



# 146

**PROFESSIONAL**

**UNIVERSAL FLIGHT  
MANAGEMENT COMPUTER  
OPERATING MANUAL**

**Just Flight**



# Universal Flight Management Computer Operating Manual

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# INTRODUCTION – FLIGHT MANAGEMENT COMPUTER

This manual provides details of how to use the UFMC (Universal Flight Management Computer) which is integrated into the Just Flight 146 Professional.

This is an extremely sophisticated FMC. A note about terminology is required here. The terms 'FMS' and 'FMC' are often used interchangeably, but an FMS (Flight Management System) is a larger and more sophisticated system than is implemented in most flight simulators. Therefore, for the purposes of this manual, the system will be referred to as the 'FMC' in this FCOM (Flight Crew Operating Manual).

The system provides guidance information for the autoflight system as well as other useful functions. Its various components allow for very precise control and management of the aircraft in all flight regimes.

The FMC helps the flight crew with navigation, performance optimisation and automatic fuel monitoring. The flight functions manage the aircraft's lateral flight path (LNAV) and vertical flight path (VNAV) via the autopilot. This FMC also tunes the navigation radios and sets the desired courses for various procedures such as approaches, SIDs and STARs, using the navigation database to supply the necessary data to fly all routes.

Cruise altitudes and altitude restrictions are selected by the pilots based on their ATC clearances and established procedures for the FMC to calculate VNAV behaviour. To accomplish this, pilots enter route and flight data into the FMC, which then uses its navigation database and aircraft position information to calculate the flight path, issue pitch and roll commands and command the aircraft's autopilot and FD operating modes (LNAV and VNAV).



# CONTROL DISPLAY UNIT (CDU)

The primary component of the aircraft's sophisticated FMC that is visible to the pilots is the CDU.

There are two of them on the flight deck. The CDU consists of a keyboard and a display with Line Select Keys (LSKs) on either side of the display.



There are two separate CDUs – one on the Captain's side of the cockpit and one on the First Officer's side.

The two functional CDUs can be called up by pressing the [F8] key in Windows and Linux (use the [fn] and [F8] keys simultaneously on a Mac) for the Captain's CDU and the [F8]+[Alt] keys in Windows and Linux (use the [fn], [option] and [F8] keys simultaneously on a Mac) for the First Officer's. Alternatively, the CDUs in the 3D panel can be used just as easily.

The upper 'dragging' zone allows the user to move the 'pop-up' FMCs around the screen as needed. By clicking and holding the upper part of the pop-up FMC you can move the CDU around the computer screen. It can also be moved to other connected monitors; this is accomplished by clicking on the top right of the pop-up window. To bring the pop-up window back to the main X-Plane screen, click on the top left corner where it says 'P\_In'.

Clicking and dragging the top right corner of the CDU allows the user to increase the size of the FMC to suit their preference and/or monitor size.

The LSKs (Line Select Keys) are used to select various lines of information on the screen:

- LSKs numbered LK1 to LK6 on the left side, numbered from top to bottom
- LSKs numbered RK1 to RK6 on the right side. also numbered from top to bottom

The following keys bring up various pages of FMC data:

- INIT REF
- RTE
- DEP / ARR
- VNAV
- FIX
- LEGS
- HOLD
- PROG
- EXEC
- MENU
- NAV / RAD
- PREV PAGE
- NEXT PAGE
- DEL
- CLR

The ATC and FMC COMM menu keys are non-functional in this version.

There are two message light 'zones' on the left and right of the CDU. The left one lights up with the message 'K' to show that it is accepting direct input from the user's computer keyboard. To enable the use of the computer keyboard again (for an XP command key, for example) simply click in the right message zone area.

There are two messages that appear in the right area. One is 'MSG' which means that there is an FMC message being displayed and serves to alert the pilots. The other is 'OFFS', which informs the pilots that the aircraft is flying a lateral deviation offset that has been entered into the FMC RTE page.

**Note:** *These clickable zones are only available on the pop-up CDUs, not the ones built into the 3D cockpit. The information displayed, however, is the same for both.*

The bottom line of the display is reserved for what is called the 'scratchpad' and is where entries into the FMC are made. Typically, items selected with the LSKs will be copied down to the scratchpad to reduce the need to retype.

# FMC FUNCTIONS

Features of the UFMC include:

- Built-in tables for climb rates and descent rates
- Optimised tables for fuel consumption in climb, cruise and descent
- Top of Climb (T/C), Top of Descent (T/D), fuel at waypoints, Expected Time of Arrival (ETA), position and overall predictions calculated dynamically
- CLB, CRZ and DES pages
- Implementation of a COST INDEX that affects climb, cruise and descent-calculated speed
- Full aeronautical database which includes airways, Standard Instrument Departures (SIDs), Standard Terminal Arrivals (STARs) and runway lengths
- Accurate computed fuel prediction for the trip
- Insufficient fuel warning message based on predicted fuel burn
- Vertical Navigation (VNAV) and Lateral Navigation (LNAV) modes integrated with the autopilot
- Provisions for altitude and speed restrictions
- Calculations for V1, VR and V2 based on real aircraft data
- Ability to save routes, load previously saved routes and to import UFMC flight plans
- 'Route Full' message
- Manual control of radio navigation aids
- Ability to pause the simulator some distance before the T/D
- Pop-up for the CDU to facilitate entries and display
- Ability to handle the following types of information and procedure:
  - Intersections
  - DME arcs
  - Altitude waypoints
  - Conditional waypoints
  - Waypoint bearings with distance
  - Holds
  - Intersection of bearings of two waypoints
  - Along track waypoints
  - Route hold page with no holding fix in route
  - Route hold page after pushing POS to hold at the current aircraft position
  - Route hold page with holding fix in route
  - Lat/long entries
  - Route lateral offset
  - Required Time of Arrival (RTA)
  - Speed transition in the approach phase until slats/flaps are extended

# NAVIGATION DATABASE

## Installation

This UFMC comes with a navigation database supplied by Navigraph for use with the FMC. There are some considerations for users to operate the aircraft most effectively which require some explanation. This is particularly important for those who wish to fly online or follow real-world flight plans.

The most important thing to understand is that the FMC has its own database and it can be updated, but X-Plane also has databases of navigation data (which can also be updated through various methods). Not everyone wants to invest time and resources in updating these databases, but problems can occur when these two sets of navigation data are not at the same revision level.

**Note:** *If an AIRAC navigation database is not installed, the FMC will show a message to this effect in the scratchpad. For this add-on to work properly, you need to install a navigation database.*

To make the proper choices, and for users to select the revision process that suits their needs, some explanation of how the UFMC uses its databases is required.

Airway information is read from X-Plane's earth\_awy.dat file. The FMC also reads fixes and navaids from the X-Plane database to ensure that the FMC is compatible with the X-Plane world as much as possible. The UFMC's philosophy is that navaids are physical transmitters that broadcast radio energy in the real world, so these should be available in the X-Plane simulated world as well, and airways are still mostly dependent on these navaids (although that is changing, with GPS gradually replacing ground-based navaids).

In all cases, navigation data is stored in the X-plane/Custom Data folder. The UFMC includes a new Navigraph AIRAC dataset that will fix some problems related to SIDs, STARs and approach procedures that were sometimes not found when airports/runways changed in X-Plane. This new dataset also allows for a much faster loading of airport information into the FMC. We have included an AIRAC dataset in this new format, but it is for cycle 2009.

**Note:** *If you have already installed the navigation database for the UFMC, you do not need to do this again. Or, if you have a more recent database already installed via some other add-on, you do not need to install the older database provided in this package. You may still wish to install the database provided in order to access the sample flight plan folder which has many representative flight plans in .ufmc format to allow for quick and easy flying. This folder is titled 'FlightPlans' and can be copied to X-Plane's Custom Data/UFMC folder. Installation is also simplified, as described below.*

### Updating navigation data for X-Plane can be done in two ways:

1. Using the data that comes with this add-on (slightly older navigation data but it is available thanks to Navigraph)
2. Using Navigraph (payware) current AIRAC data

A navigation data installer is included in this package. It is primarily intended for first-time installations because it will overwrite the existing navigation database files used by the FMC.

For Windows, run the **AIRAC\_2009\_UFMC\_Installer1.exe** file.

For Mac, run the **AIRAC\_2009\_UFMC.pkg** file.

Make sure that you select your root X-Plane folder when requested by the installer so that it can place the necessary files in their proper locations.

## Update instructions

It is also possible to install navigation dataset updates available through a paid subscription from Navigraph, which can be installed in two ways.

## Update manually

To update the Navigraph database manually, go to the [Navigraph](#) website and log in. Then click the link for the 'FMS Data Manager'.

On the right-side panel select 'Manual Install'.

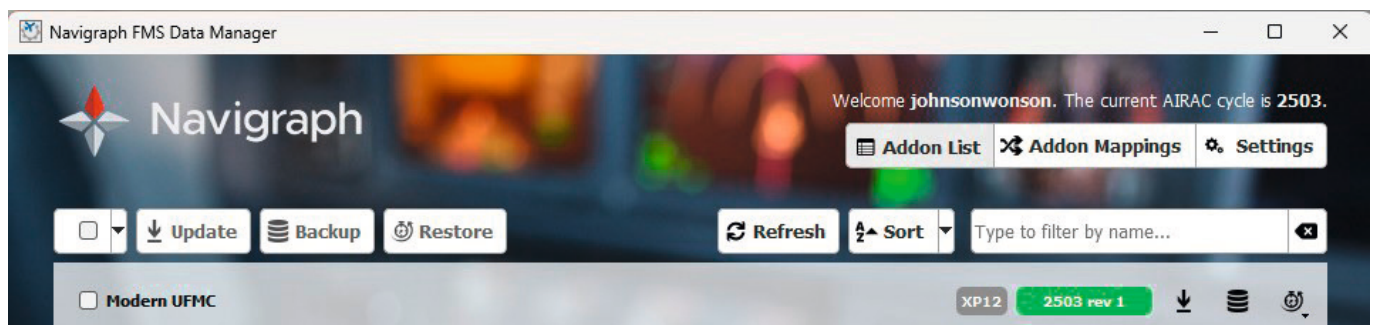
Once there, scroll down the page and select the 'UFMC' version.

Then click the Download button and unzip the downloaded archive.

Take the files from the unzipped folder and drag them into X-Plane's 'Custom Data/UFMC/' folder. If the folder does not exist yet, it will need to be created. This is the link for manually installed files: <https://www.navigraph.com/FmsDataManualInstall.aspx>

## Update with the Navigraph FMS Data Manager

Another option is to use Navigraph's FMS Data Manager (DM). Open the DM and note whether the current generation is loaded (green buttons versus yellow ones). If an update is required, select the left-most tab under the Navigraph logo to 'Select All', then click the 'Update' button. When all the files are updated you will see a screen like the one shown below:



If you have not loaded the UFMC dataset, here is how to do it:

Click the 'Addon Mappings' tab. Once there, select 'Please select an addon'. That will open a window with a long list of add-on file sets to choose from. Select 'Modern UFMC' and that set will be added to your list and stored within the Navigraph app. Save that selection and return to the add-on list where you will now see 'Modern UFMC' added to your list.

**Note:** If you already have an updated database in X-Plane, you only need to install the UFMC dataset (manually) and avoid overwriting the updated X-Plane navigation database you already have.

**Note:** Don't forget to update the X-Plane AIRAC to the same date as the UFMC AIRAC.

# FMC OPERATION

When pilots enter the aircraft's cockpit to conduct a flight, the FMC is initialized and is in the pre-flight phase. When a phase is completed, the FMC internally changes to the next phase, in the following sequence:

- Pre-flight
- Take-off
- Climb
- Cruise
- Descent
- Approach
- Landing
- Flight complete (end of route)

The FMC never reverts to a previous phase. If it is in the cruise phase, for example, and the aircraft climbs to another cruise level, it accomplishes the climb in the cruise.

## Pre-flight phase

During pre-flight the ATC flight plan, routes and performance data are entered into the FMC. Part of this data is entered manually and the other part is filled in from the FMC's own information sources, such as the known performance of the aircraft and sensed information such as fuel quantity, aircraft weight, atmospheric conditions and so on, which are channelled into the FMC by the aircraft's systems.

The flight plan defines the route of flight from origin to destination and initializes the LNAV mode. Flight plan and aircraft information are combined by the FMC to develop the performance data used by the VNAV mode. A previously stored route can be loaded (from any source that can generate flight plans in the UFMC format or as a pre-saved company route) and a newly entered route can be stored (but only when the aircraft is on the ground).

The pre-flight data consists of the following:

- Initial position (from X-Plane)
- Route of flight (previously stored or manually entered)
- Performance data (channelled to the FMC)
- Take-off data (entered manually)

Optional data includes:

- SID (from navigation database)
- STAR (from navigation database)
- Approaches (from navigation database)

The first step is to enter data with the IDENT page, which is selected with the IDENT prompt on the INIT/REF INDEX page.

After the necessary data entered on each page is checked, press RK6 to select the next page. When ACTIVATE is selected on the ROUTE page (RK6), the 'Execute' (EXEC) light illuminates, and pressing the EXEC key is required at this point to make the route active.

The next step is to use the 'Departure/Arrival' (DEP/ARR) page to select a runway and a SID. The FMC uses navigation databases for its calculations that are valid for 28 days. Each database set corresponds to the standard navigation chart revision cycle known as Aeronautical Information Regulation and Control (AIRAC). The contents of this navigation database can be periodically updated (payware) and transferred to the FMC before the active data's expiry date, particularly if you wish to fly using online ATC services such as VATSIM and IVAO.

When all required pre-flight entries are complete, the PREFLT label on the TAKE-OFF REF page changes to a dashed line. Now select THRUST LIM by pressing RK6 again.

## Take-off phase

The take-off phase starts with selection of the desired take-off N1 value and finishes when the thrust reduction altitude is reached. At this point climb thrust changes from 'Armed' to 'Selected'.

## Climb phase

The climb phase starts at the thrust reduction altitude and finishes when the top of climb (T/C) point is reached. The T/C point is where the aircraft reaches the cruise altitude that was entered on the PERF INIT page.

## Cruise phase

The cruise phase starts at the T/C point and finishes when reaching the top of descent (T/D) point. The cruise phase can include step climbs and cruise level descents.

## Descent phase

The descent phase starts at the T/D point and finishes with the approach phase.

## Approach phase

The approach phase starts when the first waypoint of the procedure sequence (such as a STAR) is reached, or when the distance to the destination airport is less than 25 nautical miles.

## Landing phase

The landing phase starts when you perform the flare and finishes at the end of route phase.

## End of route phase

Thirty seconds after aircraft touchdown, the end of route phase clears the active flight plan and pilot-entered information. To prepare for another flight, the FMC needs to be initialized on the INDEX page.

# OPERATIONAL RULES

When using the LNAV and VNAV modes, continuous checking of the pitch, roll or thrust commands by the pilot is recommended. If any problem is noticed, another roll and pitch mode must be selected.

The FMC will not follow the active waypoint when more than 3.0 NM off the active route (except if it is in LATERAL OFFSET mode). A return to the active route has to be accomplished using DIRECT TO or by changing to HDG mode to intercept the track of the desired course.

When a waypoint is in the route more than once, the FMC deletes the appropriate one automatically.

When entering airways in a route page, the start and end waypoints must be in the navigation database. A route segment must be entered as a DIRECT leg.

DIRECT TO courses are segments of a great circle route. When entering a DIRECT TO waypoint on the LEGS page, this is now the destination waypoint from the aircraft's current position.

# DATA ENTRY

Data is entered into the FMC by pressing the corresponding LSK or RSK on the scratchpad. You can also use the rest of the keys by pressing them or by using the numerical keys on your computer.

If you want to use your computer keyboard, just click in the pop-up FMC's left rectangular display zone, after which a 'KEYBOARD' message appears here to inform you that this mode has been entered. To revert to using keyboard commands for X-Plane, click in the same area again. You can revert to mouse operation by simply clicking any part of the pop-up CDU or the rest of the screen for X-Plane. If the CDU is in front of a button or device in the aircraft panel, clicking it will activate the CDU, so it may need to be moved.

The CLR key remembers the previous scratchpad data you have entered, so if you press the CLR key repeatedly you will see the last entered data. Pressing CLR once will delete the character, and if the CLR key is pressed for one second this will delete the complete scratchpad line and the previous data entered in the scratchpad will appear.

## Waypoint bearing with distance

For bearing with distance, enter in the scratchpad as follows:

**DEL180/10**

This means that you want to display a point that is on a bearing of 180° and 10 NM away from the DEL VOR.

Now indicate with LKx the position in which you want to enter the new waypoint. The FMC will then show the following:

**DEL01**

If you enter a second fix with the same name, it will show as:

**DEL02**

The FMC always displays the first three letters of what you entered and the following numbers, which can range from 01 to 49.

## Intersection of two waypoint bearings

To display these, you make the following entry in the scratchpad:

**SEA330/OLM020**

This means that you want to display a point where the 330° radial of SEA VOR and the 020° radial of OLM VOR intersect. Pressing the LKx position you want, the FMC will show the following:

**SEA01**

## Along track waypoints

When you have a route, for example from ELN to EPH (042°) and you want to have a waypoint between these waypoints, then you can enter the following:

**ELN/25**

This will be a waypoint 25 NM away from ELN, but still with the same course between ELN and EPH (042°).

The FMC will show this in the LEGS page:

**ELN01**

The same rules apply when creating waypoints as described above.

## Latitude/longitude entries

The format to enter latitude and longitude positions in the LEGS page is:

**N4147.9W08745.1**

This represents a position of N 41°47.9' W 087°45.1'.

Note that there are no spaces and also that you have to enter ALL digits (zeros, dots and decimals). When this waypoint is entered, the FMC will display it like this in the LEGS page:

**N41W087**

You can also enter this format: N45W130 or S61E020. This format can be entered in the RTE page as well.

## TERMINOLOGY

The following information describes some terminology to give you a better understanding of how to use the FMC:

**Active** – flight plan data currently being used to calculate LNAV or VNAV.

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

1. Select the ACTIVATE prompt.
2. Push the execute (EXEC) key.

**Altitude restriction** – a restriction altitude at one waypoint.

**Delete** – remove FMC data and revert to default values, dash or box prompts, or a blank entry by using the DELETE key.

**Econ** – a speed profile calculated to optimise operating costs. The economy speed is based on the cost index. A low cost index results in a lower cruise speed. Maximum-range cruise or the minimum fuel burn speed may be obtained by entering a cost index of zero. This speed profile does not take into account the time. A minimum-time speed profile is obtained by entering a cost index of 9999. A low cost index is used when fuel costs are high compared to operating costs.

**Enter** – writing data in the scratchpad and then pressing any LSK to enter the data.

**Erase** – removing entered data by selecting the ERASE key before activation.

**Execute** – press the EXEC key to make any modified data active.

**Initialize** – reset all the data required by the FMC.

**Message** – the data that the FMC displays in the scratchpad to advise the crew of a system condition.

**Modify** – active data that is changed but not yet executed. When a modification is made to the performance mode, MOD is shown in the page title, ERASE shows next to LSK RK6 and the light above the EXEC key illuminates.

**Select** – pressing a key to obtain data, make an action or to send data to the scratchpad.

**Speed restriction** – an airspeed limit in a waypoint entered by the flight crew.

**Speed transition** – an airspeed limit associated with a specified altitude entered in the FMC.

**Waypoint** – a point on the route. It can be a navigation fix (these are shown on charts and have specific names), latitude and longitude coordinates or a navigation aid (VOR or NDB station).

# INTEGRATED APPROACH NAVIGATION (IAN)

The UFMC now incorporates IAN (Integrated Approach Navigation), which is a suite of features that allows pilots to fly any non-precision approach as they would an ILS approach. Therefore a VOR, LOC and RNAV approach can be flown as an ILS approach using a glide path (G/P) generated by the FMC similar to the glideslope of an ILS.

**Note:** IAN is not available for NDB approaches in the UFMC.

Note that it is very important to correctly set the proper barometric setting for the conditions at the airport because the altimeter is the primary method of ensuring that altitude constraints are adhered to for the approach.

# LATERAL NAVIGATION (LNAV)

LNAV sends commands to an autopilot to fly to the next waypoint. LNAV engages at or above 50 feet, when laterally within 3.0 nautical miles of the active route leg, if the autopilot is engaged. FMC LNAV guidance normally follows great circle courses between waypoints.

However, when an arrival or approach from the FMC database is entered into the active route, the FMC will supply commands to fly a constant heading or track, or follow a DME arc, as required by the procedure.

# WAYPOINTS

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

The FMC message 'NOT IN DATABASE' or 'NOT FOUND' is shown if a manually entered waypoint identifier is not in the X-Plane navigation database.

**VORs** – waypoints located at VORs are identified by use of the station identifier.

**NDBs** – waypoints located at NDBs are identified by use of the station identifier.

**Fix waypoint names** – fixes with single names containing five or fewer characters are identified by the fix name.

# RTE LEGS PAGE



**Hdg** – this is the magnetic heading to follow for the next waypoint. The magnetic variation of the area is taken into account.

**Waypoint** – name of the waypoint that can be any type of navaid. This can even be a GPS coordinate. The maximum number of waypoints in a route is 160 waypoints and 25 LEGS pages.

**Number of pages** – indicates the current page and the total number of pages.

**Distance** – displays the calculated distance in NM to the next waypoint (i.e. from one waypoint to the next one).

**Speed/altitude** – speed and altitude associated with a waypoint. This is calculated by the FMC in the INIT/REF page and is later updated during the entire flight.

**Cycling through pages** – to see the remaining waypoints you can press NEXT PAGE and PREV PAGE. This functions in a cyclical way, meaning that if you reach the last page and click NEXT PAGE, you will return to the first page. You can also do the same with PREV PAGE and obtain the same result, but in reverse.

**Modifying** – to modify the route, go to the RTE page by pressing the RTE button or in the main LEGS page.

## Waypoint identifier

The active leg is always the first line of the first active RTE LEGS page. The active waypoint is on the active leg. Modified waypoints create a route discontinuity that must be resolved.

All route waypoints are shown. Waypoints on an airway are included on the RTE LEGS page. Waypoints are shown in flight sequence and they can also be modified as follows:

- Add waypoint
- Delete waypoint
- Change waypoint sequence

This can be done in the LEGS page or in the RTE PAGE.

## Distance to the next waypoint

Distance (decreasing) from the aircraft's position to the active waypoint (first waypoint or next waypoint), or from waypoint to waypoint.

## Waypoint speed/altitude restrictions

Waypoint speed or altitude restrictions are shown in a larger font.

Manual entry is allowed in any phase, but only to waypoints belonging to the climb phase or descent phase. They can also be entered by the FMC when restrictions are part of a procedure.

Speed constraints are assumed to be at or below the shown speed.

Data entry is as follows:

- Speed entry has to be an airspeed
- XXX/XXXXX – airspeed/altitude entered simultaneously
- /XXX, /XXXX, /XXXXX – altitude only
- XXX/ – speed only

Altitude restriction suffixes:

- Blank – cross at altitude predicted by the FMC
- A – cross at or above altitude
- B – cross at or below altitude (normally AT)

## Waypoint speed/altitude FMC predictions

Waypoint speed and altitude predictions are displayed in a smaller font. The predictions are calculated by the FMC during the entire flight.

Note that the VNAV PTH mode is present in the descent phase when there is an altitude restriction below the cruise altitude.

To modify the route, the following can be accomplished:

- Add and delete waypoints
- Change the waypoint sequence

## RTE LEGS page modifications

### Adding a waypoint

A waypoint can be added to the route at any point and at any moment.

Firstly, the waypoint name is entered into the CDU scratchpad.

Then find the correct line in the flight plan and press the adjacent LSK. The scratchpad waypoint name is inserted into the selected line. The entered waypoint is connected to the waypoint above and below it via a direct route.

Performance predictions to destination on the PROGRESS page are recalculated, assuming the route of flight is direct between waypoints.

## Deleting waypoints

Use the RTE or LEGS page to remove waypoints from a route, but the active waypoint cannot be deleted. The two valid methods for removing a waypoint are:

- Delete the waypoint with the DELETE function key
- Change the waypoint order

The data in the route that comes before the deleted waypoint is not affected by these changes.

## Delete entry

Pressing the DEL key arms the delete function and displays a 'DELETE' message on the scratchpad.

With 'DELETE' in the scratchpad, pushing the LSK next to a waypoint deletes that waypoint.

## Waypoint order in LEGS page

A waypoint may be manually typed in the scratchpad or copied from its LSK to the scratchpad. To copy a waypoint from the flight plan, press the waypoint's LSK on one of the LEGS pages.

Then press an LSK in a route and the waypoint will be inserted at that location, thus changing the order and creating a ROUTE DISCONTINUITY as well.

## 'Direct To' and 'Intercept Course To'

If LNAV is not active, activation will occur when the aircraft is within 3.0 miles of lateral offset and on an intercept heading to the active track leg; pushing the LNAV switch activates LNAV or else it will arm the LNAV mode.

## Direct To

As explained previously, pressing the LSK next to a waypoint will copy that waypoint into the scratchpad. Then, by pressing LSK1, the waypoint will be inserted as a destination waypoint, removing all the waypoints between the new destination waypoint and the previous destination waypoint. In this case, there will be no ROUTE DISCONTINUITY.

If you press EXEC, it will be changed. If you press ERASE, it will go back to the previous situation.

# VERTICAL NAVIGATION (VNAV)

VNAV is the vertical navigation profile during the climb, cruise, descent and approach phases of flight.

## Take-off and climb

Preparation for this phase starts in the pre-flight phase and includes the entry of TAKE-OFF REF page data.

The take-off phase automatically changes to the climb phase when the FMC switches to climb thrust. The climb phase continues to the T/C point, which is where the cruise phase starts.

During take-off and climb, the pages listed below provide functionality as described:

**TAKE-OFF REF** – make last-minute changes to the V-speeds.

**DEPARTURES** – make last-minute changes to the departure runway or SID.

**LEGS or RTE** – modify the route and monitor route progress.

**PROGRESS** – monitor the progress of the flight.

## Take-off phase

When selecting the departure runway and SID in the TAKE-OFF REF and DEP ARR pages, the pilot must also select EXEC when the light above it is illuminated, in order to confirm the selection. The modified data are entered in the same manner as during pre-flight.

The FMC commands through the FD bars an acceleration to  $V_2+20$  knots. VNAV is engaged at 400 feet AGL if the autopilot is engaged and you press VNAV.

Usually LNAV can be activated at 50ft radio altitude and commands a roll to fly the active route leg if the autopilot is engaged.

At 400 feet AGL VNAV mode can be engaged and it commands a pitch to fly the climb path. During take-off the target airspeed is  $V_2+20$  knots.

## Acceleration height

At the preselected acceleration height VNAV commands an airspeed increase to the flap retraction speed. Then, as the flaps are retracted, the speed is increased to 250 knots or the speed transition associated with the origin airport and entered in the CLIMB page, whichever is greater.

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

## VNAV climb

The VNAV climb profile uses VNAV SPD or VNAV PTH as the default climb speed or the pilot-selected climb speed (IAS, MACH or V/S) to remain within all airspeed and altitude restrictions that are part of the selected SID.

If the climb speed profile cannot achieve a particular altitude restriction, an 'UNABLE NEXT ALTITUDE' message appears in the scratchpad.

At acceleration height or the first movement of the flap handle during flap retraction (depending on what condition is selected in the TAKE-OFF page), VNAV commands acceleration to 250 knots or the preselected transition speed.

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

Passing 10,000 feet, VNAV commands acceleration to the economy climb speed (in either knots or Mach %), which is maintained until entering the cruise phase. It should be noted that waypoint speed restrictions take priority.

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

When the climb profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the message 'UNABLE NEXT ALTITUDE' in the CDU scratchpad. A different speed profile that provides a steeper climb angle must be manually selected by the pilot at this point.

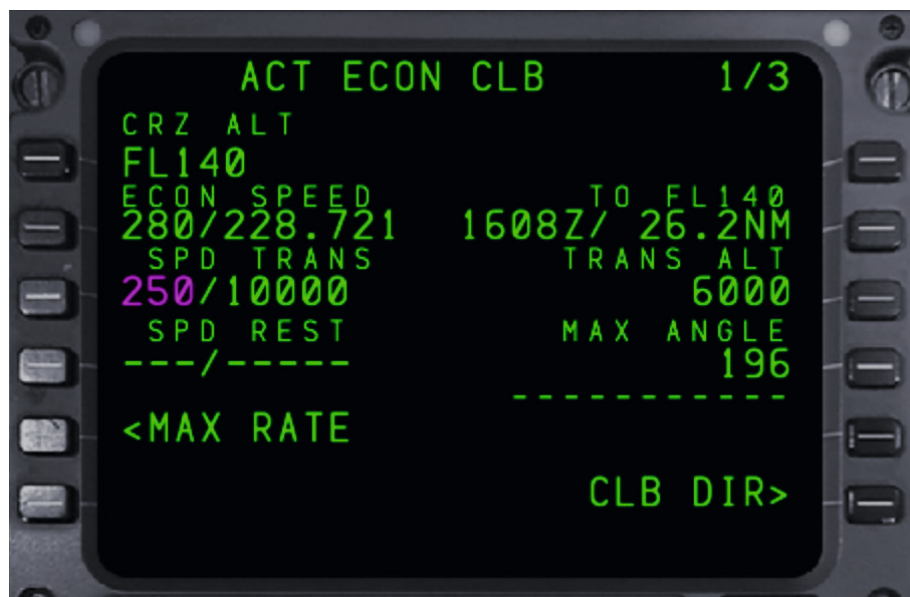
## Climb constraints

VNAV then enters the VNAV PTH mode to remain within departure or waypoint constraints. The airspeed maintained during this phase can be any of the following:

- Procedure-based speed restriction
- Waypoint speed restriction
- Default VNAV climb speed
- Manually entered climb speed

If the FMC predicts that the aircraft will not reach an altitude constraint, the message 'UNABLE NEXT ALTITUDE' will display in the CDU scratchpad. Speed intervention can be made by using the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb.

If the pilot wishes to clear all altitude restrictions below the MCP-selected altitude, this can be accomplished on the CLB page by pressing RK6, labelled as CLB DIR for 'climb direct'. The restrictions can be cleared one by one by pressing the MCP altitude knob if the altitude dialled into the MCP is above the restriction altitudes.



## Top of Climb (T/C)

The Top of Climb (T/C) is the point at which the climb phase reaches the cruising altitude. Approaching this point, the FMC also changes from the climb phase to the cruise phase.

## MCP altitude intervention

Whenever the aircraft levels off at an MCP-selected altitude that is not in the FMC, VNAV ALT engages. For example, if the FMC cruise altitude is FL370 and the altitude cleared by ATC for the aircraft is lower (e.g. FL200), then that would be the altitude set by the pilot in the MCP. The aircraft autopilot will hold that altitude and the FMC target speed. To resume the climb, input the cruise altitude into the MCP altitude window and press the VNAV button.

If a level-off is required, set the MCP altitude window to the desired altitude and the autopilot will always level off at that altitude. VNAV then changes to VNAV ALT. As stated previously, the climb can be continued by setting the altitude window to a higher altitude and VNAV (VNAV ALT changes to VNAV SPD or PTH, depending on whether any altitude restriction is associated with any waypoint before T/C). This same logic of operation can also be used when descending.

To delete the altitude restrictions of all the waypoints before the T/C, the cruise level has to be set in the MCP altitude window and then all waypoint altitude climb restrictions can be deleted by pressing RK6, labelled CLB DIR> on the CLB page.

## Cruise

During cruise the FMC sets an ECON cruise speed until reaching the top-of-descent (T/D) point. Pilots can enter another speed in the CRZ page and they can also select the 'LRC speed' in the VNAV CRZ page.

The FMC uses maximum-range cruise speed if the cost index is set to zero. Step climb fuel and ETA predictions assume the aircraft climbs at each predicted step climb point as the aircraft 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.

Predicted step altitudes are shown on the waypoints in the RTE LEGS page. The distance and ETA to the next step point (predicted) are shown on the CRZ page.

The cruise phase automatically starts at the top of climb. During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ

The RTE LEGS pages are used to modify the route. The PROGRESS pages show flight progress data. The CRZ pages show VNAV-related data.

Other pages are:

- POS REF – verifies the FMC position.
- RTE DATA – contains progress data for each waypoint on the RTE LEGS page.

The CLB page automatically changes to CRZ at the top of climb.

The CLB and DES pages automatically change to CRZ when reaching the cruise altitude. The CRZ page automatically changes to DES at the T/D.

In a VNAV SPD descent after the T/D, VNAV changes the pitch to follow the speed setting during speed intervention.

VNAV changes to approach phase using the following logic:

- Passing the first waypoint of a STAR approach, or
- The landing runway is the destination waypoint and the direct distance to the runway is 25 NM or less.

## Descent

The FMC calculates a descent path based on airspeed and altitude restrictions. The top of descent (T/D) is the point at which the cruise phase changes to the descent phase. The descent path starts at the T/D and includes waypoint altitude restrictions. It is also displayed in the ND as a small green circle with the label 'T/D'.

The descent may be accomplished at the FMC-calculated economy knots/Mach value (based on Cost Index) or at a manually entered knots/Mach value. VNAV will not command an economy target speed greater than VMO/MMO.

The FMC takes into account the descent path with a deceleration at the speed transition altitude (this is typically 250 knots below 10,000 feet).

The descent phase starts at the T/D point and continues to the end-of-descent point (usually a STAR restriction or crossing TRANS altitude). Planning for the descent phase starts during the cruise.

The approach phase starts at the end of the descent point and continues to touchdown or go-around. The only automatic page change in the descent/approach phases is the VNAV-selected page change from cruise to descent at the T/D.

During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management can be selected on the DES page.

Reaching the T/D, VNAV commands pitch to maintain the planned descent path and ECON speed.

If any level-off occurs because the MCP altitude window is set to a lower altitude, VNAV changes to VNAV ALT. To resume the descent, set the MCP altitude window to a lower altitude and press the VNAV button.

### Early descents

An early descent in VNAV is any descent initiated before reaching the top-of-descent point (T/D). VNAV commands the descent at a rate of 1,200 FPM until the predicted idle descent path is intercepted.

### Descend now

Within 50 NM of the T/D, the DES NOW prompt appears at RK6 on the VNAV DES page to initiate an immediate descent. If the RK6 is pressed, the original path and T/D are not changed and VNAV starts a descent (VNAV PTH) and captures the MCP altitude (VNAV ALT) or the idle descent path (VNAV SPD), whichever is encountered first. The MCP altitude selector must be set below the cruise altitude to initiate a descent within 50 NM of the T/D.

The DES NOW prompt is shown on the descent page when the cruise phase is active and the aircraft is within 50 NM of the T/D. Pressing the DES NOW key and selecting 'execute' will initiate a VNAV ECON descent of approximately 1,250 FPM at ECON speed.

### Cruise level modification descent

Setting an altitude below the current altitude in the MCP altitude window and pressing the VNAV button (more than 50 NM from the T/D) causes the level cruise to be set to the MCP altitude and the aircraft starts to descend to the new altitude. A VNAV PTH cruise descent is commanded at cruise speed and a rate of approximately 1,250 FPM.

The throttles must be adjusted by the crew to maintain the target descent rate and the pitch is used to maintain the commanded speed. The same can be done to increase the cruising altitude.

## Approach

During approach, roll and pitch modes usually have to be changed to LOC and G/S modes using the navigation radios automatically tuned by the FMC. The FMC continues to calculate and show your present position.

The RTE LEGS and PROGRESS pages are used to monitor the aircraft. Another page is the APPROACH REF page, which is used to specify the approach flap setting and set the approach VREF.

The FMC changes to the approach phase under the following conditions:

- The aircraft is in the descent phase and below the transition level
- The aircraft is en route to a direct-to or intercept-to the airport/runway waypoint and the aircraft is within 25 NM of the runway threshold

The FMC prompts the pilots to select the approach speed on the APPROACH PAGE when an ILS signal is present.

When the FMC is in the approach phase, the following features are available:

- The IAS/MACH command speed can be selected on the MCP while VNAV remains in VNAV PTH descent; VNAV then commands the set speed.
- The MCP altitude can be set below the aircraft altitude for a level-off without an ALT HOLD; VNAV continues to command a descent until level-off, changing to VNAV ALT.
- VNAV remains in VNAV PTH and follows the descent path

## VNAV modifications

During the cruise phase, two types of climb can be managed by VNAV: cruise level change and step climbs (both calculated and annunciated by the FMC).

Cruise climbs are entered by the flight crew. Planned step climbs have been calculated by the FMC. Optimum step climbs are calculated by the FMC. In all cases the new climb altitude must be entered into the MCP altitude window before VNAV commands the climb.

### Cruise climb

In the cruise phase, setting an altitude above the current cruise altitude in the MCP altitude window and pressing the VNAV button causes the cruise altitude to be set to the MCP altitude and the aircraft to climb to the new cruise altitude. The mode annunciation is VNAV SPD.

### Calculated step climb

When a non-zero value is entered into the STEP SIZE line on the PERF INIT or CRZ pages, the FMC calculates optimum points for step climbs as the aircraft burns fuel. The climb altitude is determined by the value in STEP SIZE. Multiple step climbs are possible, based on performance and route length. This is computed only if the T/D is more than 200 NM from the T/C; in other words, if the cruise phase is more than 200 NM.

### Wind

The FMC uses wind data to improve performance prediction accuracy. Wind data includes altitude and direction/speed. The FMC adjusts ECON climb speed and T/C using the wind speed from X-Plane.

Sometimes the FMC-calculated ECON climb speed might fluctuate if the T/C is close to a waypoint and if a significant wind velocity has been predicted for that waypoint.

# FUEL MONITORING

The FMC is able to calculate the fuel necessary for the route entered. In the PERF INIT page, pilots can press LK1 to automatically compute the ZFW, enter the reserve fuel and then the COST INDEX (0000 to 9999). The FMC will compute the recommended cruise altitude and the fuel necessary for the trip.

For a longer trip, the desired step climb can be selected (from 1,000 to 9,000 feet) and the necessary fuel will also be computed. Please note that in some cases the recommended and optimum cruise altitude may not match because the route has restrictions or is insufficiently long for you to reach the optimum cruise altitude.

The FMC receives fuel data from the aircraft's systems to calculate fuel. Fuel quantity values are predicted or entered on the PERF INIT page as calculated (CALC) or manual (MAN). In the PROGRESS page 2/2 the fuel is presented as a TOTALIZER value and as CALCULATED. The totalizer value is measured by the aircraft's systems and the calculated value is determined by the FMC integrating the instantaneous fuel consumption.

The FMC usually uses the predicted or the calculated fuel value for performance computations.

The scratchpad will display the message 'FUEL DISAGREE-PROG 2/2' if the FMC determines that there is a large difference between the totalizer fuel quantity and the calculated one. This could happen as the result of a fuel leak, for example.

The FMC continually estimates the fuel at all the remaining waypoints and the destination airport. The message 'INSUFFICIENT FUEL' is displayed in the scratchpad if the estimate is less than the fuel reserve value entered on the PERF INIT page.

**Note:** FMC-calculated fuel predictions assume a clean configuration and that the aircraft is flown using the ECON speed and altitude profiles. Flight with gear or flaps extended can cause fuel prediction errors.

# FMC PRE-FLIGHT



FMC pre-flight action is required before flight. Completion of the FMC pre-flight requires data entry in all minimum required data locations.

## Pre-flight page sequence

The usual FMC power-up page is the MENU page and then the identification page. Pre-flight flow continues in this sequence:

- Identification (IDENT) page
- Position initialization (POS) page
- Route (RTE) page
- DEPARTURES page (no prompt)
- Performance initialization (PERF INIT) page
- Thrust limit (THRUST LIMIT) page
- Take-off reference (TAKE-OFF) page

Some of these pages are also used during the flight.

## Minimum pre-flight sequence

During pre-flight a prompt in the RK6 position automatically directs the pilots through the minimum requirements to complete the FMC pre-flight. Selecting RK6 will show the next page in the flow. If a required entry is missed, a 'PRE-FLT' message on the TAKE-OFF page informs the flight crew that there is missing data.

For example, a route must be entered and activated. The minimum route data has an origin and a destination airport and a route leg. Performance data requires the entry of aircraft weights, fuel reserves, cost index and cruise altitude. Take-off data requires a take-off flap setting (18 or 24 degrees).

## Supplementary pages

When a route includes SIDs and STARs, they can be entered into the pre-flight using the DEP ARR pages.

Route discontinuities need to be removed by the pilots, and the route modifications may be entered in the RTE or LEGS pages. Speed/altitude restrictions are entered only on the LEGS page.

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

## Pre-flight pages

The pre-flight pages are presented in the sequence used during a typical pre-flight:

**Initialization/reference index page** – the initialization/reference index page allows the manual selection of FMC pages. It gives access to pages used during pre-flight but not usually used in flight.

**Identification (IDENT)** – the IDENT page is used to verify basic aircraft data and the date of the navigation database.

**Performance (PERF INIT)** – the PERF INIT page is used for the initialization of data required for VNAV operations and performance predictions.

**TAKE-OFF REF** – the TAKE-OFF REF page is used to enter take-off reference data and confirm the FMC-calculated V-speeds or enter new ones.

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

**INITIALIZE** – used to reset all flight data from the beginning.

**PAUSE AT T/D** – used to program a pause in the simulator at 5, 10 or 50 NM before T/D, so a simulator pilot can leave the aircraft unattended on a long haul flight, for example, and then perform the approach and landing.

## Identification (IDENT) page



Most of the data on this page is for flight crew verification. The flight crew verifies FMC data and checks the navigation database.

**MODEL (LK1)** – shows the aircraft model.

**NAV DATA (LK2)** – shows the navigation database identifier.

**INDEX (LK6)** – directs to the INIT/REF INDEX page.

**ENGINES (RK1)** – shows the engine model.

**ACTIVE** – shows the effective date range for the active navigation database. The active navigation database may be out of date.

## Position initialization (POS INIT) page



The position initialization page allows aircraft present position entry.

**Reference airport (REF AIRPORT) (LK2)** – the reference airport entry allows entry of the departure airport. Optional entry. Enter ICAO four-letter airport identifiers. This is only for information purposes. The actual departure and arrival airports are entered on the RTE page.

**Gate** – not implemented in this version.

**Universal time coordinate (UTC)** – UTC (GPS) displays the current time from GPS (X-Plane time).

**INDEX** – directs to the INIT/REF INDEX page.

**GPS position (GPS POS)** – displays the GPS present position.

**SET IRS POS (RK5)** – allows for entry of GPS position to align the IRSs.

**ROUTE** – directs to the ROUTE page.

## Route 1 page

**Note:** The Route 2 page is separate and allows for the same entries of a different route. This will show in blue dotted lines on the ND until it is made active.



The Route 1 page allows for a route to be entered by the flight crew or loaded through a previously saved route file. 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, or airway segments, or SIDs and STARs.

### ORIGIN

Entries:

- Must be a valid ICAO identifier in the navigation database
- Are filled automatically when a route is entered
- Enable the direct selection of departure and arrival procedures
- Are required for route activation

An entry on the ground modifies the route; entries in flight are not permitted.

**RUNWAY** – the applicable runway for the origin airport. No pilot entry is allowed; it is automatically filled when selected on the DEPARTURES page.

### Destination (DEST)

- Must be a valid ICAO identifier in the navigation database
- Entry is made automatically when a route is entered
- Enables the selection of departure and arrival procedures
- Can be changed in flight

## Flight number (FLT NO)

Pilots can enter a company flight number. Entry is optional for activation of the route and only for information purposes. It is then displayed on the PROGRESS page as a reminder.

## ACTIVATE

Press the ACTIVATE key (LK6) to set the route entered as the active route. When the EXECUTE key is pressed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required pre-flight page prompt.

Activation of a route is required for completion of the pre-flight. After route activation the ACTIVATE prompt is replaced by RTE to enter the route details.

LNAV or VNAV will be not operative if the route is not activated.

## CO Route

This allows for the loading of a stored company route.

## Route page (RTE)

The subsequent route pages 2/X through X/X show the route segments in ATC format. Route segments are defined as direct routings, 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.

## VIA

The VIA column shows the route segment to the waypoint or termination shown in the TO column. Enter the airway or DIRECT route 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. Alternatively, pilots can enter a nav aid in the TO column and the word 'DIRECT' will be placed in the VIA column.

Procedures are only entered through selections on the 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 previous TO waypoint, and
- Contain the next TO waypoint, or
- Intersect the previous VIA route segment

Invalid VIA entries will result in the message 'INVALID ENTRY' appearing in the scratchpad.

Examples of invalid VIA entries are:

- Airways and routes that do not contain the TO waypoint of the previous line
- Airways that do not intersect the previous airway at some waypoint
- Airways or procedures 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.

Entry of a SID or transition automatically enters at the beginning 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. The SID and STAR procedures are entered using the DEP/ARR page and automatically update the ROUTE pages.

When no SID is used, the first line of page 2 must be a DIRECT procedure.

## TO

Used 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 results in a DIRECT route entry in the VIA column.

Data input is mandatory when boxes are shown. Valid waypoint entries for a DIRECT route segment are any valid waypoints or fixes on the airway.

## Airways

Aircraft do not normally fly direct circle routes from the departure airport to their destination. Instead, they use airways that are developed by aviation authorities and depicted on charts. An airway is like a highway in the sky, with several waypoints at which a pilot can switch from one airway to another one.

## Obtaining routes

A good source is [vroute](#), which includes many routes.

You can also use [RouteFinder](#) to generate routes.

For real-world flight plans, a good resource is [FlightAware](#), which has a feature that lets you search IFR flight plans for a given route.

A newer option is [simBrief](#), which can output airline-style flight plans and generate UFMC route files

## Loading a route

In the RT1 PAGE, enter a saved flight plan file name without any extension. The CO ROUTE name appears in RK3 and the FMC prompts the pilot to load the flight plan.

To do so, just press EXEC and the flight plan will be loaded into the FMC. If any other key is pressed, the flight plan will not be loaded.

Every time you load a flight plan the FMC is fully initialized, so you do not have to initialize it. If the file name is not valid, an 'INVALID FILE NAME' message will appear in the scratchpad.

If the file content is not valid (if it contains invalid airways or fixes, for example), a 'NOT FOUND' message will appear in the scratchpad and the loading will be stopped.

The RTE 2 PAGE can then be viewed to check that the route is loaded.

## Saving a route

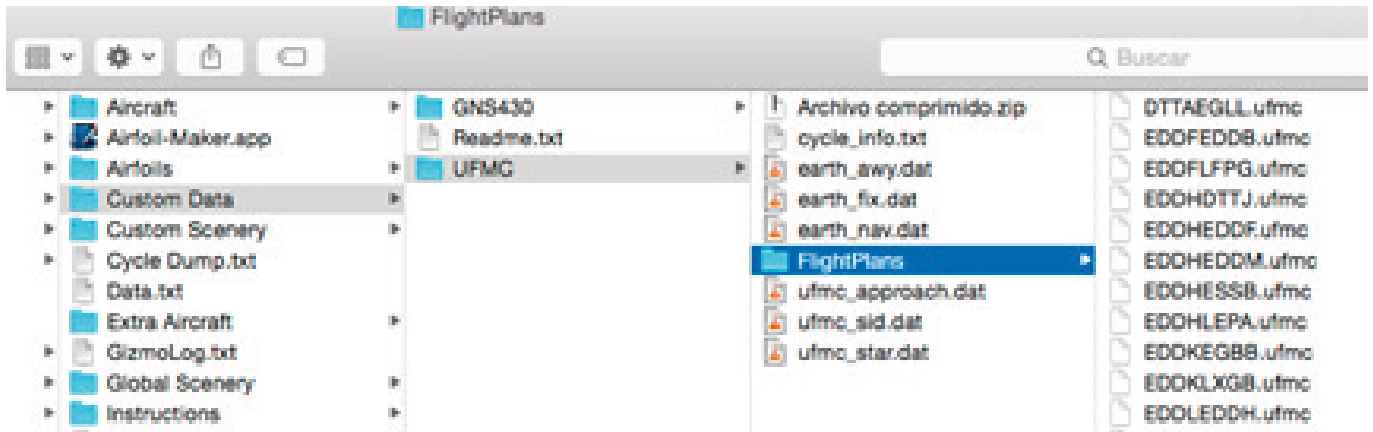
To save a route, the route must have been created previously in the FMC.

Go to the INDEX PAGE. When you press RK5 the FMC scratchpad shows a proposed file name that you can accept or partially edit.

The proposed file name is always the name composed of the departure airport in ICAO format and the destination airport in ICAO format.

Press the EXEC button to store the route using the selected name. If the file already exists, it will be overwritten without prompting.

Routes are stored in an X-plane/Custom Data/UFMC/FlightPlans/ folder that the user needs to create (it is not created automatically upon installation). However, this only needs to be done once per X-Plane installation. See the following example:



Do not change this folder name or location. The FMC saves the route in .ufmc format in this folder and loads them from this folder using the RTE 1 PAGE and RK3.

## Resolving route discontinuities

When entering a SID or a STAR, there can often be a route discontinuity, in which case the pilots need to tell the FMC what the next waypoint after the SID is, or what the route waypoint that will join with the selected STAR is.

The solution is simple and involves pressing the LSK for the waypoint that will join the SID or STAR to the existing route, which places it in the scratchpad. This waypoint can then be connected with the SID or STAR by inserting it in the appropriate part of the route with the associated LSK, thus resolving the route discontinuity.

At this point the EXEC light illuminates and pressing EXEC will activate the new route.

Deleting a waypoint on a route can also cause a route discontinuity. The pilot has to tell the FMC what will be the next waypoint after one has been deleted. To do so, the pilot can select any waypoint after the ROUTE DISCONTINUITY and this has to be confirmed by pressing the EXEC key.

## Route lateral offset

Route offsets are entered in the RTE page. These can be useful to avoid traffic or weather while remaining on the route. On RK6 there are three dashes ('---') but only after take-off. The format is XXX, consisting of L or R and a number between 1 and 99. R10, for example, means an offset of 10 NM to the right.

When a value is entered, the EXEC key illuminates. As soon as the offset is executed, the aircraft will turn towards the offset with a 45° intercept heading and capture it. During the offset, 'OFST' will be displayed on the right part of the FMC, just below the MSG field. This (and the number in RK6 on the RTE page) is the only indicator that an offset is active. In the LEGS and PROGRESS pages all individual waypoints are still shown as usual.

To delete an offset, you can either enter '0' or delete RK6. In both cases RK6 will return to '---'.

The offset is also automatically deleted when the aircraft reaches a STAR, an approach or approach transition, a hold, or if there is a turn on the route of more than 135°. In these cases an 'END OF OFFSET' message will appear in the scratchpad.

When an offset ends, the aircraft will make a 45° course change towards the original route and intercept it. In an automatic offset end, the aircraft will turn just in time to intercept the last waypoint of the offset at a 45° angle.

## Departure/arrival index page

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

Departure and arrival prompts are available for the origin airport, but the RK1 key does not work at this time. Destination airports only have arrival prompts.

**Departure (DEP)** – LK1 shows the departure page for the route origin airport.

**Arrival (ARR)** – RK1 is inoperative.

**Arrival (ARR)** – route 1 destination – RK2 shows the arrival page for the destination airport on the route.

## DEPARTURE PAGES

The departure pages are used to select the departure runway and SID procedure for the origin airport of a route. The departure page for the route is shown when the DEP ARR function key is pressed and the departure airport has been entered.

## Standard Instrument Departures (SIDs)

This shows SIDs for the airport and runway selection. Without the selection of a runway on the DEP/ARR page, the initial display contains only the airport runways. As selections are made, only the proper SIDs appear.

## Runways

This shows a list of runways for the selected airport. The runway selected is shown as <SEL>.

Pressing the desired left LSK selects the runway for use on the route. All other runways are no longer displayed.

The SIDs associated with the selected runway will then appear and all others are no longer displayed. The subsequent change of a runway is still possible (either due to ATC clearance or wind shift) and will delete the departure procedures selected previously.

Once the EXEC button is pressed, the waypoints associated with the SID are inserted in the FMC in sequence; the route can then be displayed in the ND and in the FMC.

If one of the procedure waypoints has a restriction, this appears in the FMC as a speed/altitude.

If contiguous repeated waypoints could occur when you are selecting SIDs, usually where the final waypoint of a SID is the same as a waypoint already in the route, the FMC will delete the duplicate waypoint when LEVEL CRUISE is entered in the FMC in the INIT/REF page.

As with the runway selection, a different SID or STAR can be selected. In this case the FMC will erase the waypoints associated with that procedure and insert the new ones.

# NAVIGATION RADIO PAGE



The 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.

If pilots wish to select a specific VOR, they can simply enter the frequency in the following format (with a decimal point) in the scratchpad:

**XXX.XX**

The desired course can be selected using LK2 or RK2 to track the VOR.

An ILS frequency also can be entered manually using LK4, along with the proper course, in the following format:

**XXX.XX/XXX**

In LK1 and LK2 pilots can select a frequency and course (CRS), as well as an ADF, although this can be edited.

LK4 shows the frequency and course of the selected landing runway at the destination airport.

## PERF INIT PAGE



The performance initialization (PERF INIT) page allows the entry of aircraft and route data to initialize performance calculations. This data is required for VNAV calculations.

## Gross weight (GR WT)

Aircraft gross weight is required by the FMC to make certain performance calculations. The entry can be made by the flight crew or can be automatically calculated by the FMC.

Pressing LK1 automatically shows the calculated weight when confirming the weight proposed by the FMC, as well as showing the aircraft's current ZFW.

Entry of a value after take-off speeds are selected removes the speeds and shows a 'TAKE-OFF SPEEDS DELETED' message in the scratchpad.

## Fuel

Fuel on board is automatically shown when the fuel totalizer calculations are valid.

'CALC' is shown when the source is calculated by the FMC and manual entry is possible.

The quantity unit is shown to the right of the numerical value.

Only manual entries can be deleted. If, after a manual entry, you require the FMC to calculate the fuel quantity, press the DEL key and then press LK2.

The FMC only calculates the fuel and does not fill the tanks.

The FMC is able to calculate the required fuel for the route entered by the pilots. On the PERF INIT page, pilots can press LK1 to automatically compute the ZFW, enter the reserve fuel and then the COST INDEX (from 0000 to 9999). The FMC will compute the recommended cruising altitude and the necessary fuel for the trip. For a long flight the necessary step climbs can be entered (from 1,000 to 9,000) and the fuel required will also be computed.

## Zero fuel weight (ZFW)

Aircraft ZFW is also required by the FMC. In real-world operations the ZFW is entered from the aircraft's dispatch papers and the FMC calculates the aircraft's gross weight.

In the UFMC, pressing LK1 will confirm the gross weight value proposed by the FMC, which will automatically calculate the ZFW.

Calculated zero fuel weight is automatically shown if the aircraft's gross weight is entered first and the fuel-on-board quantity is valid.

Entering a value after the take-off speeds are selected removes the speeds and shows a 'TAKE-OFF SPEEDS DELETED' message in the scratchpad.

## Reserves

This is where pilots can enter fuel reserves for the route. An entry is required to complete the pre-flight. Valid entries are in the following format:

**XX.X**

A warning is given when the predicted fuel at the end of the route is less than the reserve entered.

## Index

This is the INIT/REF INDEX page.

## Cruise altitude (CRZ ALT)

The proposed cruising altitude is a required entry. This cruise altitude is then automatically displayed on the CLB and CRZ pages. When the cruise altitude is entered, all the waypoint speed and altitude predictions are calculated based on that value.

## Cost index

The cost index is used to calculate ECON climb, cruise and descent speeds. Larger values increase ECON speeds. Entering a value of zero results in maximum-range airspeed and minimum trip fuel. A cost index value must be entered by the flight crew. Valid entries are 0 to 9,999.

Entering the cost index will compute the optimal/recommended cruise altitude and the fuel required for the trip.

## Cruise (CRZ) centre of gravity (CG)

This entry is optional on the real aircraft but is not implemented in the UFMC because the FMC takes the take-off CG information and computes cruise CG based on fuel burn throughout the flight.

## Step size

This shows the climb altitude increment used for planning the optimum climb profile.

Valid manual entries are from 0 to 9,000 in 1,000-foot increments. The step value can be entered manually in RK6.

During the climb phase, step size entries are inhibited. In-flight step size changes are made on the CRZ page in the ground or cruise phase.

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.

# TAKE-OFF REFERENCE (REF) PAGE



The take-off reference page allows the flight crew to manage take-off performance. Take-off flap setting and V-speeds can be entered and verified.

Pre-flight completion status is annunciated until complete.

Take-off reference page entries mark the completion of the normal pre-flight. The take-off flap setting must be entered and V-speeds should be confirmed (or entered manually) before the phase can be considered complete.

## Flaps

This displays the take-off flap setting. Valid entries are Flaps 18 and Flaps 24. Entry of an invalid flap position for take-off results in an 'INVALID FLAP POSITION' message appearing in the scratchpad.

The flap position is required for take-off V-speed calculations.

Entry of a value after take-off speeds are selected removes the speeds and results in a 'TAKE-OFF SPEEDS DELETED' message appearing in the scratchpad. It is necessary to press the NEXT PAGE key to go to PAGE 2/2.

The height of acceleration in feet above the ground is also shown. When reaching this height, the FMC decreases the pitch to accelerate the aircraft for flap retraction. Only the position/degrees of flaps or flaps/altitude can be entered.

## Acceleration height (ACCEL HT)

Displays acceleration height for flap retraction. The default value is 1,500 feet. Entry is optional. Valid entries are altitudes from 400 to 9,999 feet AGL (above ground level).

Can be entered as AAAA in the scratchpad and then pressing LK1.

## Index

This shows the INIT/REF INDEX page.

## V-Speeds (V1, VR, V2)

Displays dashes when:

- Required information is not entered
- Performance calculations are inhibited

Manual entry of V-speeds is permitted and V-speeds entered by the flight crew replace speeds calculated by the FMC. Calculated speeds display in a smaller font.

Pressing RK1, RK2 and RK3 will confirm the V-speeds and 'REF' is no longer displayed.

If the performance data changes:

- The FMC replaces existing speeds with FMC-calculated speeds in a smaller font
- 'REF' is displayed again

## Pre-flight status

If the required pre-flight entries are not complete, the message 'PRE-FLT' is displayed on the right side of the dashed line. Pre-flight pages requiring entries display below the dashed line as prompts.

## Runway wind (RWY WIND)

This shows the calculated headwind/tailwind and crosswind components for the take-off runway and surface wind.

Speed is shown in knots and either 'H' for headwind or 'T' for tailwind.

For example, H14 = a headwind of 14 knots.

## Thrust reduction

This shows the altitude for reduction from take-off thrust to climb thrust.

The thrust reduction entry is optional for pre-flight completion.

- It may be an altitude or a flap setting
- Range for altitudes is valid from 400 to 9,999 feet above the origin airport elevation
- Values are from the FMC's aircraft performance database

At LK3 the height of thrust reduction is shown in feet AGL and is the height where the thrust mode changes from TO to CLB (or CLB X, if selected). It is practical for this height is to be lower than the acceleration height for noise reduction purposes.

Pressing LK5 indicates whether the runway is dry or wet, therefore modifying the V1 speed.

Once all the data are entered, the FMC calculates the V1, VR and V2 speeds. If these speeds do not appear, some of the required data has not been entered. For example, a runway may not have been selected in the DEP/ARR page or the flap setting is missing.

Pressing RK1, RK2 and RK3 will accept the speeds proposed by the FMC.

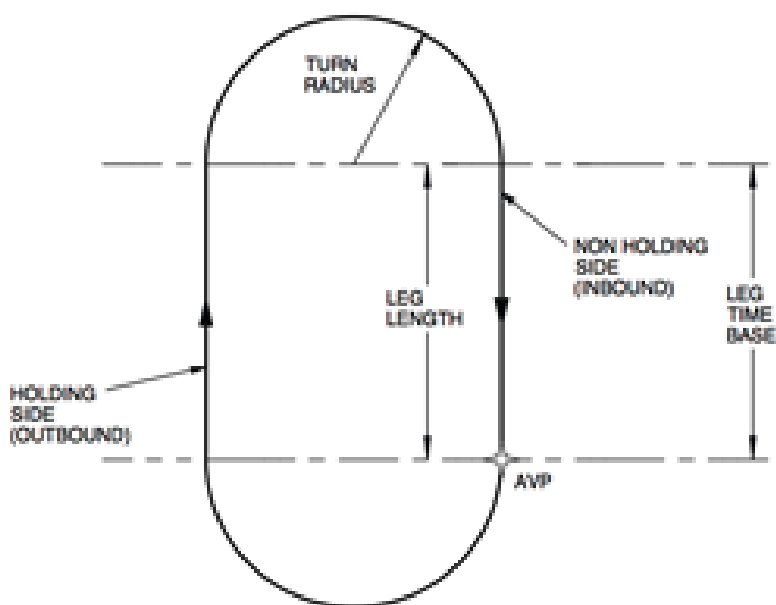
When these are selected, 'REF' disappears above the V-speeds and so does the pre-flight warning.

Between RK5 and RK6 the message '—Preflt' may appear. This means that the pre-flight is NOT yet complete. When this warning is not visible, all pre-flight data has been entered.

If the pilot wishes to modify the reference speeds, the pilot can simply enter the desired speed into the scratchpad and then press the LSK that corresponds to the V-speed being edited. During take-off the different take-off V-speeds are called out automatically.

## HOLDING

The following diagram shows the geometry of the holding pattern along with the designations of the various hold segments, to clarify the description of how holds are programmed into the FMC.



**Holding Pattern Geometry**

### Route hold page with no holding fix in route

When the pilot presses the FMC's HOLD button, the LEGS page is displayed with boxes at LK6. When a waypoint is selected with an LSK, it is copied into the scratchpad and the pilot must select it with LK6. The ROUTE X HOLD page with the holding fix in the route then opens.

The hold legs page is a fully functional LEGS page where the pilot can modify the route or perform a 'direct to' leg.

When PPOS is pressed (RK6), the page is directly changed to the ROUTE X HOLD page after it is selected and the EXEC button is pressed.

This creates a holding procedure with right turns at the current position using the current heading inbound. This is basically the same page as the ROUTE X HOLD page with holding fix in the route, except that the waypoint is in the lat/long format, e.g. N47W120.

## Route hold page with holding fix in route

**Page title** – when the hold is not yet active: RTE HOLD. When the hold is active: ACT RTE HOLD.

**LK1** – shows the waypoint where the holding is performed.

**LK2** – dashes are normally shown here.

**LK3** – shows the inbound course of the holding and the direction of the turn. By default, it shows the flight plan course and a right turn. The valid entry is XXX/X (course/turn direction). For example '022/R'.

**LK4** – displays the time between the turns. By default, it is 1.0 minutes below 14,000 feet and 1.5 minutes above 14,000 feet. The valid entry is XXX.X.

Normally, the distance between the turns is defined in minutes, but the FMC uses the entered airspeed and the wind when the aircraft enters the hold to calculate the distance. This means that if the wind changes during the hold, the time might be longer, but the distance remains the same.

**LK5** – similar to LK4, but instead of time a fixed distance in NM is used between the turns. Either LK4 is active (and LK5 displays dashes) or LK5 is active (and LK4 displays dashes). By default, this displays shows dashes. The valid entry is XX.X or X.X.

**RK1** – shows the speed and the altitude where the hold is being performed. By default, it shows the best speed (RK5) and altitude from the LEGS page.

If the pilot wishes to change these values, this can be done on the LEGS PAGE or by setting the MCP ALTITUDE selector to perform an ALT HOLD. About 3 NM before entering the hold, the aircraft's speed is reduced to the target hold speed.

**RK2** – shows when the aircraft passes the fix the next time. The time is shown in Zulu (XXXXz). This is calculated before the aircraft enters the hold and also while it is in the hold. The time in RK2 is used by the FMC for fuel and ETA predictions. It assumes the aircraft will depart the FIX at that time.

**RK3** – by default, dashes are displayed here.

**RK4** – shows how much time is available before the reserve fuel to the destination will start being consumed. It shows X+YY where 'X' is hours and 'Y' is the minutes of available fuel for holding using the following formula:

$$=(\text{Current Fuel})-(\text{Trip Fuel (from holding fix to destination)})-(\text{Reserve Fuel})$$

**RK5** – displays the best speed for the current aircraft weight and altitude.

**RK6** – normally displays 'EXIT HOLD>' after the aircraft has entered the hold. If it is pressed, this signals to the FMC that the pilots wish to leave the hold. This action has to be confirmed with the EXEC button. When this is accomplished, 'EXIT ARMED' is displayed. The FMC will immediately turn to the inbound leg towards the fix and then leave the hold and will maintain the holding speed and altitude. After passing the fix, it accelerates to cruise speed again. If still on the HOLD page, the page changes to the ACT RTE LEGS page 1/XX.

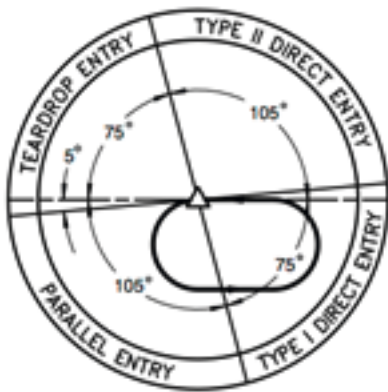
A hold can be deleted on the LEGS page the same as any other fix. If this is done, the aircraft will simply fly to the next waypoint.

You can also delete the HOLD by pressing the DEL key and then clicking on LK1 on the HOLD PAGE.

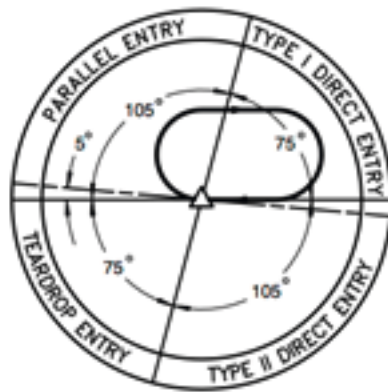
Holds in SID/STARs are actually saved in the database; you don't need to enter the course etc. here. Holds are displayed in the LEGS page in the following format:

```
(...)  
  249°  
CIVET          243/14000  
  HOLD AT  
CIVET          243/14000  
250°          12NM  
BREMR          243/12000A  
(...)
```

In the example above the first waypoint is CIVET, then the holding waypoint is shown (also CIVET).  
 The HOLD entry procedures (direct, parallel and teardrop) are computed automatically by the FMC, as represented in the following illustrations:

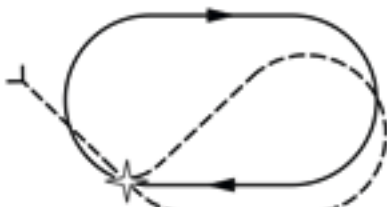


LEFT TURN HOLD ENTRY REGIONS

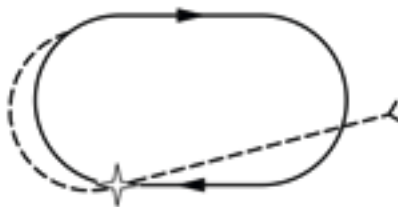


RIGHT TURN HOLD ENTRY REGIONS

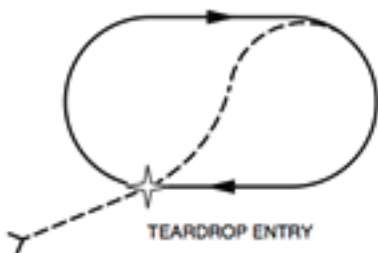
RIGHT TURN HOLD ENTRY CURVES



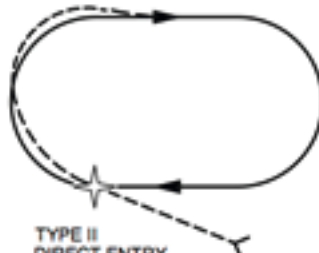
PARALLEL ENTRY



TYPE I DIRECT ENTRY



TEARDROP ENTRY



TYPE II DIRECT ENTRY

Holding Pattern Entry Curves

# CLIMB PAGE

The climb (CLB) page is used to evaluate, monitor and modify the aircraft's climb path. The data on the climb page comes from pre-flight entries made on the Route and Performance pages. FMC climb can be at either economy or fixed speeds.



## Cruising altitude (CRZ ALT)

This shows the cruising altitude entered on the PERF INIT page. Altitude is displayed in feet or FL, depending on the transition altitude. No entry is permitted on this line.

The altitude can be changed by two methods:

1. A new cruising altitude can be manually entered at any time in the PERF INIT page.
2. A new cruising altitude can be entered from the MCP if the T/C is reached. This is done by setting the cruise altitude in the altitude window (above or below current cruise level) and then pressing the altitude intervention button. The cruise altitude then changes without any modification or execution.

## Economy speed (ECON SPD), selected speed (SEL SPD)

### ECON SPD

Speed is based on cost index in knots or Mach.

Used by the FMC at altitudes above all waypoint speed restrictions and speed transition altitudes.

### SEL SPD

Shown when flight crew enters speed via this page. Valid entries are knots or Mach.

## Speed transition (SPD TRANS)

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

- The navigation database value for the origin airport
- A default speed of 250 knots and 10,000 feet (e.g. 250/10000)

## Speed restriction (SPD REST)

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

## Economy (ECON)

Changes climb speed to ECON if previously modified. Must be executed by the pilots to activate it.

A prompt is shown on the LK5 line when the climb mode is not ECON.

## Page title

The page title shows the type of climb, as follows:

- ECON – speed based on a cost index
- XXXKT – fixed climb speed profile in knots
- A crew-entered selected speed (SEL SPD)

## ECON

This can be pressed to return to the ECON speed profile.

## ERASE

This can be pressed to delete the selected speed.

## Waypoint restriction (at XXXXX)

This shows the next waypoint with altitude restriction before the T/C.

When there is a speed restriction waypoint, the FMC commands the speed restriction. These restrictions are entered on the RTE LEGS page. It is blank if no constraint exists.

## Transition altitude (TRANS ALT)

This shows the transition altitude for the origin airport contained in the navigation database. The FMC uses a default of 18,000 feet if the transition altitude is not available.

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

FMC altitude data changes from altitudes in feet to flight levels (FLs) above the transition altitude.

## **Maximum angle (MAX ANGLE)**

This is the maximum angle of climb speed. Pilot entries are not permitted.

## **Climb direct (CLB DIR)**

This displays when climb altitude constraints exist below the MCP ALTITUDE.

When pressed, it deletes all waypoint altitude restrictions below the MCP altitude or FMC cruise altitude, whichever is lowest. FMC cruise altitude, however, is not affected.

# CRUISE PAGE

The cruise page is used to monitor cruise altitude and to change the aircraft's speed.

Speed changes can be selected manually or be changed automatically by switching to other VNAV modes. Cruise climbs, cruise descents and step climbs can be accomplished from the cruise page.

When using VNAV in economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on the cost index. When the flight crew enters a selected speed, the page data also changes.

## Page title

The page title shows the active or modified type of cruise. The title usually contains ECON for the economy cruise mode. Fixed speed modifies the title.

## Cruising altitude (CRZ ALT)

This displays the cruising altitude entered on the PERF INIT page.

Changing the MCP altitude and pushing the altitude intervention button selects the MCP altitude as the active cruise altitude, without creating a modification.

The cruising altitude may also be changed in the PERF INIT page.

The FMC does not permit the cruising altitude to be modified on this page.

## Economy speed (ECON SPD), selected speed (SEL SPD)

'MOD' is shown in the page title until the particular modification is erased or executed.

## ECON

Selecting this selects the VNAV ECON mode. It is shown when an RTA waypoint is not in the flight plan and VNAV is not in the Economy mode.

## Optimum altitude and maximum altitude (OPT, MAX)

### OPT

Displays the optimum altitude based on aircraft gross weight, cost index and the speed displayed on the speed line.

### MAX

Displays the maximum cruise altitude based on current gross weight and the selected speed option. If the pilots fly the aircraft above the maximum altitude, they may experience a stall.

## RECOMMENDED

This is the cruising altitude recommended by the FMC, depending on the route distance and several other factors.

## To step climb

When the STEP SIZE is not zero and the trip length and performance is adequate, step climbs are calculated and this line will show the ETA and DTG to the point where the step climb starts in the CRZ page.

When the aircraft passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word 'NOW'.

## Step to

When using an incremental altitude 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.

If a cruising altitude above maximum altitude is entered, the message 'MAX ALT FLXXX' is displayed in the scratchpad.

The entry of a new cruising altitude deletes all waypoint altitude constraints at or above the new cruising altitude.



The STEP TO altitude from the RTE LEGS page is a calculated step climb altitude based on the step size and is blank when there is no active flight plan, or within 200 NM of the T/D point.

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, no recommended cruise level is performed.

## Step size

This shows the default step climb size of 0000.

Valid entries are altitudes from 0 to 9,000 feet in 1,000-foot increments by pressing RK5 in the PERF INIT PAGE.

It is used for calculation of the optimum step point and step climb predictions.

## WAYPOINT DATA PAGE

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

The ETA and calculated fuel remaining at the waypoint are shown for each waypoint. Manual entry is not possible on this page.

**ETA** – shows ETA for waypoint.

**Waypoint (WPT)** – shows identifier for the waypoint.

**Legs** – goes to the RTE LEGS page.

**Fuel** – shows the FMC-calculated fuel remaining at the waypoint.

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

# PROGRESS PAGES

## Progress page 1/3

The progress page shows general flight progress data.

Page one of the progress pages shows general data about the following:

- Waypoints (last, active and next)
- Destination data
- FMC speed
- Fuel remaining at waypoint



**Last** – last waypoint passed. Cannot be modified by the pilots.

**To** – active waypoint on active leg. Cannot be modified by the pilots.

**Next** – waypoint after TO waypoint, which also cannot be modified by the pilots.

**Destination (DEST)** – destination airport.

**Selected speed (SEL SPD)** – the speed line shows the FMC active commanded speed. The active speed mode is the same as that shown on the performance page, unless changed by the MCP or a limit.

**Fuel** – the estimated fuel quantity remaining at a waypoint or the destination.

## Progress page 2/3

Progress page two contains the following data:

- Wind data
- Track error data
- Fuel data
- Static Air Temperature (SAT)
- True airspeed
- Calculated fuel

**Headwind (H/WIND), crosswind (X/WIND)** – shows the headwind component (H/WIND) and crosswind component (X/WIND). The wind component data is relative to the aircraft; it displays current wind direction and speed referenced to true north. The left (L) or right (R) crosswind component is relative to the aircraft's heading.

**Cross-track error (XTK ERROR)** – displayed in NM left or right of the active route.

**Vertical track error (VTK ERROR)** – vertical path (VTK) error above (+) or below (-) vertical path.

**TAS** – aircraft true airspeed.

**Left fuel used** – instantaneous figure of fuel consumed by left engines, sensed by fuel flow meters (lb/sec).

**Fuel quantity totalizer (FUEL 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 in order to validate FMC calculations.

**Static air temperature (SAT)** – outside static air temperature.

**Right fuel used** – fuel consumed by the right engines as sensed by fuel flow meters (lb/sec).

**Total fuel used (TOT FUEL USED)** – sum of the LEFT and RIGHT fuel-consumed values.

**Fuel quantity calculated (FUEL QTY CALCULATED)** – the fuel remaining line shows two independent fuel remaining values: 'TOTALIZER' and 'CALCULATED'. They can be compared in order to validate FMC calculations.

## Progress page 3/3 – required time of arrival (RTA)

This page is used when a flight crew needs to arrive at a specific time, which is useful in delay situations.

**LK1** – normally boxes are shown here until the pilots enter something. This is the reference fix. The fix entered here must be in the current route.

**RK1** – normally blank. After having entered LK1, boxes are displayed here. The pilots can enter the ZULU time here for when they want to arrive at LK1. They can enter anything between 0000 and 2359 and can also enter a suffix here. For example, 1648A means the pilots wish to arrive at exactly 16:48 or after (17:00 would also be acceptable). 0823B means the pilots wish to arrive at exactly 08:23 or earlier (08:00 would also be acceptable).

**LK2** – here the computed speed is displayed, at which one would need to arrive at the RK1-entered time. When no time is entered, LK2 remains blank.

**LK5** – here pilots can enter a maximum speed that they do not wish to exceed. By default, it is M0.89. Pilots can enter any value between M0.5 and M0.99. When it is deleted, the line reverts back to M0.89.

**RK2** – after the PERF INIT page is completed, and after the pilots enter something into LK1, the altitude and the ETA is displayed here for reference. When this page is executed, the CRZ page does not display ECON CRZ anymore, but RTA CRZ instead. The RTA PROGRESS label on the top will change to ACT RTA PROGRESS when executed. This only takes effect in the cruise phase and on long sectors.

# 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 a speed is entered on the DES page. The descent page is blank with DES as the title until a speed is entered.

This page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a speed restriction.

The fixed speed mode controls descent speed at the fixed speed until a speed restriction is reached.

## Page title

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

The page title shows the type of descent:

- ECON – speed based on a cost index
- XXX – fixed descent speed profile

Both knots and Mach values are shown.

## ECON SPD

Economy speed based on cost index.

## MOD SPD

Displays when the flight crew enters a speed.

## Speed transition (SPD TRANS)

The transition speed is the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 250 knots is shown.

The transition altitude is the point at which 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 restriction (SPD RESTR)

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

A valid entry is a speed and an altitude (e.g. 240/8000). This entry may be deleted.

This shows the FPA, V/B and V/S and the vertical speed commanded by the FMC to meet the restrictions; it also shows if there is any deviation from the restriction.

- FPA (Flight Path Angle) – displays the aircraft's current flight path angle.
- V/B (Vertical Bearing) – displays vertical bearing from current position to the entered waypoint and altitude.
- V/S (Vertical Speed) – displays the required vertical speed to maintain the vertical bearing.

## Descend direct (DES DIR RK5)

Deletes all waypoint altitude restrictions above the MCP altitude. It is shown in the descent phase with altitude constraints between the aircraft and the E/D.

## Descend now (DES NOW RK6)

- Starts a 1,250 feet per minute descent schedule until intercepting the planned descent path.
- Arms the FMC descent phase, but it is not in the descent phase until the T/D waypoint is reached.

It is shown when the descent phase is not active and the aircraft is within 50 NM of T/D.

## APPROACH REF PAGE



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

### Gross weight (GROSS WT)

FMC-calculated aircraft gross weight is usually shown here. Manual entry by the pilots is not permitted. Permanent changes to gross weight result in the recalculation of all performance data and may only be made on the PERF INIT page. If the gross weight is greater than the maximum landing weight, the FLAPS VREF will not be calculated because the landing is not permitted. Pilots will have to dump fuel for the VREF to become available.

### Flaps VREF

A valid gross weight is necessary for VREF speed calculation. Pilots can then press the applicable LSK to choose the desired VREF speed for a given flap setting. The two VREF speeds are based on the landing flap settings (25 and 30).

It shows the calculated reference speed for the two landing flap positions. The display is blank until a valid gross weight is shown.

### Flap/speed

The flap position and VREF speed is entered for landing.

# FIX INFORMATION PAGE

This page is called up by using the FIX button on the CDU. It can be used to create waypoint fixes that can be displayed on the ND in a variety of ways.



**FIX** – these can be airports, navaids and waypoints in the navigation database. Selected fixes are displayed on the ND as a green circle.

**BRG/DIS** – bearing, distance and other data from the selected fix can be displayed in this line.

Bearing and distance can be entered as XXX/YYYY.

Distances from the fix display as a dotted circle around the fix.

Bearings from the fix show up on the ND as radial lines from the fix.

**ETA** – displays the estimated time of arrival to the intersection point.

**DTG** – displays distance to go to the intersection point.

**ALT** – displays the predicted altitude at the intersection point.

**PRED ETA-ALT** – shows the predicted along-track distance and time.

# FMC MESSAGES

FMC messages inform the flight crew when system operation is degraded or if there are data input errors. They also inform pilots about data status. These messages are categorised as follows:

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

All FMC messages illuminate the FMC message (MSG) light. It is necessary to press the CLR key to cancel the message.

## FMC alerting messages

FMC alerting messages are displayed in the CDU scratchpad and illuminate the FMC message light (MSG).

It is necessary to use the CLEAR key to cancel the message. The message is temporarily removed from the scratchpad but returns if the same condition occurs again.

**Drag Required** – aircraft speed is too fast. Drag is required to remain on the VNAV descent path and stay within speed tolerances.

**End Of Route** – the aircraft is passing the last route leg waypoint, usually the destination airport.

**Fuel Disagree-Prog 2/2** – totalizer (TOTL) fuel quantity and FMC-calculated (CALC) fuel quantity disagree by 9,000 pounds for more than five minutes.

**Insufficient Fuel** – because of a change in flight conditions or the route, the calculated route fuel burn exceeds the total fuel on board and half of the reserves.

**No Active Route** – the MCP LNAV switch is pressed and the FMC does not have an active lateral route.

**MCP Altitude** – shown at the T/D point when MCP altitude is still set to aircraft altitude.

**Takeoff Speeds Deleted** – selected V-speeds are invalid.

**Thrust Required** – VNAV is active and additional thrust is required to follow the VNAV descent path and maintain airspeed.

**Unable Next Alt** – VNAV is unable to meet the next climb restriction altitude.

## FMC advisory messages

FMC advisory messages are displayed in the scratchpad and illuminate the FMC message light (MSG).

**Delete** – the DELETE key was pressed.

**Max Alt FLXXX** – the altitude entry on the PERF INIT page is above the performance-calculated maximum altitude.

**Not on Intercept Heading** – LNAV is selected on the MCP and the aircraft is not within the capture criteria of the active leg, or the present heading will not intercept the active leg.

**Unable CRZ Alt** – performance predicts that it is impossible to reach the cruising altitude selected by the pilots.

## FMC entry error messages

FMC entry error messages are displayed in the scratchpad and illuminate the FMC message light (MSG).

**Invalid Entry** – attempted data entry into a field is not formatted correctly.

# EICAS ALERT MESSAGES

Message	Level	Message logic
FMC MESSAGE	Advisory	High priority FMC message exists

# CREDITS

FMC programming	Javier Cortés
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Design	Fink Creative

# COPYRIGHT

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