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PART IV – **Flight Management System**

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ABOUT THIS MANUAL

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WARNING:

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The '777 Captain' MANUAL is organized into four Parts:

Each Part is provided as a separate Acrobat® PDF document:

- Part I – User's Manual
- Part II – Aircraft Systems
- Part III – Normal Procedures
- **Part IV - Flight Management System** - this document

All Parts of the Manual are available free of charge via [Sim Ops](#).

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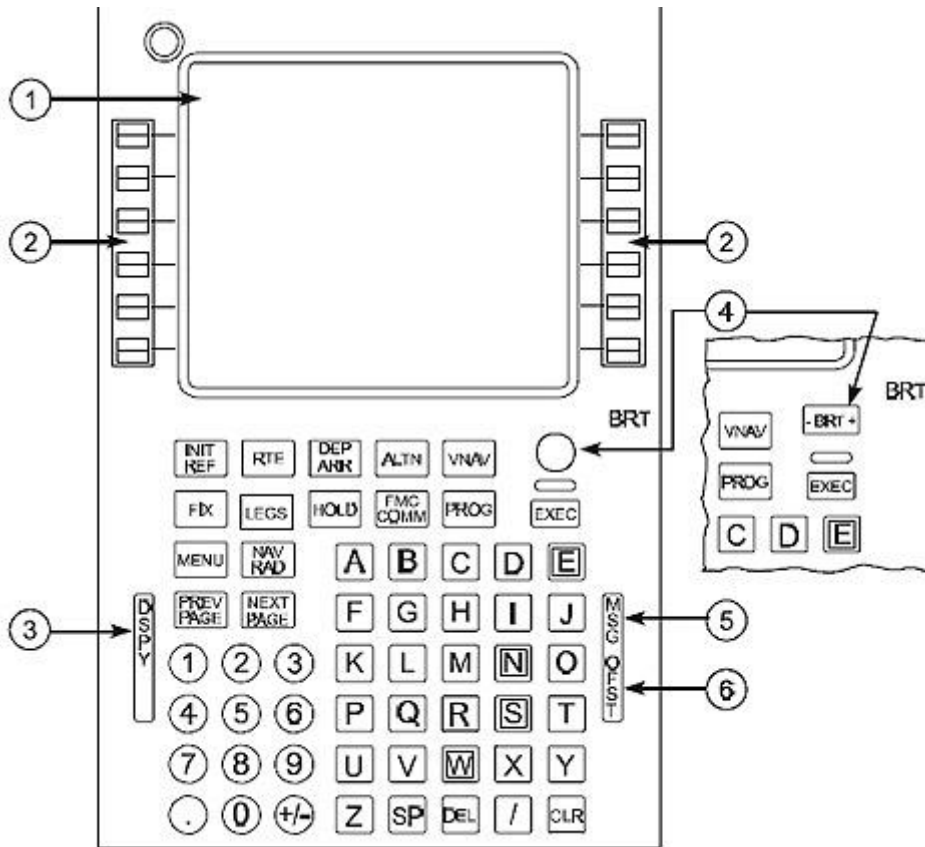
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CUSTOMER CARE

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 KeysPush

- 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.

Conventions –

- scratchpad must be blank for line select transfer
- data cannot be transferred to a blank line
- a blank scratchpad can not be transferred to a line
- not all data can be modified
- message displays if inappropriate entries attempted

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

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- when modification is in progress, and any RTE, RTE LEGS, RTE DATA, HOLD, or VNAV page is displayed.

4. Brightness Control

Rotate - controls display brightness.

On some aircraft:

Push –

- "+" increases brightness
- "-" decreases brightness
- 24 segment light brightness bar displays in the scratchpad and remains displayed for 2 seconds after release of the + or – push. Existing scratchpad information is saved and displays following fade of the brightness bar.

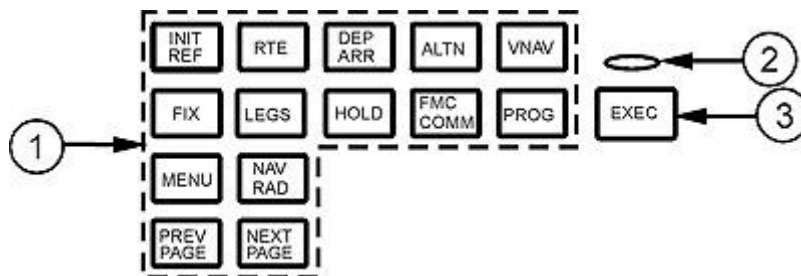
5. Message (MSG) Light

Illuminated (white) –

- scratchpad displays message
- pushing CLEAR key extinguishes light and clears message

6. Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset

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

Push-

- INT REF – shows page for data initialization or for reference data
 - RTE – shows page to input or change origin, destination, or route
 - DEP ARR – shows page to input or change departure and arrival procedures
 - ALTN – shows page to modify destination and route for alternate diversion
 - VNAV – shows page to view or change vertical navigation path data
 - FIX – shows page to create reference points on ND map
 - LEGS –
 - Shows page to evaluate or modify lateral and vertical route data
 - Show page to control ND PLAN mode display
 - HOLD – shows page to create holding patterns and show holding pattern data
 - FMC COMM – shows FMC data link status page
 - PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
 - MENU – shows page to choose subsystems controlled by CDU
 - NAV RAD – shows page to monitor or control navigation radio tuning
 - PREV PAGE – shows previous page of related pages (for example, LEGS pages)
 - NEXT PAGE – shows next page of related pages

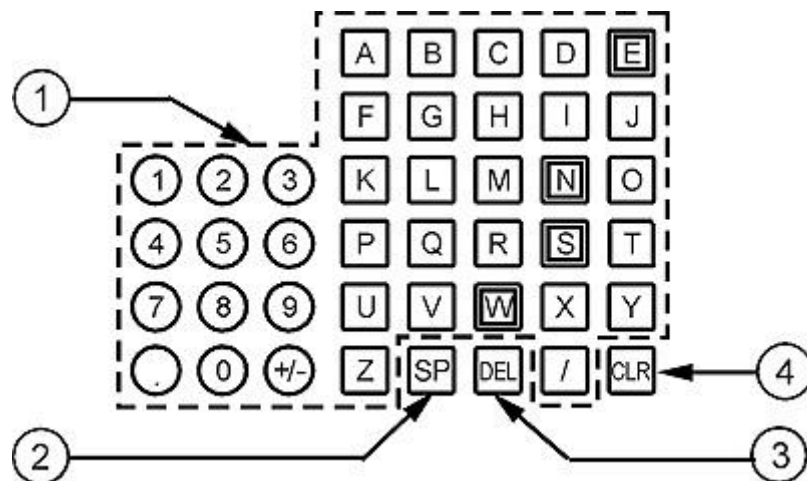
2. Execute Light

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

3. Execute (EXEC) Key

Push-

- makes data modifications) active
- extinguishes execute light.

ALPHA/NUMERIC AND MISCELLANEOUS 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. Space (SP) Key

Push –

- Puts space in scratchpad
- Puts underscore character "_" in scratchpad when CDU is used as input device for systems other than FMC

3. Delete (DEL) Key

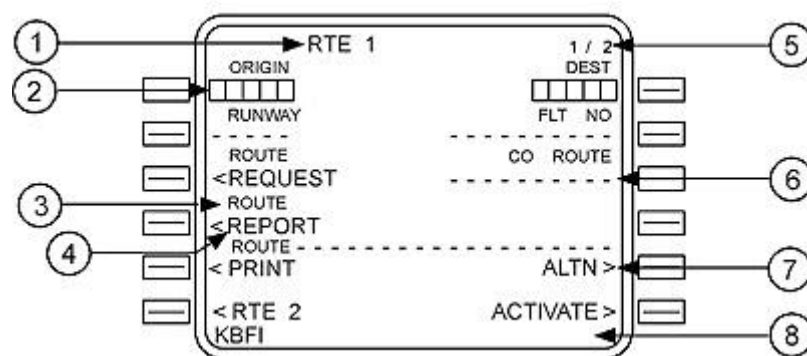
Push - puts "DELETE" in scratchpad.

4. Clear (CLR) Key

Push-

- clears last scratchpad character
- clears scratchpad message.

Push and hold - clears all scratchpad data.

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. Boxes

Data input is mandatory

3. Line Title

Title of data on line below.

4. Line

Shows –

- Prompts
- Selectors
- Data associated with line title.

Large font indicates crew entered or verified data. Small font indicates FMC computed data.

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. Dashes

Data input is optional. The data is not mandatory.

7. Prompts

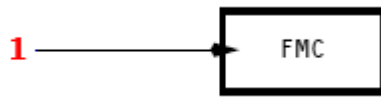
Caret "<" or ">" indicates a prompt.

Push - selects indicated information, mode, or page.

8. Scratchpad

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Displays messages, alphanumeric entries or line selected data.

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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 basis of the flight management system is the flight management computer function. Since the term FMC is universally understood, it is used here for standardization and simplification.

Under normal conditions, one FMC accomplishes the flight management tasks while the other FMC monitors. The second FMC is ready to replace the first FMC if system faults occur.

The FMC uses flight crew-entered flight plan data, airplane systems data, and data from the FMC navigation database to calculate airplane present position and 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 NDs. The EFIS control panels select the necessary data for the ND. 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 en route and terminal area navigation, RNAV approaches, and to supplement to primary navigation means when conducting other types of non-precision approaches.

CONTROL DISPLAY UNITS (CDUs)

The flight crew controls the FMC using three CDU's. The CDU's give alternate display, communications control, and navigation capability if there is a dual FMC failure.

The center CDU is a backup for the left or right CDU in case of a failure and automatically takes over functionality of the failed CDU. Only the left and right CDUs tune navigation radios when alternate navigation is active. Left and right CDUs provide backup to the left and right EFIS control panels, while the center CDU provides EFIS control panel backup for a failed left or right CDU. If the EFIS control panel or the display select panel fails, a manual selection of the CDU backup mode can be made on the MENU page.

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, the PRE-FLT label on the TAKEOFF REF page is no longer shown. The THRUST LIM prompt is shown at the next page line select key location.

TAKEOFF

The takeoff phase starts with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected. LNAV and VNAV can be armed before takeoff to engage at the applicable time

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

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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 the first waypoint of the procedure sequences or when the runway is the active waypoint and the distance to go is less than 25 NM.

FLIGHT COMPLETE

Thirty seconds after engine shutdown, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

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
- ADIRU failure.

The FMC will not sequence the active waypoint when: more than 21 nm off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO/FROM procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) are based on the first waypoint in the route. Some SIDs or STARS contain a heading vector leg. VECTORS waypoints show on the ND as a magenta line without an end point leading away from the airplane symbol. If LNAV is engaged, the DIRECT TO or INTERCEPT COURSE TO/FROM procedure can be used to start waypoint sequencing beyond the vectors leg.

When entering airways in a route page, the start and end waypoints must be in the database. A route segment must be entered as a DIRECT leg. If the engines remain operating between flights, entering a new cruise altitude before the next flight recalculates the proper vertical profile. If a climb to cruise altitude is necessary after completing a descent, a new cruise altitude entry must be made. Cruise altitude can be entered on the CLB page.

DIRECT TO courses are segments of a great circle route. When entering a DIRECT TO waypoint on the LEGS page, the course above the waypoint before execution is the arrival course at the waypoint. However, after execution, the course is the current course to fly to the waypoint. These courses may not be the same.

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

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- push the execute (EXEC) key.

Altitude constraint - a crossing restriction at a waypoint.

Delete - Remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

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 minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds. A low cost index may be used when fuel costs are high compared to operating costs.

Enter - Put data in the CDU scratchpad and then line select the data to the applicable location. New characters can be typed or existing data can be line selected into the scratchpad.

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

Execute - push Push the EXEC key to make modified data active.

Inactive - Data used to calculate LNAV or VNAV commands after the activate procedure is complete. This could be climb, cruise, descent, performance, or route data.

Initialize- Entering data required to make the system operational.

Message - Data the FMC automatically writes in the scratchpad to tell the flight crew of a system condition.

Modify - Active data that is changed but not yet executed. When a modification is made to the active route or performance mode, MOD is shown in the page title, ERASE shows next to line select key 6 left, and the execute 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.

Purge - Select the PURGE prompt to remove all airports uplinked to the ALTN LIST. (Not operational on CAL aircraft.)

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. It can be a fixed point; such as, a latitude and longitude, VOR or ADF station, airway intersection, or a conditional waypoint. 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 4000 feet."

LATERAL NAVIGATION (LNAV)

LNAV provides steering commands to the next waypoint or the selected route intercept point. When armed on takeoff, LNAV engages at or above 50 feet, 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 database is entered into the active route, the FMC can supply commands to fly a constant heading, track, or follow a DME arc, as required by the procedure.

WAYPOINTS

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

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The CDU message NOT IN DATABASE is shown if a manually entered waypoint identifier is not kept in the database. The waypoint can still be entered as a latitude/longitude, place/bearing/distance or 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 NAMES

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 POINT WAYPOINT NAMES

Unnamed turn points, intersections and DME fixes - 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) lowaltitude 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

Unnamed Flight Information Region (FIR), Upper Flight Information Region (UIR), and controlled airspace reporting points - Waypoints located at unnamed FIR, UIR, and controlled airspace reporting points are identified by the three letter airspace type identification followed by a two digit sequence number. Example:

- FRA01

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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
- N75°W170° becomes 75N70
- N50° E020° becomes 5020E
- N06° E110° becomes 06E10
- S52° W075° becomes 5275W
- S07° W120° becomes 07W20
- S50° E020° becomes 5020S
- 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
- CPR190°/29 = CP29B

DME step down fixes are identified by the distance and a "D." Examples: 138D, 106D, 56D, 3D.

PROCEDURE FIX WAYPOINT NAMES

Marker beacons -a marker beacon is identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21.

Runway – related - fixes - waypoints located at unnamed runway related fixes are identified by adding a two-letter prefix to the runway number. The following list is used to determine the applicable prefix:

- | | |
|----------------------------------|--------------------------------------------|
| • RX - Runway Extension Fix | • IM - Inner Marker |
| • FA - VFR Final Approach Fix | • BM - Back Course Marker |
| • CF - Final Approach Course Fix | • MD - Minimum Descent Altitude |
| • FF - Final Approach Fix | • A - (+ An Alpha) Step Down Fix |
| • IF - Initial Approach Fix | • RW - Runway Threshold |
| • OM - Outer Marker | • MA - Missed Approach point other than RW |
| • MM - Middle Marker | • TD - Touchdown Point Inboard of RW. |

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two-letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

- | | |
|---------------------------------------|------------------------------|
| • C() - Final approach course fix | • ()I - ILS |
| • F() - Final approach fix | • ()L - Localizer only |
| • P() - Missed approach point | • ()B - Backcourse ILS |
| • I() - Initial approach fix | • ()D - VOR/DME |
| • D() - Minimum descent altitude | • ()V - VOR only |
| • T() - Touch down point | • ()S - VOR with DME points |
| • R() - Runway centerline intercept. | • ()N - NDB |

DO NOT USE FOR FLIGHT

- ()Q - NDB with DME points
- ()M - MLS

- ()T - Tacan
- ()R - RNAV

Examples: CI32R, PV15, FN24L.

Unnamed turn points - 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 - Airport reference points are identified by the ICAO identifier.

DUPLICATE WAYPOINT NAMES

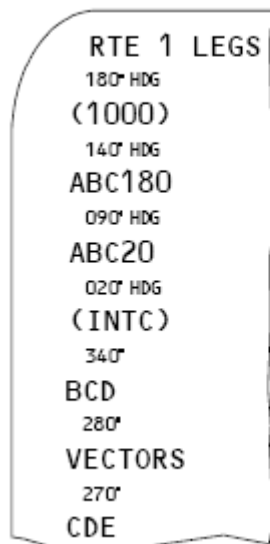
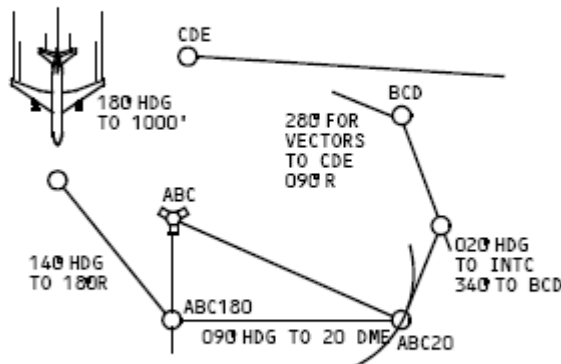
Duplicate identifiers - Application of the abbreviation rules creates identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude and longitude of waypoints with the same identifier and the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

CONDITIONAL WAYPOINT NAMES

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.

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:

DO NOT USE FOR FLIGHT

- 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.

VERTICAL NAVIGATION (VNAV)

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

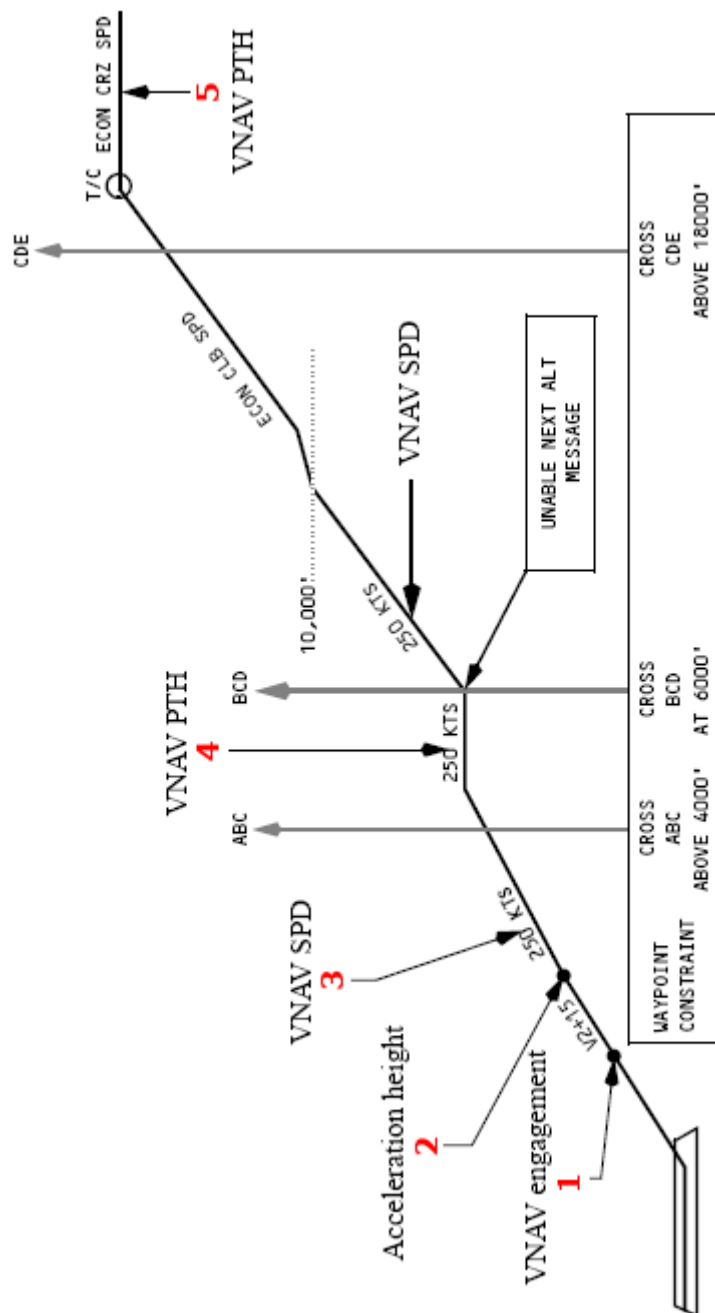
SPEED/ALTITUDE CONSTRAINTS

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. Barometric altitude constraints must be below the cruise altitude to be valid. 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 shown in small font.

A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or airspeed/altitude constraints.

Modified waypoint constraints are shaded white until they are executed. 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**

If armed for takeoff, VNAV engages at 400 feet and pitch guidance continues to maintain the target airspeed until the thrust reference mode changes.

During takeoff, the FMC updates the target airspeed to the current airspeed until VNAV activates. The target airspeed is between $V_2 + 15$ and $V_2 + 25$ knots.

2. Acceleration Height

At the acceleration height, flap retraction, or AFDS altitude capture before acceleration height, VNAV commands an airspeed increase to the greater of 250 knots, VREF + 80 knots, or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the thrust reference mode to the selected climb thrust at the thrust reduction point.

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.

If the climb speed profile cannot achieve an altitude constraint, the UNABLE NEXT ALT scratchpad message is shown.

If the FMC predicts the aircraft will not reach an altitude constraint, the FMS-CDU message UNABLE NEXT ALTITUDE displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the THRUST LIMIT page.

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 is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

CRUISE

During cruise, the FMC commands economy cruise speed or the pilot entered speed until reaching the top-of-descent (T/D) point. Other cruise speed options are:

- Long range (LRC)
- Engine out (ENG OUT)
- Flight crew entered speed
- Flight crew entered constant Mach between two or more waypoints
- Required time of arrival (RTA).

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

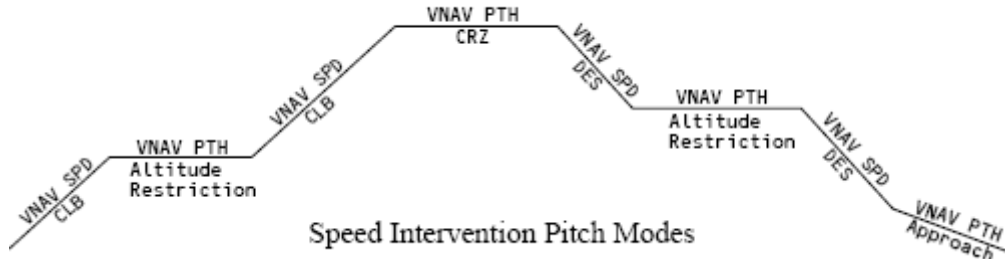
STEP CLIMB

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 shown on the CRZ page. If a step size of zero is entered, the FMC assumes a constant altitude cruise.

DO NOT USE FOR FLIGHT

Flight crew entry of a planned step altitude on the CRZ or RTE LEGS page overrides the FMC step climb predictions before that point. Entry of a planned step altitude on the RTE LEGS page overrides a "Step To" entry made on the CRZ page.

Predicted step altitudes are shown on the RTE LEGS page. The distance and ETA to the next step point (predicted or flight crew entered) are shown on the CRZ and PROGRESS pages. They are also shown on the ND map display with a green circle and S/C label.

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 the VNAV pitch flight mode annunciation for each phase of flight when using speed intervention.

In a VNAV descent after the T/D, VNAV PTH changes to VNAV SPD during speed intervention. In all other phases, the pitch mode does not change with speed intervention. Pitch controls speed in VNAV SPD mode, and during the VNAV PTH descent prior to speed intervention. Otherwise, thrust controls speed in VNAV PTH mode.

During a VNAV, non-precision approach while using speed intervention, the pitch mode is VNAV PTH. The vertical path is maintained regardless of IAS MACH selector changes.

VNAV changes to approach phase when:

- passing the first waypoint of an FMS approach (ILS, VOR, ect.), or
- the landing runway is the active waypoint and the direct distance to the runway is 25 NM or less.

If a "direct to" is executed to a waypoint in the approach, VNAV transitions to the approach phase when the airplane passes the "direct to" waypoint. If a waypoint located after the first waypoint of an FMC database approach is added and executed, VNAV will not transition to approach phase when passing the first waypoint of the approach.

DESCENT

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point. Dashed display on the LEGS page for speed and altitude descent waypoints. When an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan, the FMC creates an E/D. The E/D is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point, which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D is also created when an altitude constraint is entered on the LEGS page on a downstream waypoint.

The top of descent (T/D) is the point where the cruise phase changes to the descent phase. It displays on the ND as a green circle with the label T/D. The descent path starts at the T/D and includes waypoint altitude constraints. The path to the first constraint is based on:

- Idle thrust
- Speedbrakes retracted
- FMC cruise wind
- Wind entries on the DESCENT FORECAST page
- Predicted use of anti-ice

DO NOT USE FOR FLIGHT

- Applicable target speed.

The descent may be planned at economy Mach/CAS (based on Cost Index) or a manually entered Mach/CAS. VNAV will not command an economy target speed greater than 314 knots (VMO/MMO minus 16 knots) or a pilot entered speed greater than 319 knots (VMO/MMO minus 11 knots).

The FMC creates the descent path with a deceleration at the speed transition altitude (typically 250 knots below 10,000 feet). VNAV plans a speed target 10 knots below the transition speed to allow for unknown tailwinds. 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.

Descent path segments after the first altitude constraint waypoint are constructed as straight line point-to-point segments. The autothrottle provides thrust as required to maintain the path.

If flight plan modifications or unknown winds occur when above the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

- With greater than 15 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 5 knots above the greater of best holding speed or minimum maneuvering speed, and the scratchpad message THRUST REQUIRED displays again.

- With greater than 314 knots (VMO/MMO minus 16 knots), the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 319 knots (VMO/MMO minus 11 knots) to maintain the path. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 314 knots (VMO/MMO minus 16 knots), and the scratchpad message DRAG REQUIRED displays again.

If flight plan modifications or unknown winds occur when below the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

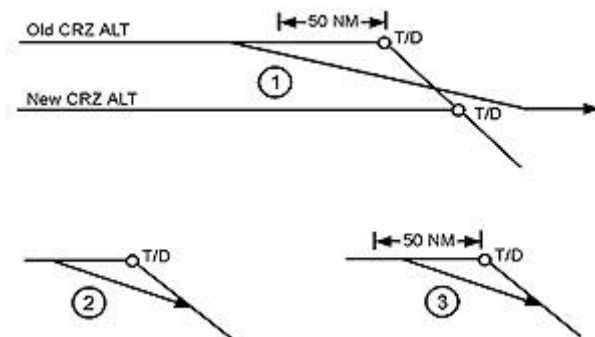
- With greater than 10 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 10 knots less than the target speed (not less than minimum maneuvering speed), and the scratchpad message THRUST REQUIRED displays again.

With greater than 10 knots above target speed, the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 15 knots above target speed to maintain the path. The maximum speed excursion allowed is 5 knots above the transition speed after the airplane is below transition altitude for the destination airport or 5 knots below the flaps placard speed if flaps are extended. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path to stop the acceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 250 knots, and the scratchpad message DRAG REQUIRED displays again.

EARLY DESCENT

An early descent in VNAV is any descent initiated prior to reaching the top of descent point (T/D). VNAV commands the descent at a reduced descent rate until the idle descent path is intercepted.

There are two types of early descents, a "Cruise Descent" and a "Descend Now." In either early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.

DO NOT USE FOR FLIGHT

1. Cruise Descent

Use the MCP altitude selector to start a cruise descent. If the distance from T/D is more than 50 NM the FMC creates a new cruise altitude, with an associated new T/D, and VNAV begins a descent to the new cruise altitude. The pitch mode annunciation is VNAV SPD during descent and VNAV PTH at the new cruise altitude. Depending upon proximity to T/D, VNAV may not capture the idle descent path since the target airspeed is economy cruise and the descent path is based on idle thrust and economy descent airspeed. In example < VNAV levels at the new cruise altitude beyond the T/D, and the pitch mode annunciation is VNAV ALT.

2. Descend Now

Use the DES NOW prompt on the VNAV DES page to start a Descend Now. The original path and T/D are not changed, and VNAV starts a descent (VNAV SPD) and captures the MCP altitude (VNAV ALT) or the idle descent path (VNAV PTH), whichever is encountered first. The DES NOW function is also initiated whenever the MCP altitude selector is used to initiate a descent within 50 NM of the T/D (Example 3).

APPROACH

The FMC transitions to "on approach" under the following conditions:

- The aircraft is in the descent phase and flaps are out of UP, or
- A VFR approach is created and,
- The aircraft has sequenced the FAXXX, or
- The aircraft is enroute to a direct-to or intercept-to the RWYYY waypoint and the aircraft is within 25 NM of the runway threshold, or
- The aircraft is enroute to a direct-to or intercept-to waypoint (DIRECT displays at 1L on RTE Page) in the descent profile and the aircraft is within 25 NM of the destination airport.
- A published instrument approach has been selected and incorporated in the active flight plan and,
- The aircraft has sequenced the first waypoint on the published approach, or
- The aircraft is enroute to a direct-to or intercept-to waypoint (DIRECT displays at 1L on RTE page) and the aircraft is within 12 NM of the runway threshold, or
- The aircraft is enroute to a direct-to or intercept-to waypoint (DIRECT displays at 1L on RTE page) that is the last waypoint in the approach (runway or missed approach point) and the aircraft is within 25 NM of the destination airport.

The FMC transitions out of "on approach" under the following conditions:

- The pilot selects TOGA.
- The aircraft lands.
- The aircraft flies beyond the last waypoint in the approach (missed approach waypoint or runway) and the VNAV page title changes from "ACT xxxxx DES" to "ACT END OF DES."

When the FMC is "on approach," the following features are available:

- The IAS/MACH window can be opened and the command speed can be set while VNAV remains in VNAV PTH descent; VNAV commands the set speed.
- The MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current airplane altitude, VNAV continues to command a descent.
- VNAV remains in VNAV PTH and follows the descent path unless the airplane accelerates to within 5 knots of the current flap placard and the airplane rises more than 150 feet above the path. In this case, VNAV PTH changes to VNAV SPD.
- If an approach angle is specified for one or more legs on the approach, the angle displays on the LEGS page and VNAV provides VNAV PTH guidance at the displayed angle. When sequencing a waypoint prior to a descent leg specified by a descent angle, VNAV commands level flight until the aircraft intercepts the descent angle path.

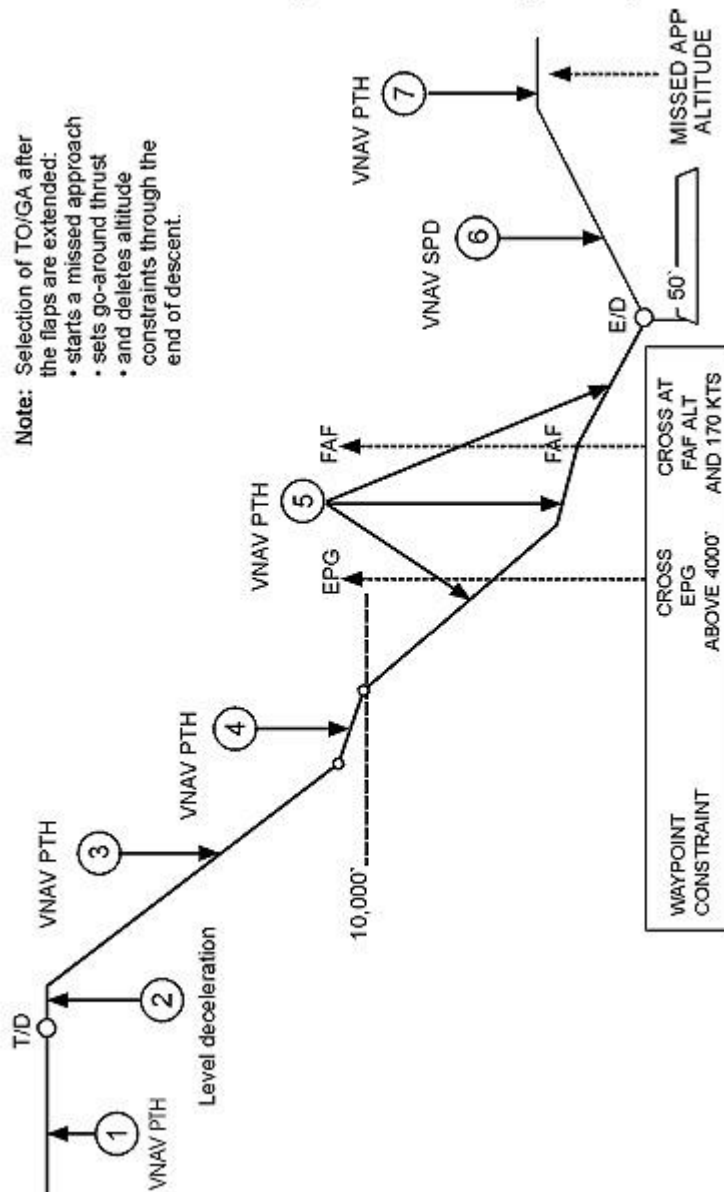
Note: Display of a specified flight path angle is not limited to approaches. A flight path angle may be defined for a leg in a STAR and displays on the LEGS page for the procedure.

A side step to another approach can be accomplished by selection of the new approach on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the INTC CRS TO line on the LEGS page or by selecting the XXXXX INTC> prompt on the ARRIVALS page.

MISSED APPROACH

A missed approach is accomplished by selection of either TOGA switch. The following features are available:

- VNAV (and LNAV) can only be activated when the airplane climbs above 400 feet radio altitude.
- All descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan.
- The highest altitude in the missed approach procedure becomes the new cruise altitude.
- The FMC transitions from active descent to active climb. This transition also occurs when the aircraft climbs toward the MCP altitude and flaps are retracted from a landing position (25 or 30 towards 20, or 20 towards 5). For example, when a missed approach is accomplished without pushing the TOGA switch.
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected.
- When cruise phase is active, the speed target is the most restrictive of 250 knots (below speed transition altitude), best hold speed, or ECON cruise (above speed transition altitude).

DO NOT USE FOR FLIGHT**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

DO NOT USE FOR FLIGHT

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

4. Descent Deceleration Phase

Before the speed restriction altitude, the FMC commands the target descent airspeed. The pitch mode remains VNAV PTH and the descent rate approximates 500 feet per minute

5. Descent and Approach

When at target speed, VNAV commands a descent and starts approach in VNAV PTH at commanded speed.

6. Missed Approach

When selected during missed approach, VNAV engages in VNAV SPD.

7. Missed Approach Level Off

At missed approach altitude VNAV SPD changes to VNAV PTH.

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.

AIRSPEED 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 three databases:

- Performance database
- Navigation database
- Airline Modifiable Information (AMI).

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 crew can enter correction factors for drag and fuel flow to refine the database.

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.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the usual navigation chart revision cycle. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the active data.

The AMI file contains airline specified data. If the FMC senses a conflict in an AMI value after a new AMI data load, the scratchpad shows the message CHECK AIRLINE POLICY.

THRUST MANAGEMENT

The autothrottle is controlled by the thrust management function. The thrust management function operates the autothrottle in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the THRUST LIM page. Automatic FMC autothrottle commands are made while VNAV is engaged. Thrust management:

- Calculates reference thrust limits and thrust settings, or follows FMC thrust settings
- Commands the thrust levers
- Senses and transmits autothrottle failures
- Commands thrust equalization through the engine electronic controls.
- Thrust limits are expressed as N1 limits. Thrust equalization references N1.
- Thrust management calculates a reference thrust for the following thrust settings:
 - TO - Takeoff
 - D-TO - Assumed temperature takeoff
 - CLB - Climb
 - CLB 1 - Climb one
 - CLB 2 - Climb two
 - CRZ - Cruise
 - CON - Continuous
 - G/A - Go-around.

With VNAV active, the reference thrust limit changes for the phase of flight. Thrust settings can be selected on the THRUST LIM page. The reference thrust limit displays above EICAS N1 indications.

The flight crew can specify the thrust reduction height where the change from takeoff to climb thrust takes place by making an entry on the CDU TAKEOFF REF page. This can be an altitude from 400 feet to 9,999 feet, an entry of 1 for Flaps 1, or an entry of 5 for flaps 5.

DO NOT USE FOR FLIGHT

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.

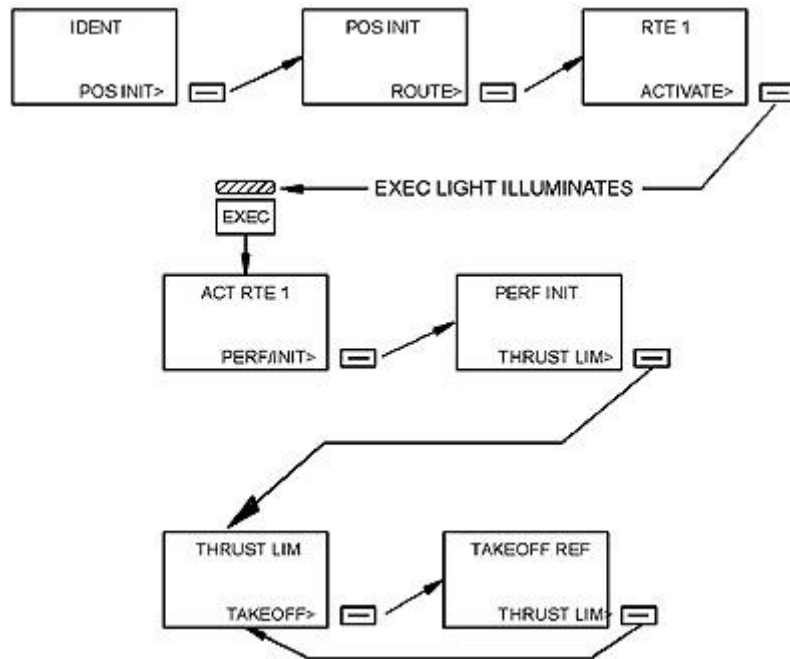
Data link can be used to load preflight data from airline ground stations. Using data link reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

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 of the CDU page automatically directs the flight crew through the minimum requirements for preflight completion. Select the PROMPT key to show 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 that is 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 entry of airplane weights, fuel reserves, cost index and cruise altitude.

Takeoff data requires a flap setting and center of gravity.

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.

Waypoints, navigation, airport, and runway data is referenced on the REF NAV DATA page.

Fixed takeoff thrust derates can be changed on the AIRLINE POLICY page.

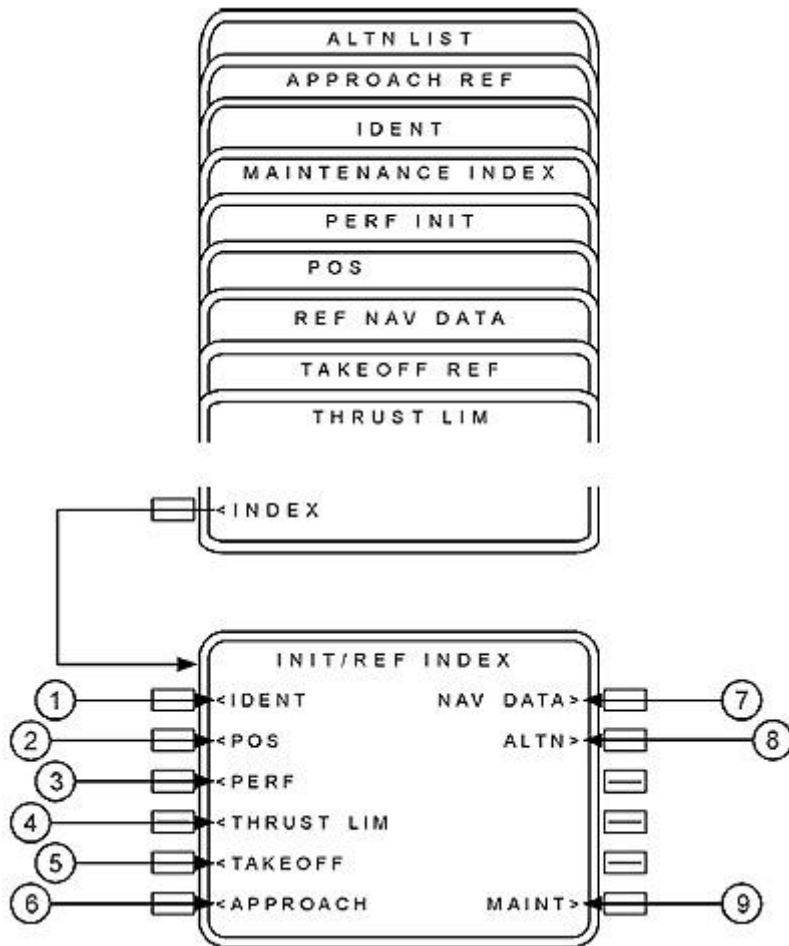
VNAV performance is improved if the forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints are entered on the WIND page.

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 FMC pages. It gives access to pages used during preflight and not usually used in flight.

**1. Identification (IDENT)**

The IDENT page is used to verify basic airplane data and currency of the navigation database.

2. Position (POS)

The POS INIT page is used for ADIRU initialization. The POS INIT page is also used for initialization of SAARU heading in the event the ADIRU fails.

3. Performance (PERF)

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

DO NOT USE FOR FLIGHT**4. Thrust Limit (THRUST LIM)**

The THRUST LIM page is used to select thrust limits and derates.

5. TAKEOFF

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

6. APPROACH

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

7. NAV DATA

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

8. Alternate (ALTN)

The ALTN page is used for alternate airport planning and diversions.

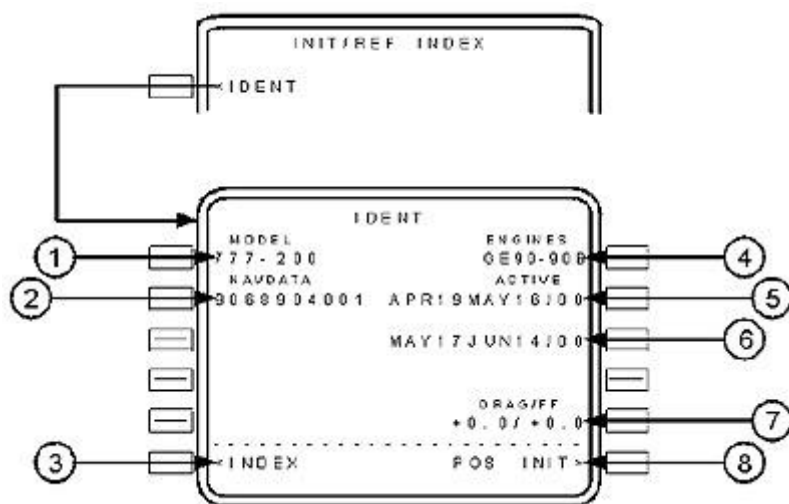
9. Maintenance (MAINT)

For maintenance use only; shows maintenance pages.

IDENTIFICATION PAGE

Most of the data on this page is for flight crew verification. Active date and drag / fuel flow accept manual entries.

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

**1. MODEL**

Shows the aircraft model.

2. Navigation (NAV) DATA

Displays the navigation database identifier.

3. INDEX

Push - displays the INIT/REF INDEX page.

4. ENGINES

Shows the engine model and thrust rating. Header displays INTERMIX RATING for engine intermix installations.

5. ACTIVE

Shows the effective date range for the active navigation database.

The active navigation database may be out of date. It can be changed to the inactive navigation database. Push the date range prompt of the inactive navigation database to copy that date into the scratchpad. Push the date range prompt of the active navigation database to transfer the scratchpad date up to the ACTIVE database line. The previous active date moves down to the inactive date line.

The line title ACTIVE is above the active navigation database date. No line title is above the inactive navigation database date. The navigation database date can be changed only on the ground. Changing the navigation database removes all previously entered route data. When an active database expires in flight, the expired database continues to be used until the active date is changed after landing.

6. Inactive Date Range

Shows the affectivity date range for the inactive navigation database.

7. DRAG/Fuel Flow (FF)

Displays the airplane drag and fuel flow correction factors. Valid data range from -5.0 to +9.9.

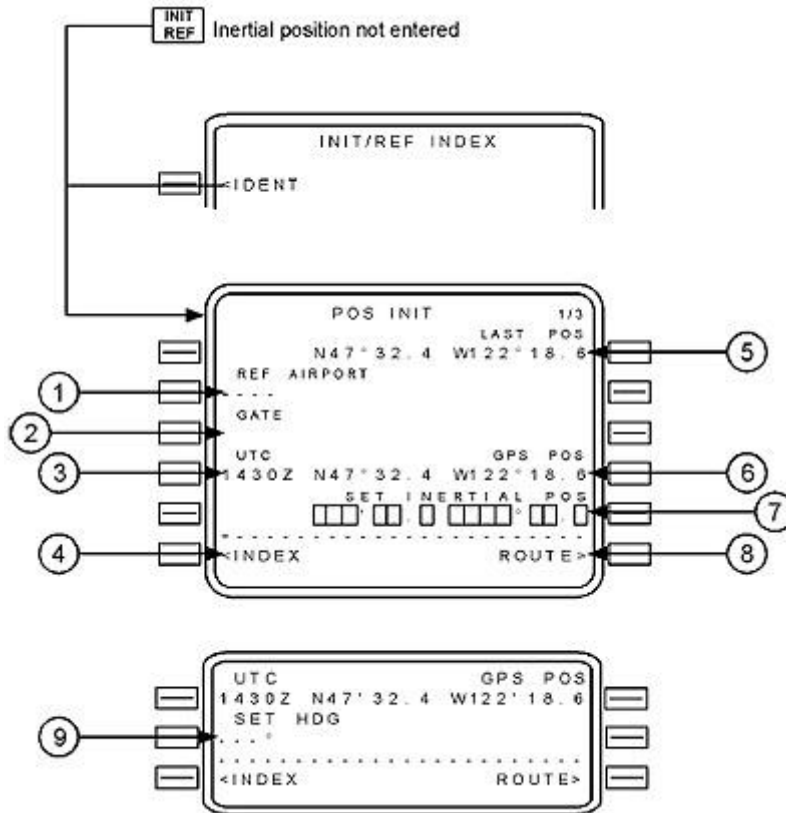
8. Position Initialization (POS INIT)

Push - displays the POS INIT page.

POSITION INITIALIZATION PAGE 1/3

The position initialization page allows airplane present position entry for ADIRU alignment. The same page is used to enter the heading for SAARU initialization when the ADIRU is inoperative. There are three POS pages.

Data on the first page is used to initialize the ADIRU. In the event the ADIRU becomes inoperative in flight, initialization of the SAARU heading is accomplished on this page.

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

The reference airport entry allows entry of the departure airport to show the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Removes previous GATE entry.

Entry blanks at lift-off.

2. GATE

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

Optional entry after the reference airport is entered.

Valid entry is a gate number at the reference airport.

DO NOT USE FOR FLIGHT

Shows the latitude and longitude of the reference airport gate from the navigation database.

Changes to dashes when a new reference airport is entered.

Entry blanks at lift-off.

3. Coordinated Universal Time (UTC)

UTC (GPS) – Displays time from GPS.

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 Inertial Position (SET INERTIAL 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 ADIRU.

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

If an entered position fails the ADIRU internal check, the scratchpad shows the message ENTER INERTIAL POSITION. If the manually entered position fails the ADIRU check after the position is entered a second time, the scratchpad message ALIGNMENT REINITIATED is shown.

The entered position is also compared with the FMC original airport position. If the entered position is not within 6 NM of the FMC original airport position, the scratchpad shows the message INERTIAL/ORIGIN DISAGREE.

Dashes are shown when the ADIRU is in the automatic realignment mode and can receive a new position update. Enter the most accurate inertial position to remove any accumulated ADIRU position errors.

Enter airplane position latitude and longitude.

Boxes are shown within one minute of ADIRU power-up. Blanks when the ADIRU changes from the alignment to the navigation mode.

Blanks when the airplane is moving or has not been stationary for a minimum of six minutes.

Dashes are shown when the ADIRU enters the automatic realignment mode on the ground. New inertial position entries can be made after dashes are shown during ADIRU automatic realignment. New entries are shown for 2 seconds. After 2 seconds, dashes are shown to allow entry of another position.

8. ROUTE

Push - displays the ROUTE page.

9. SET HDG

DO NOT USE FOR FLIGHT

Dashes display in flight when ADIRU is inoperative.

Entry of magnetic heading initializes SAARU.

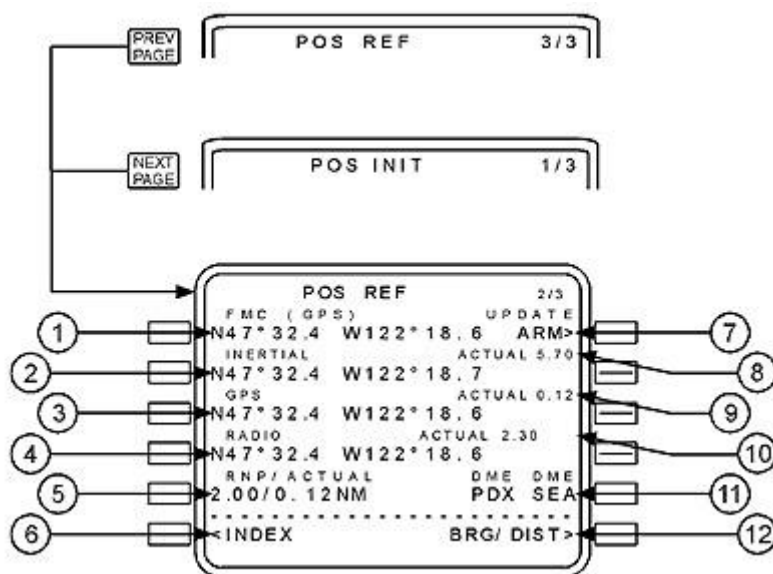
Valid entry is 0 to 360 (0 or 360 displays as 360°). Entered heading displays in large font for two seconds, followed by dashes.

POSITION REFERENCE PAGES

POSITION REFERENCE PAGE 2/3

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

This page shows latitude/longitude or bearing/distance. All position displays are in actual latitude and longitude, as calculated by the related system. The ADIRU, GPS, and radio position data can be changed to bearing/distance.



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 GPS 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
- INERTIAL - position calculated from ADIRU position data
- RADIO — position calculated from navigation radio position data

2. IRS

Shows the latitude/longitude position as determined by the ADIRU.

3. GPS

Shows the latitude/longitude position as determined by the GPS.

4. RADIO

After airborne, displays latitude/longitude position as determined by navigation radios.

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

Displays RNP values stored in the navigation database for departure and arrival procedures; or, if there are none, displays the default values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Displays RNP values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Default RNP is in small font.

Valid RNP entries are in the range 0.01 to 99.9. ACTUAL entry not allowed.

When ACTUAL exceeds RNP, the EICAS message NAV UNABLE RNP displays.

Note: The FMC stops GPS updating if GPS data accuracy degrades due to satellite availability or unfavorable geometry, or if the flight crew inputs a small RNP value. Subsequently, the FMC receives updates from another system.

6. INDEX

Push - displays the INIT/REF INDEX page.

7. UPDATE ARM

Push -

- Arms the FMC position update function
- Changes the prompt to ARMED
- Adds NOW prompts to right side of INERTIAL, GPS, and RADIO lines.

Push a NOW prompt key to update FMC position to the selected source.

8. ACTUAL-INERTIAL

Displays actual navigation performance (ANP) of the ADIRU.

9. ACTUAL – GPS

Shows the actual navigation performance of the GPS.

10. ACTUAL – RADIO

Shows the actual navigation performance of radio updating.

11. Radio Update Station(s)/Mode

Displays radio station identifiers.

Position update mode is indicated in the line title:

- DME DME

DO NOT USE FOR FLIGHT

- VOR DME

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

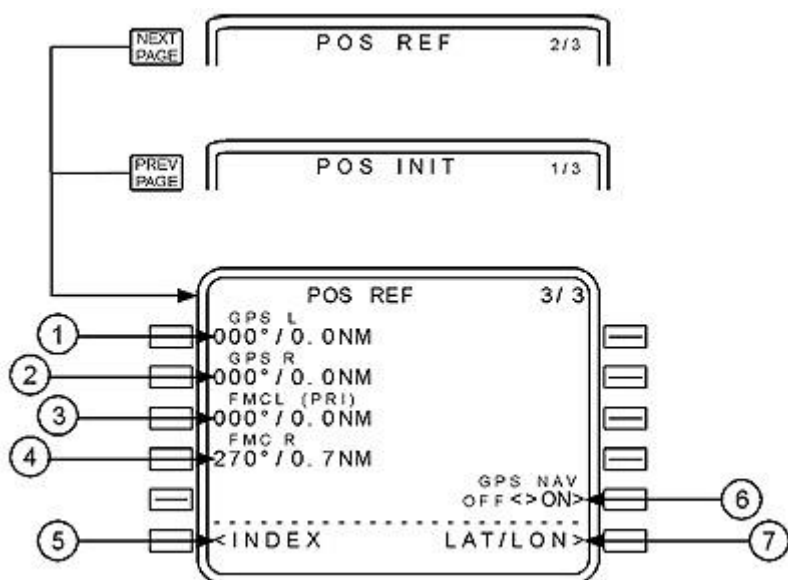
Push - alternates position data format between bearing/distance or latitude/longitude.

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 be shown in the bearing/distance or latitude/longitude format. The bearing/distance format shows the bearing and distance of the position sources relative to the active FMC position on the POS REF 2/3 page. In the example, both the left and right GPS agree with the left FMC position.



1. GPS L

Shows the left GPS position.

2. GPS R

Shows the right GPS position.

3. FMC L

Displays the left FMC calculated position.

Primary (PRI) is shown when the left FMC is active and the right FMC is inactive.

4. FMC R

DO NOT USE FOR FLIGHT

Shows the right FMC calculated position.

PRI is shown when the right FMC is active and the left FMC is inactive.

5. INDEX

Push - displays the INIT/REF INDEX page.

4. GPS NAV

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

OFF - GPS position data is not available to the FMC. OFF is shown in large green letters and ON is shown in small white letters..

ON - GPS position data is available to the FMC. ON is shown in large green letters and OFF shown is in small white letters.

Note: When power is initially applied to the airplane or when engines are shut down, GPS NAV is set to ON.

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

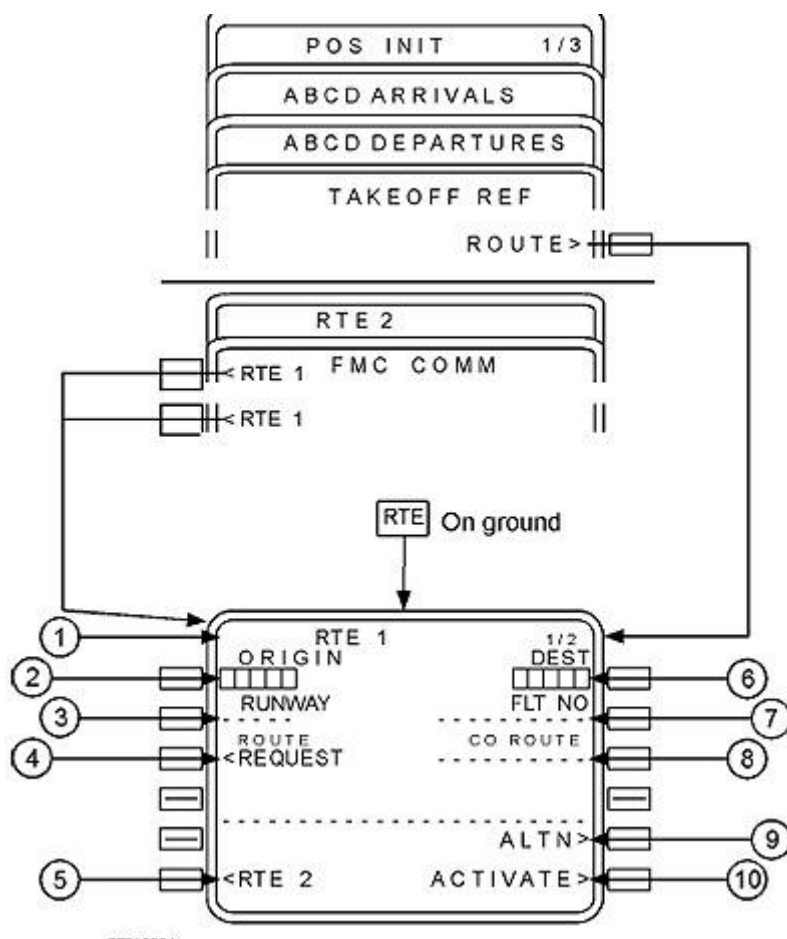
Push - Alternately changes the display of position data on POS REF 2/3 and 3/3 to latitude/longitude format or bearing/distance format.

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

ROUTE PAGE

Two routes (RTE 1 and RTE 2) can be shown in air traffic control format. Routes can be entered by the flight crew or uplinked through data link. All routes have two or more pages. The first route page shows origin and destination data. Subsequent route pages show the route segments between waypoints or fixes. ROUTE 1 and ROUTE 2 allow management of alternate or future routes while leaving the active route unmodified. ROUTE 2 has an identical page structure as ROUTE 1. When RTE 2 is active, page display logic is the same as RTE 1.

ROUTE PAGE 1/X

DO NOT USE FOR FLIGHT

1. Page Title

White when the route is active.

Cyan when the route is inactive.

The white shaded word MOD is put to the left of the page title 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
- shows MOD in page title of an active route.
- entry on the ground deletes route; in flight, entries are valid on the inactive route.

3. RUNWAY

DO NOT USE FOR FLIGHT

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

New entries on an active route cause MOD to show in the route title.

Automatically entered when part of a company route.

Can be selected on the DEPARTURES page.

FMC deletes runway after the first waypoint is crossed.

4. Route Request

Push - Transmits a data link request for a flight plan route uplink.

Flight crew can operationally fill in origin, destination, runway, flight number, company route name, or route definition to qualify request.

5. 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.

Prompt changes to RTE 1 when RTE 2 is displayed.

6. Destination (DEST)

Entry:

- must be a valid ICAO identifier in the navigation database
- made automatically when a company route is entered
- Enables selection of departure and arrival procedures.

7. Flight Number (FLT NO)

Enter the company flight number.

Entry is optional for activation of the route.

Limited to 10 characters.

Flight crew entered or uplinked.

Flight number is included in the PROGRESS page title.

Flight number can be entered on multifunction COMM display ATC LOGON page.

9. Alternate (ALTN)

Push - Shows the ALTN page.

10. ACTIVATE

Push the ACTIVATE key to arm the route for execution as the active route.

When the EXECUTE key is pushed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

DO NOT USE FOR FLIGHT

Push - Prepares the selected route for execution as the active route.

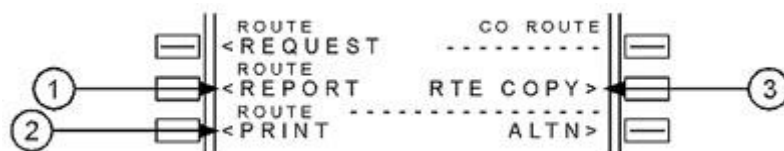
Activation of a route is required for completion of the preflight.

Shown on 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 REPORT

Push - Transmits the active route to the company via data link downlink.

2. ROUTE PRINT

Push - Sends the active route to the flight deck printer.

3. Route Copy (RTE COPY)

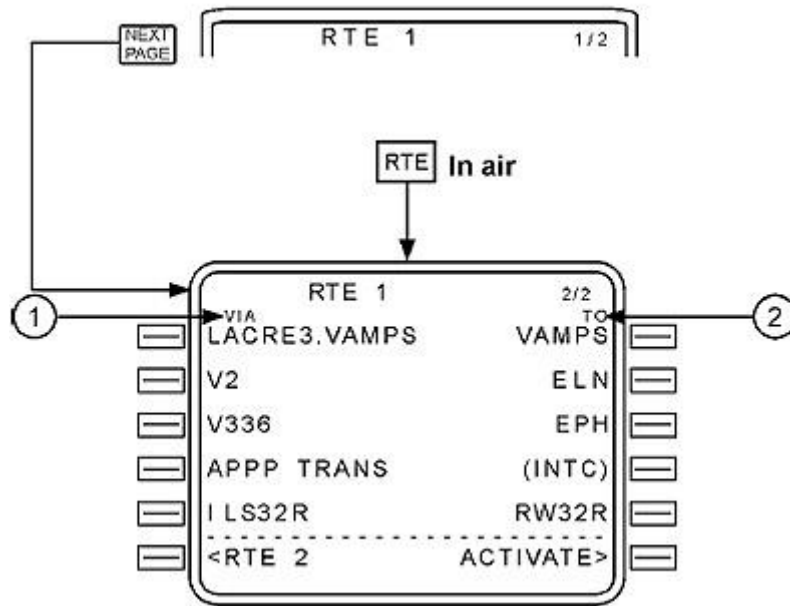
Push - Copies the entire active route (RTE x) into the inactive route (RTE y).

Shown only on the active route page.

Shows 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, nav aids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.

DO NOT USE FOR FLIGHT

1. VIA

The VIA column shows the route segment to the waypoint or termination shown in the TO column. Enter the path that describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and boxes are shown in the TO column.

Valid entries can also include procedures or DIRECT. Procedures are usually entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is usually entered as a result of entering a TO waypoint first.

Valid airways must:

- Contain the fix entered in the TO waypoint, and
- 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 shown for the first VIA beyond the end of the route.

Invalid VIA entries show the scratchpad entry INVALID ENTRY.

Invalid VIA entries are:

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

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

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

- Replaces the airway with dashes in the first line VIA.
- Shows boxes in the first line TO waypoint.
- Moves the airway to line 2 after the TO waypoint is entered.
- Enters the first fix on the airway nearest to being abeam of the departure heading in the airway line TO waypoint.

DO NOT USE FOR FLIGHT

A route can contain segments formed by the intersection of two airways.

Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one segment to the next. The FMC created waypoint intersection (INTC) is automatically shown in the first airway segment TO waypoint.

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.

Data input is mandatory when boxes are shown.

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.

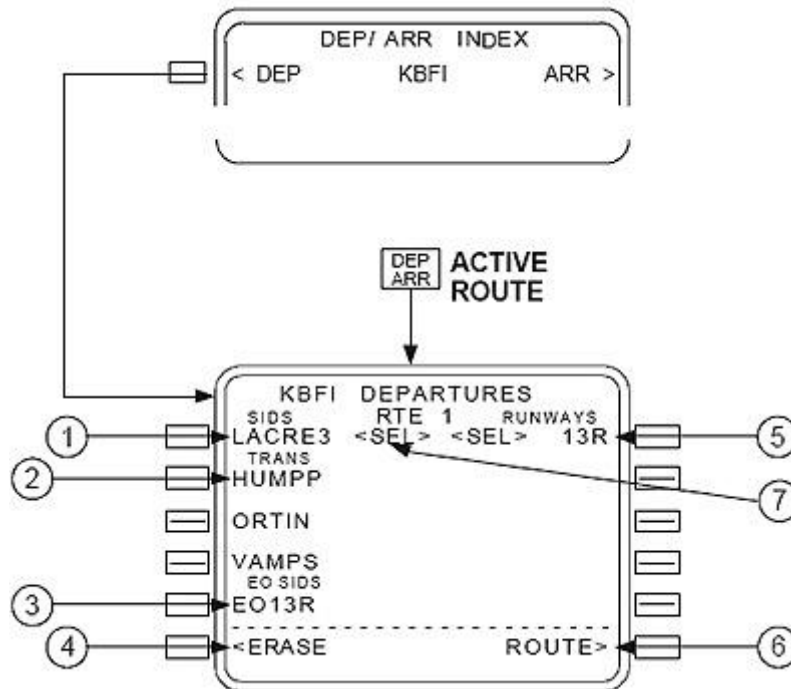
Dashes are shown on the first TO waypoint after the end of the route.

PREFLIGHT PAGES - PART 2

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.

Without the selection of a runway on the RTE 1/X page, the initial display contains all of the data for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are shown after a SID is selected.

2. Transitions (TRANS)

Displays transitions compatible with the selected SID.

Push-

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

3. Engine Out (EO) SIDS

Displays airline-defined single engine-out SIDS for selected airport. EO SID can be viewed before takeoff by line selecting and selecting the LEGS page. EO SID automatically selected during takeoff if an engine-out detected prior to "flaps up." The modification can be either executed or erased. If an EO SID does not exit, NONE displays.

Push – Displays EO SID as the selected SID.

4. ERASE or INDEX

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

ERASE push - Removes route modifications that are not executed and shows the original route.

INDEX push - displays the DEP/ARR INDEX page.

5. RUNWAYS

Displays a list of runways for the selected airport.

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

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.

6. ROUTE

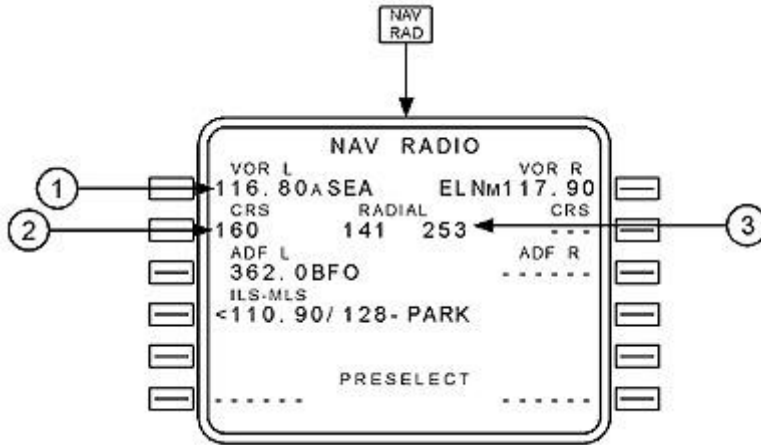
Push - displays the related RTE page.

7. Selecting Options

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.

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

VOR and ILS navigation radio tuning is normally automatic. ADF radios are manually tuned. The CDU NAV RADIO page shows the VOR, ILS, and ADF radio status and allows manual control of these radios. Entering data on this page manually tunes the selected navigation radio. Manually selected VOR courses can also be entered.

**1. VOR L and VOR R**

Left and right VOR data are shown on the CDU. VOR tuning status is shown adjacent to the VOR frequency.

The automatic tuning mode operates for procedure flying, and route operations. Enter the frequency or identifier to manually tune a VOR. VORs are tuned automatically by the FMC in the following priority:

- P - Procedure autotuning. The FMC selects nav aids necessary for approach or departure procedure guidance.
- R - Route autotuning. The FMC selects nav aids on the active route. The nav aid must be the previous VOR or a downpath VOR within a certain range of aircraft position.
- A - Autotuning. The FMC selects the best available valid nav aid.

An "M" shows the VOR is tuned manually. Manual tuning takes priority over FMC tuning.

Note: When magnetic variation at the airplane location and the VOR are far different, the ND VOR radial and ND POS green vector do not point directly to the VOR. This difference decreases as the airplane gets closer to the VOR.

Valid entries:

- VOR or non-ILS DME identifier or VOR frequency.
- VOR identifier or frequency/course; the course shows on the CRS line.

Tunes associated DME.

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

2. CRS

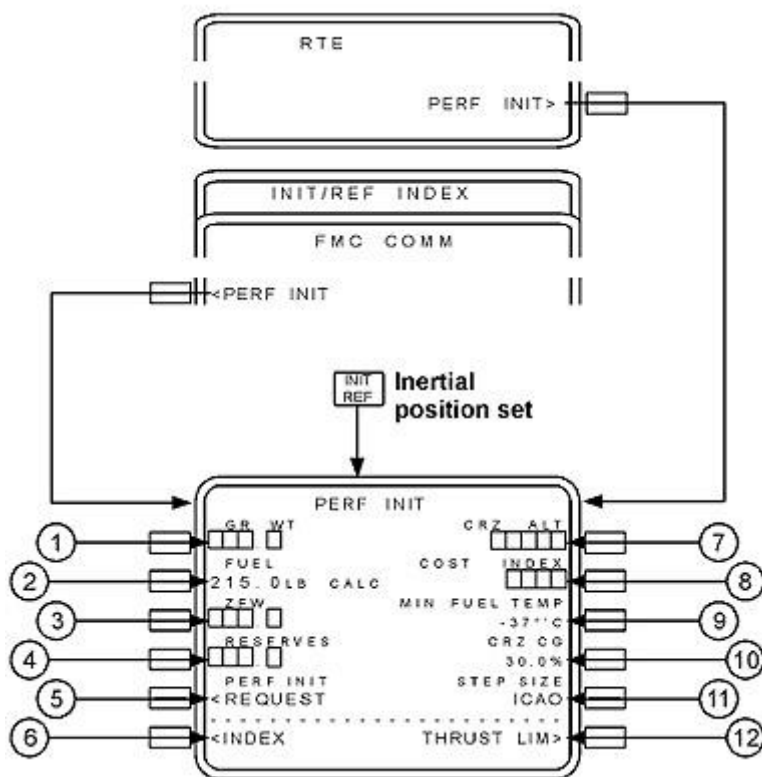
VOR course is green. Radial is white. Blank when in autotune mode. Valid entry is a three-digit course. Data can be entered when dashes are shown.

2. RADIAL

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

PREFLIGHT PAGES - PART 2**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 is required. The entry can be made by the flight crew or automatically calculated by the FMC, after entry of zero fuel weight.

Enter airplane gross weight.

Valid entries are xxx or xxx.x.

Automatically shows calculated weight when zero fuel weight is entered first.

Entry of a value after takeoff speeds are selected removes the speeds and shows 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:

- SENSED is shown when the source is from the airplane fuel totalizer and manual entry is not possible.
- CALC is shown when the source is from FMC calculations and manual entry is possible.
- MANUAL is shown when the source is from a manual entry.

Valid entry is XXX or XXX.X.

Unit of quantity is shown to the right of the numerical value.
Only manual entries can be deleted.

3. Zero Fuel Weight (ZFW)

Airplane zero fuel weight is required. Usually the ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Enter the airplane zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically shown if 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 shows the scratchpad message TAKEOFF SPEEDS DELETED.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) are shown beside the entered values (large font).

4. RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xxx or xxx.x.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) are shown beside the entered values (large font).

5. Performance Initialization Request (PERF INIT REQUEST)

Transmit a data link request for performance data uplink.

Flight crew can operationally fill in ZFW, CG, cruise altitude, reserves, cost index, or fuel temperature to qualify request.

6. INDEX

Push - displays the INIT/REF INDEX page.

7. Cruise Altitude (CRZ ALT)

Cruise altitude is required. The altitude can be entered by the flight crew or automatically entered from a company route or uplink.

Enter the cruise altitude for the route.

Automatically shows this cruise altitude on the CLB and CRZ pages.

8. 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.

9. Minimum Fuel Temperature (MIN FUEL TEMP)

When actual fuel temperature reaches the value shown, the EICAS advisory message FUEL TEMP LOW is shown.

Shows minimum fuel operating fuel temperature.

Default value from the AIRLINE POLICY page is shown in small font.

Flight crew entered or uplinked value is shown in large font.

Valid entries are -99 to -1 in °C.

10. Cruise Center of Gravity (CRZ CG)

Used to compute the high and low speed maneuver Mach numbers in cruise.

Shows default center of gravity from the performance database.

Can be manually entered or uplinked.

Default value from the performance database is shown in small font.

A flight crew entered or unlinked value is shown in large font.

Valid entry is 14.0 through 44.0.

11. STEP SIZE

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

The word ICAO is shown for the default value from the AIRLINE POLICY file.

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.

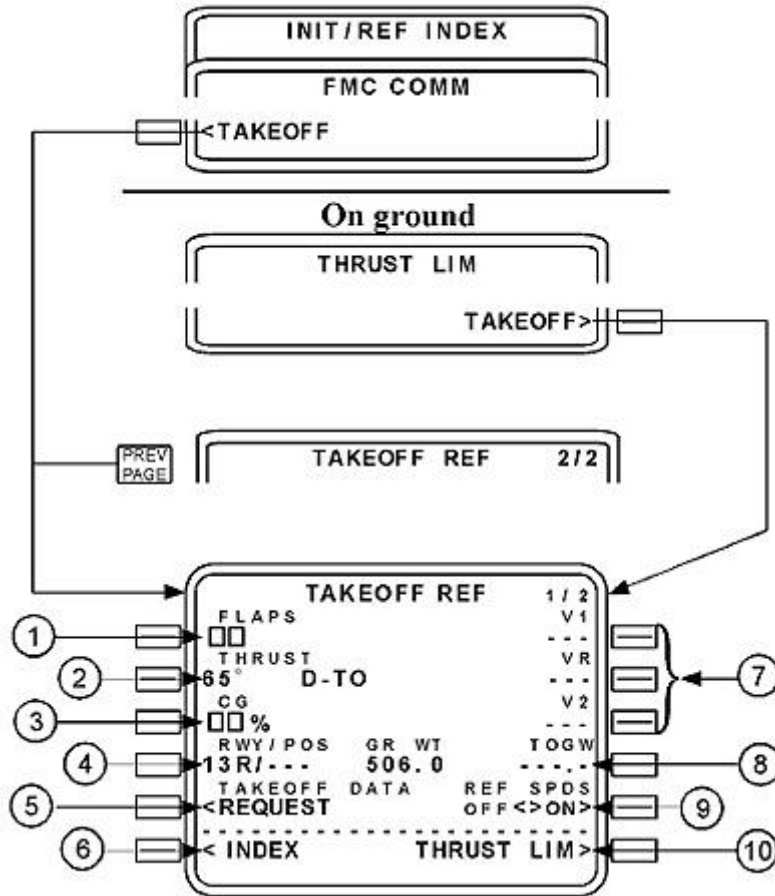
12. Thrust Limit (THRUST LIM)

Push - Shows the THRUST LIM page.

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

The takeoff reference page allows the flight crew to manage takeoff performance. Takeoff flap setting and V speeds are entered and verified.

Thrust limits, takeoff position, and takeoff gross weight can be verified or changed. Preflight completion status is annunciated until complete. Takeoff reference page entries finish the normal preflight. The takeoff flap setting must be entered and V speeds should be set before completion.

**1. FLAPS**

Displays takeoff flap setting. Valid entries are 5, 15, or 20.

Flight crew entry or data link uplink.

Entry of 5 when FLAPS 5 is the climb thrust reduction point shows the scratchpad message INVALID ENTRY.

Flap position is required for takeoff V speed calculations.

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

2. THRUST

Shows flight crew entered or uplinked assumed temperature for takeoff thrust derate calculations. Shows takeoff thrust selected on THRUST LIM page.

DO NOT USE FOR FLIGHT

Valid entries are 0° to 99°C or 32° to 210°F.

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

3. Center of Gravity (CG) and TRIM

Boxes are shown until flight crew entry is accomplished.

Valid entry is within the valid range for the airplane.

After center of gravity is entered, the FMC:

- Calculates and shows stabilizer takeoff setting to the right of the CG entry (trim display is in 0.25 unit increments)
- Updates the takeoff green band shown on the stabilizer position indicators.

4. Runway/Position (RWY/POS)

Displays the selected takeoff runway, and TO/GA push distance from the runway threshold or runway intersection identification.

Displays the takeoff runway from the active RTE page if previously selected. Runway entry does not change runway entered on RTE or DEPARTURES page.

Flight crew may enter or uplink runway and intersection data.

Valid entry of a runway intersection is an alphanumeric up to three characters, preceded by a slash (/).

Valid position entry is a one or two numeric on the range 0 - 99. It must be followed by two zeros and preceded by a slash (preceding the entry with a "-" means a longer takeoff distance is available; for example, -0300 is 300 feet before the runway threshold).

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

RWY/POS update inhibited when GPS is primary FMC navigation source.

5. TAKEOFF DATA REQUEST

REQUEST

Push – Transmits a data link request for takeoff data uplink.

Flight crew can enter RWY, intersection or position shift, CG, TOGW, or OAT to qualify the request.

REJECT

Push – Rejects the takeoff data uplink and returns the REQUEST prompt.

6. INDEX

Push - Shows the INIT/REF INDEX page.

7. V Speeds (V1, VR, V2)

Displays dashes when:

- Required information not entered
- Performance calculations are inhibited
- ADIRU is not aligned.

Flight crew entry or uplink speeds replace calculated speeds.

Calculated speeds display in small font.

Push –

- Selects V1, VR and V2 to be sent to using systems, or
- Crew entered V speeds replace calculated speeds
- Display changes to large font; REF and caret no longer display.

If the performance data changes:

- FMC replaces existing speeds with FMC calculated speeds in small font
- V speeds are removed from the PFD
- PFD speed tape message NO V SPD is shown
- Scratchpad message TAKEOFF SPEEDS DELETED is shown.

Note: After an engine is started, the FMC recalculates the takeoff speeds. Any combination of gross weight, OAT, or pressure altitude resulting in a takeoff speed change of two or more knots from the previously calculated speeds, causes the FMC to recalculate takeoff speeds.

8. Gross Weight (GR WT), Takeoff Gross Weight (TOGW)

GR WT shows airplane gross weight from the PERF INIT page.

TOGW - Enter optional airplane takeoff gross weight different from GR WT to request new takeoff data using data link.

Valid entry is any weight within the allowable airplane takeoff gross weight range. Flight crew entered value is downlinked when the REQUEST prompt is selected.

Entry of a value after takeoff speeds are selected removes the speeds, shows dashes in the speed lines, and shows the scratchpad message TAKEOFF SPEEDS DELETED.

Deletion of the TOGW value shows REF SPDS in small font.

A takeoff uplink shows the uplinked TOGW and associated REF SPDS.

9. Reference Speeds (REF SPDS), ACCEPT

REF SPDS:

Enables or disables display of the FMC calculated reference (V) speeds in the center column to the left of the V speed lines.

Push toggles together between ON and OFF.

ON – displays FMC calculated takeoff speeds for comparison with the V speeds in the right column.

OFF – deletes speeds from the center column.

The active state, ON or OFF, displays in large green font; the inactive state displays in small white font.

ACCEPT:

Push – accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

10. Thrust Limit (THRUST LIM)

Push - Shows THRUST LIM page.

11. Reference (REF)

Shows the FMC calculated V speeds for comparison with flight crew entered or uplinked values. Display is enabled and inhibited by the REF SPDS prompt.

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

The FMC takeoff phase starts with the selection of takeoff/go-around (TO/GA). Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when the FMC commands climb thrust. The climb phase continues to the top of climb point, where the cruise phase starts.

During takeoff and climb, the specific page listed below is usually used to:

- TAKEOFF REF page - Make last minute changes to thrust derate or V speeds
- DEPARTURES page - Make last minute changes to the departure runway or SID
- CLIMB page - Modify climb parameters and monitor airplane climb performance
- RTE X LEGS page - Modify the route and monitor route progress
- PROGRESS page - Monitor the overall progress of the flight
- THRUST LIM page - Select alternate climb thrust limits
- DEP/ARR INDEX page - Select an approach during a turn-back.

TAKEOFF PHASE

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

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V2+15 and V2+25 knots, depending on the flap setting.

Usually, VNAV is armed before takeoff. When armed before takeoff, LNAV activates at 50 feet radio altitude and commands roll to fly the active route leg. VNAV activates at 400 feet above runway elevation and commands pitch to fly the climb profile.

CLIMB

At acceleration height, the first movement of the flap handle during flap retraction, or AFDS capture of MCP altitude lower than acceleration height, VNAV commands acceleration to:

- 250 knots
- VREF 30 + 80 knots, whichever is greater.

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

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than VREF 30 + 80 or 250 knots.

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. The commanded speed is magenta.

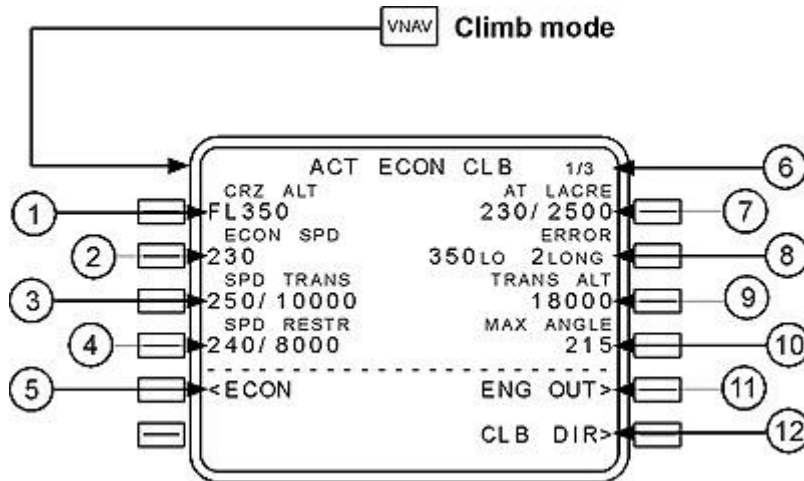
When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC shows the CDU scratchpad message UNABLE NEXT ALTITUDE. A different speed profile that gives a steeper climb angle must be manually selected.

DO NOT USE FOR FLIGHT**CLIMB PAGE**

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

The climb page is the first of the three pages selected with the VNAV function key. When the FMC changes to the cruise mode, the climb page data is blanked.

FMC climb can be economy, fixed speed, or engine out.

**1. 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.

The altitude can be changed by two methods:

- A new cruise altitude can be manually entered from the CDU at any time. The modified cruise altitude is shown in shaded white until executed.
- A new cruise altitude can be entered from the MCP, if intermediate altitude constraints do not exist between the airplane altitude and the MCP altitude. Set cruise altitude in the altitude window and push the altitude selector. The cruise altitude changes without modification or execution.

2. Economy Speed (ECON SPD), Selected Speed (SEL SPD)

ECON SPD

- economy speed based on cost index
- Used by FMC at altitudes above all waypoint speed constraints, speed restrictions, and speed transition altitudes.

SEL SPD

- shows when intermediate level off required below an existing speed constraint
- shows when flight crew enters speed

Valid entries are CAS or Mach.

The FMC commanded speed is magenta. Usually, CAS speed is magenta and Mach is white. Above CAS/Mach transition altitude, Mach is magenta and CAS is white.

3. Speed Transition (SPD TRANS)

DO NOT USE FOR FLIGHT

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

- the navigation database value for the origin airport
- The value specified from the airline policy file
- A default speed of 250 knots or the airplane performance value of VREF+80 knots and 10,000 feet (example 250/10000), if there is no airline policy value.

Magenta when it is FMC command speed.

Not shown after the transition.

Can be deleted.

Not displayed above the transition altitude.

4. 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. Entry is shaded white until executed; magenta when it is FMC command speed.

5. Economy (ECON)

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

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

6. Page Title

The page title shows the type of climb.

- ECON - Speed based on a cost index.
- LIM SPD - Speed based on airplane configuration limiting speed.
- MCP SPD - MCP speed intervention is selected.
- EO - Engine out mode is selected.
- XXXKT - Fixed CAS climb speed profile.
- M.XXX - Fixed Mach climb speed profile.
- ACT - Prefix shown when climb phase is active.

Reasons for fixed climb speeds are:

- Takeoff/climb acceleration segment constraints.
- Waypoint speed constraints.
- An altitude constraint associated with a speed constraint.
- A speed transition.
- A flight crew entered selected speed (SEL SPD).

7. Waypoint Constraint (AT XXXXX)

Shows airspeed and/or altitude constraint at waypoint XXXXX.

Can also display HOLD AT XXXXX followed by a speed/altitude constraint.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

Magenta when it is FMC command speed or altitude.

8. ERROR at Waypoint

Displays altitude discrepancy and distance past waypoint where altitude will be reached.

Blank if no error exists.

9. 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.

CDU altitude data change from altitudes to flight levels above the transition altitude.

10. Maximum Angle (MAX ANGLE)

Maximum angle of climb speed.

Entry not allowed.

11. Engine Out (ENG OUT)

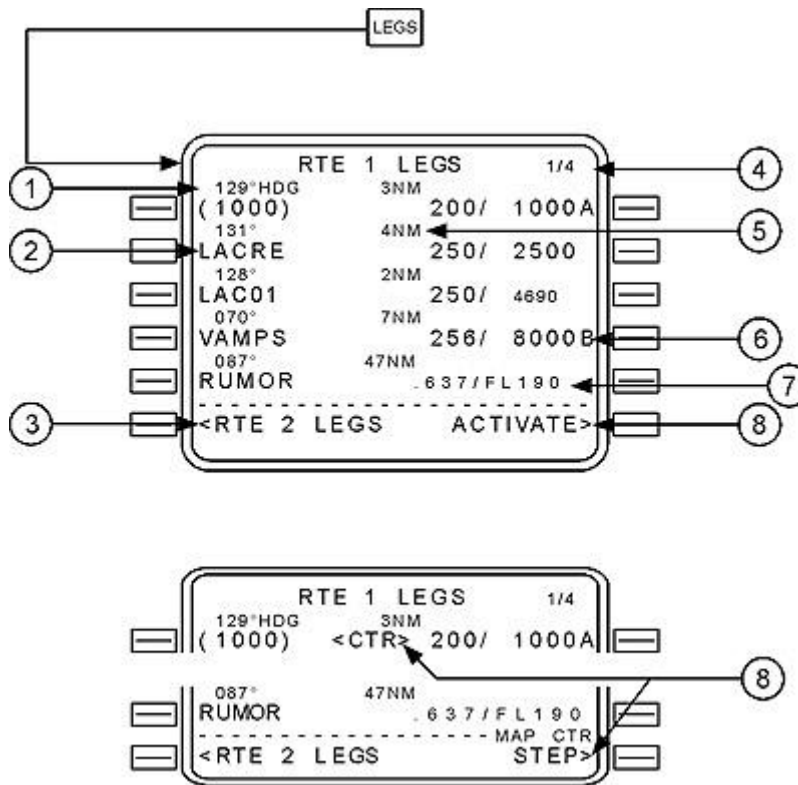
Push - Modifies page to show engine out (ENG OUT) performance data.

Shaded white until the modification is executed.

12. Climb Direct (CLB DIR)

Displays when climb altitude constraint exists between current altitude and FMC cruise altitude.

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

DO NOT USE FOR FLIGHT**RTE X LEGS PAGE****1. 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 or PROC HOLD (FMC exits HOLD when crossing the fix after entry).

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

Dashes display for an undefined course.

2. Waypoint Identifier

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

Active waypoint is on active leg and is magenta. Modified waypoints are shaded white until executed.

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

Waypoints can be modified. Examples:

- Add waypoints
- Delete waypoints
- Change waypoint sequence
- Connect route discontinuities.

Shows the waypoint by name or condition.

Boxes are shown for route discontinuities.

Dashes are in the line after the end of the route.

3. 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.

4. 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.

5. Distance to Waypoint

Distance (decreasing) from airplane to active waypoint or from waypoint to waypoint. Blank for some leg types (e.g. HDG or VECTORS).

6. 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.

Magenta when it is an FMC commanded speed/altitude. Airspeed constraint may be magenta in one line with magenta altitude in another line.

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, XXXX, XXXXX or /XXX, /XXXX, /XXXXX - Altitude only.
- Enter FL 190 or 19,000 feet as 190 or 19000. Enter FL090 or 9,000 feet as 090 or 9000. Enter 900 feet as 009 or 0900. Enter 90 feet as 0090.

Altitude constraint suffixes:

- blank - cross at altitude
- A - cross at or above altitude
- B - cross at or below altitude
- both - altitude block. If constraint is to cross between two altitudes when climbing, enter lower altitude followed by "A"; then, enter higher altitude followed by "B". Example: 220A240B. Reverse order for descent.
- S - Planned step

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.

Manual entry allowed in climb or descent phase.

DO NOT USE FOR FLIGHT**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
- MAP CTR STEP (map center step) - Changes centered waypoint on ND. <CTR> is adjacent centered waypoint on the RTE LEGS page.

ACTIVATE prompt shown when RTE and RTE LEGS flight plan is inactive.

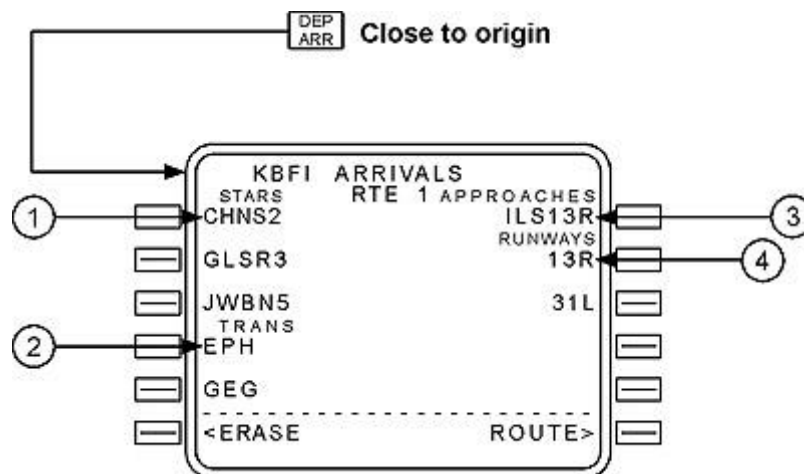
RTE DATA shown after ACTIVATE prompt is pushed.

MAP CTR STEP prompt shown when the EFIS control panel ND mode selector is in PLAN position.

AIR TURN-BACK ARRIVALS PAGE

During a turnback 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, less than 400 miles from the origin, and while nearer to the origin than the destination, push the DEP ARR function 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. Other pages are:

- POS REF page - verify the FMC position
- RTE DATA page - display progress data for each waypoint on the RTE LEGS page
- WINDS page - Enter forecast wind and temperature
- REF NAV DATA page - display data about waypoints, nav aids, airports, or runways, and can be used to inhibit nav aids
- RTE X page - select a route offset
- FIX INFO page - display position data about waypoints. Page 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
- intercept a course.

RTE LEGS PAGE MODIFICATIONS

When modifications are made to a RTE LEGS page, several automatic prompt or identifying features help the flight crew manage the modifications, such as:

- ERASE
- INTC CRS TO
- INTC CRS FROM.

Modified entries are shown in shaded white.

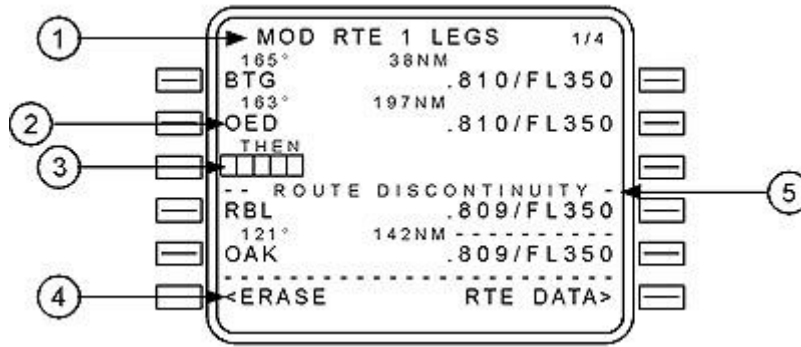
ADD WAYPOINTS

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.

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

MOD (shaded white) - Replaces ACT when modification is in progress.

ACT (white) - Replaces MOD when ERASE is selected or execute key is pushed.

2. Modified Waypoint

Waypoint name is shaded white until executed.

OED waypoint entered into the route after BTG. Modification creates route discontinuity because OED was not in active route.

3. Discontinuity Waypoint

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.

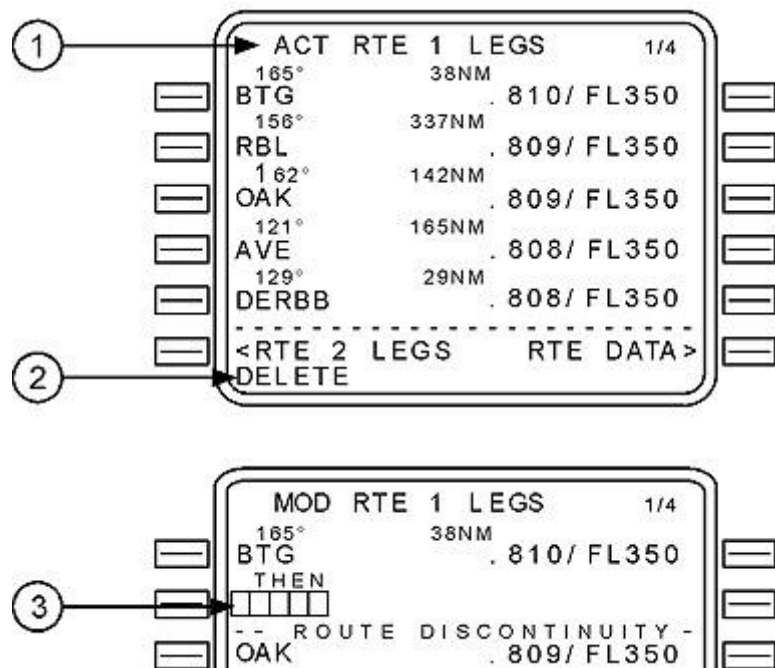
Note: Performance predictions to destination on the PROGRESS page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

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.

DO NOT USE FOR FLIGHT**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. Route Discontinuity

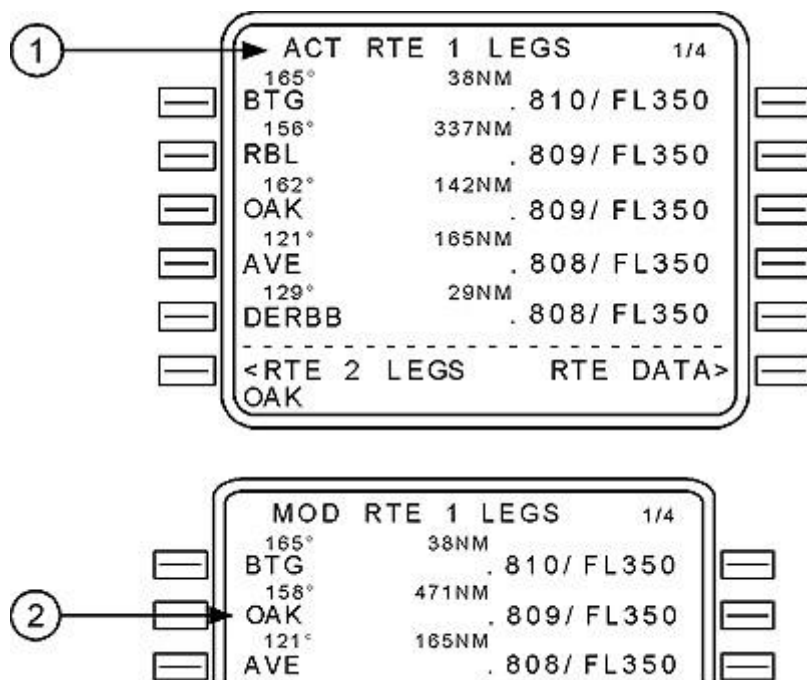
With DELETE in the scratchpad, pushing the line select key for RBL deletes the waypoint. Boxes replace RBL and a route discontinuity is displayed.

DO NOT USE FOR FLIGHT**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.

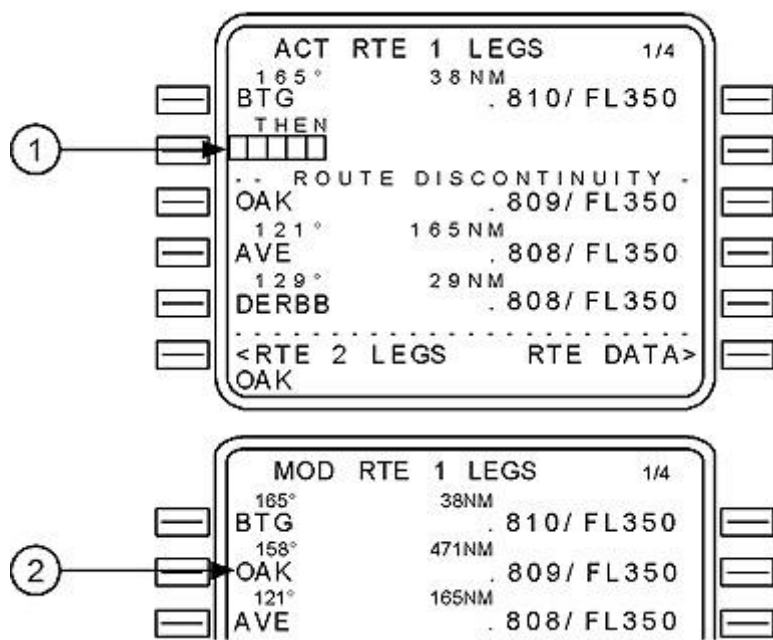
2. Change OAKs Sequence

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. Connect a route segment after the discontinuity to the route segment before the discontinuity to remove the discontinuity.

Copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity, just as when adding a waypoint.

**1. Route 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.

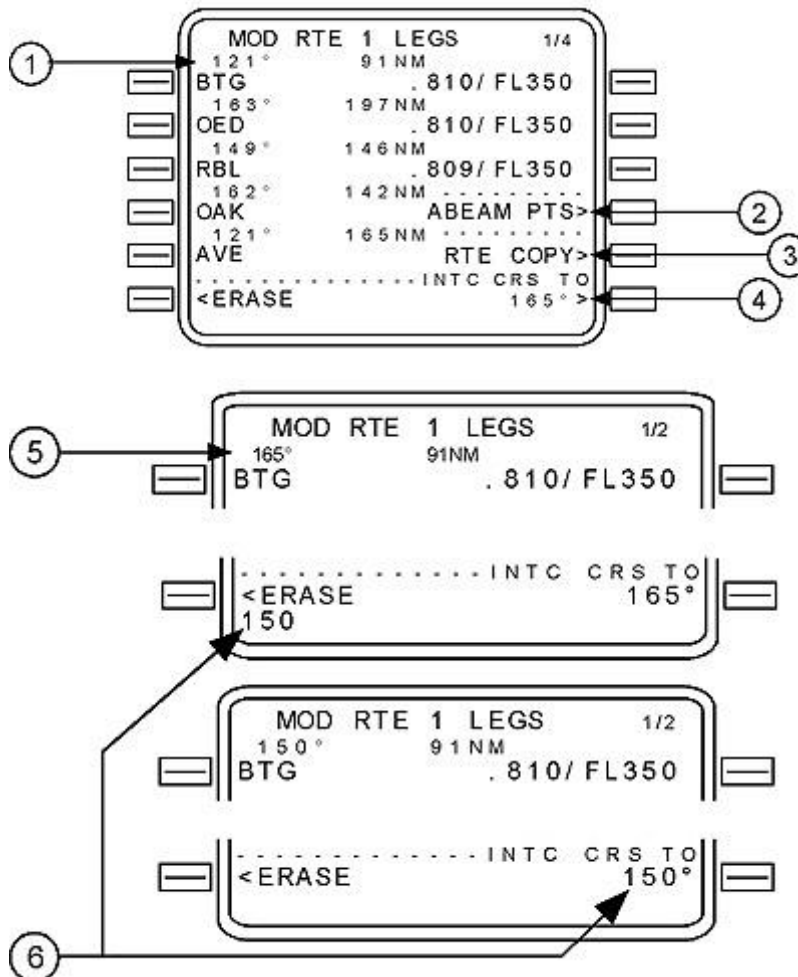
DO NOT USE FOR FLIGHT**DIRECT TO**

If the airplane passes the last active route waypoint (or offset) or the last waypoint prior to a route discontinuity, LNAV maintains the current heading and a scratchpad message displays. If LNAV is not active, activation can be accomplished in the following three ways:

- When the airplane is within 2.5 miles of the active leg and on an intercept heading to the active leg, pushing the LNAV switch activates the LNAV. The airplane turns to intercept the active leg. If the intercept angle is large, the airplane may overshoot the active leg.
- When more than 2.5 miles from the active leg, pushing the LNAV switch when the airplane is on an intercept heading to the active leg arms LNAV. Activation occurs as necessary to intercept the active leg with no overshoot. The 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. Pushing the LNAV switch arms or activates LNAV, depending on the distance to 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. Leg Direction**

DO NOT USE FOR FLIGHT

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2. Abeam Points (ABEAM PTS)

Push -

- Creates place bearing distance waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a database airport, navaid, NDB, or waypoint.
- Creates latitude/longitude waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a latitude/longitude waypoint.
- Creates a new place bearing distance waypoint based on the original "place" on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a place bearing distance waypoint.
- Creates a new latitude/longitude reporting point on the Direct To leg based on the entered latitude or longitude reporting point.
- Line title displays ABEAM PTS and line data displays SELECTED.
- Altitude/speed constraints for bypassed waypoints are removed.

ABEAM PTS prompt displays whenever the active waypoint name is modified, usually for direct-to routing.

3. Route Copy (RTE COPY)

Push -

- Copies the active route into the inactive route.
- Erases previous inactive route.
- Line title displays RTE COPY and line data displays COMPLETE.
- Subsequent route modifications remove RTE COPY prompt.

4. Intercept Course TO (INTC CRS TO) - Select

Displays whenever the active waypoint name is modified.

Displays boxes if entered waypoint not in the active route.

Displays current route course and prompt caret if entered waypoint in the active route.

When boxes displayed, valid entry is intercept course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

Push -

- When current route course (165°) displayed, selects it as intercept course to active waypoint.
- Displays entry or current route course to active waypoint.
- Removes ABEAM PTS and RTE COPY prompts.

5. Intercept Course

After pushing INTC CRS TO and prior to execution, displays direct - to inbound course at the waypoint; changed by entry in intercept course to (INTC CRS TO) line or by selecting intercept course to. After execution, displays current required track to fly inbound course to the waypoint.

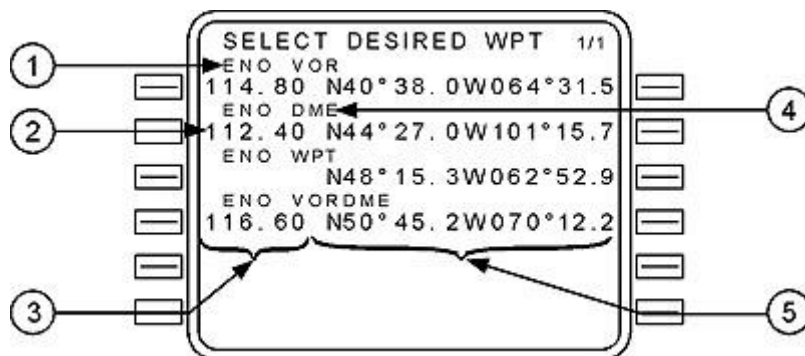
6. Intercept Course TO (INTC CRS TO)

To change intercept course:

- Enter the inbound intercept course (150°) in the scratchpad.
- Select the INTC CRS TO line to change the leg direction; intercept course to BTG of 150° is entered in the INTC CRS TO line and above the active waypoint.

SELECT DESIRED WAYPOINT (WPT) PAGE

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which geographical location to use must be made before the waypoint can be used in the route. The SELECT DESIRED WPT page is automatically shown when the FMC encounters more than one location for the same waypoint name after a waypoint entry.

**1. Identifier**

Shows the identifiers for the duplicate named waypoints. Select the correct waypoint by pushing the applicable left or right line select key.

2. Waypoint Lines

Display a sorted list of waypoints with identifier, navaid type, frequency, and coordinates:

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

Push – Selects waypoint location for use; returns display to page previously in use.

Pushing any CDU function key exits page without selecting a waypoint.

3. Frequency

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

4. Type

Shows the type of navaid. Blank if the waypoint is not a navaid.

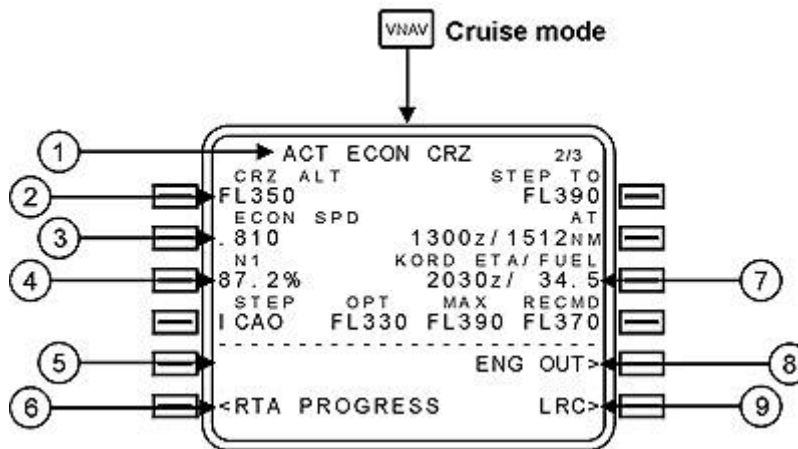
5. Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

DO NOT USE FOR FLIGHT**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:

- CO - Engine out mode and CO speed selected
- CRZ CLB or CRZ DES - Cruise climb or descent
- ECON - Speed is based on a cost index
- EO - Engine out mode is selected
- EO LRC D/D - Long range cruise drift down, is shown when EO is selected and the airplane altitude is above the maximum altitude for engine out performance
- LIM SPD - Mode is based on an airplane configuration limiting speed
- LRC - Long range cruise mode
- MCP SPD - Speed intervention is applied from the MCP
- M.XXX - Selected Mach cruise speed
- XXXKT - Selected CAS cruise 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 the transition altitude.

Modified values display in shaded white.

A new entry changes the page title to CRZ CLB or CRZ DES.

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

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.

SEL SPD displays when flight crew enters speed.

LRC or company (CO SPD) display when selected, depending on the VNAV mode.

4. N1

Shows the N1 necessary for level flight at the target airspeed.

5. Economy and Required Time of Arrival RTA/Economy (ECON, RTA/ECON)

ECON

- Push - Selects VNAV ECON mode.
- Shown when an RTA waypoint is not in the flight plan and VNAV is not in the economy mode.

RTA/ECON

- Push - Selects RTA speed mode. Shows ECON prompt.
- Shown when an RTA waypoint is in the flight plan and VNAV is not in the RTA mode..

6. Required Time of Arrival (RTA) PROGRESS

Push - Shows RTA PROGRESS 3/3.

7. Destination ETA/FUEL

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

Shows 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.

8. Engine Out (ENG OUT)

Push –

- Displays engine out cruise page
- Commands engine out performance calculations
- Changes CRZ ALT if above maximum engine out altitude
- Changes target speed to engine out LRC speed
- Upon execution, thrust reference mode changes to CON.

9. Long Range Cruise (LRC)

Push - Shows the long-range cruise page.

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.

DO NOT USE FOR FLIGHT**CRUISE CLIMB**

Setting an altitude above the current cruise altitude in the MCP altitude window and pushing the altitude selector causes the altitude to be set to the MCP altitude and the airplane to climb to the new cruise altitude. The reference thrust limit is CLB and the pitch flight mode annunciation is VNAV SPD.

Another method to start a cruise climb: set a higher MCP altitude, enter the altitude into the CRZ ALT line, then execute.

**1. During Cruise Climb**

VNAV page title displays ACT ECON CRZ CLB in a climb to a new cruise altitude.

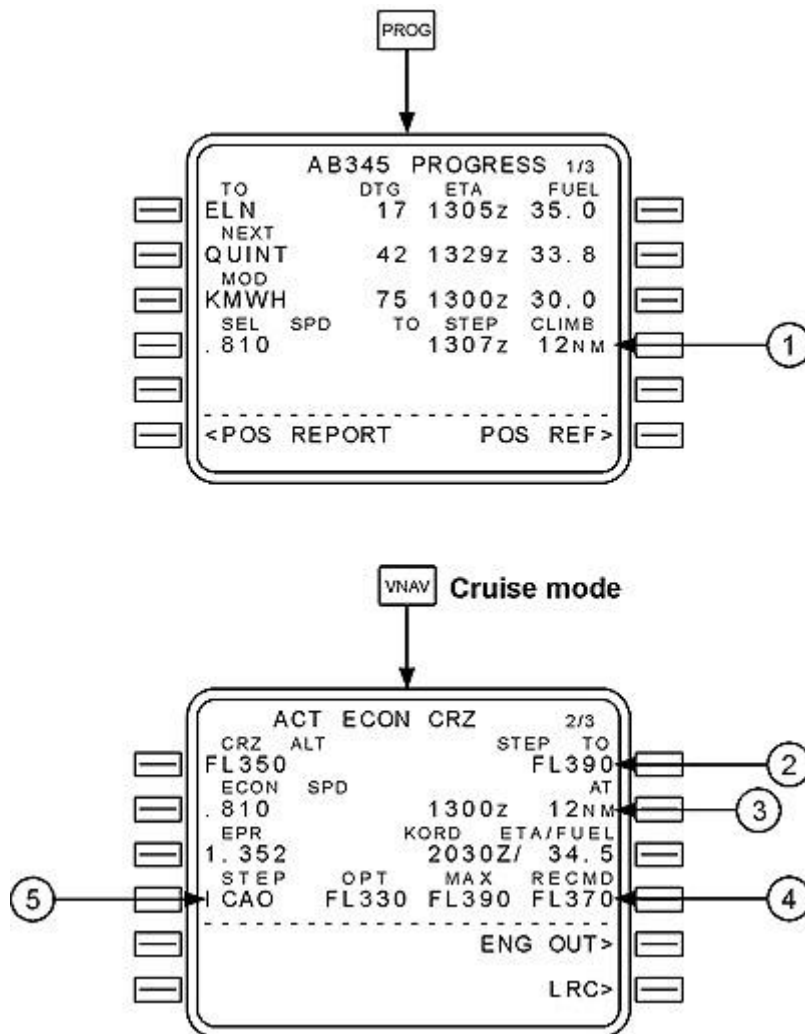
2. End of Cruise Climb

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

DO NOT USE FOR FLIGHT

CALCULATED STEP CLIMB

When a nonzero 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.



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 TO

DO NOT USE FOR FLIGHT

An altitude can be entered for a step climb evaluation. The FMC calculates the predicted step climb data and shows the results on this page and the PROGRESS page.

Entering a zero value for STEP SIZE calculates performance based on a constant altitude flight at the CRZ ALT. Entering a valid, nonzero increment or ICAO step size calculates performance based on accomplishing step climbs at calculated step climb points.

Step climb altitudes entered on the RTE LEGS page can be greater than or less than the CRZ ALT. These step climb altitudes cannot be overwritten on the CRZ page.

When using the ICAO step size, the STEP TO altitude is the next higher altitude above the OPT altitude corresponding to the direction of flight, based upon the CRZ ALT entered before takeoff. Changes to CRZ ALT while in flight do not affect calculation of STEP TO altitudes using ICAO step sizes. Changing to an alternate RTE in flight calculates hemispheric altitude based on the FMC CRZ ALT.

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

When entering a cruise altitude above maximum altitude, the scratchpad message MAX ALT FLXXX displays. Entry of a new cruise altitude deletes all waypoint altitude constraints at or above the new cruise altitude.

Shows:

- The STEP TO altitude from the RTE LEGS page
- A calculated step climb altitude based on the step size.

Manual entry is allowed.

Blank when:

- There is no active flight plan, or
- Within 200 NM of the T/D point, or
- In the EO D/D phase.

3. 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.

4. Optimum Altitude, Maximum Altitude and Recommended Altitude (OPT MAX RECMD)

Blank when RTA is active.

OPT –

- With ECON speed selected, displays altitude which minimizes trip cost based on weight and cost index.
- With LRC, EO, CO or SEL speed selected, displays altitude which minimizes trip fuel based on weight.
- Does not reflect the effect of speed if speed intervention (MCP IAS/MACH window) is selected.

MAX – Displays maximum sustainable altitude based on:

- Current gross weight
- Temperature
- Number of engines operating
- Cruise reference thrust limit default set by airline (CLB)
- Speed (ECON, LRC, SEL, EO or CO) option
- Residual rate of climb default set by airline (range: 100 to 999 feet per minute)
- Disregarding altitude or speed constraints
- Does not reflect the effect of speed if speed intervention (MCP IAH/MACH window) is selected.

DO NOT USE FOR FLIGHT

RECMD – Displays the most economical altitude to fly for the next 500 NM based on gross weight; selected cruise speed, including specified cruise speed segments; and constraint altitude cruise over a fixed distance taking into account the route of flight, entered winds and temperature forecast. The FMC evaluates altitudes up to 9,000 feet below the current CRZ ALT and up to less than MAX altitude. Recommended altitudes are selected consistent with the step climb schedule and specified step size.

If a step size of zero has been selected, the recommended cruise level is selected assuming 2,000 feet step size. The recommended altitude is set to the CRZ ALT when within 500 NM of the T/D.

Note: The recommended altitude may be above or below cruise altitude. Refer to RTE DATA and WIND pages for wind and temperature data.

5. STEP SIZE

Displays the default step climb size of ICAO.

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

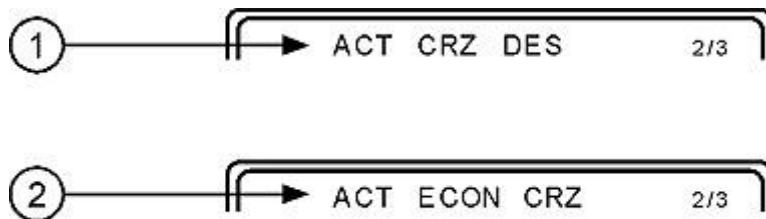
Used for calculation of optimum step point and step climb predictions.

Deletion of a manual entry defaults back to ICAO.

CRUISE DESCENT

Setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector (more than 50 NM from a T/D) causes the cruise altitude to be set to the MCP altitude and the airplane to descend to the new altitude. The CRZ page displays ACT ECON CRZ DES. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by flight crew action. A VNAV cruise descent is commanded at cruise speed and approximately 1250 feet per minute.

The autothrottles adjust thrust to maintain the target descent rate; pitch maintains the commanded speed. The 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.

DESCEND NOW (DES NOW)

When a Descend Now is initiated (DES NOW function active), the VNAV phase is descent and the DES page becomes active.

During cruise, setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector activates the DES NOW function when the airplane is within 50 nm of the T/D or if the MCP altitude is set below the highest descent altitude constraint in the VNAV descent profile.

The autothrottle sets thrust to maintain the target descent rate; then annunciates HOLD. Pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

Another method to accomplish a Descend Now: set a lower MCP altitude, page forward to the VNAV DES page and line select DES NOW, and execute.

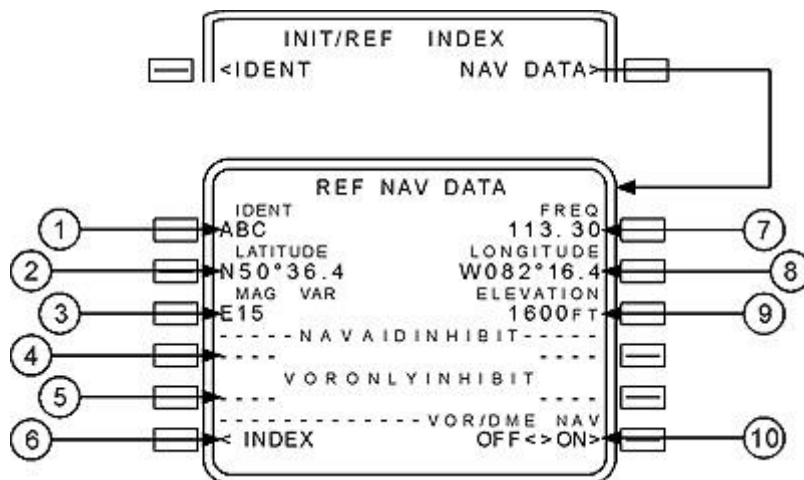
**1. Descend Now (DES NOW)**

The DES NOW prompt is shown on the descent page when the cruise phase is active. Select the DES NOW prompt and execute to start a VNAV ECON descent of approximately 1250 feet per minute at ECON speed.

Upon reaching the planned descent path, VNAV commands pitch to maintain the planned descent path and ECON speed. If the airplane reaches an altitude constraint, VNAV SPD changes to VNAV ALT until the planned descent path is intercepted, then it changes to VNAV PTH.

DO NOT USE FOR FLIGHT**NAVIGATION DATA****REFERENCE NAVIGATION DATA PAGE**

The reference navigation data page shows data about waypoints, navaids, airports, and runways. Use this page to inhibit FMC position updates from radio navaids. The navaids are always available for manual tune, autotune and the ND.

**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.

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. NAVAID INHIBIT

Valid entries are: VOR, VOR/DME, VORTAC, or DME identifiers from the navigation database.

Inhibits use of entered navaids for updating by both FMCs.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

5. VOR ONLY INHIBIT

Valid entries are VOR identifiers from navigation database.

Inhibits use of only VOR portion of entered navaid for updating by both FMCs.

DO NOT USE FOR FLIGHT

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

6. INDEX

Push - displays the INIT/REF INDEX page.

7. Frequency (FREQ)

Displays frequency of entered identifier when it is a navaid.

8. LONGITUDE

Displays longitude of entered identifier.

9. ELEVATION

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

10. VOR/DME NAV

Push - Alternately selects VOR/DME NAV ON (active) and OFF (inactive).

ON - VOR/DME data is supplied to the FMC for position updates. ON is shown in large green letters and OFF is shown in small white letters.

OFF - VOR/DME data is not available to the FMC. OFF is shown in large green letters and ON is shown in small white letters. DME - DME position updating is not inhibited.

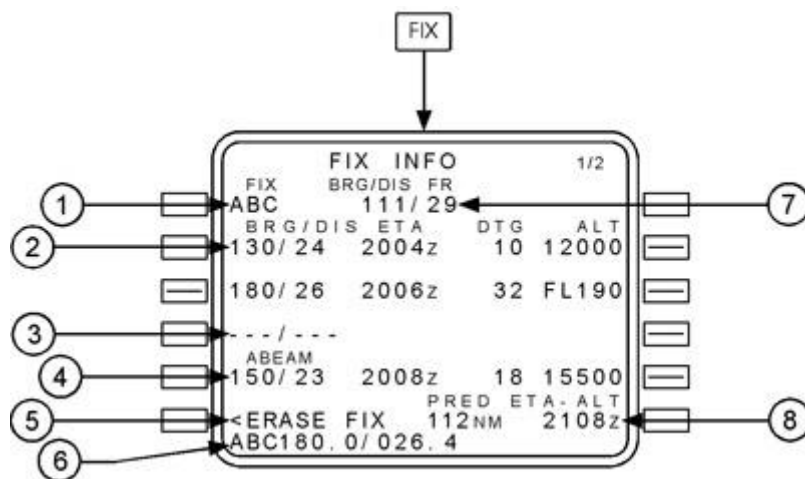
Selecting OFF shows ALL in both locations of the VOR ONLY INHIBIT line.

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.

MAGNETIC/TRUE BEARING

Magnetic or true fix bearings depend on where the airplane is operating.



DO NOT USE FOR FLIGHT

1. FIX

Enter the fix. Valid entries are airports, nav aids, and waypoints from the navigation database. The selected fix is shown on the ND and highlighted by a green or cyan 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.

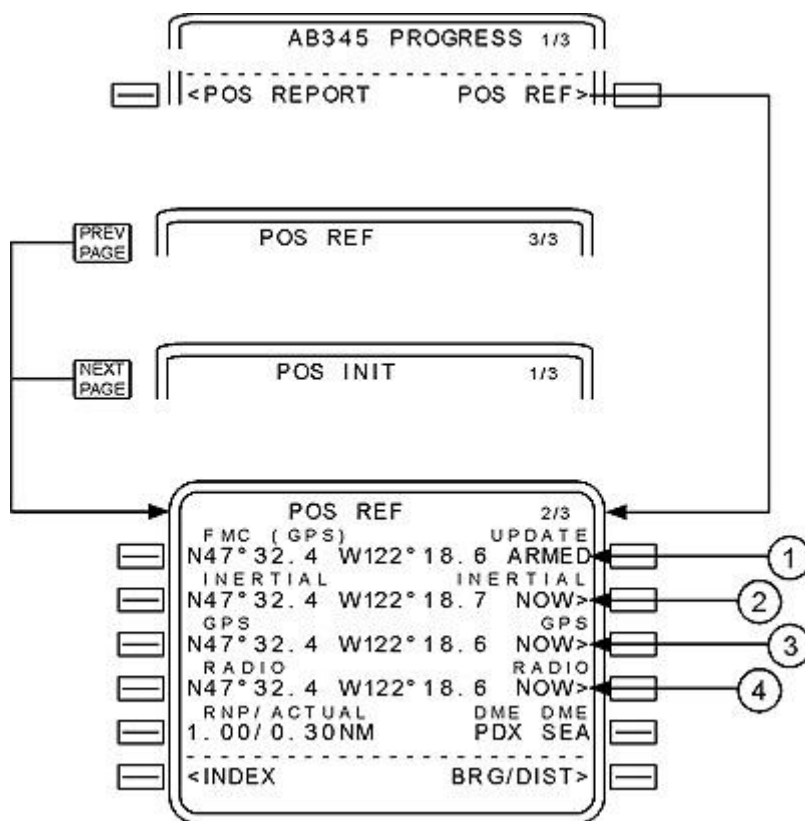
DO NOT USE FOR FLIGHT**8. Predicted Distance to ETA or Altitude (PRED ETA-ALT)**

Valid entry is altitude, flight level, or time. Time entry must be followed by "Z."

Entering an altitude or flight level displays the predicted along track distance and altitude or flight level on this line. The predicted airplane position displays on the ND route line as a green circle with the entered altitude/flight level.

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. INERTIAL NOW

Push - to update the FMC position from the inertial position.

3. GPS NOW

Push - To update the FMC position from the GPS position.

4. RADIO NOW

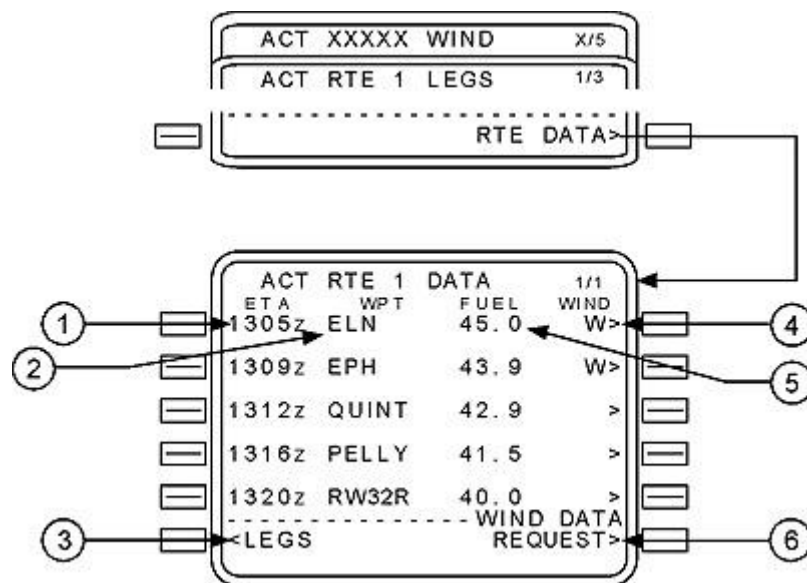
DO NOT USE FOR FLIGHT

Push - To update the FMC position from the navigation radio position.

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. ETA**

Displays ETA for waypoint.

2. Waypoint (WPT)

Displays identifier for waypoint.

3. LEGS

Push - displays RTE LEGS page.

4. WIND

W> - Indicates waypoint winds have been entered.

> - Winds not entered.

Push - Selects WIND page for the selected waypoint.

5. FUEL

Displays the FMC calculated fuel remaining at the waypoint.

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

DO NOT USE FOR FLIGHT**6. WIND DATA REQUEST**

Push - Transmits a data link request for wind and descent forecast data.

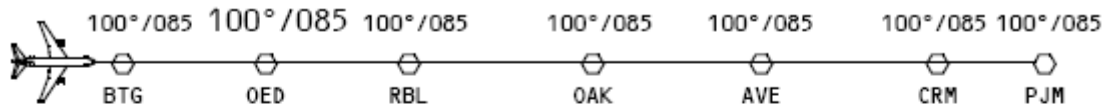
Flight Crew may enter up to four altitudes on any wind page to qualify the request.

WIND DATA

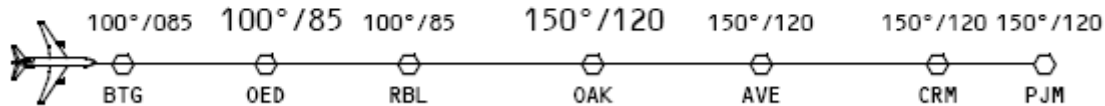
The FMC uses wind data to improve performance calculation accuracy.

The FMC puts the first entered wind data into all waypoints in the flight plan, before and after the selected waypoint. Wind data entered at a second waypoint at the same altitude changes wind data up to the first entered wind data. The wind data before this does not change. Therefore, enter wind data for waypoints closest to the airplane, then enter wind data for waypoints farther from the airplane.

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 2/3.

Inaccurate forecast wind and temperature information degrades the accuracy of the recommended altitude displayed on the cruise page.

The FMC adjusts ECON climb speed and top of climb using entered and/or sensed wind speed. FMC calculated ECON climb speed may fluctuate if top of climb is near a waypoint with approximately a 45 degree or larger track change and if a significant wind velocity has been entered or is predicted for that waypoint. This fluctuation does not occur when using a manually entered climb speed or speed intervention.

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.

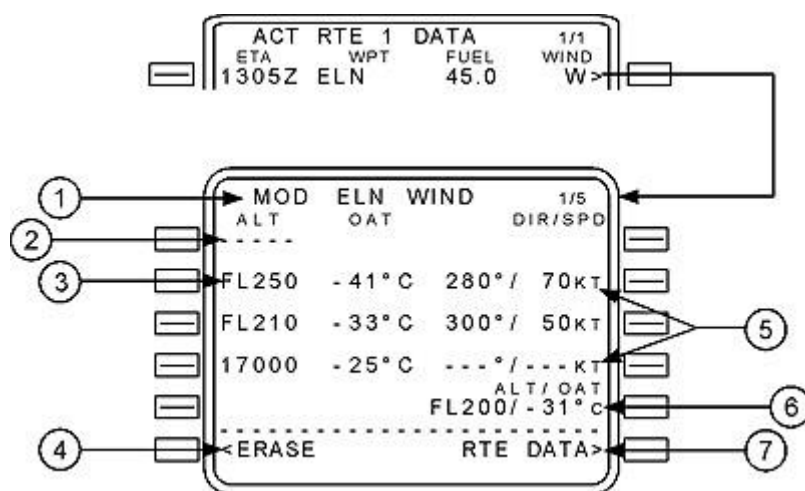
The wind page displays waypoint wind data for one to four altitudes per waypoint. This data can be uplinked or manually entered.

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.

DO NOT USE FOR FLIGHT

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



1. Page Title

Shows ACT XXXXX, where XXXXX is the waypoint for which the winds are shown.

When a route is being modified, MOD in shaded white is shown in the page title.

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.

3. Altitude/Flight Level Data

Shows the altitude or flight level for wind or OAT entries.

Data entered on 1L is shown on lines 1 through 4. Data entry not possible in lines 2L through 4L.

OAT shows the outside air temperature. Entries made using the

ALT/OAT line are shown in large font. Calculated OAT, based on standard lapse rate, is shown in small font.

4. ERASE

Push - removes modified data.

5. Direction and Speed (DIR/SPD)

Shows dashes after altitude/flight level is entered in the ALT line. Enter wind direction and speed for the altitude.

Shows entered wind direction and speed for related altitude.

DO NOT USE FOR FLIGHT

Values propagate in both directions for the first wind entered and downtrack for other entered winds. Propagated values display in small white font.

Manual entries are shown in shaded white until executed, then in large white font.

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

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

Manual entries are shown in shaded white until executed.

7. Route Data (RTE DATA)

Push - Shows the RTE DATA page.

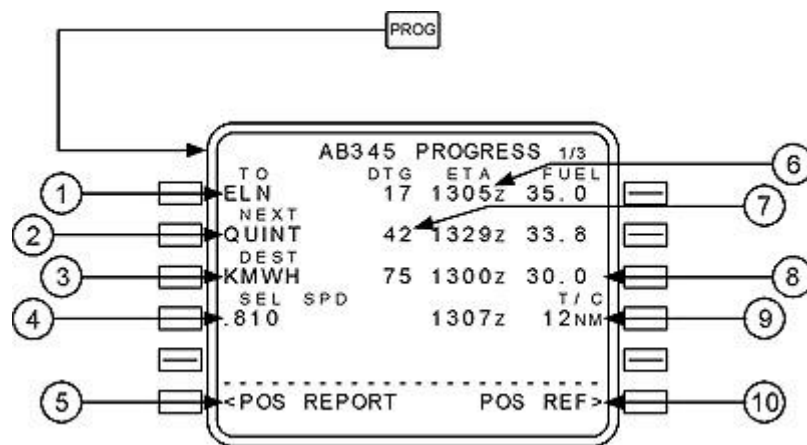
PROGRESS PAGES

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 data
- FMC speed
- cruise altitude.



1. TO

Active waypoint on active leg and is shown magenta. Can not be modified.

2. NEXT

Waypoint after TO waypoint and is shown white.

Can not be modified.

3. Destination (DEST)

Any waypoint or airport in navigation database can be entered. The line titles are:

- DEST - Performance predictions to destination. Default display.
- DIR TO FIX - When entered waypoint is not in flight plan is entered.

Data shown 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.

Remove entries with DELETE key or change all CDUs to a different page.

4. Selected Speed (SEL SPD)

The speed line shows the FMC active command speed in magenta.

The active speed mode is the same as shown 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 entered on the MCP IAS/MACH indicator
- EO SPD - Engine out speed
- CO SPD - Engine out operations at airline specified engine out company speed
- VREF +80, for engine out operations during takeoff.

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:

- T/C – top of climb
- STEP CLB – step climb data
- T/D – top of descent data
- 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.

DO NOT USE FOR FLIGHT

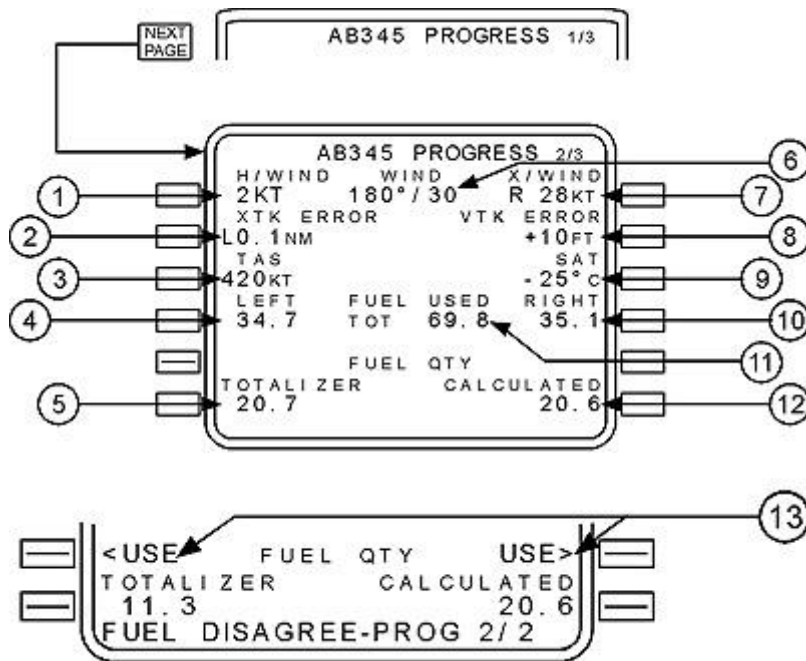
Note: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), and maximum altitude, and compute overly shallow descent path.

To obtain accurate ETA predictions, gear down cruise speed and altitude should be entered on the CLB and CRZ pages of the Control and Display Unit (CDU). Gear down cruise speed should also be entered on the DES page and a STEP SIZE of zero should be entered on the PERF INIT or CRZ page. Use of the VNAV during descent, under these circumstances is not recommended.

PROGRESS PAGE 2/3

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 airplan.

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

Fuel quantity calculated by the fuel quantity system totalizer.

The fuel remaining line shows 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. Total FUEL USED (TOT)

Displays sum of the LEFT and RIGHT fuel used values.

12. Fuel Quantity Calculated (FUEL QTY CALCULATED)

Fuel remaining as calculated by the FMC with these methods:

- Before engine start, fuel quantity calculated by fuel quantity system totalizer.
- After engine start, fuel quantity at engine start decreased by EICAS engine fuel flow rate.
- After fuel dump, resets to fuel quantity system totalizer.
- After landing, resets to fuel quantity system totalizer.

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

13. USE

Push - Selects method to calculate fuel quantity, either TOTALIZER or CALCULATED.

When one is selected:

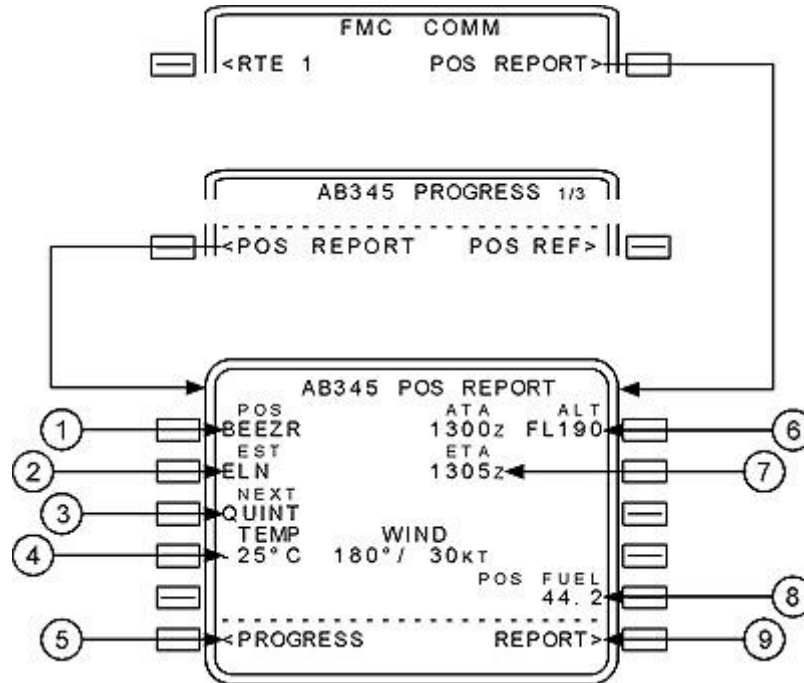
- It is used for remainder of flight.
- The other fuel calculation method blanks.
- Scratchpad clears.

Scratchpad message FUEL DISAGREE-PROG 2/3 and USE prompts are shown when TOTALIZER and CALCULATED values disagree by more than approximately 9000 pounds for 5 minutes.

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.

2. Estimate (EST)

The active waypoint is shown in magenta.

3. NEXT

The waypoint following the active waypoint.

4. Temperature and Wind (TEMP WIND)

TEMP displays the OAT in degrees C.

WIND displays the wind direction and speed.

5. PROGRESS

Push - Shows the PROGRESS page.

6. Actual Time of Arrival and Altitude (ATA ALT)

DO NOT USE FOR FLIGHT

ATA shows the actual time of arrival for the POS waypoint.

ALT shows the airplane altitude at last waypoint.

7. ETA

Shows the estimated time of arrival for the active waypoint.

8. Position Fuel (POS FUEL)

Shows the fuel on board at the POS waypoint.

9. REPORT

Push - Transmits a data link downlink of the data on this page.

The data link transmission of a position report requires the data link not be in the voice or no-communications mode.

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 or go-around. When a go-around is accomplished, the FMC enters a modified cruise or approach phase, depending on the route and cruise conditions.

Alternates can be selected at any time. Alternates are available from preflight through all phases of flight and can be updated at any time. Diversion to an alternate can be accomplished during cruise, descent, or approach.

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 and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

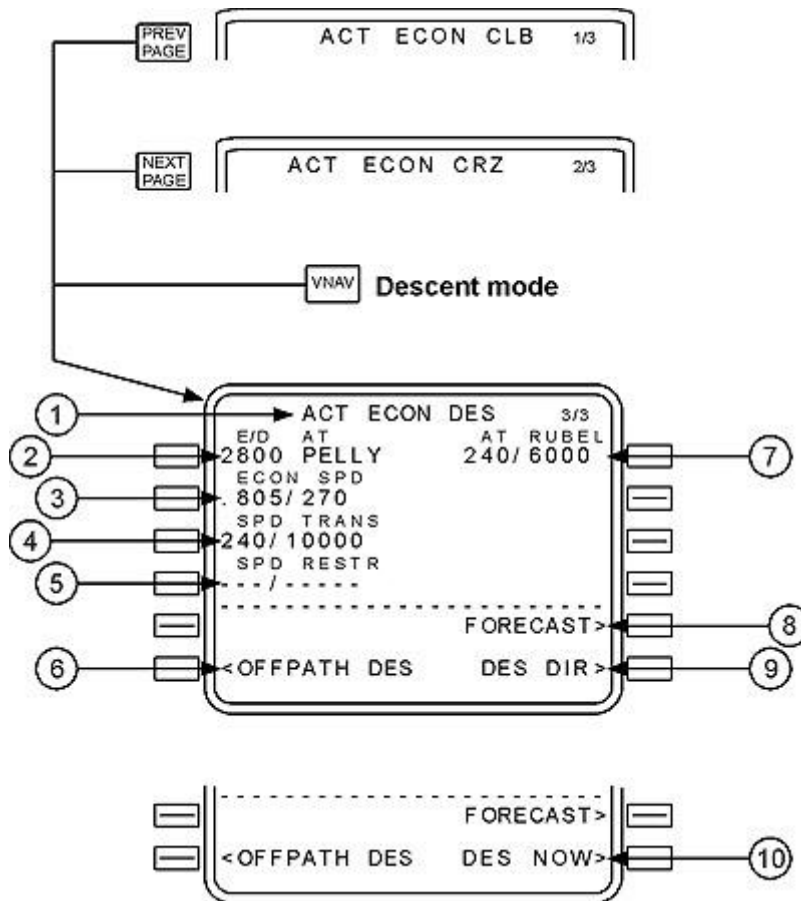
Other pages which support descent are:

- DESCENT FORECAST page - To enter forecast wind data to aid descent planning.
- OFFPATH DES page - To analyze descent performance with and without the use of speedbrakes.
- ALTN page- To manage the selection of alternate airports and diversions.

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 blank with DES as the title until an altitude constraint below the cruise altitude is entered.

This 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 at the fixed speed until a lower speed restriction is reached.

**1. Page Title**

The page title displays active (ACT) or modified (MOD) descent. Usually, the title displays ECON for economy descent. Fixed speed descents modify the title.

The page title shows the type of descent:

- ECON - Speed based on a cost index

DO NOT USE FOR FLIGHT

- 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
- END OF DES – E/D AT waypoint reached if not followed by a climb segment.

Fixed descent speeds are for:

- A flight crew entered selected speed (SEL SPD)
- A speed transition
- A speed restriction associated with an altitude constraint
- Waypoint speed constraints.

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.

The altitude is shown in magenta when altitude becomes the FMC altitude target.

Waypoint is shown in magenta when E/D waypoint becomes the active waypoint.

Blank if no E/D point exists.

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

Both CAS and Mach values are shown.

ECON SPD -

- Economy speed based on cost index
- Shows CAS and Mach values.

SEL SPD -

- Displays when flight crew enters speed
- Displays constraint speed on transitioning into a selected speed segment (waypoint speed constraint, SPD RESTR, or SPD TRANS)
- Valid entries are CAS or MACH.

The FMC commanded speed is magenta. Initially, MACH is magenta and CAS is white. Below CAS/Mach transition altitude, CAS is magenta and MACH is white.

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.

Speed is shown in magenta when it is the FMC speed target.

Blanks below SPD TRANS altitude.

Deleting causes the airplane to fly economy or selected speed if not limited by a waypoint constraint or speed restriction.

5. Speed Restriction (SPD RESTR)

Speed restrictions at altitudes higher than E/D altitude, and not associated with specific waypoints, are manually entered on this line.

Valid entry is a CAS and altitude (example 240/8000). Entry may be deleted.

Magenta when it is FMC command speed.

6. Off Path Descent (OFFPATH DES)

Push - Shows the OFFPATH DES page.

6. AT XXXXX

Shows the next waypoint constraint from the RTE LEGS page.

XXXX is:

- 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.

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

Speed and/or altitude are shown in magenta when they are the FMC target values.

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. FMC cruise altitude is not affected.

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.

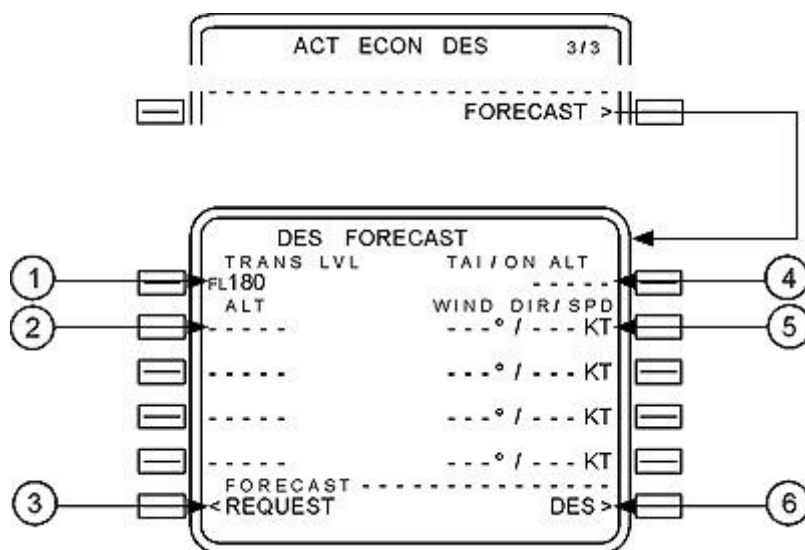
Push-

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

DO NOT USE FOR FLIGHT**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.

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. FORECAST REQUEST

Push - Transmits a data link request for descent wind data.

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

Enter the altitude where anti-ice is first turned on during the descent.

5. Wind Direction/Speed (WIND DIR/SPD)

DO NOT USE FOR FLIGHT

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.

DO NOT USE FOR FLIGHT**ARRIVALS PAGE - IFR APPROACHES**

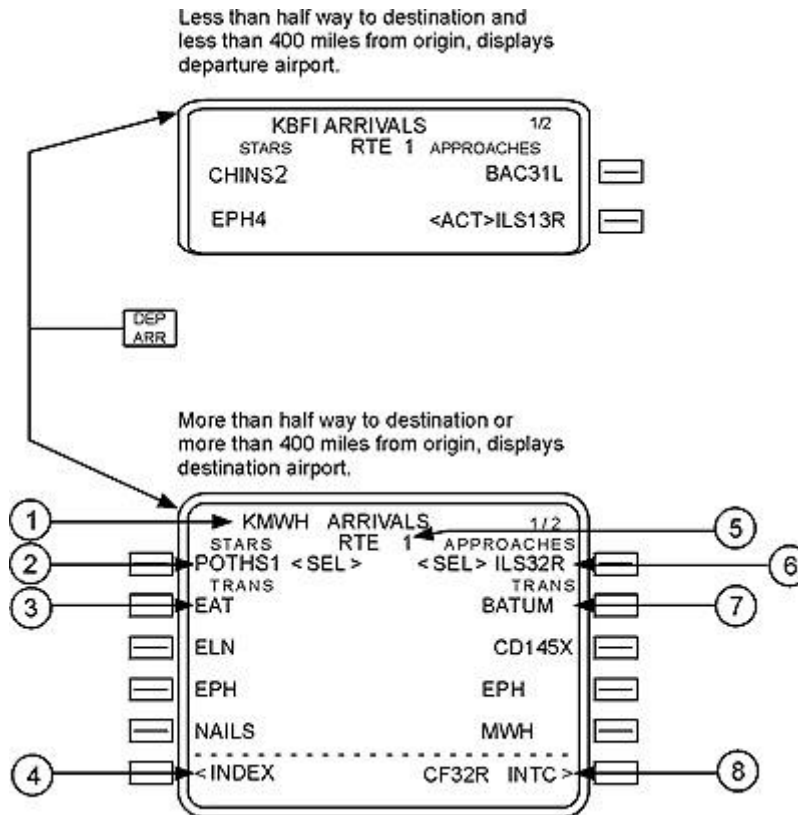
The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

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.

When a STAR is selected followed by selection of an approach or runway and a transition exists in the navigation database, the transition waypoints with associated speed/altitude constraints are inserted into the flight plan linking the STAR to the approach or runway. If more than one transition exists, selection of the applicable transition is made under TRANS on the left side of the page. Some STARS serve more than one runway. If a STAR and runway are selected and subsequently a different runway is selected, and if the STAR is compatible with the new runway, the transition waypoints are inserted into the flight plan linking the STAR to the runway. If a different STAR, runway or STAR-runway combination is desired, selecting another page and returning to the ARRIVALS displays all options.

**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), Profile Descents (PROF DES)

STARS display in a list under the STAR line title. Profile descents display below STARS under the PROF DES line title.

NONE displays when no STARS in the database.

Push –

- Selects STAR or PROF DES for entry into the route, <SEL> displays
- All other arrival procedures no longer display and transitions for the selected procedure display
- Deletes a previously selected procedure
- Displays ERASE prompt.

3. Standard Transitions (TRANS)

Displays list of transitions for the selected arrival procedure.

Push –

- Selects transition for entry into the route
- All other transitions no longer display.

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

Displays the destination airport approaches.

Selection and execution of an ILS approach autotunes the ILS receivers and displays the course. Selection and execution of a back course (BAC) approach autotunes the ILS and displays the front course. BAC approaches cannot be flown in the MCP LOC or APP mode.

Push –

- Selects approach for entry into the route; <SEL> displays; TRANS replaces RUNWAYS
- Displays profile descents for the selected approach; deletes all other approaches and runways
- Displays INTC prompt for the selected approach
- Displays ERASE prompt.

7. Approach Transitions (TRANS)

Displays a list of transitions to the selected approach.

Approach transitions include IAF's, feeder fixes and fixes providing routing to the FAF.

When transition not selected, approach will be a straight-in approach starting at a waypoint 4 to 8 miles outside the FAF. Waypoint may be a charted fix or CFXXX (XXX is the runway number).

Push –

- Selects transition for entry into the route
- Deletes all other transitions
- Displays INTC prompt for selected transition.

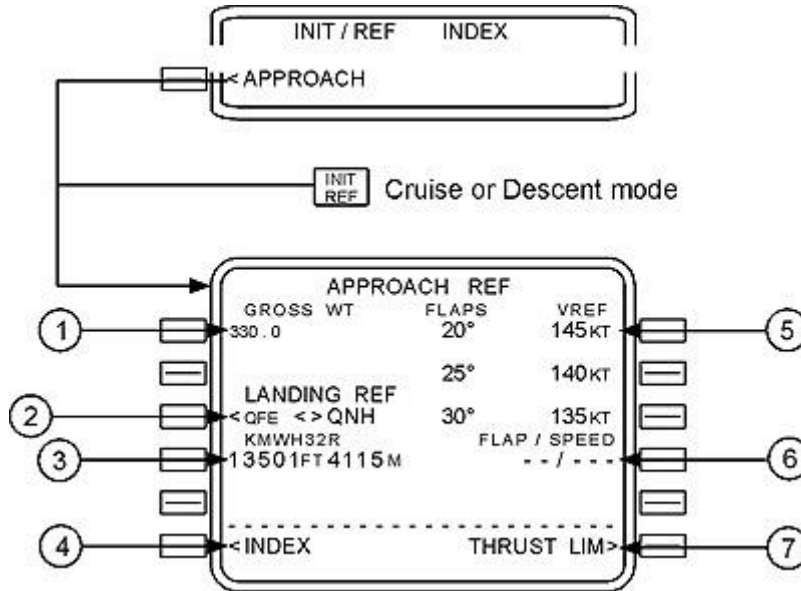
8. Final Approach Fix Intercept (XXXXXX INTC)

DO NOT USE FOR FLIGHT

Selecting the prompt shows a modified RTE LEGS page with an intercept course to the approach transition fix (usually the IAF) for the selected approach.

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 will become the FMC calculated gross weight when a different page is selected and the APPROACH REF page is reselected.

Permanent changes to gross weight result in recalculation of all performance data and may only be made on the PERF INIT page.

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

Valid entry is XXX.X.

2. Landing Reference (LANDING REF)

Landing reference is selectable between QNH and QFE. Usually, QNH is the operating mode.

Selecting QFE sets the cabin pressurization schedule, and the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb phase active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the green background color is removed.

Toggles between QFE and QNH. The active mode is shown in large green font. The inactive mode is shown in small white font.

3. Runway Length

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

DO NOT USE FOR FLIGHT

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.

4. INDEX

Push - shows the INT/REF INDEX page.

5. FLAPS VREF

A gross weight is necessary for VREF speed calculation. Push the applicable line select key to select the correct VREF speed. The three VREF speeds are based on landing flap setting.

Shows the calculated reference speed for flaps 20°, 25°, and 30°.

The display is blank until a gross weight is shown.

6. FLAP/SPEED

The flap position and VREF speed is entered for landing.

The VREF speed is shown on the PFD.

Deletion of the data removes VREF from the PFD.

B Thrust Limit (THRUST LIM)

Push - Shows the THRUST LIM page.

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, determines the entry method used (parallel, teardrop, or direct entry).
- 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.

DO NOT USE FOR FLIGHT**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.

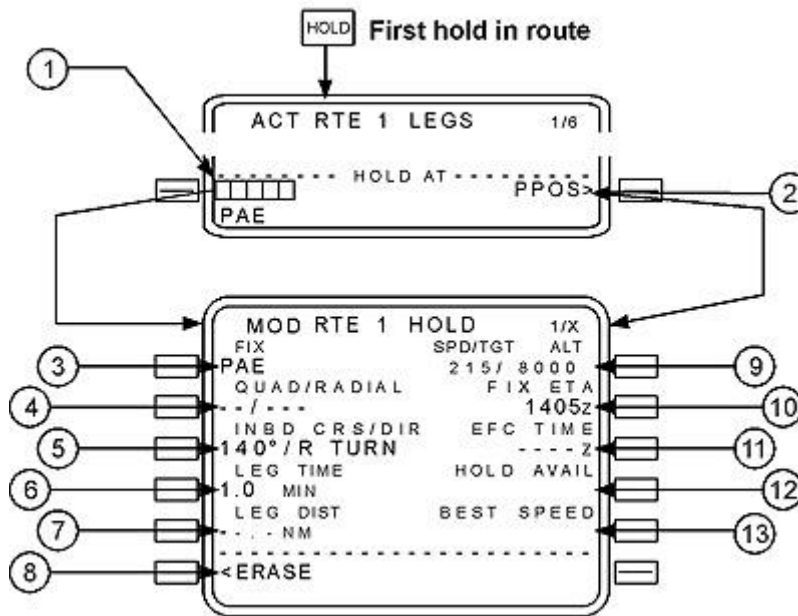
Two versions of the hold page are possible:

- An airway or procedure holding pattern.
- A flight crew-entered holding pattern.

The holding page shows 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 ND.

**1. HOLD AT**

Displays boxes to enter the holding fix: a RTE LEGS, database, or pilotdefined waypoint; a navaid or airport identifier; or a FAF already in the flight plan.

Entering a holding fix displays the RTE X HOLD page.

2. HOLD AT Present Position (PPOS)

Push –

- Creates a holding pattern at present position
- Execution establishes the holding fix at the position when EXEC is pushed and displays RTE HOLD.

3. Holding FIX

Displays the holding fix.

4. Quadrant/Radial (QUAD/RADIAL)

Normally displays dashes.

Valid entry is X/XXX, XX/XXX or /XXX. Example: NW/330.

Entry 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.

Displays magenta when the holding fix is the active waypoint.

6. LEG TIME

Displays 1.0 MIN (minute) at or below 14,000 feet.

Displays 1.5 MIN above 14,000 feet.

Displays dashes when an entry made on LEG DIST line.

Valid entry is XXX.X.

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

7. Leg Distance (LEG DIST)

Normally displays dashes. Allows entry of leg distance for hold.

Entry displays dashed on LEG TIME line.

Valid entry is XX.X or X.X.

8. ERASE

Erases all FMC modifications.

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

Dashes display or fix speed/altitude constraint from the RTE LEGS page.

Manual entries are in large font.

During cruise, entry of a target altitude lower than CRZ ALT modifies the DESCENT page and displays a T/D. After T/D, the DESCENT page remains active unless a new cruise altitude is entered.

Speed or altitude may be entered.

10. FIX ETA

With no EFC TIME entry, displays time the aircraft will next pass the holding fix.

With EFC TIME entry, displays time the aircraft will pass the holding fix after the EFC time. The FMC uses this time to calculate downtrack ETAs and fuel values based on departing the holding fix at the new FIX ETA.

11. Expect Further Clearance Time (EFC TIME)

Enter the time expect further clearance.

Entry changes performance predictions for the route after holding.

12. Hold Available (HOLD AVAIL)

Shows calculated holding time available before requiring reserve fuel to reach the destination.

13. Best Speed (BEST SPEED)

Shows the best holding speed for the airplane gross weight, altitude, and flap setting.

Note: May exceed ICAO limit speed.

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

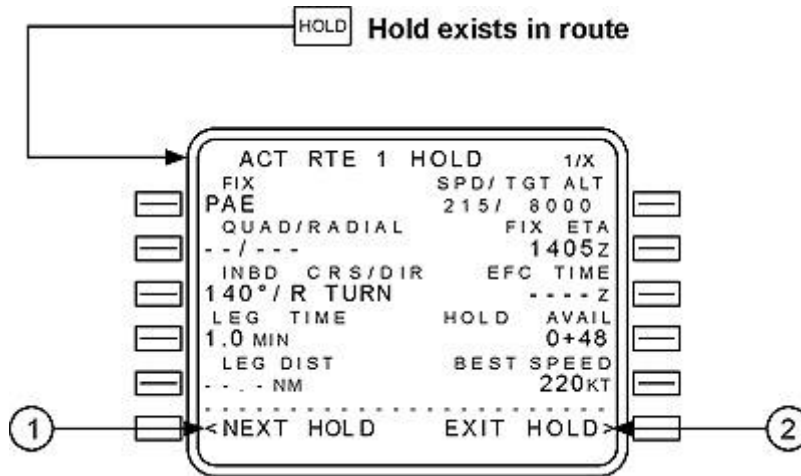
When one or more holding patterns are already in the route, push the HOLD key to show the hold page for the first holding pattern. When the hold is the next LNAV event, the active commands are shown in magenta. Holding parameters can be monitored and changed on this page. New holding patterns are added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

Most holding patterns are part of a procedure or airway and remain active until the flight crew executes an exit from holding. This may be accomplished in one of two ways.

- On the ACT RTE LEGS page, deleting or bypassing the HOLD AT waypoint causes LNAV to command a direct to the next waypoint.
- On the ACT RTE HOLD page, selecting and executing EXIT HOLD> causes LNAV to command the airplane to continue in the holding pattern until arriving at the holding fix, at which time the airplane exits the holding pattern.

The FMC automatically commands an exit from some holding patterns in procedures under the following conditions.

- For instrument approach holding patterns designed as a course reversal in lieu of a procedure turn, the airplane exits holding upon arrival at the holding fix inbound.
- For some holding patterns in SIDs, the airplane exits holding when arriving at an altitude.

**1. NEXT HOLD**

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

2. EXIT HOLD

Push -

- Arms a holding pattern exit.
- EXIT ARMED displays in shaded white; when executed, airplane returns to the holding fix via the inbound course for holding pattern exit.

Section 9: FMC MESSAGES

FMC messages tell the flight crew when system operation is degraded or if there are data input errors. They also tell about data link status. The messages are categorized as:

- Alerting messages
- Communications messages
- Advisory messages
- Entry-error advisory messages.

The scratchpad messages are shown 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 EICAS shows the advisory message FMC MESSAGE when there is an FMC alerting message. The EICAS shows the message ·FMC when there is an FMC communications message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

FMC ALERTING MESSAGES

FMC alerting messages:

- Are shown in the CDU scratchpad
- Cause the EICAS advisory message FMC MESSAGE to be shown
- Illuminate the CDU message light (MSG).

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

ALIGNMENT REINITIATED - ADIRU alignment has automatically restarted due to airplane motion, or if the flight crew-entered initial position fails the alignment comparison tests.

CHECK ALT TGT - VNAV is selected when the airplane is between the MCP window altitude and the VNAV target altitude. VNAV holds level flight.

CHECK AIRLINE POLICY - After loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the loaded value and notifies the flight crew of the difference. This is a maintenance function.

Note: If the scratchpad message is cleared, it is not shown again for that load.

DESCENT PATH DELETED - The final altitude constraint necessary to define the descent profile is deleted.

Note: This message is shown before execution of the modification which deletes the descent path.

DISCONTINUITY - The route is not defined after the waypoint (except when the waypoint is before a manually terminated leg, such as FM, VM, HM legs).

- FM - A course from a fix to a flight crew entered manual route termination
- VM - A heading leg from a fix to a flight crew entered manual route termination
- HM - A holding pattern to a flight crew entered manual route termination.

DRAG REQUIRED - Airplane speed is too fast. Drag is required to remain on the VNAV descent path and stay within speed tolerances.

END OF OFFSET - The message is shown 2 minutes before the offset leg termination point.

END OF ROUTE - The airplane is passing the last route leg waypoint.

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

FUEL DISAGREE-PROG 2/2 - Totalizer (TOTL) fuel quantity and FMC calculated (CALC) fuel quantity disagree by 9,000 pounds for more than 5 minutes.

INERTIAL/ORIGIN DISAGREE - The airplane is on the ground and one of these conditions exist:

DO NOT USE FOR FLIGHT

- The inertial position entered on the POS INIT page differs from the position of the origin airport in the active route by more than 6 NM.
- A route is activated and executed containing an origin airport with a position that differs from the ADIRU inertial position by more than 6 NM.

INSUFFICIENT FUEL - Because of a change in flight conditions or the route, the calculated route fuel burn exceeds the total fuel on board, less reserves.

LIMIT ALT FLXXX - The flight crew- or FMC-selected altitude is greater than the VNAV limit altitude.

LNAV BANK ANGLE LIMITED - Before entering or while flying a curved path or holding pattern, the FMC predicts the LNAV roll command will be limited by thrust or buffet based roll limits.

NAV DATA OUT OF DATE - The clock calendar date is after the active navigation database valid calendar cycle.

NAV INVALIDDTUNE XXXX - RNAV or VOR approach procedures must have a specific navaid tuned. It is either not tuned or a valid signal is not being received.

NO ACTIVE ROUTE - The MCP LNAV switch is pushed and the FMC does not have an active lateral route.

NO ROUTE DATA - In ALTN NAV, the MCP LNAV switch is pushed and the CDU does not have an active lateral route.

PERF/VNAV UNAVAILABLE - The MCP VNAV switch is pushed and gross weight, cost index, or cruise altitude are not entered.

RESET MCP ALT - Shown 2 minutes before the top of descent point when MCP altitude is still set to airplane altitude.

RTA FIX DELETED - A modification has removed the active RTA waypoint from the flight plan.

RW/ILS CRS ERROR -

- The airplane is within ILS automatic tuning range and the tuned ILS course does not match the course for the active arrival runway, or
- The FMC is not receiving valid course data from the same ILS that the FMC is using for frequency data.
- Inhibited if scratchpad message ILS TUNE INHIBITED-MCP is shown.

RW/ILS FREQ ERROR -

- The airplane is within ILS automatic tuning range and the tuned ILS frequency does not match the frequency for the active arrival runway, or
- The FMC is not receiving valid frequency data from either ILS.
- Inhibited if scratchpad message ILS TUNE INHIBITED - MCP is shown.

SINGLE FMC L OPERATION - The right FMC is not operational.

SINGLE FMC R OPERATION - The left FMC is not operational.

TAKEOFF SPEEDS DELETED - Selected V speeds are invalid.

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

UNABLE FLXXX AT RTA FIX - The airplane is unable to meet the required altitude at the RTA waypoint.

UNABLE RTA - The airplane is unable to meet the RTA entered on the RTA PROGRESS page.

UNABLE NEXT ALT - VNAV is not able to meet the next climb restriction altitude.

VERIFY POSITION - The FMC calculation of airplane present position is based on conflicting data. The possible conflicts are:

- The active FMC and the inactive FMC positions differ by more than twice the RNP for 5 seconds
- The difference between the FMC and the position and the aiding sensor (GPS, DME, VOR, or inertial) is greater than 12NM for 5 seconds.

DO NOT USE FOR FLIGHT

VERIFY RNP - POS REF 2/3 - The default RNP has changed due to a change in flight phase and the flight crew has previously entered a different RNP value on the POS REF 2/3 page.

VIA OFFSET INVALID - Flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.

FMC ADVISORY MESSAGES

FMC advisory messages are shown:

- On the CDU scratchpad.
- And illuminate the CDU message light (MSG).

DELETE - The DELETE key was pushed.

HOLD AT XXXX - A waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, 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 ALTN UPLINK - A company-preferred list of alternate airports and associated alternate data has been received but the data is not valid and can not be shown.

INVALID ALTN LIST UPLINK - A company list of up to 20 alternate airports has been received but the data is not valid and cannot be shown.

INVALID FLT NO UPLINK - A new flight number has been received but the data is not valid and cannot be shown.

INVALID FORECAST UPLINK - Descent forecast data has been received but the data is not valid and cannot be shown.

INVALID PERF INIT UPLINK - Performance initialization data has been received but the data is not valid and cannot be shown.

INVALID ROUTE UPLINK - A new flight plan route or modification to the active flight plan route has been received but the data is not valid and cannot be shown.

INVALID TAKEOFF UPLINK - Takeoff data for up to six runways or runwayintersection pairs has been received but the data is not valid and cannot be shown.

INVALID WIND DATA UPLINK - En route wind data has been received but the data is not valid and cannot be shown.

MAX ALT FLXXX - The altitude entry on any CDU page is above the performance calculated maximum altitude.

NOT ON INTERCEPT HEADING - LNAV is selected on MCP and the airplane is not within the capture criteria of active leg, or the present heading will not intercept the active leg.

STANDBY ONE - The FMC requires more than 4 seconds to show data.

TIMEOUT-RESELECT - Communication between the FMC and the CDU has failed. The flight crew must reselect FMC on the CDU MENU page.

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

CDU ANNUNCIATOR LIGHTS

These annunciator lights illuminate when certain conditions exists.

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 shown, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is shown.

OFST - An offset path has been entered and executed.

MSG - An FMC message is waiting to be shown or is shown.

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 |

DO NOT USE FOR FLIGHT

| | |
|-----|---------------------------------------|
| CA | Course to altitude |
| CD | Course to DME distance |
| 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 |

DO NOT USE FOR FLIGHT

| | |
|------------|----|
| 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 Nav aids.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> | = BA19410001 |
| <i>COData</i> | = BA1001 |
| <i>OPProgram</i> | = PS4052970-953 |
| <i>OPCNumber</i> | = 3173BCG00025 |
| <i>Version</i> | = 1.0 |

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 web site.

We support Original FMS database only. Original database - aeronautical data database included into the original product pack.

CUSTOMER CARE

SIM OPS

We encourage you to visit the one-stop resource for the 737 Captain flightsim operations: [the Sim Ops](#)

TECHNICAL SUPPORT

If you have trouble with this product, please use our Ticket based support system and an extensive Knowledge Base at: <https://www.captainsim.com/support>

FORUM

You are invited to join [Captain Sim forum](#)

SOCIAL NETWORKS

Please follow us at:

[Twitter](#)

[Facebook](#)

[Google+](#)

[Instagram](#)

VIDEO CHANNEL

For Captain Sim videos please subscribe to our YouTube [channel](#).