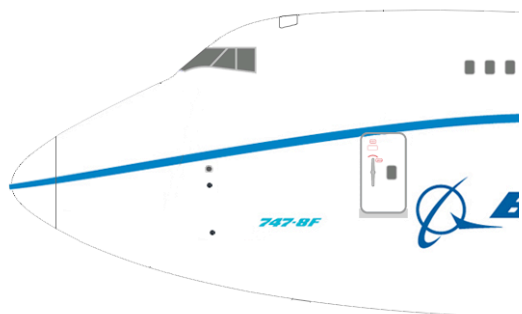
SUPERCRITICAL SIMULATIONS GROUP
747-8 PILOT REFERENCE GUIDE



CAUTION:
This Reference Guide is only intended for users of the Supercritical Simulations Group (SSG) 747-8 add-on for X-Plane. The information contained in this document is not suitable for any other use.

SUPERCRITICAL SIMULATIONS GROUP

INDEX

REVISION HISTORY

REVISION	DATE	REASON
1	May 31, 2013	Original issue
2	June 3, 2013	Updates to released version

GLOSSARY AND ACRONYMS

The following is a list of abbreviations, contractions, and acronyms that are in use in this Reference Guide.

AC	Alternating Current
ADF	Automatic Direction Finder
ADI	Attitude Director Indicator
AGL	Above Ground Level
ALT	Altitude
AP	Autopilot
APP	Approach
APU	Auxiliary Power Unit
AT	Autothrottle (also A/T)
BRG	Bearing
BRT	Brightness
CDU	Control Display Unit
CLB	Climb
CMD	Command
CON	Continuous
CRT	Cathode Ray Tube
CRZ	Cruise
DC	Direct Current
DES	Descent
DH	Decision Height
DME	Distance Measuring Equipment
EAI	Engine Anti-Ice
ECS	Environmental Control System
EFB	Electronic Flight Bag
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
FADEC	Full Authority Digital Engine Control
FBW	Fly-by-Wire
FD	Flight Director
FF	Fuel Flow
FL	Flight Level
FLCH	Flight Level Change
FMS	Flight Management System

GA	Go Around
GE	General Electric
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GS	Glideslope or Groundspeed
HDG	Heading
HSI	Horizontal Situation Indicator
IAS	Indicated Air Speed
IDG	Integrated Drive Generator
ISFD	Integrated Standby Flight Display
KIAS	Knots Indicated Airspeed
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LK	Left Key
LNAV	Lateral Navigation
LOC	Localizer
LSK	Line Select Key
MAN	Manual
MCP	Mode Control Panel
MTOW	Maximum Takeoff Weight
NAV	Navigation
NDB	Non-Directional Beacon
NM	Nautical Mile
ND	Nose Down
NU	Nose Up
OAT	Outside Air Temperature
OBS	Omni Bearing Selector
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PFD	Primary Flight Display
PNF	Pilot Not Flying
RA	Radio Altimeter
RAT	Ram Air Turbine
RK	Right Key
SAT	Static Air Temperature
SEL	Select
SSG	Supercritical Simulations Group
TA/RA	Traffic Advisory / Resolution Advisory
TAS	True Airspeed
TAT	Total Air Temperature

TCAS	Traffic Collision Avoidance System
THR	Thrust
TO	Takeoff (also T/O)
TOD	Top of Descent
TOGA	Takeoff / Go Around
UFMC	Universal Flight Management Computer (plug-in)
UTC	Coordinated Universal Time
VASI	Visual Approach Slope Indicator
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
V/S	Vertical Speed
VSD	Vertical Situation Display
WAI	Wing Anti-Ice
WX	Weather radar
X-FMC	X-Plane Flight Management Computer (plug-in)

1.0 INTRODUCTION

This Pilot Reference Guide is exclusively for the 747-8 aircraft designed for the X-Plane desktop flight simulator by the Supercritical Simulations Group (SSG). The information applies to both the Freighter (747-8F) and passenger version of the aircraft, which is designated by Boeing as the "Intercontinental" (747-8i). This Guide is in no way a complete manual for the 747-8 aircraft, and the SSG 747-8 itself is much more limited and simplified compared to the real aircraft. Therefore, flying the SSG 747-8 only will require a minimum of study and reading for its pilots.

In order to add some realistic flavor to this add-on, Two of SSG's technical advisors Tim Gleason (TG) and Sean Kelley (SK) have provided you with some pilot tips and personal comments that are interspersed throughout this Guide. Between them, these professional airline pilots have experience flying all 747 series from the Classic to the 747-8, in passenger and cargo operations. Their tips and comments are written in italics such as these and indicated by a 747 yoke icon shown on the left. Some of their comments are on the 747 in general, or the newer 747-400, which is very similar to the 747-8 in terms of operation and systems, and some are on the 747-8 itself (as indicated).

1.1 GENERAL

This SSG 747-8 aircraft is designed to work in X-Plane version 10 (both 32 and 64-bit). While the SSG 747-8 aircraft are simplified in terms of system operation, they have been created in collaboration with SSG's technical advisors. Also, SSG has made every attempt to make this aircraft as realistic as possible in terms of flying qualities, performance and appearance.

While the information contained in this Guide should help you when flying the SSG 747-8 aircraft, no add-on for a desktop simulator can completely capture the feel and functionality of a real aircraft. Therefore, some artistic license has been taken, and most of the systems and aircraft functions have been simplified for ease of use.

Those of you who have experience with 747-400 aircraft for desktop flight simulators will feel right at home in the 747-8. Both aircraft are very similar and the cockpits are almost identical. Some differences stem from the fact that the 747-8 incorporates some systems and advances found in later Boeing aircraft such as the 777 and 787. Pilots who fly both the 747-400 and 747-8 report that they are very similar in feel, with some differences in performance and limitations to keep in mind. In fact, some air carriers fly both 747 models, so pilots may have to alternate from one to the other in the course of their regular flying activities. Boeing has designed the aircraft so that the pilot type rating for both aircraft is the same, with a differences training course required for pilots transitioning between models. Usually a 3-day differences course is all that is required to transition to the 747-8 from the 747-400, all of which can be accomplished in flight simulators (full motion ones, of course).

My 747-8 training was a two-day differences course plus a line check. This differences training took place in a static, no-motion trainer. If a company has access to a 747-8 full motion simulator, this training can probably be accomplished in a three-day differences course with no line check. - SK

This Guide also includes a sample flight in Section 23 to take you through the operation of the aircraft from start to finish on a typical flight, and to familiarize you with the systems and procedures described in the rest of this Guide.

1.2 SSG PHILOSOPHY

During development of any aircraft for a desktop flight simulator, a decision has to be made about the level of detail that will be implemented. Not only will this affect the time to develop the aircraft, other considerations include the audience for the product, as well as the demand on computer resources. SSG's philosophy is that the aircraft must be fun to fly and not require an inordinate amount of time studying systems, flows, and profiles in order to successfully accomplish a flight. This is not a criticism of more procedural add-ons that mimic aircraft systems down to the smallest level. We enjoy these products and applaud their developers. However, the SSG 747-8 is designed to appeal to the widest possible audience (with a wide range of computing power), and should not require detailed system knowledge in order to operate the aircraft.

Another consideration are the priorities of the project, and in this case, SSG's focus has been on the pilot and his/her perspective and flying experience. The outside view from the panel in the SSG 747-8 is based directly on photos taken from a 747-400 cockpit, and it attempts to capture the field of view experienced by the pilot in the left seat of a 747. SSG's technical advisors report that the resulting effect is quite realistic and "feels" like a 747. Therefore, this add-on is focused on the left hand pilot's view, and allows for an enjoyable hand-flying experience. It is our attempt to capture what it is like to fly this enormous, yet graceful aircraft.

While the SSG 747-8 comes in two versions, the 747-8i and the 747-8F, it is the external models that are different, with only slightly different performance and systems. However, this Guide and the aircraft panel are common to both. The real 747-8 aircraft have slightly different cockpits, but these differences have not been implemented in this release.

The SSG development team's focus has been on aircraft handling and accurate performance compared to the real aircraft. However, evaluations by real-world pilots of personal computer-based simulators are subjective. Therefore, their opinion is largely based on the equipment they use, as well as their impressions of what it "should be." These technical advisors offered their opinion, but it's just an opinion, and no doubt other 747 pilots might have different views. In the meantime, please enjoy flying the SSG 747-8!

1.3 INSTALLATION AND OTHER CONSIDERATIONS

To install the add-on, once you unzip the main SSG file, which includes both the 747-8F and 747-8i versions (as well as several liveries), simply select the appropriate aircraft folder within X-Plane 10 where you want to install the aircraft (typically "Heavy Metal"). The download also includes this Guide, so if you are reading this, you have already found it.

We recommend using a joystick to gain maximum enjoyment and functionality with the SSG 747-8. The following are some sample joystick configurations:

Minimal:

- 3 axes
- Roll
- Pitch
- Throttle
- 8 buttons

Best:

- 4 axes, or 3 axes plus pedals
- Roll
- Pitch
- Yaw
- Throttle
- 16 buttons

For support, please visit our forum at X-Plane.ORG using the following address…

http://forums.x-plane.org/index.php?showforum=136

News and update information is also available on the SSG web site at:

http://www.supercritical-simulations.com/

1.4 CREDITS

The development team for the SSG 747-8 consists of:

Stefan Keller	Project leader, Pilot Reference Guide development, textures and technical advisor
Ricardo Bolognini	Primary 3D modeling, flight dynamics and system programming, textures
Bill Grabowski	2D panel development and textures
Carlos Garcia	Director of testing, web resources, and marketing
George Garrido	Textures and repaints
Tim Gleason	Technical advisor and product testing
Sean Kelley	Technical advisor and product testing

And a big “thank you” goes to our beta testers for all of their valuable input.

1.5 COPYRIGHT INFORMATION

This and previous releases by SSG are based on the 747-8 Freighter Ver. 1.5 released by Stekeller (a founding member of SSG). That aircraft evolved from the beta version of the Boeing 747-8 Intercontinental that was first released on October 16, 2006 (itself based on XPFW’s 747-400 for X-Plane 6.7) and was created by YYZatcboy, Henrickson & Vivar (vcows@hotmail.com, henrickson1@yahoo.ca & vivar@rogers.com). The fuselage was largely based on the default United 747-400 that comes with X-Plane 9.0 and was created by Mohammad Gazzawi & Sergio Santagada (magmail@usa.net & santagada@tin.it).

Previous versions were released as follows:

March 19, 2011	Ver. 1.0 release
August 3, 2010	Beta 2.1 release
March 29, 2010	Beta 2.0 release
January 31, 2010	Beta 1.0 release

However, this SSG aircraft has been completely redesigned, using advanced 3D modeling software and incorporating existing features that made the earlier aircraft very popular downloads. The only remnants of the original aircraft are a few textures and the original Plane Maker fuselage.

The original content of this add-on is protected by Brazilian and U.S. copyright laws and cannot be:

- Redistributed
- Copied
- Separated in parts
- Sold, or
- Any other purpose that is not specific for running the X-Plane Software

2.0 AIRPLANE GENERAL

2.1 BACKGROUND

The Boeing 747-8 was launched by Boeing in 2005, after several attempts to offer improvements over the popular 747-400 model, which itself incorporated many advances compared to the initial 747 models (the -100, -200, -300, and SP series that are now referred to as “Classics”). All 747s up to the 747-400 series were the same length (except for the unique shortened 747SP series that saw limited production). This time, Boeing stretched the basic aircraft, and incorporated several major changes as follows:

Airframe and Wing

- A fuselage stretch of 18.3 ft (5.6 m)
- New thicker and deeper wing with supercritical airfoil and incorporation of some fly-by-wire technology (ailerons and spoilers only)
- New raked wingtips instead of winglets
- Slightly taller tail
- The area under the wing and the “glove” in front of the wing were redesigned
- Larger 777-style windows (on the 747-8i only)
- Vortex generators on the middle span of the upper wing

Engines

- New General Electric (GE) GEnx-2B67 engines that are similar to engines installed on the new 787, although with a smaller fan (still approximately 12 percent greater than on previous 747 models) and with bleed air
- “Scalloped” nacelles to reduce noise
- Inboard chines (vortex generators) to smooth the airflow around the nacelles

The scalloped nacelles and cowling had an unintended side effect, a greater EPR for any specific N1 speed. In other words, greater engine thrust for the same amount of throttle setting resulting in increased fuel efficiency. - SK

Aircraft Systems

- Redesigned flaps with fewer segments, so the aircraft now has single-slotted outboard flaps and double-slotted inboard flaps

- Additional gap on leading edge flaps
- Flaperons (ailerons that droop to also serve as flaps)
- Two segments on the lower rudder for enhanced directional control
- Deployable Ram Air Turbine (RAT) for additional hydraulic power in case of engine power loss
- Improved interior and cargo handling equipment
- Improved fire suppression system
- Improved Environmental Control System (ECS)
- Strengthened landing gear and wheels with bigger tires
- Redesigned external lights, including wider use of Light Emitting Diodes (LEDs)

Cockpit

Boeing added a host of new technology and updates to the cockpit of the 747-8, while maintaining the same type rating as the 747-400 for increased crew commonality. Some of these advances include:

- New Flight Management System (FMS) with a color display, more memory and increased functionality
- New Vertical Situation Display (VSD)
- Integrated moving map display
- Optional built-in Electronic Flight Bag (EFB)
- Stabilizer trim indicator on electronic display instead of a physical indicator on the aisle stand (which is located between the pilot seats.)
- Simplified and smaller landing gear handle (no “OFF” position)
- Electronic checklist
- Cursor control device
- Elimination of mechanical clock (replaced with a digital version on the Navigation Display or “ND”)

It should be noted that some late production 747-400s already incorporated some flight deck advances compared to the original models. Some airlines even retrofitted this equipment on older models with some of these features, which include:

- Liquid Crystal Display (LCD) screens for all flight displays instead of Cathode Ray Tubes (CRTs).
- LCDs for the autoflight glareshield numerical displays
- Integrated Standby Flight Display (ISFD) instead of the original 3 standby instruments
- New style standby magnetic compass

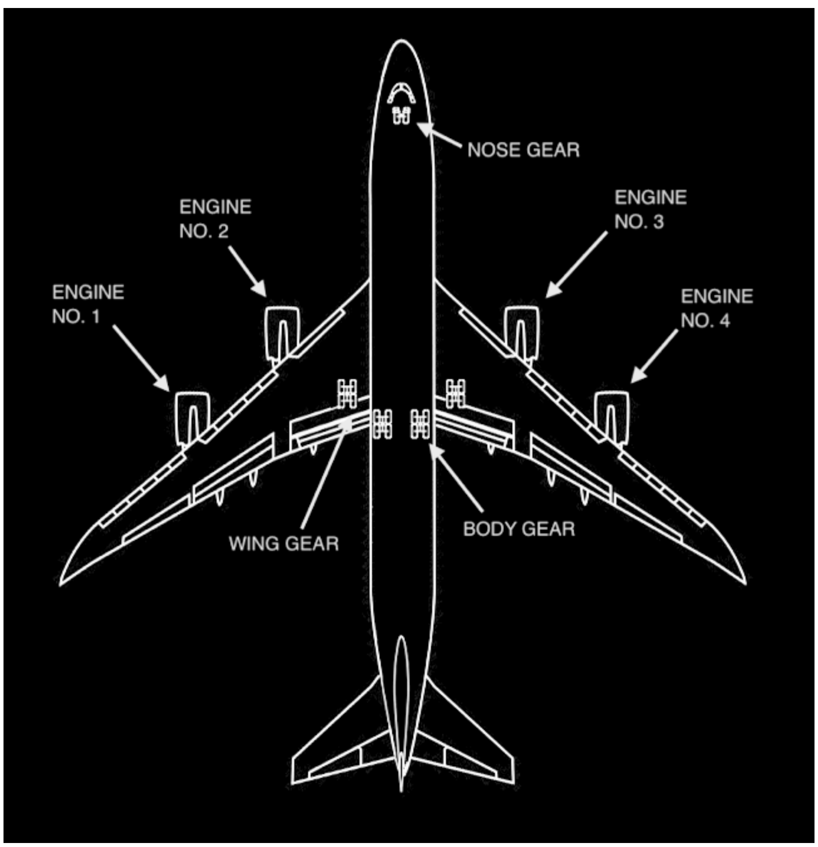
As per the Boeing web site[1], here is some basic technical information on the Boeing 747-8 aircraft, supplemented by other publicly available information:

Basic Dimensions:

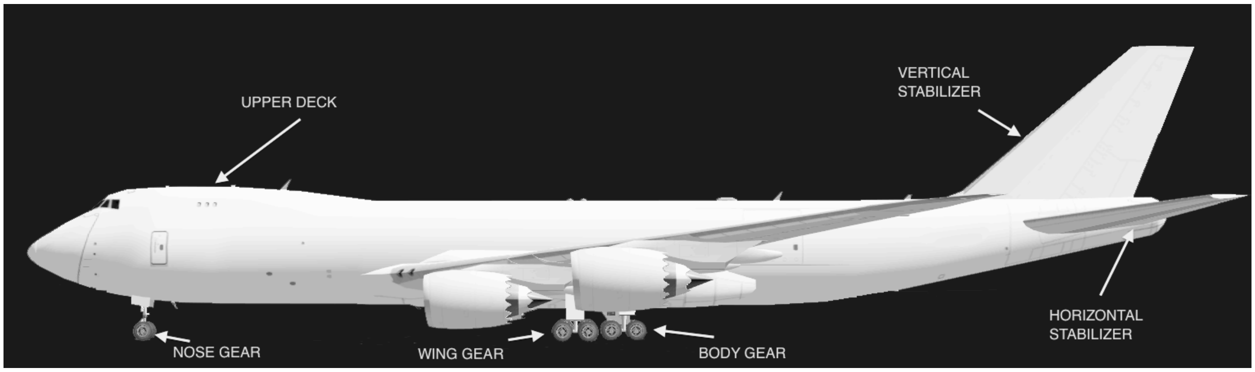
Wing Span	68.5 m (224 ft 7 in)
Overall Length	76.3 m (250 ft 2 in)
Tail Height	19.4 m (63 ft 6 in)
Interior Cabin Width	6.1 m (20.1 ft)

Exterior Description

The following diagrams show the general arrangement of the 747-8 aircraft pointing out certain components described in this Guide.



1 http://www.boeing.com/commercial/747family/747-8_fact_sheet.html



Note that the engines are numbered 1 to 4 starting from left to right of the aircraft. Also, in logical fashion, the wing gear are mounted under each wing, while the body gear are mounted on the lower fuselage body. The main gear tilt down while the body gear rotates left and right to aid in turning while taxiing. The nose gear also turns, although through a much wider range than the body gear.

The reason for gear tilt has to do with the manner in which the main landing gear extend and retract in relation to the wheel wells. If the main gear fail to tilt after takeoff then you have a fairly significant gear problem and they're not going to retract properly. - SK

2.2 AIRCRAFT LIMITATIONS

Thrust:

GEnx-2B67 (x4)	
(Maximum thrust)	66,500 lb (296 kn)

Maximum operating altitude:

Both Models	43,100 ft

Maximum Takeoff Weight (MTOW):

Both Models	987,000 pounds (447,696 kg)

Passengers (Typical 3-class configuration):

Intercontinental	467

Operating Empty Weight

Intercontinental	421,000 pounds (190,962 kg)
Freighter	470,000 pounds (213,188 kg)

Maximum Structural Payload

Intercontinental	181,000 pounds (82,100 kg)
Freighter	295,200 pounds (133,900 kg)

Other Weights

CHARACTERISTICS	POUNDS	KILOGRAMS
Max Taxi Weight	989,999	449,056
Max Landing Weight (F)	762,998	346,090
Max Landing Weight (i)	682,000	309,350
Max Zero Fuel Weight (F)	726,999	329,761
Max Zero Fuel Weight (i)	642,000	291,206

Fuel:

USABLE FUEL CAPACITY	GALLONS	LITERS	POUNDS	KILOGRAMS
Freighter	60,211	229,980	407,045	184,628
Intercontinental	64,055	242,475	429,159	194,659

Typical Cruise Speed (at 35,000 feet):

Intercontinental	Mach 0.855
Freighter	Mach 0.845

Maximum Range:

Intercontinental	8,000 NM (14,815 km)
Freighter	4,390 NM (8,130 km)

Flap Limit Speeds:

Flaps 1	-	285 kts
Flaps 5	-	265 kts
Flaps 10	-	245 kts
Flaps 25	-	210 kts
Flaps 30	-	185 kts

Gear Limit Speeds:

RETRACT	EXTEND	EXTENDED
270 kts (Mach 0.82)	270 kts (Mach 0.82)	320 kts (Mach 0.82)

3.0 GENERAL ARRANGEMENT

This SSG 747-8 aircraft includes a more advanced 2D panel than in the previous beta releases. As with all X-Plane 2D panels, the various portions of the panel are accessed using the “up” and “down”, and “left” and “right”, arrow keys. Please note that your particular field of view will depend on your computer’s screen resolution.

3.1 COMPLETE PANEL

To simplify its operation within X-Plane, the SSG 747-8 2D panel includes controls and indicators that on the real aircraft would be located on the overhead panel, as well as those on the aisle stand that lies between the two pilots (which includes the throttles, radios, etc.) displayed in the lower right hand corner of the panel.

<u>Complete Panel</u>

3.2 OVERHEAD PANEL

While not all aircraft systems are simulated, most of the essential controls and indicators for the overhead panel are located in their proper places compared to the real aircraft. The diagram below shows the SSG 747-8 overhead panel layout. Limitations in 2D panel size within X-Plane (2,048 x 2,048 pixels) necessitated a more compact format. Furthermore, the functionality of the panel would have suffered if extensive scrolling were required during normal flight operations.

<u>Overhead Panel</u>

3.3 FORWARD PANEL

The forward panel screens on the SSG 747-8 are set up using the same basic arrangement as on the real aircraft.

Forward Panel

They forward panel is composed of the following displays and controls:

- Primary Flight Display (PFD)
- Navigation Display (ND)
- Integrated Standby Flight Display (ISFD)
- Engine Indication and Crew Alerting System (EICAS) – both Upper and Lower

3.4 GLARESHIELD PANEL

The glareshield panel includes various selectors to control displays for the pilots, as well as autoflight functions. It is divided into segments as shown below:

Glareshield Panel

The Mode Control Panel (MCP) includes the following controls and indicators:

- Autothrottle selector
- Flight Director (FD) selector
- Airspeed selectors
- Heading selectors
- Vertical Speed (V/S) knob
- Autopilot selectors
- Altitude selector

3.5 DISPLAY SELECT PANEL

The various synoptic pages on the Lower EICAS can be selected with the Display Select Panel. On the real 747-8 aircraft, the top 3 buttons with green LED lights allow for switching of various display information to the various pilot screens. This function is not implemented in the SSG 747-8, but pressing the LWR CTR button will initialize the secondary engine display.

Display Select Panel

The lower buttons have the following functions:

ENG	Secondary engine information
STAT	Status
ELEC	Electrical system synoptic
FUEL	Fuel system synoptic
ECS	ECS synoptic
FCTL	Flight controls synoptic
HYD	Hydraulic system synoptic
DRS	Aircraft door synoptic
GEAR	Landing gear synoptic
INFO	Information page (not implemented in the SSG 747-8)
CHKL	Electronic checklist (not implemented in the SSG 747-8)
NAV	Navigation page (not implemented in the SSG 747-8)

At the bottom right is the CANC/RCL button, which stands for “CANCEL” and “RECALL” and allows pilots to manage various EICAS messages, and is not functional on the SSG 747-8.

To blank the Lower EICAS screen, simply select the same button twice. Pilots do this on the real aircraft to reduce the amount of visual clutter in the aircraft during critical phases of flight such as takeoff.

Pilots like to leave the lower EICAS blank at all times if not being used; including non-critical phases of flight. My own personal theory on the reasoning for this dates back to the days of CRT displays and this has carried over to the days of LCD screens. If the upper EICAS’s CRT were to have an individual color gun failure (which I have seen a couple of times in the 747 - red guns seem to fail the most frequently) or a complete display failure altogether, the lower EICAS display would have a fresh, new CRT ready to use because it’s always left blanked out. However, this practice wouldn’t be beneficial with the more modern LCD screens because the illumination source for LCDs, when powered, remains illuminated even if the screen is blanked out. - SK

4.0 AIR CONDITIONING AND PRESSURIZATION

4.1 SYSTEM DESCRIPTION

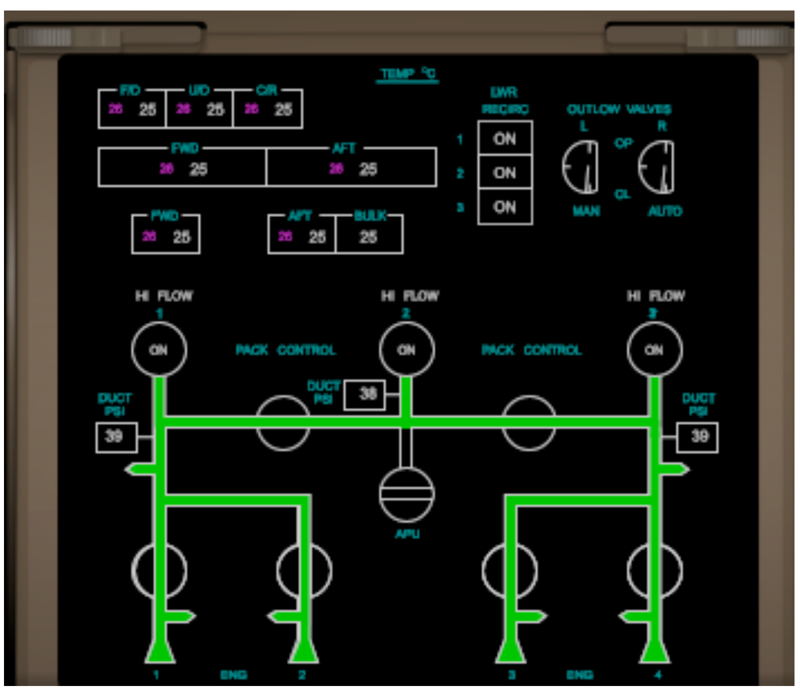
The real 747-8 has 3 packs, which are air cycle machines that convert so called “bleed air” tapped from the compressor in the Auxiliary Power Unit (APU), or the engines, into conditioned air to pressurize the aircraft and maintain selected cabin and cargo compartment temperatures. Bleed air is also used for engine starts, so the pilots need various controls for the ECS.

4.2 ECS SYNOPTIC

The ECS synoptic shows the 3 packs, normal flow between the packs, and the various sources (primarily the engines and APU). The top portion shows the various cabin and cargo compartment zones as well as selected and actual temperatures. The top right section shows the position of the outflow valves that help to regulate cabin pressure, as well as the status of various recirculation fans.

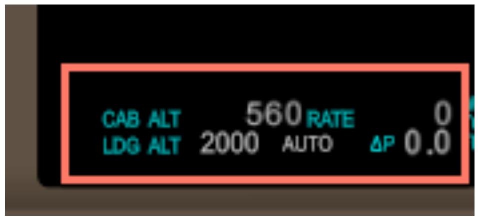
These various controls and are not implemented in this version of the SSG 747-8, so operating the switches on the overhead panel has no effect on the ECS synoptic.

<u>ECS Synoptic</u>



Also, this ECS synoptic represents the 747-8F variant. The 747-8i has a slightly different presentation.

Upper EICAS Cabin Pressure Display



On the bottom left portion of the Upper EICAS, the current cabin altitude (CAB ALT) is displayed, along with the rate and change in pressure differential between the cabin and the outside air. This is completely automatic on the SSG 747-8 and landing altitude cannot be changed.

One of the best ideas put forth by Boeing for the 747-400 is the cockpit moisturizer. On the 747 Classic, after an oceanic crossing you often feel desiccated, fatigued, and sometimes you had a slight headache from not drinking enough water. Newer models like the 747-400, and their cockpit moisturizers are an amazing addition. After landing the -400, you don't feel nearly as fatigued as airplanes without a moisturizer. Your skin doesn't feel as dried and wrinkled, and you are ready to hit the best restaurants a little sooner. - TG

5.0 AUTOMATIC FLIGHT

5.1 SYSTEM DESCRIPTION

Although it does not even approach the sophistication of the real 747-8's autoflight system, the SSG 747-8 does have a complete set of tools to perform automatic flight. However, most functionality is default X-Plane logic without customization, but with some slight differences.

<u>Glareshield Autoflight Controls</u>

5.2 AUTOPILOT

The FD can be activated with one flip of the "F/D ON" switch. The Command (CMD) button will activate the autopilot independently of the FD switch, and the DISENGAGE bar will deactivate both the FD and autopilot.

Note: For those unfamiliar with FDs, think of it as providing the guidance that the autopilot would follow using the information entered by the pilots on the MCP. The autopilot can then follow the FD commands once it is engaged; or the pilots can follow the FD commands for smooth and efficient flying. Flying without an FD is called "raw data" flying, but it is typical for airline pilots to use some sort of guidance for added safety.

The Lateral Navigation (LNAV) button is used to select input from either the source selected on the No. 1 NAV radio (normally a VOR), or the FMS with one push. When pushed, LNAV illuminates green to indicate FMS mode is in effect, but to actually command the airplane to follow the FMS flight plan, one also has to engage the Localizer (LOC) button. The LNAV button is used for VOR/FMS switching, which then requires a recycle and engagement of the LOC button. Pushing LOC by itself engages VOR tracking.

The LNAV button is effectively a NAV/FMS switch: clicking on it lights the button and enables the FMS; clicking it again turns the button light off and guidance switches back to NAV1. While this is not how the real 747-8 autoflight system functions, it is the standard X-Plane autoflight logic.

Vertical Navigation (VNAV) and Flight Level Change (FLCH) modes work as expected in X-Plane. The CMD button will engage the autopilot independently from the FD. Pushing CMD will turn the autopilot on and off, but not the autothrottle.

Pushing the Heading Hold (HDG HOLD) button will hold the desired heading entered into the selector window above it. The center Select (SEL) button on the heading selector switch, which on the real aircraft is used to acquire present heading, is non-functional on the SSG 747-8 panel. You have to dial it in. The heading selector switch also has an outer knob that can be used to select the bank limit for the autopilot, ranging from 5 to 25 degrees of bank, (or to an automatic setting).

The Vertical Speed (VERT SPD or V/S) mode works as expected after takeoff, with negative indications available. These are displayed with a “+” or “-“ sign, as applicable.

Present altitude can be captured by one press of the HOLD button, otherwise you have to dial in your desired altitude and reach it through a vertical flight mode, with SPD, FLCH (which is essentially the same as SPD here), V/S, or VNAV through the FMS.

LOC captures the VOR or ILS courses, and the Approach (APP) button also captures glideslope. However, pressing the APP button alone will capture both localizer and glideslope without the LOC button illuminating.

While it would be acceptable to press the LOC button followed by the APP button, most of the time we’ll simply press the APP button once we’re cleared for an ILS approach, the ILS is properly tuned and identified, and the localizer scale shows you on the correct side of the localizer course. On the vast majority of flights, the LOC button is never used. - SK

The DISENGAGE bar will deploy downward, and when pressed will disengage both the autopilot and FD. This will also disengage the autothrottle along with the FD and autopilot under standard X-Plane logic, although this would not occur on the real aircraft. Incidentally, the preferred method of disengaging the autopilot on the real aircraft is the yoke mounted autopilot disengage button.

It should be noted that pushing the CMD button on the MCP will disengage the autopilot without disengaging the FD (flight director), so that presently selected autoflight parameters will still be sent to the FD if hand flying is desired, for example. So when hand flying an approach in this manner, the localizer and glideslope cues will still be reflected on the FD.

5.3 AUTOTHROTTLE

To arm the autothrottle, The A/T ARM switch needs to be selected “up” before the Thrust (THR) button is engaged to activate the auto thrust system. Simply select a target speed in the box before pushing THR button and the autothrottle will accelerate to that speed. If you want the autothrottle to capture your current airspeed, push the SPD button and the value in the window will change to your current airspeed.

Throttles respond as soon as you select A/T ARM or THR. The Takeoff Go-Around (TOGA) button will roll wings level and seek the selected altitude, but only after you engage the CMD button. This is also standard X-Plane logic.

Note that although the TOGA buttons are located on the throttle handles in the real 747-8 aircraft, in the SSG version a TOGA button has been added next to the CMD button on the MCP to make it easier to access.

MCP Autothrottle Controls

The MCP autothrottle controls also include a small SEL button that allows switching from Indicated Air Speed (IAS) to Mach Number (MACH) for the MCP speed window. Typically speeds are flown in terms of MACH above transition altitude (where the Flight Levels start) and in IAS below it.

6.0 COMMUNICATIONS

6.1 SYSTEM DESCRIPTION

The SSG 747-8 is equipped with various radios for communication. They are the standard default X-Plane radios, which are operated in the conventional way. Note that on the real 747-8, most of these radios look somewhat different because they allow for digital input of frequencies rather than tuning with knobs.

6.2 RADIOS

The SSG 747-8 has 2 navigation (NAV) radios (NAV1 and NAV2) for VOR and ILS tuning, 2 ADF radios for tuning Non-Directional Beacons (NDBs) and 2 communication (COM) radios that are selectable by lit buttons on the radio panel. The radio selector knob is used to dial in the frequencies in the standby windows and the swap (arrow) button switches it to the active window.

<u>Nav/Comm Radio Panel</u>

6.3 TRANSPONDER

The SSG 747-8 has a single transponder with TCAS capability. The transponder code (or "squawk") is entered using the numeric buttons. The transponder can be switched from OFF to STANDBY modes, and then to Traffic Advisory / Resolution Advisory (TA/RA) mode. The TEST mode is inoperative on the SSG 747-8.

Transponder Panel

6.4 CABIN COMMUNICATIONS

The SSG 747-8 also has a seat belt sign switch to alert passengers (or "supernumeraries" as they are called on freighters) with two settings, one is "automatic" and the other is "on", but in the SSG 747-8 they are functionally the same.

Seat Belt Selector Knob

Activating the SEAT BELTS knob also triggers a chime that can be used to alert flight attendants during various phases of flight.

7.0 ELECTRICAL

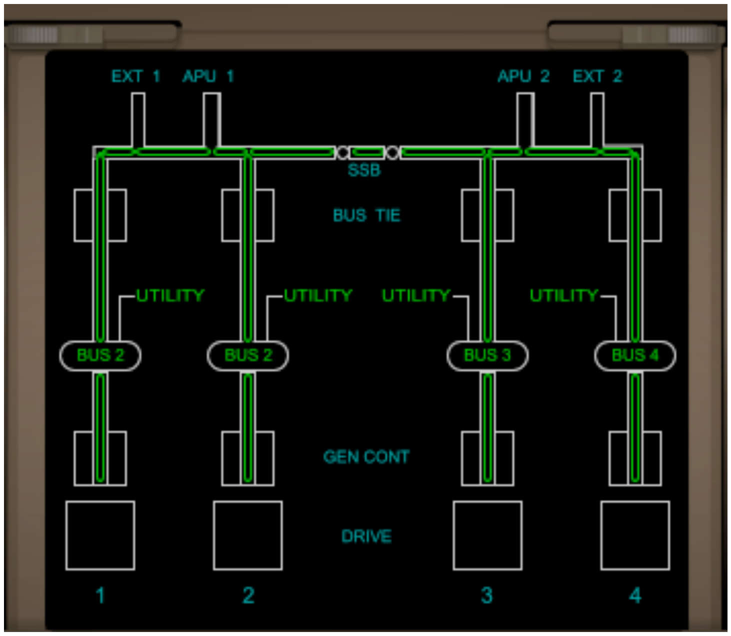
7.1 SYSTEM DESCRIPTION

The SSG 747-8 has 4 engine-driven generators that provide electrical power to the aircraft. There is also an APU generator, and a standby battery. It should be noted that the real 747-8 also has provisions for external power to be hooked up to the aircraft, if needed.

<u>Overhead Electrical Panel</u>

The overhead electrical panel allows for the switching of the battery on and off, as well as the bus ties to connect the engine-driven generators to the main electrical busses. The APU Generators (1 and 2) and engine Generator Controls (GEN CONT) can also be selected. This system is greatly simplified compared to the real 747-8, and the other buttons on the panel are inoperative.

Electrical System Synoptic



The electrical system synoptic that is accessible on the Lower EICAS is mostly cosmetic. It shows a representative display of all generators working, and it will show if the engine-driven generator bus ties are open or closed.

8.0 FIRE PROTECTION

This release of the SSG 747-8 has no fire protection systems enabled. On the real aircraft there are several types of fire extinguishers, including:

- Engine
- APU
- Cabin
- Cargo compartments
- Flight deck

A new feature on the real 747-8 is also a fuel tank inerting system for the aircraft's center tank that uses nitrogen to reduce the possibility of fumes igniting.

Not only does the fuel tank inerting system "scrub" fuel as it is being pumped aboard to remove dissolved oxygen, but it replaces the fuel tank ullage with nitrogen, knocking the levels of oxygen down so that a fire can't be ignited or sustained. It makes the fuel, even fuel that has escaped the tank, far more chemically stable. - SK

9.0 FLIGHT CONTROLS

9.1 SYSTEM DESCRIPTION

The 747-8 has a sophisticated set of flight controls. Each wing has 2 sets of ailerons, one inboard and one outboard. The outboard ailerons are locked out at higher speeds to avoid excessive wing flex.

Interestingly, the 747-8, unlike the 747-400 has outboard ailerons that are deflected down slightly if the flaps are in the 10 or 20 positions for improved takeoff performance as well as noise reduction. Up travel is reduced when the outboard ailerons are "drooped." - SK

For added lift and drag, each wing trailing edge also has 2 sets of flaps, one inboard and one outboard. They always move together in normal operations.

Additional lift is provided by 3 sets of leading edge flaps per wing. On the 747-8, these extend further to provide a bigger air gap than on previous 747 models.

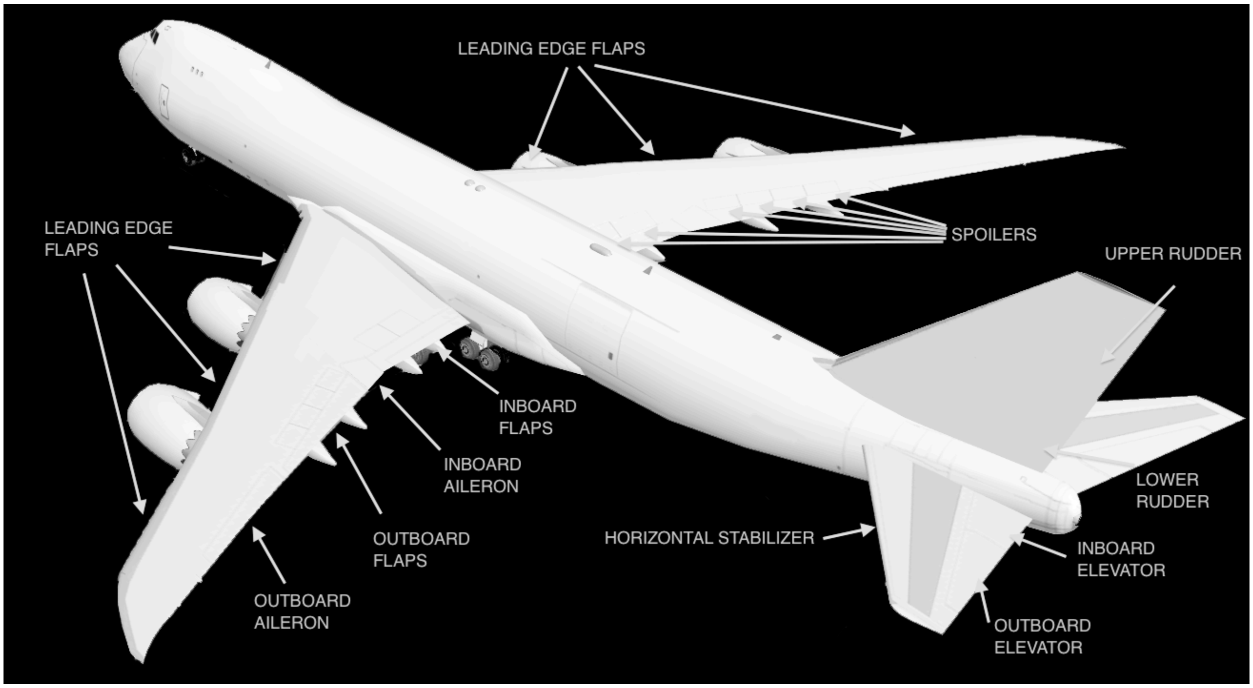
For additional drag, and to aid in turns, each wing has 2 sets of spoiler panels. There are 3 basic settings with various individual panels moving to different degrees. These are:

1. Flight spoilers
2. Speedbrakes (airborne)
3. Speedbrakes (ground)

Yaw is controlled via 2 sets of rudders on the vertical stabilizer. On the 747-8, the lower rudder is divided into 2 segments to provide additional travel. As on most swept jets, a yaw damper is installed to avoid dangerous oscillations. The yaw damper has the added benefit of applying the necessary rudder needed during turns so pilots do not need to use their rudder pedals during normal flight operations. This has been implemented on the SSG 747-8.

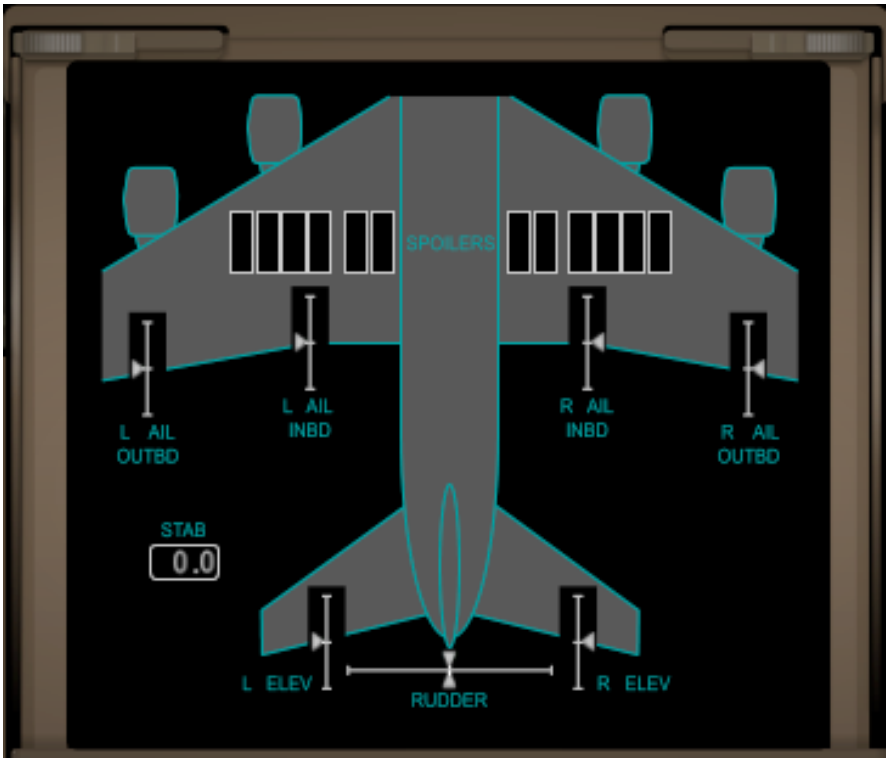
Pitch control is achieved via 2 sets of elevators on each side of the horizontal stabilizer. These move together in normal operations. Additional pitch trim is provided by the horizontal stabilizer, which moves as an entire unit up and down and acting as the stabilizer trim.

Flight Control Locations



Most of these flight controls and their operation is replicated on the SSG 747-8. The flight controls synoptic is implemented as well, and can be selected on the Lower EICAS. The synoptic display shows the position of the various flight controls, including the primary flight controls, stabilizer trim and the spoilers.

Flight Controls Synoptic



9.2 SPEEDBRAKE

The 747-8 has 4 sets of flat panels on the wing that can act as speedbrakes or spoilers.

Speedbrake/Spoiler Handle

The speedbrake handle on the center aisle stand has 4 positions that can be selected up and down with the standard X-Plane "3" and "4" keys:

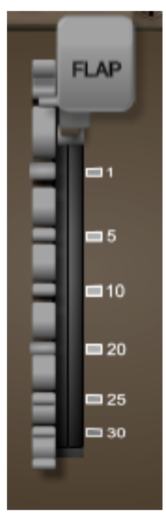
POSITION	FUNCTION
ARM	This means the spoilers are armed to deploy on touchdown and help keep the airplane firmly on the ground without bouncing. This mode is activated by pulling the speedbrake handle upward (or using the appropriate X-Plane key).
DOWN	All spoiler panels are down (i.e. flush with the wing).
FLIGHT DETENT	This is the maximum position to which the speedbrakes can be deployed in flight. On the real 747-8 aircraft there is a detent that prevents further motion of the handle in flight. This has not been implemented in the SSG 747-8.
UP	All spoiler panels are up, providing the maximum drag and lift spoiling effect.

There are also several Upper EICAS messages associated with these spoiler positions.

9.3 FLAPS

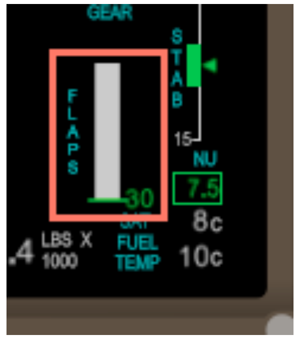
Flaps on the 747-8 can be selected by the pilots in incremental settings from 0 to 30 using the flap handle located on the aisle stand.

Flap Handle



Note that the small metal pin on the left of the flap handle indicates the selected flap position, each of which has a gate with a number marked.

Upper EICAS Flap Indicator



The flap position is also displayed on the Upper EICAS. Leading edge and trailing edge flaps move together according to system logic, so the same handle operates both sets of flaps as required. The flap setting is shown in magenta while the flaps are in movement and turns green when the selected flap position is reached.

It is also interesting to note that on the flap position display, the number displayed ALWAYS corresponds to the position of the flap handle selected. The shaded band is the position of the flaps themselves, which take time to respond to the flap position selected during extension or retraction. I mention this because every now and then you'll see new 747 pilots accidentally overshoot a flap handle detent and they'll then look down at the flap handle to see what they inadvertently selected rather than to look at the number on the flap display. - SK

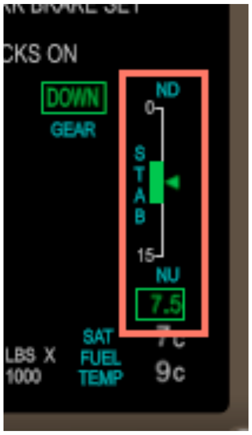
The 747-8 is equipped with a flap relief system and if you exceed these limits, flaps will retract automatically. This is implemented in the SSG 747-8, but there is no associated EICAS message to tell you that this has happened.

If you ever have the opportunity to stand under the 747 when the flaps are being extended, it is an incredible sight. The leading-edge flaps are extended pneumatically and as they move into position an ear-piercing hiss emanates from the wing, which is usually hidden by the sound of the engines. Watching the trailing edge flaps extend generates a great awe and respect for the graceful engineering that went into such complex mechanics. - TG

9.4 STABILIZER TRIM

One change in the real 747-8 compared to the 747-400 is that the stabilizer trim display is displayed on the Upper EICAS, which has been implemented on the SSG 747-8. The small green triangle shows the position of the stabilizer trim, and a numerical display shows the stabilizer trim setting in a green box at the bottom of the display. Stabilizer trim units range from 0 to 15 and are indicated in terms of "Nose Up" (NU) or "Nose Down" (ND). The green band (indicating the safe stabilizer trim range for takeoff) on the left of the indicator is dynamic on the real aircraft, but is fixed on the SSG 747-8.

Upper EICAS Stabilizer Trim Indicator



One feature of the real 747-8, is an automatic trim function that serves to minimize drag, and that automatically operates when the elevators have remained deflected in one direction from neutral for more than 3.5 seconds. This feature is implemented on the SSG 747-8, although not for the exact 3.5 seconds of the real aircraft. So, if one holds a particular pitch with the flight controls, after a second or two, the stabilizer trim will automatically engage to hold that pitch. This feature is very useful during approaches, and makes the airplane very easy to fly – which real 747 pilots have pointed out quite often about the aircraft.

9.5 YAW DAMPER

As described previously, the yaw damper is a system that applies rudder to counteract yaw on the 747-8.

Overhead Yaw Damper Switch

The yaw damper is turned on for normal flight by pressing the yaw damper button on the overhead panel. This is accompanied by a message on the Upper EICAS.

10.0 FLIGHT INSTRUMENTS

10.1 SYSTEM DESCRIPTION

The SSG 747-8 has a complete set of flight instruments that generally presents the same type of information as the real aircraft for all flight phases. Starting with the 747-400 series, all primary flight displays on 747s were changed to the "glass" type, which is to say that they are electronic displays of computer-generated information instead of conventional mechanical instruments. Such so called "steam gauges" had been the norm on older Classic 747 models.

10.2 PRIMARY FLIGHT DISPLAY (PFD)

The main display of flight instruments for the pilot is the PFD. It contains the following information.

- On the top are the mode displays for the autothrottle, roll, and pitch modes for the FD and/or autopilot respectively.
- A gray vertical tape on the left side displays IAS. Note that this is not useable below 30 kts and will indicate 30 kts even if the aircraft is not moving.
- A gray vertical tape on the right side displays altitude in feet (and meters, which can be selected by the pilot).
- The bottom contains a compass arc showing heading information, as well as the selected magnetic heading from the MCP.
- The altimeter setting is shown on the bottom right in green.
- Mach number and ground speed are shown on the bottom left in white.
- Decision Height (DH) is shown on the top right in white.
- The NAV1 (VOR) course is shown on the bottom left in white.
- FD bars are shown in magenta on the artificial horizon.
- LOC and ILS bars appear as magenta diamonds on the bottom and right of the artificial horizon.

PFD

10.3 NAVIGATION DISPLAY (ND)

The primary navigation display on the 747-8 is the ND and provides a representation of the aircraft using a small white triangle to show the aircraft's position, as well as the area ahead of the aircraft. However, this presentation can be changed in certain ND modes with a more central position for the aircraft, showing the area around the aircraft, as required. This can be useful during non-precision instrument approaches.

ND

The ND contains the following information:

- Groundspeed (GS) and wind information in the top left corner
- Range display for the ND scale in a white box on the top left
- Magnetic track on a compass arc and the numerical value in a white box at the top of the arc.
- Magnetic heading shown by an upside down white triangle cue at the top of the arc
- Distance to next waypoint on the top right
- Time/timer information on the top right
- Selected heading from the MCP as a magenta dotted line
- Frequency and DME distance information (if applicable) for the 2 selected navaids (VOR or NDB) on the left and right corners
- Other aircraft are typically displayed as white diamonds with altitude relative to the 747-8 indicated in hundreds of feet, as well as an arrow indicating whether they are climbing or descending
- Waypoints, navaids and suitable airports (those with a runway more than 6,000

feet long) as selected on the PFD/ND selector
- Weather radar returns (if selected on the PFD/ND selector)

The various ND modes are described as follows:

ND MODE	DESCRIPTION
APP	Approach mode
VOR	VOR mode
MAP	Map mode (this is the most commonly used presentation)
PLAN	Flight planning mode, which is a "North up" presentation that can be used to check the flight plan entered in the FMS.

10.4 INTEGRATED STANDBY FLIGHT DISPLAY (ISFD)

On the real 747-8, the ISFD replaces the three standby instruments that were installed on earlier 747-400 models. The ISFD is non-functional on the SSG 747-8 to improve frame rates, and because the ISFD only would be used in emergency situations where no PFD was available.

ISFD

10.5 MCP PFD/ND SELECTOR

The PFD/ND selector on the MCP has a multitude of controls in a small area. These controls are listed as follows:

- A radio altimeter warning selector knob on the top left.
  Note: On the real aircraft this can be switched to a barometric altimeter warning, but this is not implemented in the SSG 747-8.
- A barometric pressure selector knob on the top right
- A MTRS button that allows pilots to display altitude information in meters as well as feet for operations in countries where altitudes are metric (primarily the People's Republic of China and some former Soviet republics).
  Note: In the SSG 747-8, this button also switches some other displays to indicate metric information as well, such as fuel weights.
- There are two VOR/NDB selectors on either side of the panel to select between these types of radio beacons for display on the PFD and ND
- The CTR button allows for a change in presentation of the ND with aircraft in the middle to an arc presentation with the aircraft at the bottom of the display
- The ND selector switch allows pilots to switch between ND modes
- The range selector permits switching of the ND scale from 1 to 160 NM.

Note: The "FPV" display button is non-functional on the SSG 747-8.

PFD/ND Selector

10.6 OMNI BEARING SELECTOR (OBS) KNOBS

On the real 747-8, VOR courses are selected using the FMS Control Display Unit (CDU) "NAV RADIO" page. Because the SSG 747-8 does not have a fully customized FMS, two OBS knobs are provided in a panel located above the Upper EICAS. OBS1 selects the radial for the PFD, while OBS2 selects the one for the ND. Note that there is only a directional arrow for NAV2 on the ND, with no OBS.

Omni Bearing Selector (OBS) Knobs

10.7 STANDBY COMPASS

All airliners have standby magnetic compasses as a backup, and the 747-8 is no exception. It is located at the top of the central window post and within easy view of the pilots. The compass also is lit to allow for its use at night and low light conditions. A standby compass that looks much like the ones installed on the real aircraft is provided in the SSG 747-8 as well.

Standby Compass

10.8 CLOCK DISPLAY

The real 747-8 has a clock readout on the upper right corner of the ND instead of the dedicated chronometer on the left of the PFD that can be found on 747-400s. This new feature also has been implemented in the SSG 747-8. The default mode is Coordinated Universal Time (UTC), sometimes called “Zulu” time. A click on the CLOCK button for the left light control panel (see the red arrow on the illustration below), will switch the presentation to a timer readout, both digitally and with a clock face that has a rotating hand to indicate seconds. The timer will always read “00:00” and is not implemented on the 747-8, but the sweep hand for seconds does work, although it registers Zulu seconds.

Clock Button

The two illustrations below show how the clock and timer modes appear on the ND itself.

Clock Display

Timer Display

11.0 FLIGHT MANAGEMENT SYSTEM (FMS)

11.1 SYSTEM DESCRIPTION

Like all newer generation 747s starting with the 747-400, the real 747-8 has an extremely sophisticated FMS. It has several components that allow for very precise control and management of the aircraft in all flight regimes. The SSG 747-8 uses the standard X-Plane Global Positioning System (GPS) unit as an FMS. It is operated in the same manner as the default GPS and can be connected to provide guidance information for the autoflight system as described in Section 5 of this Guide.

11.2 CONTROL DISPLAY UNIT (CDU)

The only visible component of the aircraft's sophisticated FMS on the SSG 747-8 panel is the CDU, which consists of a keyboard and a display with Line Select Keys (LSKs) on either side of the display.

FMS Control Display Unit (CDU)

11.3 FULL AUTHORITY DIGITAL ENGINE CONTROL (FADEC) MODES

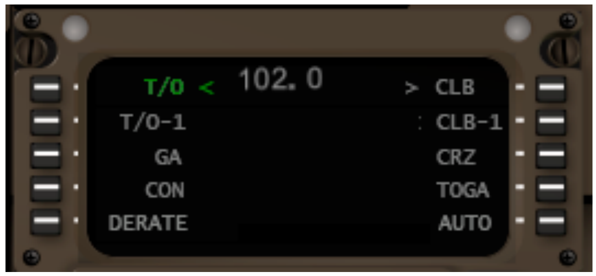
The SSG 747-8 incorporates some simplified FADEC modes compared to the real aircraft, which allow for precise engine control using the CDU. To activate these modes, simply click the “-BRT+” button located on the top right of the CDU keys (see red arrow in illustration below).

After activation, the thrust limit page appears on the CDU to select the thrust mode using the LSKs on either side of the CDU display. The modes are described as follows:

MODE	DESCRIPTION
T/O	Takeoff
T/O-1	Takeoff 1 (reduced)
CLB	Climb
CLB-1	Climb 1 (reduced)
GA	Go around
TOGA	Takeoff go around
CON	Continuous
CRZ	Cruise
DERATE	Derated thrust
AUTO	Automatic

Note: The real 747-8 has 3 takeoff modes.

When these modes are selected there are two separate indications. One is the selected mode that is shown above the engine tapes in the Upper EICAS, and the N1% value for the selected mode is shown on the top center of the CDU screen (see below).



On the ground you can only select the T/O, and GA modes. If you select a T/O mode, the thrust limit mode will be a fixed value. However, if you select the DERATE mode it will assume a thrust limit based in the actual Outside Air Temperature (OAT). The thrust limit value typically will decrease with a decrease in OAT.

Note: On the real aircraft the DERATE function is turned on automatically when you fill in the “assumed” temperature. However, this method is beyond the scope of the current SSG 747-8.

Selecting AUTO mode means that the thrust limit modes will change automatically for CLB, CLB-1, and CRZ. In this way if the aircraft reaches 1,500 ft Above Ground Level (AGL), the mode will switch from T/O to CLB, then T/O-1 to CLB-1, then CLB to CRZ, and CRZ to GA if detected via a descent indication such as setting your MCP altitude selection to less then 2,000 ft and a negative V/S of 1,800ft FPM. Then it will automatically switch the thrust limit to the GA mode. Note that if you are in CLB-1, and the plane reaches 2,5000 ft, it automatically will change to CLB mode if the AUTO mode is selected.

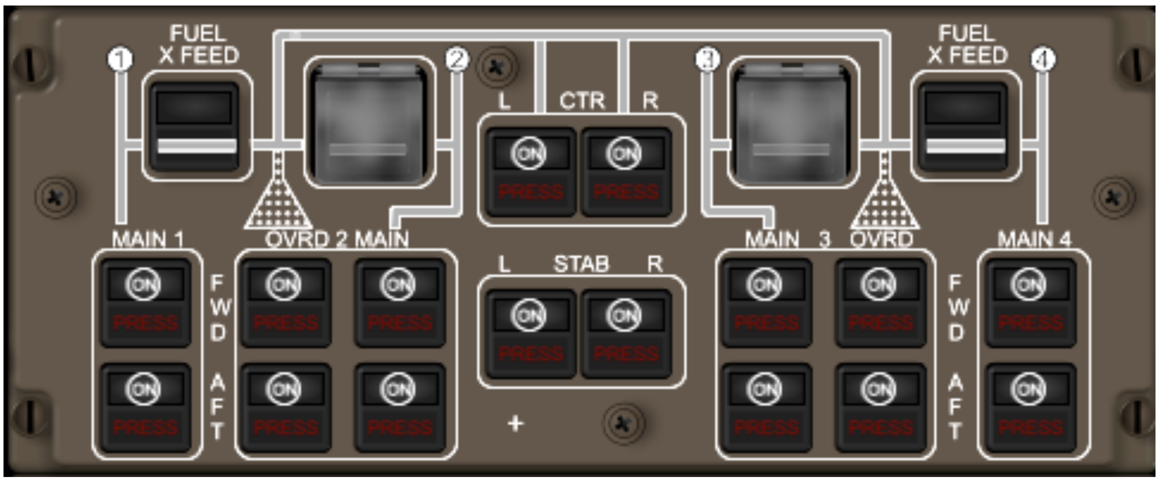
The 747-8’s FMS is more sophisticated than the 747-400’s. One thing is for sure, however, if you’re an experienced -400 pilot then you can really notice the concerted effort that the manufacturer went through to keep the FMS’s similar, even though they’re not exactly alike as far as operating them is concerned. It’s obvious when flying the -8 that the FMS was “dummied down” to keep the type-ratings the same. - SK

12.0 FUEL

12.1 SYSTEM DESCRIPTION

The 747-8 has multiple fuel tanks, with the main tank located between the wings, and several wing tanks. The 747-8i also has an additional stabilizer tank, which is simulated in the SSG 747-8i, but it cannot be controlled separately.

Overhead Panel

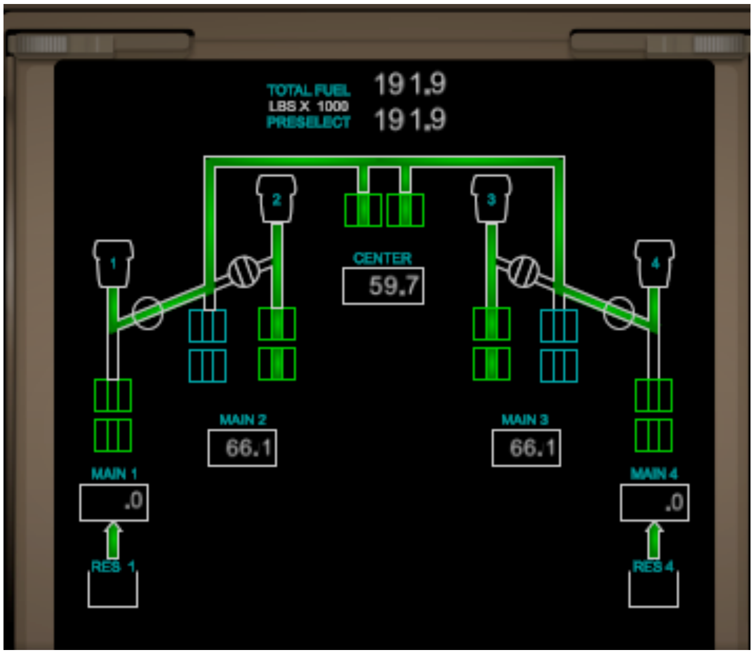


Fuel tank pumps are turned on and off with buttons on the overhead panel. Crossfeeds (X FEED) are non functional on the SSG 747-8 overhead panel.

Upper EICAS Fuel Display

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

Fuel System Synoptic



The fuel quantity in each tank is shown on the fuel synoptic, which can be displayed on the Lower EICAS.

Note: On the SSG 747-8, the units to measure fuel can be switched between pounds and kilos using the MTRS button on the PFD/ND selector.

12.2 FUEL CONTROL

While the overhead fuel panel switches are non-functional, the fuel control switches on the aisle stand can be selected to the RUN or CUTOFF positions. During engine starts, the fuel control switch has to be in the RUN position for fuel to flow to the particular engine. Similarly, to shut off an engine, the individual fuel control switch can be placed in the CUTOFF position.

Aisle Stand Fuel Control Switches

There are 4 fuel control switches located in the aisle stand portion of the SSG 747-8 panel, one switch for each engine as numbered.

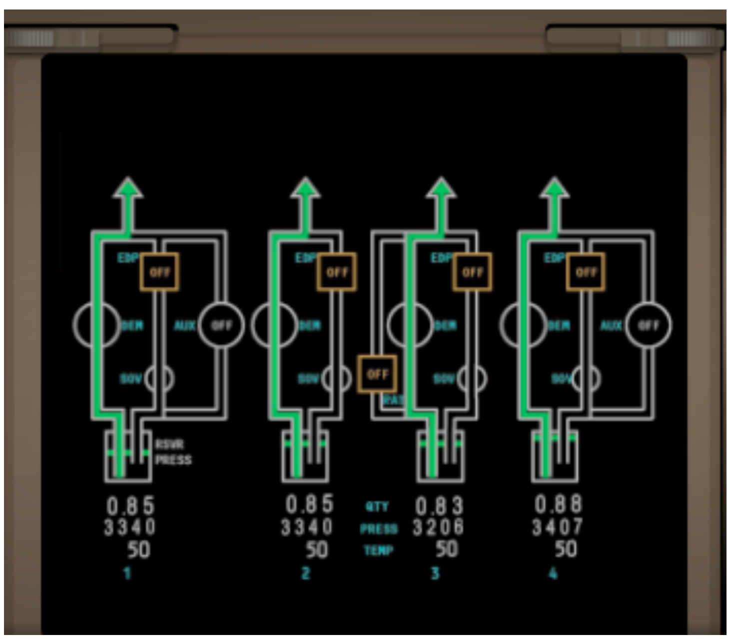
13.0 HYDRAULICS

13.1 SYSTEM DESCRIPTION

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

Note that the Overhead Hydraulic Panel on the real aircraft is not implemented in the SSG 747-8 because there are no pilot-selectable items and the hydraulic system is completely automatic. On the real aircraft, pilots typically have to turn the hydraulic systems on and off manually before and after engine starts.

<u>Hydraulic System Synoptic</u>



In the SSG 747-8, the hydraulic system synoptic that is selectable on the Lower EICAS is only cosmetic and shows how the display would look in normal flight operations with all hydraulic systems active. The only value that is active on the synoptic page is the hydraulic pressure (middle row of numbers).

13.2 RAM AIR TURBINE (RAT)

A new feature on the real 747-8 is a RAT that extends automatically from a compartment under the right wing root if there is a complete loss of engine power. The RAT was needed because Boeing determined that the engines would not windmill fast enough to provide sufficient hydraulic power to operate the aircraft's flight controls. The RAT is implemented in the SSG 747-8 and will deploy automatically as well.

<u>Overhead RAT Switch</u>

On the 747-8 the RAT deploys if there are three engine failures. It provides hydraulic power to hydraulic system number 2. - SK

14.0 ICE AND RAIN PROTECTION

14.1 SYSTEM DESCRIPTION

The 747-8 has a variety of built-in equipment to protect it against various types of icing. The primary systems for this purpose are:

- Engine anti-ice (EAI)
- Wing anti-ice (WAI)
- Cockpit window heat

The real aircraft has automatic ice detection, but in the SSG 747-8, the pilot is responsible for recognizing icing conditions and activating the anti-ice systems to avoid degradation of aircraft performance. Typically, window heat is kept on at all times the aircraft is flown. This is required to maintain the flexible properties of the windows in case of a bird strike.

In the 747-8, when we know that we're in icing conditions then we activate the anti-icing systems manually as well. At least that's my company's procedure. We also do this in the 747-400. - SK

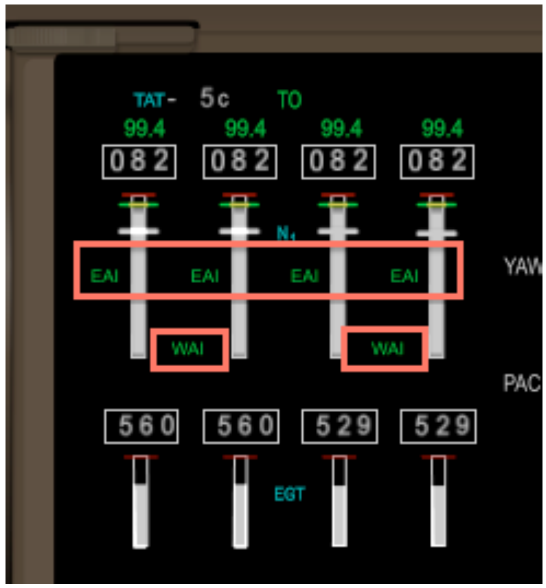
<u>Overhead Anti-Ice and Window Control Panels</u>

Ice and rain protection functions that can be selected on the SSG 747-8 overhead include:

- EAI (OFF/ON)
- WAI (OFF/ON)
- Window heat

Other buttons and switches are non-functional.

EAI/WAI Indication on Upper EICAS



The primary indication that these systems are active is a status display on the Upper EICAS.

Flying through icing conditions, I only had to use the wing anti-ice twice. The fat, blunt wing leading edge is strangely resistant to ice formation, unlike the sharper leading edges of regional jet aircraft and turboprops. That feeling of invincibility may seem to lead to dangerous conditions, but the airplane is truly unique and not only strong, but the wing design makes it difficult for ice to accumulate, at least compared to wings with a sharper leading edge. - TG

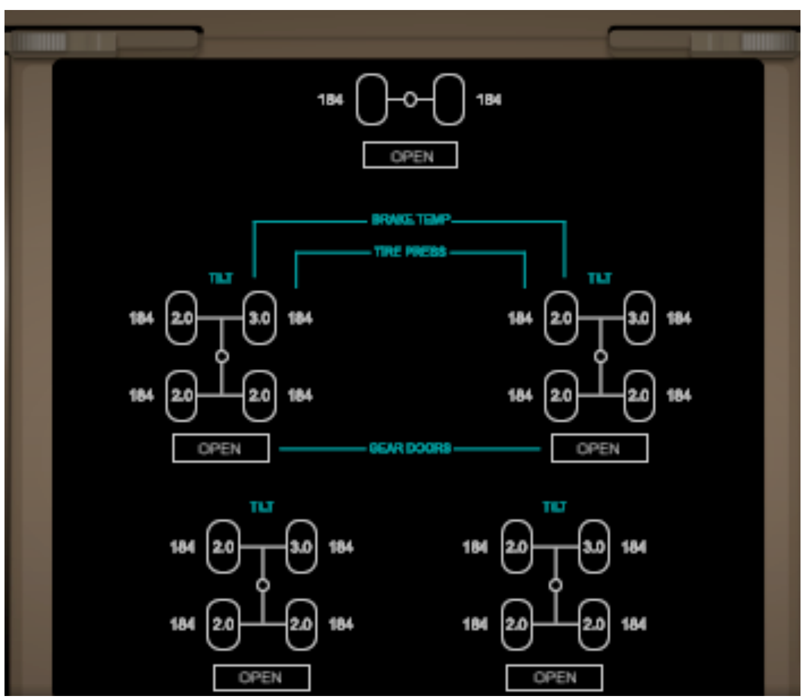
15.0 LANDING GEAR AND BRAKES

15.1 SYSTEM DESCRIPTION

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

The braking system on the 747-8 is quite sophisticated, and some of this functionality has been implemented in the SSG version. Please note that the nose gear on the 747 does not have any brakes. The wheels in the nose gear are slowed to a stop upon retraction by rubbing strips in the nosewheel well, which lies below the main cabin of the aircraft.

<u>Landing Gear Synoptic</u>



A landing gear synoptic can be called up on the Lower EICAS, but this is non-functional on the SSG 747-8. On the real aircraft, the values shown would reflect individual tire pressures and brake temperatures, as well as the position of the landing gear doors.

Upon raising the landing gear, the gear doors are so large that as they open, if the air is stable, you can notice a slight decrease in airspeed. - TG

15.2 AUTOBRAKES

The 747-8's autobrake system has various settings for the anti-skid system to decelerate the aircraft automatically. It is quite similar to the anti-lock brakes found on most modern automobiles.

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

On the 747-8, just like on the 747-400, setting number 1 of the autobrakes isn't used. It tends to modulate the brakes and apparently, increases wear and tear on them. - SK

SETTING	DECELERATION (DIST/SEC/SEC)
1	4 ft (1.2 M)
2	5 ft (1.5 M)
3	6 ft (1.8 M)
4	7.5 ft (2.3 M)
MAX AUTO	11 ft (3.4 M)

Once the aircraft has sufficiently decelerated down the runway, the system can be deactivated by switching to the "DISARM" setting.

Note: On the SSG 747-8, the DISARM setting is not enabled, so switching to OFF has the same effect. Autobrake setting 4 is not enabled either.

Landing Gear and Autobrake Controls

15.3 PARKING BRAKE

The parking brake on the 747-8 is very similar to that of an automobile. The brake is set by pushing the top of the rudder pedals and then pulling on the small parking brake handle located on the cockpit aisle stand. There is also a corresponding message that appears on the Upper EICAS to advise the pilots that the brake has been set. This system works in similar fashion on the SSG 747-8.

Note: SSG recommends clicking on the parking brake handle to operate he system rather than just hitting the standard X-Plane “B” key to ensure proper system functioning.

Parking Brake Handle

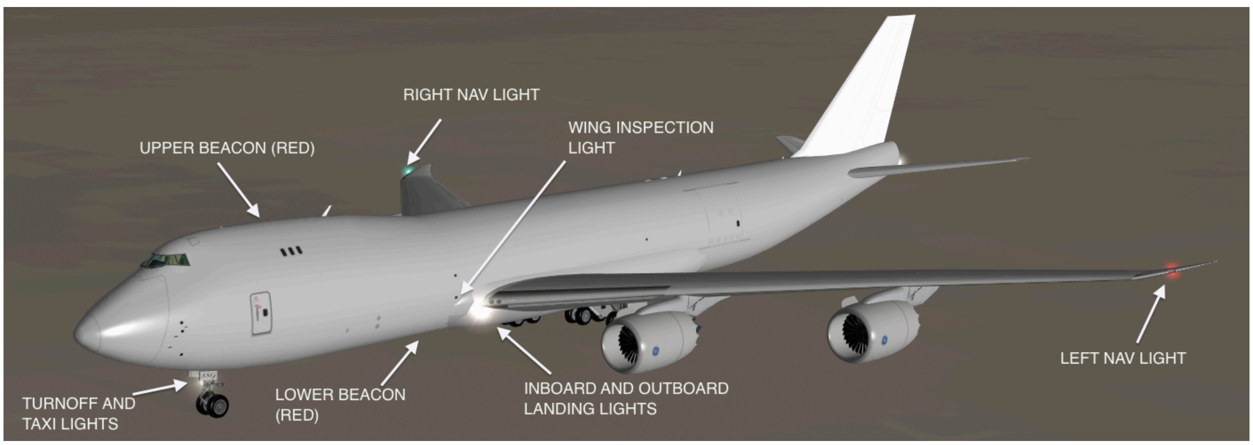
16.0 LIGHTING

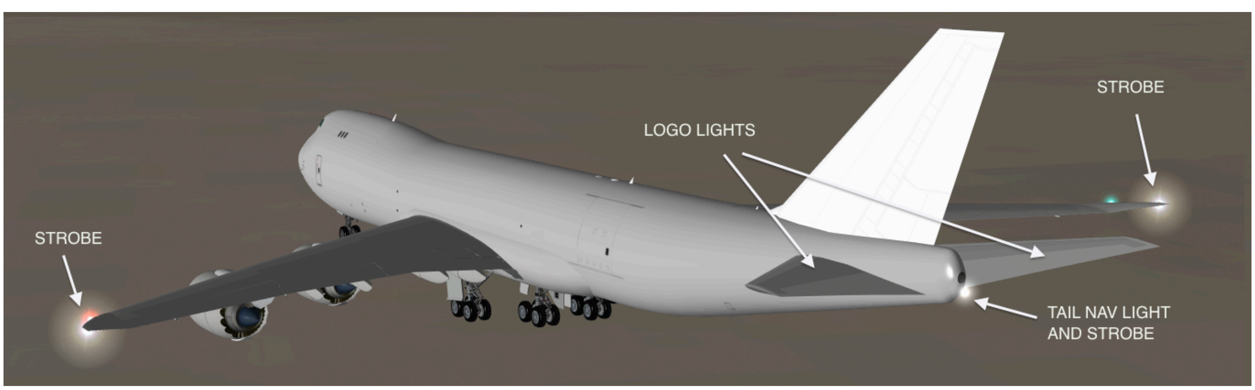
16.1 SYSTEM DESCRIPTION

The SSG 747-8 has a wide variety of customizable controls for lighting, both for the exterior of the aircraft and for the cockpit.

16.2 EXTERIOR LIGHTS

The illustrations below show the various types of exterior lights that are fitted on the SSG 747-8.





Overhead Exterior Light Panel

This panel contains individual switches for each light on the 747-8. Notice that all switches for the different lights are of different shape to make it easier for pilots to recognize them by feel. It should be noted that on the SSG 747-8, the beacon switch only has a BOTH setting, and the “IND LTS TEST” switch is non-functional.

16.3 INTERIOR LIGHTS

The SSG 747-8 panel incorporates lighting effects such as rheostats for backlighted text on the control panels, backlit gauges, a dome light, spot lighting on various areas of the panel, and modified gauges to change display screen brightness via rheostats. It should be noted that a rheostat is simply a knob that can be used to control an electrical device in increments (i.e. gradually).

The PANEL rheostat on the left side panel controls the illumination of panel text and markings. The dome, panel backlighting, and spots can be controlled separately. For example, the dome light can be turned up for pretakeoff activities, then decreased and spots used for flight using mostly backlighting, and then use spots after landing, which is quite similar to how the real 747-8 interior lighting is used by flight crews.

There are 7 lighting knobs, and your enjoyment of the SSG 747-8 panel will be in direct relation with your ability to appreciate and use them. They are not difficult to use, and work as follows:

RHEOSTAT	LOCATION	CONTROLS
DSPL - INBD	Left glareshield	PFD, ND, and EICAS brightness
MAP	Left glareshield	Overhead spot light that will illuminate area under PFD
PANEL	Left glareshield	Backlighting for lettering for glareshield, main panel, and aisle stand
CPT BREAKER OVHD	Overhead	Backlighting for lettering

RHEOSTAT	LOCATION	CONTROLS
PANEL		on overhead panels
GLARESHIELD PANEL FLOOD	Overhead	Spot lighting for glareshield and under the glareshield
DOME	Overhead	Overall brightness for cockpit (Turn this down to low at night)
AISLE STAND PANEL / FLOOD	Overhead	Spot lighting for aisle stand and radios

Note: The STORM switch on the overhead panel can be used to turn all lights UP or DOWN, typically in conditions where lightning is a factor (which is why they are called “storm” lights”) to preserve night vision for the pilots.

SSG recommends that you try to start a flight in daytime and play with these various knobs to see what they do, and then try a similar flight at night. One technique is to start night operations by turning the dome light to very low, then turning up the panel lights, illuminating the spots for cockpit work. At takeoff you can then turn down the spots and run with panel lighting. With all these options you may even begin to prefer flying at night!

Overhead Light Panel

Left Side Panel

Interestingly, pilots, once at cruise altitude, frequently like to fly with the "thunderstorm" lights on at night. It brightens the cockpit up just like daytime. Some pilots even say that it tricks their bodies into thinking that it is daytime, making it easier for them to fly at night without getting as fatigued as fast. - SK

17.0 PNEUMATICS

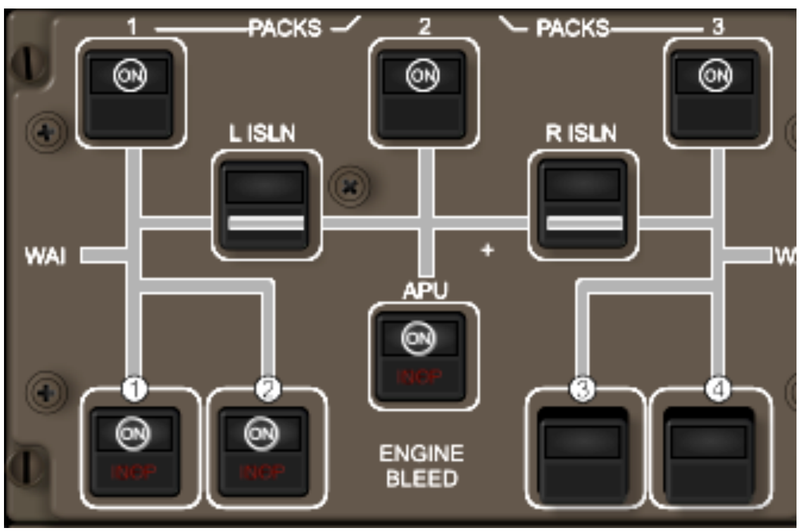
17. 1 SYSTEM DESCRIPTION

As described in Section 4 of this Guide, the 747-8 has several sources of bleed air, one for each engine and one for the APU. The pneumatics controls are located on the 747-8's overhead panel. With the panel, the bleed air from the APU and Engines can be selected (left or right side).

On the real aircraft, each engine bleed valve can be controlled individually, and so can the isolation valves. This is not possible using default X-Plane logic. Also note that the 3 packs cannot be switched on and off individually either. They remain on at all times.

In addition to pressurization and temperature control, the pneumatics on the 747-8 are used for engine starting, leading edge and nacelle anti-ice, and some other systems.

<u>Overhead Pneumatics Panel</u>



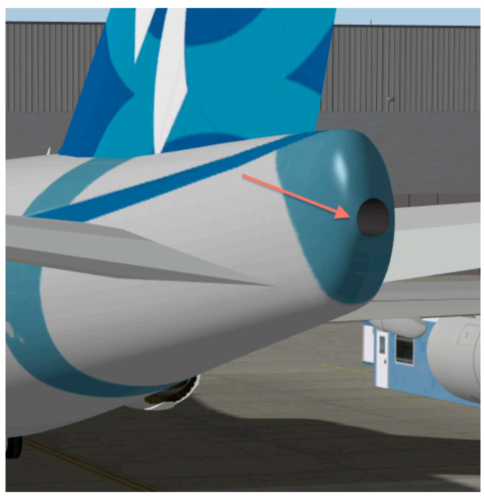
The engines on the 747-8 are considerably slower at starting than those on the 747-400. We turn off all 3 packs on the -8 before engine starting, unlike the -400 where we typically leave one pack on. - SK

18.0 AUXILIARY POWER UNIT (APU)

18.1 SYSTEM DESCRIPTION

The APU is a small turbine powerplant mounted in the 747's tail that provides pneumatic and electrical power for the aircraft while it is on the ground. It runs on the same fuel as the aircraft's engines and allows the aircraft to function quite independently while on the ground, without the need for external power, air, or start carts. The APU is not designed for use in flight on the 747-8 (that is, it cannot be started in flight but it can operate up to a few thousand feet of altitude under certain special circumstances)

APU Exhaust



The location of the APU is in the aircraft tailcone, and its exhaust is shown in the illustration above (see arrow).

18.2 APU OPERATION

APU operation is quite simple: a single switch on the overhead panel can be set to START and then released. After it is released, it moves to the ON position during the APU starting sequence, which is fully automatic.

Overhead APU Control Switch

Status Synoptic

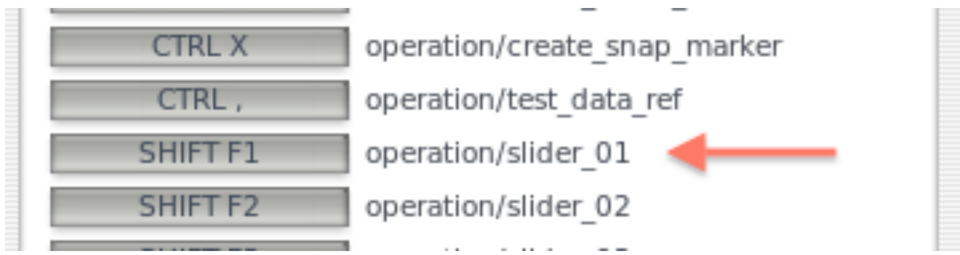
The status synoptic on the Lower EICAS provides a means to monitor the APU's status by indicating its N1 and N2 percentages. There are also status messages on the Upper EICAS associated with operation of the APU.

19.0 DOORS AND WINDOWS

19.1 SYSTEM DESCRIPTION

The SSG 747-8 has only one opening door, which is the nose cargo door on the 747-8F version. On the real aircraft, a door status synoptic can be called up on the Lower EICAS. This synoptic is available on the SSG 747-8, but it is only cosmetic.

The door is opened and closed using the keyboard command or joystick button selected for “operation/slider_01” under X-Plane’s “Joystick & Equipment” menu. See the item below:

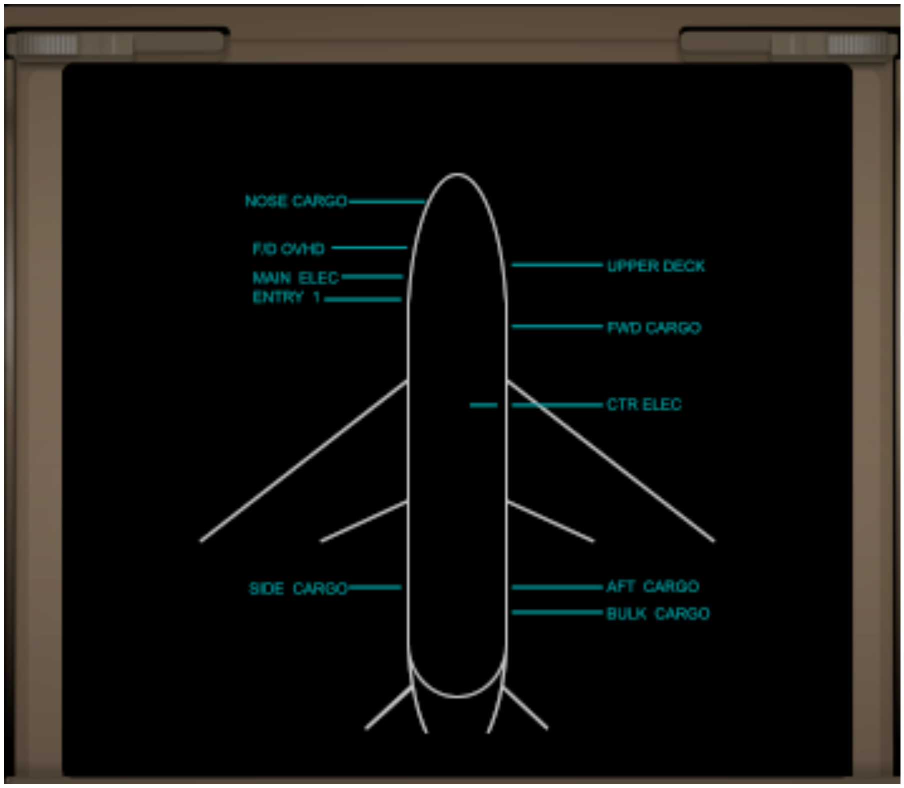


So on the Mac, for example, you would need to press “FN+SHIFT+F1” to open the door.

When the door is opened on the SSG 747-8F you can see loaded pallets inside the aircraft fuselage, and the number of pallets (and their position) will change based on the weight of the payload selected in the X-Plane “Weight & Balance & Fuel” menu.

Be aware that on the real aircraft, the door can only be opened once the aircraft is depressurized and typically when all engines are shut down and the aircraft is parked and chocked. Such protective measures are not implemented in the SSG 747-8, so you must be careful not to open the door in other situations.

Doors Synoptic



20.0 POWERPLANT

20.1 SYSTEM DESCRIPTION

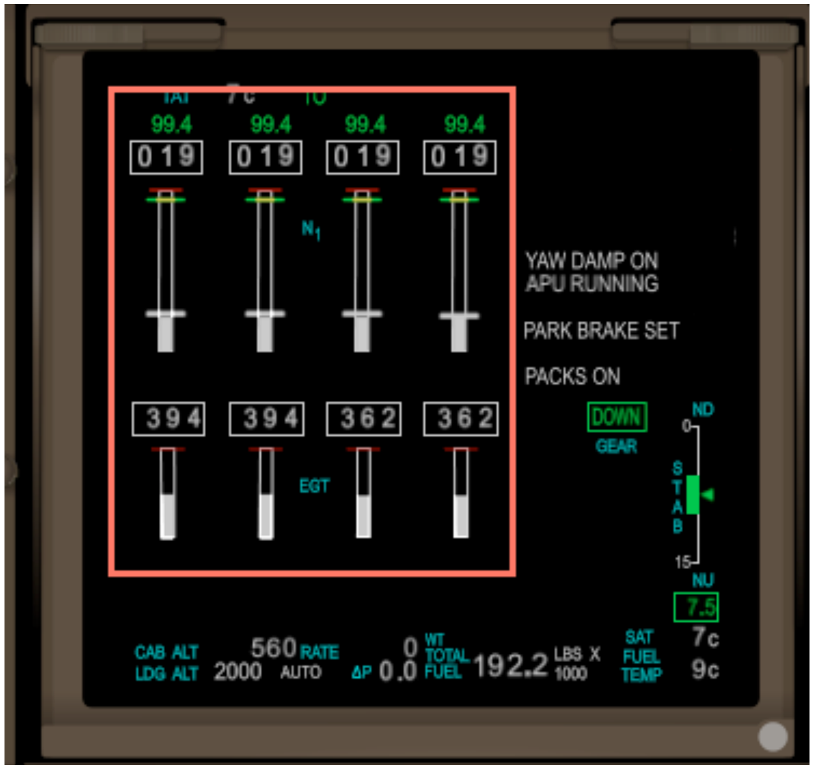
The 747-8 is equipped with 4 powerful GE GEnx-2B engines (a derivative of the GEnx-1B engines used on some 787 models). This new engine allowed for the greatest advances in efficiency that convinced Boeing to create a follow-on to the successful 747-400 series. These GEnx engines have increased power, reduced fuel consumption, and are more environmentally friendly than the GE, Rolls-Royce, and Pratt & Whitney engines installed on the 747-400.

While the engines are more powerful, it's interesting to note that the 747-8's climb performance seems to be somewhat sluggish compared to the 747-400's due to its lower thrust-to-weight ratio when the -8 is at maximum takeoff weight. - SK

20.2 ENGINE INDICATORS

Engine performance and status is primarily indicated on two EICAS screens. The Upper EICAS engine indicators are always visible, and the Lower EICAS has secondary engine parameters that can be accessed through one of the synoptics for the Lower EICAS.

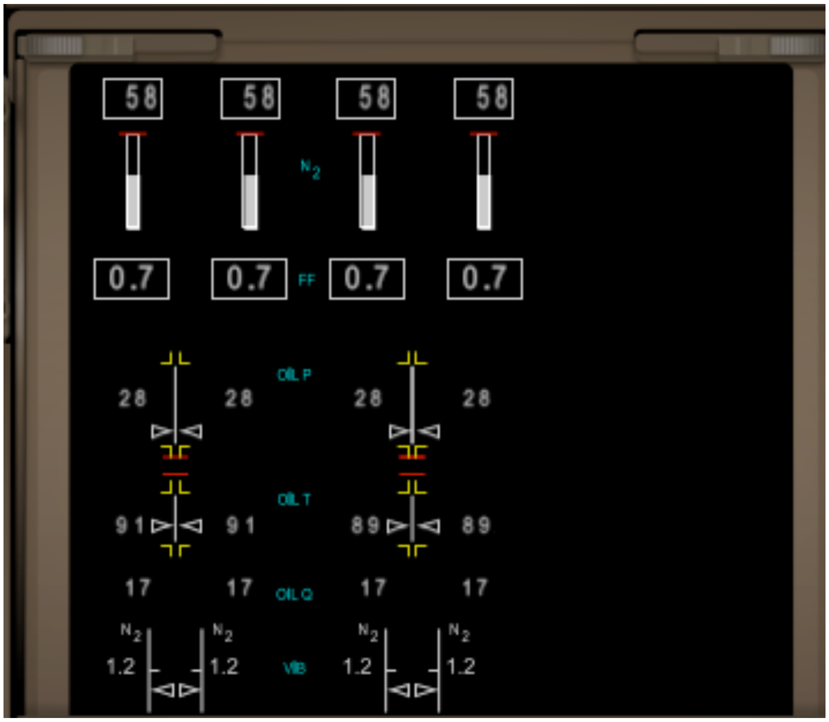
Primary Engine Display (Upper EICAS)



The displays within the red box above show the primary engine indications, these include (from top to bottom):

- Full Authority Digital Engine Control (FADEC) Mode
- Selected N1 for FADEC mode (N1 is the primary engine fan visible at the front of the engine while N2 is the second engine spool, which turns independently from the N1 spool.)
- Current N1 value (in the white boxes)
- Individual vertical tapes showing the N1 percentage value as a white bar
- Exhaust Gas Temperature (EGT) tape

Secondary Engine Synoptic



The secondary engine synoptic is accessed on the Lower EICAS, and shows the following information for each engine:

- Current N2 value (in the white boxes)
- Individual vertical tapes showing the N2 percentage value as a white bar
- Fuel Flow (FF)
- Oil Pressure
- Oil Temperature
- Oil Quantity
- Engine vibration

20.3 ENGINE STARTING

The GEnx engines are started using pneumatic power (primarily bleed air) by opening a starter valve that lets high pressure air into the engine to drive the fans and provide enough energy to start the engine compression cycle, at which point fuel is introduced and ignited. Once the engine has started, the engine is self-sustaining and the starter and igniter are no longer required. This process is completely automatic on the 747-8 using start switches on the overhead panel, with fuel being controlled with the fuel control switches on the center aisle stand. This same process is used for engine starting on the SSG 747-8.

Overhead Engine Start Switches

Note: One difference between the 747-400 and the 747-8 is that there are no longer center white lights in the starter switches to show the starters are operating. These lights are also absent on the SSG 747-8 overhead panel.

20.4 THRUST REVERSERS

All 747 models have cascade type reversers for installaed engine types, in which small doors interrupt the flow of air coming from the N1 section of the engine, and its air is blown forward and outward through grilles in the engine nacelles. These grilles are uncovered by a sleeve when reverse thrust is selected by the pilots – normally on landing – as shown below (the grilles are indicated with red arrows.)

Thrust Reverser Operation

The thrust reversers can be engaged and disengaged using the standard "Shift" + "/" key combination.

Upper EICAS Reverse Thrust Indication

The pilots have an indication on the Upper EICAS that each individual engine is in reverse by the “REV” indication above the N1 tape white boxes.

Note: While the real aircraft has systems that prevent the thrust reversers from being operated in flight, the SSG 747-8 does not have such safeguards. Therefore, pilots should be very careful to avoid accidentally applying reverse thrust while in flight.

21.0 WARNING SYSTEMS

21.1 SYSTEM DESCRIPTION

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

21.2 MASTER CAUTION BUTTON

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

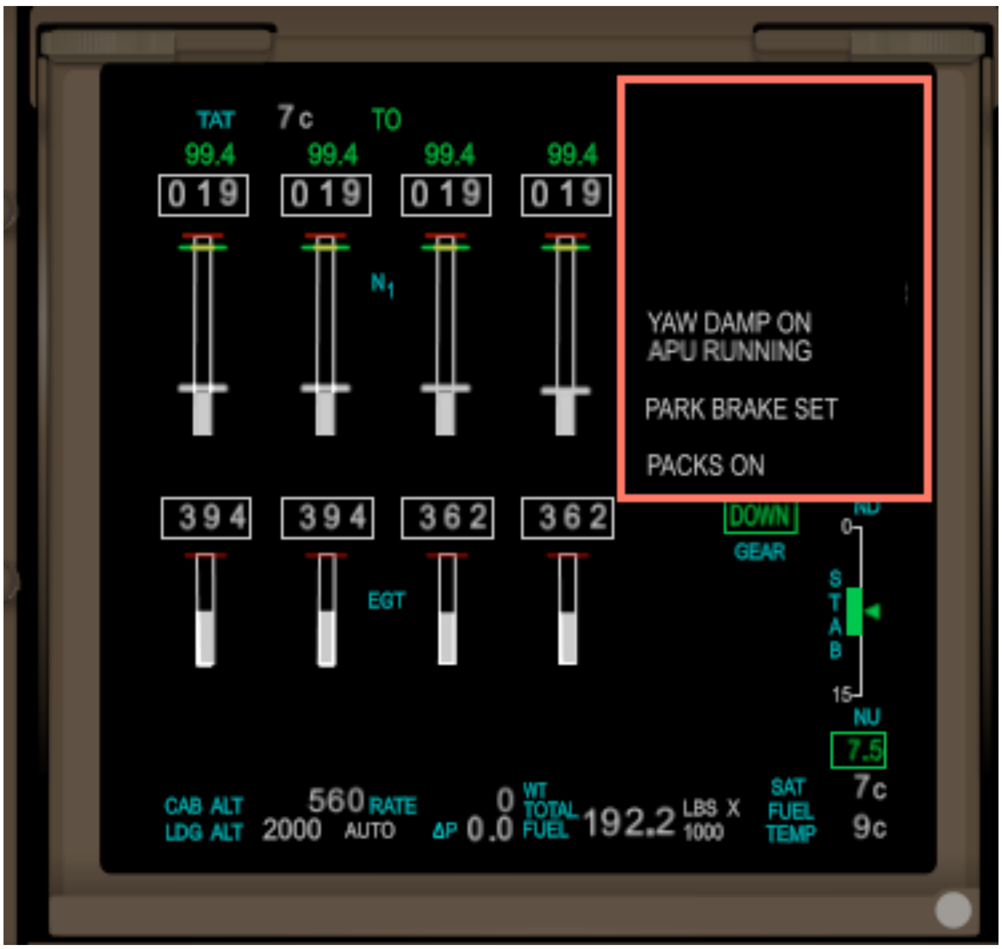
Note: A CAUTION light appears in amber on the Master Caution button, which on the real 747-8 warns the pilots that a caution message has appeared on the Upper EICAS. While the CAUTION light does appear under certain conditions, this exact logic is not replicated in the SSG 747-8.

Master Caution Button

21.3 EICAS MESSAGES

In the SSG 747-8, there are 4 types of messages that appear on the Upper EICAS (the system on the real aircraft is much more sophisticated and there is a significant number of different messages that are presented to the pilots in multiple pages.)

Upper EICAS Messages



EICAS messages are color coded as follows:

EICAS MESSAGE	COLOR
Warning	Red
Caution	Yellow

EICAS MESSAGE	COLOR
Advisory	White
Memo	White

EICAS Warning Messages

MESSAGE	MEANING
AUTOPILOT DISC	Autopilot has disconnected, typically when selected by the pilots.

EICAS Alert Messages

MESSAGE	MEANING
SPEEDBRAKE EXT	Speedbrakes are extended and pilots should be aware that they have additional drag as a result.

EICAS Advisory/Memo Messages

MESSAGE	MEANING
APU RUNNING	APU is running
AUTOBRAKES RTO	Autobrakes are set to the RTO setting
AUTOBRAKES 1	Autobrakes are set to setting 1
AUTOBRAKES 2	Autobrakes are set to setting 2
AUTOBRAKES 3	Autobrakes are set to setting 3
AUTOBRAKES MAX	Autobrakes are set to the maximum setting
PARK BRAKE SET	Parking brake has been set
PACKS ON	All packs are "on"
SEATBELTS ON	Seatbelt signs are set to AUTO (which in the SSG 747-8 means they are "on")
SPEEDBRAKE ARMED	Speedbrake handle is armed to deploy spoilers on touchdown
YAW DAMP ON	Yaw damper is "on"

21.4 TRAFFIC COLLISION AVOIDANCE SYSTEM (TCAS)

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

<u>Traffic Display (TFC) Button</u>

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

On the 747, other airplanes can be displayed as a white open diamond (non-threat), a closed white diamond (proximate), a closed yellow diamond (Traffic Advisory), or a closed red diamond (Resolution Advisory). In a nutshell, all of this is based on how much of a threat another aircraft poses to your own aircraft based on the "closest point of approach" of your two aircraft. - SK

22.0 OPERATING PROCEDURES

22.1 GENERAL GUIDELINES

It goes without saying that the 747 in general, and the 747-8 in particular, is a very large aircraft. As a result, it is slower to respond to control inputs than a smaller and lighter aircraft. Jet engines also have an inherent delay in responding to changes in commanded thrust. Due to these factors, any pilot control inputs have to be made in sufficient time for them to be effective. Another factor to consider is that the 747 operates over a wide range of weights, and behaves differently at its lighter weights than at higher ones. In fact, 747 pilots have stated that it is harder to fly the 747 when it is very light because it climbs fast, everything happens very quickly, and it is easy to exceed flap and other speed limitations.

One thing that is different during climbout on the 747 is how long it takes to retract the flaps. At heavy weights the stall speeds are so high that your climb speed will be around 280, well above the 250-knot limit below 10,000 feet. From flaps 5 to 1 takes a long time (approximately 30 seconds), the airplane steadily accelerating all the while. Finally at flaps 1 and at a safe airspeed you can move the flap lever to "UP". - TG

One of Boeing's test program's goals was for the 747-8 to have the same flight characteristics as the older, and very successful, 747-400. That aircraft in turn behaved similarly to the so-called "Classic" 747s. Therefore, if you have experience flying other 747s in X-Plane or other desktop flight simulators, that experience should translate very well into flying the SSG 747-8.

If that is not the case, and you are a "newbie", this section of the Guide should help you fly the SSG 747-8 aircraft in an effective and professional manner. Clearly, a simple Guide cannot replace the hours of training and experience that real-world 747 pilots possess. Nevertheless, it should be sufficient to permit you to take off, fly long distances, and land safely in the SSG 747-8 within the X-Plane "plausible world." For additional practical guidance, we have also included a sample flight from takeoff to landing in Section 23 of this Guide.

22.2 TAXIING

One of the big difficulties for pilots transitioning to the 747 is the height of the cockpit above the ground, compared to other aircraft. The cockpit sits at 28 feet 5 inches (8.66 meters) above the tarmac, so it is difficult to see how fast you are going. Therefore, pilots use the groundspeed indicator on the ND and limit turns to 10 knots in normal conditions, and 3 to 7 knots in adverse conditions such as ice and rain. In a straight line, speeds should be limited to 25 knots, while 15 knots is the preferred taxi speed in wet conditions, and 10 knots for icy conditions.

Furthermore, the main landing gear is located 97 feet 4 inches (29.6 meters) behind the nosewheel, and Boeing has provided the aircraft with a system called “body gear steering” that turns the body gear in the opposite direction of the nosewheel to aid in turns. This feature has been implemented on the SSG 747-8 and operates automatically.

To time turns while taxiing, one rule of thumb that works for 90 degree turns in 747s from the 747-100 to the 747-400 (which had a shorter body length compared to the 747-8) is to wait until the centerline of the taxiway or runway you want to turn into is parallel to the pilot’s shoulders, and then start the turn. The 747-8 is a bit longer, but this is still an effective technique because the nose gear lies just behind the vertical plane of the pilots’ seats.

In X-Plane, one can also access external views to see the aircraft from behind and above the aircraft to judge when a turn has to be initiated. While this is unrealistic, it is a helpful technique to use when learning how to taxi the huge 747-8 around airport tarmacs.

On the real aircraft, differential thrust (using engine power on either side of the aircraft) can be used in slippery conditions, or during tight turns to avoid stopping during the turn. If this happens, significant thrust would be required to start moving again. Also, one should straighten the nosewheel and then use it to turn again only once the aircraft starts moving to avoid putting too much stress on the nose gear.

One consideration that is not an issue in a simulator, but that should be adhered to for the sake of realism and professionalism, is to limit the amount of thrust used while taxiing. The aircraft’s engines generate a great deal of thrust, with an exhaust velocity of 50 MPH (80 KPH) when they are at idle. Therefore, excessive use of thrust can create a lot of damage to the ground vehicles and aircraft servicing equipment found at airport ramps. The jet efflux can also damage, or even overturn, other aircraft – particularly smaller ones.

22.3 TAKEOFF AND CLIMB

Due to the large variation in weights for the 747-8, the amount of runway the aircraft requires for takeoff will vary. The following are some field length guidelines for takeoff at Maximum Takeoff Weight (MTOW). Of course, lower weights will require less runway, and a headwind will reduce the distance required, among other factors.

Takeoff Field Length:

Minimum 5,000 ft (approximate, MTOW sea level, standard day)
Maximum 10,000 ft (approximate, MTOW sea level, standard day)

It should be noted that real 747 flight crews have sophisticated tables for various runways to calculate planned takeoff lengths that take into account wind, runway slope, and various performance penalties. They also have dispatchers and specialized performance-related computer systems at their disposal. However, such tools are beyond the scope of this Guide.

Flaps

Flap selection for takeoff is normally 20 degrees on the 747-8, but 10 degrees of flaps can be used as well. On the 747, leading edge flaps (in front of the wings) are deployed automatically in sequence with the flaps. One feature of the 747-8 versus older 747 models is the implementation of “flaperons”, in which both the inboard and outboard ailerons droop with the application of flaps to provide additional lift for takeoff and landing. The next time you fly as a passenger on a 777 or 747-8i, and sit behind the wing, you can see this system in action. This feature been implemented in the SSG 747-8 as well and is automatic.

Take-off Speeds:

Different V-speeds (“V” stands for “velocity”) are calculated for large transport aircraft to enable takeoffs to be accomplished safely. V_1 is the speed at which the pilots are committed to takeoff, so any faults identified before V_1 will cause pilots to abort the takeoff. After V_1 it is best to take off, address the issue, and land as soon as practical under the circumstances. While it may seem undesirable to take off with a known fault, rejected takeoffs are very hazardous. Brakes get extremely hot, and at speeds above V_1, stopping before the end of the runway may not be possible. Not all airports have flat, open, and undeveloped land beyond the runways, so this is not considered a viable option.

V_R is the rotation speed (when the pilot starts pulling back on the yoke for takeoff) and V_2 is the safe flying speed after which the landing gear can be retracted, as long as a positive rate of climb is achieved.

This table provides approximate takeoff speeds from low takeoff weight (TOW) to maximum TOW (MTOW) which is (500 - 987,000 lbs / 225 - 447,696 kgs) at normal N1 engine power setting, with a clean and dry runway:

V SPEED	FLAPS 10 (KTS)	FLAPS 20 (KTS)
V_1	127 - 159	127 - 154
V_R	127 - 177	127 - 170
V_2	149 - 188	147 - 181

Note: Maximum tire speed for the 747-8 is 235 MPH (376 KPH)

Takeoff Technique:

With respect to technique, once you are lined up on the runway, increase thrust evenly and smoothly up to 70% N1 and allow the engines to stabilize. Then, smoothly apply takeoff power. At V_R, pull back on the yoke at 2 to 3 degrees per second until reaching 10 degrees nose up (you don't want to get a tail strike, which on the 747-400 can occur at 12.5 degrees with the wheels on the ground). The 747-8 has built-in tail strike protection, but this feature has not been implemented in the SSG 747-8.

On the real 747-400 and 747-8, once the engines have stabilized upon advancement for takeoff, the TOGA switch is then pressed. This engages the autothrottles, which then advance the engines to the calculated thrust setting. From then on, on a typical flight, the autothrottles will control the engines all the way up until shortly before touchdown when the autopilot and autothrottles are disengaged for landing; that is, of course, unless an autoland is accomplished. - SK

Once the aircraft is airborne, you can increase the pitch up to 15 to 20 degrees for the climb, typically following the FD cues. After gear retraction, lower the nose to about 10 degrees for the rest of the climb. Among other things, this will start building speed and increases passenger comfort (not everyone likes that "rocket ship" feeling).

After rotation, ensure the aircraft is accelerating past V_2+10 knots, and after 1,500 feet, set climb power (slight reduction in thrust, certainly below 100% N1). The altitude for power reduction is set in the real 747-8 using the FMS, and is implemented in simplified fashion in the SSG 747-8. Also, if you own the excellent "UFMC" plug-in for X-Plane from FJCC, a customized configuration file for that add-on is included with the SSG 747-8. A freeware plug-in with similar functionality called "X-FMC" is also available, and a configuration file for this plug-in also is included in this package.

The autopilot can be engaged 250 feet above the runway, if desired. When flying manually, and an early turn after takeoff is desired, perform the turn once you are at least 400 feet above the airport, and limit the bank angle to 15 degrees at this point. The aircraft has a large wingspan after all, with large pod mounted engines slung below those wings so excessive banking performed too close to the ground could result in aircraft damage.

A typical takeoff can be conducted as follows:

1. Set target altitude to 3,000 feet, heading to match runway heading, airspeed to 220 knots, and vertical speed to 1,500 feet in the MCP windows. Compare to values on PFD.
2. Engage the FD switch on the MCP, and check that FDs activate on the PFD.
3. Set flaps, autobrake to RTO, and release the brakes.
4. Engage THR button on MCP, then press the TOGA button.
5. Accelerate to liftoff, unstick to climb, retract gear, retract flaps once radar altitude is more than 400 feet, engage CMD for autopilot operation above 1,500 feet, ensure vertical speed is set in the window is at least 1,500, push V/S to engage the vertical speed climb mode.
6. Once level at 3,000 feet with ALT engaged, set the roll mode to HDG.

After 3,000 feet, and while still accelerating, start retracting the flaps one notch at a time, adhering to the flap limit speeds (listed at the end of this guide and placarded on the panel). In many countries, the speed limit below 10,000 feet is 250 kts, so once you climb above 10,000 feet, start accelerating to between 300 and 310 kts for the rest of the climb until reaching cruising altitude (above transition altitude these are referenced using the term “Flight Level” or “FL”), at which time the operating speed is expressed in terms of percentage Mach (which is the speed of sound at that altitude), for example “Mach 0.84”.

In the U.S. transition altitude is 18,000 feet, although it will vary from country to country and terminal area to terminal area. At the transition altitude, all aircraft adjust their altimeters to the standard value of 29.92 inches of mercury (or 1013 Hectopascals) so that every aircraft is using the same plane of reference.

<u>ROC Rate Of Climb</u>

These are some standard target rates of climb for the 747-8, depending on weight.

Below 10,000 ft
- ✈ Maximum 3,800 feet per minute (FPM) at 250 kts

Above 10,000 ft to Cruise FL

- 2, 200 FPM — from 10,000 - 20,000 ft at 280 - 340 kts
- 2,000 - 1,500 FPM — from 20,000 - 26,000 ft
- 1,500 - 400 FPM — from 26,000 - 35,000 ft

Hand Flying and Trim

Those of you with real flying experience, and particularly instrument flying experience, understand the value of trim for proper flying technique. The importance of trim is a bit more difficult to appreciate in a desktop flight simulator like X-Plane because control forces are not normally fed back to the flight controls that are used to control the simulator.

Stabilizer trim (which adjusts pitch, or the up/down motion of the aircraft nose) is particularly important, and the goal is for the aircraft to maintain its attitude when controls are relaxed. In other words, if you let go of the yoke/stick, there should be no change in aircraft pitch. Be aware that large jet aircraft with swept wings like the 747 operate at a wide range of pitch angles (just look at a 747 on approach compared with a Cessna single-engine aircraft on approach and you will see the difference).

22.4 CRUISE

Upon reaching cruising altitude, the aircraft should capture the set altitude (if on autopilot) and maintain it as desired. Cruise altitude for the aircraft is typically 28,000 to 35,000 ft (depending on weight). At higher weights, it may be necessary to level off at a lower altitude and burn off fuel, climbing incrementally (in what are called “step climbs” typically of 2,000 to 3,000 feet) in order to reach the target cruising altitude. The 747’s high bypass engines are more efficient at higher altitudes, which can only be reached once the aircraft is sufficiently light (otherwise the engines have to work too hard to maintain cruising speed and it may not be possible to hold altitude.)

In general, flying the 747 can be expressed simply as “a pleasure.” The stability is almost unmatched. And by stability I mean flight control stability as well as speed stability. The only time speed stability isn’t so good is during approach if you get behind the power curve, but that’s true in any airplane. Except for that uncomfortable regime of flight, if you set an airspeed, the airplane maintains it. If you want to fly Mach .85, the airplane flies Mach .85. The Mach indicator is expressed to the thousandth position, such as Mach .851. In light turbulence, the thousandth number rolls back and forth slightly, but in smooth air, it almost never changes. - TG

Cruise Performance:

Typical Cruise Speed	0.80 - 0.85 Mach @ FL280 - FL350
Max cruising speed	0.845 Mach (-8F) / 0.855 Mach (-8i)
Maximum Operating Speed (M_{MO})	0.90 Mach (365 kts)
Never Exceed Speed (M_{NO})	0.92 Mach

Note: Apparently, the 747-8 has been flown up to 0.98 Mach during flight-testing!

22.5 DESCENT

First, you should determine the amount of altitude that you need to lose, or the Top of Descent (TOD). For a typical 3-degree descent, the gradient is 300 feet per nautical mile. For example, if you are at FL310 and want to descend to FL040 (a typical altitude above the ground for the start of an ILS approach) you take the difference of 27,000 feet (31,000 - 4,000 = 27,000) divide by 300, and get 90 miles for TOD. So you need start your descent 90 NM from the start of the approach (which you can estimate as roughly 12 or so miles from the runway threshold). This "dividing by 3" method gives you the added resource of using groundspeed x 5 (or divide by 2) to maintain the 3-degree descent. So if you start your descent 90 NM out with a ground speed of 500 knots, you need 2,500 feet per minute. However, some pilots recommend adding an additional 20 NM if a straight-in approach is anticipated. An easy way to determine the distance to the airport is by using the FMS.

Because the aircraft is so aerodynamically clean, and the wing is swept and efficient, descent should be initiated by closing the throttles and pushing the yoke forward to achieve approximately 340 knots and 3,000 feet per minute of descent. Or you can dial in the rate of descent and new target altitude into the autopilot, remembering to adjust the speed either manually or by using the autothrottle.

Before passing through 10,000 feet, you should reduce your speed to 250 knots to comply with typical ATC speed limits below that altitude. Use speedbrakes if necessary, otherwise reduce your rate of descent and the aircraft's speed by using pitch. All of these factors interplay with each other, and it takes some experience and finesse to get it right. Incidentally, this learning curve is common for real pilots who are transitioning to jets. Some jet aircraft just don't seem to want to slow down.

Below 10,000 ft the rate of descent can vary, but should be between 1,600 and 2,400 FPM depending on whether speedbrakes are used. Remember to adhere to flap limit speeds during the descent and bring in the flaps on schedule to slow you down and provide sufficient lift for the approach phase of the flight.

Here are some guidelines for flap extensions under normal procedures.

250 kts:	(10,000 ft and below during descent): Flaps 1
220 kts:	Flaps 5
200 kts:	Flaps 10 (typically on the downwind/base leg of the traffic pattern)
180 kts:	Flaps 20 (early final)
170 kts:	Flaps 25 (glideslope capture, typically Flaps 25, then gear down)
V_{REF}+5-10	(depending on wind): Flaps 30 (short final but after gear extension).

Note: V_{REF} is calculated as V_{SO} x 1.3 and is specified for a particular flap setting (25 to 30 degrees). V_{REF} will be reduced when landing at less than the MLW.

V_{SO} is the stall speed with full flaps and gear down
V_{S1} is the stall speed in the clean configuration

22.6 APPROACH

Once in the airport vicinity and using an ILS (for example), descend on the ILS glideslope at between 1,500 and 500 FPM (ideally 600 to 700 FPM), but in all cases following the needles. Then reduce the rate of descent at the runway threshold to between 400 and 200 FPM for a smooth touchdown.

Approach Speed:

The approach speed ranges from low to maximum operational landing weights, (450 to 757,000 lbs / 205 to 343,370 kgs) using Flaps 25. These values are for the Freighter, the Intercontinental passenger model has lower landing weight values.

V SPEED	LOW WT	MAX WT
V_{so}	112	152
V_{s1}	152	214

Standard Approach:

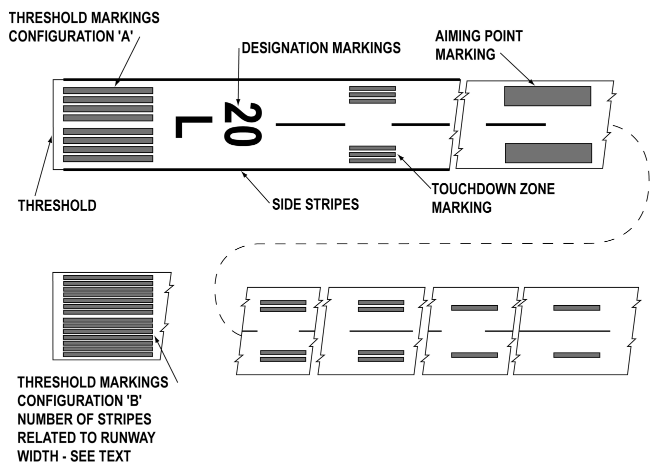
- Approach speed 150 to 180 kts
- Typical approach speed 153 kts
- V_{REF} 121 to 156 kts

Range is from Low LW to MLW (450 to 757,000 lbs / 205 to 343,370 kgs), again, these values are slightly lower for the Intercontinental.

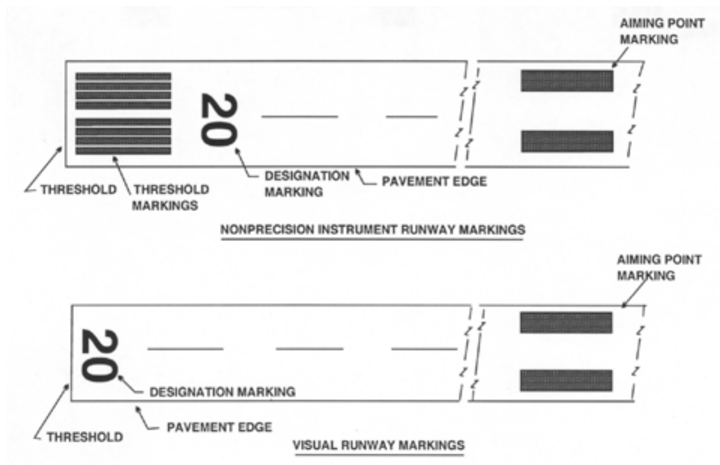
V_{REF}	LOW WT (KTS)	MTOW (KTS)
V_{REF25}	125	160
V_{REF30}	121	153

22.7 LANDING

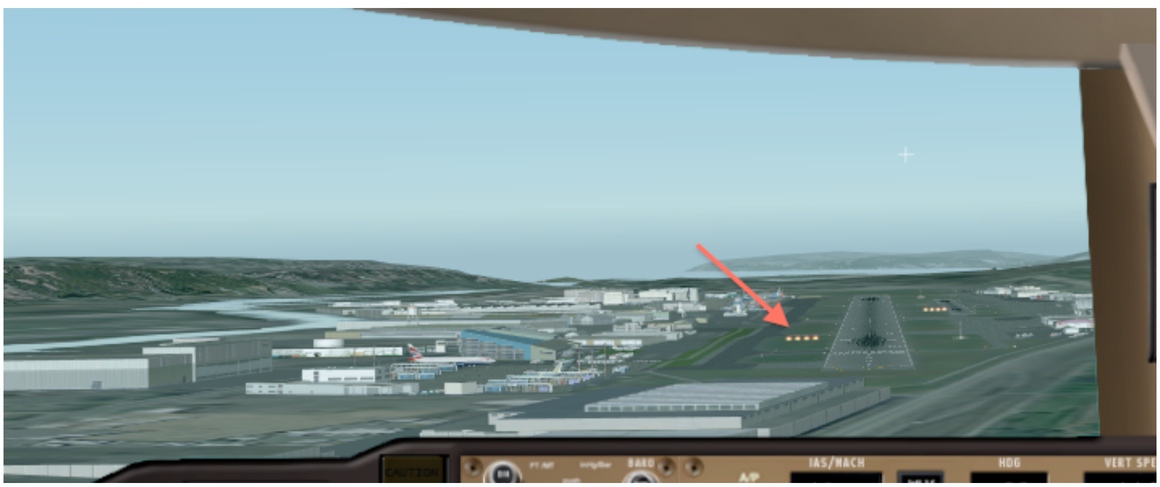
On finals to the runway, you should aim towards the far end of the aiming point markings on the runway. The markings should also appear fixed and not rising or descending as you approach on glideslope. Of course, if Visual Approach Slope Indicator (VASI) or Precision Approach Path Indicator (PAPI) lights are available, use them because they are more accurate. See below for images of what these aiming point markings look like: [2]



[2] Taken from the FAA's Aeronautical Information Manual (AIM) at http://www.faa.gov/air_traffic/publications/atpubs/aim/



These are VASI lights as seen in X-Plane:



As you get closer to the runway threshold, things start happening faster. The rate at which the aircraft descends through the radar altimeter callouts of "100 - 50 - 40 - 30 - 20 -10" helps real 747 pilots because they can keep their eyes outside and use their hearing as another sense to measure their rate of descent. At 50 feet, the runway threshold should just be passing under the nose of the aircraft.

These callouts used to be made by the copilot (or pilot-not-flying), but on newer aircraft it is a computer-generated voice. You may be able to see this in action in videos shot in the cockpit of 747s that are available commercially and on the Internet. These callouts are also audible in the SSG 747-8.

At 10 feet, close the throttles and start raising the nose 1 to 2 degrees for a very gentle flare. Do not pull back too much or you risk a tailstrike. If you have timed things right, the airplane should settle nicely on the 16 wheels of the main landing gear. This is a feature that makes 747 landings smoother than on some other large aircraft because they absorb a lot of energy.

The 747-8 has a "flare assist" function to make landings easier. And coming from experience, I feel that it is not enough. The 747-8 requires a pilot to make a more deliberate effort to flare the aircraft than the 747-400. On the -8, once the throttles are chopped for the landing, the airplane tends to run out of airspeed fairly quickly. As such, many of us delay our throttle reduction on the -8 relative to the -400. It takes a more concerted effort to flare the aircraft than pilots are used to in the -400. - SK

Engage the reverse thrust and use as much reverse as needed until you reach 80 knots, at which point you should reduce to idle reverse down to safe taxi speed. Then disengage the reverse thrust and brake manually, or you can preset the autobrakes to do that for you.

The reason these reversers are disengaged as the aircraft slows is to avoid ingesting debris into the engines. Modern carbon brakes are so effective that idle reverse thrust sometimes is sufficient (and it is also environmentally friendly in terms of noise and pollution).

Landing Field Lengths:

FLAPS 25	
Minimum	5,000 ft (approximate value for dry runway at sea level)
Maximum	8,600 ft (approximate value for dry runway at sea level)

Here's an industry secret: The 747 is one of the easiest airplanes to land. Once you comprehend the concept of inertia and once your mind gets caught up to the speed if you came from slower airplanes, the 747 makes beautiful landings almost every time, and only part of it is because of pilot skill. Of course, gusty winds can make you a little nervous with the low-hanging engines way out on the wing, so keep your bank less than five degrees to avoid a "pod strike."

Landing the 747 is mechanical. There is little "feel" involved. Unlike smaller airplanes in which you can use peripheral vision to gauge height and forward vision to measure rate of descent, the high upper deck on the 747 takes away those aids. Depending on your landing weight and approach flaps, there are fixed pitch angles for approach and flare.

Just like in all airplanes, a stable approach leads to a stable landing. Because of the long wingspan of the 747 you enter ground effect just under 200 feet above the ground, and it's instantly recognizable to newcomers on the airplane. People aren't expecting ground effect at 200 feet, so typically new 747 pilots initially shallow their rate of descent inadvertently and let the airspeed drop when entering ground effect. Once you recognize and train your arm to counteract the nose-up tendency around 200 feet you will remain on the glide path until touchdown. - TG

23.0 SAMPLE FLIGHT

The following is a tutorial on a typical flight in an SSG 747-8 to familiarize you with the operation of the aircraft in a standard environment using the sample aircraft checklists found in Section 24 of this Guide.

23.1 PLANNING

Planning a flight for the 747-8 can be accomplished in the same way as a flight for any other X-Plane airliner or advanced aircraft. Virtually all airline operations are conducted under Instrument Flight Rules (IFR) regardless of the weather. This means that some familiarity with IFR procedures is important. However, it is possible to do this in X-Plane with a minimum of effort, with or without involving Air Traffic Control (ATC). All that is required is to pick a departure and arrival airport, determine the distance and fuel required, and choose a routing. There are various on-line tools available to do this, which will not be listed here. One good option is to look for a real-world flight on sites such as Flightaware.com and copy the flight plan to make things easier. These days, navigation charts for most countries are available on the Internet as well. U.S. terminal charts, for example, can be found at www.airnav.com

One interesting planning note is that the 747-8 reportedly consumes the same amount of fuel for a given route as the 747-400. At first that does not seem like an amazing achievement, except when you consider how much bigger and heavier the -8 is compared to its -400 cousin. Many planning tools are available for the 747-400, so those can be used. A good rule of thumb is that the 747 consumes about 10 tons (10,000 kgs) of fuel per hour, which should get you into the ballpark, and then add some reserves to that "trip fuel" figure to avoid surprises.

For today's flight, we are going to take a brand new 747-8F from the factory in Everett, Washington, Everett Paine Field (KPAE) to a customer in Oakland, California, at Metropolitan Oakland International Airport (KOAK), from where a company crew will take over for its first revenue flight. Here is the flight plan for this flight.

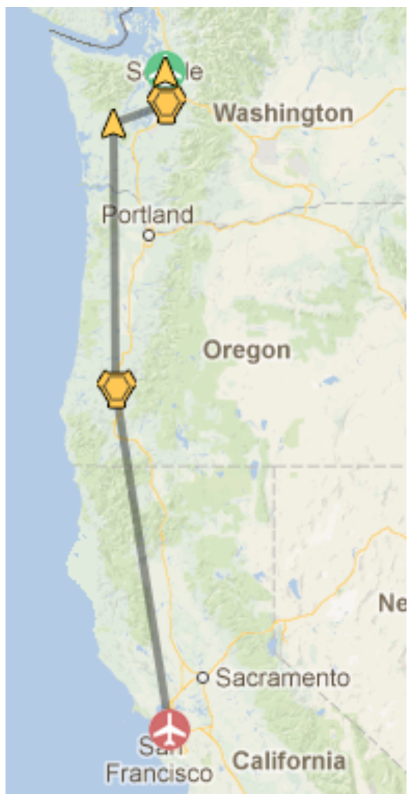
Planned Route:

```
KPAE-KOAK
Duration:             1 hour 38 minutes
Speed Filed:          453 kts
Altitude Filed:       FL370
Distance Planned:     654 NM
Route:                SEA J70 ELMAA RBG RAIDR2
```

By entering this flight plan information into an on-line flight simulation planner like www.simroutes.com, we get the following flight plan:

IDENT	NAME	FREQ	CRS
KPAE	Snohomish Co		
SEA	Seattle VOR	116.80	182
ELMAA	ELMAA Intersection		249
RBG	Roseburg VOR	108.20	179
RAIDR2	Raidr Two Arrival		-
KOAK	Metropolitan Oakland Intl		171

A map of the planned route is shown below:

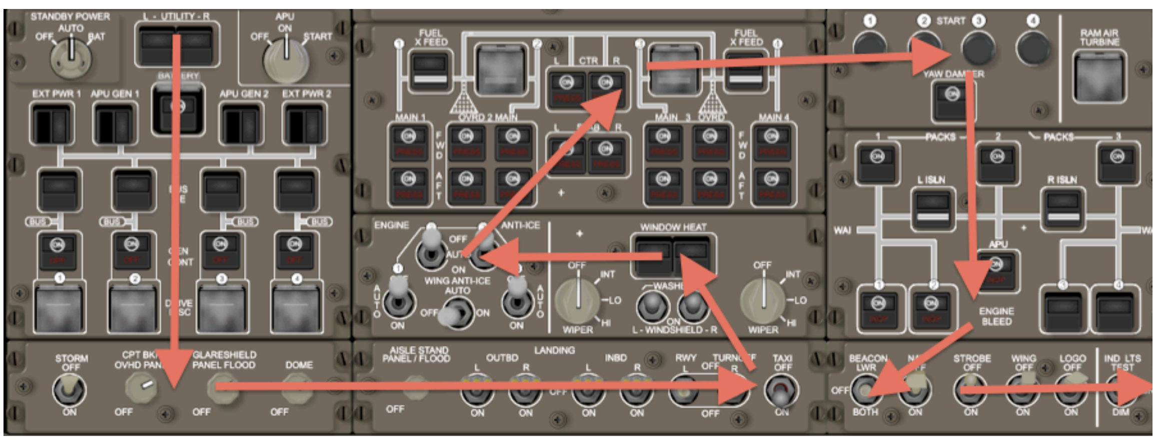


23.2 FLIGHT DECK ACCESS AND PREFLIGHT

Typically one pilot conducts a preflight walkaround of the aircraft, while the other prepares the cockpit and starts loading flight plan information into the FMS.

One thing about the 747 that you never get past is how immense it really is. No matter how many times I performed the external walkaround (preflight) I was in awe at its size. Everything is Jumbo: The wheels, the struts, the engines, the wings, the height, the wingspan, radome, everything. Standing underneath the 747, if you reach up with your hand, you might be able to touch its belly. Getting to the flight deck of the 747 requires strength, endurance, and patience. We carried 18 flight attendants and while they conduct their preflight checks with the army of cleaning people, it creates quite an obstacle course just to get to the stairs. The stairs to the upper deck can be windy or straight, depending on the model of 747, but both require careful adeptness to twist your elbow while dragging your bags up the stairs and around the corner. If the upper deck is equipped with economy class seats, you have to walk past 66 seats, the lavatories, and eventually reach the flight deck. -TG

In the cockpit, this preparation is accomplished by the use of “flows”, which are learned patterns that pilots use to make sure that all knobs, levers, switches, and buttons, are in their correct position for departure – mainly to ensure that the aircraft is “safe” and that nothing untoward will happen once systems are powered up. A sample flow showing the SSG 747-8 overhead panel is reproduced below:



An important note here is that there are two basic preflights. One is for an aircraft that is “cold and dark” where none of the systems are powered, such as in a first flight of the day. The other is a “through flight” where pilots will board an aircraft that has just come in (or that they have flown in themselves) and where certain systems are already up and running.

23.3 COCKPIT SETUP

Once all the flows have been completed, we can then set up the cockpit for departure using the POWER UP checklist and starting the APU, loading the flight plan in the FMS, and turning on our NAV lights (these should be "on" whenever the aircraft is powered up). We can then go through the BEFORE START checklist. An important check at this point is ensuring we have the required fuel on board. Once this entire process is completed, we are ready for pushback and start. Because the aircraft is on the test ramp, we can start our engines and taxi out directly for today's flight.

Because the flight deck on the 747 is on the upper deck where the top of the fuselage narrows, the pilot seating area is surprisingly small, considering the immensity of the aircraft. If you're not careful you'll bang your head on an overhead switch or a window pane. However, the 747 flight deck is very deep from door to windshield. Sitting in the pilot's seat provides a vantage point unique to the 747. At first you are surprised at how high above the ramp you actually are. The ramp personnel are waaay down there. Sitting in the Captain seat, you see the TOP of the jet bridge. Which in some ways is disappointing because you can't interact with the waving children or see the smiles of the passengers excited for their journey. - TG

23.4 ENGINE START

Today the APU will provide the bleed air necessary to start our engines. We turn the beacon lights on to alert ground personnel and other aircraft that we are starting our engines and then ensure the parking brake is set before we start our engines. Each engine is started by pulling its overhead start switch and then setting the fuel control for that engine to RUN. The autostart system takes over from there (manual starts are not enabled in the real 747-8). In the SSG 747-8, the fuel control switch is operated first and then the start switch is engaged because of its position on the 2D panel. The starter needs to be engaged for approximately 10-15 seconds, at which point the Upper and Lower EICAS screens can be monitored to verify the engine has started and is running at idle. This process is then repeated for the other 3 engines.

We then run through the AFTER START checklist and ensure that all engines are running normally, and the aircraft is ready to taxi. Flaps can be lowered to the desired takeoff setting (20 degrees today) and the flight controls checked for freedom of movement and correct indication on the Lower EICAS.

When ramp control gives you clearance to push and the tug starts pushing you rearward, the height of the ground makes it difficult to discern whether you are moving. As such, sometimes you have to rely on your IRS/INS ground speed to verify you are in fact, moving. - TG

23.5 TAXI

Once the AFTER START checklist is complete, we double-check the following, on the overhead panel:

- Bus Ties all AUTO
- Yaw Damper OFF
- APU OFF
- APU Bleed OFF
- Engine Bleed ON

Then we turn our taxi lights on and because winds are calm, we can depart southward on course. So we release the parking brakes and begin our taxi to the departure end of runway 16R. If winds favored a northbound departure, we would have had to select a different runway.

After the engines are started, the tug pulls away, and the ground personnel give you a salute, you begin rolling forward. Taxiing the 747 is a unique experience. The flight deck is so high above the ground that the taxiways (and runway) appear very narrow. One item that Boeing never improved upon was the tiller. You have to grip an oval-shaped handled attached to a crank, which is then mechanically connected to the nose gear. The force required to turn the tiller is noticeable if you are wearing a ring. The oval handle digs the ring into the side of your finger as you make turns. Eventually I removed my ring during taxiing.

Looking forward from the cockpit, the cutoff angle is such that you cannot see the ground for 65 feet in front of the nose. At some stations, marshallers stand on elevated platforms so you can see their guidance, rather than having them disappear under the nose. And of course, you always have to be mindful of thrust. Four engines, each producing 56,000 pounds of thrust (on the 747-400), can cause great damage to unsecured objects behind you. Below a takeoff weight of 600,000 pounds, no thrust above idle is necessary to move the airplane forward. Just release the brakes and go.

The perspective while taxiing the 747 is captivating when you first experience it. 777s actually look small. The top of the 777 fuselage is far below you. 737s look like crop dusters. When you wave to the A380 pilots, you look DOWN into the flight deck of the A380, which is positioned on the lower deck. But of course, the A380 flight deck, while on the lower deck, is a luxury suite compared to the 747 flight deck. - TG

23.6 TAKEOFF AND CLIMB

KPAE is a towered airport, and a typical departure clearance would include an instrument departure procedure, as well as a departure frequency and initial altitude. In this case, ATC clears us for a PAINE TWO departure with an initial altitude of 5,000 feet. Looking at the PAINE TWO departure procedure plate for KPAE, we see that the procedure for all runways is described as “fly runway heading or as assigned; expect vectors to join assigned route. Maintain assigned altitude; expect filed altitude/flight level five minutes after departure.” So our planned departure today will be to take off and fly a heading of 159 to our initial altitude of 5,000 feet towards the Seattle VOR.

These procedures would be studied even before pushback to configure and set all radios and selected altitudes and headings for the autoflight system. Also, pilots would review the departure procedure as well as any emergency procedures as part of a verbal departure briefing between the crew during the taxi to the runway. Setting up the aircraft for departure would include:

On the MCP:

- FD on
- A/T arm
- Target IAS set in window
- Set HDG in window
- Set target altitude in window

Lower panels:

- Seat belts AUTO
- Autobrakes to RTO
- Set stab trim in green band

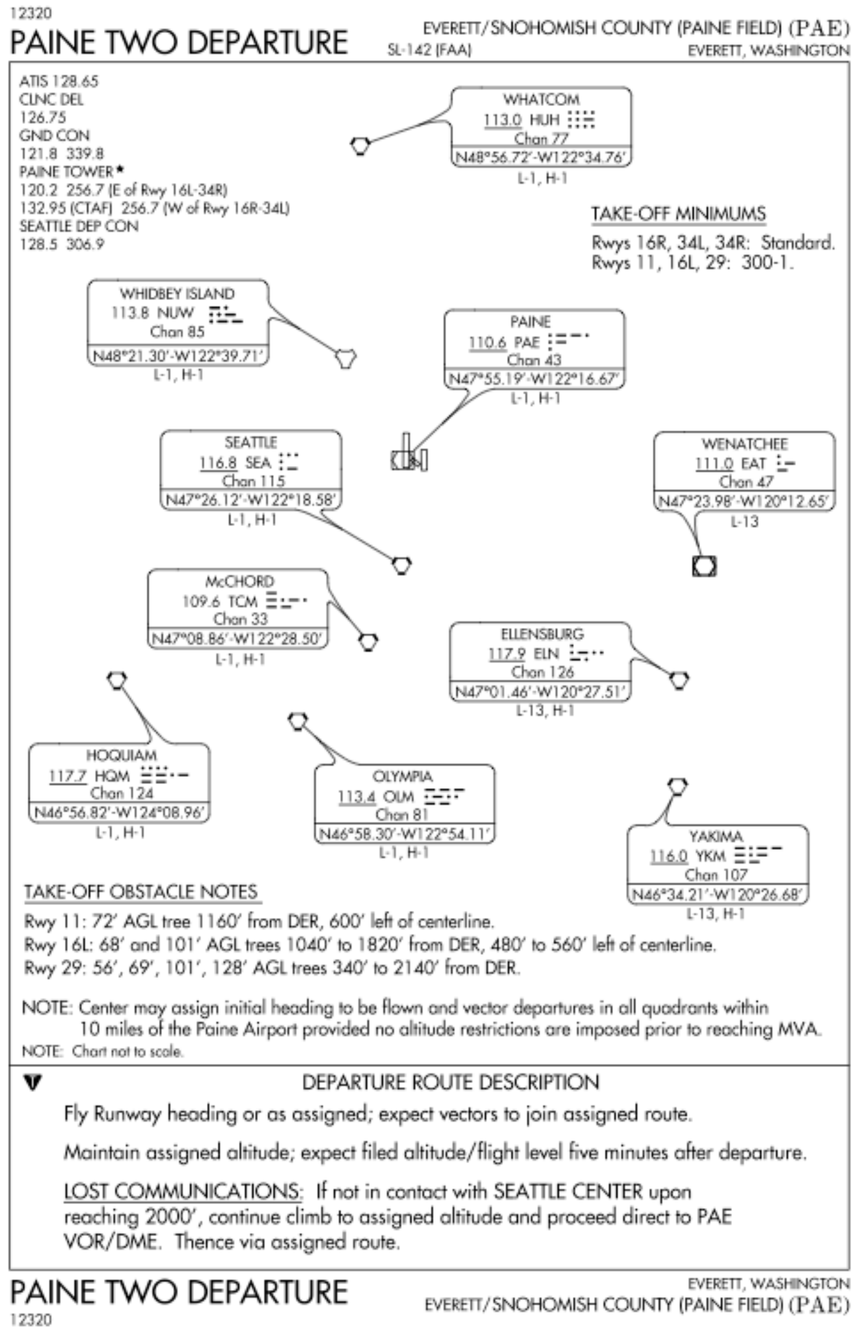
Once we are cleared on to the runway for takeoff, we accomplish the following:

- Signal the crew with the seat belt sign switch 2-3 times
- All lights and strobes on
- Push the HOLD button under the HDG window on MCP to track the heading on the FD
- Push THR button on the MCP
- Push the TOGA button under AP ENGAGE on the MCP

Once the throttles are at the takeoff setting, we keep the aircraft on the runway centerline using the rudders. At V_1 we are committed to takeoff and we continue accelerating to V_R. At rotation speed, we accomplish the takeoff and start the climbout phase of our flight.

Taking off the 747 is unlike any other airplane. From the high cockpit the runway looks more like a sidewalk than a road. When ATC says, "Runway 09, cleared for takeoff" you manually advance the thrust to 40% N1 (on the 747-400). After ensuring that each engine is stable, press TOGA and the autothrust takes over. You feel the mechanical vibration of each thrust lever as they wind into position with a slight whirring noise, and you begin rolling. It looks like you are barely crawling when the PNF calls "80." The high cockpit dramatically reduces the sense of motion. Passing 100, then 120, each looks only slight faster than 80, which seemed slow. The red threshold lights come in sight and the PNF calls "V1, rotate." Lifting the nose at 3 degrees per second, the end of the runway disappears and just before liftoff, all you see are the treetops ahead of you some distance beyond the runway end. The plane gracefully lumbers into the air and climbs steadily. - TG

After takeoff, we select the landing gear UP, select climb thrust passing through 1,500 feet, and then bring in the flaps based on our predetermined schedule as we accelerate. Passing through our initial altitude of 5,000 feet we are then cleared to manually track towards the Seattle VOR, and then push the CMD button on the MCP, after which we can then capture the flight plan route, by pressing the LNAV button then LOC button on the MCP.



Approaching the Seattle VOR, which is located directly on the Seattle-Tacoma airport, the autopilot automatically starts the turn towards ELMAA intersection as we continue our climb. Then climbing through 10,000 feet, we can increase the speed past 250 knots to a proper climb speed, and most of the exterior lights can be turned off, except for the navigation and strobe lights, which stay on throughout the flight. Wing and nacelle anti-ice should be turned on when flying through cloud in temperatures close to freezing.

Then, while passing through 18,000 feet, which is the transition altitude in the U.S. the altimeter setting can be set to the standard 29.92 inches of mercury and we can set our speeds using Mach number. After the climb to 25,000 feet, we can then climb to our cruising altitude of 35,000 feet. After passing through ELMAA intersection, the autopilot automatically tracks directly towards Roseburg VOR on our way South towards our destination.

23.7 CRUISE

Once we have leveled off in the cruise, the autopilot indicates it has captured our target altitude with a chime and we can enjoy the view, with Portland, Oregon passing by on our left.

We can select airports on the ND and thus see "KPDX" and a circle indicating the location of Portland International airport. In the cruise, we settle on a speed of M0.86 or 0.86 times the speed of sound, which in today's conditions gives us a groundspeed of 494 knots. Because conditions are calm we can turn off the passenger seat belt sign.

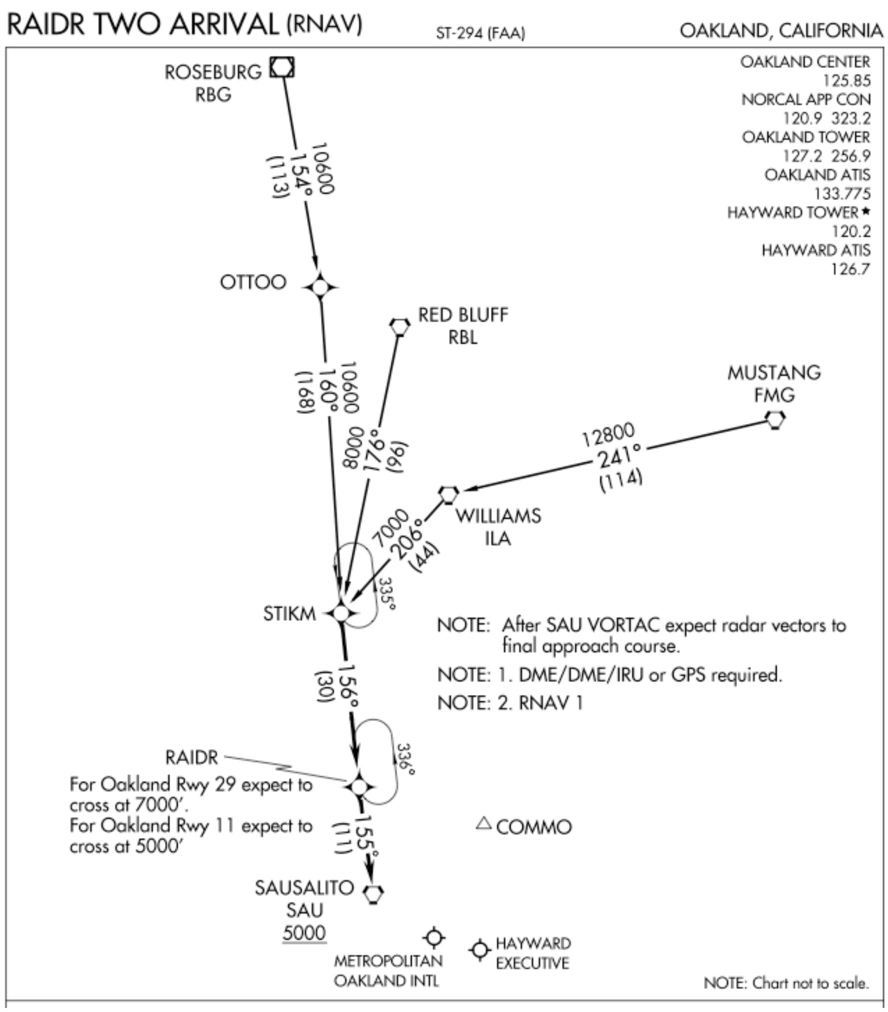
A short time of experience in the 747 creates a strong sense of invincibility, whether real or perceived. In turbulence, the mass of the giant bird just shudders casually, accompanied by a hollow rumbling of the fuselage. As the turbulence approaches the strong side of light, the seatbelt sign should be turned on. Although it may feel light in the cockpit, the rear of the airplane experiences more of a jolting sensation. - TG

In the cruise at 35,000 feet, we can monitor the aircraft systems by going through the various synoptics on the lower EICAS, keeping an eye on our fuel state (including fuel temperature), and also looking out for traffic on the ND, and visually where possible. Passing by Eugene, Oregon, we check our destination weather and keep an eye on weather at diversion airports as needed. We also perform periodic checks of our winds at altitude to determine if we are going to be consuming more fuel than planned and could have difficulty arriving at our destination on schedule.

One of the things that I immediately note when flying the 747-8 is how quiet it is from the cockpit. This is probably partially due to the standard noise-attenuating headsets, but even with the headsets off it is very quiet in there compared to the 747-400. Flying it sometimes reminds me of playing a video game with the sound turned completely off. The ECS will suddenly turn all 3 packs onto high flow for testing purposes every once in a while before turning them right back down to low flow. That and you hear the engines *groan a little when the thrust setting changes. Beyond these two things it's deafeningly silent in the cockpit. - SK*

We had already selected Roseburg VOR on our NAV2 radio and it now is within range, and we can use the DME distance to the VOR and compare it to the distance shown in our FMS as a double check of our position. Modern navigation systems are very reliable, but pilots routinely check their position, almost obsessively. This kind of cross-check procedure is also very important before oceanic crossings to make sure all on-board navigation systems are functioning correctly before there will be no ground based navaids available. At this point, we can start planning our descent and study our approach and landing procedures for Oakland International.

23.8 DESCENT



Passing the Roseburg VOR, we take a look at our RAIDR TWO arrival into Oakland and see that we can start our descent to 10,600 feet even though Oakland now lies over 300 NM away and we can see Medford, Oregon up ahead on our left. Clearly, there is a lot of traffic that needs to be sequenced into the Bay Area. Our first waypoint on the arrival is OTTOO, so we enter that into the FMS and fly towards it. We can then program the FMS to fly towards STIKM and RAIDR and Sausalito VOR with a final altitude no lower than 5,000 feet. At that point, we can start our approach into KOAK. We could have entered these waypoints on the arrival earlier, but sometimes clearances change and we would have to reprogram the FMS. The real 747-8 FMS can do this with one or two keystrokes, so that is easier to do than when using the default X-Plane GPS.

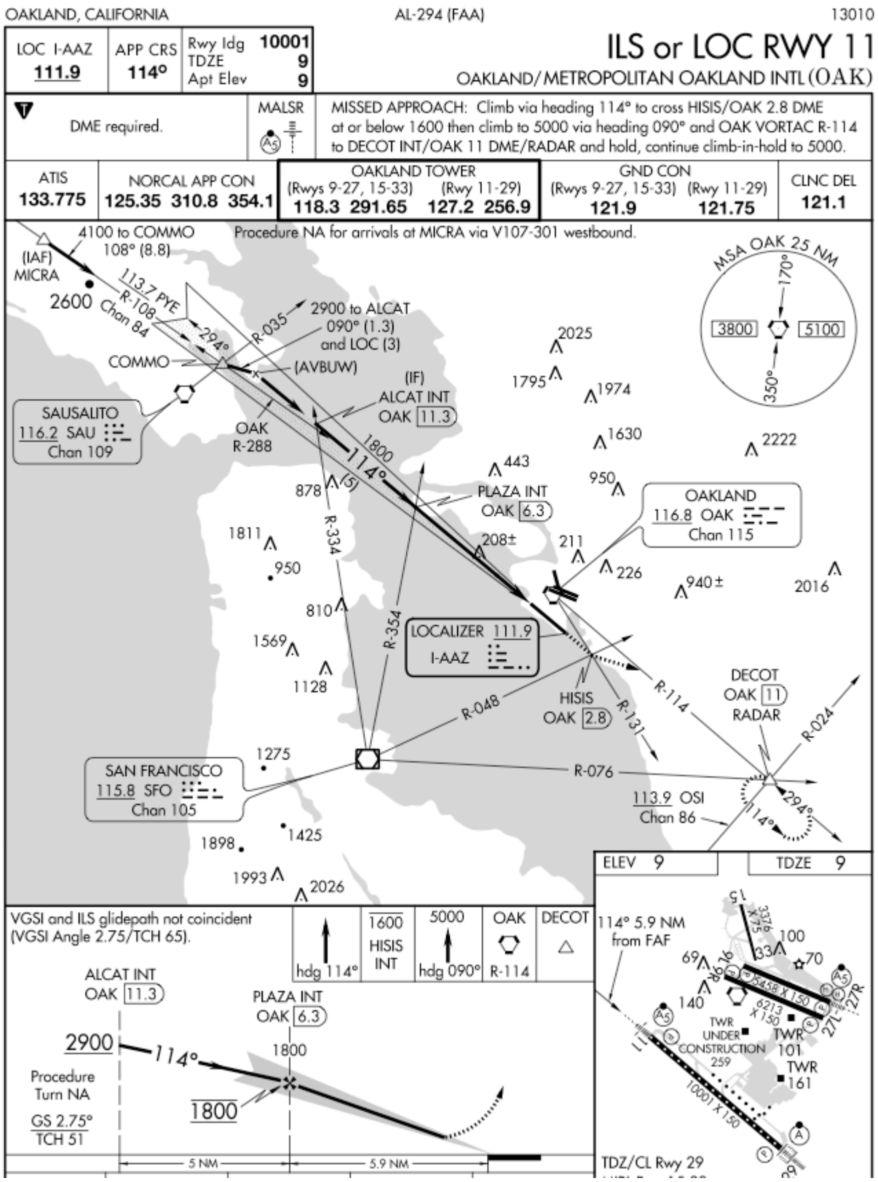
Fuel is still looking good, with winds pretty much as forecast, so we are confident we can make our destination without requiring a diversion at this point. As described in Section 22 of this Guide, without a published arrival, we could apply a "quick and dirty" formula to calculate our descent point if ATC does not ask us to descend sooner. In any case, we would run through the DESCENT checklist before we start to go down to the lower altitudes.

Unless ATC has provided us with a different altimeter setting, right before we descend through 18,000 feet we call up the ATIS information for KOAK to get the local altimeter setting that we can use below 18,000. On the real aircraft, pilots are able to get a lot of weather information, such as ATIS, via a datalink that can even send information to an on board printer in the cockpit's aisle stand. Passing through 10,000 feet, we turn the seatbelt sign on (if turbulence did not require us to turn it on sooner) and then turn on all lights to make our aircraft is more visible in this area of higher traffic. Also, remember that below 10,000 our speed limit is 250 kts. This is a good time to conduct the APPROACH checklist.

23.9 APPROACH AND LANDING

The RAIDR 2 arrival takes us down to 5,000 feet. We are going to fly the ILS approach for runway 11, so without radar vectors, after the Sausalito VOR, based on the approach chart for ILS RWY 11, we turn left to a heading of 090 degrees to intercept the ILS for runway 11. As we descend following the guidance on our chart, we tune and identify the ILS frequency of 111.9 and set the approach course of 114 degrees. We then select LOC on the MCP for the autopilot to intercept the localizer. Once the glideslope becomes active we select APP for the autopilot to fly the glideslope. In visual conditions like today's we can disconnect the autopilot and fly the airplane manually, following the FD prompts down to minimums.

We then accomplish the LANDING checklist to ensure the gear is down and locked, our speedbrakes are armed, and the autobrakes are set as required (higher settings are advisable if the runway is wet or we have to make an early turnoff).



The 747 has so much inertia, especially at heavier landing weights, that you can actually reduce thrust a little earlier than you can in lighter commercial airliners, such as the 737 where you have to maintain some thrust almost to touchdown. At 50 feet, and sometimes even higher, begin reducing thrust (assuming you are on speed and the wind is calm). At 30 feet, be at idle. Just before the “30” foot call on the radio altimeter, *begin the flare. Increase pitch 2 to 3 degrees above the approach pitch angle and feel the airplane settle deftly on the runway.*

Just at touchdown, you feel the rumble as each of the 16 wheels of the main trucks contacts the surface in sort of drumbeat announcing your arrival. The speed brakes will deploy automatically (if armed), so apply some backpressure as the nose falls to gently lower it to the runway. Apply reverse thrust as necessary, exit the next high-speed turnoff, and taxi to the gate. - TG

23.10 TAXI, PARKING AND SHUTDOWN

Once you the aircraft has slowed sufficiently on the runway, we exit the runway and clean up the aircraft, accomplishing the AFTER LANDING checklist, which includes items like turning off most of the lights and starting the APU, and otherwise cleaning up the aircraft. Now we are back in a taxi phase of flight and we can navigate to our parking spot.

23.11 POST-FLIGHT ACTIVITIES

Once the engines have been shut down, turn off the beacon and other lights, and complete the SHUTDOWN checklist. However, leave the navigation lights on to make the wingtips more visible while on the ramp, and the logo light can stay on for "advertising" purposes from dusk to dawn.

Airlines typically require crews to complete flight logs and maintenance logbooks to capture all the information for each flight. You can choose to record information such as the fuel used and the hours flown to see how close you were in your flight planning. At this point, the parking brake can be released as well. In real life, the aircraft would be chocked at this point, so they are unnecessary. Depending on whether it is a through or terminating flight, you could leave the APU and other systems on, or off. If it is the end of the flying day, complete the TERMINATING checklist.

To get used to these procedures, we have also included in the aircraft package 2 FMS flight plans representing test flights from the test ramp at KPAE to Seattle's Boeing Field / King County International Airport (KBFI) and vice versa - from the delivery ramp at KBFI to KPAE. The flight plan from KBFI to KPAE is more detailed using step down fixes to the KPAE Runway 16R approach, and is a good way to practice takeoffs to flight plan approaches to an ILS. To make the flights more immersive and realistic, we also recommend using Tom Curtis's excellent Seattle area scenery packages available at X-Plane.ORG. A good start position is the "South Test Ramp HEAVY" at KBFI for example. Also, we recommend setting the fuel quantity to 2 hours remaining because they are short flights.

SUPERCRITICAL SIMULATIONS GROUP

24.0 SAMPLE DATA CARDS

These can be filled out with target speeds and flap retraction and deployment schedules as a convenient reference for flight operations.

747-8

wt	TAKE-OFF FLAPS __ DRY THRUST	
V_1		INITIAL CLIMB ATTITUDE 15°
V_R		
V_2		
$V_2 + 10$		
V_{F5}	$(V_2 + 10)$	
V_{F1}	$(V_2 + 40)$	
V_{F0}	$(V_2 + 65)$	
V_1 WIND ADJUSTMENTS		
ADD 1 KT PER 15 KT HEAD		
SUBT 4 KT PER 10 KT TAIL		

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Landing	wt
V_{P1}	$V_{REF} + 60$
V_{P5}	$V_{REF} + 40$
V_{P10}	$V_{REF} + 20$
V_{P20}	$V_{REF} + 10$
V_{REF}	
V_{TH30}	
$V_{GA\ Min}$	

24.0 AIRCRAFT CHECKLIST

POWER UP

Battery	ON
Generators	ON
Inverters	ON
Avionics	ON
APU	START
Bleed Air	APU
APU Generator	ON
Nav Lights	ON

BEFORE START

Fuel Control Switches	CUTOFF
Throttles	VERIFY CLOSED
Fuel Quantity	CHECKED
Annunciators	TEST
Yaw Damper	ON
Performance Data	CHECKED AND SET
NAV Systems	SET
Altimeters	SET
Autopilot	SET
Seatbelt Sign	ON/AUTO
Beacon	ON
Fuel Pumps	ON
Parking Brake	ON

AFTER START

Bleed Air	BOTH
APU	OFF
APU Generator	OFF
Anti-Ice Systems	SET
Trim	SET
Autobrakes	RTO
Ground Equipment	REMOVED
Exterior Lights	SET

BEFORE TAKEOFF

Flaps	SET (10-20º)
Flight Controls	CHECKED
Take-off Data	CHECKED
Crew Briefing	COMPLETE
Cabin	READY AND ALERTED
Transponder	CODE & TA/RA
Exterior Lights	SET
Radar	SET
Takeoff Clearance	RECEIVED

AFTER TAKEOFF

Anti-Ice Systems	SET
Exterior Lights	SET
Gear	UP
Flaps	UP
Pressurization	SET

DESCENT

Terrain Clearance	CHECKED
Approach Briefing	COMPLETE
Seatbelt Sign	ON

APPROACH

Exterior Lights	SET
Descent Limit	….. ft SET
Landing Data	COMPLETE
NAV Systems	SET
Landing Data	SET
Autobrakes	SET
Speedbrakes	ARMED
Altimeters	SET

LANDING

Gear	DOWN & 3 GREEN
Cabin	ALERTED
Spoilers	ARMED
Flaps	SET (25-30º)

AFTER LANDING

Reverse Thrust	AS NEEDED THEN STOW
Exterior Lights	SET
Radar	OFF
Autobrakes	OFF
Speedbrake	DOWN
Flaps	UP
Transponder	STANDBY
Radar	OFF
APU	START
Pressurization	SET
Trim	SET

SHUTDOWN

Parking Brake	SET
APU Generator	ON
Fuel Control Switches	CUTOFF
Fuel Pumps	OFF
Anti-Ice Systems	OFF
Flight Directors	OFF
Exterior Lights	SET
Seatbelt Sign	OFF
Yaw Damper	OFF
Generators	OFF
Bleed Air	APU

TERMINATION

Electrical System	SET
APU	OFF
Bleed Air	OFF
APU Generator	OFF
Avionics	OFF
Nav Light	OFF
Battery	OFF
Inverters	OFF
Parking Brake	OFF

25.0 RECOMMENDED ADDITIONAL MATERIAL

The following books are references that SSG recommends in order to help you when learning to fly the SSG 747-8 in X-Plane.

- Davies, D.P., *"Handling the Big Jets",* U.K. Civil Aviation Authority, 2004

- Stewart, Stanley, *"Flying the Big Jets",* Airlife Publishing (particularly the 3rd edition that focuses on the 747-400 and was published in 1992. It is often available at on-line auction sites)

- Ray, Mike, *"The Unofficial Boeing 747-400 Simulator and Checkride Procedures Manual"*, University of Temecula Press, 2009 (also available on line as a PDF file at http://www.utem.com/)

AirUtopia has also produced an excellent DVD titled "Boeing 747-8F – Magic of Flight" that shows flights in the cockpit being performed by Global Supply Systems (GSS) pilots on behalf of British Airways Cargo in Europe and the Americas. This DVD is very well done, and informative, with various camera angles. It also includes a detailed walkaround of the aircraft and views inside the cargo compartment as well as loading operations.