching the cruise altitude unless the climb profile contains other constraints.

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

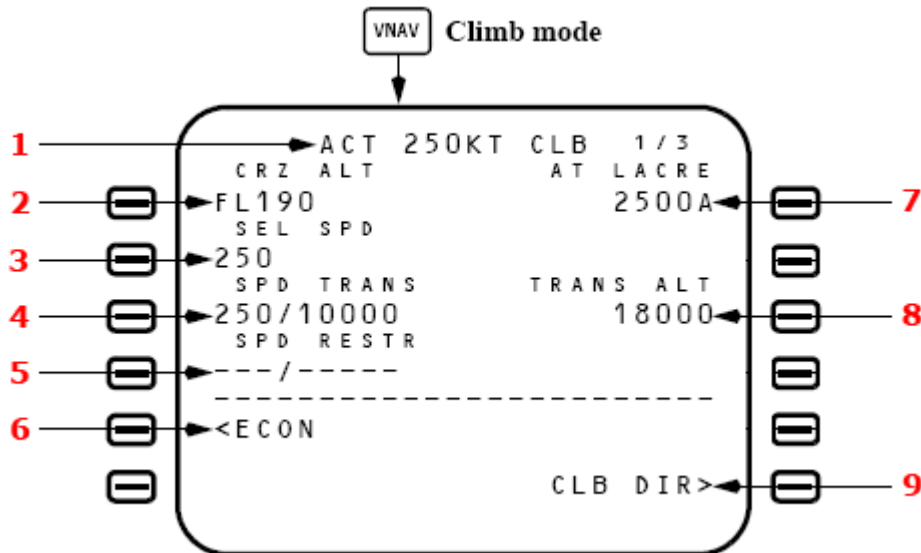
**CLIMB PAGE**

The climb page is selected by pushing the CDU VNAV function key while on the ground, during takeoff, or in climb.

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 FMC data bases.

When the airplane reaches the top of climb, the FMC changes to the cruise mode, the cruise page is displayed and the climb page data is blanked.

The FMC provides speed control in the climb mode to provide the best economy, a fixed speed, or the engine out speed. In each mode, the same type of data is shown on the page.

**1. Page Title**

ACT is displayed when the climb phase is active.

The page title displays the type of climb:

- ECON - speed based on the cost index
- LIM SPD - speed based on airplane configuration limiting speed
- MCP SPD - MCP speed intervention selected
- XXXKT - fixed CAS climb speed profile
- M.XXX - fixed Mach climb speed profile

Fixed climb speeds are for:

- climb segment constraints
- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed transition
- a flight crew selected speed.

**2. Cruise Altitude (CRZ ALT)**

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on transition altitude.

**3. Economy Speed (ECON SPD), Selected Speed (SEL SPD)**

ECON SPD

- economy speed based on cost index

- shows CAS and Mach values.

**SEL SPD**

- shows when intermediate level off required below an existing speed constraint
- shows when flight crew enters speed
- CAS or Mach value may be entered.

**4. Speed Transition (SPD TRANS)**

The speed transition line shows the transition speed/altitude from one of these sources:

- the navigation database value for the origin airport
- a default speed of 250 knots and 10,000 feet.

Not displayed above the transition altitude.

Can be deleted.

**5. Speed Restriction (SPD RESTR)**

Speed restrictions not associated with specific waypoints are manually entered on this line.  
Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

**6. Economy (ECON)**

Push - changes climb speed to ECON. Must be executed.

Prompt is shown on line 5L when the climb mode is not ECON.

**7. Waypoint Constraint (AT XXXXX)**

Displays next airspeed and/or altitude constraint at waypoint XXXXX.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page or are inserted as part of a SID.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

**8. Transition Altitude (TRANS ALT)**

Transition altitude for origin airport contained in navigation database. FMC uses 18,000 feet if transition altitude is not available.

Manually change transition altitude here or on DESCENT FORECAST page.

Valid entries are XXX, XXXX, XXXXX, or FLXXX.

Altitude information displayed on the CDU changes from altitudes to flight levels above the transition altitude.

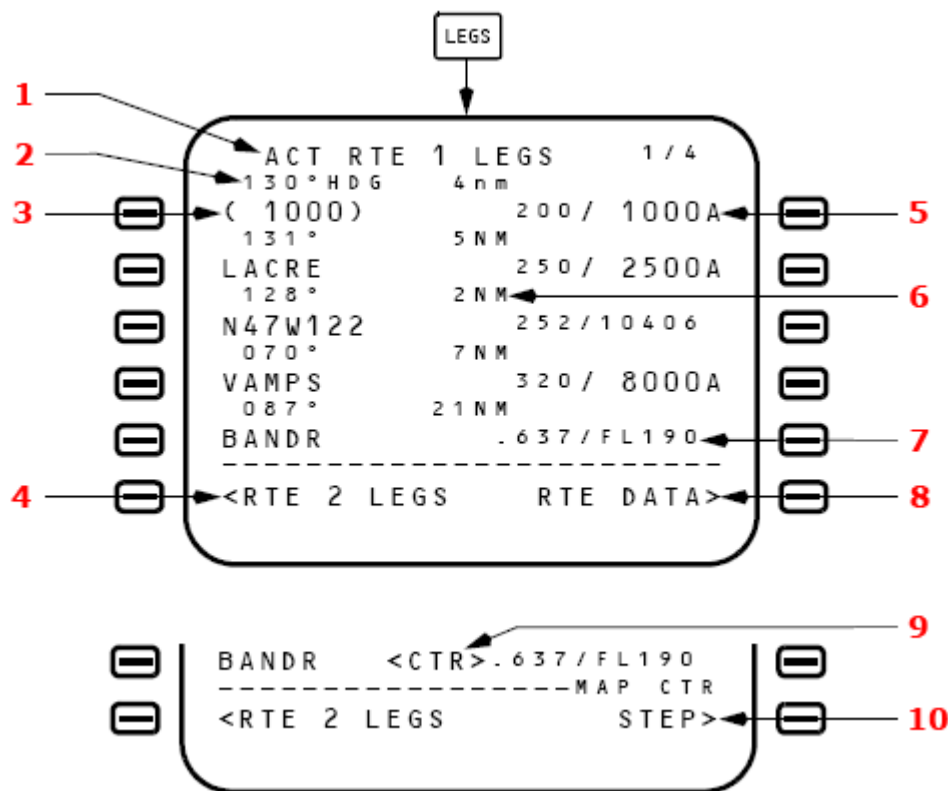
**9. Climb Direct (CLB DIR)**

Push - deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Blank if no constraints exist.

**ROUTE LEGS PAGE**

The RTE LEGS page is used to evaluate and modify the planned route of flight during the climb and to add or delete waypoint constraints to comply with the ATC clearance. The data on the RTE LEGS page comes from preflight entries made on the route and departure pages, and from the FMC data bases.

**1. Page Title**

Title format shows route status:

- RTE X LEGS - inactive route
- ACT RTE X LEGS - active route
- MOD RTE X LEGS - modified active route.

**2. Leg Direction**

Leg segment data in line title:

- courses - magnetic (xxx°) or true (xxx° T)
- arcs - distance in miles, ARC, turn direction (example: 24 ARC L)
- heading leg segments — xxx° HDG
- track leg segments — xxx° TRK
- special procedural instructions from database - HOLD AT, PROC TURN.

Calculated great circle route leg directions may be different than chart values.

Dashes are shown for an undefined course.

**3. Waypoint Identifier**

Shows waypoints by name or condition.

Active leg is always the first line of the first active RTE X LEGS page.

All route waypoints are shown in flight sequence. Waypoints on an airway are included on the route legs page.

Waypoints can be modified. Examples:

- add waypoints
- delete waypoints
- change waypoint sequence
- connect route discontinuities.

Boxes are shown for route discontinuities.

Dashes are displayed on the line following the last waypoint on the route.

#### **4. Route 2 Legs (RTE 2 LEGS)**

Push-

- shows the RTE 2 LEGS
- when RTE 2 LEGS page is shown, prompt changes to RTE 1 LEGS.

#### **5. Waypoint Speed/Altitude Constraints**

Waypoint speed or altitude constraint in large font.

Manual entry allowed in climb or descent phase. Entered by FMC when constraints are part of a procedure.

Speed constraint is assumed to be at or below the displayed speed.

Valid entries are:

- speed - airspeed or Mach - requires an altitude constraint at the same
- waypoint
- altitude in thousands of feet or flight level (19000, 190)
- XXX/XXXXX - airspeed/altitude entered simultaneously
- XXX/ - airspeed only
- XXXXX or/XXXXX-altitude only.

Altitude constraint suffixes:

- blank - cross at altitude
- A - cross at or above altitude
- B - cross at or below altitude
- both - altitude block. Example: 220A240B

#### **6. Distance to Waypoint**

Distance between the waypoints displayed in nautical miles.

The first line displays the distance from the airplane to the active waypoint.

#### **7. Waypoint Speed/Altitude Predictions**

Waypoint speed and altitude predictions are displayed in small font.

Dashes are displayed in the descent region prior to descent path calculation.

Descent path calculation requires altitude constraint below cruise altitude.

#### **8. ACTIVATE, Route Data (RTE DATA)**

Push - three possible prompts

- ACTIVATE - activates inactive flight plan; shows RTE DATA prompt
- RTE DATA - shows route data page
- STEP - changes the center point on the HSI map in the PLAN mode.

**9. Center (<CTR>)**

Displays when PLAN mode selected.

Displays adjacent to the waypoint around which HSI plan mode is centered.

**10. MAP Center (CTR) STEP**

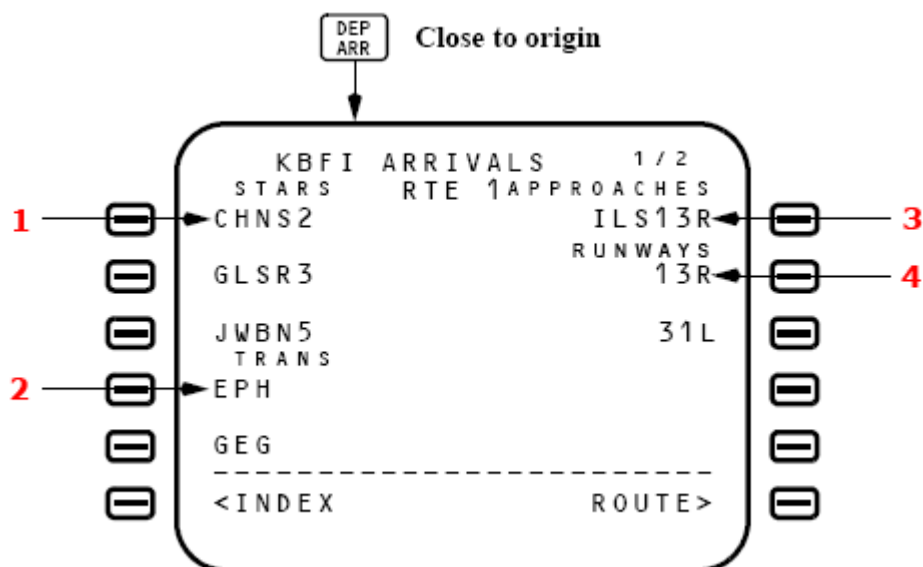
Replaces ACTIVATE or RTE DATA when PLAN mode selected.

Push - steps <CTR> to next waypoint. HSI plan mode recenters.

**AIR TURN-BACK****ARRIVALS PAGE**

During a turn-back situation, the flight crew requires quick access to the arrivals data for the origin airport. The arrivals page allows access without changing the destination on the route page.

During climb if the airplane is less than 400 miles from the origin and less that half way to the destination, push the DEP ARR key to show the ARRIVALS page for the origin airport.

**1. Standard Terminal Arrivals (STARS)**

Shows STARS for origin airport.

**2. Transitions (TRANS)**

Shows transitions for origin airport.

**3. APPROACHES**

Shows approaches for origin airport.

**4. RUNWAYS**

Shows runways for origin airport.

## **Section 7: FMC CRUISE**

### **INTRODUCTION**

The cruise phase starts at the top of climb.

During cruise, the primary FMC pages are:

- RTELEGS
- CRZ
- PROGRESS.

The RTE LEGS pages are used to modify the route. The CRZ pages display VNAV related data. The PROGRESS pages display flight progress data. During cruise, the specific page listed below is used to:

- POS REF page - verify the FMC position
- RTE DATA page - display progress data for each waypoint on the RTE LEGS page
- REF NAV DATA page - display data about waypoints, nav aids, airports, or runways, and can be used to inhibit nav aids
- RTE page - select a route offset
- FIX INFO page - display position data about waypoints. Position data can be transferred to other pages to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page - shows a list of duplicate waypoints from the navigation database. The flight crew selects the correct waypoint from the list
- POS REPORT page - display data for a position report.

The CLB page changes to CRZ at the top of climb. The CRZ CLB and CRZ DES pages change to CRZ when a new cruise altitude is reached. The CRZ page changes to DES at top of descent.

### **LNAV MODIFICATIONS**

This section shows typical techniques to modify the route. The modifications include:

- add and delete waypoints
- change waypoint's sequence
- connect discontinuities

### **RTE LEGS PAGE MODIFICATIONS**

Modifications to the LNAV route are usually made on the RTE LEGS page. When the route is modified, MOD is displayed in the title and the execute light is illuminated.



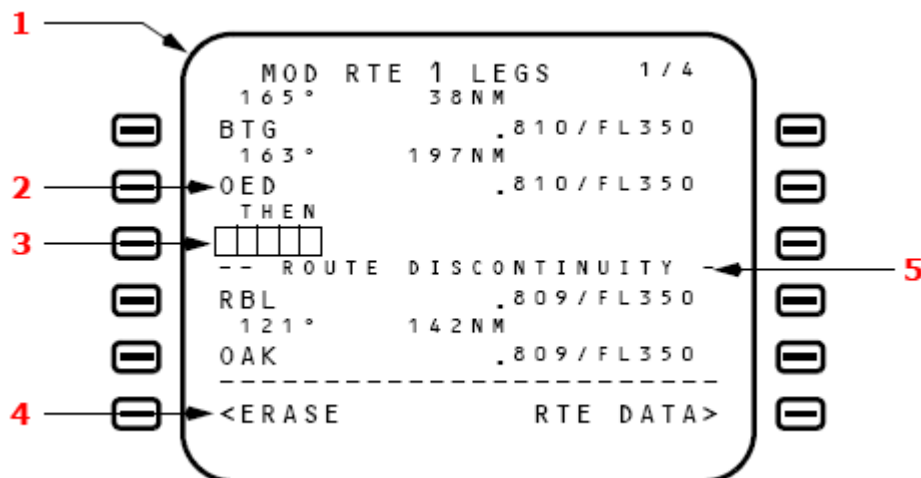
**DO NOT USE FOR FLIGHT****ADD WAYPOINTS**

Waypoints can be added to the route at any point. Added waypoints are followed by route discontinuities.

First, enter the waypoint name in the scratchpad.

Second, locate the correct line in the flight plan and push the adjacent line select key. The scratchpad waypoint name is put into the selected line. The entered waypoint is connected to the waypoint above it via a direct route. A route discontinuity follows the waypoint.

For example, OED is typed into the scratchpad. Push line select key 2L to put OED into line 2. The FMC assumes BTG direct OED. RBL and the rest of the flight plan are kept but, are put after the route discontinuity.

**1. Page Title**

MOD — replaces ACT when modification is in progress.

ACT - replaces MOD when ERASE is selected or execute key is pushed.

**2. Modified Waypoint**

OED waypoint entered into the route after BTG Modification creates a route discontinuity because OED was not in the active route. The FMC now requires routing beyond OED.

**3. Discontinuity**

Discontinuity is corrected when applicable waypoint is entered in boxes.

**4. ERASE**

Push - removes all modifications and shows active data.

Displayed when the FMC contains modified data.

Removed when the modifications are executed.

**5. ROUTE DISCONTINUITY**

Line title separates route segments when there is a discontinuity.

**DO NOT USE FOR FLIGHT****Note**

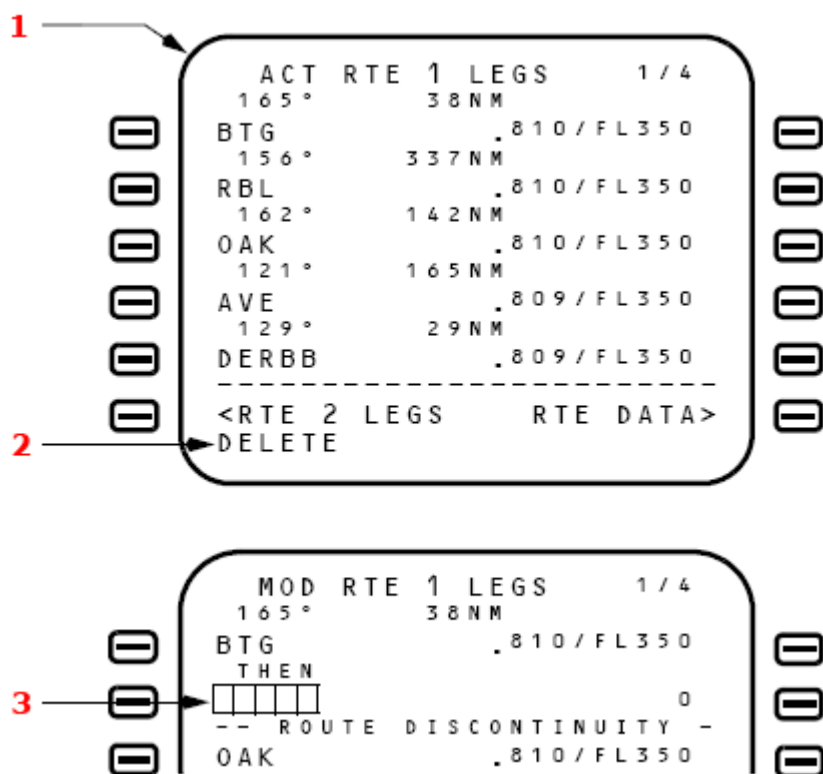
Performance predictions to destination on the PROGRESS page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

**DELETE WAYPOINTS**

Use the RTE LEGS page to remove waypoints from the route. The active waypoint can not be deleted. Two methods to remove a waypoint are:

- delete the waypoint with the DEL function key
- change the sequence of other waypoints.

The data in the route before the deleted waypoint does not change. A discontinuity is put in the route when the DEL function key is used to remove a waypoint.

**1. Active Route**

The active route shows RBL followed by OAK and AVE.

**2. DELETE Entry**

Pushing the DEL function key arms the delete function and selects DELETE to the scratchpad.

**3. Discontinuity**

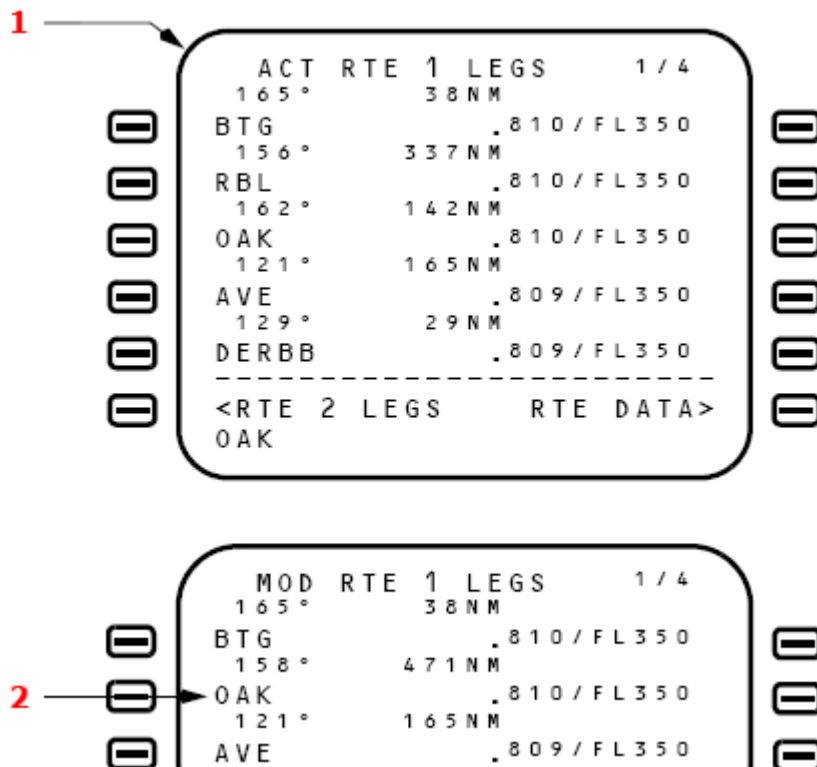
With DELETE in the scratchpad, pushing the line select key for RBL deletes the waypoint. Boxes replace RBL and a route discontinuity is displayed.

**CHANGE WAYPOINT SEQUENCE**

Waypoints moved from one position in the flight plan to another do not cause route discontinuities.

The waypoint may be manually typed or copied from any of the RTE LEGS pages. To copy the waypoint, push the line select key adjacent to the waypoint.

The example below shows the flight plan being modified to fly from BTG direct OAK. Push the line select key adjacent to OAK to put OAK in the scratchpad. Push the line select key adjacent to RBL. RBL is removed from the flight plan and the routing is direct from BTG to OAK to AVE. The modification does not cause a route discontinuity. Several waypoints can be removed from the flight plan at a time with this method.

**1. Active Route**

The active route shows RBL followed by OAK and AVE. The clearance is to fly from BTG direct OAK. The OAK waypoint is selected to the scratchpad.

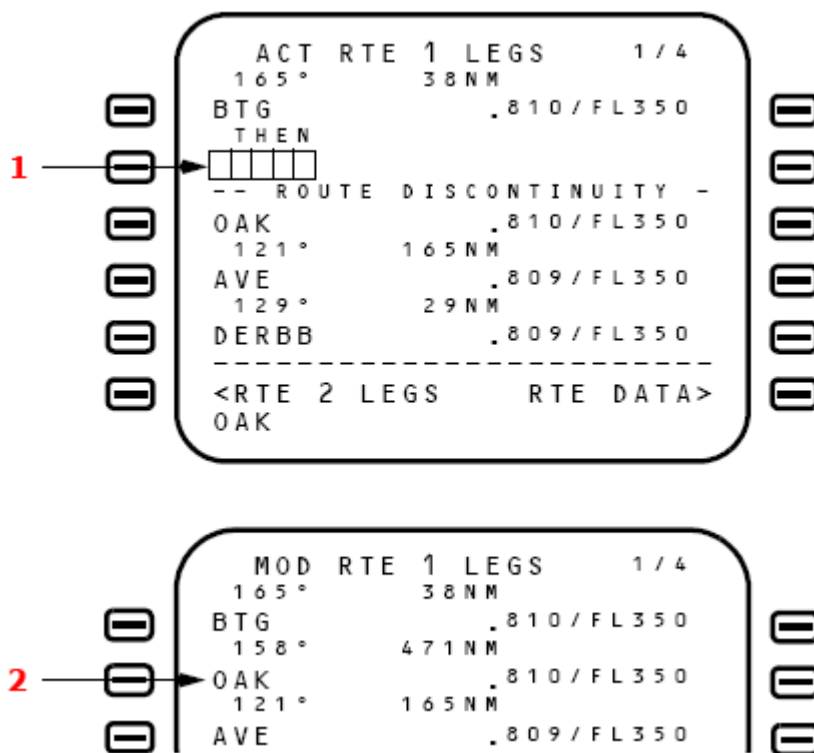
**2. Change OAK's Sequence**

OAK is selected to the waypoint after BTG RBL is removed with no discontinuity.

**DO NOT USE FOR FLIGHT****REMOVE DISCONTINUITIES**

A discontinuity exists when two waypoints are not connected by a route segment.

To remove a discontinuity, copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity.

**1. Discontinuity**

The active route has a discontinuity after BTG. The example shows how to fly direct from BTG to OAK. Copy OAK to the scratchpad. Any subsequent waypoint in the route can be selected to the scratchpad to remove the discontinuity.

**2. Continuous Route**

Select OAK to the boxes to remove the discontinuity.

If a waypoint which does not already exist on the route is entered into the boxes the discontinuity moves one waypoint further down the route.

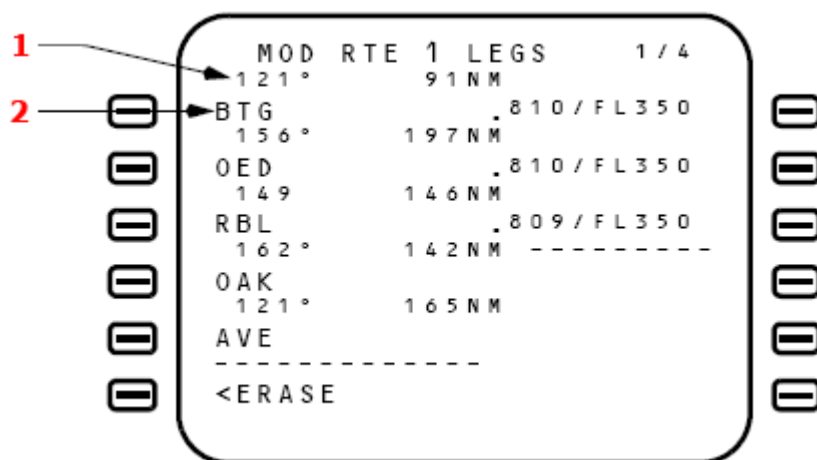
**DO NOT USE FOR FLIGHT****DIRECT TO**

If the airplane is not on the active leg segment, LNAV may deactivate or it may not activate when armed. This happens after the airplane crosses a discontinuity, or is not on an intercept heading to the active leg segment. Here are three ways to arm or activate LNAV:

- When the airplane is within 2.5 miles of the active leg, push the LNAV switch. LNAV activates and intercepts the active route leg.
- When more than 2.5 miles from the active leg, push the LNAV switch when the airplane is on an intercept heading to the active route leg. Initially, LNAV arms and then activates as the airplane approaches the active leg. An intercept heading must intersect the active leg inbound before the active waypoint.
- Fly direct to a waypoint or intercept a course to a waypoint. Enter a waypoint in the RTE LEGS page active waypoint line to fly direct. Use the INTC CRS TO prompt in line 6R to create an intercept course to the waypoint. Push the LNAV switch and LNAV arms or activates, depending on the distance from the active leg.

**MODIFICATION OF THE ACTIVE WAYPOINT**

The example below depicts the airplane being off course to the right, followed by a modification to fly direct to BTG.

**1. Course to Active Waypoint**

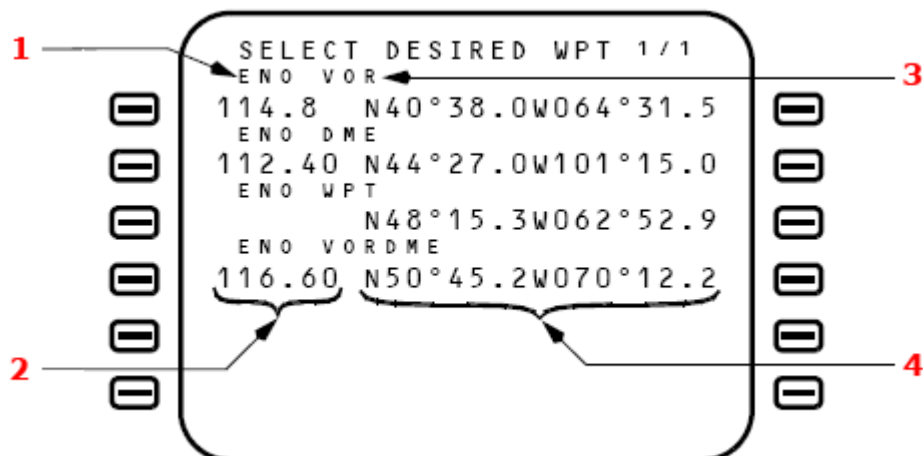
Displays current required track to fly inbound course to waypoint.

**2. Active Waypoint**

Displays crew entered direct/intercept waypoint. If entered waypoint is not part of the active route it will be followed by a discontinuity.

**DO NOT USE FOR FLIGHT****SELECT DESIRED WAYPOINT (WPT) PAGE**

The SELECT DESIRED WPT page is displayed when a waypoint identifier or name is entered and the navigation database contains more than one location for the same waypoint name. Selection of a waypoint returns the display to the previous page.

**1. Identifier**

Displays a list of the waypoints in the navigation database that have the same identifier as entered.

Up to 48 waypoints (8 pages) can be listed.

Waypoints are sorted as follows:

- when page is accessed as a result of a flight plan entry or modification, sort is based on proximity to the waypoint preceding the entered waypoint
- when page is accessed as a result of a DIR/INTC, FIX INFO, or REF NAV DATA entry, sort is based on proximity to current aircraft position.

Select the desired waypoint by pushing either the left or right line select key adjacent to the waypoint. The CDU page where the waypoint identifier was entered is then displayed with the selected waypoint inserted.

**2. Frequency**

Displays frequency of the waypoint if it is a navaid. Blank if the waypoint is not a navaid.

**3. Type**

Displays the type of waypoint for each duplicate name.

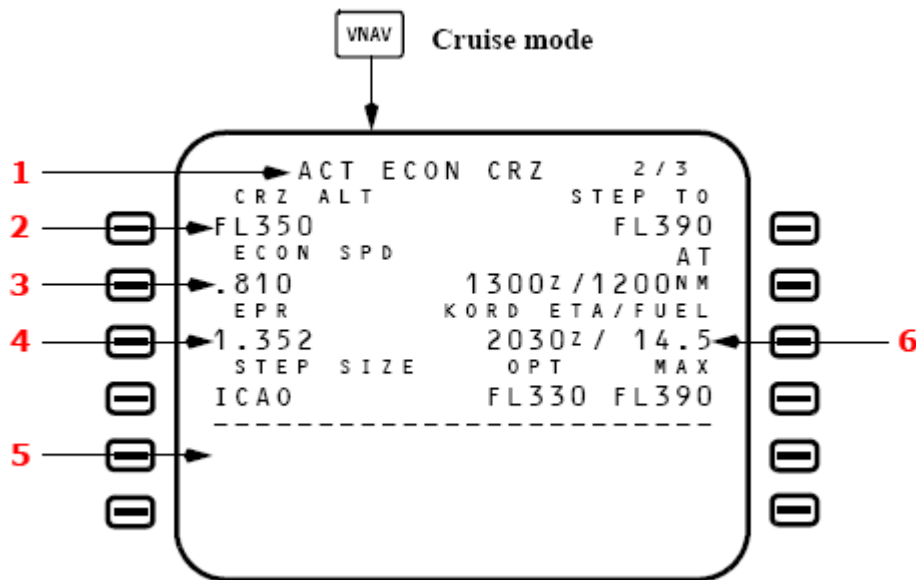
**4. Latitude/Longitude**

Displays the latitude/longitude for each duplicate name.

**CRUISE PAGE**

The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually selected or automatically selected with the selection of other VNAV modes. Cruise climbs, cruise descents, and step climbs can be accomplished from the cruise page.

When using the economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in the engine out mode, the data changes to include the airplane capabilities with one engine inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.

**1. Page Title**

The page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Fixed speed, engine out, and long range cruise modify the title.

Page titles include:

- CRZ CLB or CRZ DES - cruise climb or descent
- ECON - speed based on cost index
- LIM SPD - based on an airplane configuration limiting speed
- LRC - long range cruise selected
- MCP SPD - speed intervention applied from the MCP
- M.XXX - fixed Mach cruise speed
- XXXKT - fixed CAS cruise speed.

Fixed cruise speeds are for:

- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a flight crew selected speed (SEL SPD).

**2. Cruise Altitude (CRZ ALT)**

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, OR FLXXX. Altitude displays in feet or flight level depending on the transition altitude. Changing the MCP altitude enters the new altitude in the scratchpad for entry. Entry creates a modification.

When the modification is executed the page title changes to CRZ CLB or CRZ DES.

**DO NOT USE FOR FLIGHT****3. Economy Speed (ECON SPD), Selected Speed (SEL SPD)**

Displays target speed or Mach.

MOD displays in the page title until the modification is erased or executed.

A manually entered speed changes the line title to SEL SPD.

ECON can be replaced with LRC or company (CO SPD), depending on the VNAV mode.

**4. EPR**

Displays EPR necessary for level flight at the target airspeed.

**5. Economy (ECON)**

Blank when ECON is the active speed. Displays a prompt when ECON is not the active speed.

Push - selects economy cruise speed.

**6. Destination ETA/FUEL**

Estimated time of arrival and calculated fuel remaining at the destination.

Displays the same data for the alternate airport when a DIVERT NOW modification is selected from the ALTN page.

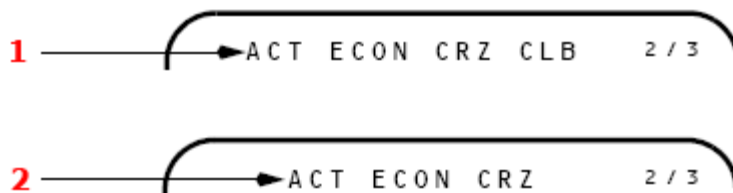
Calculations are based on optimum step climbs and cruise altitudes.

**VNAV MODIFICATIONS**

During the cruise phase, VNAV can calculate two types of climbs: cruise climbs and step climbs. Cruise climbs can be entered by the flight crew. Optimum step climbs are calculated by the FMC. In all cases, the new climb altitude must be selected in the MCP altitude window before VNAV commands the climb.

**CRUISE CLIMB**

To initiate a cruise climb set the higher altitude on the MCP, then enter the altitude in the CRZ ALT line and execute. When the CRZ page is displayed, the new MCP altitude is automatically copied to the scratchpad to be line selected to the CRZ ALT line.

**1. During Cruise Climb**

VNAV page title displays ACT ECON CRZ CLB in a climb to a new cruise altitude. ECON is replaced by the selected speed if other than ECON.

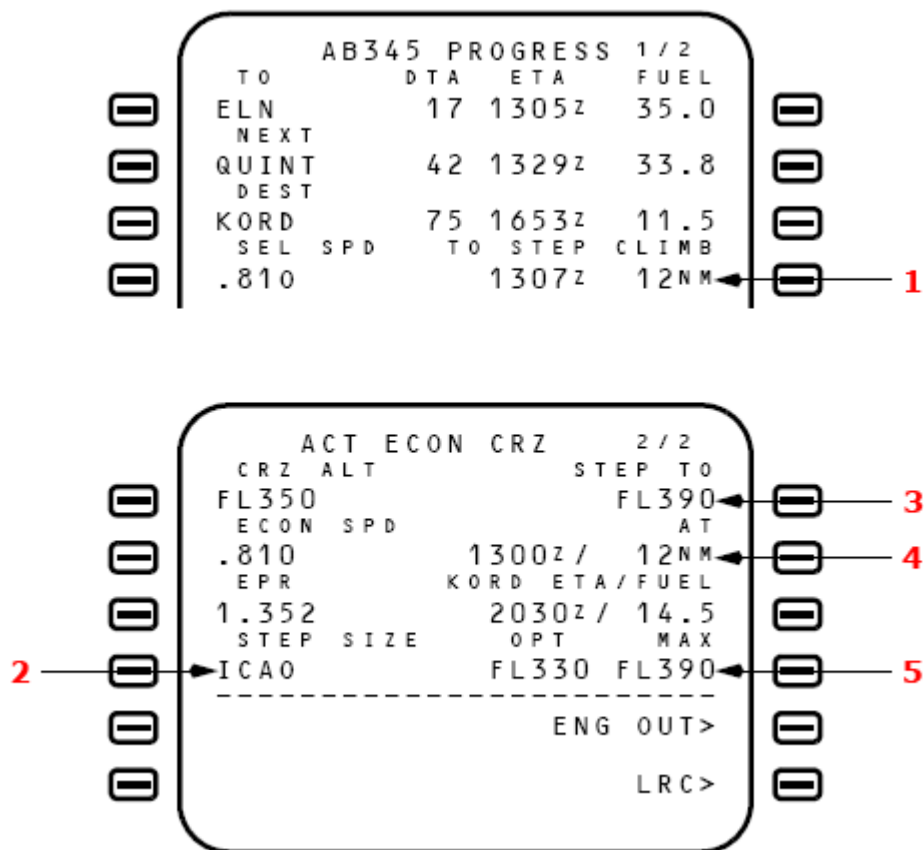
**2. End of Cruise Climb**

VNAV page title returns to ECON CRZ after level off at cruise altitude.



**DO NOT USE FOR FLIGHT****CALCULATED STEP CLIMB**

When a non-zero value is entered into the STEP SIZE line on the PERF INIT or CRZ page, the FMC calculates optimum points for step climbs as the airplane performance permits. The climb altitude is determined by the value in STEP SIZE. Multiple step climbs are possible based on performance and route length. VNAV commands the step climbs if the MCP altitude and the FMC CRZ ALT are set to the new altitude.

**1. TO STEP CLIMB**

When the step climb start point is the next VNAV event, the line title changes to TO STEP CLIMB.

Displays the ETA and DTG to the point where the step climb starts.

If the airplane passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word NOW.

When the FMC calculates that a step climb is not advised, the ETA and DTG are replaced with the word NONE.

**2. STEP SIZE**

Displays the default step climb size of ICAO.

Valid entries are altitudes from 0 to 9000 in 1000 foot increments.

Used for calculation of optimum step point and step climb predictions.

Deletion of a manual entry defaults back to ICAO.

**3. STEP TO**

Displays a calculated step climb altitude based on the step size.

Blank when:

- there is no active flight plan
- less than 200 NM from the T/D point
- less than 500NM from the destination
- step size is zero

**4. AT**

Displays the ETA and DTG to the step climb point.

Displays NOW when past the calculated step climb point.

Line title changes to TO T/D when within 200 NM of the top of descent point. ETA and DTG are relative to the T/D point.

The data is the same as displayed on the PROGRESS page.

**5. Optimum Altitude and Maximum Altitude (OPT MAX)**

OPT - displays the most economical altitude to fly based on gross weight and the active cruise speed.

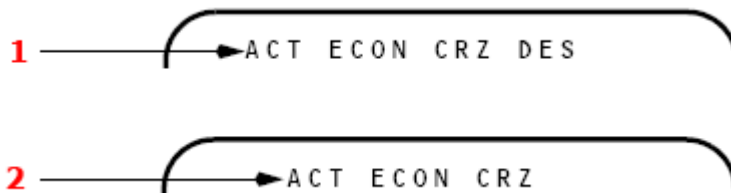
MAX — displays the two engine maximum altitude based on gross weight, climb and cruise speeds within the speed envelope, and sufficient excess thrust to provide a specified residual rate of climb capability.

**CRUISE DESCENT**

Cruise descents can be started in the cruise phase when the airplane is more than 50 miles from the T/D point.

A cruise descent can be started by selecting a lower altitude on the MCP, entering the new altitude in the CRZ ALT line and executing. A VNAV cruise descent is commanded at the current cruise speed and approximately 1250 feet per minute rate of descent.

The autothrottles adjust thrust to maintain the target descent rate; pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

**1. During Cruise Descent**

VNAV page title shows cruise phase in a descent to a new cruise altitude.

**2. End of Cruise Descent**

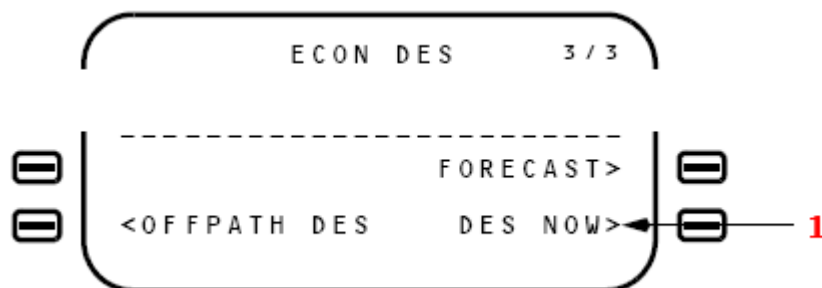
VNAV page title shows cruise phase after level off at new cruise altitude.

**EARLY DESCENT**

An early descent starts when the descent for landing is commenced prior to the FMC calculated top of descent (T/D) point. Early descents should not be started when the distance to the T/D is greater than 50 nautical miles. When further from the top of descent point, the cruise descent function should be used.

Early descents are started on the DES page. Once an early descent is started, VNAV changes to the descent phase and cruise features are no longer available.

The autothrottle adjusts thrust to maintain the target descent rate; pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

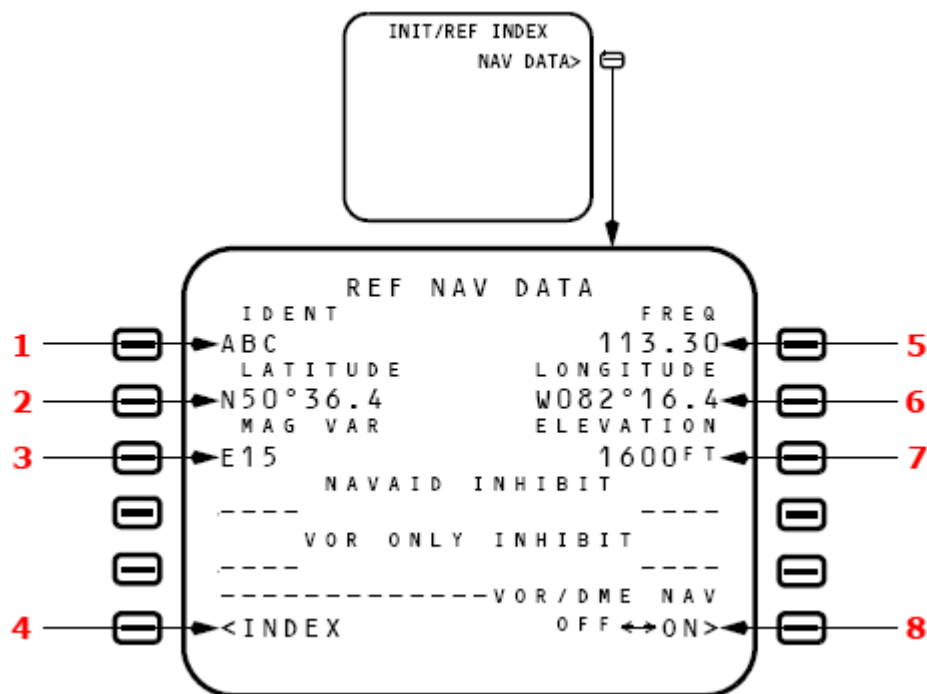
**1. Descend Now (DES NOW)**

The DES NOW prompt is shown on the descent page when the cruise phase is active. Reset the MCP altitude and select the DES NOW prompt and execute to start an early descent. The descent page becomes active and the airplane starts a VNAV ECON descent at ECON descent speed.

Upon reaching the planned descent path, VNAV commands pitch to maintain the planned descent path and ECON speed.

**NAVIGATION DATA****REFERENCE NAVIGATION DATA PAGE**

The reference navigation data page displays data about waypoints, nav aids, airports, and runways. Use this page to inhibit FMC position updates from radio nav aids.

**1. Identifier (IDENT)**

Valid entries are any waypoint, navaid, airport, or runway from the navigation database. Only runways at the destination airport can be entered.

Entry changes to dashes when page is exited and then reselected.

**2. LATITUDE**

Displays latitude of entered identifier. When the identifier is a runway the latitude displayed is for the threshold of the runway.

**3. Magnetic Variation (MAG VAR), LENGTH**

MAG VAR - displays magnetic variation when entered identifier is a navaid.

LENGTH - displays runway length when entered identifier is a runway.

**4. INDEX**

Push - displays the INIT/REF INDEX page.

**5. Frequency (FREQ)**

Displays frequency of entered identifier when it is a navaid.

**DO NOT USE FOR FLIGHT****6. LONGITUDE**

Displays longitude of entered identifier. When the identifier is a runway the longitude displayed is for the threshold of the runway.

**7. ELEVATION**

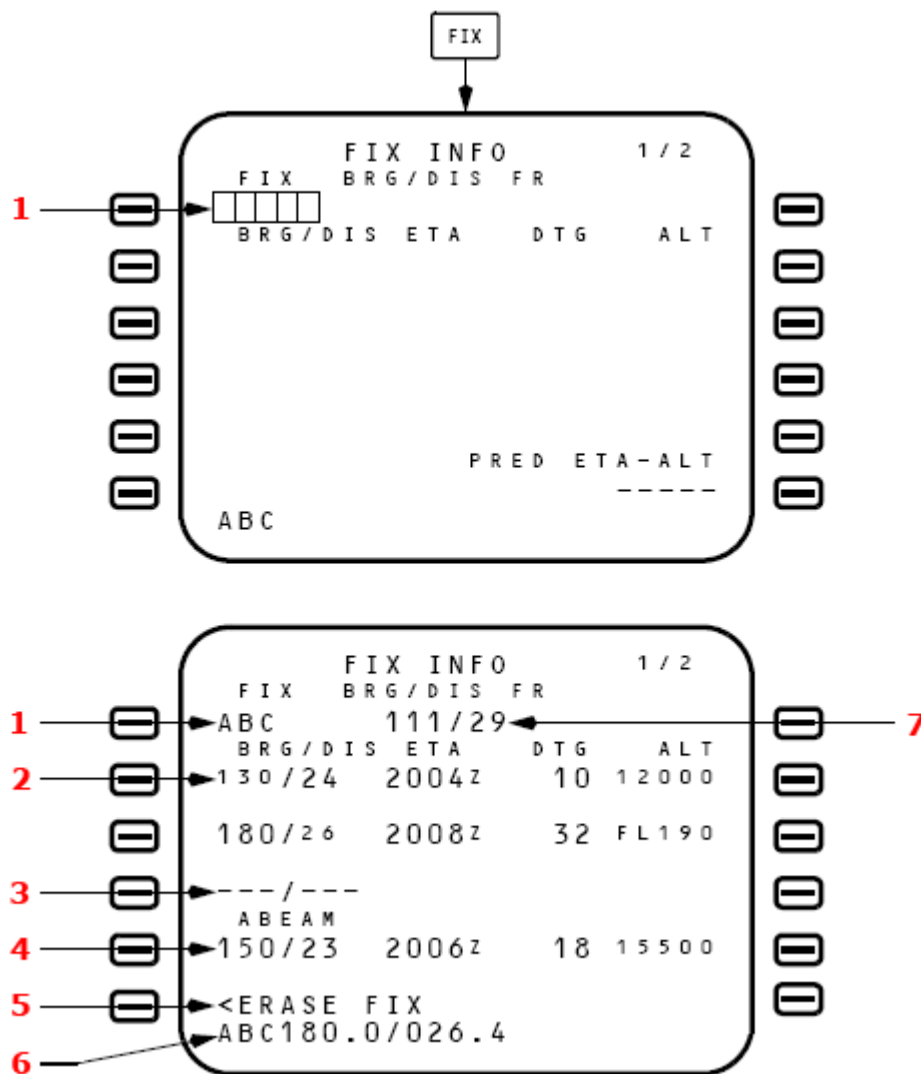
Displays elevation of entered identifier when it is a navaid, airport, or runway.

**8. VOR/DME NAV**

Alternately switches VOR/DME NAV updating between OFF and ON.

**FIX INFORMATION PAGE**

Two identical fix information pages are used to create fixes and waypoints for the HSI. Some of the created waypoints can be copied into the route.



## **1. FIX**

Before entry of a name or identifier, boxes displayed and most data lines are blank.

Valid entries are airports, nav aids, and waypoints from the navigation database. The selected fix displays on the HSI and is highlighted by a green circle.

## **2. Bearing/Distance (BRG/DIS), ETA, DTG, ALT**

Valid entries are XXX/YYY.Y:

- decimal values can be omitted
- leading zeros can be omitted for distance entries
- distance only entries must start with a slash (/).

Distances from the fix display on the HSI as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the intersection display for the closest of the two intersections.

Bearings from the fix display on the HSI as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA - displays the estimated time of arrival to the intersection point.

DTG - displays the distance to go to the intersection point.

ALT - displays the predicted altitude at the intersection point.

Push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

## **3. Bearing/Distance (BRG/DIS) - Dashes**

Enter a bearing, distance, or both bearing and distance from the fix. A bearing and distance from the fix displays on the HSI as a waypoint fix point. ETA, DTG, and predicted do not display.

## **4. ABEAM**

Displays ABEAM prompt.

Push - displays bearing and distance from the fix perpendicular to the nearest segment of the flight plan path, and ETA, DTG, and altitude at the intersection point.

Second push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

## **5. ERASE FIX**

Push - removes all fix data from the page and the HSI.

## **6. Route Intersection Point Copied**

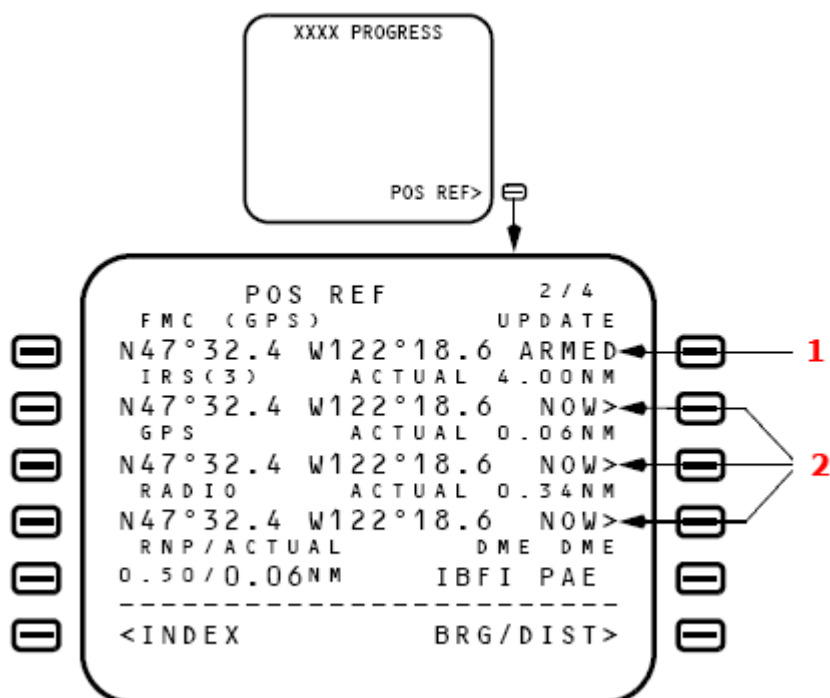
Pushing the line select key for one of the BRG/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

## **7. Bearing/Distance From (BRG/DIS FR)**

Displays the bearing and distance of the airplane from the fix.

**DO NOT USE FOR FLIGHT****IN-FLIGHT POSITION UPDATE**

FMC position update can be accomplished on the POS REF 2/3 page in flight.

**1. UPDATE ARMED**

Pushing the ARM prompt arms the position update function. ARM changes to ARMED. Each of the position update sources have a NOW prompt.

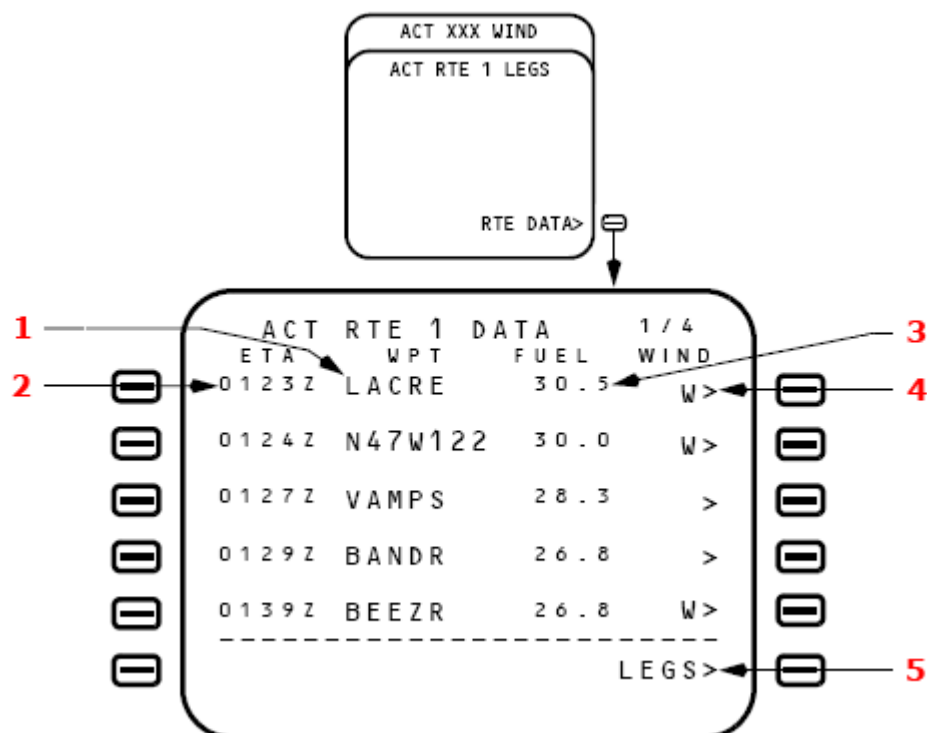
**2. NOW**

Push - to update the FMC position from the desired source. The FMC position is changed to the position of the selected system. If a valid source with a more accurate position (smaller ACTUAL) exists, the FMC position will quickly return to the most accurate position source.

**ROUTE AND WAYPOINT DATA****ROUTE DATA PAGE**

The route data page displays progress data for each waypoint on the ACT RTE X LEGS page. This page is available only for the active route.

The ETA and calculated fuel remaining are displayed for each waypoint. Manual entry is not possible. One page shows data for five waypoints.

**1. Waypoint (WPT)**

Displays identifier for waypoint.

**2. ETA**

Displays ETA for waypoint.

**3. FUEL**

Displays the FMC calculated fuel remaining at the waypoint.

**Note**

ETA and estimated fuel calculations assume a direct flight across route discontinuities.

**4. WIND Page Prompts**

Push - selects WIND page for the selected waypoint.

A "W" next to the prompt indicates that wind data has been entered on the wind page for that waypoint.



**DO NOT USE FOR FLIGHT****5. LEGS**

Push - displays RTE LEGS page.

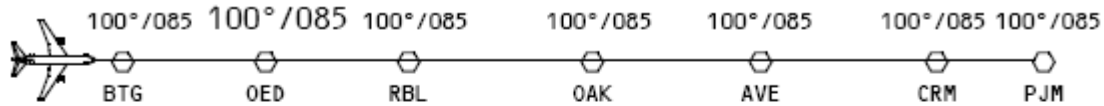
**WIND DATA**

The FMC uses wind data to improve performance calculation accuracy.

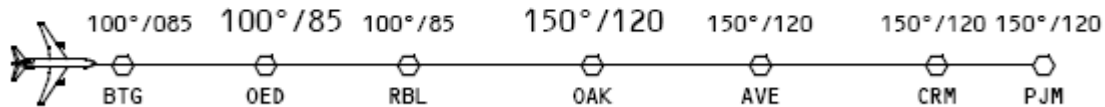
The FMC applies the first entered wind to all waypoints in the flight plan. Wind data includes altitude and direction/speed.

Wind data entered at another waypoint changes the wind only for the waypoints down track from that waypoint either to the end of the track, or to the next entered wind. Therefore, enter winds for waypoints closest to the airplane first, then enter winds for waypoints further down track.

For example: at FL 350, 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK and through the end of the route.



First Waypoint (OED) - at FL350, 100°/085 wind entered at OED



Second Waypoint (OAK) - at FL350, 150°/120 wind entered at OAK

Entered winds are mixed with sensed winds for performance calculations. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. The FMC mixes these winds for predictions in between. Sensed winds are displayed on the HSI and on progress page 2.

**WIND PAGE**

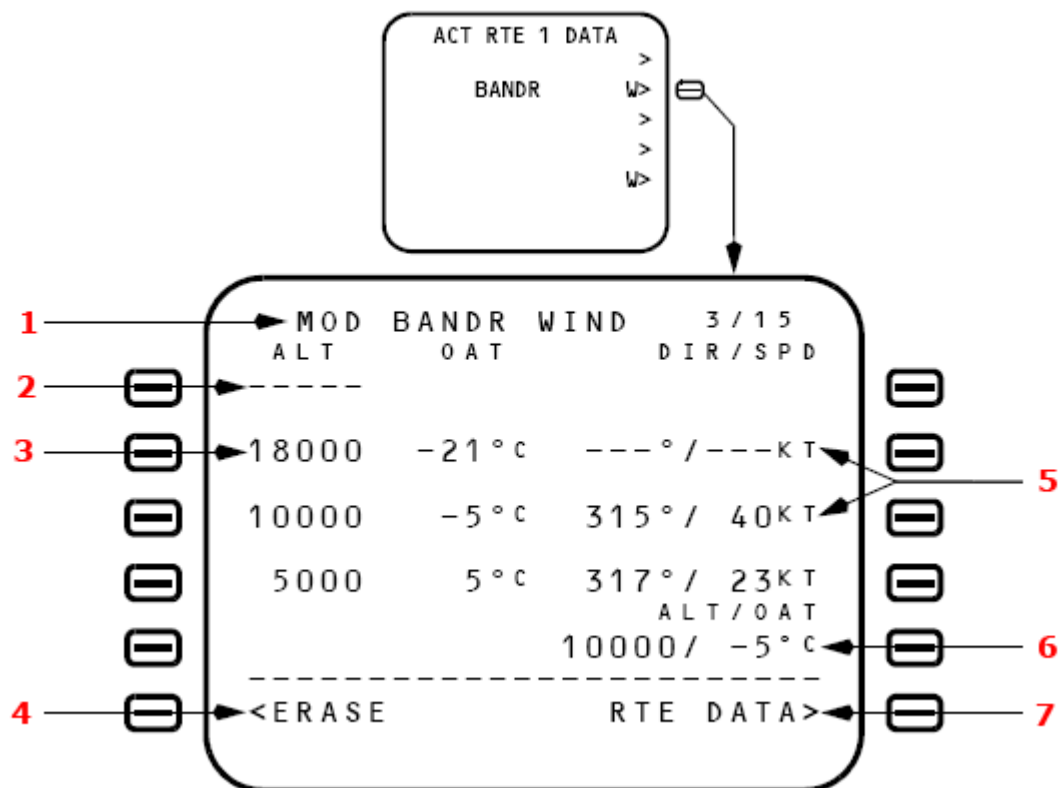
The wind page is used to enter forecast winds and temperatures at specific altitudes for specific waypoints to enhance VNAV performance. The FMC calculates step climb points based on the wind effect.

The wind page displays waypoint wind data for one to four altitudes per waypoint. This data can be uplinked or manually entered.

The altitudes are entered first. The altitudes can be entered in any order and are sorted and displayed in ascending order.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any one altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.

**DO NOT USE FOR FLIGHT****1. Page Title**

Displays ACT XXXXX, where XXXXX is the waypoint for which the wind page was selected.

When a route is being modified, MOD in is shown in the page title. If ACT is displayed when the wind page is first accessed, entry of wind data caused MOD to be displayed. Wind entries must be executed.

**2. Altitude (ALT)**

Enter altitude or flight level for wind entries. Altitude data entry is possible only on line 1L.

After altitude entry, data is sorted in ascending order in lines 1 through 4. Dashes display on right side of line for wind direction and speed entry.

When all four lines have data, one must be deleted before new data can be entered.

Entered altitudes are propagated to all wind pages.

**3. Altitude/Flight Level Data**

Displays the altitude or flight level for wind entries. Data entered on 1L is displayed on lines 1 through 4 in ascending order. Altitude entry is not possible in lines 2L through 4L.

Calculated OAT based on standard lapse rate from the entry made on the ALT/OAT line are display in small font.

**4. ERASE**

Push - removes modified data.

**DO NOT USE FOR FLIGHT****5. Direction and Speed (DIR/SPD)**

Displays dashes after altitude/flight level entry in the ALT line. Enter predicted wind direction and speed for the altitude.

Values propagate to other waypoint winds. Propagated values display in small font.

Manual entries display in large font.

**6. Altitude/Outside Air Temperature (ALT/OAT)**

Enter altitude and OAT. The altitude for OAT does not have to be one of the wind altitudes. The FMC uses standard lapse rate to calculate the temperature at the other altitudes.

Entries must be executed.

**7. Route Data (RTE DATA)**

Push - displays the RTE DATA page.

**PROGRESS PAGES**

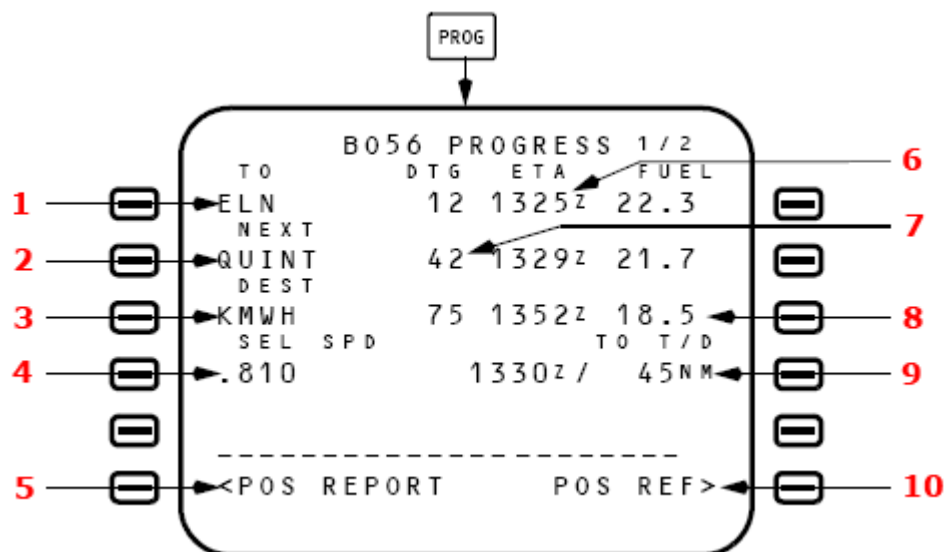
The progress page displays general flight progress data.

**PROGRESS PAGE 1**

Page one of the progress pages displays general data about:

- waypoints (active and next)
- destination
- FMC speed
- next VNAV profile point.

The page title displays the company flight number entered on the RTE page.

**1. TO**

Active waypoint is displayed. Can not be modified.

**2. NEXT**

Waypoint after TO waypoint is displayed.

Can not be modified.

**3. Destination (DEST)**

When the page is selected the active route destination is displayed. Any waypoint or airport in navigation database can be entered over the destination.

The line titles are:

- DEST - performance predictions to destination. Default display.
- DIR TO FIX - when entered waypoint is not in flight plan. Data is based on flying present position direct to the waypoint.
- EN ROUTE WPT - when entered waypoint is in flight plan. Line data are based on flying the flight plan route to the waypoint.
- MOD - a modification has been made on another page. Performance predictions include modification.

Entries do not modify the active route and are deleted when CDU is changed to a different page.

**4. Selected Speed (SEL SPD)**

Displays the FMC active command speed.

The active speed mode is the same as on the 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 - selected speed manually entered on the CDU
- LIM SPD - speed is limited by VMO, MMO, flap limit, or buffet limit
- MCP SPD - MCP speed IAS/MACH indicator

**5. Position Report (POS REPORT)**

Push - displays the POS REPORT page.

**6. ETA**

Estimated time of arrival at waypoint or destination.

**7. Distance To Go (DTG)**

Distance to go to waypoint or destination.

**8. FUEL**

Estimated fuel remaining at waypoint or destination.

**9. TO Top Of Descent (T/D)**

ETA and DTG to next VNAV profile point.

The line title and data change for other phases of flight. Other line titles:

- TO T/C-top of climb data
- TO STEP CLIMB - step climb data
- TO E/D-end of descent data
- LEVEL AT - time and distance to level off in engine out mode.

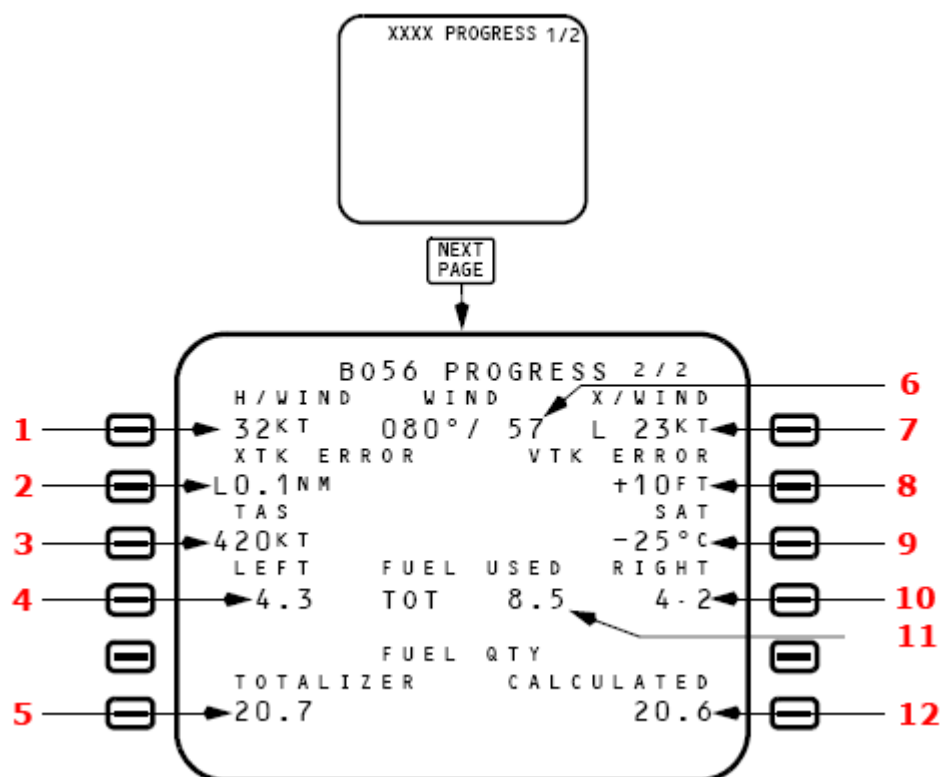
**10. Position Reference (POS REF)**

Push - displays the position reference page.

**PROGRESS PAGE 2**

Progress page two contains:

- wind data
- true airspeed
- fuel data
- track error data
- static air temperature.

**1. Headwind (HAVIND), Tailwind (TAVIND)**

Displays headwind (HAVIND) or tailwind (TAVIND) component relative to the airplane heading.

**2. Crosstrack Error (XTK ERROR)**

Displays crosstrack (XTK) error in nautical miles left or right of the active route.

**3. TAS**

Displays airplane true airspeed.

**4. LEFT FUEL USED**

Displays fuel used by left engine sensed by fuel flow meters.

**5. Fuel Quantity (QTY) TOTALIZER**

Displays total fuel quantity from the fuel system quantity processor.

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations.

**6. WIND**

Displays current wind direction and speed referenced to true north.

**7. Crosswind (X/WIND)**

Displays left (L) or right (R) crosswind component relative to airplane heading.

**8. Vertical Track Error (VTK ERROR)**

Displays vertical path (VTK) error above (+) or below (-) vertical path.

**9. Static Air Temperature (SAT)**

Displays outside static air temperature.

**10. RIGHT FUEL USED**

Displays fuel used by right engine sensed by fuel flow meters.

**11. FUEL USED Total (TOT)**

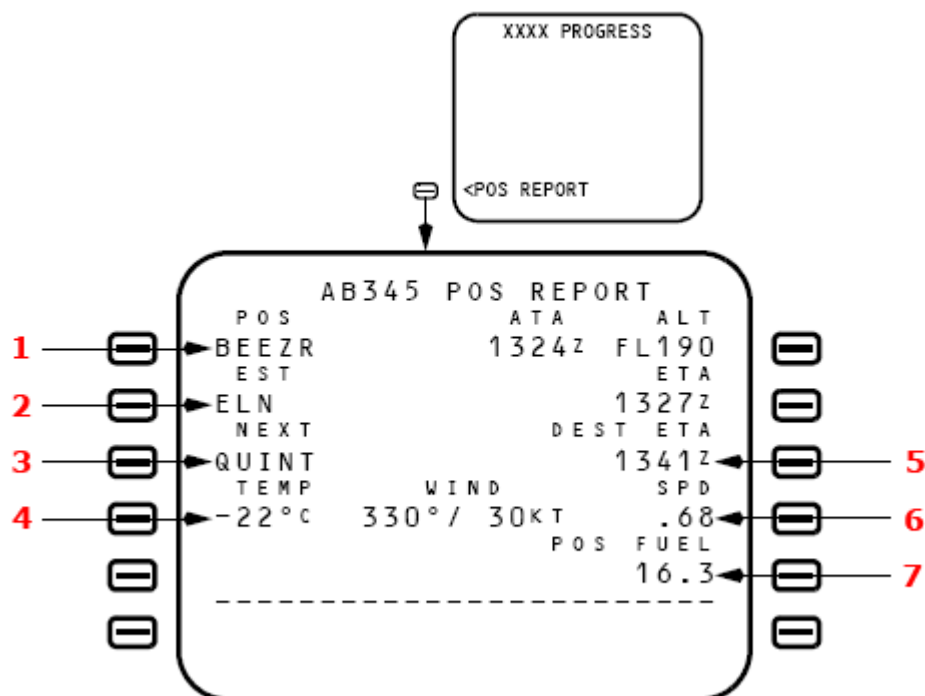
Displays sum of the LEFT and RIGHT fuel used values.

**12. FUEL Quantity (QTY)**

**DO NOT USE FOR FLIGHT****POSITION REPORT PAGE**

The position report page displays data for a position report. A data linked position report can be initiated from the page.

The page contains reference data only. Manual entries are inhibited.

**1. Position (POS)**

Waypoint used to report position. This is the previous active waypoint. The actual time of arrival (ATA) and altitude (ALT) at the waypoint follow the waypoint name.

**2. Estimate (EST)**

The active waypoint is displayed with the ETA to that waypoint.

**3. NEXT**

The waypoint following the active waypoint.

**4. Temperature and Wind (TEMP WIND)**

TEMP displays the OAT in degrees C.

WEND displays the wind direction and speed. Wind direction is shown in degrees true.

**5. Destination ETA (DEST ETA)**

The FMC calculated ETA for the destination is displayed.

## **6. Speed (SPD)**

Displays the target FMC speed.

## **7. Position Fuel (POS FUEL)**

Displays the fuel on board at the POS waypoint.



## **Section 8: FMC DESCENT AND APPROACH**

### **INTRODUCTION**

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for the descent phase starts during cruise.

The approach phase starts at the end of descent point and continues to touchdown.

The only automatic page change in the descent/approach phases is the VNAV selected page change, from cruise to descent, at the top of descent.

### **EARLY DESCENT**

Early descent is commenced before reaching the top of descent.

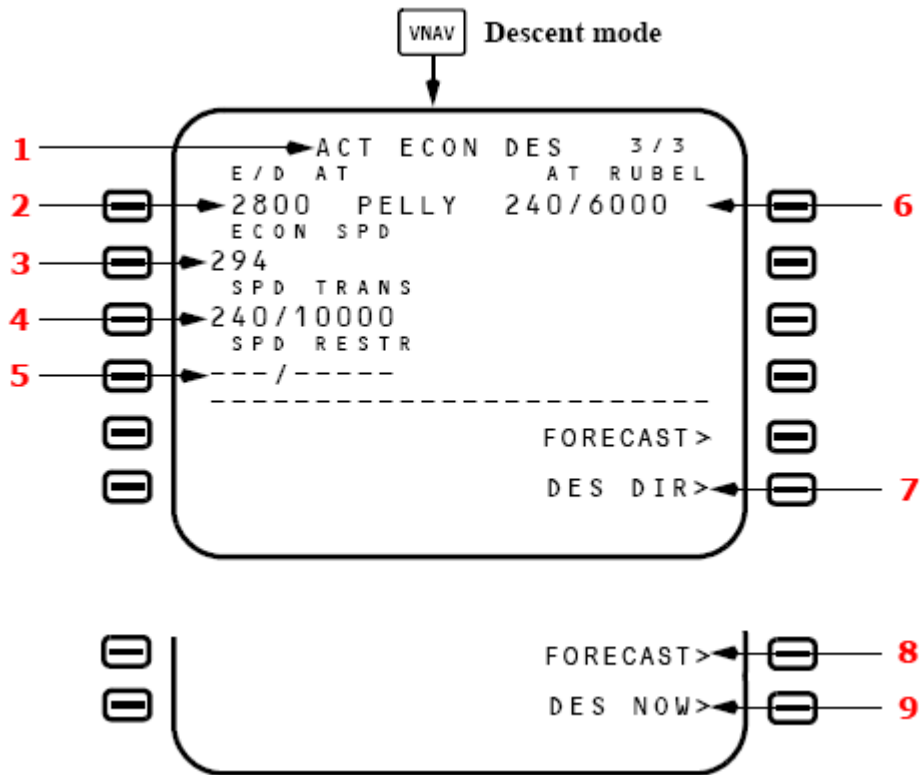
**DESCENT**

During descent, LNAV progress is managed using the RTE LEGS page, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

**DESCENT PAGE**

The descent page is used to monitor and revise the descent path. Descent speed modes are economy (ECON) and fixed speed (SEL). The default VNAV descent mode is ECON. A fixed speed descent is flown when speed intervention is used or a speed is entered on the DES page. The descent page is no longer available after the end of descent.

The page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a lower speed restriction. The fixed speed mode controls descent speed until a lower speed restriction is reached.

**1. Page Title**

The title usually shows ECON during descent. Fixed speed descents modify the title.

The page title shows the type of descent:

- ECON - speed based on a cost index
- LIM SPD - speed based on airplane configuration limiting speed
- MCP SPD - MCP speed intervention is selected
- XXXKT - fixed CAS descent speed profile
- M.XXX - fixed Mach descent speed profile
- ACT - prefix shown when descent phase is active
- MOD - prefix shown when descent phase is active and the flight plan is modified.

Reasons for fixed descent speeds are:

- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed transition
- a flight crew entered selected speed (SEL SPD).

**2. End of Descent At (E/D AT)**

Shows the end of descent altitude and waypoint.

The end of descent point is a waypoint in the descent phase with the lowest altitude constraint.

Blank if no E/D point exists.

**3. Economy Speed (ECON SPD), Selected Speed (SEL SPD)**

Shows the current target descent speed.

ECON SPD -

- economy speed based on cost index
- shows CAS or Mach.

SEL SPD -

- shows when intermediate level off required below an existing speed constraint
- shows when flight crew enters speed
- CAS or Mach value may be entered.
- page title changes to ACT XXXKT DES or ACT M.XXX DES
- <ECON prompt appears at line 5L to allow selection of economy descent speed

**4. Speed Transition (SPD TRANS)**

The transition speed is usually 10 knots less than the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 240 knots is shown. The transition altitude is the point that the transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet is shown.

Blanks when the transition has occurred.

Can be deleted.

**5. Speed Restriction (SPD RESTR)**

Speed restrictions not associated with specific waypoints are manually entered on this line.

Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

An entry creates a modification.

**6. ATXXXXX**

Shows the next waypoint constraint from the RTE LEGS page.

Line title shows:

- AT XXXXX (the waypoint identifier)
- HOLD AT XXXXX
- AT VECTORS
- AT(INTC).

The constraint is speed/altitude. Blank when no constraint exists.

Can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

**DO NOT USE FOR FLIGHT****8. FORECAST**

Push - shows the DESCENT FORECAST page.

**7. Descend Direct (DES DIR)**

Push - deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude.

Shown in descent phase with altitude constraint between airplane and E/D.

**9. Descend Now (DES NOW)**

Shown when the descent phase is not active.

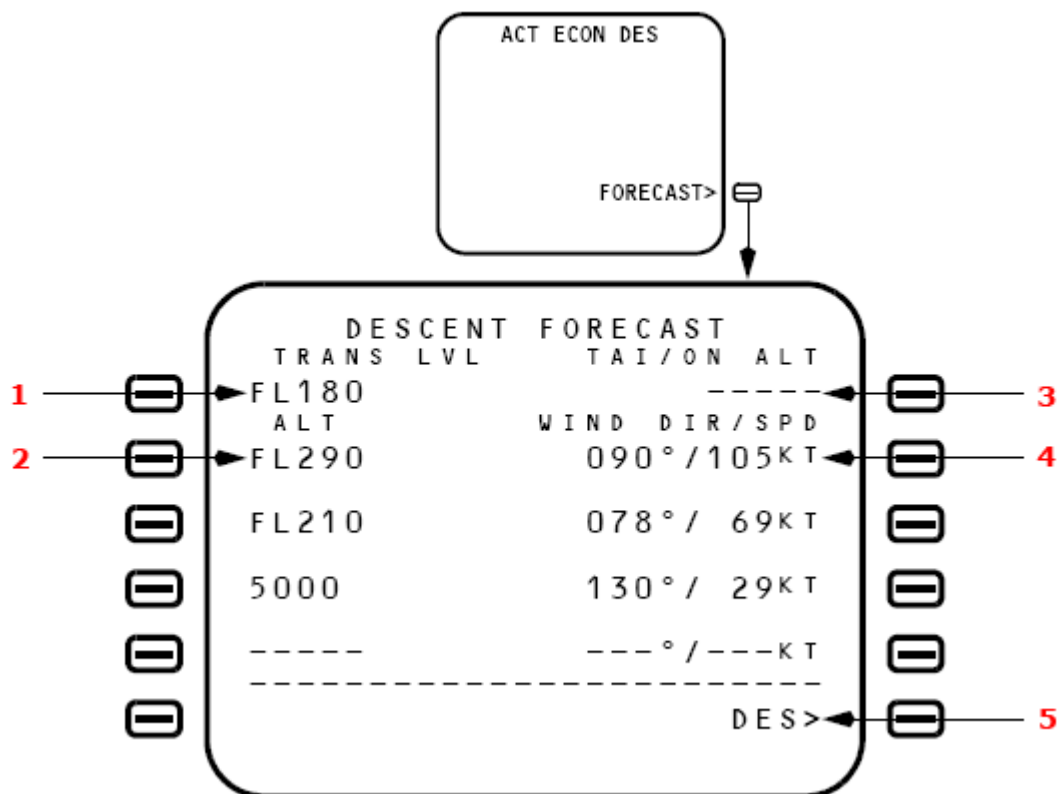
Push-

- starts a 1250 feet per minute descent schedule until intercepting the planned descent path
- activates the FMC descent phase.

**DESCENT FORECAST PAGE**

The descent forecast page is used to enter wind data for descent, and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

The primary entries are wind direction and speed for up to four descent altitudes, and the altitude that anti-ice is turned on.

**1. Transition Level (TRANS LVL)**

Shows the transition level.

**DO NOT USE FOR FLIGHT**

The transition level can be specified by the arrival procedure. The default transition level is FL 180.

Above transition level, altitudes are in flight levels. Below transition level, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

**2. Altitude (ALT)**

Enter altitude of forecast wind data.

Altitudes and flight levels can be entered in any order. Entries are not sorted.

Execute not necessary.

**3. Thermal Anti-Ice On Altitude (TAI/ON ALT)**

Enter the altitude where anti-ice is first turned on during the descent. The FMC calculates the descent profile based on the higher thrust caused by thermal anti-ice operation below this altitude.

**4. Wind Direction/Speed (WIND DIR/SPD)**

Enter the wind direction/speed for the specified altitude. Initial entry must have wind direction and speed, subsequent entries may have one or the other.

Execute not necessary.

**5. Descent (DES)**

Push - shows the DES page.

**APPROACH**

During approach, roll and pitch modes usually change to the approach guidance supplied by navigation radios. The FMC continues to calculate and show present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and DESCENT pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- APPROACH REF page - to access the FMC calculated approach VREF speed
- ARRIVALS page - to select arrival and approach procedures
- HOLD page - to manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

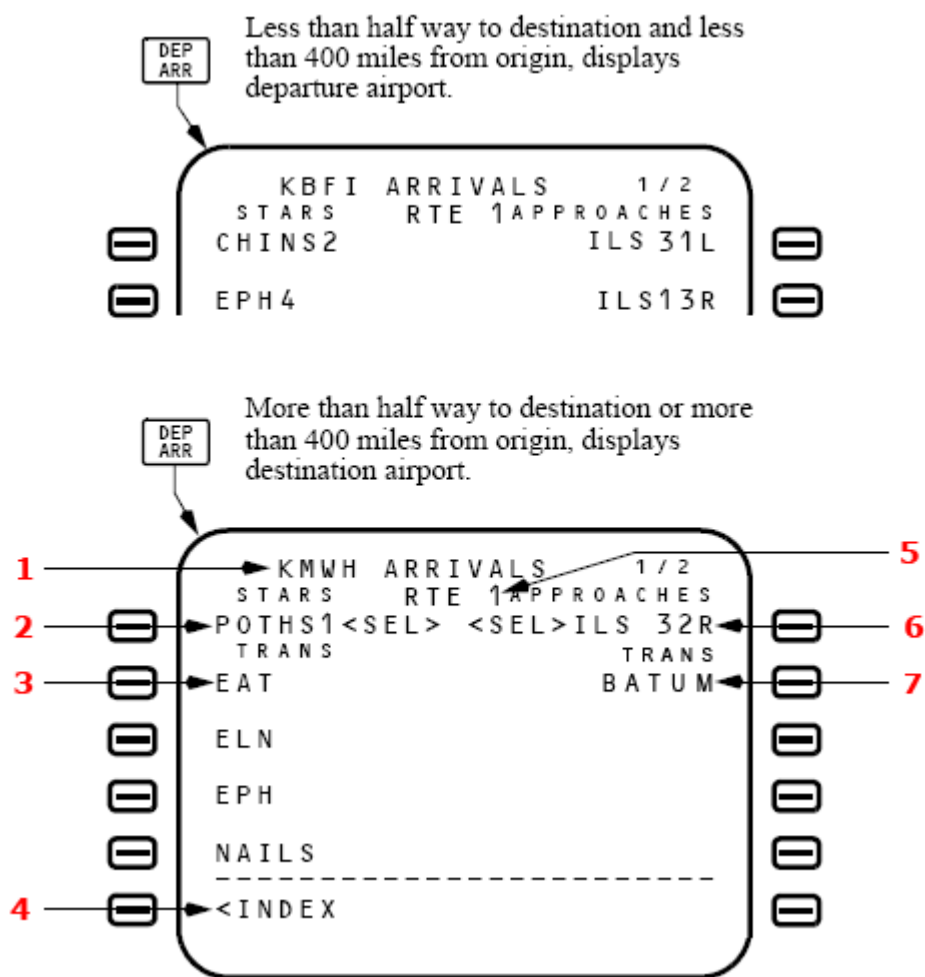
**ARRIVALS PAGE - IFR APPROACHES**

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

The approaches, STARS, and transitions are shown and selected on this page.

**Selecting Options**

Selecting an approach, STAR, or descent transition option shows <SEL> inboard of the selection, and makes a route modification. The other options within the same category are removed from the list. When the modification is executed, <SEL> changes to <ACT>. Select another page and return to ARRIVALS to show all options; the applicable <SEL> or <ACT> prompts are shown.

**1. Page Title**

The airport identifier is shown in the title.

Airports with more than 5 runways or STARS produce multiple arrivals pages.

**2. Standard Terminal Arrivals (STARS)**

Lists the STARS for the airport.

STARS are shown first in a list under the STAR line title.

When a selection is made the procedures not selected are removed from the page.

The selected procedure is listed with <SEL> and a list of compatible transitions is shown.

### **3. Standard Terminal Arrivals Transitions (STARS TRANS)**

Lists all the transitions for the selected STAR.

When a selection is made the transitions not selected are removed from the page. The selected transition is listed and marked <SEL>.

### **4. INDEX**

Push - shows the DEP/ARR INDEX page.

### **5. Route 1 (RTE 1)**

Shows the selected route number (RTE 1 or RTE 2).

### **6. APPROACHES**

Lists available approaches and runways for the destination airport.

When a selection is made, other approaches and runways are removed from the page and compatible transitions are listed. The list of STARS is reduced to those compatible with the selected approach.

### **7. Approach Transitions (TRANS)**

Transitions are listed when an approach is selected. Shows a list of available transitions to the selected approach.

Approach transitions include:

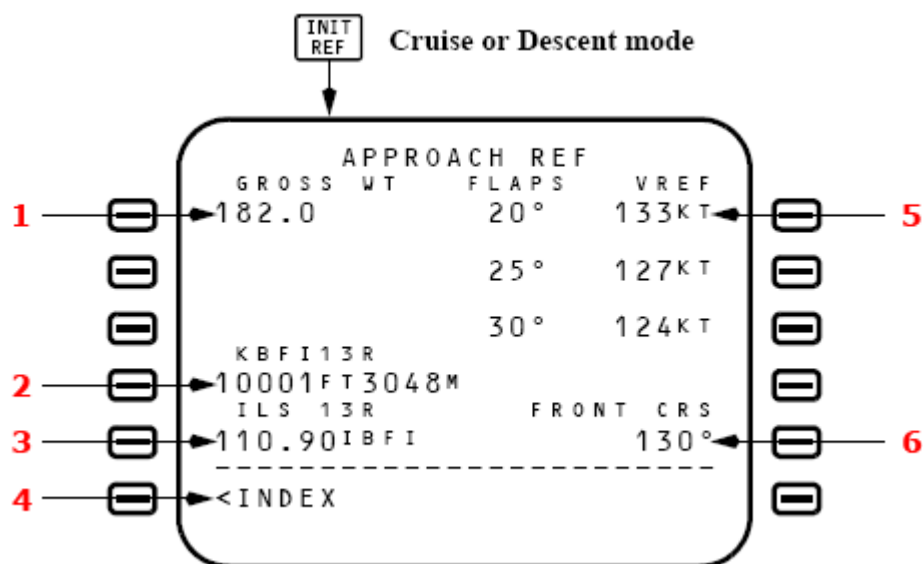
- IAF
- feeder fix
- fixes which define routing to the FAR

Selecting an approach without a transition makes a straight—in approach which starts at:

- a charted fix or CFXXX, where XXX is the runway number
- a waypoint 4—8 miles outside the final approach fix.

**DO NOT USE FOR FLIGHT****APPROACH REFERENCE PAGE**

The approach reference page shows approach planning data and approach reference speed (VREF) selection.

**1. Gross Weight (GROSS WT)**

FMC calculated airplane gross weight is usually shown.

Manual entry is allowed in case the FMC calculated gross weight is unavailable or invalid, or to allow previewing recommended approach speeds at other than the calculated FMC gross weight. The manually entered gross weight is for reference only and is deleted when a different page is selected. Permanent changes to gross weight may only be made on the PERF ESTIT page.

Shows boxes when gross weight is not available from the FMC.

Valid entry is XXX.X.

**2. Runway Length**

The shown runway reference changes based on route progress. The destination runway is the reference when the present position is more than halfway to the destination or more than 400 NM from the origin airport. The origin airport runway is the reference when less than halfway or less than 400 NM from the origin airport.

Shows the length in feet and meters of the referenced runway.

**3. ILS**

Display is blank prior to entering a destination runway in the active route.

Displays the runway, corresponding ILS frequency and facility identifier from the navigation database for the runway shown.

**4. INDEX**

Push - shows the INT/REF INDEX page.



## 5. FLAPS VREF

Shows the calculated reference speed for flaps 20°, 25°, and 30°. A gross weight is necessary for VREF speed calculation.

The display is blank until a gross weight is shown.

## 6. FRONT Course (CRS)

Displays the front course for the ILS and runway shown to the left.

## HOLDING

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

The entry method used (parallel, teardrop, or direct) is determined by

- airplane track, not heading or direction from which the active route approaches the holding pattern.
- the airplane flies the initial outbound leg a computed distance from the holding fix, rather than a specific time. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active
- teardrop entries use a 40 degree offset angle
- parallel and teardrop entries may cause the airplane to fly beyond the displayed holding pattern; however, the airplane remains in protected FAA or ICAO limits.

**HOLD PAGE (FIRST HOLD)**

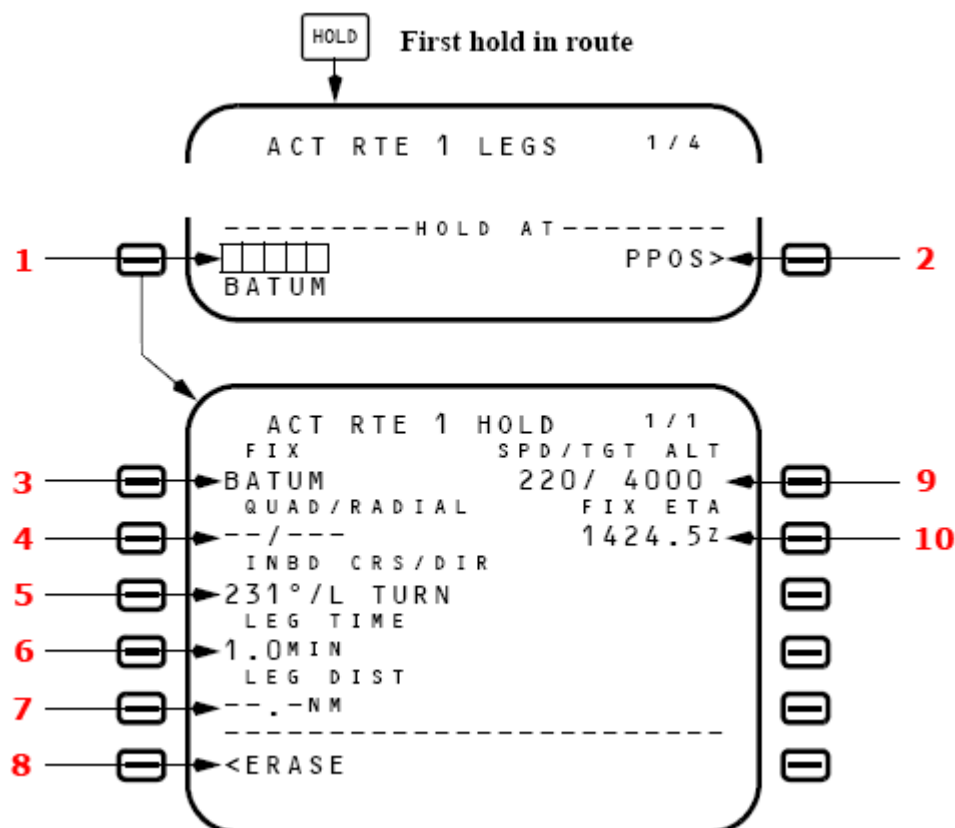
The hold page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the HOLD function key to show the RTE X LEGS page with the HOLD AT line.

The holding page displays actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the HSI.

**1. HOLD AT**

When the HOLD function key is pushed and no holding pattern exists in the route, the RTE LEGS page displays prompts to enter the holding fix. Enter the holding fix to show the RTE X HOLD page.

Normally a route waypoint is entered as the holding fix. If a waypoint that is not part of the active route is entered the scratchpad message HOLD AT XXX appears where XXX is the entered waypoint. The holding fix can then be inserted in the route in the proper sequence.

**2. HOLD AT Present Position (PPOS)**

Selects the airplane present position as the holding fix.

**3. Holding FIX**

Displays the holding fix.

**4. Quadrant/Radial (QUAD/RADIAL)**

The holding quadrant and radial are entered.

Valid entry is X/XXX, XX/XXX, or /XXX (example NE/040).

Automatically changes INBD CRS/DIR to agree.

**5. Inbound Course/Direction (INBD CRS/DIR)**

Displays the holding inbound course and turn direction.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Automatically changes QUAD/RADIAL to agree.

**6. LEG TIME**

Default display is 1.0 MIN (minute) at or below 14,000 feet or 1.5 MIN above 14,000 feet.

Displays -- if a LEG DIST is entered.

Valid entry is X, X.X, or .X in minutes from 0.1 to 9.9.

When climbing/descending through 14,000 feet with VNAV engaged and the SPD/TGT ALT on line 1R displayed in large font, the FMC adjusts leg time (1.0 MIN at or below 14,000 feet; 1.5 MIN above 14,000 feet).

**7. Leg Distance (LEG DIST)**

Default display is --.NM if no leg distance has been entered or if a LEG TIME is entered

**8. ERASE**

Erases all FMC modifications.

**9. Speed/Target Altitude (SPD/TGT ALT)**

Waypoint holding fix speed/altitude constraint from the RTE LEGS page. Manual entries are in large font.

During cruise, an altitude entry below cruise altitude activates the descent page, unless a new cruise altitude is entered. Altitude entry must be at or below cruise altitude.

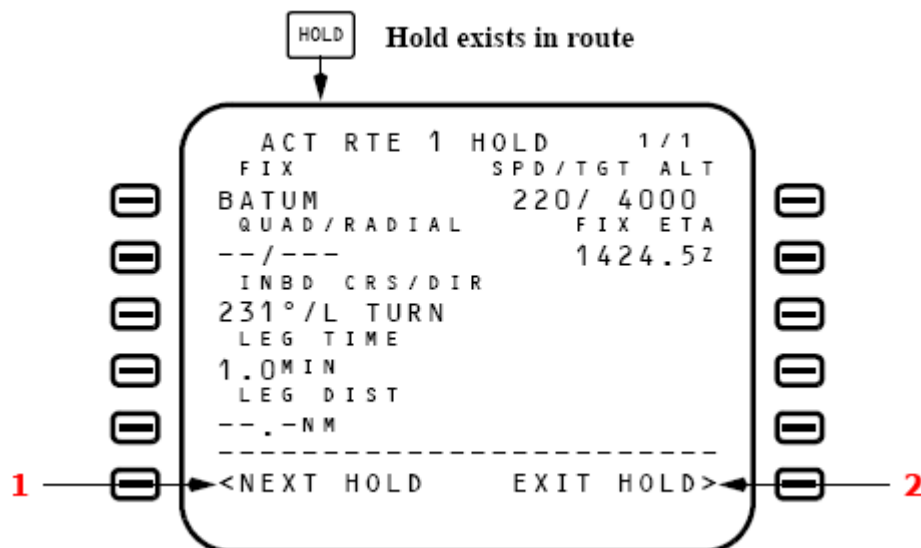
A speed entry requires an altitude constraint.

**10. FIX ETA**

Displays the ETA to the next passing of the holding fix.

**DO NOT USE FOR FLIGHT****HOLD PAGE (EXISTING HOLD)**

When one or more holding patterns are already in the route, push the HOLD key to show the hold page for the first holding pattern. Holding parameters can be monitored and changed on this page. New holding patterns are added using the NEXT HOLD prompt.

**1. NEXT HOLD**

Push - displays a new hold page for a new holding pattern entry.

**2. EXIT HOLD**

Push-

- arms a return to the holding fix via the inbound course for holding pattern exit
- EXIT ARMED displayed
- EXEC light illuminated.

When the EXEC key is pushed, the airplane will cross the holding fix and exit holding. If executed when outbound in the holding pattern the airplane will immediately turn inbound and exit holding when the fix is crossed.

**Section 9: FMC MESSAGES**

FMC messages alert the flight crew to conditions that could degrade the system operation and advise the crew of input errors.

The messages are categorized as:

- alerting messages
- advisory messages

The scratchpad messages display according to their level of importance. A less important message replaces another message in the scratchpad when the CLEAR key is pushed or the condition is corrected.

The FMC light illuminates and the EICAS advisory message FMC MESSAGE displays when there is an FMC alerting message.

Scratchpad advisory messages appear in the scratchpad without an EICAS message or FMC light. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

**FMC ALERTING MESSAGES**

FMC alerting messages:

- display in the CDU scratchpad
- illuminate the amber FMC light on the instrument panel
- cause the EICAS advisory message FMC MESSAGE to display
- illuminate the CDU message light (MSG).

Use the CLEAR key or correct the condition responsible for the message to remove the message.

**DISCONTINUITY** - LNAV active and the airplane has passed the last waypoint prior to a route discontinuity (except on a manually terminated leg, such as a VECTORS legs).

**DRAG REQUIRED** - VNAV active and additional drag required or autothrottle off and less thrust required to maintain the VNAV descent path.

**END OF ROUTE** - LNAV active and end of active route overflown. AFDS maintains last heading.

**ENTER IRS POSITION** - the flight crew-entered present position did not pass one of the IRS comparison checks, or the IRS is ready to change to navigate mode and has not received a present position entry. Use the CLEAR key to remove this message.

**INSUFFICIENT FUEL** - estimated fuel at destination less than entered RESERVES value.

**NO ACTIVE ROUTE** - LNAV selected and no active route activated.

**PERF/VNAV UNAVAILABLE** - VNAV selected and gross weight, cost index, or cruise altitude are not entered.

**RESET MCP ALT** - 2 minutes prior to the top of descent point with VNAV active and MCP not set to altitude below cruise altitude.

**TAKEOFF SPEEDS DELETED** - selected V speeds have been deleted due to changes in takeoff performance or configuration data.

**THRUST REQUIRED** - VNAV active, autothrottle disconnected, and additional thrust required to track VNAV descent path and maintain speed.

**FMC ADVISORY MESSAGES**

FMC advisory messages are displayed on the CDU scratchpad and illuminate the CDU message light (MSG). There are no EICAS messages associated with these messages and they do not cause the FMC light to illuminate.

Those messages which are caused by an entry error must be cleared before the entry can continue.

**DELETE** - DEL key pushed.

**HOLD AT XXXX** — a waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, after selection of the HOLD function key. Selection of HOLD AT XXXX into a RTE LEGS page waypoint line makes a holding fix at the XXXX waypoint.

**INVALID DELETE** - deletion of selected data is not allowed.

**INVALID ENTRY** - entry format or range is incorrect for the selected field or the entered airway or TO waypoint does not coincide with the navigation database.

**MANUALLY TUNED** - attempt to remotely tune a VOR that is manually tuned.

**NOT IN DATABASE** - data is not in the route or the navigation database.

**NOT ON INTERCEPT HEADING** - LNAV selected and the airplane is outside active capture criteria and the present heading will not intercept the active leg.

**UNABLE CRZ ALT** - performance predicts a zero cruise time at the entered cruise altitude.

**XXXXXX** - altitude set in the MCP window when VNAV is engaged, the CLB or CRZ page is displayed, and the altitude is above, within 4000 feet below, and not equal to the CRZ ALT.

**CDU ANNUNCIATOR LIGHTS**

These annunciator lights illuminate when certain conditions exist.

**DSPY** - a flight plan modification is pending and the RTE, RTE LEGS, RTE DATA, or RTE HOLD page not containing the active leg or route segment is displayed, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is displayed.

**FAIL** - the associated FMC has failed.

**MSG** - an FMC message is waiting to display or is displayed.

**Section 10: NAVIGATION DATABASE****CAPTAIN SIM NAVIGATION DATABASE FILES FORMAT**

The files are held in the "Captain\_Sim/navigation" subfolder of FS installation folder.

The data within the files is organized into blocks, each block describing a single SID or STAR procedure. Each such block is identified by a header enclosed in braces, which has this format:

```
{BIKF;RW02;ALD1A;ALDAN}
```

Which specifies, the Airport, the Runway to which the procedure applies (this can be ALL meaning this procedure exists for all runways), the Procedure name, and the Transition waypoint.

Each block then contains several lines each describing a leg in the procedure. Each line contains 19 values separated by semicolon – that is ;

If any value in line is not available, it is not indicated, but its field remains. I.e. any line should contain **eighteen** semicolons anyway.

**SID, STAR and IAP**

SID are held in SIDs.db file.

STARs are held in STARs.db file.

IAPs are held in IAPs.db file.

The format for the three files is identical:

```
{Airport;applicable runways;SID name;transition name}
```

```
Alt1;Alt2;AltType;ArcRadius;Bearing;Distance;Fix;FixLat;FixLon;MagCourse;Path;RecNav;RteDist;RouteType  
;Speed;TransitionAlt;TransitionID;Turn;
```

Where:

*Alt1* - is the altitude constraint

*Alt2* - is the second altitude constraint for BETWEEN type constraints

*AltType* - describes the type of following altitude constraints and can be "+" for AT OR ABOVE, "-" for AT OR BELOW, "B" for BETWEEN or " " for AT type constraints

*ArcRadius* - is radius for RF type legs

*Bearing* - is the radial for CR and VR legs

*Distance* - is distance for CD, FC, FD or VD legs

*Fix* - is a fix or waypoint this leg is based on (for example Track to Fix type leg, this field shows the name of the fix in question)

*FixLat* and *FixLon* - are the coordinates of this fix, where applicable. The current database lists 91.00 / 181.00 where such coordinates are not defined (for example Heading to Altitude leg), but exact values are not important.

*MagCourse* - is course or heading where it is required

*Path* - describes the leg path type and can be one of the following standard AIRAC types:

HA	Hold one circle
HF	Hold until altitude reached
HM	Hold with manual termination
IF	Initial fix
PI	Procedure turn
TF	Track between fixes
CA	Course to altitude
CD	Course to DME distance

**DO NOT USE FOR FLIGHT**

CI	Course to leg
CR	Course to radial termination
CF	Course to fix
DF	Track to fix
FA	Course from fix to altitude
FC	Course from fix to given distance
FD"	Course from fix to DME distance
FM	Course from fix to manual termination
RF	Constant radius to fix
VA	Heading to altitude
VD	Heading to DME distance
VI	Heading to leg
VM	Heading to manual termination
VR	Heading to radial termination

*RecNav* - is Recommended Navaid for this leg. This is used for legs such as Course from Fix to DME Distance or Course to Radial Termination and lists the navaid name which is to be tuned to and checked for DME distance or radial.

*RteDist* - is route distance. If it's value equals to 1, it means this is the first point of the missed approach.

*RouteType* - describes which part of the procedure this leg belongs to: 1 = SID runway transition, 2 = SID common part, 3 = SID enroute transition, 4 = STAR runway transition, 5 = STAR common part, 6 = STAR enroute transition. For example, there can exist several versions of a SID for different runways, they will have the same lines with RouteType of 2 or 3 and different lines with RouteType of 1 describing paths from different runways. Or, SID blocks with different lines of RouteType 3 show similar SIDs with different enroute transition waypoints.

*Speed* - is speed restriction at this leg

*TransitionAlt* - is Transition altitude for this procedure.

*TransitionID* - is the name of transition waypoint this procedure applies to

*Turn* - can be "L" or "R" for left or right turns as demanded by procedure

## Airports

Held in Airports.db file.

File format:

Elevation; ICAO; Latitude; Longitude

## Airways

Held in Airways.db file.

File format:

AirwayName; Bidirectional; Latitude; Longitude; Type; WaypointName;

Bidirectional – equals to either '1' or '0'

Type:

ATLANTIC	1
BAHAMA	2
CORRIDOR	3
ADVISORY	4
DIRECT	5
MILITARY	6
NORTHAMERICAN	7
OCEANIC	8
RNAV	9
SUBSTITUTE	10
TACAN	11
AIRWAY	12



**Root points**

Held in Fixes.db file.

File format:

ID; Latitude; Longitude; UsageCode

UsageCode:

HL	1
LL	2
BOTH	3
RNAV	4
TERMINAL	5

**Stations (VOR and NDB)**

Held in NavAids.db file

File format:

Altitude; Frequency; ID; Latitude; Longitude; Type; UsageCode

Type:

VOR	1
VORTAC	2
TACAN	3
VORDME	4
NDB	5
NDBDME	7
DME	9

**Runways**

Held in Runways.db file.

File format:

AirportICAO; GS\_Angle; ILS\_Frequency; Latitude; LengthFeet; Longitude; Name; TrueHeading;

**Aircraft type referencing**

Is fulfilled via [productcode].cfg file

For example:

<i>NavDataID</i>	<i>= BA19410001</i>
<i>COData</i>	<i>= BA1001</i>
<i>OPProgram</i>	<i>= PS4052970-953</i>
<i>OPCNumber</i>	<i>= 3173BCG00025</i>
<i>Version</i>	<i>= 1.0</i>

**CUSTOM TERMINAL PROCEDURES****Terms:**

Original database - aeronautical data database included into the original product pack.

Custom terminal procedures - terminal procedures .db files (SIDs, STARs or IAPs of any airport) created and/or modified by user.

**HOW TO ADD CUSTOM TERMINAL PROCEDURES?**

Any advanced user can add custom terminal procedures without a risk of damaging the original database.

**DO NOT modify/remove/edit files located in [FSX Root Folder]\Captain\_Sim\navigation\ folder!**

**1.** Create [airport\*]\_stars.db and/or [airport]\_sids.db and/or [airport]\_iaps.db files. In order to do this right click at any folder of your computer, create .txt file and change the file extension to .db

\* - airport is the airport ICAO four letters code (e.g. KSEA).

For example:

KSEA\_stars.db

KSEA\_sids.db

KSEA\_iaps.db

**2.** Paste SID and/or STAR and/or IAP data of the named airport into corresponding .db file in accordance with Section 10: Navigation Database, Captain Sim Navigation Database Files Format part of this Manual.

**3.** Copy the new .db files into [FSX Root Folder]\Captain\_Sim\navigation\user\ folder.

**Note:**

- Custom procedures has a priority over original procedures, so if available FMS use custom procedures from the \user\ folder, and ignore procedures from original database.

- You may add the \_stars.db, \_sids.db, \_iaps.db files in any combination (just one, two or all three files). FMS use whatever it finds in the \user\ folder, taking the rest from original database.

- As soon as you remove custom procedures files from the \user\ folder, FMS will automatically switch back using original database.

**4.** Run MS FSX and test the custom procedures. If you get any error just delete the corrupted files from \user\ folder.

We support Original FMS database only. Original database - aeronautical data database included into the original product pack.

**AERONAUTICAL DATA**

Aeronautical database (AIRAC Cycle 0903) included into the original product pack is provided by NAVIGRAPH&NAVData Service.

Updates can be purchased at [NAVIGRAPH&NAVData](http://www.navdata.com) web site.

We support Original FMS database only. Original database - aeronautical data database included into the original product pack.

**DO NOT USE FOR FLIGHT**

## **CUSTOMER SUPPORT**

For Customer Support please visit: <http://www.captainsim.com/support/>

Thank you,  
Enjoy your flight!

Captain Sim Team  
[www.captainsim.com](http://www.captainsim.com)