11. Flight Management, Navigation
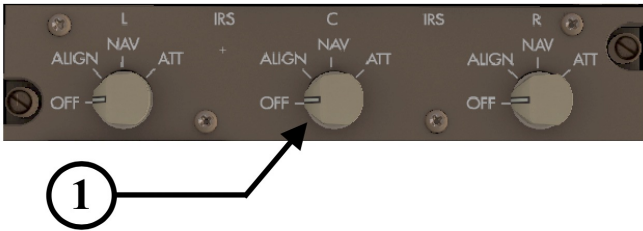
Inertial Reference System (IRS)

Inertial Reference Unit (IRU) Selectors

OVERHEAD PANEL

1. IRU Mode Selectors

There are 3 IRU Mode Selector switches, one for each IRU (Left, Center and Right) that comprise the overall IRS. The switches control the IRUs, which all are independent from each other, and comprise laser gyro and accelerometer units in the aircraft's electronics bay that measure aircraft movement in all 3 axes. Each IRU interprets these signals and sends position information to the FMCs. Therefore, this source is completely separate from GPS position information and predates GPS use in civil applications (back when the 747-400 was first introduced into service).

The FMC uses a weighted average of all 3 IRU position information to display aircraft position. Although the IRUs are precision equipment, they will drift over time, just like Inertial Navigation Systems (INSs) in the 747 Classics of the old days. In flight, the IRUs can be updated with VOR (old way) and/or GPS (newer way) position information to remain accurate.

The IRUs can only detect movement and have no way to independently determine the position of the aircraft. Therefore, there are 2 processes that are required for them to be useful. One is alignment and the other is position initialization.

Alignment

It is important to know that the gyro platforms in the IRUs provide attitude and other information to the flight displays. Why install additional gyros when you have these sophisticated platforms already installed? Therefore, when IRU mode selectors are in the OFF position you will get various "flagged" (yellow boxes) or blanked indications on the PFDs and NDs.

The real IRUs use a fascinating method to align, which is to use the True North Pole as a reference and the motion of the earth and gravity (which it can detect) to determine what the aircraft's relationship is to True North and its latitude and true heading. In the real aircraft there are 2 important things to know regarding alignment:

1. The airplane cannot be moved during this process or it will stop (this is simulated in the SSG 747-8).
2. It takes some time for sufficient motion to be detected for this to work.

To initiate alignment, the IRS switch is rotated from OFF to NAV, not ALIGN. The alignment process takes about 8 to 10 minutes.

NOTE: Normally only the OFF and NAV positions on IRU selectors are used. ALIGN and ATT modes are for abnormal/alternate situations and are not implemented in the SSG 747-8.

Because this is a flight simulator, the tablet OPTIONS menu has a selection that allows you to select a shorter alignment time if you do not wish to wait and are OK with less realism in the alignment process.

Once the IRU selectors have been set to NAV, the Upper ND displays a message showing "TIME TO ALIGN" at the top left and below it "L" and "C" and "R" for left, center and right IRUs. Each IRU has a timer for the alignment process showing "7+ MIN" at first and counting down the time in minutes until that particular IRU is aligned.

When the alignment process is complete, the flags on the PFD and ND disappear and enter navigation mode so you then get the normal displays showing all the necessary information.

Weather Radar

Weather Radar Panel
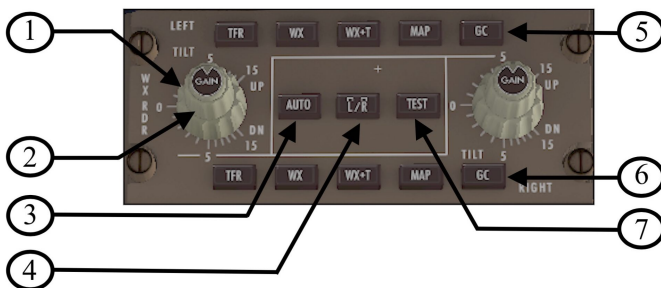
AFT AISLE STAND

2. Gain control

NOTE: Other controls are non-functional

Weather radar returns are shown on the ND by pressing the "WXR" button on the MCP PFD/ND Selector. The SSG 747-8 has limited controls for the weather radar. However, the attenuation on the radar display for the ND can be adjusted. This is useful in conditions where there are a lot of radar returns that might mask other ND details.

Flight Management Computer

Like all newer generation 747s starting with the 747-400, the real 747-8 has an extremely sophisticated FMC. A note about terminology is required here. Often the terms "FMS" and "FMC" are used interchangeably; however, an FMS 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.

The system provides provide guidance information for the autoflight system, as described in Section 4 of this FCOM, as well as other useful functions. Its various components allow for very precise control and management of the aircraft in all flight regimes using inertial guidance capabilities from ring gyros on a stabilized platform, and with Global Positioning System (GPS) position input as well.

The FMC helps the flight crew with navigation, performance optimization and automatic fuel monitoring. The flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV) via the autopilots. The FMC also tunes the navigation radios

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and sets the desired courses for various procedures such as approaches, SIDs, and STARs, using navigation database supplies 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 behavior. To accomplish this, pilots enter route and flight data into the FMC, which then uses its navigation database and airplane position information to calculate the flight path, and issue pitch, roll, and thrust commands to the aircraft's autopilots and autothrottle to fly the desired autothrottle, autopilot, and FD operating modes (e.g. LNAV and VNAV) in an optimum fashion.

It should be stated up front that the FMC in the SSG 747-8 has some limitations in its capabilities versus the real one, and some features are added to make it more useful in a flight simulator.

Control Display Unit (CDU)

Control Display Unit (CDU)

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SSG B747-8 SERIES

The primary component of the aircraft's sophisticated FMC that is visible to the pilots is the CDU (see figure above). There are 3 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.

The SSG 747-8 has two separate CDUs on the captain and first officer side.

NOTE: The Center CDU on the pedestal between the pilots is not used for navigation in the real aircraft. It used for satellite communication, ACARS (textual messaging) and as a central maintenance computer terminal. In the SSG 747-8 it displays the menu options for these functions (see below), but it is not currently functional. At a later time, we may implement some additional features with it.

The two functional CDUs can be called up by pressing the "F8" key in Windows and Linux ("fn" and "F8" keys simultaneously on a Mac) for the captain's and the "F8" + ALT keys in Windows and Linux ("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 dragging (Upper 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 XP screen, click on the top left corner where it says "P_In".

Expanding – 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.

LSKs numbered LK1 to LK6 on the left side numbered from top to bottom

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SSG B747-8 SERIES

LSKs numbered RK1 to RK6 on the right side also numbered from top to bottom

These LSKs are used to select various lines of information in the screen.

The following keys bring up various pages of FMC data as described in this section:

> 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 of the SSG 747-8.

There are two message light "zones" on the left and right of the CDU. The left one lights up with the message "KEYB" to show that it is accepting direct input from the user's computer keyboard. To enable the use of the computer keyboard again (say for an XP command key) 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-in to the 3D cockpit. However, the information displayed is the same for both.

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

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FMC Functions

Lateral Navigation (LNAV) is provided to the autopilot including FLARE and ROLLOUT modes. FLARE allows for smooth landings, changing the pitch to decrease the vertical speed during touchdown. ROLLOUT ensures the aircraft tracks the correct runway heading during touchdown and runway rollout after landing. This is a very good feature during landings in high crosswinds.

The throttle is fully controlled by the FMC, except in the approach phase, where the pilot can also choose to operate the throttles manually. If the autothrottle is disarmed, then the throttles are controlled manually by the pilot. The pilot can disarm the autothrottle during any flight phase, even when it is being controlled by the FMC (e.g. with VNAV engaged). If the MCP Speed knob is pressed, then the blank speed window on the MCP shows the current speed computed by the FMC (VNAV remains engaged). The pilot can change this speed by rotating the MCP Speed knob. If it is pressed again (and VNAV is engaged) the window is blanked again and the speed setting is computed by the FMC once again.

Features of the FMC in the SSG 747-8 include:

- Optimum N1 limits in takeoff, climb and cruise, and go around
- Built in tables for climb rates and descent rates
- Optimized 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
- Step climbs that can be selected from none (0000) to 9,000 feet in size. The cruise altitude changes are showed in the LEGS page
- Implementation of a COST INDEX that affects at climb, cruise, and descent calculated speed
- Full aeronautical database that 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 LNAV modes integrated with the autopilot.
- Provisions for altitude and speed restrictions
- Derated takeoffs
- Calculations for V1, VR and V2 based on real aircraft data
- Ability to save routes, load previously saved routes, and to import standard XP flight plan
- "Route Full" message

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- Manual and automatic 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 procedures:
  - Intersections
  - DME arcs
  - Altitude waypoints
  - Conditional waypoints
  - Waypoints 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/Lon entries
  - Route lateral offset
  - Required Time of Arrival (RTA)
  - Speed transition in the approach phase until slats/flaps are extended

To adjust the brightness in the CDU screen you can use the brightness button. However, this only works for the CDUs on the 3D panel center console, not on the pop-up.

FMC Operation

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

- Preflight
- Takeoff
- Climb
- Cruise
- Descent
- Approach
- Landing
- Flight complete (end of route)

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

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Preflight Phase

During preflight, 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 that is funneled into the FMC by the aircraft's systems such as fuel quantity, aircraft weight, atmospheric conditions, etc. 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 flights plans in the XP format, or as a presaved company route), and a newly entered route can be stored; however, only when the aircraft is on the ground.

The preflight data consists of the following:
- Initial position (from XP)
- Route of flight (previously stored or manually entered)
- Performance data (funneled to the FMC)
- Takeoff data (manually entered)

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 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). As described in Volume I of this FCOM, the contents of this navigation database can be periodically updated and transferred to the FMC before the active data's expiration date, particularly if you wish to fly using on-line ATC services such as VATSIM and IVAO.

When all required preflight entries are complete, the PREFLT label on the TAKEOFF REF page changes to a dashed line. Now select THRUST LIM pressing RK6 again.

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Takeoff Phase

The takeoff phase starts with selection of the desired takeoff 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 airplane 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 NM.

Landing Phase

The landing phase starts when "FLARE" engages and finishes at the End of Route phase.

End of Route

Thirty seconds after aircraft touchdown, the flight complete 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 2.5 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.

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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 starting and ending 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 through the scratchpad by pressing the corresponding LSK or RSK. You can also use the rest of the keys by pressing them or use the numerical keys on your computer. If you want to use your computer keyboard, just click in the FMC dragging zone, after which a "KEYBOARD" message appears on the left of the FMC, to inform you that this mode has been entered. To revert to using keyboard commands back to XP you press the MSG area. You can obtain the operation of the mouse by simply clicking any part of the pop-up CDU or the rest of the screen for XP. 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.

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

Now indicate with LK1 the position you want to enter the new waypoint. Then the FMC will show the following:

```
DEL01
```

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

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 LSK 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.

Lat/Long Entries

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

N4147.9W08745.1

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

Note that there are no spaces. When this waypoint is entered, the FMC will display it as follows 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 terms describes some terminology to better understand the use of 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 using the DELETE key.

Econ: A speed profile calculated to optimize operating cost. 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 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. Airliners normally use a low cost index of 70 to 90.

Enter: Writing data in the scratchpad and then pressing any LSK to enter 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 navigational aid (VOR or NDB station).

Integrated Approach Navigation (IAN)

The SSG 747-8 now incorporates IAN (Integrated Approach Navigation), which is a term developed by Boeing for a suite of features that allows pilots to fly any non-precision approach as they would an ILS approach. Therefore, a VOR, LOC, GLS 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 yet for NDB approaches in the SSG 747-8.

It is important to note that there is no AUTOLAND capability and you have to land IAN approaches manually. The procedure to fly an IAN approach is very straightforward. The first step is to select the non-precision approach to the desired runway. As with an ILS approach, when you are lower than 6,000 feet MSL and closer than 20 NM from the arrival runway, just press the APP button on the glareshield to arm the autopilot approach mode. The IAN system will set up the approach, which can then be flown in the same manner as an ILS following the same needles on the PFD as on an ILS, but the pointers are magenta triangles rather than diamonds to distinguish them from an ILS.

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

Lateral Navigation (LNAV) Operation

LNAV sends commands to an autopilot to fly to the next waypoint. LNAV engages at or above 50 feet, when laterally within 2.5 nautical miles of the active route leg, if one of the three autopilots 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, 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 XP navigation database.

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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 120 Waypoints and 20 LEGS pages.

Number of pages: Indicates the current page and the total number of pages.

Distance: This 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, thus functioning in a cyclical way, meaning that if you reach the last page and click NEXT PAGE, you will return to the first page which (page 1). You can also do the same with PREV PAGE and obtain the same results but going in reverse.

Modifying: To modify the route, go to 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 route legs page. Waypoints are shown in flight sequence. 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 restrictions 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 entire flight.

Note that the VNAV PTH mode is present in the Descent phase when there is an altitude restriction below the cruise altitude. And also note that AT may be not Idle during descent because the altitude restrictions.

To modify the route, the following can be accomplished:

- Add and delete waypoints
- Changing the waypoint sequence

RTE Legs Page Modifications

Add a Waypoint

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

First, 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. However, the active waypoint cannot be deleted. The two valid methods to remove 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 in the following situations:

- When the aircraft is within 2.5 miles of lateral offset and on an intercept heading to the active track leg, pushing the LNAV switch activates the LNAV or else it will arm the LNAV mode.
- The aircraft turns to intercept the active leg. If the intercept angle is large, the airplane may overshoot the active leg, but will later rejoin the active leg.

Direct To

As explained before, pressing the LSK next to a waypoint will copy that waypoint into the scratchpad. Then, by pressing LK1, 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."

Vertical Navigation (VNAV) Operation

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

Takeoff and Climb

The FMC takeoff phase starts with the selection of the N1 Mode (TO/GA). Preparation for this phase starts in the Preflight phase and includes entry of TAKEOFF REF page data.

The Takeoff 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 takeoff and climb, the pages listed below provide functionality as described:

- TAKEOFF REF - To make last minute changes to the thrust derate or 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
- THRUST LIM - Select climb thrust limits

Takeoff Phase

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

The FMC calculates and sets the takeoff thrust when the TO/GA mode switch is pressed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands through the FD bars an acceleration to V_2+20 knots. VNAV is engaged at 400 AGL if the autopilot is engaged.

Usually, LNAV activates at 50 feet radio altitude and commands a roll to fly the active route leg if the FD is set to "ON" and the autopilot is engaged.

At 400 AGL the VNAV mode is engaged and it commands a pitch to fly the climb path. During takeoff, 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 up 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 to remain within all airspeed and altitude restrictions that are part of the selected SID. The autothrottle uses the selected climb thrust limit.

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 TAKEOFF page), VNAV commands acceleration to 250 knots or the preselected transition speed.

The VNAV commanded speed always is 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.

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands acceleration to the economy climb speed (in either kts 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 that 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 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. Alternatively, climb derates can be deleted on the THRUST LIMIT page.

If the pilot wishes to clear all altitude restrictions below the MCP selected altitude, this can be accomplished on the CLB page and pressing RK6, labeled as "CLB DIR" for "climb direct". The restrictions can be cleared one by one by pressing the MCP Altitude knob if the altitude dialed 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 changes from the Climb phase to the Cruise phase as well.

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 (i.e. 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, the input the cruise altitude into the MCP altitude window and press the altitude intervention button (the MCP Altitude knob), and the climb will restart again.

If a level-off is required, set the MCP altitude window to the desired altitude and the autopilot always will level off at that altitude. Then VNAV changes to VNAV ALT. As stated previously, the climb can be continued by setting the altitude window to a higher altitude and pressing the altitude intervention button (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 be accomplished when descending as well.

In the climb, if the MCP altitude window is set to an altitude above the altitude restriction waypoint, each restriction can be deleted individually by pressing the altitude intervention button.

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, then all waypoint altitude climb restrictions can be deleted pressing RK6 labeled "CLB DIR>" on the CLB page.

Cruise

During the 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, or use the speed intervention button. They can also select the "LRC Speed" in the VNAV "CRZ" page.

The FMC uses maximum range cruise speed if cost index is set to zero. Step climb fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size shown on the CRZ page. If a step size of zero is entered, the FMC assumes a constant altitude cruise.

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

Speed Intervention Button

In VNAV mode, pressing the Speed Intervention Button enables the flight crew to change airplane speed with the IAS/MACH selector.

Only 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. This is displayed on the LEGS PAGE with the label "T/D". 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 kts/Mach (based on Cost Index) or a manually entered kts/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 (typically this is 250 kts below 10,000 feet). The autothrottle provides thrust as required to maintain the path and speed.

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 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 there is any altitude restriction during descent, the throttles may change from idle, which is their standard setting for the descent.

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 Altitude Intervention 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 RSK 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 airplane 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 Altitude Intervention 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 autothrottles adjust thrust 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 change to LOC and G/S Modes using the navigation radios automatically tuned by the FMC. The FMC continues to calculate and show 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 enroute 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 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 airplane 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 climbs can be managed by VNAV: cruise level change and step climbs (they are the same but are calculated and annunciated by the FMC).

Cruise climbs are entered by the flight crew. Planned step climbs has 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 altitude intervention button, causes the cruise altitude to be set to the MCP altitude and the airplane to climb to the new cruise altitude. The reference thrust limit is CLB and the mode annunciation is VNAV SPD.

Calculated Step Climb

When a nonzero 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 XP.

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.

Throttle Management

The thrust management function operates the autothrottle in response to flight crew input or to automatic FMC commands. Reference thrust can be selected on the N1 LIM page.

Automatic FMC autothrottle commands are made ONLY while in VNAV mode. FMC thrust management has the following functionality:

- Calculates reference thrust limits for every phase
- Thrust limits are expressed as N1 limits.
- Calculates a reference thrust for the following thrust settings:
  1. TO - Takeoff
  2. D-TO - Assumed temperature takeoff
  3. R-TO 1 - Reduced Takeoff 1
  4. R-TO 2 - Reduced Takeoff 2
  5. CLB - Climb
  6. R-CLB 1 - Reduced Climb 1
  7. R-CLB 2 - Reduced Climb 2
  8. CRZ - Cruise
  9. CON - Continuous
  10. G/A - Go-around

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

The flight crew can specify the thrust reduction height where the change from takeoff to climb thrust takes place by making an entry on the TAKEOFF REF page. This can be an altitude from 400 to 9,999 feet, an entry of 10 for Flaps 10, or an entry of 20 for Flaps 20.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Assumed Temperature Thrust Reduction Takeoff

** NOT TO BE USED FOR REAL WORLD FLIGHT **

Entering an assumed temperature in the N1 LIMIT page that is higher than the actual temperature reduces takeoff thrust and also helps to extend engine life.

Derated Thrust Climb

During climb, the R-CLB derates are gradually removed until reaching 15,000 feet. In the cruise, the thrust reference defaults to CRZ. The reference can be manually selected on the THRUST LIM page.

Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a constant 10% derate of maximum climb thrust to 10,000 feet then increases thrust with altitude in linear fashion to 15,000 feet. CLB 2 consists of a 20% derate of maximum climb thrust to 10,000 feet, then increases thrust in linear fashion to maximum climb thrust at 15,000 feet.

For takeoff thrust reductions from 5% to 15%, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions greater than 15%. All of which can be selected by the pilots as they require.

On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

It should be noted that the use of derated climb thrust reduces engine maintenance costs, but slightly increases the total trip fuel.

Fuel Monitoring

The FMC is able to calculate the fuel that is 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.

NOTE: The required fuel must be provided to the aircraft using the standard XP menu, there is no automatic refueling in the SSG 747-8.

For a longer trip, the desired Step Climb can be selected (from 1,000 to 9,000 ft), and the necessary fuel will be computed as well. Please note that in some cases, the recommended and optimum cruise altitude may not match because the route has restrictions or is insufficiently long 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 half of 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 Preflight
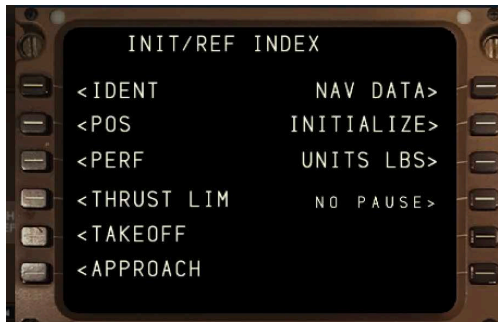
FMC preflight action is required before flight. Completion of the FMC preflight requires data entry in all minimum required data locations.

Preflight Page Sequence
The usual FMC power-up page is the MENU Page and then the identification page. Preflight 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
- Takeoff reference (TAKEOFF) page

Some of these pages are also used during the flight.

Minimum Preflight Sequence
During preflight, a prompt in the RK6 position automatically directs the pilots through the minimum requirements to complete the FMC preflight. Selecting RK6 will show the next page in the flow. If a required entry is missed, a "PRE-FLT" message on the TAKEOFF 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 destination airports, and a route leg. Performance data requires entry of aircraft weights, fuel reserves, cost index and cruise altitude. Takeoff data requires a takeoff flap setting (10 or 20 degrees).

Supplementary Pages
When a route includes SIDs and STARs, they can be entered into the preflight 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, navigation, airport, and runway data is referenced on the REF NAV DATA page.

Fixed takeoff thrust derates can be changed on the N1 LIMIT page.

Preflight Pages
The preflight pages are presented in the sequence used during a typical preflight:

Initialization/Reference Index Page
The initialization/reference index page allows manual selection of FMC pages. It gives access to pages used during preflight and not usually used in flight.

Identification (IDENT)
The IDENT page is used verify basic airplane data and date of the navigation database.

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

Thrust Limit (N1 LIMIT)
The N1 LIMIT page is used to select thrust limits and derates.

TAKEOFF REF
The TAKEOFF REF page is used to enter takeoff 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.

NAV DATA
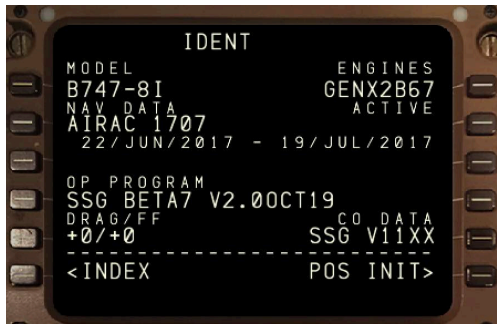The NAV DATA page is used for FMC flight plans loading.

INITIALIZE
Is used to reset all fight data from the beginning.

PAUSE AT T/D
Is 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, checks 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 airplane 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)

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UTC (GPS) – Displays current time from GPS. (XP Time)

<u>INDEX</u>
Directs to the INIT/REF INDEX page.

<u>GPS Position (GPS POS)</u>
Displays the GPS present position.

<u>SET IRS POS (RK5)</u>
Allows for entry of GPS position to align the IRSs.

<u>ROUTE</u>
Directs to the ROUTE page.

Route 1 Page

NOTE: 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.

Allows for a route to be entered by the flight crew or loaded through 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.

<u>ORIGIN</u>
Entries:

- Must be a valid ICAO identifier in the navigation database.
- Is filled automatically when a route is entered.
- Enables direct selection of departure and arrival procedures.

- Is required for route activation.
- Entry on the ground modifies route; in flight, is not permitted.

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

Destination (DEST)
Entries:

- Must be a valid ICAO identifier in the navigation database.
- Is made automatically when a route is entered.
- Enables selection of departure and arrival procedures.
- May 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 preflight page prompt.

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

CO Route
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, navaids, 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 navaid 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 do the following:

- 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" to appear 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
Is 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

** NOT TO BE USED FOR REAL WORLD FLIGHT **

Aircraft normally do not 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 newer option is SimBrief, which can output airline style flight plans and generate XP route files:
http://www.simbrief.com/home/

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 is prompts the pilot to load the flight plan.

To do so, just press EXEC, and the flight plan will be loaded in to 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, then an "INVALID FILE NAME" message will appear in the scratchpad.

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

Then the RTE 2 PAGE can be viewed to check the route loaded.

Save Route

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

Go to INDEX PAGE and when pressing the RK5, the FMC shows in the scratchpad a proposed file name that you can accept or partially edit.

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

Then pressing the EXEC button, the route will be stored using the selected name. If the file already exits, it will be overwritten, without prompting.

SSG B747-8 SERIES

NOTE: This version of the SSG 747-8 has an important change for loading and saving routes.

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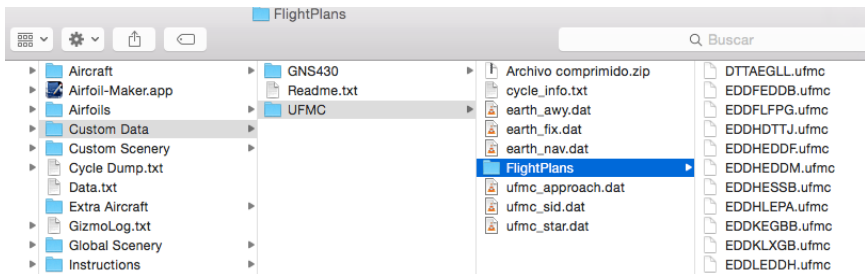
Do not change this folder name or location. The FMC saves the route in .ufmc format in this folder the, and loads them from this folder using the RTE 1 PAGE and RK3.

Now, for those who wish to load FMS flight plans made in the default XP .fms format, such as those created by flight planning tools or used in other XP aircraft with the default GPS, for example, these must be located in the XP folder for .fms files, under

Output/FMS plans

To load this type of FMS plan file, simply select the desired plan and load it using the FMC's INDEX PAGE -> NAV DATA key.

Resolving Route Discontinuities

When entering a SID or STAR, there often can be a "route discontinuity." In these cases the pilots have to inform the FMC what is the next waypoint after the SID, or what is the route waypoint that will join with the selected STAR.

One important point is to ignore T/C and T/D because these are fictitious waypoints and they do not have to be selected or deleted.

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

At this point the EXEC light illuminates, by pressing "EXEC", the new route will be active.

Deleting a waypoint on a route can also cause a route discontinuity. The pilot has to inform the FMC what is going to be the next waypoint since one was deleted. To do so, the pilot can select any waypoint after the ROUTE DISCONTINUITY. Again, 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, for example. On RK6, there are three dashes ("---" but only after takeoff). The format is XXX, consisting of L or R and a number between 1 and 99, so for example R10 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 in the RTE page) is the only indicator that an offset is active. In the LEGS and Progress page, all individual waypoints are still shown as usual.

To delete an offset, you can either enter "0", or you delete RK6. In any case, RK6 will return to "---"

The offset is also automatically deleted when the aircraft reaches a STAR, an approach or an approach transition, a hold, or if there's 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 take 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 departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival data for any other airport in the navigation database.

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

Departure (DEP)
LK1 Shows the departure page for 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 departures pages are used to select the departure runway and SID procedure for the origin airport of a route. The departures 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 proper left LSK selects the runway for use on the route. All other runways are no longer displayed.

Then, the SIDs associated with the selected runway appear, all others no longer are displayed. Subsequent change of a runway is still possible (either due to ATC clearance or wind shift) and it 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. Then the route can 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.

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

Just like 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.

** NOT TO BE USED FOR REAL WORLD FLIGHT **

Navigation Radio Page

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

Radio navigation is controlled automatically by the FMC through this page. In RK1 the VOR frequency selected by the FMC is shown, as well as the name of the VOR and the radial in which the aircraft will fly with respect to the VOR. These automatic selections use the FMC to guarantee the lateral path.

Usually the navaid selection is in the automatic mode, so the FMC will tune the left and right VORs. 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

Then LK1 or RK1 can be selected, as appropriate. The mode in the left or right side will then change to "Manual." The desired course can be selected using LK2 or RK2 to track the VOR. If the VOR mode is selected on the ND, the course line and the VOR that was manually selected will appear. To return the VOR tuning to automatic again, pilots can simply press the DELETE key and then RK2 or LK2.

An ILS frequency also can be entered manually using RK1 or LK1, along with the proper course in the following format:

XXX.XX/XXX

** NOT TO BE USED FOR REAL WORLD FLIGHT **

The FMC will automatically tune the ILS frequency for the arrival runway selected on both sides (left and right) to perform an automatic landing (AUTOLAND 3). Simply enter the frequency in the same format above in the scratchpad, and enter the ILS inbound course in the course line.

Then LK1 or RK1 can be selected, as appropriate.

NOTE: Do not select LK4 even though that is where the FMC displays automatically selected ILS frequencies. XP can only accommodate 2 navigation radios.

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. This frequency will be passed automatically to LK1 the moment that the aircraft approaches the track with an angle less than 45 degrees relative to the axis of the track and a height less than 6,000 feet and less than 25 NM distance to the airport. In this manner, it is not necessary to select and activate the ILS frequency. The FMC automatically fills in the radio frequency when the signal is being received and the aircraft is oriented in the right direction to intercept the actual ILS from the chosen STAR. However, the autopilot will not capture the ILS until the pilots have confirmed the desired approach in the APPROACH page.

PERF INIT Page

The performance initialization ("PERF INIT") page allows for the entry of airplane 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 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 takeoff speeds are selected removes the speeds and shows a "TAKEOFF SPEEDS DELETED" message in the scratchpad.

Fuel
Fuel on board is automatically shown when the fuel totalizer calculations are valid. The source of the automatically generated data is included in the line:

- CALC is shown when the source is FMC calculations and manual entry is possible.

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

NOTE: The SSG 747-8 uses pounds as a unit of measure.

Only manual entries can be deleted. If, after a manual entry, it is required for 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. These can be filled using the standard XP menu.

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 sep climbs for the flight can be selected (from 1,000 to 9,000), and the fuel necessary will be computed as well.

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 airplane gross weight.

In the SSG 747-8, 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 airplane gross weight is entered first and the fuel on board quantity is valid.

Entry of a value after takeoff speeds are selected removes the speeds and shows a "TAKEOFF 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 preflight. Valid entries are in the following format:

XX

The total fuel figure includes the reserve fuel. Please note that the FMC does not take into account the minimum fuel for contingencies or alternate airports. So these can be entered in the reserve fuel. The FMC only calculates the minimum fuel needed to reach the arrival airport, therefore pilots must add a reserve of fuel to ensure a safe arrival at the destination (in real world operations this is also a legal requirement for pilots).

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 of 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.

Cruise (CRZ) Center of Gravity (CG)

This entry is optional on the real aircraft but is not implemented in the SSG 747-8 Anniversary Edition because the FMC takes the takeoff 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 feet 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.

Thrust Limit
This displays the THRUST LIMIT page.

Thrust Limit Page

```
        THRUST LIMIT
   SEL/OAT                TO
   --/15°C             105.0
  <TO-1   <SEL> <ARM> CLB-1>
   TO 1
  <TO-2               CLB-2>
   TO 2
  <TO-3               CLB-3>

  ---------------------------
  <INDEX             TAKEOFF>
```

The thrust (N1) limit page allows selection and display of reference thrust in preparation for takeoff. Derated takeoff thrust by use of the assumed temperature method is also shown on this page.

More page data displays are:

<SEL> - Identifies the selected takeoff or climb thrust reference mode.

<ARM> - Identifies the armed climb thrust reference mode.

The <ARM> prompt changes to <SEL> when the armed climb mode becomes active.

Assumed Temperature (SEL), Initially blank. Displays entered assumed temperature up to the maximum thrust reduction limit.

Entry of an assigned temperature warmer than OAT reduces takeoff thrust and displays "D" as part of the thrust mode.

Valid entries are -99 to 99 degrees Celsius.
OAT displays outside air temperature in degrees C.

This maximum %N1 depends in great part on the external temperature and also on the airport elevation. For example, if the aircraft is found parked in the shade compared to the runway giving a major temperature difference, or during the time the FMC TAT is programmed until the aircraft is entering the runway, this temperature can change significantly.

Using LK1, the pilots can enter a temperature manually (positive or negative, in degrees Celsius) and it will be this temperature that is taken into account for the calculation of the maximum % N1, instead of the OAT.

Takeoff (TO)
Selects the full-rated takeoff thrust limit.

Index
Shows the INIT/REF INDEX page.

Climb (CLB)
Selects the full rated (CLB) climb thrust limit. Pressing a climb line select key overrides an automatic selection.

Climb 1 (CLB 1)
Selects a percentage derate for climb thrust limit. The default thrust derate for CLB 1 is not modifiable by the flight crew.

Climb 2 (CLB 2)
Selects a percentage derate for climb thrust limit. The default thrust derate for CLB 2 is not modifiable by the flight crew.
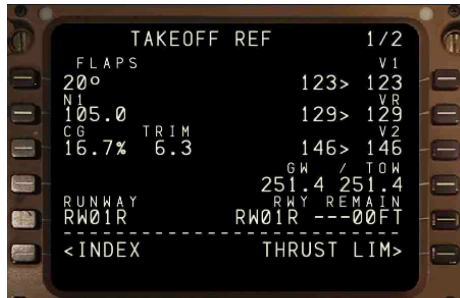
Manual selection of a climb thrust rating overrides the automatic selection.

RK1 shows the FMC calculated % N1 maximum for the takeoff, taking into account the airport pressure altitude, the airport OAT, the aircraft gross weight and wind adjustments.

This value can be decreased in LK2 to LK4 for takeoff and in RK2 to RK4 the % of N1 during the Climb phase. These reductions are at the discretion of the flight crew for a given aircraft configuration and lighter weights.

Takeoff Reference (REF) Page

```
         TAKEOFF REF      1/2
   FLAPS                  V1
  20°              123>  123
  N1                     VR
  105.0            129>  129
  CG      TRIM           V2
  16.7%   6.3      146>  146
                   GW  / TOW
                  251.4 251.4
  RUNWAY           RWY REMAIN
  RW01R           RW01R ---00FT
  ----------------------------
  <INDEX             THRUST LIM>
```

The takeoff reference page allows the flight crew to manage takeoff performance.
Takeoff flap setting and V-speeds can be entered and verified.
Preflight completion status is annunciated until complete.

Takeoff reference page entries mark the completion of the normal preflight. The takeoff
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 takeoff flap setting. Valid entries are Flaps 10 and Flaps 20. Entry of an
invalid flap position for takeoff, results in an "INVALID FLAP POSITION" message
appearing in the scratchpad.

The flap position is required for takeoff V-speed calculations.

Entry of a value after takeoff speeds are selected removes the speeds and results in a
"TAKEOFF 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. Default value is 1,500 feet. Entry is
optional. Valid entries are altitudes from 400 to 9,999 feet Above Ground Level (AGL).

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

** NOT TO BE USED FOR REAL WORLD FLIGHT **

Thrust
Thrust derate calculations. Shows takeoff thrust selected on THRUST LIM page.

Index
This shows the INIT/REF INDEX page.

V-Speeds (V_1, V_R, V_2)

Displays dashes when:

- Required information not entered
- Performance calculations are inhibited

Flight crew entry speeds replace calculated speeds. Calculated speeds display in a smaller font.

Pressing RK1, RK2, and RK3 will confirm the V-speeds and REF is no longer displayed. Manual entry of V-speeds is permitted and V-speeds entered by the crew replace speeds calculated by the FMC.

If the performance data changes:

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

Thrust Lim
Shows the THRUST N1 LIMIT page.

Preflight Status
If the required preflight entries are not complete, the message "PRE-FLT" is displayed on the right side of the dashed line. Preflight 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 takeoff runway and surface wind.

Speed is shown in knots and:

- "H" for headwind
- "T" for tailwind

e.g. `H14` = a headwind of 14 knots.

Climb Thrust Rating And Thrust Reduction (THR REDUCTION)

This shows the climb thrust rating selected on the THRUST LIM page and the altitude for reduction from takeoff thrust to climb thrust.

The thrust reduction entry is optional for preflight 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 it 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 if the runway is dry or wet, therefore modifying the V_1 speed.

Then, once all the data are entered, the FMC calculates the V_1, V_R and V_2 speeds. If these speeds do not appear, then some of the required data has not been entered. For example, a runway may not have been selected in the DEP/APP page or the flap setting is missing.

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

When these are selected, the "REF" disappears above the V speeds and so does the preflight warning.

Between RK5 and RK6 the word "--Preflt" may appear. This means that the Preflight is NOT yet complete. When this warning is not visible, then all preflight data has been entered.

If the pilot wishes to modify the reference speeds, the desired speed can simply be entered into the SCRATCHPAD and then the LSK that corresponds to the V-speed the pilot wishes to edit can be pressed. During the takeoff, the different takeoff 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.
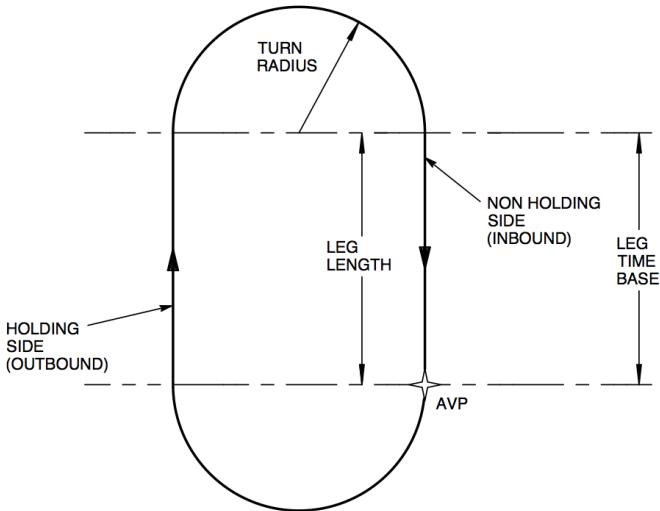
Holding Pattern Geometry

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 holding fix in 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.

** NOT TO BE USED FOR REAL WORLD FLIGHT **

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 route, except that the waypoint is in the lat/lon format. For example:

```
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 were the holding is performed.

LK2: Normally, dashes are shown here.

LK3: This 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). "022/R" for example.

LK4: This 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. However, 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: This 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 set 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: This field 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: This field 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, "Y" is minutes available fuel for holding using the following formula:

=(Current Fuel)-(Trip Fuel (from holding fix to destination))-(Reserve Fuel)

RK5: This displays the best speed for the current aircraft weight and altitude.

RK6: This 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, then "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, then the aircraft will simply fly to the next waypoint.

You can delete also the HOLD pressing the DEL key and then the LK1 HOLD PAGE Holding in SID/STARs are actually saved in the database, you don't need to enter the course etc. here. Holding are displayed in the LEGS page in the following format:

```
(...)
  249°
CIVET                 243/14000
  HOLD AT
CIVET                 243/14000
  250°      12NM
BREMR                 243/12000A
(...)
```
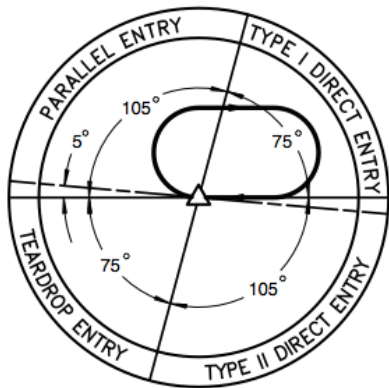
In this example the first waypoint is CIVET, then the holding waypoint is shown (also CIVET).

The HOLD entry procedures (direct, parallel and teardrop) are computed automatically by the FMC, as represented in the illustrations below.
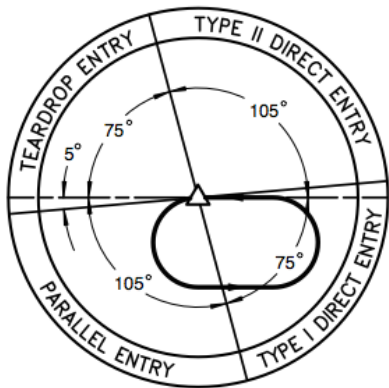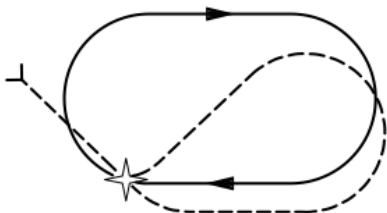
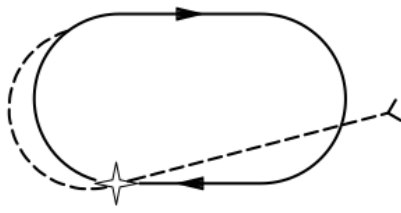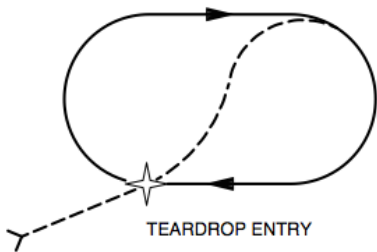LEFT TURN HOLD ENTRY REGIONS   RIGHT TURN HOLD ENTRY REGIONS

RIGHT TURN HOLD ENTRY CURVES

PARALLEL ENTRY

TYPE I DIRECT ENTRY

TEARDROP ENTRY
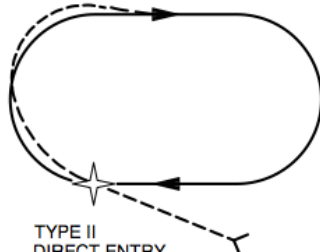
TYPE II
DIRECT ENTRY

Holding Pattern Entry Curves

** NOT TO BE USED FOR REAL WORLD FLIGHT **

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 preflight entries made on the Route and Performance pages. FMC climb can be at either economy or fixed speeds.

Cruising Altitude (CRZ ALT)

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

The altitude can be changed by two methods:

- A new cruising altitude can be manually entered at any time in the PERF INIT page.
- A new cruising altitude can be entered from the MCP, if the T/C is reached. This is accomplished 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 kts or Mach
- Used by the FMC at altitudes above all waypoint, speed restrictions, and speed transition altitudes.

** NOT TO BE USED FOR REAL WORLD FLIGHT **

SEL SPD

- Shown when flight crew enters speed through this page
- Valid entries are kts 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 flight 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 lower. However, FMC cruise altitude is not affected.

Thrust Limit Page

Thrust limits are selected on the thrust limit page. After the aircraft is airborne, this display replaces the takeoff thrust limits with applicable thrust limits for the climb. The selected limits are shown here and on the EICAS.

Fixed thrust derates can be selected for the climb. Go-around, continuous and cruise thrust limits are available as well.

Go-Around (GA)
Selects the go-around thrust limit mode.

Continuous (CON)
Selects the maximum continuous thrust limit. Selection is usually used for critical situations, such as an engine out condition.
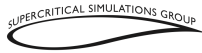
Cruise (CRZ)
Selects the cruise thrust limit mode.

Index
Shows INIT/REF INDEX page.

Cruise Page

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

Speed changes can be manually or automatically selected with the 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 changes as well.

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

Cruising Altitude (CRZ ALT)
This displays the cruising altitude entered on 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 be changed in the PERF INIT page as well.

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.

** NOT TO BE USED FOR REAL WORLD FLIGHT **
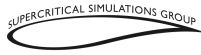
Optimum Altitude and Maximum Altitude (OPT, MAX)

OPT
Displays the optimum altitude based on aircraft gross weight, Cost Index, and speed displayed on the speed line.

MAX
Displays the maximum cruise altitude based on current gross weight and 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.

When entering a cruising altitude above maximum altitude, the message "MAX ALT FLXXX" is displayed in the scratchpad.

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

```
       ACT ECON CRZ      2/3
  CRZ ALT          STEP TO
  FL210
  ECON SPD              TO T/D
  336           1952Z/5.0 NM
  N1            KJFK ETA/FUEL
  98.0              2011Z/7.9
   STEP     OPT    MAX   RECMD
  0000    FL407  FL421  FL407
  -----------------------------
  <LRC          RTA PROGRESS>
```

The STEP TO altitude from the RTE LEGS page is a calculated step climb altitude based on the step size and it 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 in 1,000-foot increments by entering at RK5 in 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 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 1/2
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

```
        SSG001   PROGRESS      1/3
   LAST        ALT  ATA         FUEL
   VECTORS  3034 1932Z         20.2
   TO          DTG  ETA
   RIGNZ         4 1935Z       17.9
   NEXT
   JCOBY        10 1936Z       16.9
   DEST
   KJFK        224 2014Z        3.5
   MCP  SPD
   250
```

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
This is the estimated fuel quantity remaining at a waypoint or the destination.

Progress Page 2/2

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)
This shows the headwind component (H/WIND) and crosswind component (X/WIND).

Wind component data is relative to the aircraft. It displays current wind direction and speed referenced to true north.

Left (L) or right (R) crosswind component is relative to the aircraft's heading.
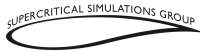
Cross-track Error (XTK ERROR)
Cross-track (XTK) error is displayed in NM left or right of the active route.

Vertical Track Error (VTK ERROR)
Vertical path (VTK) error above (+) or below (-) vertical path.

TAS

Aircraft true airspeed.

Left Fuel Used
Instantaneous fuel figure consumed by left engines sensed by fuel flow meters. (lbs/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 to validate FMC calculations.

Static Air Temperature (SAT)
Outside static air temperature.

Right Fuel Used
Fuel consumed by right engines as sensed by fuel flow meters. (lbs/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 to validate FMC calculations.

Required Time of Arrival (RTA)

Progress Page 3/3

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:
This is 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. They 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 is the computed speed 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, then 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, then 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

Economy Speed (ECON SPD), Selected Speed (SEL SPD)
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 kts 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 altitude (e.g. 240/8000). This entry may be deleted.

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

- FPA is "Flight Path Angle" and displays the aircraft's current flight path angle.
- V/B is "Vertical Bearing" and displays vertical bearing from current position to the entered waypoint and altitude.
- V/S is "Vertical Speed" and 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 airplane is within 50 NM of T/D.

Approach REF Page


```
            APPROACH REF
  GROSS  WT      FLAPS        VREF
  540.5          25°          141

                 30°          139
     KJFKILS 04L
  12079FT 3682M
     ILS04L/CRS            FLAP/SPD
  110.90/044° PARK          25/141

  --------------------------------
  <INDEX                THRUST LIM>
```

The approach reference page shows approach planning data and approach reference speed (V$_{REF}$) selection.

Gross Weight (GROSS WT)

FMC calculated airplane gross weight is usually shown here. Manual entry by the pilots is not permitted. Permanent changes to gross weight result in recalculation of all performance data and may only be made on the PERF INIT page. If the gross weight is greater that 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 V$_{REF}$ to become available.

Flaps VREF

A valid gross weight is necessary for V$_{REF}$ speed calculation. Pilots can then press the applicable LSK to choose the desired V$_{REF}$ speed for a given flap setting. The two V$_{REF}$ 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 V$_{REF}$ speed is entered for landing.

FIX Information Page

This page is called up 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 INFO          1/1
    FIX  BRG/DIS FR
    □□□□□
    BRG/DIS   ETA  DGT    ALT




                  PRED ETA-ALT
                     ------
```

FIX
These can be airports, navaids and waypoints in the nav database. Selected fixes are displayed on the ND as a green circle.

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

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.

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PRED ETA-ALT
Shows 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 categorized 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
Airplane speed is too fast. Drag is required to remain on the VNAV descent path and stay within speed tolerances.

End Of Route
The airplane 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 5 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, autothrottle is disconnected, 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 airplane 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 it is impossible the 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 Messages

EICAS Alert Messages

Message	Level	Message Logic
FMC MESSAGE	Advisory	High priority FMC message exists.

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12. Fuel

## System Description

Intercontinental

The 747-8 has multiple fuel tanks, with the main tank located between the wings, and 6 wing tanks. The 747-8i also has an additional horizontal stabilizer tank, which is simulated in the SSG 747-8. The Freighter fuel system is the same as depicted in this section, other than not having a stabilizer tank.

Fuel Tank Location (Intercontinental)
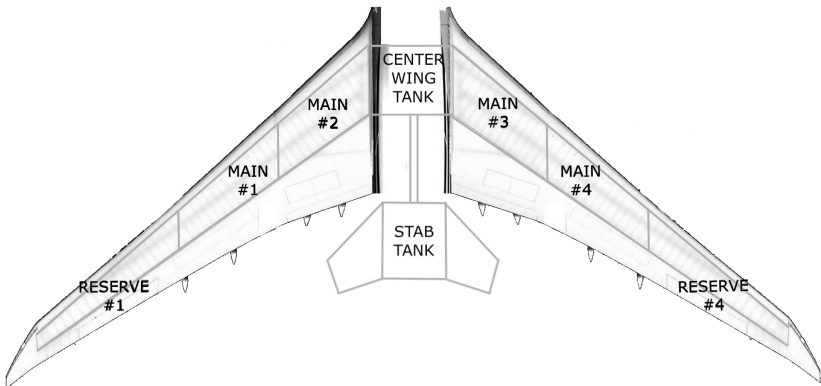
Overhead Panel (Intercontinental)

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SSG B747-8 SERIES
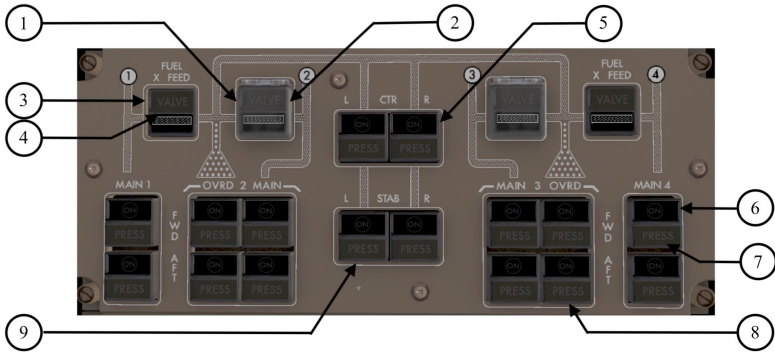
OVERHEAD PANEL

1. Crossfeed valve switch
2. Crossfeed light
3. Crossfeed valve switch
4. Crossfeed light
5. Center wing tank pump switch
6. Main pump switch
7. Fuel pressure light
8. Override fuel pump switch (not implemented)
9. Stabilizer tank pump switch (not present on the Freighter)

Fuel tank pumps are turned on and off with buttons on the overhead panel. Crossfeeds are functional on the SSG 747-8 overhead panel and all valves work as well. The reserve tanks supply fuel via gravity feed to the outboard tanks if the valves are opened, and all feeds work as in the real aircraft.

EICAS Fuel Display

The EICAS displays total fuel information as well as the fuel temperature, which is a consideration on some flights because jet fuel typically freezes at -40 to -47°C (-40 to -53°F) depending on fuel type. No fuel heat is available on the real 747-8, so pilots have the choice to either accelerate or choose to fly at an altitude with warmer temperatures. SSG 747-8 pilots will need to do the same thing in such situations.

Fuel System Synoptic (Intercontinental)
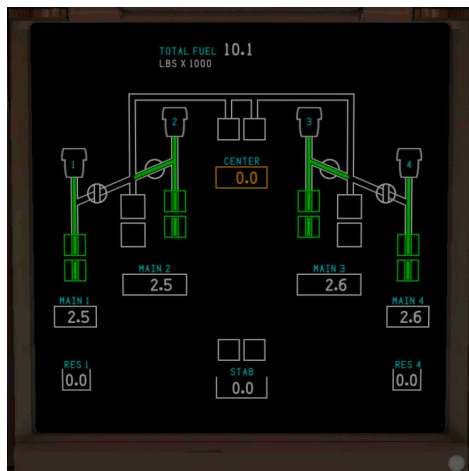
The fuel quantity in each tank is shown on the fuel synoptic, which can be displayed on the MFD. The "PRESELECT" value is displayed once fuel is loaded to the aircraft and the passenger doors are closed. It is reset again once the doors are opened again.

The fuel is used in the following order, which is similar but not identical to the real aircraft's because of limitations within XP. The system will require some pilot input to change the configuration of the fuel system for the duration of a flight, especially a long one.

The reserve tanks feed by gravity to the outboard tanks when their fuel quantity becomes low, and if an outboard tank is not full the reserve tank fuel will drop to the outboard one.

If the center tank is full the stabilizer tank (on the Intercontinental) will be consumed first and when it gets to a minimum value, it will stop feeding the center tank and the pilot will need to turn off the stabilizer tank fuel pumps.

From this point, the center tanks will feed all engines until main tank 2 quantity is equal to or less than the sum of the main tank 1 quantity plus reserve tank 1 quantity (and the same condition exists in the right wing tanks). Then an EICAS message will appear advising the pilots that they have to configure the fuel panel so that then each wing tank feeds its own engine, turning off the pumps that are no longer needed, as well as the crossfeeds. Keeping the valves opened the fuel system will maintain fuel balance, but if they are closed it cannot. The normal procedure is to keep all valves ON.

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Fuel Control

In addition to the overhead fuel panel pump and crossfeed switches, the fuel control switches on the aisle stand can be selected to the RUN or CUTOFF positions. During engine starts, the fuel control switch has to be in the RUN position for fuel to flow to the particular engine. Similarly, to shut off an engine, the individual fuel control switch can be placed in the CUTOFF position. This is normally how the engines are shut down.

There are 4 fuel control switches located on the aisle stand behind the throttles, with one switch for each engine as numbered.

Fuel Jettison System

Sometimes it becomes necessary to dump fuel in order to land the aircraft, usually in an emergency. The reason for this is that the MTOW of the aircraft is much higher than the MLW. Landing an aircraft at a weight higher than the MLW is hazardous in itself, so it is prudent to reduce the weight by jettisoning fuel before landing. This system is implemented in the SSG 747-8.

Overhead Fuel Jettison Panel
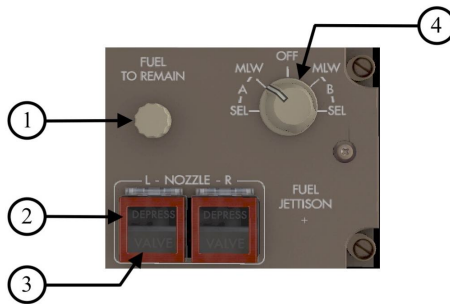
OVERHEAD PANEL

1. FUEL TO REMAIN selector
2. Fuel jettison nozzle valve switches
3. Fuel jettison nozzle valve lights
4. Fuel jettison selector

Pilots have the option of selecting a particular landing weight at which they desire to land, or simply select MLW. This can be indicated on the fuel jettison selector. There is a knob that can be used to select the desired landing weight and once the system is

configured by selecting "A" or "B" the clear plastic guards lifted and the fuel jettison nozzle valve buttons pressed. The fuel is then jettisoned from two nozzles, one at each wingtip, which can be seen in the simulator.

Fuel Tank Capacities

Freighter

	Liters	Kilograms	U.S. Gallons	Pounds
1 and 4 main	42,026	33,743	11,102	74,383
2 and 3 main	110,155	88,443	29,100	194,970
Center	64,973	52,167	17,164	114,999
Reserves	12,378	9,938	3,270	21,909
Total	229,532	184,277	60,636	406,261

Intercontinental

	Liters	Kilograms	U.S. Gallons	Pounds
1 and 4 main	42,026	33,743	11,102	74,383
2 and 3 main	110,155	88,443	29,100	194,970
Center	64,973	52,167	17,164	114,999
Reserves	12,378	9,938	3,270	21,909
Stabilizer	12,492	10,030	3,300	22,112
Total	242,024	194,321	63,936	428,404

EICAS Messages

EICAS Alert Messages

Message	Level	Message Logic
FUEL CTR CONFIG	Caution	Fuel in center tank low.
FUEL IMBAL 1-4	Advisory	Fuel difference of 3,000 pounds between main tanks 1 and 4. Message no longer displayed when difference less than 1,000 pounds.
FUEL IMBAL 2-3	Advisory	Fuel difference of 6,000 pounds between main tanks 2 and 3. Message no longer displayed when difference less than 1,000 pounds.

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Message	Level	Message Logic
FUEL IMBALANCE	Advisory	There is a fuel difference of 6,000 pounds between inboard main tanks and outboard main plus reserve tanks. Message no longer displayed when difference less than 1,000 pounds.
FUEL LOW CTR	Advisory	Before start, center wing tank quantity less than 17,000 pounds with pump switch ON, or in climb, center wing tank quantity approximately 7,000 pounds with pump switch ON, or in cruise, center wing tank quantity approximately 3,000 pounds with pump switch ON.
FUEL LO STAB	Advisory	Stabilizer tank (on Intercontinental only) quantity is less than 2,490 pounds with pump switch ON, or with jettison active, stabilizer tank quantity is less than 507 pounds with pump switch ON.
FUEL OVRD 2, 3 AFT / FWD	Advisory	Fuel override pump pressure is low when pump is activated.
FUEL PUMP 1, 3, 3, 4, AFT / FWD	Advisory	Main pump pressure is low when pump is activated.
FUEL QTY LOW	Caution	Fuel quantity 2,000 pounds or less in one or more main tanks.
FUEL TANK/ENG	Advisory	When crossfeed valve 1 or 4 are open and an inboard tank quantity is less than or equal to the respective outboard tank plus reserve tank.
JETT NOZ ON	Advisory	Both fuel jettison valves open.

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13. Hydraulics

System Description

The real 747-8 has a sophisticated hydraulic system with both engine-driven and electric pumps that power four separate hydraulic systems (one powered by each engine) and provide extensive redundancy. The hydraulic system drives the primary flight controls (ailerons, rudders, and elevators) as well as some additional systems, like the landing gear and brakes.
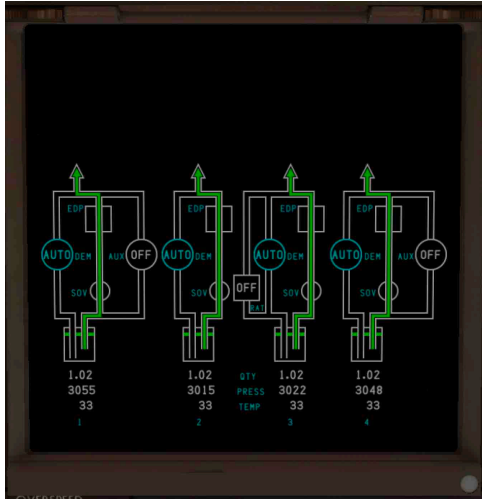
Hydraulic Panel

OVERHEAD PANEL

1. Hydraulic DEMAND pump selector
2. ENGINE hydraulic pump switch
3. Hydraulic system (SYS) FAULT light (not implemented)
4. Demand pump low PRESS light (not implemented)
5. ENGINE hydraulic pump low PRESS light (not implemented)

The Overhead Hydraulic Panel has limited implementation in the SSG 747-8 because and operation is completely automatic. On the real aircraft, pilots typically have to turn the hydraulic systems on and off manually before and after engine starts.

One function that has been implemented is the AUX mode for both the No. 1 and No. 4 hydraulic demand pump selectors. Selecting the AUX mode on both pumps before pushback allows for sufficient hydraulic pressure for steering and braking functions during pushback. After the engines are started, these switches can be rotated to AUTO along with those for systems No. 2 and No. 3 for normal operations.

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Hydraulic Synoptic

In the SSG 747-8, the hydraulic system synoptic that is selectable on the MFD shows which hydraulic systems are active. The hydraulic pressure (middle row of numbers) reflects real values.

Ram Air Turbine (RAT)

RAT Panel

OVERHEAD PANEL

A new feature on the real 747-8 is a RAT that extends automatically from a compartment under the aircraft's right wing root (see screenshot below) if there is a loss of engine power (3 engines or more). The RAT was needed because Boeing determined that the

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engines would not windmill fast enough to provide sufficient hydraulic power to operate the aircraft's flight controls. On the real aircraft, the RAT deploys if there are three engine failures. It provides hydraulic power to hydraulic system number 2.

The RAT has been implemented in the SSG 747-8. It will automatically deploy in case 3 or more engines fail. It can also be deployed by opening the plastic guard and then pressing the overhead RAT switch for 1 second. At that point the RAT will deploy and the turbine (propeller) will start spinning and provide hydraulic power, which can be seen on the hydraulic synoptic. The RAT button has 2 lights. The bottom amber one (UNLKD) indicates the RAT is not in its normal locked and up position – and thus has deployed. The top green (PRESS) light indicates the RAT is providing hydraulic pressure.

On the real aircraft deploying the RAT is a one-way affair and it cannot be retracted by the flight crew. It requires maintenance action. However, since this is a simulator and we did not want to require a restart to continue flying after deploying the RAT, we have provided a means to reset it. With the aircraft stationary on the ground and all engines shut down, pressing and holding the RAT button will stow the RAT once again.

EICAS Messages

EICAS Alert Messages

Message	Level	Message Logic
HYD PRESS SYS 1, 2, 3, 4	Caution	Hydraulic system pressure is low.

| Message	Level	Message Logic
RAT UNLOCKED	Advisory	The RAT is not stowed and locked.

14. Landing Gear

System Description

The 747-8 has 5 sets of landing gear with two nose wheels and 16 main wheels. In normal conditions they are all operated with a single lever in the cockpit. The 747-8 only has "UP" and "DOWN" positions for the landing gear, without the "OFF" position that was found in the 747-400 and 747 Classic models. Please note that the real 747 landing gear handle has a wheel made of clear plastic, which is why it looks almost transparent in the SSG 747-8.

Landing Gear Panel
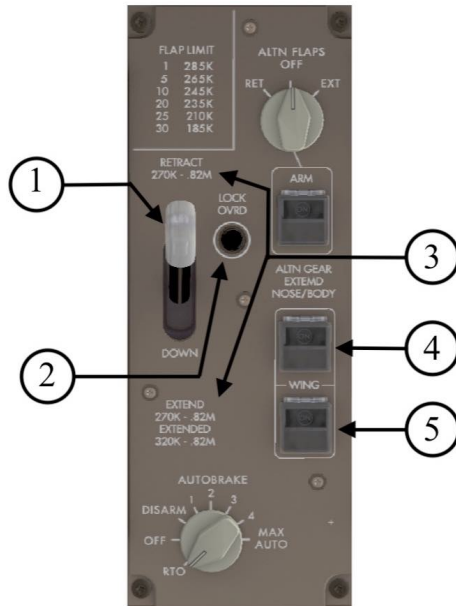
CENTER FORWARD PANEL

1. Landing gear lever
2. Landing gear lever LOCK override (OVRD) switch
3. Landing gear limit speed placards

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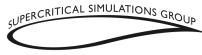
4.   NOSE/BODY alternate (ALTN) GEAR EXTEND switch (not implemented)
5.   WING alternate (ALTN) GEAR EXTEND switch (not implemented)

NOTE: The autobrake selector panel is at the bottom.

There is a built-in protection to prevent an inadvertent raising of the landing gear while there is weight on the wheels. The SSG 747-8 also has such a system and the landing gear handle will only go up if the aircraft is airborne. If it is necessary to raise the gear for some reason (such as maintenance) there is a GEAR OVERRIDE button above the landing gear handle. Pressing this button will override the protection logic and allow the gear to be raised. Use it with caution!

The main gear tilt down while the body gear rotates left and right to aid in turning while taxiing, this is called "body gear steering" and operates automatically. The reason for the gear tilt has to do with the manner in which the main landing gear extend and retract in relation to the wheel wells. The nose gear also turns, although through a much wider range than the body gear.

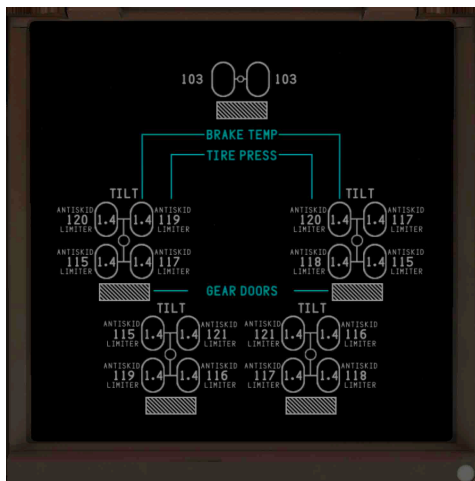A landing gear synoptic can be called up on the MFD.

Brake temperatures are shown as values between 0.0 and 9.9. White is the normal range and amber is the high range.

The tire pressure indication displays the individual tire pressures.

Landing gear door status is also shown as CLOSED or OPEN.

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Landing Gear Synoptic

Brakes

The 747-8 has a sophisticated set of brakes to slow the aircraft down, including an autobrake system that has various settings for the anti-skid system to decelerate the aircraft automatically. It is quite similar to the anti-lock brakes found on most modern automobiles, except that the wheels are not connected to any sort of driving mechanism.

Some of this functionality has been implemented in the SSG 747-8, and the anti-skid functions follow real system logic, which operates much like that of an automobile as well. If the system senses a wheel skidding, it will adjust the wheel braking to regain traction on the runway/taxiway surface.

The brakes are operated in the normal fashion by the pilots using the tops of the rudder pedals. Each side can be operated independently to allow for differential braking in some circumstances.

Please note that the nose gear on the 747 does not have any brakes. The wheels in the nose gear are slowed to a stop upon retraction by rubbing strips in the nosewheel well, which lies below the main cabin of the aircraft.

Autobrakes

On the autobrake panel, "RTO" setting stands for "Rejected Takeoff" and will apply full braking if the pilot applies brakes during the takeoff roll. The settings from "1" to "MAX AUTO" can be used on landing and have the following values:

Setting	Deceleration (Dist/Sec/Sec)
1	4 ft (1.2 M)
2	5 ft (1.5 M)
3	6 ft (1.8 M)
4	7.5 ft (2.3 M)
MAX AUTO	11 ft (3.4 M)

Once the aircraft has sufficiently decelerated down the runway, the system can be deactivated by switching to the "DISARM" setting. Once the aircraft is airborne, the autobrake switch will move from RTO (which is the standard mode for takeoffs) to OFF. RTO cannot be engaged in flight.

NOTE: On the SSG 747-8, the DISARM setting is not enabled, so switching to OFF has the same effect.

Parking Brake

Parking Brake Lever
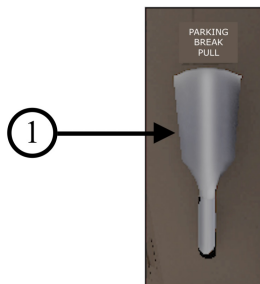
CONTROL STAND

1.   Parking brake lever

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SSG B747-8 SERIES

The parking brake on the 747-8 is very similar to that of an automobile. The brake is set by pushing the top of the rudder pedals and then pulling on the small parking brake lever located on the cockpit aisle stand. This system works in similar fashion on the SSG 747-8.

Also, note that the SSG 747-8 is equipped with chocks, which allows for the parking brake to be disengaged when the aircraft's engines are shut down and prevent the aircraft from rolling.

NOTE: SSG recommends clicking on the parking brake handle to operate the system, rather than using the standard XP "B" key, to ensure proper system functioning.

EICAS Messages

EICAS Alert Messages

Message	Level	Message Logic
GEAR SPEED	Caution	The aircraft has exceeded the safe landing gear extension speed.
BRAKE SOURCE	Caution	Normal and alternate brake system pressures are low.

EICAS Memo Messages

Message	Level	Message Logic
AUTOBRAKES 1, 2, 3, 4	Memo	Autobrake level selected.
AUTOBRAKES RTO	Memo	Autobrakes MAX selected.
AUTOBRAKES MAX	Memo	Autobrakes RTO selected.
PARK BRAKE SET	Memo	Parking brake valve closed.

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15. Warning Systems

System Description

The SSG 747-8 has various warning systems, both to advise pilots of aircraft status, and to warn pilots of external hazards. These include EICAS messages, as well as other aural and visual warnings.

Master Caution Button

Master Caution Button

This button is located on the left side of the cockpit glareshield and lights up a WARNING message in red to alert the pilots that a warning message has appeared on the EICAS with an associated tone. The light can be extinguished by pressing the Master Caution button once.

A CAUTION light appears in amber on the Master Caution button, which warns the pilots that a caution message has appeared on the EICAS, and also has an associated tone.

EICAS Messages

In the SSG 747-8, like on the real aircraft, there are 4 types of messages that appear on the EICAS. A significant number of different messages can be presented to the pilots on multiple pages and they can be cycled through and removed using the CANC and RCL buttons on the Display Select Panel.

EICAS messages are color coded as follows:

EICAS Message	Color
Warning	Red
Caution	Yellow
Advisory	White
Memo	White

The various EICAS messages, with their meaning and logic, are listed in this FCOM with their associated system.

Traffic Collision Avoidance System (TCAS)

The aircraft's TCAS system is activated by selecting TA/RA on the aircraft's transponder. To display other traffic on the ND, the TFC button has to be pushed. This button is located in the range display knob on the Glareshield Panel.

It is necessary for pilots to press the TFC button for traffic to be visible on the ND, the button can be pressed once to make traffic visible, and once again to remove them from the display. Traffic is displayed in white, or it becomes red if the system identifies it as a collision hazard.

Takeoff Configuration Warning

The SSG 747-8 has a takeoff configuration warning system to alert the pilots that the aircraft is not properly configured for takeoff. This system takes into account the following conditions and will sound a warning if a takeoff is attempted:

- Flaps not in takeoff position (10 or 20 degrees)
- Parking brake set
- Speedbrake lever not in DOWN position
- Stabilizer trim not in takeoff range
- Nosewheel turned more than 30 degrees

Pilots should discontinue the takeoff and determine which condition has caused the alarm before attempting the takeoff again.

Ground Proximity Warning System (GPWS)

The SSG 747-8 has a simplified GPWS with some elements of the Enhanced GPWS that is now installed on the real aircraft. When the GPWS Terrain switch is pushed on the MCP, the TERR symbol is displayed on the ND and a look-ahead view of the terrain stored in an on board database is presented on the ND in a sweep fashion similar to a radar. Terrain contours are color coded as follows:
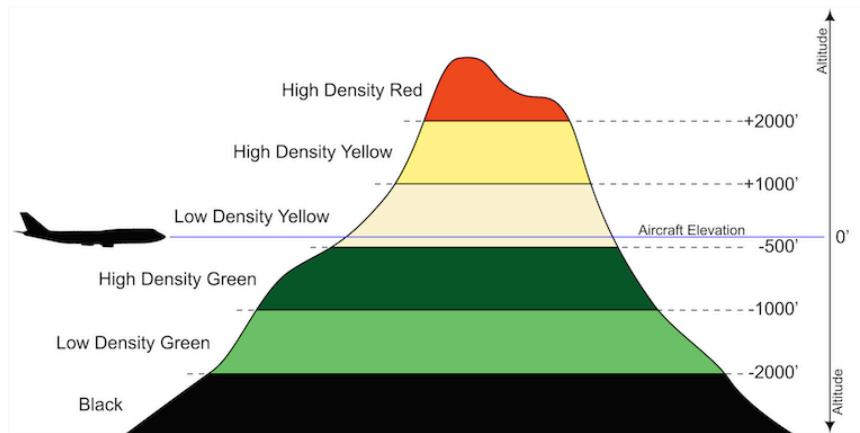
NOTE: Only the TERR or WXR modes can be displayed at one time. Many operators recommend having one pilot display the terrain while the other displays weather radar returns to get a complete picture of any potential hazards ahead of the aircraft.

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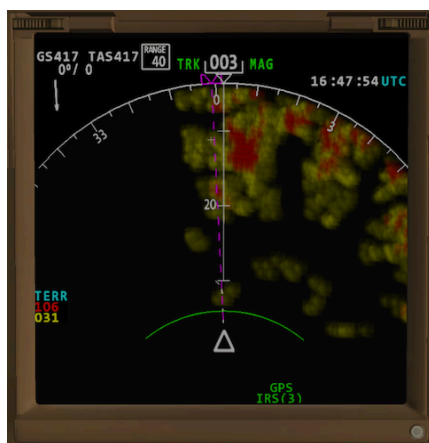
In this mode, two values below the TERR symbol on the display indicate the maximum absolute altitude of the terrain being displayed on the ND. The top number represents the highest terrain pixel displayed on the ND while the lower number is the lowest terrain pixel, and these are color coded to match the altitude of that terrain.

The following callouts are also implemented as part of the GPWS to alert pilots of terrain hazards, and to assist pilots during landings to some safety concerns related to the airplane's configuration and position during approaches to land:

"GLIDE SLOPE"
"DON'T SINK"
"SINK RATE"
"TERRAIN"
"TOO LOW, FLAPS"
"TOO LOW, GEAR"
"TOO LOW, TERRAIN"
"PULL UP"

EICAS Messages

EICAS Alert Messages

Message	Level	Message Logic
AIRSPEED LOW	Caution	Airspeed is less than minimum maneuvering speed.
ALTITUDE ALERT	Caution	Airplane has deviated more than 200 feet from the MCP selected altitude.
AIRSPEED HIGH	Caution	Aircraft has exceeded its maximum maneuvering speed.
CONFIG FLAPS	Warning	Flaps not in a takeoff position.
CONFIG GEAR		Any landing gear is not down and locked when any thrust lever closed below 800 feet radio altitude, or when the flaps are in a landing position.
CONFIG PARK BRK	Warning	Parking brake is set when airplane is on the ground, airspeed is less than V_1, 3 or more fuel control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG SPOILERS	Warning	Speedbrake lever is not down when the airplane is on the ground, airspeed is less than V_1, 3 or more fuel switches are in

Message	Level	Message Logic
		RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG STAB	Warning	Stabilizer is not within the greenband when the airplane is on the ground, airspeed is less than V_1, 3 or more fuel switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
OVERSPEED	Warning	Airspeed exceeds V_{MO}/M_{MO}.

** NOT TO BE USED FOR REAL WORLD FLIGHT **

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