Multiplayer Pilot Co-pilot Manual
Boeing 747-400

Version 2

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Flight Simulation Australia

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About this resource

This manual has been produced for the use of flight simulation enthusiasts, who wish to achieve the greatest possible level of realism when flying the default FSX Boeing 747-400. Specifically, it was developed to support those who wish to engage in pilot and co-pilot sessions sharing the one aircraft in FSX: Steam Edition multiplayer sessions. Procedures and checklists are adaptations of real flight operations. The Flight Procedures format is based on the Boeing Company's 747- 400 Operations Manual and Flight Crew Training Manual adapted to suit the default FSX 747-400. This publication therefore doubles as a 'How to fly the Boeing 747-400' tutorial. The multiplayer hosting and sharing of aircraft procedures could be applied to any aircraft in your virtual hangar.

Statement of copyright

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WARNING! These procedures and checklists were developed for use with Microsoft Flight Simulator X from research of a wide range of sources. The procedures and parameters are a close approximation of real flying operations. However, under no circumstances should they be used in real aircraft operations.

Setting up a Pilot and Co-pilot Multiplayer Session

FSX:Steam Edition Multiplayer enables you to share the control of a single aircraft with another person. This is a great tool for giving or receiving instruction over the Internet or a LAN with someone in the next room or in another country. In a training situation, for example, an instructor can demonstrate a manoeuvre, then hand over control to the student to practice it. This feature can be even more enhanced by establishing a simulated pilot co-pilot scenario and flying the aircraft under normal operating procedures. Not only is this good fun but it allows you to achieve a more "as real as it gets" experience. Having a pilot and co-pilot in a large aircraft such as the Boeing 747-400 enables you to share the heavy workload that exists on the flight deck, especially at takeoff and landing.

Pre-flight Planning

Being pilot and co-pilot in a Boeing 747 requires good teamwork. To get the most out of a pilot/co-pilot session there needs to be decisions made and important organisational and planning considerations addressed even before starting up FSX. The first decision is who is going to be pilot (Captain/Instructor) and co-pilot (First Officer/Student). Secondly agreement on who will be responsible for the various aspects of planning the flight is needed.

Things to consider in pre-flight planning include:

Time: Have an agreed date and time on when you are going to begin the session. Set aside enough time to complete the whole flight. Set a timeline for the completion of pre-flight planning requirements.

Conditions: You might agree on the conditions for the flight – location, time, weather etc. Alternatively, it could be up to an instructor or check ride captain to establish these variables.

Documentation: Gather all the necessary data and paper work needed to plan and execute the flight. Some of the resources you will need can be found in the Reference Information and Appendix sections of this manual. Other information will need to be accessed from external sources.

Requirements include:

- Flight plan
- Maps and charts (SIDs, STARs and approach plates)
- Weather conditions
- Fuel planning template
- Speed card
- Checklists

The preparation of this documentation involves processes similar to what real world pilots do in operation centres at airports prior to boarding the aircraft.

Photo: © Monika Wisniewska | Dreamtimes.com

Hosting a Multiplayer session

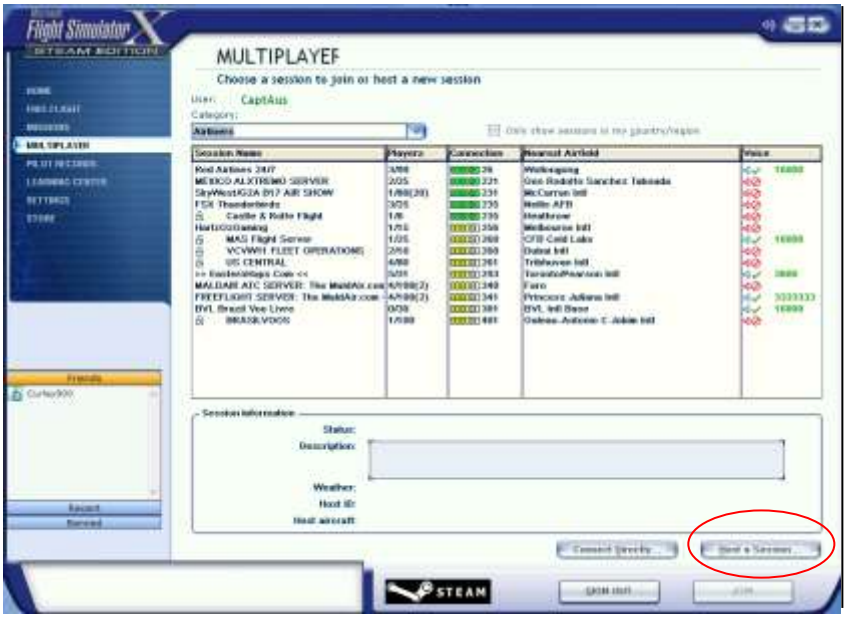
When you host a multiplayer session, you set the location, weather, and other conditions that all other pilots will experience in the flight. You can host over the Internet using FSX: Steam Edition Multiplayer, or host on a Local Area Network (LAN). As host, you can also provide detailed information about your session. For example, you can decide whether you want your session visible to everyone, or whether you want a private session with only friends and make the session invisible to others.

Setting up a Multiplayer session

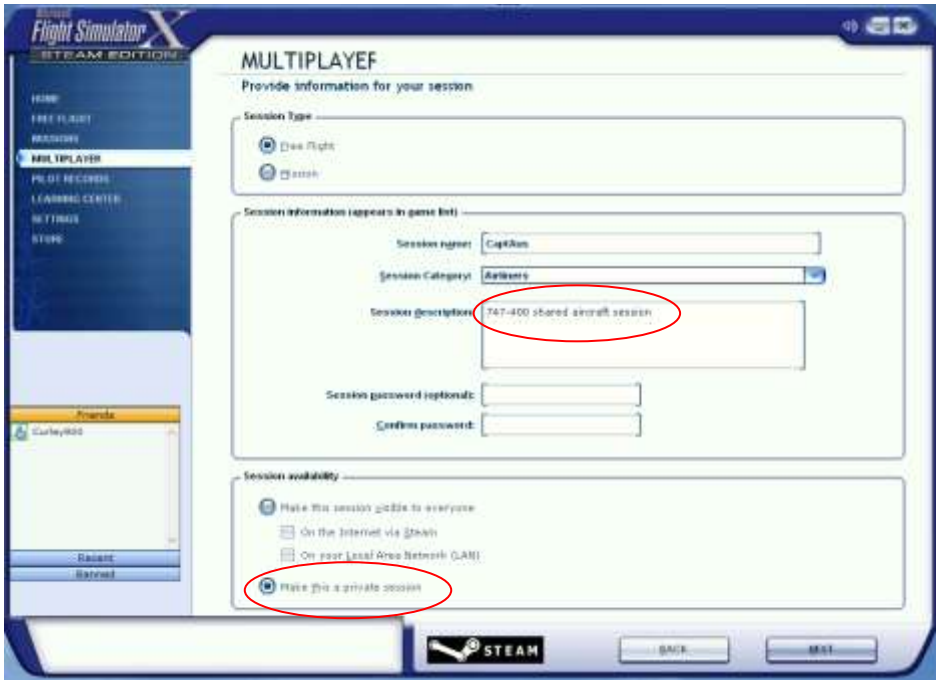
The following steps show how to set up a Multiplayer session:

1. On the **Multiplayer** screen, sign in with your Steam user ID, then click on **SIGN IN.**

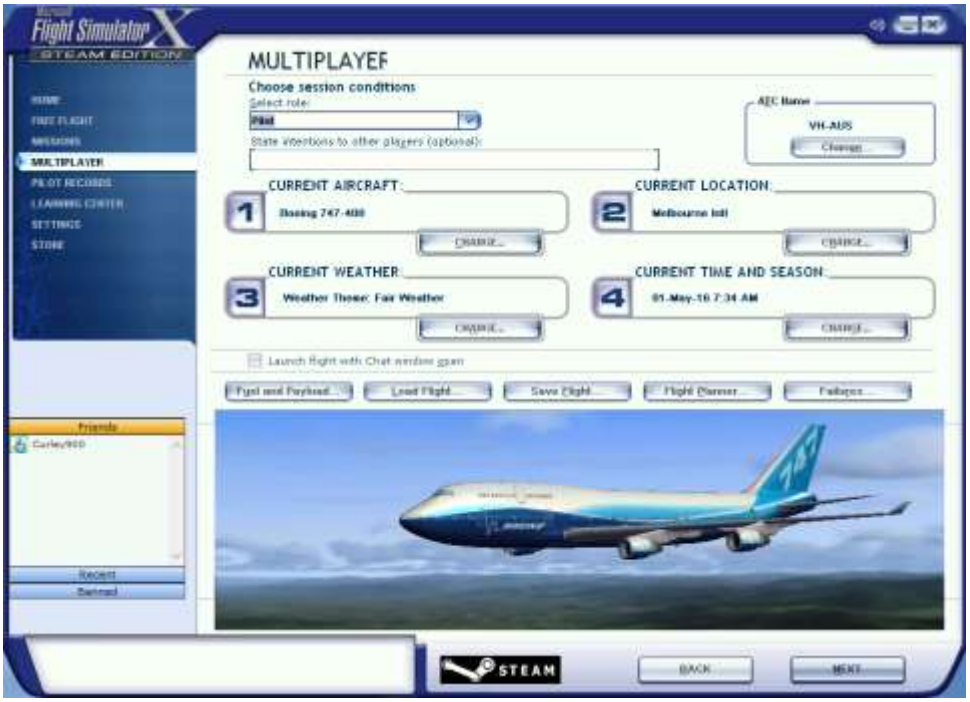
2. In the window that appears, click on **Host a Session**.



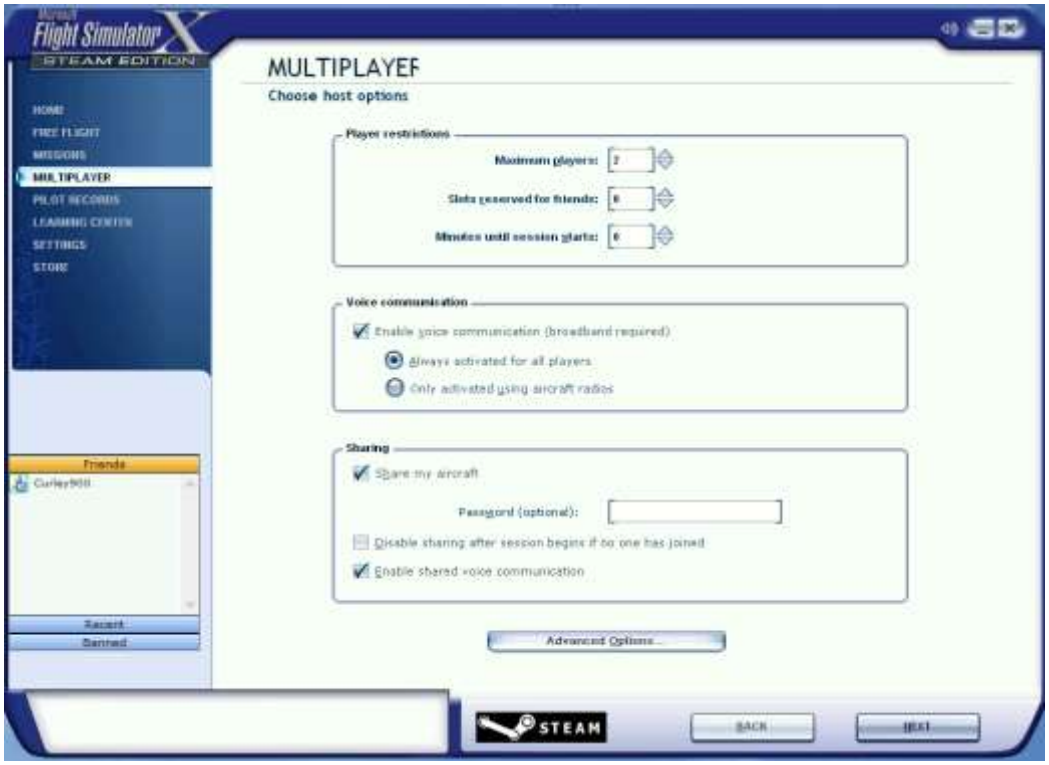
3. Click **Next.** In the window that opens, enter your session's conditions. In the example below the session description is '747-400 shared aircraft session'. You may opt to make this session visible to everyone, or, make it a private session. If it is a pre-arranged session, it is advisable to make it a private session. The use of a password is optional. Click **NEXT**.



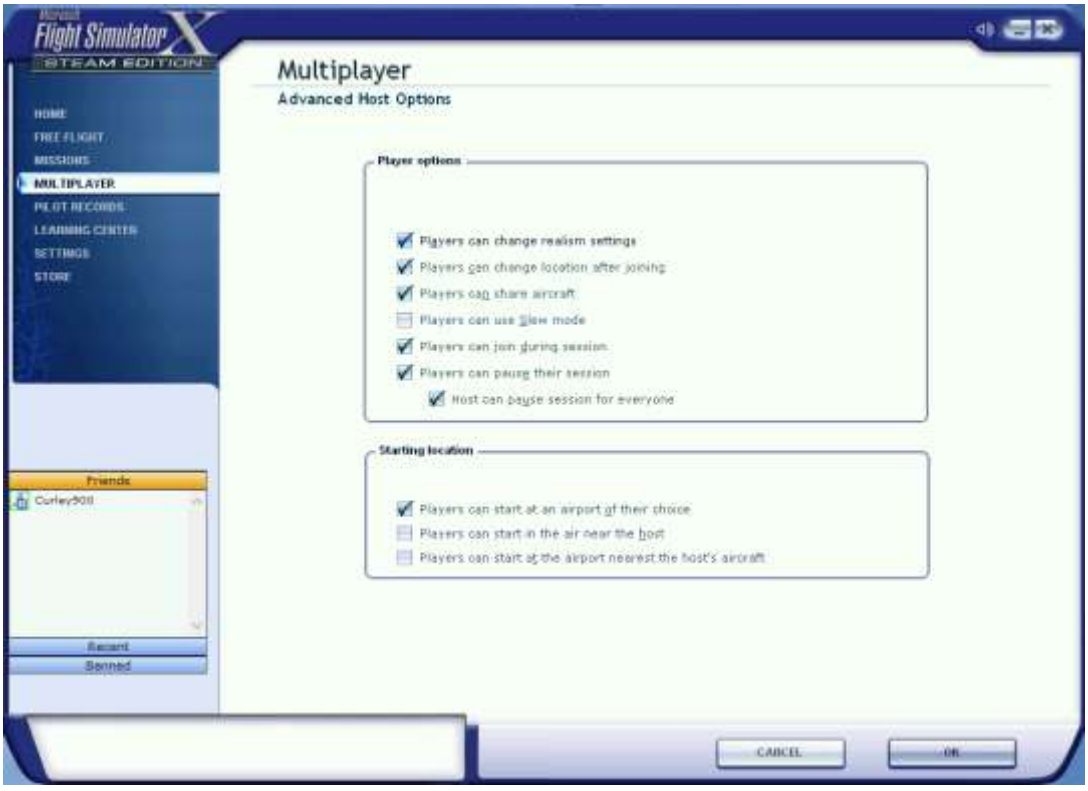
4. In the next window that opens, select the aircraft and parameters for the flight as you would for any flight. Click **NEXT**.



5. In this window, set up the host options as shown below. If you wish to fly with only one other person only, set maximum players as '2'.



6. Click **Advance options** and check the boxes as shown below.



7. Click **OK.** The previous window will appear. Click **NEXT**.

8. Click **FLY NOW** to enter the session.

You are now ready to fly in your Multiplayer session.

The next step is to get your flying partner to join you in your aircraft.

Connecting directly to a private session

If you have arranged with a friend to use Multiplayer but do not wish to have the session visible to all, you can connect directly to a private session. In this situation, the host will set up the session and advise you of the IP Address of his servers machine.

The host can determine the Public IP Address simply by going to a site such as http://whatismyip.com.

To connect to the host's server, click on **Connect Directly** in the Multiplayer Session page and enter the IP Address provided in the four boxes.

How to join an aircraft

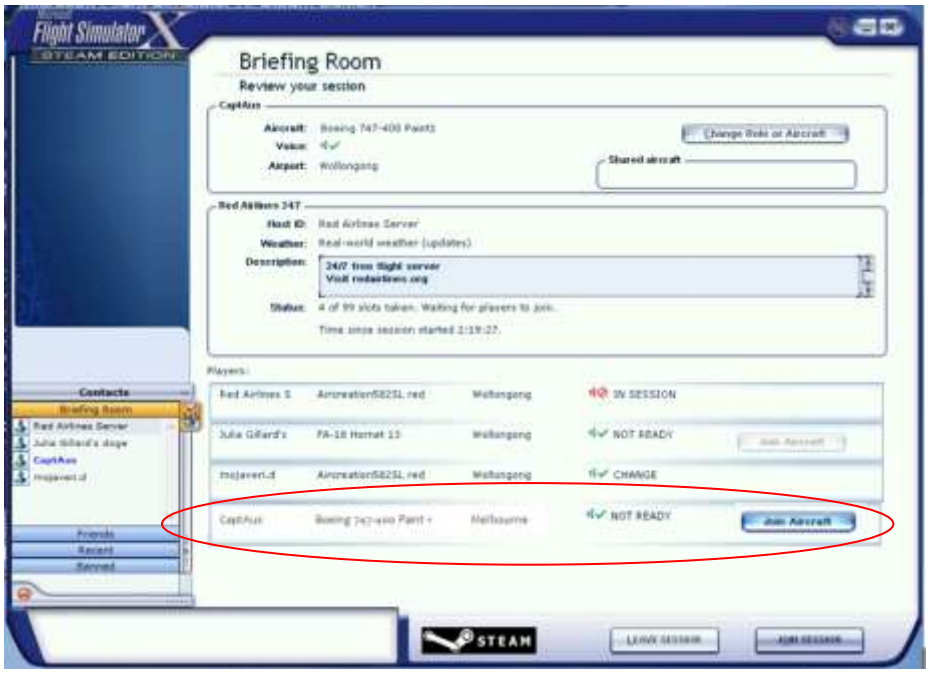
You can join the host's aircraft if the host has made the aircraft available to join as outlined above. You can also join another player's aircraft if the host has enabled **sharing for all players** and another player has chosen to share his aircraft.

To join a shared aircraft in a session set up by a host:

1. Sign into FSX: Steam Edition Multiplayer.

2. Select the Session Name you want and click on **JOIN.** In this example, the Session Name is **CaptAus**

3. In the **Briefing Room**, click on the aircraft which you wish to join and click on **Join Aircraft.** You are now virtually sitting in your host's aircraft.



Transferring aircraft control

Once you start flying in a Multiplayer shared aircraft session, you can transfer control of the aircraft back and forth. The pilot in control (pilot flying) is the only one who can fly the aircraft. However, the other pilot can still operate the aircraft after control has been transferred.

To transfer control of the aircraft:

- Press **Shift+T**.

The other pilot (pilot not flying) will receive a message asking if he wants to receive control of the aircraft. To accept control of the aircraft and become pilot flying:

- Press **Shift+T**.

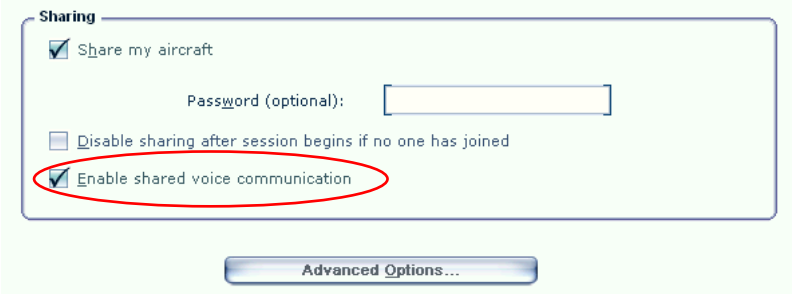
Stop sharing an aircraft

At some point in a session you may wish to stop sharing control of the aircraft with the host ending the session. To stop sharing aircraft control, Press **ESC** to exit to the **Briefing Room**. The other pilot will receive a message that the aircraft is no longer shared.

Voice communication

A Saitek Pro Flight headset
www.saitek.com

A Windows-compatible headset is essential for a shared aircraft Multiplayer session. To use voice communications while sharing an aircraft, you must select the voice communications option.



There are three voice communication options:

Option	How it works
Always activated for all players	All players in the session can hear all other players. Players must press and hold **CAPS LOCK** to talk.
Only activated using aircraft radios	Players wishing to talk to each other must tune to the same radio frequency, and then press and hold **CAPS LOCK** to talk. Press and hold **SHIFT+CAPS LOCK** to broadcast to all players, regardless of whether they are on the same radio frequency.
Enabled shared voice communication	Only available when two players are sharing an aircraft. With this option, **players don't have to press a button to talk**. This option is for pilot co-pilot operations.
A better option for clarity and reliability is to use Teamspeak voice communications if available.	

Flying the 747-400

AIRCRAFT SPECIFICATIONS

Dimensions: **Default FSX 747-400**

Length:	231 feet, 10 inches (70.6 m)
Wingspan:	211 feet, 5 inches (64.4 m)
Height:	63 feet, 8 inches (19.4 m)

Capacity

Maximum operating altitude:	40,000 feet (minimum payload)
Cruise altitude:	35,000 feet
Maximum range:	7,325 nm (13,570 km)
Maximum fuel capacity	57,164 US gallons (216,366 litres)
Seating:	Up to 524 passengers

Weights

Empty weight:	394,660 lbs	868,200 kg
Maximum fuel weight:	382,997 lbs	842,593 kg
Maximum payload weight:	97,915 lbs	215,413 kg
Maximum gross weight (MGW):	875,000 lbs	1,925,000 kg
Maximum taxi weight:	853,000 lbs	1,876,600 kg
Maximum takeoff weight (MTOW):	875,000 lbs	1,925,000 kg
Normal takeoff weight (NTOW):	800,000 lbs	1,760,000 kg
Maximum landing (MLW):	652,895 lbs	1,436,369 kg

Speeds

Maximum operating speed:	365 KIAS at MSL
Maximum operating speed:	Mach 0.92 at altitude
Cruise speed:	Mach 0.85 (522 mph) at altitude

Fuel

Maximum capacity:	382,997 lbs (57,164 US gallons)
Normal capacity:	304,991 lbs (45,521 US gallons)
Average fuel burn:	24,000 pounds per hour

Required runway length for takeoff

At Standard 20°C & 1013mb

Normal takeoff weight 800,000 lbs:	7, 200 feet
Maximum takeoff weight 875, 000 lbs:	11,500 feet

Weight and fuel factors

The newspaper article, opposite, clearly emphasises the need for pilots to be more vigilant in the management of fuel. Too much fuel onboard at takeoff can be just as catastrophic as not having enough at the end of the flight.

The maximum takeoff weight (MTOW) of the 747-400 is 875,000 pounds. Table 1 below shows the weight and quantity of jet fuel and resultant takeoff weight (TOW). The data is calculated to include the maximum weight of payload (crew, passengers, baggage and freight).

The normal takeoff weight (NTOW) however is 800,000 pounds. Therefore to takeoff with full fuel tanks and full payload weight exceeds NTOW and leaves no margin for error. A stall and crash after liftoff is probable. 80 – 90% of fuel in all tanks should be enough for a long flight.

The Age 10 January 2012

Pilots warned over fuel

PILOTS need to be more rigorous in checking how much fuel their aircraft has before take-off and how much it uses in flight, the transport safety watchdog says.

Poor management of fuel in operating some aircraft continues to pose serious risk of running out of fuel en route, says the Australian Transport Safety Bureau.

An average of 21 incidents involving fuel mismanagement have been reported each year over the past 10 years.

However, the bureau says the number of incidents is probably higher because not all involve power cutting out.

Its report on fuel mismanagement incidents, released yesterday, found they were most likely to happen in private or charter flight operations.

From 2001 to 2010 there were 10 deaths and 18 serious injuries in crashes resulting from fuel starvation. This occurs when there is enough fuel to finish the flight but the supply to the engine is interrupted.

The other type of incident is fuel exhaustion, when the aircraft runs out of fuel. While 82 per cent of such incidents resulted in forced or precautionary landings, no one was hurt or killed.

The bureau recommended the best way to avoid fuel starvation was for pilots to keep a fuel log and know how their aircraft fuel supply worked. AAP

% tanks full	Weight (lbs)	Quantity (gals)	TOW
100	382,997	57,164	875,000
95	364,733	54,438	855,751
90	346,468	51,711	837,485
85	328,205	48,986	819,222
80	321,433	47,975	812,461
75	291,678	43,534	782,695
70	273,414	40,808	764,431
65	255,149	38,081	255,149
60	236,885	35356	727,903
55	218,620	32,630	709,637
50	200,356	29,904	691,347
45	182,091	27,178	673,108
40	163,828	24,452	654,846
35	148,565	22,174	639,583
30	127,299	16,274	618,317
25	109,035	16,274	600,053
20	90,772	13,548	581,790
15	72,507	10,852	563,524
10	54,243	8,096	545,261

Table 1: Fuel weight and takeoff weight

Fuel burn

Fuel burn calculation is a critical factor with the operation of any large aircraft. It is particularly relevant to flight planning in determining the weight of the aircraft at various stages of a stepped climb to cruise, throughout cruise and descent. It is particularly important to ensure you are not in excess of maximum landing weight on arrival. Fuel burn at cruise will differ with aircraft weight and altitude, but can be estimated at an average of 24,000 pounds per hour. Table 2 shows average fuel burns for the various phases of a flight. Table 3 provides more specific fuel burn rates at a wide range of altitudes.

	Pounds per hour (4 engines)	Pounds per hour (1 engine)
Taxi	8,000 lbs	2,000 lbs
Takeoff	60,000 lbs	15,000 lbs
Climb	36,000 lbs	9,000 lbs
Cruise	24,000 lbs	6,000 lbs
Descent	8,000 lbs	2,000 lbs

Table 2: Average fuel burns Source: Freechecklists.net

Altitude	Indicated Airspeed	True Airspeed	Fuel Burn per engine
Ground	N/A	N/A	3,000 PPH
12,000’	340 KIAS	390 KTAS	6,800 PPH
13,000’	340 KIAS	396 KTAS	6,500 PPH
14,000’	340 KIAS	401 KTAS	6,300 PPH
15,000’	340 KIAS	407 KTAS	6,100 PPH
16,000’	340 KIAS	413 KTAS	5,800 PPH
17,000’	350 KIAS	430 KTAS	5,400 PPH
FL180	350 KIAS	436 KTAS	5,100 PPH
FL190	350 KIAS	443 KTAS	4,800 PPH
FL200	350 KIAS	450 KTAS	4,700 PPH
FL210	355 KIAS	461 KTAS	4,300 PPH
FL220	355 KIAS	468 KTAS	4,000 PPH
FL230	355 KIAS	475 KTAS	3,700 PPH
FL240	355 KIAS	482 KTAS	3,500 PPH
FL250	355 KIAS	489 KTAS	4,500 PPH
FL260	355 KIAS	496 KTAS	5,800 PPH
FL270	350 KIAS	504 KTAS	6,200 PPH
FL280	345 KIAS	500 KTAS	6,500 PPH
FL290	342 KIAS	503 KTAS	6,100 PPH
FL300	334 KIAS	500 KTAS	6,700 PPH
FL310	326 KIAS	498 KTAS	6,500 PPH
FL320	319 KIAS	496 KTAS	6,400 PPH
FL330	312 KIAS	494 KTAS	6,300 PPH
FL340	304 KIAS	491 KTAS	5,900 PPH
FL350	297 KIAS	490 KTAS	5,800 PPH
FL360	291 KIAS	490 KTAS	5,700 PPH
FL370	284 KIAS	488 KTAS	5,400 PPH
FL380	277 KIAS	487 KTAS	5,200 PPH
FL390	270 KIAS	486 KTAS	4,700 PPH
FL400	264 KIAS	487 KTAS	4,600 PPH
FL410	258 KIAS	487 KTAS	4,500 PPH

Table 3: Fuel burn by altitude Source: Deltava.org

How much fuel do you need onboard?
The determination of how much fuel you need onboard for a flight therefore needs to be calculated carefully. Remember that weight is drag, drag is more fuel burn which costs money. This is particularly relevant for virtual pilots flying for virtual airlines, so do not carry fuel more than you need. You have a destination to go to and a maximum landing weight (MLW) limit. You do not want to arrive to your destination with total weight above MLW! Fuel is required for the following contingencies:

Flight fuel: Fuel required from the airport of departure to the destination, based on planned operating conditions.

Ground operations fuel: A quantity to cover APU consumption, engine start and ground manoeuvres until start of takeoff.

Contingency fuel: The fuel required to cover deviations during from the planned operating condition of the flight as well as to provide operational flexibility in case off in-flight malfunctions. This is normally 5% of the planned flight fuel.

Holding fuel: The quantity of fuel which will permit an aircraft to hold for a time, at the holding fuel consumption rate and configuration, at a level not greater than FL200 at the forecast temperature.

Alternate fuel: The fuel to fly from your destination airport to an alternate, based on planned operating conditions.

Final reserve: The amount required to fly for 30 minutes at holding speed at 1500 feet above the destination or alternate airport.

Table 4 shows a fuel planning example for a 1,200 nm flight at a cruise altitude of FL300.

Flight Time: 500 KTAS/60 = 8.33 NM per minute.
1,200 nm/8.33 = 144 minutes (round to nearest minute).
Add an additional 30 minutes fuel burn during climb and descent.
144 + 30 = 174 minutes/60 = 2.9 hours
Total flight time = 2.9 hours.

Flight fuel	2.9 hrs x 6,700 lbs/hr	77,720 lbs (4 engines)
Ground operations	8,000 lbs/hr	4,000 lbs (4 engines + APU)
Contingency fuel	5% of flight fuel	3,886 (4 engines)
Alternate fuel	0.5 hrs x 6,700 lbs/hr	13,400 lbs (4 engines)
Holding fuel	0.5 hr x 6,700 lbs/hr	13,400 lbs (4 engines)
Final reserve	0.5 hr x 6,700 lbs/hr	13,400 lbs (4 engines)
FUEL REQUIRED	32.8% of capacity	125,806 lbs 18,777 gals 64.74 tons

Table 4: Fuel planning example

1 gallon jet fuel = 6.7 pounds (lbs). Weight can vary slightly according to fuel density.
1 ton jet fuel = 298.5 gallons
1 US gallon = 3.785 litres
1 kilogram = 2.2 lbs

See Appendix 2 for a fuel and weight planning template.

V speeds

On any flight, we should be concerned about flying the appropriate airspeed for the event involved. V stands for velocity. V speeds are standard terms used to designate airspeeds at different stages of the aircraft's operation. Using them is considered best practice to maximise safe operations and aircraft performance. There are some forty-three regulatory V speed designators for aircraft operations, but for the purposes of this manual only 8 will be referred to, as specified in Table 5.

V_1	Critical engine failure recognition speed. The aircraft can stop within runway length.
V_r	Rotation speed. The speed at which the aircraft's nose wheel leaves the ground.
V_2	Takeoff safety speed. The speed at which the aircraft may safely become airborne with one engine inoperative.
V_{ref}	Velocity reference. Landing reference speed or threshold crossing speed.
V_s	Stall speed in flight, flaps retracted and gear up (clean)
V_{app}	Final approach speed
V_{so}	Stall speed or minimum flight speed in landing configuration.
V_{ne}	Never exceed speed. The red line.

Table 5: Key V Speeds

Three V speeds are of particular importance. **V_s** is the speed at which the aircraft will stall in straight and level flight with flaps and landing gear up (clean). **V_{so}** is the speed at which the aircraft will stall in the landing configuration – full flaps deployed and landing gear down. It is important to note that these speeds will differ widely with different aircraft weights. Stall speeds can vary up to 45 KIAS from MTOW to MLW. You should never fly slower than 130% of stall speed.

Aircraft are certificated to Vref airspeeds 30% above stall speed in the landing configuration. **V_{ref}** is the minimum speed the aircraft should safely fly in landing configuration just prior to flaring at 50 feet above the ground. This speed is typically equal to 1.3 x V_{so}. Vref is an approach speed, yes, but it is not the approach speed you want to fly the approach at. Consider Vref as a **minimum** approach speed. You want to be at Vref when you are over the runway and in the flair. Anything before that will be Vref + some amount and that will depend on weight and wind. That speed is called **V Approach (Vapp).** Pilots usually fly at V_{app} which is typically 5 knots higher than V_{ref}. If the wind is blowing, add one-half of the gust factor to your landing speed. For example, if the wind is 10 knots gusting to 20, add half the difference (5 knots) to your speed. 1.3 V_{so} gives you a safety margin, but only after all manoeuvring is completed and full flaps and gear are down. So use 1.3 V_{so} on short final only.

Takeoff speeds

V speeds on takeoff vary according to aircraft weight, flap settings and atmospheric conditions. For example, with the B747-400 at maximum takeoff weight (MTOW) and Flaps 10, V_1 is 160 KIAS and V_r 170 KIAS. However, with Flaps 20, V_1 is 155 KIAS and V_r is 171 KIAS. The speed at which the aircraft becomes airborne is designated as **V_2**. For flight simulation purposes the following rule of thumb speeds shown in Table 6 can apply for takeoff with MTOW, at standard temperature, sea-level altitude – 59°F (15°C) 29.92 inches of mercury (101325 Pa) – and on a dry runway.

V Speed	KIAS
V_1 Flaps 10	160
V_1 Flaps 20	155
V_r Flaps 10	177
V_r Flaps 20	171
V_2 Flaps 10	188
V_2 Flaps 20	181

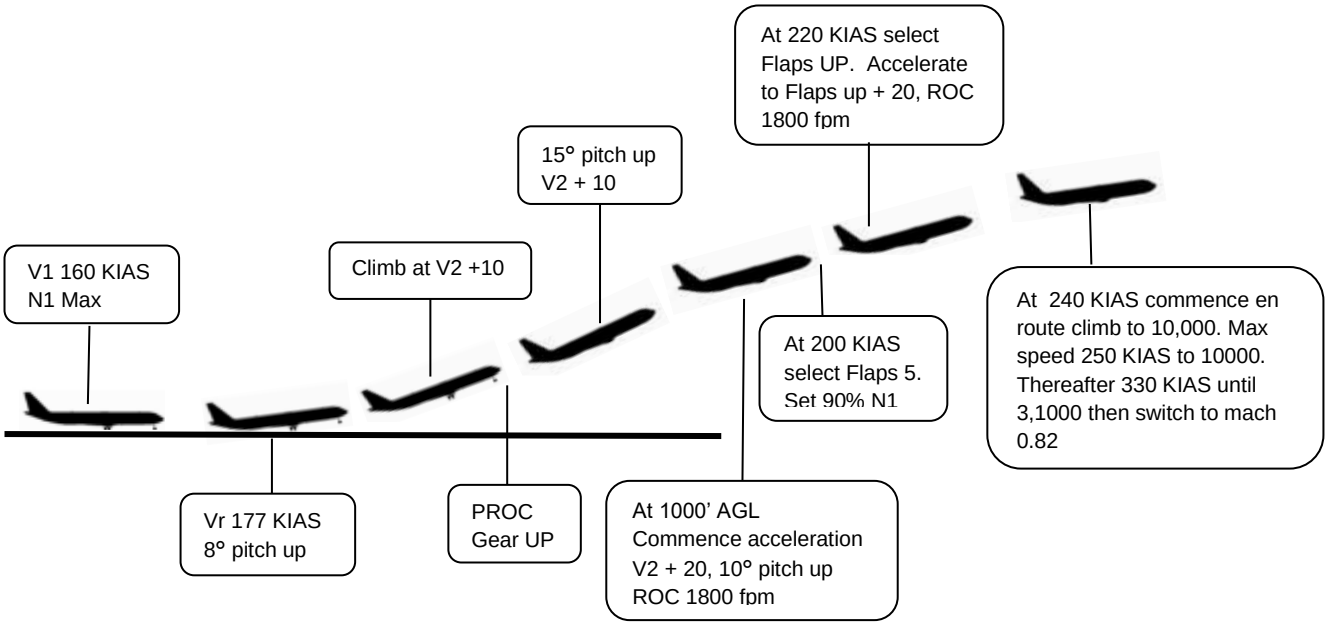
Table 6: Takeoff V speeds

Pilot operating handbooks (POH) normally specify Vref airspeeds based on Maximum Gross Weight (MGW). For large aircraft such as the B747-400, performance charts are provided to assist in the calculation of V speeds for various gross weights. Table 7 gives reference data for V_1 and V_2 speeds at Flaps 10 and Flaps 20 at various weights. Speeds throughout the takeoff and climb sequence of events will vary according to the pre-determined V_1 and V_2 speeds. For instance, the initial climb speed immediately after lift-off is V_2 + 10 knots. Acceleration after passing 1,000 feet should be V_2 + 20. These speeds will differ, then, in accordance with the initial V_2 speed. For more realistic flight simulation operations this Table 7 should be referred to as an essential part of flight planning.

Gross weight (lbs)	Flaps 10			Flaps 20		
	V_1	V_r	V_2	V_1	V_r	V_2
880,000	160	178	188	155	171	181
858,000	159	176	187	153	170	180
836,000	157	174	185	152	168	178
814,000	155	171	183	149	165	176
792,000	152	168	180	147	162	174
770,000	149	165	177	144	159	171
748,000	147	162	175	141	156	169
726,000	144	158	172	138	152	166
704,000	141	155	169	135	149	163
682,000	137	151	166	132	146	160
660,000	134	148	164	129	142	158
638,000	131	144	161	126	139	155
616,000	128	141	158	123	135	152
594,000	124	137	155	119	132	149
572,000	121	133	153	115	127	146
550,000	117	130	150	111	124	143
528,000	113	126	147	107	121	141
506,000	109	123	144	104	117	138
484,000	105	119	142	100	113	136
462,000	101	115	139	96	110	133
440,000	96	111	136	92	106	130

Table 7: Takeoff reference speeds Source: Deltava.org

747-400 Takeoff Profile at MTOW 875,000 pounds



See Appendix 1 for typical flight profile reference data.

Maneuvering and landing reference speeds

When landing we should be concerned about flying the appropriate airspeed for the event involved. The indicated airspeed an airliner pilot chooses to use on final approach to land with flaps deployed and landing gear down is known as **V_{ref}.** V_{ref} is 1.3 times V_{so} and is based on based on the Maximum Gross Weight (MGW) of 875,000 pounds. The FSX knee pad reference data specifies V_{ref} speeds as follows:

880,000 lbs (Flaps 25): 188 KIAS
880,000 lbs (Flaps 30): 181 KIAS
450,000 lbs (Flaps 25): 134 KIAS
450,000 lbs (Flaps 30): 129 KIAS

These are ballpark figures and are probably good enough for flight simulator operations. Many flight simulator pilots fly a final approach airspeed they've become accustomed to regardless of its impact on where the airplane will touch down on the runway. They have become fond of a particular airspeed, regardless of its suitability. For each knot above V_{ref} over the runway threshold, the touchdown point will be an additional 100 feet down the runway. I encourage you to use a final approach airspeed closer to that which the aircraft was certificated and the actual weight of the aircraft on landing. Therefore V_{ref} is going to be different for each landing weight and consequently flap deployment speeds will take their queue from the established V_{ref} value. Table 8 below provides flap deployment speeds for a much wider range of landing weights to enable you to exercise a greater deal of realism. Remember that maximum landing weight (MLW) is 652,895 pounds.

Landing weight (lbs)	Flaps 0	Flaps 1	Flaps 5	Flaps 10	Flaps 20	Flaps 25	Flaps 30
660,000	238	218	198	178	168	164	157
650,000	238	217	197	177	167	162	156
640,000	236	216	196	176	166	161	155
630,000	234	213	194	174	164	160	153
620,000	233	213	193	173	163	158	152
610,000	232	212	192	172	162	157	151
600,000	320	211	190	171	161	156	150
590,000	229	210	189	170	159	154	148
580,000	228	209	188	168	158	153	147
570,000	227	207	186	167	157	152	146
560,000	225	205	185	165	155	150	144
550,000	223	203	183	163	153	148	143
540,000	222	202	182	162	152	147	141
530,000	221	201	181	161	151	146	140
520,000	220	200	179	160	150	145	139
510,000	218	198	178	158	148	143	137
500,000	215	196	176	156	146	141	135
490,000	215	195	175	155	146	140	134
480,000	213	193	173	153	143	138	132
470,000	212	192	172	152	142	137	131
460,000	211	190	170	152	142	135	130
450,000	209	189	169	149	139	133	128
440,000	208	188	168	148	138	132	127
430,000	206	186	166	146	136	130	125
420,000	205	185	165	145	135	129	124
410,000	204	184	164	144	133	127	123
400,000	202	182	162	142	132	125	121

Table 8: Minimum maneuvering and landing reference speed Source: PMDG

Flap calculation
The default 747-400 kneeboard reference information specifies **maximum** flap placard speeds as follows:

Flaps 1: 280 KIAS
Flaps 5: 260 KIAS
Flaps 10: 240 KIAS
Flaps 20: 230 KIAS
Flaps 25: 205 KIAS
Flaps 30: 180 KIAS

Flap deployment speeds, however, are determined as a value relative to V_{ref}. Table 9 contains Boeing's flap manoeuvring speeds for various flap settings. The manoeuvring speed is the recommended operating speed during takeoff or landing operations. These speeds guarantee at least full manoeuvre capability of at least 40° of bank (25° bank and 15° overshoot) within a few thousand feet of airport altitude.

Flap position	All weights
Flaps UP	Vref 30 + 80
Flaps 1	Vref 30 + 60
Flaps 5	Vref 30 + 40
Flaps 10	Vref 30 + 20
Flaps 20	Vref 30 + 10
Flaps 25	Vref 30 + 5
Flaps 30	Vref 30

Table 9: Flap deployment speeds

Example: Let's assume you are landing with a gross weight of 550,000 pounds. V_{ref} for this weight will be 143 KIAS. (See Table 8). Flaps would be ideally deployed therefore at the following speeds:

Flaps 1: 203 KIAS (143 + 60)
Flaps 5: 183 KIAS (143 + 40)
Flaps 10: 163 KIAS (143 + 20)
Flaps 20: 153 KIAS (13 + 10)
Flaps 25: 148 KIAS (143 + 5)
Flaps 30: 143 KIAS (Vref)

A speed card for a flight with a takeoff weight of 836,000 lbs and a landing weight of 550,000 lbs is shown opposite. See Appendix 3 for a speed card template.


B747-400

Speed Card

Takeoff

Gross Weight:		lbs	
Flaps 10		Flaps 20	
V1	KIAS	V1	KIAS
Vr	KIAS	Vr	KIAS
V2	KIAS	V2	KIAS

Landing

Landing Weight:		lbs					
Flaps:	0	1	5	10	20	25	30
Manoeuvring:	230	x	x	x	x	x	x
Vref:							
Vapp (Vref + 5):							

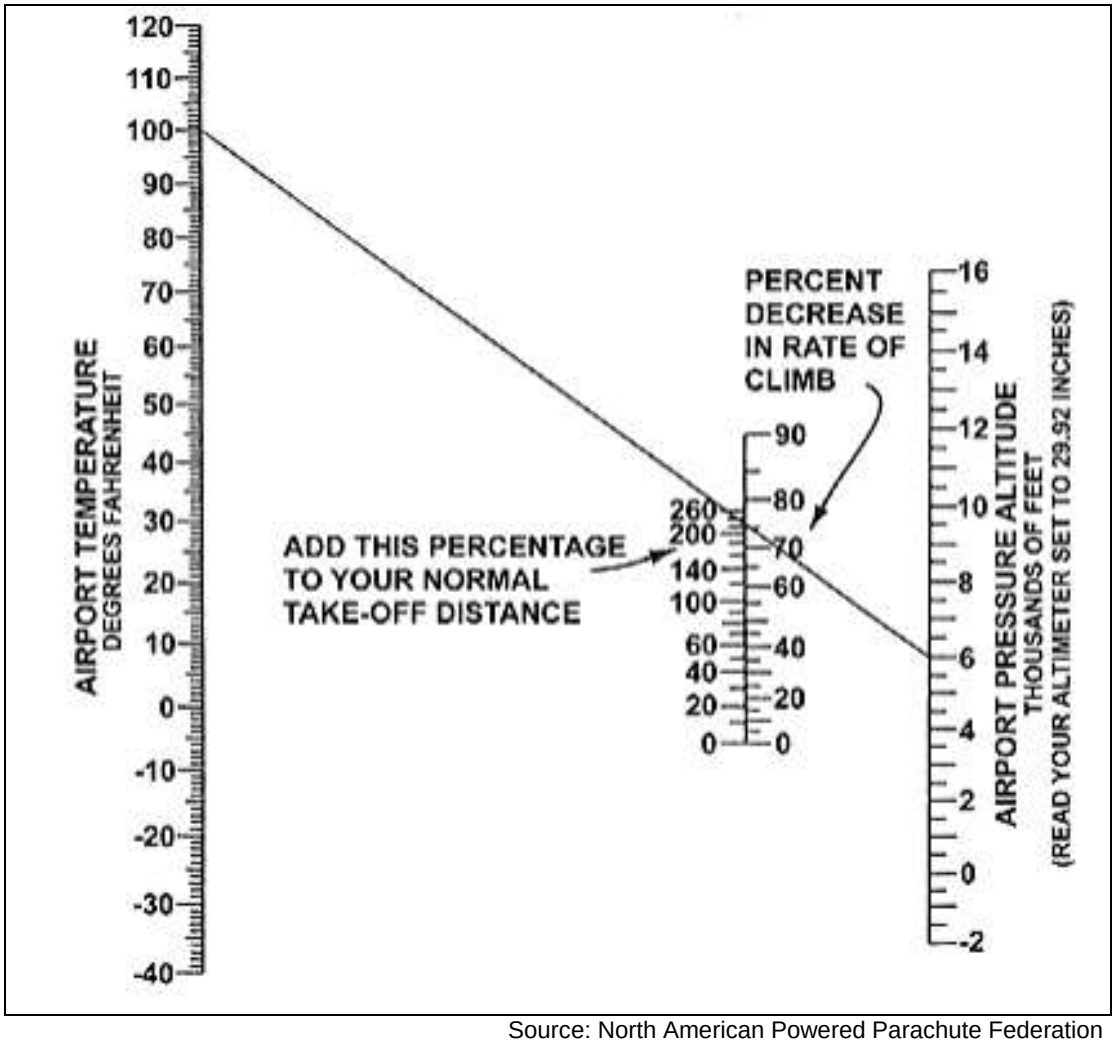
Required runway length for takeoff
At Standard 20°C & 1013mb
Normal takeoff weight 800,000 pounds: 7, 200 feet
Maximum takeoff weight 875,000 pounds: 11,500 feet.

Note that the above runway lengths are the minimum required. In snow and ice conditions maximum takeoff weight requires 14,000 feet and at maximum landing weight is 6,500 feet is needed.

Density altitude
Density altitude has an unescapable influence on aircraft and engine performance. When the temperature rises above the standard temperature for the locality, the density of air in that locality is reduced and the density altitude increases. This affects aircraft aerodynamic performance, and decreases the horsepower output of the engines. From a pilot's point of view, an increase in density altitude results in:

1. Increased take-off distance
2. Reduced rate of climb
3. Increased true airspeed on approach and landing
4. Increased landing roll distance

The Kock Chart for altitude and temperature effects
The Kock Chart can be used to figure the approximate temperature and altitude adjustments for aircraft takeoff distance and rate of climb. To find the effect of altitude and temperature, connect the **temperature** and **airport altitude** by a straight line. Read the increase in take-off distance and the decrease in rate of climb from standard sea level values.



Source: North American Powered Parachute Federation

The diagonal line shows that 230% must be added for a temperature of 100 degrees and a pressure altitude of 6 000 feet. Therefore, if your standard temperature sea level take-off distance, in order to climb to 50 feet, normally requires 1,000 feet of runway, it would become 3 300 feet under the conditions shown. In addition, the rate of climb would be decreased 76%. Also, if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

The table below gives a rule of thumb example of temperature affects on density altitude. The figures are based on the still current 1976 version standard US atmospheric conditions at sea level: 59°F (15°C) and 29.92 inches of mercury (101325 Pa). The maximum takeoff and landing altitude for most aircraft is 8,400 feet pressure.

STD TEMP	ELEV/TEMP	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 55°C
59°F 15°C	Sea Level	1,200'	1,900'	2,500'	3,200'	3,800'	4,400'
52°F 11°C	2,000 feet	3,800'	4,400'	5,000'	5,600'	6,200'	6,800'
45°F 7°C	4,000 feet	6,300'	6,900'	7,500'	8,100'	8,700'	9,400'
38°F 3°C	6,000 feet	8,600'	9,200'	9,800'	10,400'	11,000'	11,600'
31°F -1°C	8,000 feet	11,100'	11,700'	12,300'	12,800'	13,300'	13,800'

Table 10: Temperature and density altitude Source: North American Powered Parachute Federation

Step climbing to initial cruise level
The vertical speed (VS) depends on weight at take-off, weather conditions and noise abatement procedures. Use the step climb procedure for climbing to cruise level.

When speed reaches V_r apply back pressure and rotate to approximately 8° nose up. Maintain this attitude until lift off (V_2) to prevent tail strike. Continue rotation (15° pitch up) to achieve and hold a speed of V_2 + 10 to 1,000 feet. V_2 (lift off speed) at MTOW is about 188 KIAS. Rotation rate should be 3 degrees per second.

When passing 1,000 feet decrease the pitch to 10° and accelerate to V_2 + 20, approximately 208 KIAS, and adjust the rate of climb (ROC) to allow for a reasonable speed increase and maintaining a ROC of 1,800 fpm and a speed of 250 KIAS.

Passing 10,000 feet set the target speed to 330 KIAS unless departure procedure dictates otherwise. After crossing FL220, reduce the rate of climb to 1,500 fpm, and after FL290, reduce again to 1,000 fpm. Change speed values to mach when passing FL230 to FL280 and maintain mach 0.76 climb speed. At cruise level adjust speed to mach 0.85.

Typical thrust settings
To 1,000 feet, maintain takeoff thrust setting
At 3,000 feet, reduce thrust to 96% N1
At 10,000 feet, reduce thrust to 90% N1

Cruise
Depending on the weight and fuel, start normal cruise level at 31,000 feet. Accelerate to economic cruise speed of mach 0.85. Typical thrust setting is around 90% N1.

After fuel burn, indicated by a higher speed or reduced N1 readout, start climbing to 35,000 feet. After levelling out at this altitude repeat the process outlined above and go to final cruise level of 38,000 feet.

Monitor engine and fuel readouts constantly. Do not exceed economy cruise speed of mach 0.85.

Fuel burn
Fuel burn at cruise will differ with aircraft weight, but can be estimated at an average of 24,000 pounds per hour

Approach and Landing

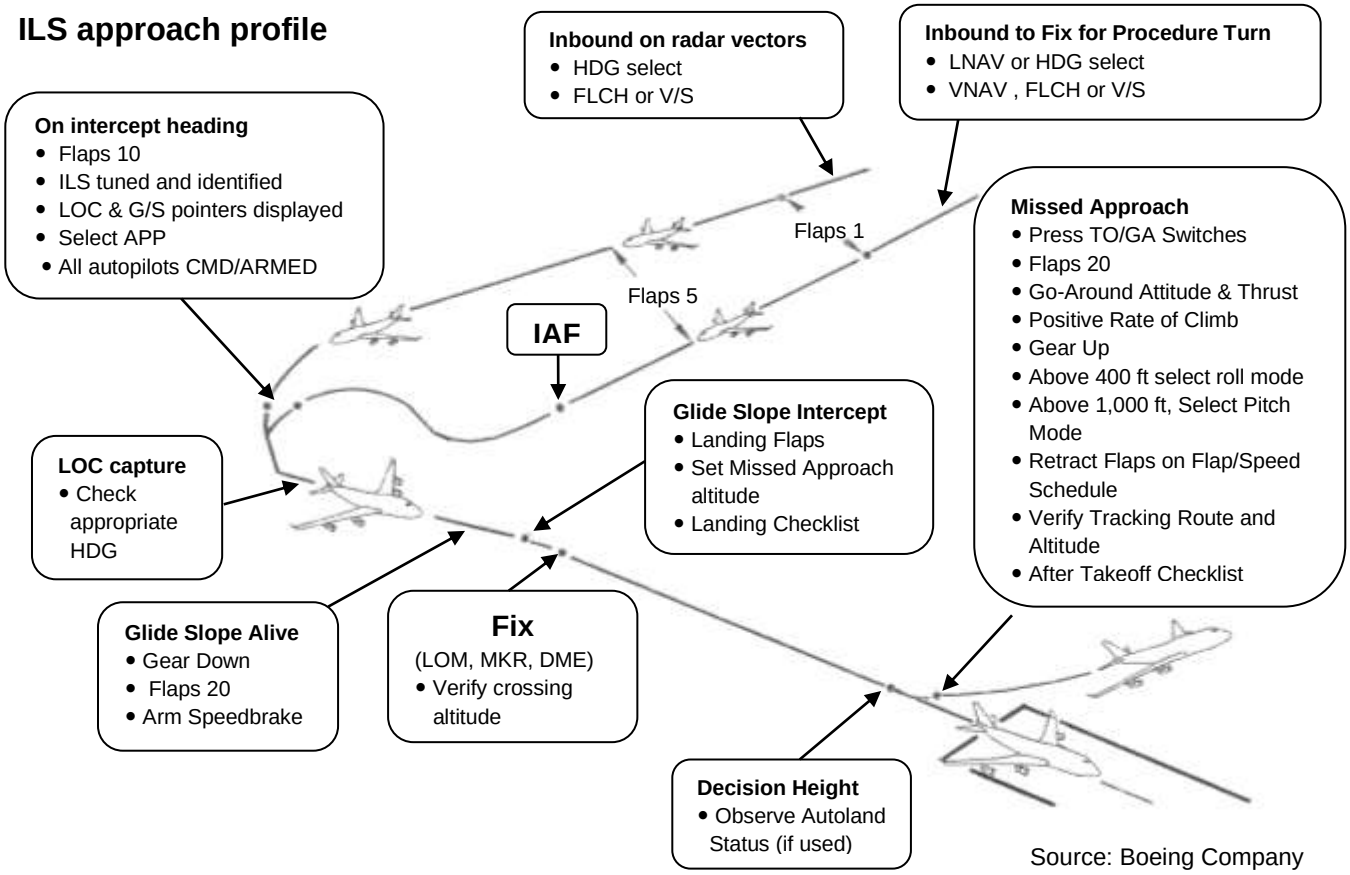
The landing procedure for a 747 needs to be well planned before you attempt to do it. This is a big aircraft and, heavily laden with payload and fuel, it will take some time to manoeuvre and slow down. Unlike the easier to land 737, the 747 needs more management to set up a good landing. For those of you who fly for virtual airlines and use FS Passengers, you don't want your customers complaining or possibly even damaging the aircraft.

You will find it easier to land the 747 making an ILS approach. Being able to make a good ILS approach is a skill to be learnt and a valuable one to have. See the Ground School page on the *Aussie Star* website for tutorials on making an ILS approach.

Practice making ILS approaches is encouraged, especially under varying weather conditions. Not only is it usually normal practice with real operations, it's good fun and most satisfying to perform a good landing using the ILS. Things don't always go to plan when landing, so practicing go-arounds is also a good idea. You need to be prepared for this eventuality and know the procedures well because a go-around can produce challenging situations.

Approach planning should commence at top of descent and be completed by arrival at transition altitude, usually 10,000 feet, 30 nm from the destination airport and at 240 knots.

ILS approach profile



Source: Boeing Company

Speed	Altitude	Distance from Airport	Flaps
220 KIAS	Below 10,000 feet	30 nm	Up
200 KIAS		15 nm	Up
180 KIAS		10 nm	5°
160 KIAS	Varies	Final Approach Fix	10°
Vref + 5	Varies		25°
Vref + 5	Varies	Runway Threshold	25° or 30°

Table 11: Approach/Landing Speed Profile Source: Deltava.org

Normal Flight Procedures

These procedures are commenced once pre-flight planning has been completed and both pilots have established themselves in an FSX Multiplayer session in a shared aircraft environment and with a cold and dark cockpit.

Checklist items are included in the following flight procedures. However, it is probably easier to have the actual checklists at hand. Checklists are published in a separate document for convenience and can be found on the Flight Simulation Australia website www.flightsimaus.com.au.

The symbol indicates that a checklist is required. These can be found in Appendix 4 on pages 32 to 34.

Interaction between Captain and First Officer should be in a calm, courteous and professional manner. It is worth viewing the YouTube videos listed in the reference section on page 35 to see a 747 flight deck crews in action.

Photo: © Aleksandar Milosovic | Dreamstime.com

Pre-Start Procedures

The captain calls “Ready for pre-start checklist”. The first officer (or pilot not flying) generally calls the checklist items and the captain (or pilot flying) actions the called items and responds.

Before Start Checklist

Departure briefing by captain:

Aircraft weight is _____ pounds. We will use Flaps ____ for takeoff. V speeds for takeoff are: V1 _____knots, V2 _____ knots and Vr _____ knots. V2 + 10 will be _____knots and V2 + 20 will be _____ knots. After takeoff we will climb initially to _____ feet. At _____ feet/miles out/VOR/NDB/intersection we’ll turn left/right to a heading of _____. We’ll continue to our transition altitude of _____ feet and then on to cruise level of FL _____.

- Discuss any weather considerations and departure procedures e.g. SIDs
- If ATC is active any departure instructions will need to be followed.

---- PRE-FLIGHT CHECKLIST COMPLETE ----

First officer contacts ATC for start-up and push back clearance.

Engine Start Procedures

Normal start sequence: 1 – 4 – 3 – 2

Alternative start sequence: 1 & 4 – 3 & 2 with two engines being started simultaneously.

Engine start can occur during push back at captain's prerogative.

The captain calls "Start-up checklist please"

Engine Start Checklist – commence

First Officer	Captain
Thrust Levers	IDLE
Engine Area	CLEAR (Captain & First Officer)
MFD	EICAS 2

Captain	First Officer
Call "Start 1" Monitor N2 rotation At >20% Fuel Control Switch to RUN Observe oil pressure increase	Pull Engine #1 Start Switch Monitor N2 rotation
Call "Start 4" Monitor N2 rotation At >20% Fuel Control Switch to RUN Observe oil pressure increase	Pull Engine #4 Start Switch Monitor N2 rotation
Call "Start 3" Monitor N2 rotation At >20% Fuel Control Switch to RUN Observe oil pressure increase	Pull Engine #3 Start Switch Monitor N2 rotation
Call "Start 2" Monitor N2 rotation At >20% Fuel Control Switch to RUN Observe oil pressure increase	Pull Engine #2 Start Switch Monitor N2 rotation

Engine Start Checklist – complete remaining items

First Officer	Captain
Anti-ice	ON/OF (as required)
Pitot Heat	ON
MFD	EICAS 1

----STARTUP CHECKLIST COMPLETE----

Monitor engine displays for start parameters below until engines are stabalised at idle:
N2: 55.8 FF: 1.5 OIL P: 245 OIL T: 104

Before Taxi Procedure

Captain	First Officer
Call “Before taxi checklist please”	

 Before Taxi Checklist

First Officer	Captain
Nav Lights	ON
Taxi Lights	ON
Heading Indicator	SET
Altimeter	SET
Standby Instruments	SET
Radios & Avionics	SET FOR DEPARTURE
Autopilot	SET (not activated)
Autothrottle / Speed	SET (not activated)
F/D	SET
Yaw Damper	ON
Autobrake	SET RTO
Elevator Trim	SET for takeoff
Doors	CLOSED
Jetway	RETRACTED

----BEFORE TAXI CHECKLIST COMPLETE----

Captain or Pilot Flying	First Officer or Pilot Not Flying
Call “Ready for taxi”  Taxi Checklist	Contact Ground for taxi clearance. Record taxiway directions. (or announce intentions if no ATC)
Parking brake	RELEASED
Taxi to assigned runway Maximum speed 20 knots on taxiways, 10 knots on corners.	
Brakes/Gyro/Turn Coordinator CHECK during taxi and turns	
Call “Flaps ___” (normally 10°)	SET Flaps ___
Flight Controls FREE AND CORRECT	
Cabin notification	COMPLETED

Before Takeoff Procedure

Captain or Pilot Flying	First Officer or Pilot Not Flying
Call “Before takeoff checklist”  Before Takeoff Checklist Pilot Not Flying / Pilot Flying Brakes — SET Throttle — IDLE Flaps — SET ____° (Normally 10°) Spoilers — RETRACTED Engine Instruments — CHECK Takeoff Data (V1, Vr, V2) — CHECK Nav Equipment — CHECK Anti-ice — ON / OFF (As required) Transponder — ON & SET Taxi Lights — OFF *----BEFORE TAKEOFF CHECKLIST COMPLETE----*	
Release brakes on clearance	Request takeoff clearance

Takeoff Procedure  Normal takeoff at MTOW and Flaps 10

Captain or Pilot Flying	First Officer or Pilot Not Flying
Align aircraft with runway	Landing Lights switches ON Strobe Light switch ON
Advance Thrust levers to 40% N1 and allow engines to stabalise then to full thrust	
Forward pressure on yoke until 80 knots.	Monitor engine instruments throughout takeoff. Adjust takeoff thrust prior to 80 knots if required
Verify 80 knots	Call “80 knots”
Monitor airspeed noting V1	Call “V1”
Rotate at Vr, PITCH 8° nose up until lift-off, then increase to 15°. Establish positive rate of climb	At Vr, call “Rotate” Monitor airspeed and vertical speed
Call “Gear UP” when positive rate of climb is established.	Call “Positive rate” when established. Position Landing Gear lever UP.
When above minimum altitude for autopilot engagement, ENGAGE A/P	Verify LNAV and VNAV engaged
At 1,000 feet decrease pitch to 10°, accelerate to V2+20 (208 KIAS). Rate of climb 1 800 fpm	At 1,000 feet, call “1,000” Adjust speed bug knob to V2+20
At 200 KIAS call for “FLAPS 5 ”	Position Flap Lever at Flaps 5
At 210 KIAS call for “Flaps 1”	Position Flap Lever at Flaps 1
At 220 KIAS call for “Flaps UP”	Position Flap Lever at Flaps UP

Captain or Pilot Flying	First Officer or Pilot Not Flying
Call “After takeoff checklist”	Execute after takeoff checklist

 After Takeoff Checklist

Pilot Not Flying

Throttle	AS REQUIRED
Trim	SET FOR 250 KNOTS
Autothrottle	ARMED AND SET
Autopilot	ON AND SET
Autobrake	OFF
Flaps	OFF

----AFTER TAKEOFF CHECKLIST COMPLETE----

Climb and Cruise Procedure

 Cruise Checklist

Captain or Pilot Flying	First Officer or Pilot Not Flying
Climb speed: 250 KIAS to 10,000 feet 300 KIAS to FL310 Mach 0.80 above FL310 Accelerate to cruise speed: FL180 330 KIAS FL240 Mach 0.76 (335 KIAS) FL280 Mach 0.82 (335 KIAS) FL330 Mach 0.85 (315 KIAS) Cruise speed: Mach 0.85 at optimum altitude for aircraft weight. Do not exceed econ. cruise speed of mach 0.85	96% N1 to 3,000 feet 90% N1 to 10,000 feet At 10,000 feet: Landing Lights OFF Seat Belt Sign OFF At transition altitude (FL180): ALTIMETER 29.92” (1013mb)

Pilot Not flying

Engine Instruments	MONITOR CONSTANTLY
Fuel Quantity	MONITOR CONSTANTLY
Radios	TUNED and SET
ATIS/Airport Information	CHECK
Altimeter	CHECK
Radios	SET
Anti-ice	AS REQUIRED

Descent and Approach Procedure

Descent Checklist

Captain or Pilot Flying	First Officer or Pilot Not Flying
When cleared to descend or at top of descent, set altitude bug to required altitude. Descent speed: Mach 0.80 to FL340 300 KIAS FL340 to 10,000 ft. 240 KIAS below 10,000 ft.	At FL180 RESET Altimeter to LOCAL At 10,000 ft. landing lights ON Fuel Quantities and Balance CHECK Check weather (ATIS, Flight Services) Verify landing weight Verfiy Vref speed
Call for "Approach briefing"	

First Officer to Captain (landing)

"Weather conditions are _____ (obtain from ATIS, map view data). Active runway for landing is _____ at _____ (airport) using the _____ Approach (STAR – if used). Top of descent will be _____ nm DME from airport. Our final approach altitude will be _____feet. Our landing weight will be _____ pounds. V speeds for the approach will be:

Vref: _____ knots (Flaps 30, gear down)
Flaps 1: _____ knots (Vref + _____ KIAS)
Flaps 5: _____ knots (Vref + _____ KIAS)
Flaps 10: _____ knots (Vref + _____ KIAS)
Flaps 20: _____ knots (Vref + _____ KIAS)
Flaps 25: _____ knots (Vref + _____ KIAS)
Flaps 30: _____ knots (Vref + 0 KIAS)

Missed approach procedures are (Refer to Approach Plates). Taxiway turnoff will be to the _____ (left or right) with taxi route from active being _____, parking at Gate _____ ."

Captain or Pilot Flying Call for "Approach checklist"	**First Officer or Pilot Not Flying** Execute approach checklist
Verify Vref speed. Set approach DH on PDF as required	Select VRef speed

Approach Checklist

Pilot Not flying

Seat belt sign	ON
No Smoking sign	ON
Avionics and Radios	SET
Speed: Established	220 KIAS
MFD	EICAS 1
Landing Lights	ON (at 10,000 feet)
Auto spoilers	ARM
Autobrake	SET AS REQUIRED

----APPROACH CHECKLIST COMPLETE----

Landing Procedure

Pilot Flying	Pilot Not Flying
En route to initial approach fix (IAF) for procedural turn, reduce speed for flaps extension. Call for “FLAPS 1”	LNAV or HDG selected Set Flaps 1
Approaching IAF, call for “FLAPS 5”	Set Flaps 5
On turn to localiser heading, call for “FLAPS 10”	Set Flaps 10 Set Heading bug
When on localiser intercept heading: Verify ILS tuned and identified LOC and G/S pointers displayed Arm APP mode	
Glide slope alive, call for “GEAR DOWN and FLAPS 20”	Set Flaps 20 Set Gear DOWN, Verify 3 GREEN. GPS/Nav switch set to NAV
Position Speedbrake lever to ARM	
At glide slope capture, call for “Flaps 30”	Set Flaps 30
Monitor approach progress and speed	At final approach fix/OM, verify crossing altitude
Call “Landing checklist”	Execute landing checklist
Landing Checklist Pilot Not Flying Landing Gear DOWN Autopilot OFF and DEACTIVATED Autothrottle OFF and SPEED DEACTIVATED *----LANDING CHECKLIST COMPLETE----*	
Monitor rollout progress and proper autobrake operation.	
Verify Thrust levers closed and speed brake lever up. Without delay, apply Reverse Thrust levers.	Verify Speedbrake lever UP and call “SPEEDBRAKES UP” If Speedbrake lever not UP, call “SPEEDBRAKES NOT UP”
WARNING: After reverse thrust is initiated, a full stop landing must be made.	
By 60 knots, initiate movement of Reverse Thrust levers to reach reverse idle detent prior to taxi speed. Position levers full down (forward thrust) when engines have decelerated to reverse idle.	Call “60 KNOTS”
Prior to taxi speed, call “Disarm autobrakes” and continue manual braking as required.	Disarm autobrakes
Turn off runway and commence taxi to parking.	

Go Around Procedure (if required)

Pilot Flying	Pilot Not Flying
Push TO/GA switch	
Call for “FLAPS 20”	Set FLAPS 20
Verify rotation to go-around and thrust increase.	
	Verify thrust adequate for go-around, adjust if necessary.
After positive rate of climb established, call for “GEAR UP”.	Verify positive rate of climb, then select gear lever UP.
Above 400 feet radio altitude select LNAV.	
Above 1,000 feet radio altitude, select VNAV.	
Call for “Flaps _____” according to flap retraction schedule.	Position Flap lever as directed.
Verify missed approach route being tracked and missed approach altitude captured.	
	Position Landing Gear lever OFF
Call for “After Takeoff checklist”.	Execute AFTER TAKEOFF Checklist

After Takeoff Checklist

Pilot Not Flying

Throttle	AS REQUIRED
Trim	SET FOR 250 KNOTS
Autothrottle	ARMED AND SET
Autopilot	ON AND SET
Autobrake	OFF
Flaps	OFF

----AFTER TAKEOFF CHECKLIST COMPLETE----

After Landing Procedure

Pilot Flying	Pilot Not Flying
Accomplish this procedure when clear of the active runway	
Call “Taxi to parking checklist” Taxi to parking. Speed maximum 20 knots.	Execute taxi to parking checklist

 Taxi to Parking Checklist

Pilot Not Flying

Strobe Lights	OFF
Flaps	UP
Spoilers	RETRACTED
Taxi Lights	ON
Landing Lights	OFF
Transponder	1200
Elevator Trim	TAKEOFF SETTING
Lights	AS REQUIRED

----TAXI TO PARKING CHECKLIST COMPLETE----

Shutdown Procedure

Pilot Flying Call for “Shutdown checklist”	Pilot Not Flying

 Shutdown Checklist

First Officer	Captain
Parking Brake	SET
Throttle	IDLE
Passenger Signs	OFF
Anti-ice	OFF
Taxi Lights	OFF
Nav Lights	OFF
F/D	OFF
Avionics	OFF
Fuel Control Switches	CUTOFF
Beacon	OFF
Doors	OPEN (Shift+E)
Jetway (if available)	DEPLOY (Shift+J)
Battery Master switch	OFF (Control+M)

----SHUTDOWN CHECKLIST COMPLETE----

Appendix 1 – Typical Flight Profiles

Climb Profile

Speed	Altitude
V2 + 20 KIAS	1,500 ft AFE*
250 KIAS	10,000 ft
330 KIAS	FL180
.76 mach	FL240
.82 mach	FL280
.84 mach	Cruise alt.
.85 mach	Level Cruise

*Above Field Elevation

Standard Climb Rates

FPM	Altitude
2000 – 2500	Below 10,000 ft MSL*
1000 – 2000	10,000 ft to FL180
1000 – 2000	FL180 – FL280
500 – 1500	Above FL280

*Mean Sea Level

Descent Rate

Target Speed	Descent Rate	Altitude
280 KIAS	2500 fpm	Cruise to below 10,000 ft MSL
250 KIAS	1500 fpm	Below 10,000 ft MSL

Approach/Landing Speed Profile

Speed	Altitude	Distance from Airport	Flaps
220 KIAS	Below 10,000 feet	30 nm	Up
200 KIAS		15 nm	Up
180 KIAS		10 nm	5°
160 KIAS	Varies	Final Approach Fix	10°
Vref + 5	Varies		25°
Vref + 5	Varies	Runway Threshold	25° or 30°

Source: deltava.org

Appendix 2 - Fuel and Weight Planning Template

B747- 400

Fuel and Weight Planning Template

Basic Operating Empty Weight:	394,660	lbs
+ Payload:		lbs
= Zero Fuel Weight:		lbs

Must be less than 535,000 lbs

Zero Fuel Weight:		lbs
+ Contingency Fuel:		lbs
+ Alternate Fuel:		lbs
+ Holding Fuel:		lbs
= Planned Landing Weight:		lbs

Must be less than 652,895 lbs

Planned Landing Weight:		lbs
+ Flight Plan Fuel:		lbs
= Planned Gross Takeoff Weight:		lbs

Must be less than 875,000 lbs

Planned Gross Takeoff Weight:		lbs
+Taxi Fuel Burn Off:		lbs
= Planned Taxi-Out Weight:		lbs

Must be less than 877,000 lbs

Appendix 3 – Speed Card

B747- 400

Speed Card

Takeoff

Gross Weight:		**lbs**	
Flaps 10		Flaps 20	
V1	KIAS	**V1**	KIAS
Vr	KIAS	**Vr**	KIAS
V2	KIAS	**V2**	KIAS

Landing

Landing Weight:		lbs					
Flaps:	**0**	**1**	**5**	**10**	**20**	**25**	**30**
Manoeuvring:	230	x	x	x	x	x	x
Vref:							
Vapp (Vref + 5):							

Appendix 4 – Rules of Thumb Calculations

Top of Descent (TOD) distance calculation
On descent into an airport, the aim is be to be at 10,000, 30 nm out and at 250 knots maximum. Top of Descent (TOD) is the point in nautical miles from the airport (or your target altitude position) at which you commence your descent. Take your Current Altitude minus the Target Altitude and multiply by 3.
Example: FL350 to FL100: 35 – 10 x 3 = 75 nm.
OR
Start descent when time to airport equals altitude to loose for 1,000 feet per minute descent.
Example: 10,000 feet to lose, start descent 10 minutes out at 1000 ft/min.

Rate of Descent (ROD) calculation
ROD = Ground Speed (GS) divided by 2 x 10
Example: GS 150 kts / 2 x 10 = 750 fpm
OR
ROD = Ground Speed (GS) x 5.
Example: GS 150 kts x 5 = 750 fpm

True Air Speed (TAS)
TAS = [(IAS x 2%) x (ALT/1,000 ft)] + IAS
Example: If IAS = 300 and ALT = 20,000: 300 x 0.02 X 20 + 300 = 420 KTAS

Descent Rate (for 3° glide slope)
TAS x 5
Example: 5 x 420 KTAS = 1,200 ft/min

Distance travelled based on ground speed
Take your Ground Speed and divide by 10. That's the distance flown in 6 minutes.
Example: GS = 150 kts = 15 nm in 6 minutes (= 2.5 nm per minute)

Three degree glideslope
Divide Ground Speed (GS) by 2, then add a zero.
Example: 120 kts GS / 2 = 60, add '0' = 600 fpm.

Descending Distance & Rate of Descent
Take your current altitude and multiply it by 3. Now take half of your Ground Speed and add a zero. This is your rate of descent in hundreds of feet per minute.
Example: If you are flying at 12,000 feet at a ground speed of 150 kts and you need to descend to 2,000 feet, the difference is 10,000 feet. Multiply 10 x 3 = 30. At 30 nm out you must begin your descent. Half you ground speed is 75, add a zero; so 750 feet per minute is your rate of descent.

Bank Angle (BA)
For standard turns for airliners: Plan bank angle (BA) to be maximum 25° for passenger comfort.

Rollout Angle (RA)
BA / 2
Example: If current heading is 090° and desired heading is 270° and BA is 20°
RA = 20 / 2 = 10, so start rollout at 260, i.e. 10° before the desired heading.

Appendix 4

Boeing 747-400 CHECKLISTS

Before Start Checklist	
Parking Brake……..	SET
Thrust Levers……	IDLE
Fuel Flow Switch……	CUT OFF
Battery Master Switch….	ON
Panel Lights……	AS REQUIRED
Gear Lever……	CHECKED DOWN
Flaps……..	UP
Spoiler……..	RETRACTED
Fuel Quantity……	CHECK
Anti-ice……..….	OFF
Aircraft Lighting……	OFF
Flight Controls…….	FREE & CORRECT
Elevator Trim……	SET FOR TAKEOFF
Avionics…….	ON
Seat Belt Sign……..	ON
No Smoking Sign…….	ON
Departure Briefing……	COMPLETE

Engine Start Checklist	
Engine Start Sequence 1 – 4 – 3 - 2	
Thrust Levers……	IDLE
Engine Area……..	CLEAR
MFD……	EICAS 2
Engine 1 Start Switch…..	START (hold)
N2 > 20% Fuel Flow……	RUN
Fuel Flow……..	CHECK
Repeat for Engines 4 – 3 – 2	
Monitor engine start parameters and stabilisation at idle:	
N2: 55.8 FF:1.5 OIL P: 245 OIL T: 104	
Anti-ice……..	AS REQUIRED
Pitot Heat……..	ON
MFD……	EICAS 1

Before Taxi Checklist	
Nav Lights…….	ON
Taxi Lights…….	ON
Heading Indicator…….	SET
Altimeters……..	SET
Standby Instruments……	SET
Radios & Avionics……	SET FOR DEPART
Autopilot…….	SET (not activated)
Autothrottle / Speed…….	SET (not activated)
F/D Switch…….	ON
Yaw Damper…….	ON
Autobrake……..	SET RTO
Elevator Trim…….	SET FOR TAKEOFF
Doors……..	CLOSED
Jetway……	RETRACTED

Taxi Checklist	
Parking Brake…….	RELEASED
Brakes/Gyro/Turn Coord.	CHECK
Flight Controls……..	FREE & CORRECT
Flaps……..	SET 10° (or 20°)
Cabin Notification…….	COMPLETED

Before Takeoff Checklist	
Brakes……	SET
Throttle……..	IDLE
Flaps……..	CHECKED SET
Spoilers……..	RETRACTED
Engine Instruments……..	CHECK
Takeoff Data (V1, Vr, V2)	CHECK
Nav Equipment…….	CHECK
Taxi Lights…….	OFF
Landing Lights……..	ON
Strobe Lights…….	ON
Anti-ice……..	AS REQUIRED
Transponder…….	ON & SET

Normal Takeoff at MTOW & Flaps 10	
Takeoff Thrust……..	FULL or TOGA
Brakes……	RELEASED
V1……..	160 KIAS
Vr ……...	177 KIAS
Pitch……	8° - 10° NOSE UP
V2……	188 KIAS
Positive Rate of Climb….	GEAR UP
Pitch……	↗15° NOSE UP
V2 + 10……..	198 KIAS
At 1000 feet: V2 + 20…..	208 KIAS
Pitch……	↘ 10° NOSE UP
Rate of Climb……	1800 FPM
At 200 KIAS……..	Select FLAPS 5
At 220 KIAS……..	Select FLAPS UP
	Accelerate to FLAPS UP + 20
At 240 KIAS……..	↗ 10,000 feet
	Max speed 250 KIAS

After Takeoff Checklist	
Throttle……...	AS REQUIRED
Trim……	SET FOR 250
Autothrottle……	ARM AND SET
Autopilot……..	ARM AND SET
Autobrake……...	OFF
Seat Belt Sign……...	OFF
No Smoking Sign…….	CHECK ON
Landing Lights……..	OFF (+10,000 feet)

Cruise Checklist	
At FL 180	ALTIMETER 2992
Accelerate to cruise speed	FL 180 0.67 MACH
	FL240 0.76 MACH
	FL280 0.82 MACH
	FL330 0.85 MACH
Flight Instruments……..	CHECK
Fuel Quantity……..	CHECK
Radios……...	TUNED & SET

Descent Checklist	
ATIS Airport Information…	CHECK
Altimeter……...	CHECK
Radios……..	SET
Anti-ice……	AS REQUIRED
Descent Speed……	↘FL240 0.75 MACH
	↘FL180 0.65 MACH
At FL180……...	ALTIMETER TO LOCAL
Descent Speed……	To FL120 300 KIAS
	Below 10,000 feet 240 KIAS
At 10,000 feet……..	LANDING LIGHTS ON
Fuel Quantity & Balance…	CHECK
Flaps……	CHECK UP
Landing Gear……..	CHECK UP
Weather……	CHECK ATIS

Approach Checklist	
Seat Belt Sign……..	ON
No Smoking Sign……	CHECK ON
Avionics & Radios……..	SET
Speed Established……..	220 KIAS
MFD……..	EICAS 1
Landing Lights……	ON
Auto Spoilers……..….	ARM
Autobrake……	SET

Landing Checklist	
Landing Gear……...	DOWN
Autopilot……..	OFF & DEACTIVATED
Autothrottle……..	OFF & SPEED DEACTIVATED

Taxi to Parking Checklist	
Strobe Lights……	OFF
Flaps……	UP
Spoilers……	RETRACTED
Taxi Lights……	ON
Landing Lights……	OFF
Transponder……	SET TO 1200
Lights……	AS REQUIRED

Shutdown Checklist	
Parking Brake……..	SET
Throttle…….	IDLE
Passenger Signs…….	OFF
Anti-ice……..	OFF
Taxi Lights……	OFF
Nav Lights……	OFF
F/D Switch……..	OFF
Avionics……	OFF
Fuel Control Switches……	CUTOFF
Beacon…….	OFF
Jetway (if available)……	DEPLOY
Battery Master Switch	OFF

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Microsoft Flight Simulator X Learning Centre

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Comments and amendments

While every effort has been made to make this resource as accurate as possible for its use as a flight simulation manual, no guarantee can be made of total accuracy. Any correction or suggested amendments would be welcomed at fs.au@optusnet.com.au


Aussie Star Flight Simulation