

# **767**

## *Pilot in Command*

Microsoft<sup>®</sup> Flight Simulator 2000 Upgrade

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## **PANEL OPERATION and SYSTEMS MANUAL**

This manual is for information purpose and is intended to be used  
With Microsoft Flight Simulator 2000 and 767 Pilot in Command (Wilco Publishing) only.

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## DESCRIPTION

This 767 simulator is one of the most advanced panel modelling programs you will find on the market. This panel showcases innovations created during over 2 years of development. If you ever wondered what it would be like to fly behind the controls of a real airliner then you have found the right panel. You can be sure that operating the 767 with this panel is as real as it can get because it was designed and co-produced by an active 767 pilot currently flying for a major U.S. Airline!

This manual is intended to familiarize you with the 767 panel for FS2000. This panel is a highly accurate representation of the actual 767 cockpit and its systems. Every effort has been taken to make the systems and controls as accurate as possible. Those of you that are familiar with the 767 can recognize the level of detail created and the integrity of the included systems. There are some minor differences between this panel and the real aircraft and the information provided in this manual is aimed at teaching the simulator version and not the real aircraft. However, you could just as easily use the actual Boeing operating manual to study up on how to operate this panel.

Each section of this manual provides a description of the subject system and a textual explanation of how things work. The end of each section has labelled pictures of panel controls and detailed explanations of how they work. If you are already familiar with the operation of complex panel systems, then you can familiarize yourself very quickly with this panel by reviewing the panel control explanations at the ends of each section. Most sections also contain a brief paragraph labelled "Easy Fly Quick Tip". This quick tip is intended for those who really have no desire to mess with the systems and wish to get things up and running quickly.

This section provides an overview of the entire panel. It describes the different panel "windows" that are used to operate the plane, and provides an explanation of the functionality built into the panel. Also in this section is a brief description of miscellaneous panel components.

## PANEL LAYOUT



## MAIN PANEL (1)

The main panel contains almost all of the controls necessary to properly fly the 767. We have placed a tremendous amount of information onto the main panel in an effort to minimize the use of “windowed” panel components and maximize the overall cockpit feel. During high workload periods of takeoff and landing there is almost no need to switch panel windows to determine the aircraft configuration or to access essential switches. Most of them are all right here on the main panel.

The panel is completely accurate in its layout of the basic flight instruments and autopilot controls. The panel is patterned after 767's found at most major US airlines. Some components have been shrunk and adjusted to fit in the main panel. The only creative liberty invoked during the design of the main panel was the removal of the standby flight instruments from the main panel to make room for the warning annunciators and controls. The standby flight instruments are now windowed in a separate panel and can be accessed by pressing <shift><3>. They will be displayed on top of the warning annunciators and “blend” into the panel nicely.

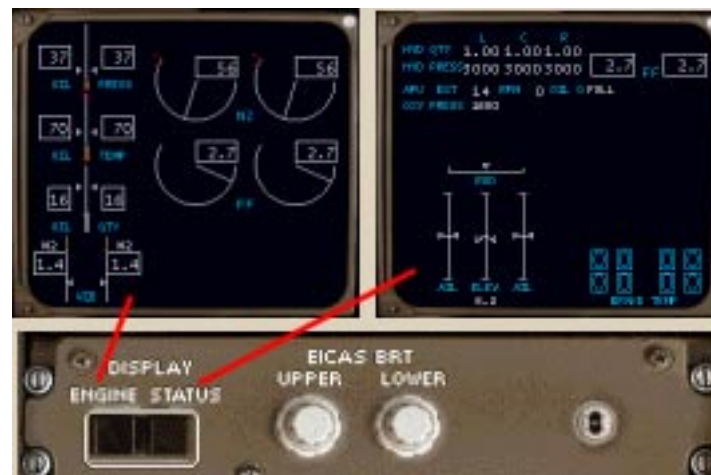
The basic flight instruments are the focal point of the panel. They were designed for maximum readability while maintaining the maximum cockpit feel. Those who are not familiar with the 767 might wonder why the Vertical Speed gauge has a grey housing: it is one of the many options that carriers can choose from when equipping their 767's. This particular VSI is integrated with the TCAS on the real plane. In the real plane there is a separate screen for the display of TCAS information while TCAS “commands” to the pilot are displayed on the VSI. Some carriers have the TCAS co-located with the VSI and display traffic data and VSI data together on a small LCD screen. Some may have seen this style of VSI on older versions of our 767. This version of the VSI was chosen because it is the style found in the aircraft currently flown by the designer.

There are four CRT screens on the main panel. The two on the left are part of the flight instruments and are referred to as the EADI and EHSI (described in the Flight Instrument section). The EADI replaces the standard attitude indicator and the EHSI replaces the standard compass gauge.

The EADI and EHSI-brightness controls are on the main panel. This picture shows the knobs used for this task. Below the knobs are the buttons needed to quickly call up the other panel windows. One that will be used quite often is the FMC button. Pressing it or using the keyboard combination <shift><6> brings up the FMC (described in the FMC/NAV section). The FMC will display over the two CRT screens on the right side of the panel. Pressing the PDST key or using the keyboard combination <shift><5> will bring up the pedestal. Pressing the OVHD key or using the keyboard combination <shift><4> will bring up the overhead systems panel.



The two screens on the right side of the panel are called the EICAS screens (described in the Engine section). They provide engine indications, warning/caution messages and other system information. Brightness controls for these two screens are located directly below the lower screen. The lower screen has three display modes that are controlled by the two toggle switches labelled "ENGINE" and "STATUS". Pressing the ENGINE button will toggle between the engine indications screen and a blank screen. Pressing the STATUS button will toggle between the status page and a blank screen. Normally the engine screen is displayed at all times.



## PEDESTAL (2)

The pedestal is called up using the PDST button on the main panel or the keyboard combination <shift><5>. The pedestal contains a number of aircraft control items that could not be included in the main such as the throttles, flap lever, spoiler lever, parking brake, fire handles, and radios.

The throttles, flaps and spoilers can be controlled using keyboard commands, joystick commands or mouse-clicks on the controls themselves. The parking brake can also be controlled via mouse click or keyboard command. All other controls found on the pedestal are described later in this manual. Radio controls are described later in this section.



### OVERHEAD PANEL (3)

The overhead panel is called up using the OVHD button on the main panel or the keyboard combination <shift><4>. The overhead contains controls for a majority of the aircraft systems. Each system is described in detail in this manual.

You will notice on the overhead above the Seat Belt/No Smoking signs there are two yaw damper switches. In the real plane these control power to the yaw damper system. Since we only need one yaw damper switch in the sim, we designated the left yaw damper switch to control the yaw damper. The right switch controls the "auto co-ordination" feature of FS2000. Turning the right yaw damper switch OFF will turn off auto co-ordination of the rudders and ailerons. There is also a caution message generated on the EICAS screen to remind you of this.

### FLIGHT MANAGEMENT COMPUTER (FMC) (4)

The FMC is called up using the FMC button on the main panel or the keyboard combination <shift><6>. The FMC keyboard and display unit are used to enter flight plan and performance data for the complete management of all phases of flight. It is also used to keep track of flightplan progress and to generate the navigation MAP display on the EHSI. The FMC is described in great detail in the FMC/NAV section.

### VISIBLE OVERHEAD



Controls for exterior lighting and the "whiskey" compass are found on the visible overhead. The three switches above the compass control the landing lights. The other pushbutton switches above the landing lights control (from left to right): Position lights, Red Beacon light, White anti-collision lights, and Wing lights. The runway turnoff switches have no function in the sim at this time.

If you press the LT OVRD switch to ON, the panel "flood lights" will be turned on. The panel will become automatically backlit at night. This switch has no effect on the panel appearance during the day.

## SAVING PANEL SETTINGS

When the panel is initially loaded, all of the switches are placed automatically into a "ready to fly" state. This means you can load and fly without having to set up the panel or initialize the systems. However, you can save a custom panel setup by saving your flight using the FS2000 "Save Flight" feature.

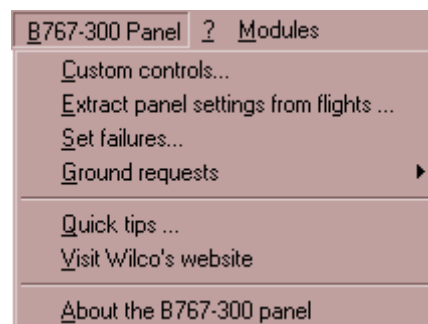
To save your favourite panel set-up, just do the following:

- 1) Place all the panel switches and other settings where you would like them when the panel loads.
- 2) Go into the "Flights" menu and select "Save Flight..."
- 3) When the menu pops up just enter the "Title of Flight" and optional "Description".
- 4) To make this panel setup load as the default panel for FS2000 just check the "Make this the default Flight" box.
- 5) Click the check mark to save the flight.

Please note that the "ready to fly" state is loaded the first time you run the panel. Anytime you load a saved situation all of your switches and settings will be placed exactly as you saved them. If you wish to extract panel settings from any other saved flight into a currently loaded situation you can do so by using the "Extract panel settings from flights..." menu option. See the explanation later in this section on how to do this.

## B767-300 PULL DOWN MENU

There are a number of options that you can select using the B767-300 pull down menu located in the FS2000 menu bar. When you select the menu the following options are displayed:



"Custom Controls...": Selection of this item will pull up the following menu box:



This menu allows you to assign custom keyboard commands to most of the switches on the main panel. The switches that can be custom programmed are listed in the "Affectation List". This list outlines functions that have been custom programmed and do not use FS2000 parameters. All other switches on the main panel (e.g. gear, flaps, etc.) respond to the default FS2000 keyboard commands.

The panel comes pre-loaded with default keyboard assignments for each listed function. Anytime you load the panel these keyboard commands are used.

If you change any of the keyboard commands they will be saved and subsequently loaded each time you use the panel. To restore the default keyboard settings press the "Defaults" button and all switch settings will be restored to their default assignments. Please note that selection of "Defaults" has no effect on the FS2000 keyboard commands.

It is possible to have a conflict with default FS2000 keyboard commands. The user will have to experiment with the sim if any of the default keyboard commands are changed. There are no limitations to the types of keyboard assignments used. For the most part the "<ctrl><alt> + \_\_\_\_" keyboard commands are not used by FS2000 so a majority of custom commands for this panel use the "<ctrl><alt>" keys to avoid assignment conflicts.

“Extract panel settings from flights...”: This selection is used to import saved panel settings from a different flight into a currently loaded 767 panel. If the sim is already running with the 767 panel loaded and you wish to load the switch settings from a saved 767 flight into the currently loaded panel you have to use this menu:



The “Available panels settings” list shows all 767 flights that have been saved using the FS2000 “Save Flight” feature. Select one of these flights and press the check mark to extract the panel settings from the saved flight. All panel switches will be reset to the values saved in the selected flight. Note that **ONLY** the panel switch settings are loaded and not the other saved flight parameters (such as aircraft position and weather).

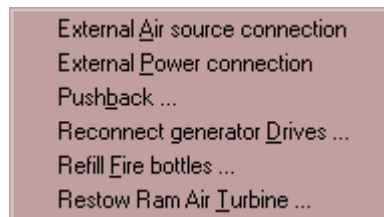
“Set failures...”: Use this menu item to set system failures.



The menu items are self-explanatory. Each of the four menu tabs lists a variety of failures that can be introduced to the selected system. Select the system that you would like to have fail and pull down the failure type selection window (the down arrow). After making the failure selection, input the number of seconds' delay before the failure occurs. In the case of random

failures, you can select the number of failures per hour. To clear failures, just select "No Failure" in the failure type selection window.

"Ground requests": Selecting this item displays the following sub-menu:



These items can only be selected on the ground (as the name implies). Each of these items is further discussed in the appropriate section of this manual.

**"External Air source connection"**

- ▶ Requests that external bleed air be hooked up or removed from the aircraft.

**"External power connection"**

- ▶ Requests that external power be hooked up or removed from the aircraft.

**"Pushback"**

- ▶ Requests a pushback.

**"Reconnect generator Drives"**

- ▶ Reconnects the generator drive if it has been disconnected by the pilot.

**"Refill Fire bottles"**

- ▶ Recharges exhausted fire extinguisher bottles.

**"Ram Air Turbine Restowing"**

- ▶ Restows the RAT if deployed.

## PEDESTAL RADIOS

All of the radios except for the NAV1 radio are found on the pedestal. The NAV1 radio is found on the main panel next to the autopilot panel.

The VHF COMM radio shows how the mouse click areas are arranged for control of the radios. Two frequencies can be tuned into each radio. However, only one will be active. The active frequency is determined by moving the FREQ SEL TFR switch and is highlighted using bright white digits.

The VOR2 radio can be tuned manually or the FMC can do this automatically. If you want to program a frequency into the active window and it changes to something else, it means that the NAV radios are under the control of the FMC. There is more information on this in the FMC/NAV section.

Changing ADF frequencies is the same as with VHF COMM and VOR2, except that there are three separate mouse areas to control each individual digit.



The Transponder code is adjusted upwards using the “+” mouse areas. When the frequency reaches “7” it will roll over to “0”.

## NAV1 RADIO

The NAV1 radio is found on the main panel next to the autopilot panel. Mouse click control of the frequency is exactly the same as for the pedestal radios. Control of the course (CRS) is via simple +/- mouse click boxes located over the knob. There is no option to have a standby NAV1 frequency.

The operation of this radio is completely different from anything seen on other panels. There are two modes of operation for the NAV1 radio: AUTOMATIC and MANUAL mode. The button above the VOR/DME text is used to select the operating mode. In the MAN mode, the frequency is selectable by the pilot just as in a normal VOR radio. In the AUTO mode the FMC now has control over the tuning of NAV1. The frequency dialed in by the pilot while in MAN mode is saved and can be recalled by switching back to MAN mode. The importance of this will be explained in the FMC/NAV section.





## FMC DESCRIPTION

The Flight Management Computer ( FMC) is the brain behind navigating the 767 from point A to point B with accuracy. This quick review is meant to get pilots up and running with the FMC without a long and detailed review of every aspect of its operation. Those familiar with the operation of a real FMC can skip this section since the FMC found in this panel has almost all of the same capabilities and functions as the FMC in the actual aircraft.

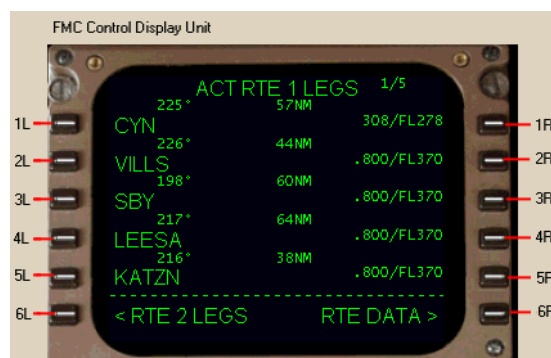
## FMC PILOT INTERFACE

The pilot controls the FMC via a keyboard that is called up using a mouse button on the main panel labelled "FMC" or with the key <shift><5>combination. The keyboard is conveniently located and sized so that it fits on top of the engine gauges and can be used in flight without interfering with the operation of the autopilot or the viewing of the main flight instruments.

The keyboard has a display called the Control Display Unit (or CDU). The CDU has a series of 6 buttons on each side of the display called "line select keys" (or LSK) for the selection of data on the screen. Each button is identified based on location with 1R being the top right button and 6R being the lower right button. The same for the left side with 1L being the top left and 6L being the bottom left.

The bottom row of data on the CDU is called the "scratchpad". The scratchpad is normally blank and is used for the display/input of data. If the FMC generates a message, it is shown in the scratchpad. During some operations there are action prompts visible in the scratchpad that can be selected by pressing the adjacent LSK.

When the pilot presses an LSK the data abeam the LSK is transferred to the scratchpad. Then the data from the scratchpad can be transferred to any line in the CDU by pressing the corresponding LSK. Data can also be input using the keyboard and then transferred to any line in the CDU by pressing the corresponding LSK.



## FMC SETUP

When the plane first powers up and you display the FMC, the CDU displays some choices. Press the 1L LSK to select the FMC. That calls up the IDENT page. The IDENT page requires no data input but lists program information. Notice that in the scratchpad next to the 6R LSK it says "POS INIT". Press the 6R LSK and the POS INIT page is displayed. Again there is no data entry required here at this time. Now press 6R LSK again to get to the ROUTE page. Data entry is now required to get a route into the FMC.

## FMC ROUTE PROGRAMMING

You can program a route one of two ways: manually, via data entry into the FMC, or automatically, through the FS2000 Flight Planner. If you plan to use the FS2000 Flight Planner you must save your route with a maximum of 8 characters (with no spaces or special characters). If you program your route manually, you have the same 8-character limitation if you wish to save it.

We shall explain how to load a flight plan from the FS2000 FP first. Enter the FS2000 Flight Planner and create a route. Then save the route with the maximum 8-character limitation in mind. On the ROUTE page you can see a line called CO ROUTE abeam the 3R LSK. Enter the name of your flight plan (without the .pln extension) into the scratchpad of the CDU using the FMC keyboard and then press the 3R LSK. The route that you created with the FS2000 FP automatically loads. You can review the route by pressing the PREV PAGE and NEXT PAGE keys. When satisfied, you then have to ACTIVATE and EXECUTE the route. To do this, press the 6R LSK to ACTIVATE and then press the lighted EXEC key on the FMC keypad.

There is a pre-programmed route stored in the flight-planning directory that came with the panel, which you can practice with. The route name is JFKMIA1 and can be loaded by placing this route name into the CO ROUTE line of the ROUTE page.

To program a route manually you would enter the ICAO 4-letter identifier for the departure and arrival airports into the open boxes in lines 1L and 1R respectively. Type in the departure runway and drop it into the space abeam 2L LSK. Press the NEXT PAGE key where you will find the route entry pages. The left side of the CDU is used to enter airways. The right side is used to enter fixes. So if you want to program a route that uses only VORs and waypoints you would put them all into the right side LSK lines. If you have airways then you would place the airway name in the left side LSK in the next line just after the first waypoint of the airway. You must then enter the ending waypoint of the airway in the right LSK of the same line to complete the airway entry. Continue to do this until you have finished programming the route and then ACTIVATE and EXEC the route as described previously.



To save a manually programmed route you press the MENU key and then the SAVE ROUTE key abeam the 5R LSK. Select the 1L to save a route programmed into RTE 1 unless you were programming RTE 2 routes. Then select 2L. With this selection a "filename" line is displayed abeam the 5L LSK. Type in the 8-letter name of the route and then drop it into the 5L LSK by pressing the 5L LSK button. You then get a "SAVE ROUTE TO DISK" prompt abeam the 6L LSK. Press the 6L LSK and the route is saved. To call up the route again in the future you would enter the same name and put it in the CO ROUTE line of the ROUTE page.

## PERFORMANCE

After the route has been entered, the next page that the 6R LSK takes you to is the PERF INIT page. Every line that has a boxed entry requires data to be put there by the pilot. In the ZFW line abeam the 3L LSK you should enter 245 since that is the zero fuel weight of this flight model. Then just fill in the rest of the information as you see fit. More information on this data is provided in the FMC/NAV section.

After the PERF INIT page is completed, the 6R key takes you to the last page to setup called the TAKEOFF REF page. All that is required here is the flap setting entry at 1L LSK for the calculation of V-speeds for takeoff. Once that is completed, you can use all the functions of the FMC for route navigation.

## ROUTE NAVIGATION

Before takeoff, select the LEGS page using the LEGS key, which displays the waypoints of your route. The first waypoint is the ACTIVE waypoint and is the first point you would most likely be cleared to after takeoff. After you depart the airport and you wish to go direct to this waypoint using LNAV, you should press the 1L LSK to bring the name of the point into the scratchpad, then reselect the 1L LSK to make the point active again. This action causes the FMC to draw a new course line from the current aircraft position to the active waypoint. You should then press the lighted EXEC key and engage LNAV on the AFDS. The AFDS will then automatically controls heading to follow the programmed route.

If you wish to go direct to another point in your route, you need to line-select it up to have it become the active waypoint. To do this, just place the name of the desired down-line waypoint into the scratchpad and drop it into 1L by pressing the 1L LSK. You must then EXEC the route change by pressing the lighted EXEC button. If you made a mistake you can always cancel the transaction by pressing the 6L LSK where the ERASE prompt would be. This action cancels all changes and restores the original route to the CDU.

This covers very basic route modifications. The FMC is capable of far more complex tasks, which will be explained in the FMC/NAV section.

## VNAV

Vertical Navigation capabilities are provided and can be used for climb, cruise and descent. Because of the complex nature of the VNAV system it shall be discussed in the FMC/NAV section.

## **FLIGHT INSTRUMENTS DESCRIPTION**

The flight instruments on the 767 are a combination of older style round gauges and the newer style glass cockpit CRT screens. The big difference between this cockpit layout and older generation aircraft is the replacement of the attitude indicator and the heading gauge with computer generated displays that provide far more information to the pilot. Also included is a fully functioning Flight Management Computer (FMC) that can handle all navigation requirements for any flight. The operation of the FMC is discussed in the FMC/NAV section.

### **ELECTRONIC ALTITUDE DIRECTION INDICATOR (EADI)**

The EADI is a screen with a computer driven display of the typical Attitude Direction Indicator (ADI). In addition to basic attitude information this display provides information about the AFDS modes of operation as well as ILS information. The EADI receives power from the Left AC Bus. Additionally it receives its attitude information from the IRS computer. If the IRS is not aligned, the EADI displays background data only without the round attitude ball. Once the IRS has initialized the attitude ball is displayed.

The EADI displays the armed and engaged modes of the AFDS. The armed modes are displayed in white and the engaged modes are displayed in green. Anytime the AFDS switches modes, the newly engaged mode is displayed with a green box around it for approximately 10 seconds. This is an additional visual indication to the pilot that the AFDS has changed modes.

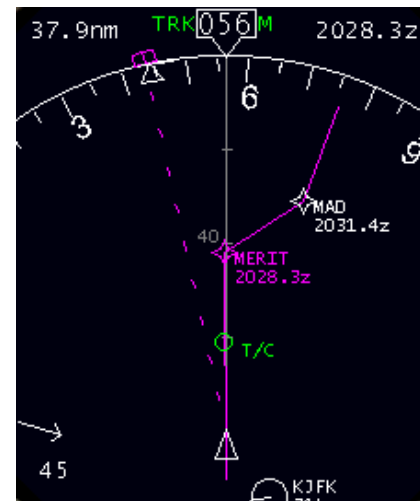
### **ELECTRONIC HORIZONTAL SITUATION INDICATOR (EHSI)**

Also the EHSI is a screen with computer driven displays. In addition to basic heading information this screen provides all necessary data for navigation using the FMC. The EHSI receives power from the Left AC Bus. It too receives all of its information from the IRS and FMC. If the IRS is not aligned only the background data is displayed, without the heading scale. Once the IRS has initialized, the heading scale and FMC map can be displayed.

Four different display modes can be selected by the pilot depending on the phase of flight. The most commonly used mode is called the MAP mode. In this mode the aircraft position and heading are displayed along with the surrounding navigation fixes, airports, route data and more. The other modes display classic ARC and ROSE type compass information for both VOR and ILS navigation. The MAP mode of the EHSI is unique in that the display is based primarily on aircraft track rather than aircraft magnetic heading. The other modes display aircraft heading primarily. To explain this concept further study the following two paragraphs carefully.

The MAP mode of the EHSI is oriented to display aircraft ground track (TRK). This means that the current aircraft track along the ground as determined by

magnetic heading and the wind component is primarily displayed rather than the aircraft heading. The actual aircraft heading is displayed using a small heading cursor below the track scale. Since the MAP mode displays a pictorial of the FMC programmed route the track display is optimal because when you are aligned with the proper route the track display will be straight up and down. If you are off track (or off your programmed route) it becomes obvious, since the FMC route picture will not be properly aligned with the straight up track display.



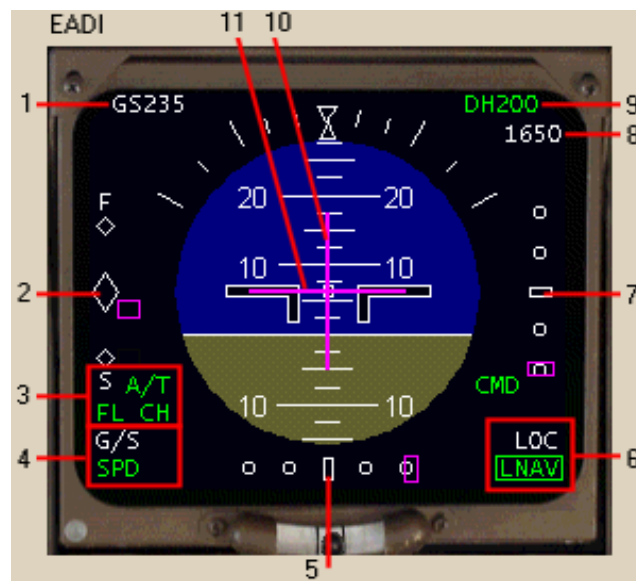
This example shows the track displayed in the MAP mode of the EHSI. After learning about the MAP display symbols (explained further in this section) come back and study this example. You see that the aircraft is flying a 056-degree ground track toward MERIT intersection. The wind is from the left at 45 knots. The magnetic heading the aircraft is flying to maintain the ground track to MERIT is 044-degrees. The heading cursor and the heading bug show this magnetic heading. The important point to take from this example is that the MAP mode displays the actual track heading across the ground rather than the magnetic heading. However, you are still able to read your magnetic heading using the small heading cursor below the track scale.

## OTHER FLIGHT INSTRUMENTS

The other flight instruments that surround the EHSI and EADI are classic round style gauges. They include the following: Airspeed, Altimeter, Vertical Speed Indicator (VSI), Radio Magnetic Indicator (RMI), Radar Altimeter (RA) and the Clock. All of these gauges receive power from the Left AC Bus. If any gauge is not being powered, an OFF flag or other warning is displayed within the gauge.

If the primary flight instruments fail or are not being powered because of some major electrical fault, there are a set of standby flight instruments that can be displayed. The standby instruments are called up using the keys <shift> <3> simultaneously. These instruments overlay the center warning panel. The standby airspeed is a regular pitot static instrument and works without power. The standby altimeter and standby attitude indicator both require Standby Bus power.

## FLIGHT INSTRUMENT REVIEW



The Attitude ball is only displayed when the currently selected IRS is initialized. Otherwise only background data is displayed. The green CMD indicates that an autopilot is engaged. If only the flight director is on, then FD is displayed in green.

**1- Ground Speed Readout:** Displays current aircraft ground speed.

**2- Fast/Slow Indicator:** Indicates the difference between the AFDS commanded airspeed and the actual aircraft airspeed. The scale indicates speed variances of +/- 10 knots from commanded speed. If the box is near the S the aircraft is too slow, and if the box is near F the aircraft is too fast.

**3- Autothrottle Mode Announcement:** Indicates the current mode of operation for the autothrottle. The green A/T displays anytime the autothrottle switch is in the ARM position. The currently engaged mode displays below the A/T. The possible modes are:

- SPD - Speed mode. The Autothrottle adjusts power to maintain AFDS selected airspeed.
- FL CH - Flight level change mode. The Autothrottle adjusts power based on climb or descent to MCP altitude.
- THR HLD - Throttle hold mode. It allows pilot to control power manually without disengaging the autothrottle.
- IDLE - Power levers commanded to idle.
- GA - Go around mode.

**4- Vertical Mode Annunciation:** Displays the current AFDS vertical mode. The white annunciation indicates the armed mode and the green one

indicates the currently engaged mode. The armed mode replaces the engaged mode automatically when engaging parameters are met for the armed mode.

#### ARMED MODES (white)

- G/S - APP mode has been selected and the glideslope is armed to capture.
- FLARE - During an autoland, the FLARE mode arms between 1200 and 1500 feet radio height if two or three autopilots are engaged.
- VNAV - Used on the ground to arm VNAV for automatic engagement during the climbout.

#### ENGAGED MODES (green)

- TO - Flight director is in takeoff mode.
- SPD - Pitch is varied to maintain airspeed during FL CH mode.
- ALT CAP - Altitude capture mode.
- ALT HOLD - Altitude hold mode.
- VNAV SPD - VNAV Speed mode.
- VNAV PTH - VNAV Path mode.
- V/S - Vertical speed mode.
- G/S - Glideslope tracking mode.
- GA - Go around mode.
- FLARE - Flare mode engaged during autoland.

**5- Localizer Deviation Scale:** Only displayed when an ILS frequency is tuned into NAV1 and a signal is being received.

**6- Roll Mode Annunciations:** Displays the current AFDS roll mode. The white annunciation indicates an armed mode and the green one indicates the currently engaged mode. The armed mode replaces the engaged mode automatically when engaging parameters are met for the armed mode.

#### ARMED MODES (white)

- LOC - APP has been selected and the localizer is armed for capture.
- BCRS - BCRS button has been selected and the localizer back course is armed to be captured.
- LNAV - Lateral Navigation has been armed to engage.
- ROLL OUT - During the autoland the roll out mode engages upon landing for centerline guidance.

## ENGAGED MODES (green)

TO	-	Flight director is in takeoff mode.
HDG HOLD	-	Heading Hold mode.
HDG SEL	-	Heading Select mode.
LNAV	-	Lateral Navigation mode (FMC route tracking).
LOC	-	Localizer tracking mode.
BCRS	-	Back course tracking mode.
ROLL OUT	-	Autoland roll out mode.
GA	-	Go around mode.

**7- Glideslope Deviation Scale:** Only displayed when an ILS frequency is tuned into NAV1 and a signal is being received.

**8- Radio Altitude Digital Display:** Displays aircraft's actual height above the ground. Calibrated to display from 0 to 2500 feet above the ground.

**9- Decision Altitude:** Dialed-in on the pedestal. Below this altitude the Radio Altitude digital display turns amber and the GPWS calls out "Minimums".

**10- Flight Director Roll Command Bar:** It is displayed anytime the FD switch is ON. It gives roll commands based on AFDS commanded heading or track. The needle moves to indicate the direction the pilot must turn. The pilot must control the bank angle necessary to keep this needle centered. If the needle moves off center, the pilot should bank the plane in the direction of needle movement until the needle is again centered.

**11- Flight Director Vertical Command Bar:** Displayed anytime the FD switch is ON. It gives pitch commands based on active AFDS pitch mode. The needle moves to indicate the pitch angle the pilot must maintain. The pilot controls pitch angle so that the needle remains centered. If the needle moves up or down from center, the pilot should pitch the plane in the direction of needle movement until the needle is again centered.



**1- EHSI Range Control:** When the EHSI is in the MAP mode this knob controls the range that is displayed in the EHSI. Rotating the knob selects the following range scales: 10, 20, 40, 80, 160 and 320 miles. The grey track line shows the intermediate mileage for each scale. For example, if you are in the 40-mile range there will be a 20-mile marker on the grey track scale.

**2- EHSI Display Control:** Controls what is displayed on the EHSI. The modes are as follows:

PLAN - Shows a North oriented map of the current FMC route. In this mode you can <STEP> through each waypoint on the FMC LEGS page to verify the integrity of the programmed route. This is useful when flight planning or making route modifications beyond the 320-mile EHSI range.

MAP - Described in detail below, this displays the current aircraft track and FMC programmed route. It also displays other data based on the MAP buttons described in #3 below.

EXP VOR and ILS - These modes display an H.S.I. ARC compass that is heading oriented (unlike the track oriented MAP mode). The ARC compass only shows 70 degrees worth of the compass in a large arc across the top of the display. Also displayed is an ILS or VOR course deviation needle (CDI). The only time the CDI will be active is when a valid VOR or ILS is tuned in. If an ILS is tuned in it only displays in the ILS mode. If a VOR is tuned in it only displays in the VOR mode.

FULL VOR and ILS - These modes display an H.S.I. ROSE compass that is heading oriented (unlike the track oriented MAP mode). It is the same as the EXP mode except the entire compass is displayed.

**3- MAP Display Buttons:** These buttons are used to control the display of extra data on the EHSI MAP.



NAV AID- Toggle on/off the display of VORs. When in the 80-mile mode and above only high altitude capable VORs are displayed. Note that this button does not affect the green auto-tuned VOR symbols.

ARPT- Toggle on/off the display of airports. Only larger airports with runways of 4,500 feet and above are displayed.

RTE DATA- Toggle on/off the display of waypoint crossing times and altitudes. This data is also found in the FMC on the LEGS RTE DATA page.

WPT- Toggle on/off the display of waypoints. Waypoints are only displayed on the 40-mile mode and below. If the scale is selected higher than the 40-mile mode the waypoints are not displayed regardless of switch position.

## EHSI MAP DISPLAY





represent the runway and are drawn to the exact length of the runway. The dashed extended centerlines are 14.2nm in length from the end of each runway. In the 80-mile range and above, this symbol is replaced by a white circle and line oriented toward the runway heading.

**8- Airplane Symbol:** The tip of the triangle is the present aircraft position.

**9- Waypoint Symbol:** When the WPT button is pressed on the EHSI Control panel, all waypoints in the vicinity of the aircraft are displayed. The waypoints are only displayed in the 40-mile mode and lower.

**10- Vertical Track Indicator (VTI):** When making a VNAV descent this display comes up. It is referred to as a "poor mans glideslope" because it is calibrated to show you if you are within +/- 400 feet of the VNAV vertical track. This track is based on waypoint altitude constraints. If the pointer is in the middle, then the aircraft is on vertical track and will reach each waypoint listed in the LEGS page of the FMC at the programmed altitude.

**11- FMC Active Waypoint:** This is the active waypoint in the FMC. When LNAV is engaged, the AFDS navigates the aircraft to this waypoint by following the magenta course line. The name of the waypoint is also listed (in this case LGA01).

**12- Top of Climb Prediction (T/C):** The FMC predicts when the aircraft will reach the FMC programmed cruise altitude. That point is shown along the FMC track using the T/C symbol.

**13- In-Active Waypoint:** The inactive down line waypoints in the FMC route are displayed in white. In this case the MERIT intersection. All waypoints are connected using the magenta course line that is the eventual track the aircraft shall follow.

**14- Top of Descent Prediction (T/D):** The FMC predicts when the aircraft must start its descent based on FMC programmed altitude constraints for each waypoint in the LEGS page. From this point the aircraft can make an idle power descent to reach the first altitude constraint.

**15- AFDS Heading Bug:** The heading dialed into the AFDS HDG window is displayed using this dashed line and bug. If in HDG SEL mode the magnetic heading triangle (#2) lines up with the heading bug when the aircraft is on the selected AFDS heading. This heading will be different from the aircraft track (#17) because of wind affecting the aircraft ground track.

**16- Waypoint Crossing Time:** The Zulu time at which the aircraft will cross the active FMC waypoint.

**17- Aircraft Track Display:** When in the MAP mode, the EHSI displays aircraft track in the center of the display. TRK indicates that the heading listed in the

box is the actual aircraft track across the ground. Aircraft magnetic heading and wind component determine the ground track.

In this case the aircraft's track along the ground is 348. You can see from the heading triangle (#2) that the aircraft magnetic heading is 357. You can also see that a right crosswind exists based on the wind component display (#5). Thus, if you stay on your current magnetic heading and the winds remain steady, your aircraft will follow the 348 degree ground track as displayed by the grey track line ahead of the aircraft symbol.

### EHSI VOR DISPLAYS



Here are examples of the EHSI VOR displays in EXPANDED (left) and FULL (right) modes. The compass is magnetic heading oriented (HDG) and not track oriented like the map mode, therefore current aircraft heading is displayed. Also there are two VOR needles and 1 ADF needle that show the current bearing to each tuned navaid. The blue pointer is the ADF. The thin green pointer is NAV1. The thick green pointer is NAV2.

An important note about the heading triangle below the HDG box is that it now displays current aircraft TRACK. Unlike in the map mode where it displays aircraft magnetic heading, it has now switched functions to show aircraft track. In this example the aircraft track is the same as the aircraft magnetic heading since there is no wind shown.

The course deviation needle is shown in magenta. It is only displayed when an active VOR frequency is tuned into the NAV1 receiver on the main panel. If an ILS is dialed into NAV1 there will be no course deviation needle displayed. To display ILS information on the EHSI you would select one of the ILS modes.

The CDI pointer is set using the CRS knob on the NAV1 receiver. In this case a course of 315 has been dialed in.

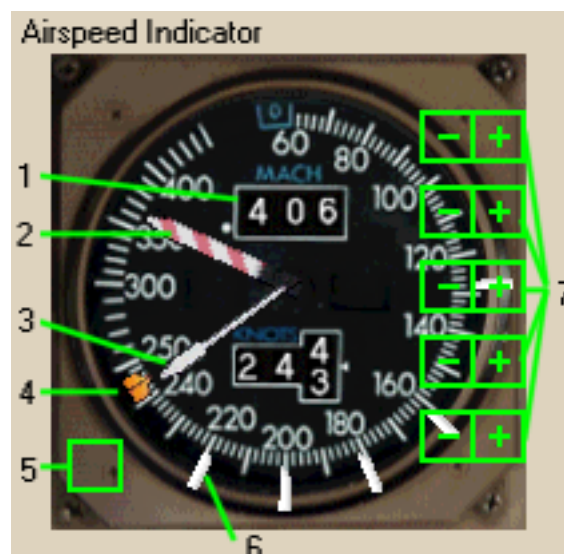
Note: NAV2 information is only displayed as bearing information on the RMI and the thick green pointer on the EHSI. It cannot be displayed using the CDI pointer on the Captain's EHSI.

### EHSI ILS DISPLAYS



Same exact function and layout as the VOR display describe above. The difference is that only ILS information can be displayed. A visible difference between the two modes is the presence of the glideslope scale on the right hand side. The CDI and GS pointer are only displayed when an active ILS frequency is dialed into NAV1.

If a VOR is dialed into NAV1 there will be no course deviation needle displayed. To display VOR information you would select a VOR mode.



**1- Mach Display:** It displays current airspeed in Mach. If the Mach airspeed is less than .400 the window is blank.

**2- MMO/VMO Pointer:** It displays airspeed/mach limit. Above this speed you receive an overspeed warning.

**3- Airspeed Pointer:** It points to the current indicated airspeed in knots. It is not active below 60 knots. Digital readout of the airspeed is also shown in the box labelled "KNOTS".

**4- Airspeed Command Bug:** It displays the currently selected AFDS airspeed. If VNAV is in use it displays the airspeed commanded by the FMC.

**5- Speed Bug Quick Set:** An invisible mouse click area resides here. When clicked it sets all of the speed bugs to the correct speeds based on FMC INIT REF page. When clicked on the ground, it sets takeoff bug speeds. When clicked in the air, it sets approach speeds based on current aircraft weight.

**6- Airspeed Reference Bug:** Manually settable reference speed bugs. There are a total of 5 bugs that can be set automatically (see 5 above) or manually (see 7 below).

**7- Speed Bug Click Areas:** Invisible mouse click areas along the right side of the airspeed gauge that can be used to manually set the airspeed reference bugs. There are no markers for them so you must use trial and error to find them.



**1- NAV1 Pointer:** Bearing pointer that can be set to display bearing to the station selected in NAV1 or the ADF.

**2- NAV1 Pointer Control:** Used to switch the function of the pointer between NAV1 display and ADF. Note: The use of this switch has no effect on the DME displayed. The knob is controlled by mouse clicks.

VOR - The pointer displays bearing to station selected in NAV1.

ADF - The pointer displays bearing to station selected in ADF.

**3- Nav2 Pointer:** Bearing pointer that can be set to display bearing to the station selected in NAV2 or the ADF.

**4- NAV2 Pointer Control:** Used to switch the function of the pointer between NAV2 display and ADF. Note: The use of this switch has no effect on the DME displayed. The knob is controlled by mouse clicks.

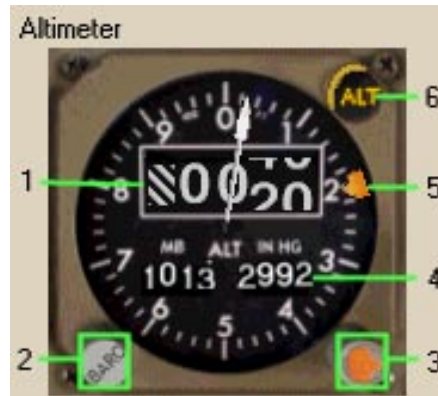
VOR - The pointer displays bearing to station selected in NAV2.

ADF - The pointer displays bearing to station selected in ADF.

**5- DME Display:** It displays DME to the stations selected in NAV1 and NAV2.

DME-L: It displays distance to the VOR selected in NAV1.

DME-R: It displays distance to the VOR selected in NAV2.



**1- Altitude Readout:** It displays current aircraft altitude in feet based on altimeter setting. The white pointer rotates to indicate altitude changes in hundreds of feet.

**2- Altimeter Setting Control:** Mouse click area used to change the current altimeter setting. Both MB and IN HG are changed simultaneously.

**3- Altitude Reference Bug Control:** Mouse click area used to control the amber altitude reference bug.

**4- Altimeter Setting:** It displays selected altimeter setting.

**5- Altitude Reference Bug:** Set manually using the control knob (3). This bug is a reference bug only that can be optionally used by the pilot as a reminder of engine-out acceleration altitudes for takeoff or decision altitudes for landing.

**6- Altitude Alert Light:** It comes on with an aural warning when you are within 900 feet of the AFDS selected altitude. The light extinguishes when the aircraft is within 300 feet of the selected altitude. Once the AFDS altitude is captured the light and warning comes on again to warn that you have deviated from the selected altitude.





**1- Chronometer Control:** Mouse click area that controls the chronometer function of the clock. The chronometer is basically a timer that counts up until reset. Click once to start the timer and the white needle clicks off the seconds and the digital CHR displays the minutes. Click a second time to stop the chronometer. Click a third time to reset the chronometer.

**2- Elapsed Timer (ET) Control:** Mouse click areas that control the elapsed timer function of the clock. The elapsed timer can run unaffected in the background while the Chronometer is in use. The ET is normally selected to RUN just prior to takeoff to keep track of total flight time.

1: HLD- This is the default position of this switch. This is called the HOLD function. When the clock is running, if you select HLD the ET will pause.

2: RUN- When set to run the ET is started. The elapsed time in hours:minutes is then displayed in the ET.CHR window. When in the run position, you can stop the elapsed time temporarily without resetting the ET by selecting HLD and then restart by reselecting RUN.

3: RESET- When pressed, it resets the ET to zero and blanks out the ET display. The ET knob then springs back to HLD.

**3- ET/CHR Display:** Display used for the chronometer and the ET. If the ET is in use when the chronometer is used, the chronometer display has priority. When the chronometer is reset, the ET is then redisplayed. If neither the ET nor the chronometer is in use, the display stays blank.

**4- Time Display:** Time display can be set using mouse clicks located on top of the digital readout.

## IRS DESCRIPTION

The Inertial Reference System (IRS) is a computer system that uses laser gyros to determine aircraft position, attitude, heading and acceleration. It also provides track and ground speed information to the FMC along with wind speed and direction. The IRS has three separate Inertial Reference Units (IRU) controlled from the overhead panel. The data supplied by the IRS is used to generate the EADI and EHSI displays. It is also used by the autopilot and the FMC for navigation.

Normally all three IRUs are used by the FMC for navigation purposes. If there is a problem with any of the IRUs the Captain's FMC will revert to a single IRU source. If the L IRU is available it will use it. If the L IRU is not available it uses the C IRU. If both L and C IRUs fail the Captain's FMC can only use FMC-generated position information.

The FMC uses the average of the three IRS positions to determine where the aircraft is on the ground. Once in the air, the FMC updates its position using VOR/DME and/or VOR cross-radials. The VOR/DME selector switch must be in AUTO for this to occur. If the switch is in MAN, the FMC will use the average position of the IRUs to display current aircraft position. This is indicated by the FMC message "IRS NAV ONLY".

The EADI and EHSI for the Captain are normally generated using data from the Left IRU with the Center IRU as an alternate source. However, in this sim it is possible to use data from either the Center or Right IRU if the left IRU fails.

## IRS ALIGNMENT

Alignment is a process where the IRS orients itself with true North and establishes the current aircraft position using latitude/longitude co-ordinates entered by the pilot. The IRS normally requires an initialization period of 10 minutes for full alignment on the ground. However, for simplicity we have reduced that to 2 minutes. Alignment can only occur on the ground with the aircraft stopped and both AC and DC power available. This means the IRUs will not align if the MAIN AC BUSES are not powered. Once alignment is complete, the map display on the EHSI will be available along with the attitude ball on the EADI.

Normally at the gate all three IRUs are switched OFF. The pilot selects NAV using the IRU selector switches to enter the ALIGN mode. At this time, the pilot enters the current aircraft latitude/longitude position using either the IRS keypad on the overhead or the FMC POS INIT page. After the aircraft position is entered the IRUs will align and enter the NAV mode. This is indicated when the EADI and EHSI start to display attitude and heading information.

There is an option for “quick” alignment of the IRUs. If the present position of any IRU is incorrect the latitude/longitude can be updated using the ALIGN position of the IRU selector. This function is only available on the ground with the aircraft stopped. IRUs can be individually or collectively quick aligned. Placing an individual IRU selector switch to ALIGN will remove the individual IRUs’ alignment allowing the pilot to enter new lat./long. co-ordinates into the IRS keypad or FMC POS INIT page. After the new co-ordinates are entered the pilot places the selector back to NAV. After 30 seconds the IRU will re-align with the new co-ordinates and EADI/EHSI data will redisplay.

## **LOSS OF ALIGNMENT**

If an IRU loses alignment in flight, the IRU cannot be restored. The pilot can select a different IRU source for the EADI/EHSI by using the INST SOURCE SELECT switches along the left side of the panel. The FMC handles IRS faults automatically.

The pilot can attempt to restore attitude and heading information from any IRU that has lost alignment by placing the IRU selector switch to the ATT position. This is called the “attitude” mode. The EADI attitude ball will be restored automatically in the ATT mode. However, to get heading information the pilot must enter the current magnetic heading into the IRS keypad to allow the IRU to generate heading information on the EHSI. With the IRU in the ATT mode the heading information can be displayed in the ILS and VOR EHSI modes or by reference to the heading “carrot” on the MAP display, if available.

## **IRS DRIFT**

Over time it is normal for the IRS position to “drift” from actual aircraft position. To minimize the effects of IRS drift the FMC uses the average of the three IRU positions. Additionally, the FMC updates its position using VOR/DME when the VOR/DME switch is in AUTO and suitable NAV signals are received. If the IRS position and the FMC calculated position differ you will get an FMC message to check your position.

Another phenomenon to be aware of is called a “map shift”. If the IRS position is incorrect and is used by the FMC (when no VOR/DME update is available) the map display will show the aircraft in the wrong position. If a map shift has occurred, the EHSI map display and LNAV will be incorrect because the FMC is generating information based on the incorrect IRS position. Pilots must be always aware of their actual position to guard against a map shift, especially when in the IRS NAV ONLY mode.

## B767-300 IRU MENU SELECTIONS

A number of menu items exist that can make managing the IRUs a whole lot easier or harder. They are found under the "Set failures" - "General" tab of the B767-300 pull down menu. Along the bottom are "realism" settings.

- To prevent the IRUs from drifting uncheck the "IRUs will drift" box. The IRUs will then always display present aircraft position.
- To allow the IRUs to align automatically without entering lat/long co-ordinates uncheck the "IRS needs co-ordinates entry" box. The IRUs will then align when placed in NAV using the present aircraft position.

To make IRU management more realistic you should leave the realism boxes checked. You can also introduce failures in the IRS by looking at the "Navigation" tab. Selection of IRS excessive drift and IRU failure is possible from this menu.



## IRS CONTROLS AND INDICATIONS



**1- IRS Data Window:** It displays IRS data based on the DSPL SEL switch position. In this picture you see present lat./long. co-ordinates of the C IRU (see 2 and 3 below for why).

**2- Display Select Knob:** It controls the display of data in the IRS Data Window.

- TK/GS - Ground TRACK and ground speed for the selected IRU.
- PPOS - Latitude/longitude position for the selected IRU.
- WIND - Wind direction/speed calculated by the selected IRU.
- HDG - True heading for the selected IRU.

**3- System Display Knob:** It controls which IRU's data is displayed in the IRS Data Window. In the picture the Center IRU is selected and the current PPOS for the C IRU is displayed.

**4- IRS Mode Annunciators:** If the IRU is in NAV mode (fully aligned) or OFF these annunciators should be blank. They illuminate for the following:

- ALIGN - Comes on steady when IRU selector is in ALIGN or NAV position during the alignment period.
  - It comes on flashing for one of the following: Aircraft was moved during alignment, IRS co-ordinates are significantly different from previous aircraft position, or no co-ordinates were entered during the alignment period. In this case the pilot must re-initiate the alignment process.
- ON DC - It comes on if the IRU is operating on only the DC power source. Alignment is not possible when this light is illuminated.
- DC FAIL - The backup DC power source for the IRU has failed. IRU will continue to operate normally with AC power.
- FAULT - There is a fault in the IRU and it is totally inoperative.

**5- IRS Mode Selector Knobs:** It selects the mode of operation for the individual IRUs.

- OFF
  - It removes power from the IRU (alignment is lost).
  - The ALIGN light illuminates for 30 seconds during shut down of IRU.
- ALIGN
  - From the NAV mode you can update the lat./long. co-ordinates of the IRU by placing the switch in this mode, entering the new co-ordinates and then placing the switch back to NAV.
  - This is called a "quick align" and takes 30 seconds.
  - It only works on the ground with the aircraft stopped.
- NAV
  - It initiates full alignment and puts IRU into navigation mode.
  - Moving the selector from OFF to NAV allows entry of lat./long. co-ordinates in the IRS keypad or the FMC POS INIT page.
  - Full alignment takes 2 minutes (in the sim).
- ATT
  - IRU alignment is lost and put into the "attitude" mode.
  - Attitude information is displayed on the EADI.
  - Magnetic heading information is available after entering current magnetic heading using the IRS keypad.

**6- IRS Keypad:** It is used to enter lat./long. or heading information into the IRS. It is only active during alignment (ALIGN light on) or ATT mode. Pressing keys labelled N, S, E, or W initiate lat./long. entries. Pressing the H key initiates magnetic heading entries.

## IRS OPERATION QUICK GUIDE

### 1) How to normally align the IRUs:

- The aircraft must be on the ground and not moved during alignment process.
- Both AC and DC power must be on the aircraft (i.e. AC Buses powered).
- Place all three IRS Mode Selector knobs to the NAV position.
- Observe the ON DC lights come on momentarily (self test) followed by the steady illumination of the ALIGN lights.
- Place the DSPL SEL knob to PPOS and the SYS DSPL knob to one of the IRUs to be aligned.
- Now enter the current aircraft latitude/longitude position:

Example: Current aircraft position = N4037.7 W07346.2

- a) For IRS Keypad entry of co-ordinates: press the "N" key followed by 40377 then press the "W" key followed by 07346.2 and press the ENT key.
  - b) For FMC entry of co-ordinates: Press the INIT REF key to find the POS INIT page. If this page is not displayed press the 6L LSK (< INDEX) and select the < POS INIT page. Enter co-ordinates manually into the FMC scratchpad using the FMC keyboard and then press the 5R LSK to put the co-ordinates into the "SET IRS POS" boxes.
- Full alignment will take 2 minutes from the time the IRU Selectors are placed in NAV.

### Notes:

- Lat./long. position must be entered using all digits. You cannot leave out zeros. In this example entry of W7346.2 would be invalid.
- To find current aircraft lat./long. position use <shift> <z> and find the co-ordinates shown in the top left corner of the outside window.
- IRUs may be aligned individually or all at the same time.
- Co-ordinates entered using the IRS Keypad (or FMC) during alignment will be transferred to ALL IRUs during alignment. It is not necessary to enter coordinates individually for each IRU.
- Full alignment is indicated by the ALIGN lights extinguishing and the EADI attitude ball being displayed.
- You can monitor the alignment countdown by placing the DSPL SEL switch to HDG. This will show a countdown of seconds to the end of alignment.
- If alignment fails, the ALIGN lights will flash. You must turn the IRS Select knobs OFF and then to NAV to attempt another alignment.



2) How to “Quick Align” an IRU: This is used to update IRU lat./long. if incorrect after full alignment.

- The aircraft must be on the ground and not moved during the alignment process.
- For each IRU you want to quick align, move the IRU Select knob from NAV to ALIGN.
- Observe the ALIGN lights illuminate for those IRUs in ALIGN mode.
- Place the DSPL SEL knob to PPOS and the SYS DSPL knob to one of the IRUs to be quick aligned.
- Now enter the current aircraft latitude/longitude position:

Example: Current aircraft position = N4037.7 W07346.2

- a) For IRS Keypad entry of co-ordinates: press the “N” key followed by 40377 then press the “W” key followed by 07346.2 and press the ENT key.
- b) For FMC entry of co-ordinates: Press the INIT REF key to find the POS INIT page. If this page is not displayed, press the 6L LSK (< INDEX) and select the < POS INIT page. Enter the co-ordinates manually into the FMC scratchpad using the FMC keyboard and then press the 5R LSK to put the co-ordinates into the “SET IRS POS” boxes.
  - Place the IRS Select knobs back to NAV.
  - Quick alignment takes 30 seconds.

Notes:

- Lat./long. position must be entered using all digits. You cannot leave out zeros. In this example entry of W7346.2 would be invalid.
- To find current aircraft lat./long. position use <shift> <z> and find the co-ordinates shown in the top left corner of the outside window.
- IRUs may be quick aligned individually or all at the same time.
- Co-ordinates entered using the IRS Keypad (or FMC) during alignment will be transferred only to those IRUs in the quick align mode. Alignment of other IRUs is not affected.
- The end of quick alignment is indicated by the ALIGN lights extinguishing.
- You can monitor the quick alignment countdown by placing the DSPL SEL switch to HDG. This will show a countdown of seconds to the end of alignment.
- If alignment fails, the ALIGN lights will flash. You must turn the IRS Select knobs OFF and then to NAV to do a full alignment.

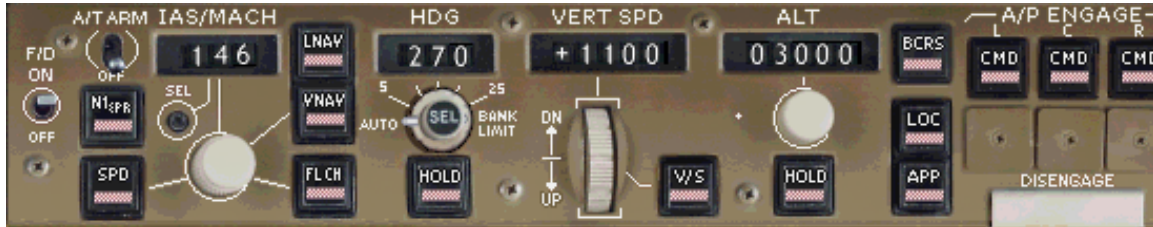
3) How to use the ATT mode: If an IRU loses alignment in flight you cannot re-align it. The ATT mode might restore attitude and heading information to the EHSI and EADI. This example assumes the Left IRU has lost alignment since the Captain EADI/EHSI uses the L IRU primarily.

- Place the L IRU Select knob to ATT mode.
- Observe the attitude ball return to the EADI.
- Place the EHSI selector to one of the VOR or ILS modes (EXP or FULL).
- Enter the current aircraft magnetic heading into the IRU as follows:
  - a) Place the DSPL SEL knob in HDG.
  - b) Move the SYS DSPL knob to the affected IRU (in this case "L").
  - c) Press "H" on the IRS Keypad followed by the current aircraft magnetic heading as read from the whisky compass. The heading entry is in the xxx.x format (the period is inserted automatically).
  - d) Press the ENT key to enter the heading into the IRU.
- Observe the magnetic heading listed in the IRS Display window.
- Observe that the EHSI heading is restored.

Notes:

- If you move any IRS Select knob to ATT mode, alignment will be lost for the rest of the flight.
- Magnetic heading may need updating periodically during flight since there is no error correction in this mode.
- Flight director information is NOT available in ATT mode.
- EHSI map data MAY be available depending on number of aligned IRUs and FMC position information.
- The ATT mode does not supply position information to the FMC since that is lost with loss of alignment.

## AFDS DESCRIPTION



Automated flight on the 767 is made possible by the Automatic Flight Director System (AFDS). The AFDS uses the following components: an autothrottle, a flight director, three autopilots, a Thrust Computer, a Flight Management Computer, and a Mode Control Panel (or MCP, pictured above). The MCP is the main interface between the pilot and computer. When we talk about engaging an AFDS mode we are talking about making selections on the MCP. All AFDS modes are announced on the EADI.

The AFDS in this panel has all of the capabilities found in the real aircraft. This system is capable of automatically flying the aircraft from just after takeoff until making a complete automatic landing and rollout. The AFDS autothrottle can manage aircraft power in all phases of flight from takeoff until automatic landing, if desired.

The AFDS works with the Thrust Management Computer (TMC) and the Flight Management Computer (FMC) to make completely automated flight possible. The TMC controls power available to the autothrottle. The FMC is the interface for Lateral Navigation (LNAV) and Vertical Navigation (VNAV) capabilities (discussed in the FMC/NAV section).

## FLIGHT DIRECTOR

The Flight Director system is turned on and off using the F/D switch on the left side of the MCP. When the Flight Director switch is turned ON, the EADI announces "FD" along with the active AFDS modes. On the ground the flight director is initially in "takeoff" mode and "TO" is displayed as the active AFDS modes. Also the Flight Director command bars are displayed on the EADI. The pilot can manually fly the airplane by adjusting pitch and bank to keep the FD command bars centered. This ensures that the plane is following the AFDS-commanded flight path. The commanded flight path is based on pilot inputs to the MCP and the FMC.

The pilot can manually fly the airplane using the flight director. With the flight director turned on, all AFDS modes of operation can be engaged and are displayed on the EADI. The flight director commands a path for the pilot to fly based on MCP settings. Manually flying the airplane without the flight director is possible, but the AFDS modes will not be available. The flight director should

always be turned on and an AFDS mode selected prior to engaging the autopilot in CMD mode. Engagement of an autopilot without an AFDS mode selection is possible but may result in an undesirable aircraft flight path.

## **AUTOPILOT**

There are three separate autopilot systems that can fly the aircraft automatically: Left, Center and Right. Selection of an autopilot engages the AFDS in the CMD mode. The CMD mode engages the autopilot servos to automatically fly the airplane based on the AFDS commanded flight path. The EADI announces "CMD" in place of "FD" when an autopilot is engaged. Pressing the DISENGAGE bar on the MCP removes power from the autopilot and returns manual control of the airplane to the pilot. However, disengaging the autopilot does not disengage the autothrottle.

All three autopilots require electrical and hydraulic power to function. The Left and Center autopilots are normally powered by the Left Main AC Bus. The Right autopilot is normally powered from the Right Main AC Bus. The three autopilots receive hydraulic power from their respective (L, C and R) hydraulic systems.

Normally only one autopilot can be engaged to fly the aircraft. During the approach phase additional autopilots can be armed for the execution of an automatic landing. After selection of the approach mode on the MCP, the pilot selects one or both of the remaining two autopilots by pressing their respective CMD buttons. Then, at 1500 feet radio altitude, the additional autopilots engage to carry out the automatic landing. The AFDS autoland status is announced on the "Autoland Status" gauge found on the main panel. More information about autoland can be found later in this section.

## **AUTOTHROTTLE**

The autothrottle can control power from the beginning of takeoff until after touchdown during an automatic landing, if desired. The controls for the autothrottle are found on the left side of the MCP. When the autothrottle is "armed" using the arm switch, the autothrottle engages when one of the speed modes is selected (discussed below). The autothrottle receives guidance from the TMC and limits power based on the current TMC mode. The TMC modes work automatically based on the AFDS modes selected. However, the pilot can select other modes using the Thrust Rating Panel (discussed in the ENGINE section). The autothrottle is automatically disengaged during single engine operation and cannot be used.

Anytime the autothrottle is engaged the pilot can still manually override the autothrottle by moving the power levers. However, when the power levers are released the power setting returns to the level commanded by the autothrottle. There are times when pilot intervention may be required

because it is possible to command the autopilot to do something that the autothrottle cannot comply with fast enough. For example, a quick level off from a steep climb can put the autothrottle behind the airplane. Manually reducing the power can help the autothrottle catch up with the airplane (since it may otherwise not reduce power fast enough to prevent the airspeed from increasing beyond what is requested).

## **LATERAL MODES**

Lateral modes are selected to control aircraft heading. The lateral modes are: Heading Hold, Heading Select, Lateral Navigation (LNAV), Localizer, Approach and Back Course. There is also a bank limiting system that can be used to set the maximum bank angle the AFDS commands during turns.

The most basic modes are the Heading Hold (HDG HOLD) and Heading Select (HDG SEL) modes. The Heading Hold mode is selected by pressing the HOLD button directly below the heading select knob. When pressed, the AFDS commands you to roll out on present aircraft heading. Selection of HOLD has no effect on the heading in the heading window. The Heading Select mode is selected by pressing on the SEL knob just below the heading window. When selected, the HDG SEL mode commands the aircraft to fly to the heading listed in the heading window. The aircraft continuously flies to any new heading dialed into the heading window.

Lateral Navigation is made possible by programming a route into the FMC. Once a route is programmed into the FMC and displayed on the EHSI, LNAV can be engaged to intercept and track the desired route. LNAV has two modes of operation: armed and active. When LNAV is armed, the AFDS continues to fly using the currently active lateral mode until intercepting the programmed route. Then LNAV becomes active upon intercepting the route and controls aircraft heading to maintain the necessary course. LNAV is explained in more detail in the FMC/NAV section.

Localizer (LOC) mode has two modes: armed and active. When LOC is armed, the plane stays in its previous lateral mode until intercepting the localizer. When the localizer is intercepted, the LOC mode becomes active and the aircraft heading is adjusted to maintain the localizer course.

The Approach (APP) mode is similar to the LOC mode except that with APP mode you get both localizer and glideslope (GS) tracking. When the APP button is pressed, both the LOC and GS tracking modes are armed. The previous lateral and vertical modes remain engaged until capture of the LOC and GS respectively.

The Back Course mode (BCRS) is exactly the same as the LOC mode except that, when engaged, it tracks inbound on a localizer back course approach. But

remember to set the localizer front course into the NAV CRS window to get proper course guidance.

## **VERTICAL MODES**

Vertical modes are selected to make the aircraft climb and descend the airplane. There are three basic modes: Flight Level Change, Vertical Navigation, and Vertical Speed.

Flight Level Change (FL CH) is an airspeed dependent mode. When selected it automatically flies the airplane to the altitude selected in the ALT window. The airplane automatically maintains the airspeed in the airspeed window during the climb or descent. Changes to the airspeed cause the autopilot to change pitch angle to maintain the commanded airspeed. Selection of this mode will never cause the plane to fly away from the target altitude. The plane will always fly to the target altitude. If selected after takeoff, the Thrust Computer automatically changes from the takeoff mode to the climb mode.

When Vertical Navigation (VNAV) is engaged the AFDS follows the vertical guidance provided by the FMC. When VNAV is selected the airspeed window blanks out and speed control is transferred to the FMC. The FMC then controls the climb, cruise and descent using speeds calculated for best economy. However, the pilot can control the speed at any time by reprogramming the FMC or using the "speed intervention" mode on the MCP. For more about VNAV see the FMC/NAV section. If selected after takeoff, the Thrust Computer automatically changes from the takeoff mode to the climb mode.

Vertical Speed (VERT SPD) mode will make the aircraft climb or descend at the selected vertical speed. It also automatically engages the autothrottle in the SPD mode. Vertical Speed mode can only be selected when the present aircraft altitude differs from the MCP selected altitude. For example, if the plane is at 12,000 feet and the MCP ALT window says 16,000 feet the pilot can press the V/S button to open up the VERT SPD window. The VERT SPD window is normally blank when not using vertical speed mode. When vertical speed is selected the window opens up with the current aircraft vertical speed. The pilot can then adjust the vertical speed by using the thumb wheel below the VERT SPD window.

An important note about VERT SPD mode is that unlike the FL CH mode (that will fly you TO a selected altitude) the VERT SPD mode allows the pilot to fly AWAY from the selected altitude. This means you can make the plane climb or descend regardless of the target altitude in the MCP. However, just like the FL CH mode the pilot must manually select the desired speed in the airspeed window.

## ALTITUDE HOLD

The AFDS target altitude is entered into the altitude window on the MCP. If climbing or descending in a vertical mode, the AFDS commands a level off at this selected altitude. The airplane automatically enters the altitude hold mode after level off. During a climb or descent, by hitting the HOLD button, the pilot can command a level off at any intermediate altitude without changing the altitude in the ALT window by hitting the HOLD button. The ALT HOLD button commands the AFDS to level off at whatever altitude exists when the button is pressed. This mode does not affect the altitude displayed in the ALT window.

When VNAV is in use the altitude displayed in the ALT window is compared to the FMC programmed altitude constraints. When the altitude programmed into the FMC differs from the altitude in the ALT window the AFDS is conservative and levels off at whichever altitude is encountered first. More information about VNAV and altitude hold is found in the FMC/NAV section.

## AUTOLAND

The AFDS is capable of executing a completely automatic landing. The autopilot requires a minimum of two operating autopilots plus the autothrottle to successfully complete the autoland procedure. The failure of any required aircraft system can degrade the AFDS's autoland capability. The current status of the AFDS autoland capability is announced in the Autoland Status display, located on the main panel.

Autoland is engaged during approach by selecting multiple autopilot operation. When the AFDS is in the APP mode selection of additional autopilots will "arm" them to engage at 1500 feet radio altitude to allow for an automatic landing. There are two automatic landing modes: LAND 2 and LAND 3. The LAND 2 mode is engaged when only two autopilots are selected for the approach. The LAND 3 mode is engaged when all three autopilots are selected for the approach. The only difference between these modes is the level of system redundancy. Both modes result in an automatic landing.

During an automatic landing the AFDS vertical and lateral autoland modes are announced on the EADI along with a status message in the Autoland Status window. At 1500 feet radio height the AFDS does a self-test that results in the status window displaying one of four messages: LAND 2, LAND 3, NO LAND 2 or NO AUTOLND. Additionally, the FLARE and ROLL OUT modes are armed and displayed in white on the EADI. These modes engage automatically during the automatic landing procedure.

## EADI ANNUNCIATIONS



The EADI announces the armed and engaged AFDS modes anytime the AFDS is engaged in the FD or CMD. These mode messages are explained in detail in the Flight Instruments section of this manual.

## EICAS MESSAGES

### ▷WARNINGS:

AUTOPILOT DISC      -    The Autopilot has disconnected.

### ▷CAUTIONS:

AUTOPILOT                      -    The Autopilot has lost a required input for normal operation. Autopilot stays engaged.

ALTITUDE ALERT                -    Airplane has deviated from MCP set altitude.

AUTOTHROT DISC                -    Autothrottle has been disconnected.

AUTO COORD OFF                -    Simulator auto coordination of ailerons and rudder has been turned off.

**Easy Fly Quick Tip:** Sorry to say there are no easy quick tips for operation of the autopilot system. The AFDS above all systems in this panel should be understood completely. Experimentation with the panel and reading this section a few times will best teach you how it works.

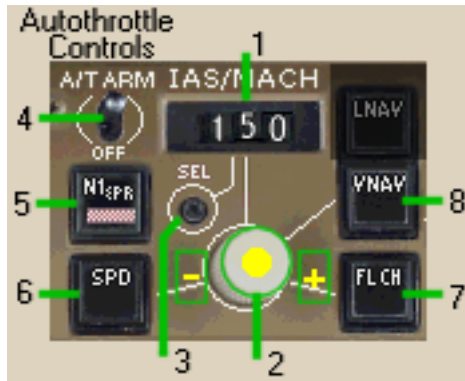


## AFDS CONTROLS

### Flight Director Switch:

- OFF: AFDS flight director bars will not display on the EADI.
- ON: It turns on the flight director. When on the ground it engages the AFDS in the "Takeoff" mode. "TO" is displayed for the lateral and vertical modes.
  - ▶ TO Vertical Mode
    - On the ground it commands an 8° pitch up.
    - In flight it commands  $V_2 + 15$  knots.
  - ▶ TO Lateral mode
    - On the ground it commands wings level.
    - In flight it commands a bank to maintain ground track.
- The FD switch is normally turned on prior to gate departure.
- If the autopilot is engaged while the flight director is in the TO mode, the AFDS automatically switches to Vertical Speed and Heading Hold modes.
- If the autopilot is engaged with the flight director switch OFF, the AFDS automatically selects the Vertical Speed and Heading Hold modes.





#### 1- Airspeed Window:

It displays the current AFDS target airspeed or mach. The selected speed is also displayed on the airspeed gauge with an amber reference bug. The airspeed window is "blanked out" when VNAV is selected since speed is then controlled by the FMC. When the airplane is powered up, a speed of 200 is displayed.

#### 2- Airspeed Select Knob:

- Using the mouse clicks on either side of the knob you can control the exact airspeed or mach in the airspeed window.
- Speed Intervention: When using VNAV the window is normally blanked because speed is controlled via the FMC. However, if you press the airspeed select knob (yellow dot) the airspeed window opens up and displays the current airspeed. With the window open you have control of the airspeed via the window instead of the FMC. Pressing the airspeed knob a second time closes the window and speed control is transferred back to the FMC.
- Speed intervention is used most often for temporary speed restrictions.

#### 3- IAS/MACH Select:

Pressing this button alternates the airspeed display between Indicated Airspeed and Mach speed. The AFDS uses whatever speed is displayed in this window as a target. If a Mach speed is selected, the airspeed gauge amber bug displays the corresponding indicated airspeed.

#### 4- Autothrottle Arm Switch:

- OFF - Autothrottle is off. The throttle is pilot controlled.
- It disengages autothrottle, if engaged.
- A/T ARM - The autothrottle is armed to engage with the selection of a speed mode. A/T is displayed in the EADI.

Note: The autothrottle cannot be used during single engine operations. Even if the switch is in the arm position, the autothrottle will not engage.

#### **5- N1 Mode:**

- When pressed, it engages the autothrottle in N1 mode. The maximum N1 power setting based on current TRP mode is commanded by the autothrottle.
- It is normally used during the takeoff roll to engage the autothrottle to provide takeoff power. It is also used automatically by VNAV for climb.
- N1 is annunciated on the EADI.

#### **6- Speed Mode:**

- When pressed, it engages the autothrottle in the speed mode. The autothrottle sets power to maintain the airspeed set in the airspeed window.
- It is normally engaged automatically by the selection of a pitch mode (such as VERT SPD or FL CH) or altitude hold mode (ALT HOLD).
- SPD is annunciated on the EADI.

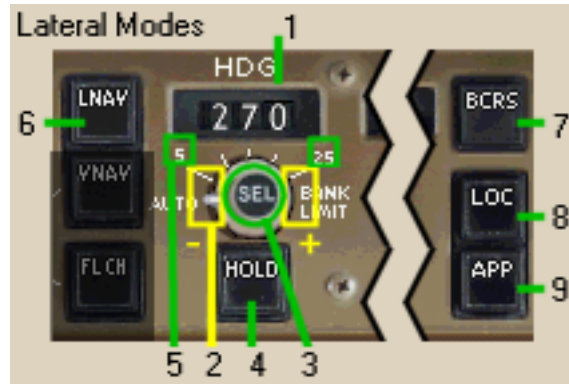
#### **7- Flight Level Change Mode (FL CH):**

- It engages the plane in an airspeed-dependant climb or descent.
- It engages the autothrottle in a FL CH mode that controls power automatically to make the aircraft climb or descend as required.
- It automatically selects Speed (SPD) as the vertical mode since pitch is now dependent on the selected airspeed.
- Resets the airspeed window to the current indicated airspeed.
- If a climb is required the TMC is automatically set to a climb mode (CLB, CLB1 or CLB2 depending on TRP settings).
- This mode will fly the airplane to the altitude set in the ALT window. If a climb is required, it gives you climb power and pitch to maintain the selected airspeed. If a descent is required it gives you IDLE thrust and pitch to maintain selected airspeed.
- In a FL CH descent the autothrottle changes to throttle hold mode (THR HLD) which allows the pilot to alter the vertical speed of the descent by adding or removing power. The autothrottle re-engages in the SPD mode during altitude capture.
- FL CH and SPD are annunciated on the EADI.

#### **8- Vertical Navigation Mode (VNAV):**

- When pressed, it transfers control of the autothrottle to the FMC.
- Autothrottle modes are selected automatically during VNAV engagement.
- The airspeed window blanks out and airspeed control is via the FMC.
- VNAV is annunciated on the EADI.

Note: VNAV is explained in depth in the FMC/NAV section.



#### 1- Heading Select Window:

- It displays the current AFDS target heading as selected by the pilot.
- The heading bug on the EHSI displays this selected heading.
- The HDG SEL mode is used to follow the displayed heading.
- When the airplane is powered up a heading of 000 is displayed.

#### 2- Heading Window Click Areas:

- These click areas control the heading in the HDG window.
- The EHSI heading bug also moves via these click areas.

#### 3- Heading Select Mode Control Knob (HDG SEL):

- When pressed, it engages the AFDS in Heading Select mode.
- The AFDS commands the aircraft to capture, follow and maintain the heading displayed in the HDG window.
- HDG SEL is announced on the EADI.

#### 4- Heading Hold Mode Button (HDG HOLD):

- When pressed, it engages AFDS in Heading Hold mode.
- The AFDS commands the aircraft to roll out and maintain the aircraft heading that exists at the time of engagement.
- This mode operates independently from the heading bug and heading displayed in the HDG window.
- HDG HOLD is announced on the EADI.

#### 5- Bank Limit Selection:

- Pressing either of the two green box areas moves the Bank Limit selector.
- When in AUTO, the bank is controlled automatically by the AFDS based on airspeed. Bank limit is decreased from 25 degrees as airspeed increases.
- The index marks are for manual control of bank limit. Selections are as follows: 5, 10, 15, 20, and 25. When the bank limit index is on one of these settings, the AFDS limits bank commands to the selected value.

#### **6- Lateral Navigation Mode (LNAV):**

- When engaged, it transfers heading control to the FMC.
- Two modes of operation are possible when pressed:
  - ARMED - The previous lateral mode remains engaged and LNAV is armed to engage when the FMC programmed course is captured. LNAV is annunciated in white above the currently active lateral mode.
  - ENGAGED - LNAV is in control of heading to maintain FMC track. LNAV is annunciated in green as the active lateral mode.
- LNAV is explained in more detail in the FMC/NAV section.

#### **7- Localizer Back Course Tracking Mode (BCRS):**

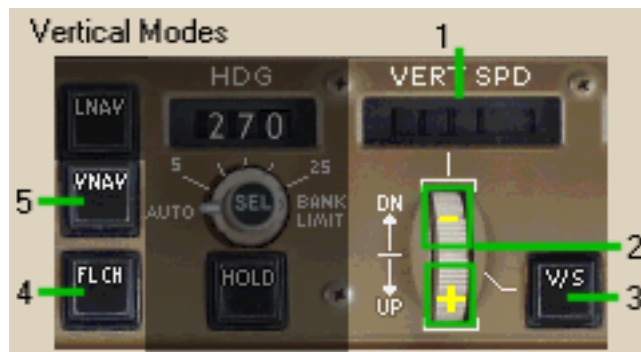
- When pressed arms AFDS to capture and track the localizer back course.
- This mode will not replace the active lateral mode until the localizer back course is captured.
- When armed BCRS is annunciated in white above the currently active lateral mode.
- When the back course is captured BCRS turns green and becomes the active lateral mode. AFDS controls heading to maintain the localizer back course track.
- The localizer front course must be entered into the NAV CRS window.

#### **8- Localizer Tracking Mode (LOC):**

- When pressed, it arms the AFDS to capture and track the localizer course.
- This mode will not replace the active lateral mode until the localizer course is captured.
- When armed, LOC is announced in white above the currently active lateral mode.
- When the localizer course is captured LOC turns green and becomes the active lateral mode. The AFDS controls heading to maintain localizer track.

#### **9- Approach Tracking Mode (LOC and G/S):**

- When pressed, it arms the AFDS to capture and track both the localizer course and glideslope path.
- Selection of this mode will not replace currently active lateral or vertical modes until each is captured.
- When armed, LOC and G/S are annunciated in white above the currently active lateral and vertical modes.
- When the localizer course is captured, LOC turns green and becomes the active lateral mode. The AFDS controls heading to maintain localizer track.
- When the glideslope track is captured, G/S turns green and become the active vertical mode. The AFDS controls pitch to maintain the glideslope path.



#### 1- Vertical Speed Window:

- Normally blank, it opens up when the V/S button is pressed.
- When opened it displays the current aircraft vertical speed.

#### 2- Vertical Speed Thumb Wheel:

- It is used to adjust the vertical speed in the VERT SPD window.
- It is active only when the VERT SPD window is open.
- It adjusts vertical speed in 100-foot increments.

#### 3- V/S Mode:

- When pressed, it engages the plane in the vertical speed mode.
- It engages the autothrottle in the SPD mode.
- When pressed, it opens up the VERT SPD window.
- Vertical speed mode is only available when your present altitude differs from the altitude in the MCP ALT window.
- V/S is annunciated in the EADI.

#### 4- Flight Level Change Mode (FL CH):

- It engages the plane in an airspeed-dependent climb or descent.
- It engages the autothrottle automatically in the FL CH mode.
- It engages pitch automatically in the SPD mode to maintain airspeed.
- It resets the airspeed window to the current indicated airspeed.
- This mode will fly the airplane to the altitude set in the ALT window. If a climb is required, it gives you climb power and pitch to maintain the selected airspeed. If a descent is required, it gives you IDLE thrust and pitch to maintain the selected airspeed.
- FL CH and SPD are announced on the EADI.

#### 5- Vertical Navigation Mode (VNAV):

- It transfers control of the climb/cruise/descent to the FMC.
- Autothrottle modes are selected automatically during VNAV engagement.
- The airspeed window blanks out and airspeed control is via the FMC.
- VNAV is annunciated on the EADI.

Note: VNAV is explained in depth in the FMC/NAV section.



**1- Altitude Window:**

- It displays current AFDS target level off altitude.
- When in a vertical mode, the AFDS automatically levels off at the displayed altitude and enters altitude hold mode.
- When the airplane is powered up, an altitude of 10,000 is displayed.

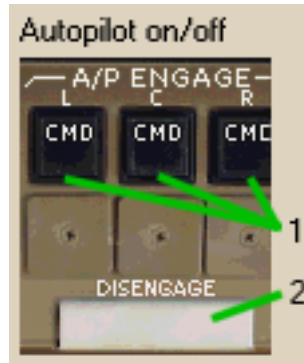
**2- Altitude Select Knob:**

- Press the click areas to change the altitude in the ALT window.
- Changes altitude are in 100-foot increments.

**3- Altitude Hold Mode (ALT HOLD):**

- When pressed, it commands the AFDS to level off at the current aircraft altitude.
- The light bar in the HOLD button lights up automatically any time the AFDS enters ALT HOLD mode.
- When climbing or descending to the altitude in the ALT window, it is not necessary to press the HOLD button. The AFDS will level off and enter ALT HOLD automatically.

Note: VNAV operation causes the ALT HOLD mode to function differently. See the FMC/NAV section for more information.



### 1- Autopilot Command Modes (CMD):

- When pressed, it individually engages the respective autopilot.
- Normally only one autopilot may be engaged.
- When engaged, the autopilot follows the currently selected AFDS modes automatically.
- If no AFDS modes have been selected or the flight director is in TO mode when the autopilot is engaged, the AFDS is automatically placed in vertical speed and heading hold modes.
- CMD is annunciated on the EADI.

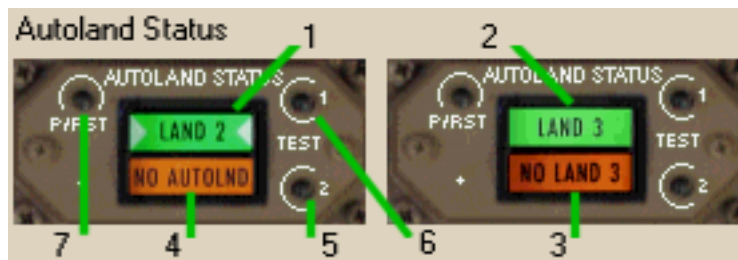
### MULTIPLE AUTOPILOT OPERATION (AUTOLAND)

- When the AFDS is in the approach mode (APP), the selection of multiple autopilots is possible to allow for an automatic landing.
- After selection of APP is made, pressing the CMD buttons for any remaining autopilots will "arm" them to engage at 1500 feet radio altitude.
- During multiple autopilot operation an automatic landing will be made.
- See "Autoland Status" explanation below for more on the autoland modes.

### 2- Autopilot Disengage Bar:

- When pressed, it disengages all active autopilots.
- A red bar is visible when the Disengage Bar is pressed. The disengage bar remains in the disengage position until it is pressed again. While the red bar is visible autopilot engagement is inhibited.
- Disengagement of any autopilot results in a Master Warning that can be cancelled by pressing the Disengage bar a second time.





#### 1- LAND 2:

- It indicates that the AFDS is currently engaged in the LAND 2 mode.
- It displays at 1500 feet radio altitude when the APP mode is selected and two autopilots are engaged.
- FLARE and ROLL OUT will also be announced on the EADI.
- The aircraft executes an automatic landing and rollout in this mode.
- It requires a minimum of two autopilots.

#### 2- LAND 3:

- It indicates that the AFDS is currently engaged in the LAND 3 mode.
- It displays at 1500 feet radio altitude when the APP mode is selected and three autopilots are engaged.
- FLARE and ROLL OUT are also annunciated on the EADI.
- The aircraft executes an automatic landing and rollout in this mode.
- It requires all three autopilots.

#### 3- NO LAND 3:

- It illuminates any time there is a system fault that results in a LAND 2 condition.

#### 4- NO AUTOLND:

- It indicates there is a system fault that prevents the AFDS from executing an automatic landing.
- The engagement of multiple autopilots is not possible with this status message displayed.
- This message is displayed any time a fault is detected regardless of autopilot operation.

#### 5/6- Autoland Status Test Buttons:

- When pressed displays the autoland status messages.
  - ▶ Test 1 - LAND 3 and NO LAND 3 are displayed.
  - ▶ Test 2 - LAND 2 and NO AUTOLND are displayed.

#### **7- Press/Reset Button:**

- It blanks out and resets a NO AUTOLND or NO LAND 3 message.
- If the conditions that caused the message to display still exist, the message will return.
- If in the APP mode and this button is pressed the NO LAND 3 message can be removed even though the limiting condition exists. However, the NO AUTOLND message cannot be cancelled in this situation.

## **ELECTRICAL SYSTEM DESCRIPTION**

The aircraft receives electrical power from four different sources: aircraft battery, APU, external power, and two engine-driven generators. The system manages electrical distribution automatically and requires very little pilot interaction. Priority is given to the engine-driven generators followed by the APU and then aircraft battery. External power selection and de-selection is pilot controlled and takes priority over other sources.

### **BATTERY POWER**

The battery is switched on/off using the latch switch at the top of the electrical panel. When selected ON, the battery supplies power to a limited number of components as a starting point for applying APU or External Power to the aircraft. The DISCH annunciation indicates that the battery is being discharged. The battery is required to be switched ON for starting the APU.

With the battery switched ON, power can be supplied to the Standby Buses via the Standby Power selector. This selector has three positions: OFF, AUTO and BAT. With the selector in AUTO, power is supplied to the standby bus automatically. With the selector in BAT, the battery alone supplies power to the standby buses and the battery shows a DISCH condition. With the selector OFF, the standby buses are not powered. The selector is placed in AUTO for normal operations.

The Standby Buses are important because they provide power for the standby flight instruments as well as some basic warning circuits.

### **AUXILIARY POWER UNIT (APU)**

The APU can provide all electrical requirements for satisfactory operation of all aircraft systems. The APU can be used on the ground and in flight. There are no altitude restrictions for the use of the APU as an electrical source in flight. The APU is most commonly used for supplying electrical and pneumatic power prior to gate departure. The APU is also used for starting the engines. However, if the APU is inoperative an external source of power can be used.

The APU is controlled via the rotary start selector near the bottom of the electrical panel. The battery switch must be switched ON in order to start the APU. Fuel is provided to the APU automatically from the Left FWD Fuel Pump. When the start switch is placed to ON, the FAULT light cycles on/off to indicate the APU fuel valve has opened. To start the APU the pilot must momentarily move the switch to the START position. The spring-loaded switch moves back to the ON position when released.

It is possible to monitor the APU start on the EICAS STATUS page provided the plane is powered from external power or the engine generators. The APU runs a self-test, which is indicated by the RUN light flashing twice just after selecting START. When the APU is on speed and ready to generate power, the RUN light illuminates and remains steady. When starting the APU on battery power, the RUN light is the only indication that the APU is available.

The APU is connected to the electrical system by the APU GEN switch on the electrical panel. The APU GEN switch is left IN for all normal operations. When the APU is running, the APU GEN switch operates automatically to supply APU power to the aircraft as required. APU power is used anytime external power is not in use and the engine driven generators are OFF.

APU shutdown is accomplished by placing the selector switch to OFF. The APU automatically shuts down as indicated by the RUN light extinguishing and the FAULT light cycling as the fuel valve closes. If the APU was in use as a bleed source at the time of shutdown, the APU will RUN for a one-minute cool-down period. Even though the switch is OFF, the APU continues to RUN during this period. If the pilot decides during the cool-down period that the APU is needed, the shutdown signal can be cancelled by placing the start switch to START. This cancels the shutdown signal and the APU continues to RUN.

## **EXTERNAL POWER**

External power is generally used when the aircraft is dispatched with an inoperative APU or when it is sitting at the gate for prolonged periods of time and an APU shutdown is desired. External power can provide adequate power for operation of all aircraft systems.

External power is available on the ground by accessing the 767 Ground Requests menu and selecting "Auxiliary power". When external power is selected in the menu, the AVAIL light illuminates in the EXT PWR pushbutton. This indicates that external power is hooked up and ready to be used by the aircraft. Removal of external power from the airplane is also done from the Ground Request menu.

For the airplane to use external power the pilot must manually select EXT PWR by pressing the AVAIL button. Also, to remove external power from the aircraft systems the pilot must de-select it by pressing the same button.

Selection of external power "kicks off" any other power source that is currently powering the plane. Then, when external power is removed, the system returns to its previous preferred source of power.

## ENGINE GENERATORS

Each engine has one engine driven generator attached. One generator can supply adequate electrical power for all aircraft systems. The generators operate independently and are never paralleled. This means that when both generators are on line the electrical system is split into two separate systems where each generator powers its reliant systems independently.

Generator power is supplied to the aircraft via the GEN CONT switches on the electrical panel. These switches are left IN for all normal operations. They operate automatically to supply power to the aircraft systems.

In the event that a generator overheats or malfunctions it can be disconnected from the engine using the GEN DRIVE DISC switch. Double-clicking this switch disconnects the generator drive shaft from the engine and illuminates the DRIVE light. The drive can only be reconnected on the ground via the Ground Requests menu and cannot be reconnected in flight.

## POWER DISTRIBUTION

The Bus Tie switches on the electric panel control the distribution of electrical power to the Left and Right Main AC Buses. These switches are normally left in the AUTO position and are only switched out by procedure to isolate an electrical problem. In the AUTO position the Bus Tie switches automatically open and close so that only one source of power reaches its Main AC Bus. These power "transactions" are not normally visible to the pilot.

The Bus Tie switches act as power cops for flow of power to the Main buses. They control power to their respective Main AC bus, based on the following priority:

1. On side engine-driven generator.
2. APU generator.
3. Opposite side engine-driven generator.

The selection of External Power by the pilot overrides all of these power sources. In this case both Bus Tie switches would close to allow external power to reach each bus. Concurrently with this action any generator supplying power to that bus (engine or APU) would be removed.

In normal operations, with both engine generators operating, the Bus Tie switches isolate the Left and Right electrical systems so that each generator supplies power to its respective Main AC Bus.

## MAIN AC BUSES

The Left and Right Main AC Buses are the main source of electrical power for a majority of aircraft systems. They can only be powered from the APU, Engine Generator or External Power. Battery power cannot power the Main AC Buses.

In normal operations the Left generator supplies power to the Left AC Bus and the right generator supplies power to the Right AC Bus. A loss of one generator would cause the BUS TIE relays to close allowing one generator to power both AC buses. Selection of APU power in this case would be handled automatically to re-isolate the buses to use independent power sources.

The Left Main AC Bus is the power source for the following:

- ▶ The Captain's basic flight instruments
- ▶ The Captain's EADI and EHSI
- ▶ The Cockpit panel lighting
- ▶ The Left and Center autopilots
- ▶ The Upper EICAS screen
- ▶ The FMC
- ▶ The Center hydraulic No. 1 Primary pump
- ▶ The Right hydraulic electrical Demand pump
- ▶ The Left AFT, Left Center and Right FWD Fuel pumps
- ▶ The Left and Center IRU

As you can see, keeping power to the Left Main AC Bus is of critical importance.

The Right Main AC bus powers the remaining systems with the exception of the standby flight instruments.

## OTHER BUSES

We already mentioned the Standby Bus. As long as the Standby Power selector is in AUTO, power is automatically supplied to this bus. The Standby Bus supplies power for the standby instruments and basic warning circuits.

On the main electric panel are switches for the Left and Right Utility Buses. These buses control power for galley items and also the L and R Recirculation fans. These switches are left ON for all normal operations. You might notice that during a start these buses turn OFF automatically and then come back on after the start is completed. This is an automatic load shed feature and is completely normal.

## EICAS MESSAGES

### ▷CAUTIONS

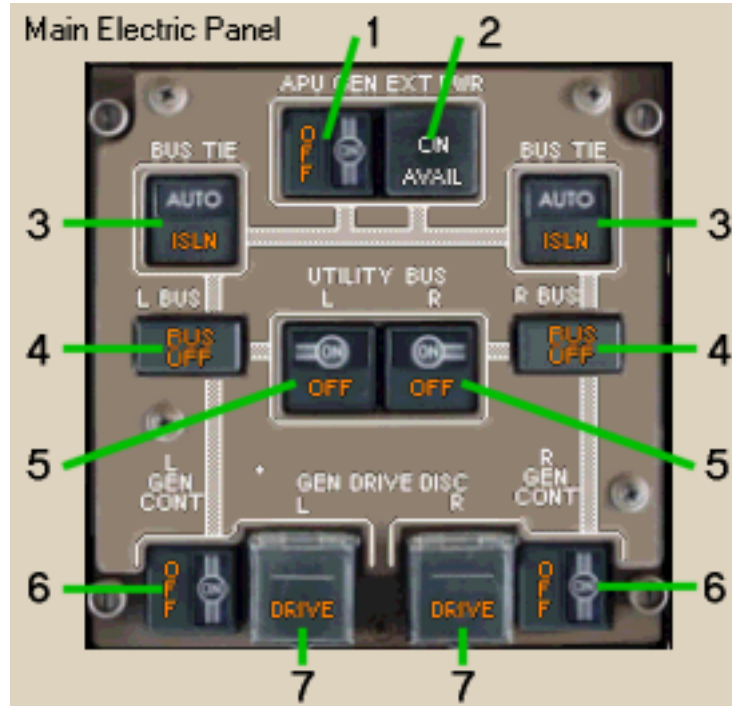
- L/R AC BUS OFF - The Left or Right Main AC Bus is not powered.
- L/R BUS ISOLATED - The Left or Right bus tie is open manually or by fault.
- L/R GEN DRIVE - Low gen(erator) drive oil pressure or high temp with engine running.

### ▷ADVISORIES

- BATTERY OFF - The battery switch is OFF.
- MAIN BAT DISCH - The battery is discharging.
- STANDBY BUS OFF - The standby bus is not receiving power.
- L/R GEN OFF - The Left or Right generator is OFF with the engine running.
- APU GEN OFF - The APU gen switch is OFF or the APU gen breaker is open with the APU running
- APU FAULT - The APU has shutdown for a fault.
- L/R UTIL BUS OFF - The Left or Right utility bus is not powered.

**Easy Fly Quick Tip:** Turn the battery ON, push IN all electrical panel switches and place the Standby Power selector to AUTO. This is the normal configuration for all phases of flight. Turn the APU rotary switch to START momentarily and wait for the RUN light. When the RUN light illuminates, the aircraft will be completely powered and ready for starting. After start, place the APU switch to OFF and you are ready to go.

## ELECTRICAL SYSTEM CONTROLS



### 1- APU Generator Control Switch:

It controls the status of the APU GEN breaker.

- Switch IN
  - Automatic control of the APU GEN breaker.
  - Power is automatically supplied to the system when required, provided the APU is running.
- Switch OUT
  - The APU GEN breaker is open and power cannot be supplied by the APU.
  - It illuminates the OFF light.
- OFF
  - The APU GEN control switch is OFF or there is a fault in the APU generator while it is running.

**2- External Power Control Switch:** It is pressed to apply EXT PWR to the system.

- AVAIL
  - External power is plugged in and available for use.
- ON
  - When the EXT PWR switch is pressed, the ON light indicates that external power is being used to power the aircraft systems.



**3- Bus Tie Control Switches:** It controls the power source for the Left and Right AC Buses.

- AUTO
  - Automatic control of power to the AC buses.
  - It prevents two power sources from powering the same bus.
- ISLN
  - It manually isolates the respective AC bus.
  - In this case the only power source available to the AC bus is from the respective engine GEN.

**4- Main AC Bus Off Light:** It indicates that the Main AC Bus is not powered.

**5- Utility Bus Control Switches:** It controls power to the utility buses

- Switch IN
  - Power is supplied to the utility bus automatically when the respective Main AC Bus is powered.
- Switch OUT
  - The Utility bus is OFF. It illuminates the OFF light.
- OFF
  - The Utility bus is not powered.

**6- Generator Control Switches:** They control power from the engine driven generators.

- Switch IN
  - It automatically controls power from the engine generator.
  - Power is supplied automatically when needed.
- Switch OUT
  - The Generator is OFF and power is not available.
- OFF
  - The Generator breaker is open and power is not available nor being used by the system.

**7- Generator Drive Disconnect Switches:** When double-clicked they disconnect the generator drive from the engine. Once disconnected, the generator is no longer available for use. Also it can only be reconnected on the ground via the Ground Requests menu.

- DRIVE
  - The generator drive oil temperature is high or pressure is low
  - It also illuminates when the drive is disconnected.



### 1- Battery Switch:

- ON - The Battery is ON and connected to the battery bus.  
 - It is required to be ON for starting the APU.  
 - It is always ON for all normal operations.

- OFF - The battery switch is OFF.

**2- Battery Discharge Light:** When illuminated, it indicates that the battery is being discharged. In normal operations the battery is charged from the Right Main AC Bus.

**3- Standby Power Selector:** It controls the power source for the Standby Bus.

- OFF - The Standby Bus is OFF and receives no power.
- AUTO - Power to Standby Bus is automatically controlled.  
 - In normal operations power is from the Main AC Bus.
- BAT - The Standby Bus is powered from the Battery only.

**Standby Bus OFF Light:** It illuminates if the Standby Bus is not powered. If the standby bus is OFF the standby flight instruments are not powered.



**1- APU Selector Switch:** It is used to turn the APU ON and OFF.

- OFF - The APU is OFF or will be shut down if running.  
 - If the APU was used as a bleed source there is a one-minute cool-down period before the APU will shutdown.

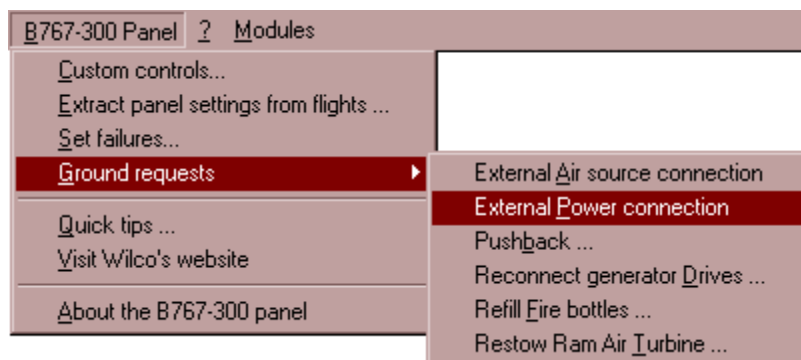
- ON
  - Spring-loaded position.
  - Moving from OFF to ON opens the APU fuel valve and arms the APU for starting.
  - It commands the Left FWD Fuel Pump ON to supply fuel.
  - Once started, the APU continues to RUN in this position.
  
- START
  - Momentary position: it initiates the APU start sequence.
  - The RUN light flashes twice to indicate the beginning of start.
  - When released, it returns to the ON position.
  - If the APU is in the cool-down period, the momentary selection of START cancels the shutdown signal and the APU continues to RUN.

Note: The Battery switch must be ON to successfully start the APU.

**2- APU RUN Light:** When illuminated steadily it indicates that the APU is on speed and is available to supply electrical and pneumatic power.

**3- APU FAULT Light:** It illuminates to indicate an APU fault. Also illuminates momentarily when the APU fuel valve is in transit.

## ELECTRICAL SYSTEM MENU ITEMS



- ▶ Used to request External Power connection and disconnect.
- ▶ Used to reconnect generator drives when on the ground.

## FUEL SYSTEM DESCRIPTION

Fuel on the 767 is carried in three tanks. There are two wing tanks of equal capacity and a large center tank. Each tank has two pumps for delivery of fuel under pressure to the engines. A crossfeed valve ensures that fuel can be fed from any of the three tanks to both engines. One tank and its corresponding fuel pumps can deliver fuel to both engines simultaneously. There are no provisions for transfer of fuel between tanks in flight. Fuel for the APU is supplied from the left wing tank.

### WING TANKS

Each wing contains a tank capable of carrying 40,700 lbs. of fuel for a total of 81,400 lbs. Each tank contains two output pumps (FWD and AFT) for delivery of fuel to the engines. Fuel from the wing tanks can gravity feed to the engines at most altitudes. However, if the pumps are off you may experience a flameout or reduced engine power at higher altitudes.

The fuel pumps in the wing tanks are powered from the Main AC Buses. The Left Main AC Bus powers the Left AFT and Right FWD fuel pumps. The Right Main AC Bus powers the Left FWD and Right AFT fuel pumps.

Fuel is provided to the APU from the Left wing tank. The Left FWD fuel pump is used for this purpose and operates automatically regardless of switch position when AC power is available and the APU is running.

If either wing tank fuel quantity drops below 2,200 lbs. the FUEL CONFIG light illuminates along with an EICAS caution of LOW FUEL.

The lateral balance of the fuel must be maintained within 1500 - 2500 lbs. difference between the two tanks. If fuel balance goes outside of these limits the FUEL CONFIG light illuminates along with an EICAS advisory.

### CENTER TANK

There is one large center tank capable of holding 80,400 lbs. of fuel. There are two boost pumps in this tank (Left and Right) for delivery of fuel to the engines. Fuel cannot be gravity fed from the center tank making it absolutely dependent on the fuel pumps for accessing fuel.

The center tank fuel pumps are powered from the Main AC buses. The Left Main AC Bus powers the Left pump. The Right Main AC Bus powers the Right pump.



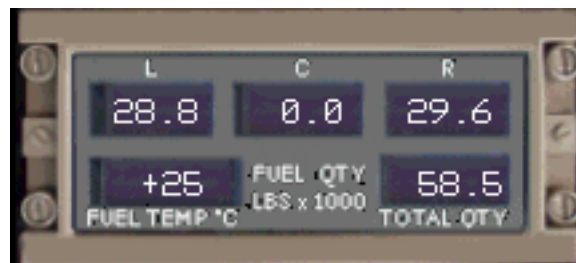
The fuel pumps in the center tank provide twice the output pressure of the wing tank pumps. Therefore, when the center pumps are ON the engines are provided fuel from the center tank only. Even though the wing pumps are operating, the center pumps overpower them.

The center tank pumps have inhibits on them when their respective engine is shut down or N2 is below 50%. This inhibit is removed when N2 for the respective engine is above 50%. So if you turn on the center tank pumps at the gate with the engines shut down, the PRESS lights illuminate for each pump. As each engine is started, the respective pump PRESS light goes out as the inhibit is removed.

If the center tank fuel quantity is above 1200 lbs., the FUEL CONFIG light illuminates if the center tank pumps are not selected ON.

## FUEL QUANTITY AND DISTRIBUTION

Fuel quantity is indicated on the overhead panel just below the fuel panel. The quantity for each tank plus the total quantity is displayed in pounds.



A standard distribution for the 767 is to fill the main wing tanks first. If more than 80,000 lbs. of fuel are required then the center tank is used after the wing tanks are full.

Standard burn techniques require that you use all center tank fuel first before using the wing tanks. When dispatched with center tank fuel, you should turn on ALL fuel pumps in all tanks prior to engine start. As you progress, and the center tank empties. Turn off the center tank pumps when fuel is exhausted from that tank. This operating technique ensures that you will not have weight and balance problems during the flight.

## FUEL CROSSFEED

There is a crossfeed switch on the fuel panel that opens and closes a crossfeed valve to allow fuel to feed through the crossfeed manifold. This crossfeed does not permit transfer of fuel between tanks. It only allows fuel from one main tank to feed both engines simultaneously.

To maintain wing tank balance you can crossfeed fuel from one wing tank to both engines until the fuel quantities are equal. The crossfeed procedure starts by opening the crossfeed valve. Then turn off both fuel pumps in the tank with less fuel. In this configuration the tank with operating pumps provides all fuel to both engines. When the fuel is balanced just reverse the procedure. Note that fuel crossfeed will not work with the center tank pumps operating.

## EICAS MESSAGES

### ▷CAUTIONS

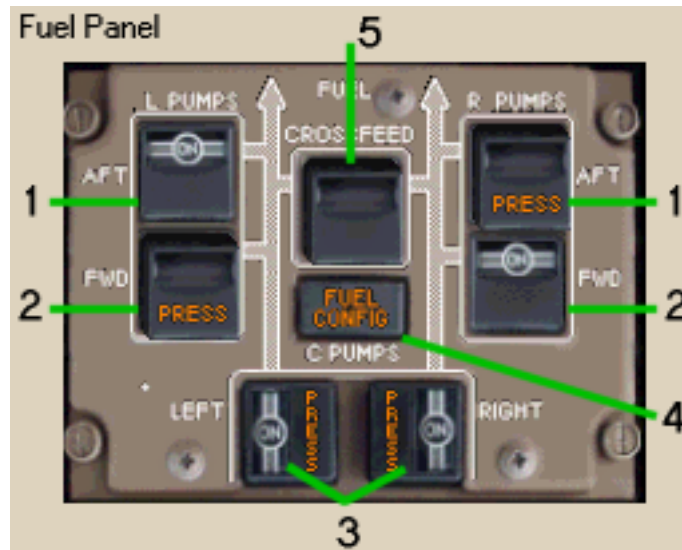
- |                    |   |   |
|--------------------|---|---|
| L/R FUEL SYS PRESS | - | Low fuel pressure in respective system.             |
| LOW FUEL           | - | Less than 2,200 lbs. remaining in either wing tank. |

### ▷ADVISORIES

- |                   |   |  |
|-------------------|---|--|
| FUEL CROSSFEED    | - | Crossfeed valve not in commanded position.   |
| L/R FWD FUEL PUMP | - | Forward pump pressure is low or switched off.  |
| L/R AFT FUEL PUMP | - | Aft pump pressure is low or switched off.  |
| C L/R FUEL PUMP   | - | Center pump fuel pressure is low or switched off.  |
| FUEL CONFIG       | - | Center tank pumps switched off with more than 1200 lbs. in center tank; or wing tank fuel quantity differs by more than 1500 - 2000 lbs.; or less than 2,200 lbs. remains in either wing tank. |

**Easy Fly Quick Tip:** Prior to engine start turn on ALL fuel pumps. If you do not have center tank fuel, then turn off the two center pumps. If you do have center tank fuel, then turn off the center pumps when the EICAS warnings for center tank fuel pumps are displayed.

## FUEL PANEL CONTROLS



### 1/2- FWD and AFT Main Fuel Pump Switches:

Control power to the FWD and AFT fuel pumps in the wing tanks.

- |            |   |
|------------|---|
| Switch IN  | - Fuel pump signalled to operate.   |
| Switch OUT | - Fuel pump OFF.<br>- Illuminates PRESS light.                              |
| PRESS      | - Illuminates for low pressure in the respective pump or the switch is off. |

### 3 - Center Tank Fuel Pumps:

Control power to the Left and Right center tank fuel pumps.

- |            |  |
|------------|--|
| Switch IN  | - Fuel pump signalled to operate.<br>- Center pumps provide double the output pressure of the wing pumps so all fuel to engines comes from center tank.  |
| Switch OUT | - The Fuel pump OFF.<br>- The PRESS light will NOT illuminate.   |
| PRESS      | - It illuminates for low pressure in the respective pump only.<br>- It does not illuminate if the switch is OUT.<br>- It also illuminates if the center tank pumps are inhibited when the respective engine N2 is below 50%. |

#### **4- FUEL CONFIG Light:**

It illuminates for one of the following reasons:

- ▶ The center tank pumps are switched off with more than 1200 lbs. in the center tank.
- ▶ The wing tank fuel quantity differs by more than 1500 - 2000 lbs.
- ▶ There are less than 2,200 lbs. of fuel remaining in either wing tank.

#### **5- Crossfeed Valve:**

It controls the opening and closing of the crossfeed valve.

Crossfeed procedure is as follows:

1. Open crossfeed valve by pressing in the crossfeed switch.
2. Turn off both fuel pumps in the tank with the least amount of fuel.

To terminate crossfeed:

1. Turn both fuel pumps back on.
2. Close the crossfeed valve.

Note: The Crossfeed will not work when the center tank pumps are ON.



## HYDRAULIC SYSTEM DESCRIPTION

The 767 hydraulic system is broken down into three separate systems: left, center and right. Each system has multiple pumps that are each driven by separate power sources. The system is designed so that a loss of 1 or 2 systems still permits limited operation of basic flight controls and other systems in a limited capacity. There is also a Ram Air Turbine (RAT) that can be deployed automatically or manually to power critical flight controls in the event of a complete hydraulic system failure.

### LEFT and RIGHT HYDRAULIC SYSTEM

The left and right hydraulic systems have identical pump configurations. They both consist of two pumps: an engine driven primary pump and an electrically driven demand pump. Either pump can supply the necessary pressure to satisfy the demands of its hydraulic components.

The engine driven primary pumps operate any time the engines are running and their respective pump control switch is ON. They operate continuously to satisfy the normal demands of their system. In normal operation the primary pump switch is left in the ON position and is only turned OFF when directed by an abnormal procedure. Pulling the fire handle automatically shuts off the respective primary pump and isolates it from the hydraulic system.

The electrically driven demand pumps operate as their name implies: on demand. A three-position rotary switch controls the demand pumps. The switch has OFF, AUTO and ON positions. In the AUTO position, the demand pump only operates if the primary pump fails or is turned off. In the ON position, the demand pump runs continuously regardless of primary pump status.

Each demand pump is supplied electrical power from a different AC source. The Left Demand Pump is powered from the Right Main AC Bus. The Right Demand Pump is powered from the Left Main AC Bus. In normal operation the Demand Pumps are turned OFF when parked at the gate. They are switched to AUTO prior to engine start.

The Left hydraulic system provides power to the following systems: ailerons, elevators, rudder, spoilers, stab trim, left autopilot, yaw dampers, and rudder ratio.

The Right hydraulic system provides power to the following systems: ailerons, elevators, rudder, spoilers, right autopilot, and normal brakes.

## **CENTER HYDRAULIC SYSTEM**

The center hydraulic system has three separate pumps controlled by two separate power sources. There are two electrically driven primary pumps and one air driven demand pump (ADP). The ADP is capable of providing normal system demands if both electric primary pumps fail. The ADP also provides supplemental hydraulic power to the center system during operation of high demand items such as flaps and gear.

The center primary electric pumps are designated as Number 1 and Number 2 primary electric pumps. They operate on two separate power sources. The Number 1 primary pump is powered from the Left Main AC Bus. The Number 2 primary pump is powered from the Right Main AC Bus. In normal operations these pumps are turned OFF at the gate and turned ON before engine start. To reduce electrical demands, the Number 2 primary electric pump will not operate if all other electric pumps are operating.

The air driven demand pump (ADP) is powered using bleed air from the center pneumatic duct. The center isolation valve must be open for the ADP to receive power. A three-position rotary switch controls the air driven demand pump (ADP). The switch has OFF, AUTO and ON positions. In the AUTO position the ADP supplies hydraulic power to the center system on demand. In the ON position the ADP operates regardless of system demands.

The center hydraulic system provides power to the following systems: ailerons, elevators, rudder, spoilers, center autopilot, alternate brakes, flaps/slats, landing gear and nose wheel steering.

## **RAM AIR TURBINE**

The Ram Air Turbine (RAT) is an emergency system that can be used to power primary flight controls in the event of dual engine failure or total hydraulic power loss. The RAT is basically a propeller that when deployed drops into the air stream and creates hydraulic pressure. A minimum airspeed of 130 knots is required for satisfactory RAT operation.

The RAT deploys automatically with dual engine failure. It can also be deployed manually by using the RAT switch on the overhead panel. Once deployed the RAT can only be stowed on the ground using the Ground Requests menu.

The RAT uses the center hydraulic system and can only provide partial power for the ailerons, elevators, rudder and spoilers. It cannot provide power for the other components that use the center hydraulic system.

## ALTERNATE BRAKES and STEERING

Normally the brakes are powered using the Right hydraulic system. Alternate power for brakes is provided using the Center hydraulic system. If power to both the Right and Center hydraulic systems is lost you might be able to regain pressure for the brakes by using the Reserve Brakes and Steering system.

This system uses reserve hydraulic fluid from the Center hydraulic system and the Number 1 primary electric pump to provide pressure for the brake system. The system is activated using the RESERVE BKS & STRG switch on the main panel. Pressing the switch causes the No. 1 electric pump to run regardless of its switch position and move isolation valves to channel the pressure to the brake system.

Illumination of the Brake Source light on the main panel indicates that the hydraulic pressure in the Center and Right systems is low. Use of the Reserve Brakes and Steering switch should restore satisfactory pressure for use of the brakes. When the switch is selected ON, the Brake Source light extinguishes if pressure is restored for braking.

## EICAS MESSAGES

### ▷ CAUTIONS

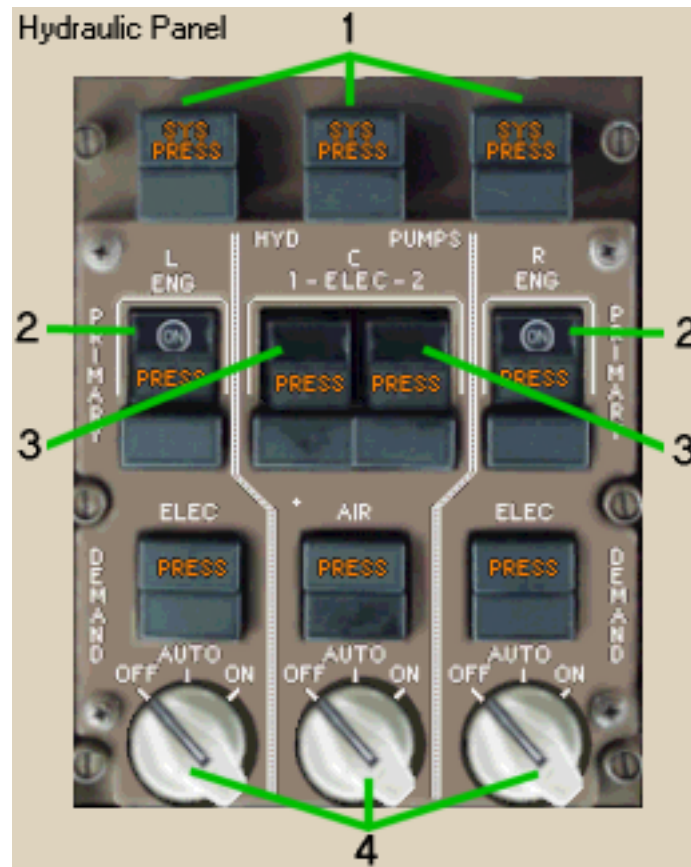
L/C/R HYD SYS PRESS - Hydraulic system pressure is low.

### ▷ ADVISORIES

L/R HYD PRIM	- Low pump pressure with engine running.
C HYD PRIM 1 / 2	- Low pump output pressure.
L/C/R HYD DEM PUMP	- Low pump output pressure.
BRAKE SOURCE	- Center and Right hydraulic pressure low.
RAT UNLOCKED	- The Ram Air Turbine is unlocked.

**Easy fly Quick Tip:** To set up the hydraulics for normal flight just push all of the primary pump switches in and turn all of the rotary demand pump switches to AUTO. Set it and forget it.

## HYDRAULIC SYSTEM CONTROLS



- 1- **SYS PRESS:** It indicates when the respective system pressure is low. It generates an EICAS caution annunciation.
- 2- **Primary Engine Driven Pump Controls:** They control operation of the Left and Right systems engine driven pumps.
  - Switch IN - Turns on pump when engine is running.
  - Switch OUT - Turns off pump
  - PRESS - The pump output pressure is low or the pump is switched off.
- 3- **Primary Electric Driven Pump Controls:** It controls operation of the center systems Number 1 and Number 2 electrically driven pumps.
  - Switch IN - Turns the pump on.
  - Switch OUT - Turns the pump off.
  - PRESS - Pump output pressure is low or pump is switched off.

Note: No. 2 primary electric pump will not operate if all electric pumps are ON and aircraft is powered from only one power source.

#### 4- Demand Pump Controls:

The control the operation of the hydraulic Demand pumps.

- OFF - The pumps are off and will not operate.
- AUTO - The pumps are armed to run when the system demands require it.
- The Left and Right pumps run when the respective Primary pump fails or is turned off.
  - The Center ADP runs when the system pressure is low, or high demand items are selected.
- ON - The pump operates continuously regardless of system demands.
- PRESS - It illuminates for one of the following:
- ▶ The Pump selector is OFF.
  - ▶ In AUTO, if the pump fails to operate when signalled ON.
  - ▶ The Pump selector is ON and the pump pressure is low.

#### RESERVE BRAKES AND STEERING CONTROL

- Switch OUT - Reserve brake and steering OFF (normal position).
- Switch IN - The ON light illuminates.
- Number 1 primary pump is turned on regardless of pump switch position.
  - It isolates center reserve hydraulic fluid to pressurize the brake system.
- VALVE - The isolation valve is in transit or not in the commanded Position.
- BRAKE - The Center and Right hydraulic pressures are too low for operation of the brakes.
- SOURCE - It should extinguish when the RB & S switch is ON to indicate satisfactory pressure is available for the brakes.



## RAM AIR TURBINE CONTROL

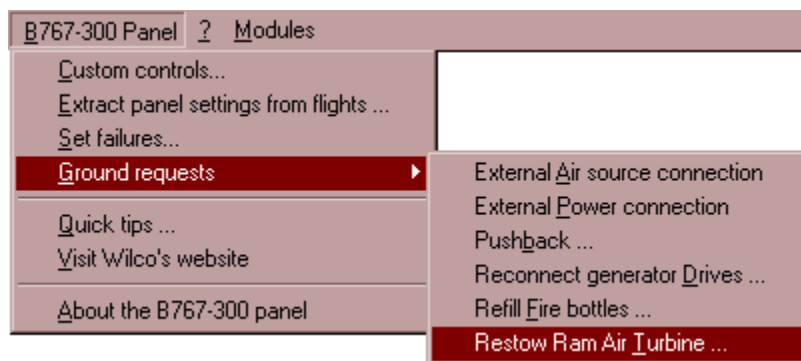
It is located above the Start switches on the overhead panel.

- PRESS** - When the RAT is deployed this indicates sufficient pressure is being produced.
- UNLKD** - It illuminates when RAT is deployed either automatically or manually.



To manually deploy the RAT just press on the switch.

Menu selection for re-stowing the RAT after deployment:



## **PNEUMATIC SYSTEM DESCRIPTION**

The pneumatic system provides air for the operation of air conditioning packs, engine starts, wing anti-ice, engine anti-ice and the operation of the center hydraulic demand pump. Air for the system can come from three sources: engine bleeds, the APU, or an external source. The APU is normally used on the ground to supply air for air conditioning and starting. However, if the APU is inoperative an external source of air can be requested from the Ground Request menu to accomplish an engine start.

### **ENGINE BLEEDS**

The Left and Right engines both have bleed valves that, when open, supply air to the pneumatic system. Each bleed valve is controlled automatically if its bleed switch is pushed in. The valves open based on system demands to supply air to the system and for cross-bleed starting, if necessary. The engine bleed switches are pushed IN for all normal operations.

### **APU BLEED**

The APU is capable of supplying sufficient air for the operation of both air conditioning packs while on the ground. Additionally, the APU air is used for normal engine starts. However, the APU cannot start the engines and supply the packs with air at the same time. The APU can be used in flight up to 20,000 ft if necessary.

The APU bleed valve controls the flow of APU bleed air to the system. This valve operates automatically depending on system logic. If the APU bleed switch is pushed IN the valve opens automatically based on system demands. The APU bleed switch is pushed IN for all normal operations.

If the APU bleed valve is open and the APU is shut down, the APU valve automatically closes and signals the APU to begin a one-minute cool-down.

### **EXTERNAL AIR**

External air can be hooked up to the system if desired by the pilot. It is requested through the Ground Requests menu. There are no cockpit controls for the use of external air by the system. However, the pilot can monitor the duct pressure to determine the status of external air input. External air is only used if the APU is shutdown or inoperative.

## **PNEUMATIC DISTRIBUTION**

Air is distributed through the aircraft using a series of interconnected ducts. Normally, the left and right distribution ducts are isolated so that air from each engine is supplied to its on-side equipment only. However, through the use of isolation valves, bleed air can be used from any one source to supply the entire system. Additionally, the isolation valves are normally open on the ground so that the APU can supply air to the entire system and for engine start.

The flow lines drawn on the pneumatic panel can help the pilot visualize the flow of air in the system. The left and right isolation valves are normally closed after engine start so that the left and right systems operate isolated. These isolation valves must be open to supply air for engine starts. The center isolation valve is always left open and is only closed by abnormal procedure.

The air driven hydraulic pump receives air for operation through the center duct. If the center isolation duct is closed and the APU is not supplying bleed air, the center hydraulic demand pump will not operate.

Pneumatic duct pressure can be monitored using the duct pressure gauge on the pneumatic panel. Each duct has a pressure needle that registers duct pressure downstream from the isolation valves. For a successful engine start a minimum of 25 psi must be available. Therefore, the packs must be turned off prior to engine start. If the packs are accidentally left on and an engine start is attempted, the duct pressure may not be sufficient to drive the starter motor. This will be evident by monitoring both duct pressure and N2 rotation.

The left, center and right ducts are monitored for leaks. If a leak is detected a DUCT LEAK light illuminates in the affected system. Additionally, a caution and EICAS alert are generated.

## **AIR CONDITIONING SYSTEM**

Bleed air is supplied to the left and right air conditioning packs. A rotary selector controls the operation of the packs. The selector has two main positions (OFF and AUTO) for use in this panel. The other positions (N, C and W) can be selected but have no programmed function.

With the pack in AUTO the air condition system operates when bleed air is available. The status of the pack is annunciated above the rotary selector. The PACK OFF light illuminates if the pack is switched off or there is no bleed air available. There is also an INOP light that indicates a fault with the respective pack.

In addition to air conditioning the air from these packs pressurizes the aircraft. If both packs are turned off or become inoperative in flight you may receive a



CABIN ALTITUDE warning message. This would indicate that the cabin altitude has become excessive and that you have to turn the packs on or descend below 10,000ft for continued safe flight.

The TRIM AIR switch controls air to the temperature controllers. It is left in the ON position for normal operations. If the switch is turned off, the three INOP lights above the temperature controllers illuminate to indicate that the temperature controllers are now inoperative. In this case the cabin is maintained at 75 degrees F. (Note: This version of the panel does not have the cabin temperature controllers working since there are no cabin temperature indicators. We hope to add this in future versions.)

The RECIRC FAN switches control power to the recirculation fans. These fans are powered by the Utility Buses. Recirculation fans are used to help the air conditioning system keep the aircraft at a comfortable temperature while reducing the bleed air demands by the packs. The air from these fans is also used for equipment cooling. The reduced bleed demands created by use of the recirculation fans lowers the operating costs of a flight because less power is taken away from the engines, which lowers the power setting required.

## **EICAS MESSAGES**

### **WARNINGS**

CABIN ALTITUDE        -    The cabin altitude is above 10,000 ft.

### **CAUTIONS**

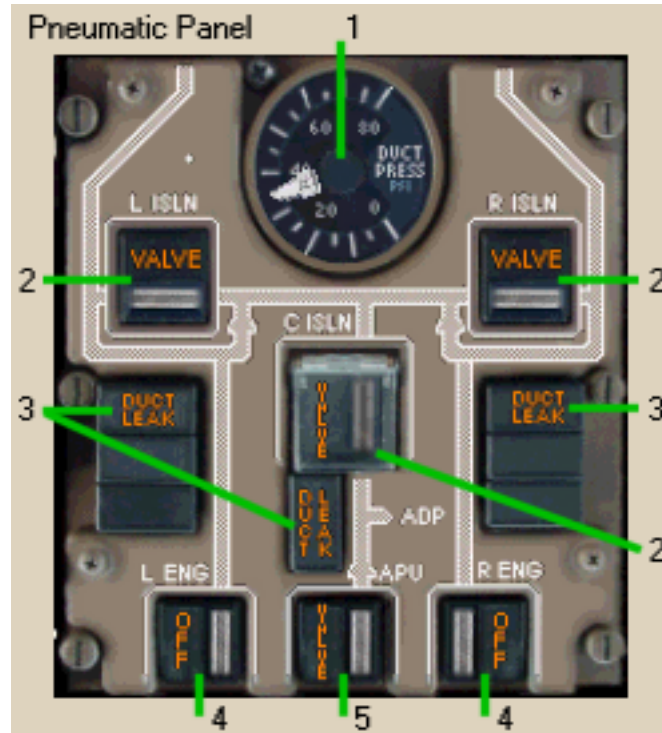
BODY DUCT LEAK        -    There is a leak between the APU and center isolation valve.  
L/R BLD DUCT LEAK    -    There is a leak in the left or right duct manifold.

### **ADVISORIES**

APU BLEED VALVE    -    The APU bleed valve is not in the commanded position.  
L/R ENG BLD OFF    -    The bleed valve is closed with the engine running.  
L/R PACK OFF        -    A pack is OFF or has internally overheated.  
L/R RECIRC FAN     -    A recirculation fan is OFF or has failed.  
TRIM AIR OFF        -    The trim air switch is OFF.  
L/R PACK TEMP      -    A pack outlet temperature is excessive.

**Easy Fly Quick Tip:** Always leave all three bleed valve switches IN. Always leave the center ISOL switch IN. For engine starts, push IN (open) the left and right ISOL switches and turn OFF the packs. After engine starts, turn the packs ON and close the left and right ISOL valves.

## PNEUMATIC SYSTEM CONTROLS



### 1- Duct Pressure Gauge:

It displays the duct pressure in the left and right ducts. A minimum of 25 psi is required for starting the engines.

### 2- Isolation Valve Switches:

They control the flow of bleed air between the left, right and center systems via the crossover manifold.

- Switch IN - The isolation valve is OPEN.
- Switch OUT - The isolation valve is CLOSED.
- VALVE - The isolation valve is not in the commanded position or is in transit.

Note: The center isolation valve is left OPEN for all normal operations. Left and Right isolation valves are only opened on the ground for engine starts and to provide APU bleed air for pack operation. They are normally closed after both engines are started.

### **3- DUCT LEAK Light:**

It indicates that a leak has been detected in the respective duct. The duct pressure gauge can be a good way to confirm an actual leak.

### **4- L and R Engine Bleed Valve Control:**

It controls the engine bleed valves.

Switch IN - The engine bleed valve is automatically controlled based on system demands and logic.

Switch OUT - The engine bleed valve is commanded to close.

OFF - The engine bleed valve is closed.

### **5- APU Bleed Valve Control:**

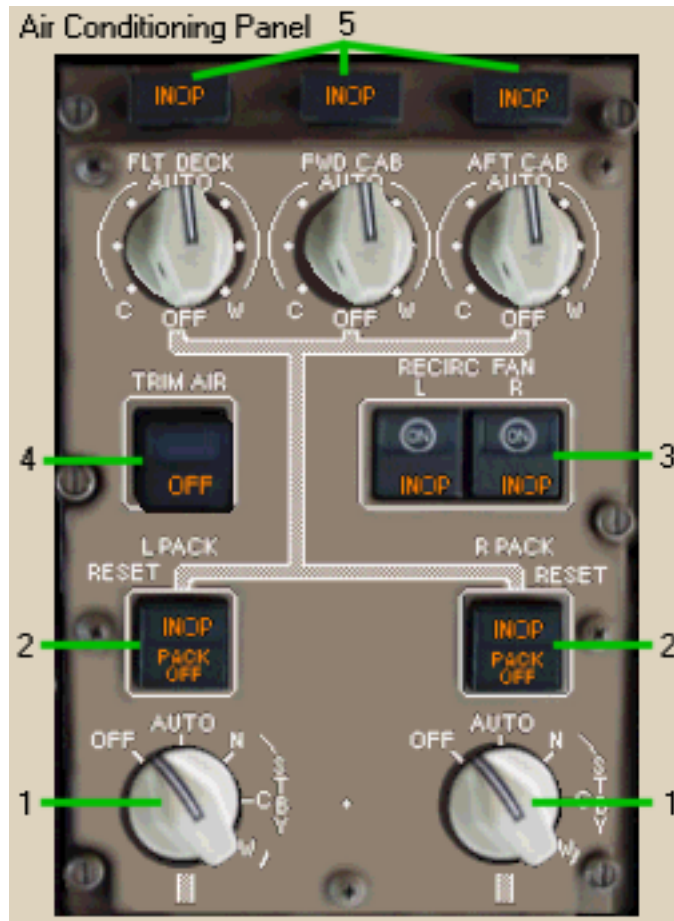
It controls the operation of the the APU bleed valve.

Switch IN - The APU bleed valve is armed for automatic operation  
- The APU bleed valve opens based on system logic.

Switch OUT - The APU bleed valve is commanded closed.

VALVE - The APU bleed valve is not in the commanded position.  
- It flashes on/off when the valve is in-transit.

## AIR CONDITIONING CONTROLS



### 1- Pack Control Selector:

It controls the operation of the air conditioning pack.

OFF - The pack is commanded OFF.

AUTO - The pack runs when bleed air is available.

N,C,W - Not used in this sim.

### 2- Pack Status Annunciators:

They indicate the status of the packs.

INOP - The pack has a fault or has overheated.

PACK OFF - The pack switch is OFF or there is no bleed air.

### 3- Recirculation Fan Switches:

ON - The recirculation fans are ON.

INOP - The recirculation fans are OFF or have failed.

#### 4- Trim Air Switch

Controls air to the temperature controllers.

ON - Air is supplied to the temperature controllers.

OFF - Air is not supplied to the temperature controllers and the cabin is maintained at 75 degrees F.

#### 5- Temperature Selector INOP Lights:

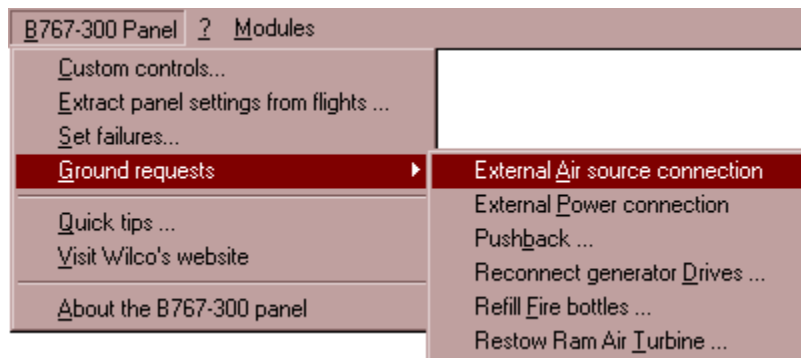
These are mainly here for future development. INOP lights indicate that the temperature controllers are OFF, the Trim Air switch is OFF, or the temperature controller has failed.

In this panel all three illuminate if the Trim Air switch is OFF.

### EXTERNAL AIR REQUEST MENU

To be used when parked at the gate to request external air hook-up. Use this menu also to request that the external air be removed.

External air is used when the APU is off or inoperative to provide air for air conditioning and engine start.



## **ENGINES DESCRIPTION**

Two General Electric CF6-80C2 engines power the 767-300. Each engine is capable of producing 61,500 pounds of thrust. Cockpit controls for the engines include the throttles, fuel cut-off switches, EEC switches, fire handles, and a Thrust Rating Panel (TRP). Also, as part of the autopilot system, there is an autothrottle that can control power settings for all phases of flight. The FMC can also be used to control engine power for de-rated takeoffs as well as VNAV climb, cruise and descent.

## **ENGINE CONTROLS**

Primary control of engine power is from the throttles located on the center pedestal. Also located on the pedestal, just above the speed brakes, are the Engine Electronic Control (EEC) switches. The center pedestal is called up using the mouse button marked PDST located on the main panel below the autobrakes or from the keyboard by using the <shift> <5> key combination.

The throttles can be controlled manually by the pilot or automatically through the use of the autothrottles. The autothrottle sets power based on AFDS settings. When the autothrottle is in use, the pilot can still move the throttles. However, the power setting previously commanded by the autothrottle is always restored when they are released. One exception to this is the "throttle hold" mode. When THR HLD is annunciated on the EADI the autothrottle is temporarily disconnected from the power levers, giving the pilot complete control of the power setting. The use and operation of the autothrottle is described in more detail in the AFDS section.

The EEC switches turn on and off the electronic engine control. The EEC acts to limit the power settings to prevent an over-boost of the engines. Pushing the throttles up to the limit results in the maximum power setting available without causing damage to the engines. This power setting is indicated on the engine display with an amber line. If the pilot turns the EEC off then the power setting can be set beyond this limit and engine damage may occur.

## **ENGINE INDICATING and CREW ALERT SYSTEM (EICAS)**

The engine gauges are all displayed on the two center CRT's referred to as EICAS screens. These screens display engine data as well as messages generated by the Crew Alert System (CAS). The bottom EICAS screen also has a "status" page that can be called up for display of other system information (see MISC section for more information). The EICAS screens are explained in detail in the diagrams at the end of this section.

In the event that both EICAS screens fail there is a standby engine gauge located to the left of the screens just below the warning annunciators. There

is a two-position switch that controls the display of data. In the AUTO position the display is blank when both EICAS screens are operating. If the EICAS screens fail, the engine data is automatically displayed. In the ON position engine data is displayed at all times.

## **ENGINE STARTING**

Engine starting is accomplished using bleed air supplied by the APU, the other engine, or an external source. Both air and electrical power are required to start the engines. There are two igniters per engine that can be selected using the ignition selection switch on the overhead start panel. Bleed air reaches the engines through a start valve that is controlled using the Start switch on the overhead start panel. When starting the engines the isolation valve for the engine being started must be OPEN and both packs must be turned off to reduce demands on the air source.

Fuel to the engine is controlled through the fuel control switches found on the pedestal below the throttles. An engine valve and a spar valve are opened and closed using this switch. The electric fuel pumps supply fuel under pressure to the engines. These pumps are turned on prior to engine start.

Starting of the engines is controlled using the Start Panel on the overhead in conjunction with the fuel control switches. The Start switch is a multiposition switch that is normally left in the AUTO position. The GND position is a spring-loaded position that controls opening and closing of the start valve. The OFF position shuts off all ignition to the system and closes the start valve (used by abnormal procedure only). The FLT position provides ignition to the engines from both ignition sources (used for in-flight engine restarts). The CONT position provides ignition to the engine from the selected igniter (used during turbulence or heavy rain to prevent flameout).

The engine start procedure requires that you have either battery or external power on. Turn on all required fuel pumps and ensure that the two isolation valves for the left and right pneumatic ducts are open. Turn off both packs and ensure that there is sufficient duct pressure for start (min 25psi). Placing the start switch to the GND position opens the start valve, which is verified by the corresponding VALVE light cycling on and then off. The N2 rotation verifies that the start valve has opened. A magenta index line on the N2 gauge indicates the minimum N2 for adding fuel. When the N2 is above the index line, place the fuel cut-off switch to RUN and watch for the light to go off. At approximately 50% N2 the starter cuts out, as verified by the start switch moving back to AUTO and the VALVE light flashing as the start valve closes.

## THRUST MANAGEMENT

The 767 has a Thrust Management Computer that in combination with the Thrust Rating Panel (TRP) commands the necessary power settings for each phase of flight. The TRP is controlled from a small push button panel above the gear handle. The TRP commanded power settings are displayed on the N1 engine gauge using green index pointers and a digital display. When setting power the green TRP reference bugs are just references. They are not limiting the power available in any mode. The maximum power setting available is always the EEC limit indicated by the amber line on the N1 gauge.

For takeoff power there are two modes: Takeoff power (TO) and de-rated takeoff power (D-TO). In the TO mode the computer calculates the maximum takeoff power for the current airport temperature. In the D-TO mode a temperature higher than current airport temperature (called the assumed temperature) is entered into the FMC Takeoff Reference page that is used to calculate the reduced thrust setting. The assumed temperature is calculated primarily on the basis of aircraft takeoff weight for a given airport runway.

In the climb there are three separate climb modes: Full climb power (CLB), de-rated climb power one (CLB1), and de-rated climb power two (CLB2). Climb one and two offer reduced climb power settings when full power is not required and for fuel savings. Climb two offers the lowest climb power setting that allows the plane to climb and meet all obstacle clearance requirements.

During the climb the power is automatically reduced to one of these climb settings when an AFDS vertical mode is selected (FL CH, VNAV, or V/S). If the AFDS is not being used, you can manually select the climb power using the TRP buttons.

You can pre-select a reduced climb power mode on the ground using the TRP buttons. If after takeoff you wish to climb in a reduced power mode automatically, you just select button "1" or button "2", which shows up on the EICAS as a white 1 or 2 next to the green TO display. Then, when you select an AFDS vertical mode, the power setting is automatically reduced to the selected CLB mode (CLB1 or CLB2 is announced). If no climb mode is pre-selected, the TRP commands full climb power (CLB).

If you are climbing in a reduced climb mode and wish to climb at full climb power, you can cancel the reduced climb mode by pressing on the button that corresponds to the current climb mode. An example is if you are currently in CLB1 mode and wish to have full climb power, just press the "1" TRP button. That cancels CLB1 mode and gives you CLB mode. The same applies to CLB2 mode when switching to CLB mode. You would press the "2" button to cancel CLB2 and get CLB mode.



However, if you are climbing in one reduced mode and wish to select the other reduced mode, you just press the other climb mode key. For example, if you are climbing in CLB2 mode and wish to climb in CLB1 mode, just press the "1" key and the mode changes to CLB1.

For cruise, the TRP displays the maximum cruise power setting based on altitude and temperature. However, the autothrottle may not need this much power depending on the programmed cruise speed. The CRZ mode is automatically selected when you level off at the pre-programmed FMC cruise altitude. In any case, manual selection of CRZ mode is always available from the TRP panel.

The other two TRP modes are Continuous (CON) and Go-around (GA). Pressing the CON key displays the maximum continuous power setting for the current altitude and temperature. This is usually used when you have an engine failure and need max continuous power. The GA mode is automatically selected when on approach and flaps are selected to 1. The GA mode displays the maximum go-around power setting to be used in the event of a go-around.

## **EICAS MESSAGES**

### **▷CAUTIONS:**

- |                      |   |
|----------------------|---|
| L/R ENGINE SHUTDOWN  | - Fuel cutoff switch if OFF.                      |
| L/R ENGINE OIL PRESS | - Engine oil pressure is low with engine running. |

### **▷ADVISORIES:**

- |                |   |
|----------------|---|
| REV ISLN VALVE | - Reverse lockout has malfunctioned in flight.        |
|                | L/R ENG EEC   |
|                | - EEC has failed or switched off with engine running. |

**Easy Fly Quick Tip:** To start the engines, make sure you have power to the plane (APU or External). - Make sure all three pneumatic isolation valves are OPEN. Make sure that the pneumatic duct pressure is above 25 psi (using the APU or External air). Turn off both air conditioning packs and turn on all fuel pumps. Place the engine start selector to GND position and observe N2 increase. When N2 is above the magenta index line, place the fuel control switch on the center pedestal to RUN. After the start selector returns to AUTO you can start the other engine using the same procedure. After both engines are started, turn both packs on and shut down the APU.

**ALTERNATE EASY START PROCEDURE:**

- ▶ Make sure ALL fuel pumps are ON.
- ▶ Place BOTH fuel control switches on the pedestal to RUN.
- ▶ Press and hold down <ctrl> <shift> <F4> all together momentarily.
- ▶ Press individually <J> followed by <+> and another <+>.  
Note: <+> is the <shift> <=/+> key combination and NOT the keypad <+>.
- ▶ Both engines start simultaneously.

## ENGINE START CONTROLS



### 1- Engine Start Switches:

Controls engine start valve and ignition.

- |      |   |  |
|------|---|--|
| GND  | - | Commands start valve to open and turns ignition on.    |
|      | - | Magnetically held to GND during start sequence.        |
|      | - | Released to AUTO when start is finished (50% N1).      |
| AUTO | - | Normal position of start switches.                     |
|      | - | Manually selecting AUTO during start terminates start. |
| OFF  | - | It turns off ignition and also terminates start.       |
| CONT | - | It turns on selected ignition source continuously.     |
|      | - | It is used during turbulence or heavy precipitation.   |
| FLT  | - | It turns on both ignition sources continuously.        |
|      | - | It is used for in-flight engine restarts.              |

### 2- Ignition Selector:

It selects source of ignition for engines. Each engine has 2 igniters. Normally use ignition 1 on odd-numbered flights and ignition 2 for even-numbered flights.

### 3- Start Valve Light:

When illuminated, it indicates that the start valve is not in the commanded position. It also illuminates if the start valve is in transit. During start, it cycles off/on when the start valve is in transit.

## ENGINE FUEL CONTROL



Fuel to each engine is controlled through two valves: the Engine Valve and the Spar Valve. The Engine Valve is located in the engine nacelle. The Spar Valve is located in the wing closer to the fuel tanks. Both valves must move for fuel to flow to the engines. The Fuel Control switches control the movement of both valves.

- RUN** - The Engine and Spar Valves are commanded open.
- CUT OFF** - The Engine and Spar Valves are commanded closed.
  - Closing of only one valve results in engine shutdown.
- ENG VALVE** - It Indicates the engine valve is not in the commanded position.
  - It cycles on/off when the valve is in transit.
- SPAR VALVE** - Indicates the spar valve is not in the commanded position.
  - It cycles on/off when the valve is in transit.

## ENGINE ELECTRONIC CONTROL (EEC) SWITCHES

They control power to the EEC for each engine. The EEC limits fuel flow to the engines when required to prevent exceeding maximum limits.



ON - Engine thrust is limited to prevent exceeding engine limitations.

OFF - Engines are not limited and can be set beyond maximum limits.

Note: When EEC is selected OFF or INOP the thrust limit pointer and command sector are not displayed.

## EICAS UPPER DISPLAY

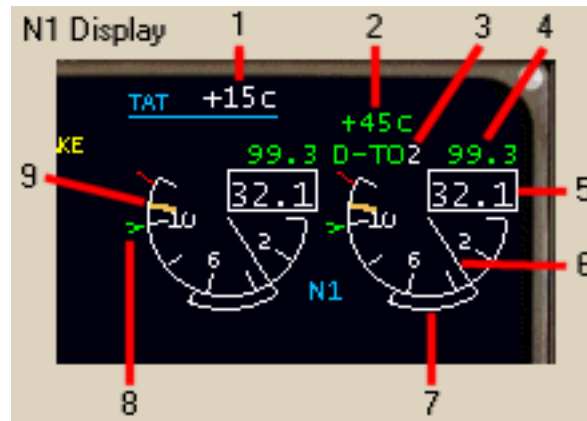
The upper EICAS CRT displays the Crew Alert System messages along with the N1 and EGT engine data. This screen is displayed continuously when the Left Main AC Bus is powered. The knobs below the lower EICAS screen control dimming of the screen.



In this picture you can see that the N1 display shows a target power setting of 107.6 and is in the TO mode. This would be the full takeoff power setting. Also you can see the white "2" next to the TO symbol. This means that the pilot has pre-selected a reduced climb power mode. In this case CLB2 has been pre-selected. The TRP automatically switches from TO mode to CLB2 mode

upon selection of an AFDS vertical mode. The N1 display is further explained in the "N1 Data Display" section.

## N1 DATA DISPLAY



### 1- TAT Temperature Display:

Displays the current outside temperature in degrees Celsius.

### 2- Assumed Temperature (Derated Power):

Display of the FMC-entered temperature on which the reduced thrust calculation is based. It is displayed if an FMC entry was made on the Takeoff Reference page.



### 3- Thrust Reference Mode:

It displays the current mode that the Thrust Management Computer (TMC) is in. These modes are selected using the Thrust Rating Panel. The white "2" indicates that a derated climb mode has been pre-selected. The available modes are:

- ▶ TO - Full takeoff thrust.
- ▶ D-T0 - Derated takeoff thrust.
- ▶ CLB - Full climb power.
- ▶ CLB1 - Climb 1 mode (derated climb power).
- ▶ CLB2 - Climb 2 mode (fully derated climb power).
- ▶ CRZ - Cruise power.
- ▶ CON - Maximum continuous power.
- ▶ GA - Go-around power.

### 4- N1 Thrust Digital Reference:

It displays thrust reference being commanded by the TMC.

**5- N1 Digital Display:**

It displays the current N1 power setting in percent.

**6- N1 Pointer Display:**

It displays the current N1 power setting in round dial format. The pointer extends beyond the scale arc only when the EEC is ON.

**7- Command Thrust Display:**

This arc (called command sector) shows the difference between current N1 and the target N1 based on power lever position. The N1 being commanded by the current power lever position is the line at the end of the command sector. The command sector display is inhibited if the EEC is OFF.

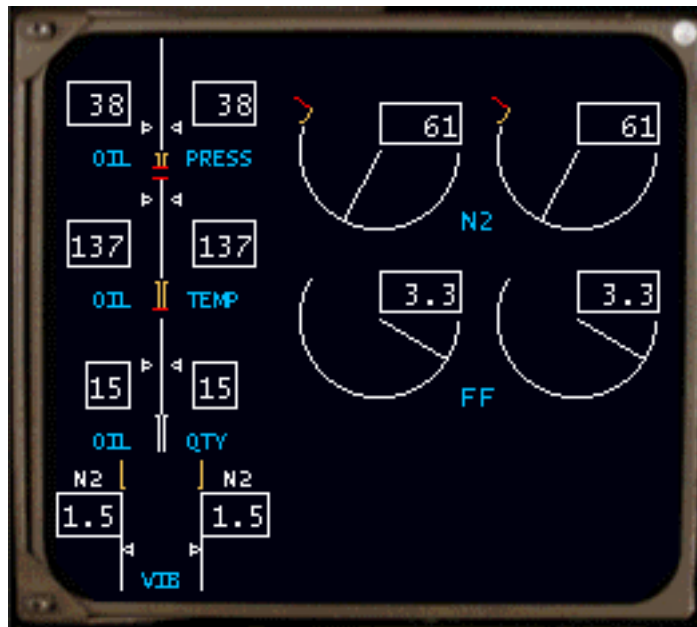
**8- N1 Thrust Reference Pointer:**

It displays the thrust reference being commanded by the TMC. This pointer shows the same value as the N1 Thrust Digital Reference (index line 4).

**9- N1 Limit Pointer:**

It displays the maximum N1 limit for each engine. The EEC determines this value and limits power to this maximum regardless of the power lever position. When the EEC is turned off this line disappears and the engine thrust is not limited. In this case the engine can be run beyond maximum limits.

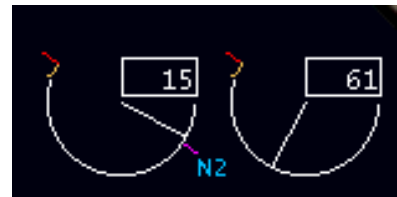
## EICAS LOWER DISPLAY



The lower EICAS screen displays secondary engine data. This screen can also be used to display the STATUS screen for information on other systems.

Pressing the "Engine" button below the lower EICAS display toggles this engine display ON and OFF. Also this screen can be dimmed using the knobs located below the display.

During start of an engine the N2 dial displays a magenta index line. This index line represents the minimum N2 for placing the fuel control switch to RUN. Placing the fuel control switch to RUN at an N2 below the index line may cause start problems.



If any engine parameter is in a caution range or exceeding a limit, the engine indications change color. This applies to engine displays on both EICAS screens.

- |       |  |
|-------|--|
| AMBER | - Engine parameters are in the caution zone.           |
| RED   | - Engine parameters are exceeding their maximum limit. |





## STANDBY ENGINE DISPLAY



The standby engine display shows N1, EGT and N2 data for each engine. It is controlled by a two-position switch.

**ON** - Engine data is displayed continuously

**AUTO** - Engine data normally is not displayed unless both EICAS screens are off or fail.

## THRUST RATING PANEL (TRP) CONTROLS

It provides for control over the Thrust Rating Computer modes of operation. The TRP selections are annunciated within the N1 data display. If the autothrottle is in use the thrust settings are limited according to the TRP mode selected.



- ▶ **TO/GA**
  - It selects TO mode on the ground.
  - It selects GA mode in flight.
- ▶ **CLB**
  - In flight it is used to select full climb power if previously in TO/GA, CON or CRZ mode.
  - If in a derated climb mode, you must press the button that corresponds to the active derated climb mode to cancel the derated climb power and enter CLB mode.
- ▶ **1 and 2**
  - It selects derated climb thrust modes.
  - On the ground: pre-select CLB1 or CLB2 mode.  
TO 1 or TO 2 is displayed.  
Switches to CLB1 or CLB2 with AFDS vertical mode selection after takeoff.
  - In flight: it selects or cancels derated climb mode.
- ▶ **CON**
  - In flight: it selects maximum continuous thrust limit.
- ▶ **CRZ**
  - In flight: it selects cruise thrust limit.
  - It is automatically selected when at FMC cruise altitude.

## **FLIGHT CONTROLS DESCRIPTION**

The flight controls and landing gear on the 767 require electrical and hydraulic power for normal operation. Some systems have an absolute requirement for hydraulic power while others can use electrically powered alternate systems for operation.

The flight controls are broken down into two groups: Primary flight controls and Secondary flight controls. The Primary flight controls consist of the elevators, ailerons and rudder. The Secondary flight controls consist of the leading edge flaps, trailing edge flaps, stabilizer trim, and spoilers.

The landing gear consists of one nose gear assembly and two main gear assemblies. The brakes are installed on the main landing gear only.

### **PRIMARY FLIGHT CONTROLS**

The primary flight controls consist of the elevators, ailerons and rudder. Flight control surface positions can be monitored on the lower EICAS screen STATUS page. Movement of the flight controls is accomplished through the keyboard, yoke or joystick. There are no panel controls for the movement of the flight controls.

All Primary flight controls have an absolute requirement for hydraulic power to function. For this reason they all receive partial hydraulic power from all three hydraulic systems. This creates triple redundancy for power to these controls in the unlikely event there are multiple failures in the hydraulic system. Additionally, a Ram Air Turbine (RAT) in the center hydraulic system can be deployed to create pressure for the operation of these flight controls in the event of a (highly unlikely) complete loss of all hydraulic pumps or of a dual engine flameout.

On the side auxiliary panel there are six flight control shutoff valve buttons. These buttons are primarily used on the ground to isolate a leaking system. Pressing these buttons shuts off hydraulic power to the flight controls. An EICAS message is generated if any of these buttons is turned off. Pressing the <shift> <7> keys simultaneously accesses the side auxiliary panel.

### **SECONDARY FLIGHT CONTROLS**

The secondary flight controls consist of the leading and trailing edge flaps, stabilizer trim and spoilers. The spoilers have an absolute requirement for hydraulic power for normal operation. The flaps and stabilizer trim both have alternate methods of operation if the primary power sources fail.

## FLAPS

The leading and trailing edge flaps use hydraulic power from the Center hydraulic system only. Flaps are moved into position by hydraulic power when selected using the flap handle on the center pedestal or the keyboard. Valid flap selections are: Up, 1, 5, 15, 20, 25, and 30. For takeoff the use of flaps 5 and 15 is authorized for the 767-300. For landing the use of flaps 25 and 30 is authorized. However, flaps 30 is the normal landing flap setting.

Selection of flaps 1 moves only the leading edge slats into position. The trailing edge flaps begin to move with the selection of flaps 5. If the flap handle is moved and the flaps fail to drive into the commanded position, you get a caution. If the trailing edge flaps fail to move into position, you get a TRAILING EDGE amber light and an EICAS caution. If the leading edge flaps fail to move into position, you get a LEADING EDGE amber light and an EICAS caution.

If the flaps fail to move into the selected position, there is an alternate means of operating the flaps. The alternate method uses electric motors to drive the flaps into position. The alternate flap controls are located just below the flap indicator.

## STABILIZER TRIM

The stabilizer trim system is used to trim out control forces on the elevators during flight. This system uses hydraulic power from the left and center hydraulic systems. The current trim setting is indicated on the pedestal using two identical gauges on opposite sides of the throttle quadrant.

Both the pilot and the autopilot use the stabilizer trim during normal flight. The pilot moves the trim using the trim switch on the yoke or keyboard. The autopilot automatically trims the elevator when in CMD mode.

If the stabilizer is being moved without a command from the pilot or autopilot an "unscheduled stab trim" caution message on the EICAS is generated. If the trim is moving without input from the pilot (called a runaway trim) the pilot can cut out the stab trim using the two stab trim cut-out switches on the pedestal. Use of these switches cuts off hydraulic power to the stabilizer trim.

If normal control of the stabilizer trim system is lost, there is an alternate control on the pedestal. The two levers labelled STAB and TRIM, to the left of the throttle, move the stab trim using mechanical signals. However, hydraulic power is still required for the stab trim to actually move.

## SPOILERS

The spoilers are a series of flat panels on the main wing that are raised to destroy lift on the wing. This is useful when the pilot is required to make a steeper descent or slow the plane down faster. All three hydraulic systems are used to power the spoilers.

The spoilers can be controlled using the lever on the pedestal or the keyboard. When the spoiler lever is moved aft, the spoilers are raised incrementally until in the full up position. There is also an "arm" position that is set on approach. When the spoilers are armed, they fully deploy upon touchdown to help keep the plane from bouncing.

## **LANDING GEAR**

The landing gear operation is controlled using the handle on the far right side of the panel. The handle has three positions: down, up and off. The gear handle is placed to the off position in flight after the gear is up. This action cuts off hydraulic power to the landing gear. Normal operation of the landing gear requires hydraulic power from the center hydraulic system.

If the landing gear fails to extend using normal means there is an alternate gear extension method. The alternate gear extension switch is located on the pedestal. It uses an electric motor to allow the gear to be extended. This switch requires only battery power for operation.

The brakes are installed on the two main landing gear assemblies. Brakes are normally powered using hydraulic power from the right hydraulic system. Alternate hydraulic power is provided by the center hydraulic system. If both center and right hydraulic power fails, a "reserve brake" switch can be used to try and restore hydraulic pressure to the brakes.

There is an Autobrake system that can be used during takeoff and landing that applies brakes automatically when required. The autobrake selector is located on the main panel and has the following positions: RTO, OFF, DISARM, 1, 2, 3, 4, and MAX AUTO. Depending on the position of the switch the autobrakes apply varying amounts of brake pressure using the normal brake system. If the normal brake system is inoperative the autobrakes are not available.

The RTO position is used for takeoff and applies maximum brakes automatically when the power levers are reduced to idle above a speed of 85 knots. The other positions are used for landing and automatically apply brakes during the landing roll. In all modes of operation the autobrakes can be disconnected by applying brakes manually or by moving the autobrake switch to the DISARM position.

## EICAS MESSAGES

### WARNINGS:

The following warnings are accompanied by a CONFIG warning on the main panel. All warnings are activated when takeoff power is applied and the described condition exists.

- |                |  |
|----------------|--|
| PARKING BRAKES | - The parking brake is on.                       |
| SPOILERS       | - The spoilers are not down.                     |
| FLAPS          | - Flaps are not set for takeoff.                 |
| STABILIZER     | - The stab trim is not set in the takeoff range. |

The following warnings are accompanied by a CONFIG warning on the main panel. They are activated based on radio altitude (RA) while on approach.

- |               |  |
|---------------|--|
| GEAR NOT DOWN | - The gear is not down when below 500 feet RA.             |
| FLAPS         | - Flaps are not in the landing position below 200 feet RA. |

### CAUTIONS:

- |                  |  |
|------------------|--|
| TE FLAP ASYM     | - Trailing edge flaps are split.                     |
| LE FLAP ASYM     | - Leading edge flaps are split.                      |
| SLAT DISAGREE    | - Leading edge flaps not in commanded position.      |
| FLAP DISAGREE    | - Trailing edge flaps not in commanded position.     |
| GEAR DISAGREE    | - Gear handle and gear position do not agree.        |
| UNSCHD STAB TRIM | - Stabilizer trim is moving without being signalled. |

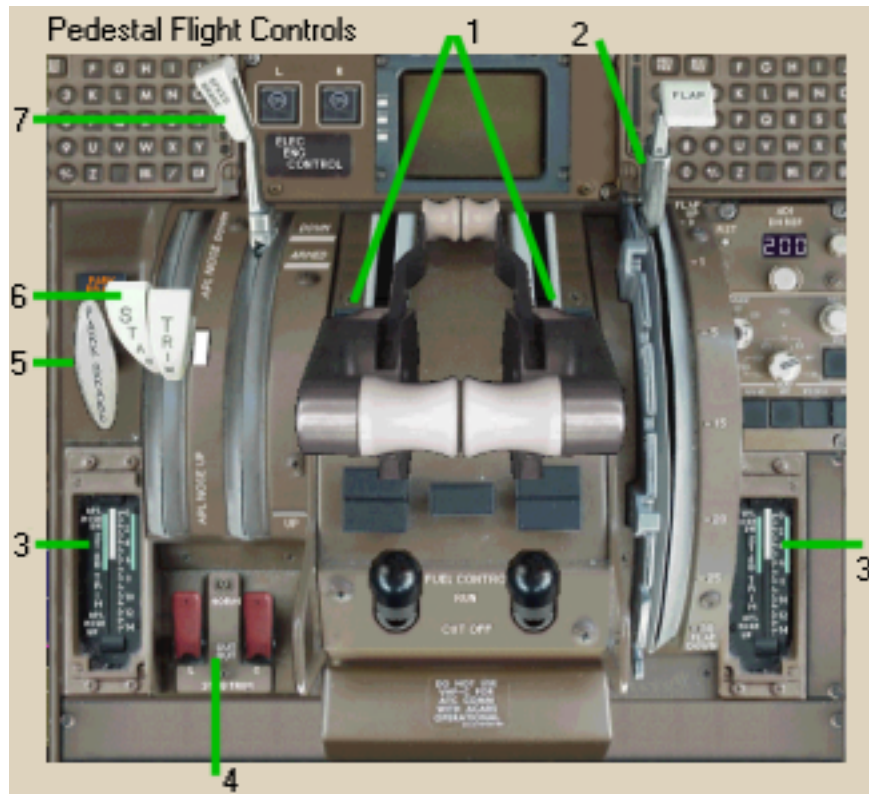
### ADVISORIES:

- |               |  |
|---------------|--|
| AUTOBRAKES    | - Autobrakes are disarmed.   |
| STAB TRIM     | - Stab trim cutout switches are off.   |
| ANTISKID      | - Antiskid system has failed.  |
| PARKING BRAKE | - Parking brake is on.   |
| WING HYD VAL  | - One wing hydraulic shutoff valve is closed.  |
| TAIL HYD VAL  | - One tail hydraulic shutoff valve is closed.  |
| FLT CONT VAL  | - More than one flight control shutoff valve is closed. It replaces individual messages. |

**Easy Fly Quick Tip:** So long as all hydraulic pumps are ON, the flight controls, landing gear and brakes operate normally. In this case all flight controls operate the same way as the default panels.

## PANEL CONTROLS AND INDICATORS

The pedestal is called up via keyboard <shift><6> or via mouse click on the main panel PDST button.



**1- Throttle Controls:** They can be controlled via the mouse or keyboard and move automatically when the autothrottle is in use. They can be moved manually to override the autothrottle.

**2- Flap Lever:** It can be controlled via the mouse or keyboard.

**3- Stab Trim Index:** It displays the current position of the stabilizer trims. The green bands represent the allowable takeoff trim setting range. The white index must fall within the green band when takeoff power is set or you will get a CONFIG warning.

**4- Stab Trim Cut-out Switches:** The two-position switch cuts hydraulic power to the stabilizer trim system. The stab trim is inoperative with both switches in the CUT OUT position.

NORM - Normal position of the switch allows stab trim movement.  
CUT OUT - Cuts hydraulic power to the respective stab trim system.

**5- Parking Brake Handle:** When pressed, it engages or releases the parking brake. The PARK BRAKE amber light illuminates any time the parking brake is engaged.

**6- Stab Trim Manual Control Levers:** When the levers are moved via mouse clicks the stab trim moves in the direction shown. It is used only if the electric trim is inoperative.

- APL NOSE UP            - Moves the stabilizer to give nose up trim.
- APL NOSE DOWN       - Moves the stabilizer to give nose down trim.

**7- Spoiler Control Lever:** When moved via mouse clicks, it controls the movement of the wing spoilers. The spoilers can be moved slowly up and down with the mouse or instantly with the keyboard. In the ARM position the spoilers automatically deploy upon landing.



**1- Flap Problem Cautions:** They illuminate anytime there is a flap position problem.

**LEADING EDGE** - The leading edge stats are not in the commanded position.  
**TRAILING EDGE** - The trailing edge flaps are not in the commanded position.

**2- Flap Indicator:** It indicates the actual position of the flaps.

**3- Alternate Flap Selector:** It is used to electrically position flaps to the desired position. They are used only if normal hydraulic power is not available to the flaps. Flaps only move to the commanded position when the TE and LE ALTN buttons are pressed.

**4- TE and LE Alternate Flap Select Buttons:** When both buttons are pressed and display ALTN the flaps move to the position dialed into the Alternate Flaps selector.

**Note:** When using the alternate flap system you should place the flap handle to agree with the alternately selected flap setting.





**1- Landing Gear Handle:** It is used to raise and lower the gear hydraulically.

- UP - Landing gear is commanded up.
- OFF - Hydraulic power to the gear is cut off.
- DOWN - Landing gear is commanded down.

**2- Landing Gear Position Indicators:** It is illuminated green when the respective gear is down and locked.

**3- Gear Disagree Light:** It illuminates when any one landing gear position does not agree with current landing gear handle position. It comes on during normal gear extension and retraction.

**4- Doors Disagree Light:** It illuminates any time the landing gear doors do not agree with landing gear handle position. It comes on during normal gear extension and retraction. When the landing gear is extended using the alternate gear-switch, the DOORS light stays on steadily because the main gear doors are not closed when using the alternate procedure.



**1- Alternate Gear Extend Switch:** When pressed, it electrically controls the extension of the landing gear. The landing gear handle should be placed down when using the alternate extension switch. The DOORS caution remains illuminated using this extension procedure because the main gear doors will remain open.

**2- Ground Proximity Override Switches:** When landing with an abnormal gear or flap configuration, you place these switches in OVRD to inhibit the GPWS warnings for landing.

- FLAP - Inhibits "Too low flaps" GPWS aural warning.
- GEAR - Inhibits "Too low gear" GPWS aural warning.



**1- AUTO BRAKES Caution:** It illuminates any time the autobrakes are disarmed automatically or manually. It also illuminates if the autobrake selector is placed in the DISARM position.

**2- AUTO BRAKES Select Knob:**

It is used to select autobrakes for takeoff or landing.

**RTO** - For takeoff, when above 85 knots and both throttles are reduced to idle maximum braking is applied automatically.

**1,2,3,4,MAX AUTO** - For landing, it selects the amount of braking to be applied automatically upon touchdown. "1" is the least and MAX AUTO is the most.

**DISARM** - Disengages autobrakes.

Application of manual brakes or placing the Autobrake selector to DISARM disengages the autobrakes.



**1- Reserve Brakes and Steering Switch:** They are used when normal and alternate brake systems fail to restore brake pressure.

Switch OUT - Reserve brakes and steering OFF (normal position).

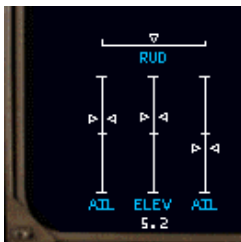
Switch IN -

- The ON light illuminates.
- The Number 1 primary hydraulic pump is turned on regardless of pump switch position.
- It isolates the center reserve hydraulic fluid to pressurize the brake system.

**2- Reserve Brakes VALVE caution:** It illuminates when the reserve brake isolation valve is in transit or is not in its commanded position.

**3- BRAKE SOURCE Caution:** It illuminates any time the Center and Right hydraulic pressures are too low for normal operation of the brakes. This caution should extinguish when the RB & S switch is ON to indicate satisfactory pressure is available for the brakes.

## FLIGHT CONTROL INDICATORS



These indicators can be found on the STATUS page of the lower EICAS screen. They show the actual position of the flight control surfaces. The number below the ELEV indication is the current stab trim index position.



These are the flight control shutoff valve switches. This panel can be accessed through the pull down view menu or by pressing keys <shift> and <7> simultaneously. When a switch is turned OFF the hydraulic power to that flight control is removed. An EICAS message is generated any time one of these switches is off.

## WARNING / FIRE SYSTEM DESCRIPTION

The main component of the warning system is called the Crew Alerting System (CAS). The CAS messages are all displayed on the EICAS upper screen. There are three different types of messages: Warnings, Cautions, and Advisories. The messages are displayed according to the following priorities: Warnings are listed first, followed by Cautions and then Advisories. Cautions and Advisories can be cancelled from the screen using the "cancel" button located on the main panel. The only way to clear a Warning message is to fix the condition that triggered the Warning.

Any time a Warning or Caution message appears on the CAS in flight, the master WARNING or CAUTION light illuminates in a button located on the glare shield. This provides the pilot with a visual clue that there is something wrong with the airplane. Additionally, Warnings and Cautions will trigger an audible alert when the plane is in flight. Pressing the Warning/Caution button will cancel the audible alert and clear the button light. Most audible alerts are inhibited while on the ground with the engines shut down.

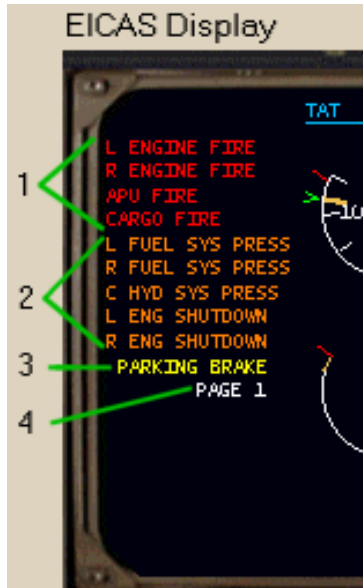


Warning and Caution annunciators are located on the main panel to the left of the EICAS screens. These annunciators illuminate along with the appropriate CAS message when the indicated condition exists. These annunciators are for systems that are critical to safety of flight and provide the pilot with an additional clue that something is wrong with the airplane.

The fire warning system provides notification of an engine fire, APU fire or cargo compartment fire. The FIRE annunciator on the main panel along with a CAS warning is displayed. There are also fire handles for both the engines and the APU. The handle will light up red to indicate a fire. Pulling an illuminated fire handle will shut down the engine and arm the extinguisher bottles for discharge. Rotating the fire handle will discharge a fire bottle into the engine nacelle. There are two fire bottles that can be used in both the left and right engines. The APU has one fire bottle that can only be used for the APU.

The Ground Proximity Warning System (GPWS) will provide aural warnings for the pilot in the event of the following conditions: Excessive descent rate, excessive terrain closure rate, altitude loss after takeoff or go-around, and unsafe terrain clearance when not landing. Additionally, the GPWS system will make altitude callouts during landing. The system is programmed to recognize phase of flight that should minimize out of place warnings.

## CAS MESSAGES



**1- Warnings:** All warnings are displayed on top of the EICAS screen in red. They cannot be cancelled unless the problem causing the warning is fixed. Warnings require immediate crew attention.

**2- Cautions:** All cautions are displayed below any warning messages and are displayed in orange. These may be cancelled by pressing the CANCEL button. Cautions require timely corrective action.

**3- Advisories:** All advisories are displayed below any Warnings or Cautions and are indented from the other messages and displayed in yellow. These may be cancelled by pressing the CANCEL button. Advisories require corrective action on a time available basis.



**4- Page #:** Anytime there is more than one page of data on the EICAS screen the page # will be displayed at the bottom of the CAS message stack. Pressing the CANCEL button will cycle through the pages. Pressing RECALL will take you back to page one or re-display page one if the CAS had been previously blanked out.

## WARNING AND CAUTION ANNUNCIATORS



**FIRE** - It indicates there is a fire in one of the engines, the APU or the cargo compartment. It will remain illuminated for as long as the fire condition exists and will be extinguished when the fire is put out.

**CONFIG** - Configuration warning light. It indicates that the airplane is not in the proper configuration for that phase of flight.

During Takeoff, when take-off power is applied, it warns of the following:

- ▶ The Stabilizer trim not in the takeoff range.
- ▶ Flaps are not set for takeoff.
- ▶ The Parking brake is set.
- ▶ The Spoiler handle is not down.

During Landing, it warns of flap and gear configuration problems when close to the ground.

**WINDSHEAR** - It indicates that a windshear condition has been detected.

**PULL UP** - It illuminates when a GPWS warning is triggered that requires the pilot to climb. The GPWS system can be tested by pressing on the mouse click area over the PULL UP annunciator.

**A/P DISC** - The autopilot has been disconnected. It is cancelled by pressing the autopilot disconnect bar a second time or by pressing the WARNING button on the glare shield.

**CABIN ALT** - The cabin altitude is above 10,000feet.

**OVSP** - The airplane is exceeding maximum airspeed as indicated by the barber pole on the airspeed indicator.

**AUTOPILOT** - An operating channel of the autopilot has failed. The autopilot will stay connected with the remaining modes.

**A/T DISC** - The autothrottle has been disconnected. It is cancelled by pressing the CANCEL button next to the EICAS screens.

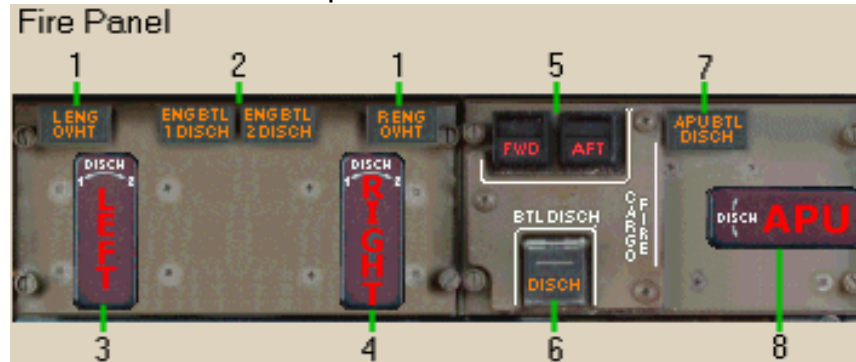
**FMC** - There is an FMC message in the CDU scratchpad. Cancelled by clearing the message in the FMC.

**G/S INHIBIT** - When pressed, it inhibits all GPWS warnings.



## FIRE PANEL

The fire panel is located on the pedestal.



**1- L (R) ENG OVHT:** It illuminates when an overheat condition is detected in the respective engine.

**2- ENG BTL 1 (2) DISCH:** It indicates that the fire bottle has been discharged. Pulling and rotating the fire handle discharges the fire bottles.

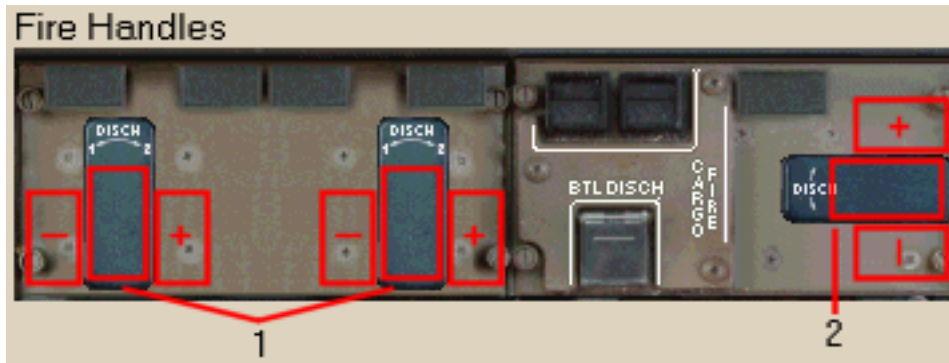
**3/4- L (R) ENGINE FIRE Handles:** It illuminates to indicate a fire in the respective engine. When pulled, it shuts off fuel to the engine and automatically shuts off other engine components. Rotating the handle to the left discharges the fire bottle #1 into the engine. Rotating the handle to the right discharges the fire bottle #2 into the engine. The fire handle light will go out when the fire is extinguished.

**5- CARGO FIRE BUTTONS:** It is illuminated to indicate a fire in either the forward (FWD) or rear (AFT) cargo compartments. Pressing the illuminated button will arm the cargo extinguishers to discharge into the selected compartment. Pressing the BTL DISCH button will discharge the fire-extinguishing agent into the selected compartment. The FWD or AFT red lights will go out when the fire is extinguished.

**6- BTL DISCH Button:** When a cargo compartment switch is armed (FWD or AFT), pressing this button will discharge the fire extinguisher into the selected compartment. The DISCH light illuminates to indicate the cargo fire bottles have discharged.

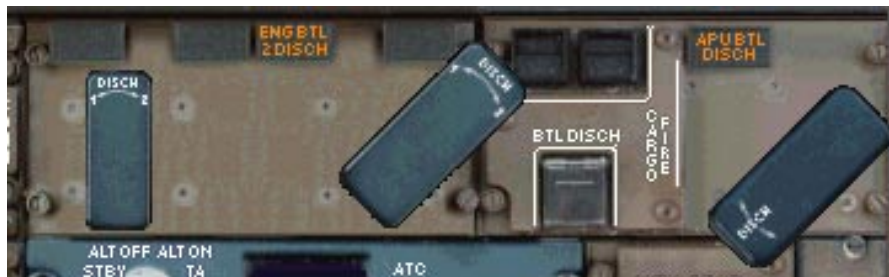
**7- APU BTL DISCH:** It indicates that the APU fire bottle has been discharged.

**8- APU FIRE Handle:** It illuminates to indicate a fire in the APU. When the handle is pulled the APU will shut down. Rotating the handle left or right will discharge the APU fire bottle. The fire handle light will go out when the fire is extinguished.



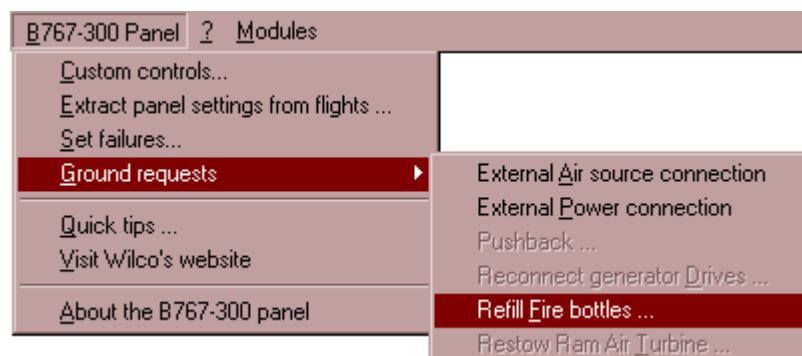
**1- Engine Fire Handle Mouse Clicks:** Pressing the blank area will “PULL” the fire handle. This action shuts down the engine. Once pulled, the fire handle can be rotated left or right by pressing on the ‘+’ or ‘-’ area. Pressing the ‘+’ rotates the handle to the right and discharges bottle #1. Pressing the ‘-’ rotates the handle to the left and discharges bottle #2.

**2- APU Fire Handle Mouse Clicks:** Operation is identical to the engine fire handles. There is only one APU fire bottle, so rotating the APU fire handle to the left or right will discharge it.



This graphic shows the fire handles rotated and the respective fire bottles discharged. Once discharged, the fire handles can be reset by pressing on the blank mouse click area. The first click will rotate the handle to neutral and the second click will push in the fire handle.

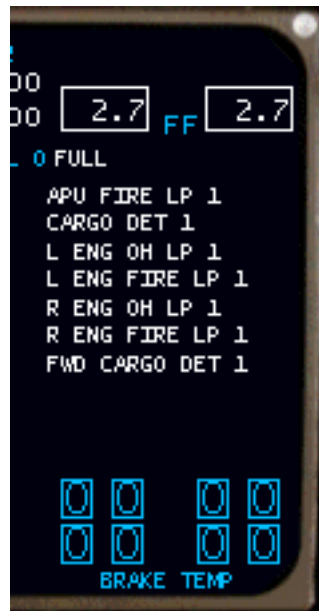
The fire bottles can be refilled on the ground by accessing the “B767-300 Panel” menu as shown below.



## FIRE TEST



Pressing the fire test button on the pedestal will illuminate all fire indications and sound the fire bell. Also, with the lower EICAS STATUS page displayed, you can see STATUS messages related to the system test.



## GROUND PROXIMITY WARNING SYSTEM

Control of the GPWS system involves two mouse click areas. Pressing over the PULL UP annunciator will "test" the system. A good test is shown by all of the GPWS annunciators lighting up and an aural "GLIDESLOPE WHOOP WHOOP PULL UP" sounding. Pushing on the PULL UP annunciator is not the way in which the actual plane tests its GPWS. This is a creative liberty on our part for functionality.

The GPWS system can be inhibited by pressing on the G/S portion of the "G/S INHIBIT" button. This will effectively turn off the GPWS system completely. In the real airplane this would only inhibit the GLIDESLOPE warning.

The following is a summary of callouts this system will make:

**TERRAIN TERRAIN** - Closure rate to the ground is excessive. The warning envelope depends on configuration, airspeed, radio height and closure rate.

**WHOOP WHOOP PULL UP** - It indicates close proximity to the ground which requires immediate action from the pilot. The warning envelope depends on configuration, airspeed, radio height and closure rate.

**TOO LOW FLAPS** - The warning envelope depends on radio altitude and airspeed.

**TOO LOW GEAR** - The warning envelope depends on radio altitude and airspeed.

**TOO LOW TERRAIN** - It indicates the aircraft is too close to the ground and not in the landing configuration. The warning envelope depends on airspeed and radio height.

**DONT SINK** - It indicates sink rate after initial take-off climb or during a go-around.

**SINK RATE** - Excessive descent rate. If not corrected, it may lead to a PULL UP message.

**MINIMUMS MINIMUMS** - It is triggered on an approach and at the radio height noted on the EHSI, as selected using the DH selector on the pedestal.

**GLIDESLOPE** - Below the glideslope by an unacceptable margin. The warning envelope depends on radio altitude and dots "fly up" (dots below glideslope).