737NGX

Touch and Go Landings

737NGX Handling Tutorial

737NGX-800WL in the circuit pattern

By Jonathan Fyfe
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Introduction

This tutorial was created to share my own insight into performing Touch and Go Landings using the PMDG 737NGX and Microsoft Flight Simulator X.

As a real-world pilot I hold a CPL, multi-engine IFR and hold a Grade 3 instructors license.

I always enjoyed the real-world busy circuit training environment, and while learning to "fly" the 737NGX, became inspired to write an instructional guide on touch and go landings for the aircraft. This is not an "official" guide, however it does include key information (excerpts of the text and the associated "Touch and Go Landings" diagram) from the *Boeing Flight Crew Training Manual*[1] *and the Boeing Flight Crew Operations Manuals* that should stand the 737NGX trainee in good stead.

My 737 experience is gained from a few informal sessions in actual Boeing 737 simulators and also from Microsoft Flight Simulator and the PMDG 737NGX.

I have spent over 80 hours "in" the PMDG 737NGX, have followed the supplied PMDG Tutorials 1 & 2, and I am progressing through Angle of Attack's comprehensive 737NGX Captain's training package.

Aim

The aim of this guide ***737NGX – Touch and Go Landings*** is to teach circuit training flying techniques relevant to the PMDG 737NGX, with focus on gaining approach and landing proficiency. Note that there are a lot of speed and performance "numbers" presented in here – while they should be referenced, do not overly chase them, as this will interfere with the enjoyment and aim of this handling exercise.

This is a challenging exercise – I initially flew many substandard circuits while creating this guide and researching everything!

Who is this guide for?

This guide is for FSX users who have purchased the PMDG 737NGX and want to experience handling it in the circuit pattern. Those who haven't may follow along using the default 737-800 or with another add-on.

- Difficulty Level: Medium/Hard
- Time to complete: 60 mins

[1] "Approach and Missed Approach" in the Boeing Company's *737 Flight Crew Training Manual*, and Performance data from the Boeing Company's *737 Flight Crew Operations Manual*

Disclaimer

The techniques demonstrated and the diagrams, charts, nav data and other operational content herein should only be applied to simulation usage. The instruction provided is likely to have some disparity with airline training methods.

The content is provided “as-is” and although reasonable effort has been spent to compile everything, this guide is provided purely for entertainment purposes - and may contain some errors.

The information has been compiled from a variety of sources, as well as being created by the author.

Finally, although I may have corresponded with individuals from PMDG about certain product details, I have no affiliation with PMDG, Boeing or any training organization.

Requirements

Flight Simulator X (FSX) with SP2 or Acceleration
PMDG 737NGX

Optional

Orbx FTX YMAV Avalon scenery
Orbx FTX AU Blue Temperate South scenery

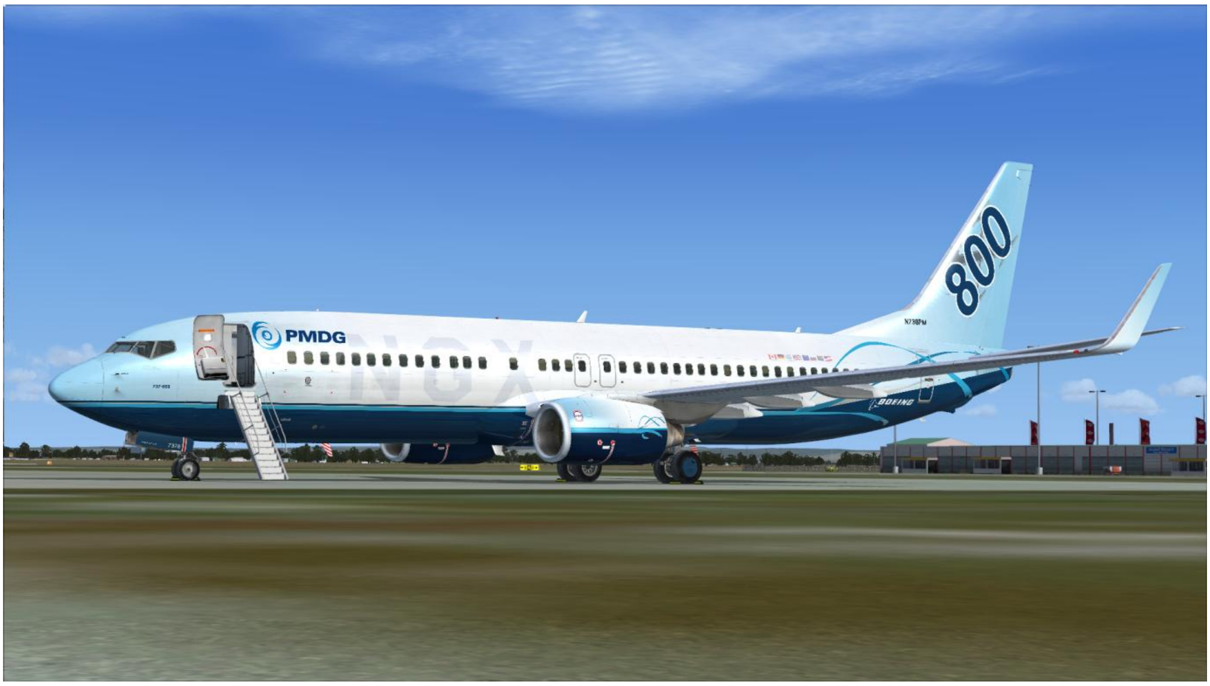
Recommended

Familiarity with the setup and practices recommended in the official PMDG 737NGX documentation and the tutorials by Ryan Maziarz.

I recommended that you have a perhaps 5+ hours familiarization and flight time in the 737NGX prior to undertaking this flight exercise. You should be able to competently perform circuits in non-jet aircraft such as the C172 or Beech Baron.

Additionally, real-world circuit training experience in any aircraft would be highly advantageous.

The 737-800



The 737NGX-800WL in the PMDG House livery

This is our aircraft for today's training session.

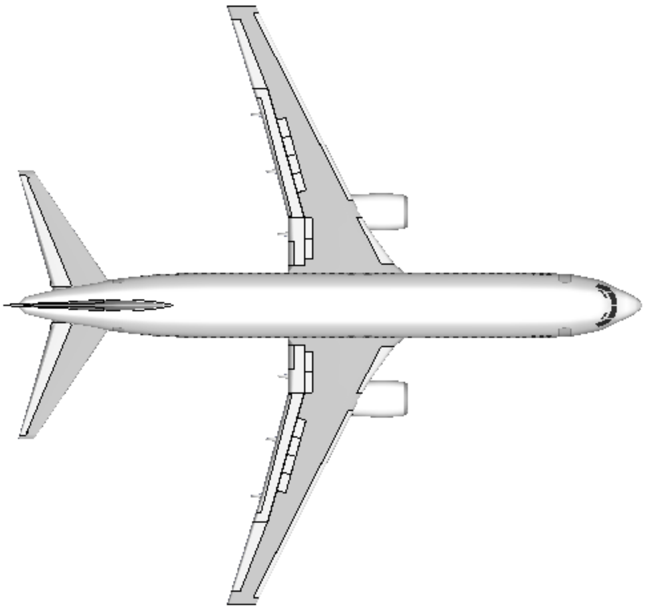
The Boeing 737-800 NG is powered by CFM56-7B engines and is demonstrably one of the most popular and successful airliner variants of all time.

PMDG Simulations (www.precisionmanuals.com) produce the 737NGX simulation software under license from Boeing Management Company.

Glossary

Term	Definition
A/P	Autopilot
A/T	Autothrottle
AFE	Above Field Elevation
APU	Auxiliary Power Unit
CDU	Control Display Unit
CWS	Control Wheel Steering
F/D	Flight Director
FCOM	Flight Crew Operations Manual
FCTM	Flight Crew Training Manual
FMC	Flight Management Computer
FPM	Feet Per Minute
FT	Feet
HDG SEL	Heading Select
IAS	Indicated Airspeed
MCP	Mode Control Panel
N1	Low Pressure Rotor Speed
PAPI	Precision Approach Path Indicator
QRH	Quick Reference Handbook
TOW	Takeoff Weight
V/S	Vertical Speed
V1	Takeoff Decision Speed
V2	Takeoff Safety Speed
VR	Rotation Speed
VREF	Reference Speed
ZFW	Zero Fuel Weight

Groundwork – Flight Briefing



Groundwork – Flight Briefing

Exercise overview

Today's flight will be a circuit training exercise, with the objective of practicing handling the aircraft in the pattern with emphasis on approach and landing. We will fly two circuits - a touch and go then a full stop.

Aircraft

We will use the 737-800WL PMDG House variant of the 737 aircraft for our circuit training.

Payload and Fuel

The aircraft will be at a very light gross weight, typical for circuit training.
ZFW is 41,400 kg (0 pax, 0 cargo), today's fuel load is **6,900 kg**[2], plus 100 kg unusable, therefore TOW will be **48,400 kg**. (The FMC will calculate 7000 kg after CDU entry of 6900).

Reference Speeds[3]

V-speeds:

V_1 **118**, V_r **118,** V_2 **121**; Climb out speed V_2+20 = **141** kts.

V_{Ref15} is 133

V_{Ref30} is 127 (+5 kts wind allowance gives **132** kts approach speed).

V_{Ref40} is 120

Maneuver speeds

Flap 5 (V_{Ref40} + 30) = 150 kts, Flap 15 (V_{Ref40} + 20) = 140 kts

Takeoff thrust

N1 = **86.0% N1** (22K Derate with assumed temperature +60 reduced thrust)

Trim

Takeoff trim will be 3.16 units, Approach trim will be around 5.0 units.

Weather

Today's weather is FSX Fair Weather, winds calm and QNH 1013/29.92.

[2] This tutorial uses KG for weights as the setting is Australia where weights are metric
[3] From FCOM and the FMC – for the 737-800 at 48,500 kg, 22k derate and assumed temperature thrust reduction method.

A Note on Fuel and Weight

Note that when a fuel load is specified via CDU entry on the NGX load screen, the FMC will calculate an increase on this figure by 100 kg. My understanding is that this matches the real world behavior.

1. 6900 kg is entered
2. 6.9 shows on the fuel summation unit
3. 7.0 shows on the FMC Perf Init page

Similarly, if 0 kg is entered, 0.0 shows in the summation unit and 0.1 on the Perf Init page. This results in a GW (Gross Weight) of 41.5 for a ZFW of 41.4
This 100 kg may be an allowance for unusable fuel but I have not been able to confirm this.

In any case, with our 6,900 kg load, the FMC will use 7,000 kg to give a gross weight of 48,400 kg.

CDU / FMC usage

This flight training exercise can be accomplished without any use of the FMC.

If you do choose to load up the PERF INIT section, you will get airspeed bugs set for V-speeds and flap maneuver speeds on the PFD. Alternatively you can manually set the bugs to the values indicated previously via the center panel rotary controls. (See later in the AIRWORK section).

If you choose to fly without any FMC performance inputs, consider adding the Airport Fix (See later in the AIRWORK section) to assist with turning final.

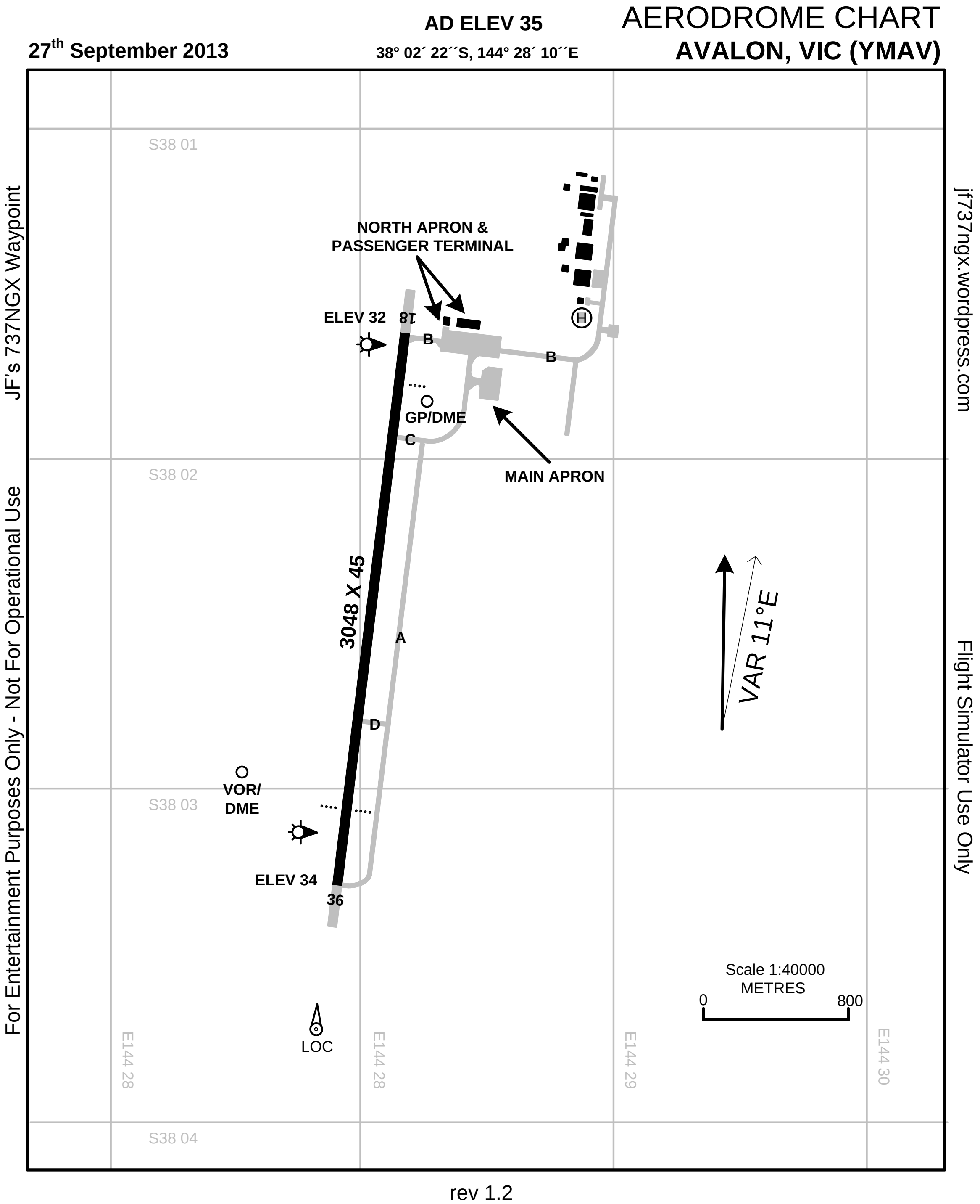
FMC values displayed on the CDU

Here are the V-speeds, Trim setting, N1 limit calculated in response to the entered weight (payload and fuel) and flap 15 setting. (48,400 kg, 22K Derate and Assumed temperature of +60). Approach Reference speeds are also calculated.

Airport and Chart

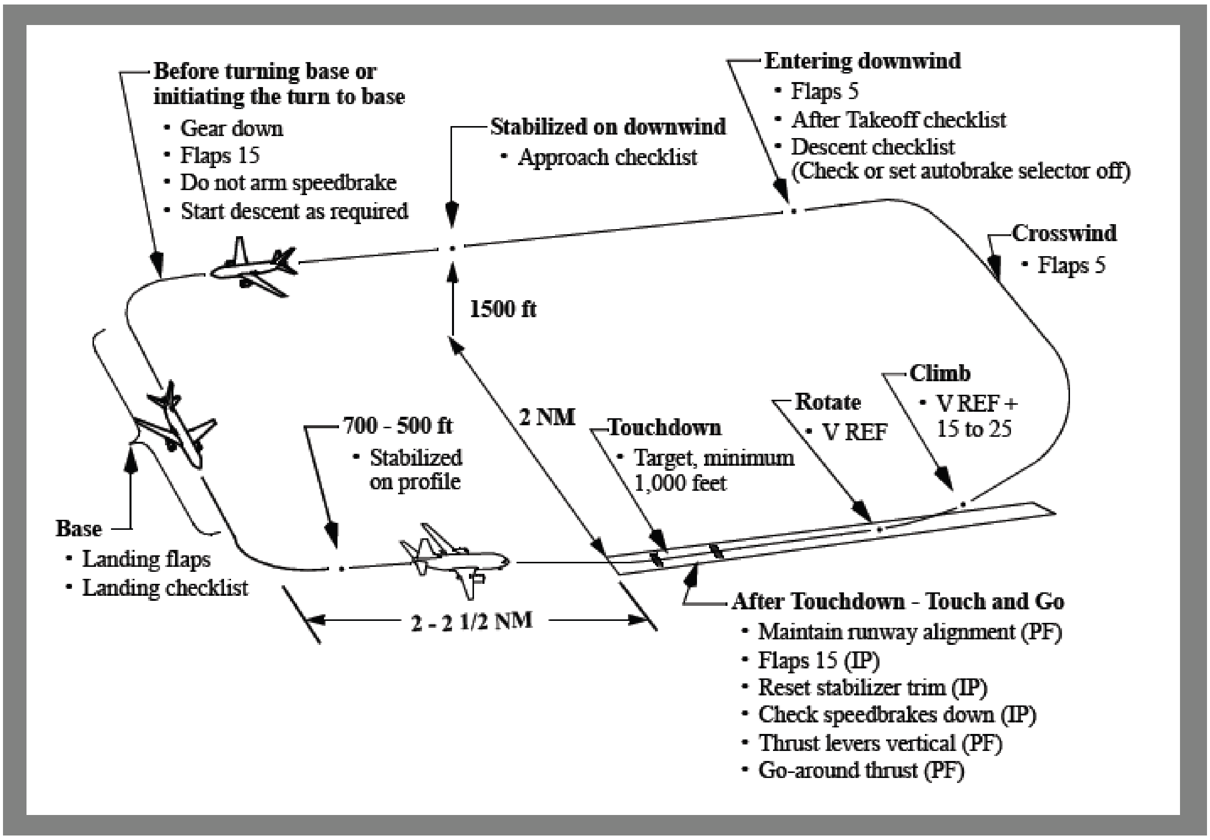
This tutorial is set at Avalon airport in Victoria, Australia (YMAV). Avalon is used for airline circuit training in the real world. It's a 3,048 m (10,000 ft) runway orientated north-south and at sea level – ideal for the trainee.

Today we will be using Rwy 36 which is aligned 356°M and is equipped PAPI for visual approach slope guidance.



The Circuit Pattern[4]

Below is the standard Touch and Go Circuit (Pattern) as depicted in the 737 Flight Crew Training Manual (FCTM).



This is an ideal circuit which is initially difficult to master due to its fairly compact size and the performance capability of the 737 at light gross weights

> *After a low-weight, non-derated takeoff, low-hour PMDG 737NGX pilots may quickly find themselves at 2,000 AFE accelerating through 200+kts with the airfield about 4 miles behind before feeling settled enough to turn crosswind!*

I can't stress enough that you should be very proficient in handling light aircraft such as the Cessna 172 and/or Beech Baron in the circuit before progressing to jet aircraft such as the Boeing 737. The stock aircraft are more than adequate for this purpose.

Note that the primary objective of touch and go landings is <u>approach and landing practice</u>. It is not intended for landing roll and takeoff procedure training.

[4] From the 737 Flight Crew Training Manual; Chapter 5 - Approach and Missed Approach

Circuit Area Reference

Circuit training is primarily a VFR activity, so it is advantageous to be familiar with the geography surrounding the airport. Above is a depiction of the circuit pattern overlaid on the local area[5].

[5] The scenery shown is FTX Pacific Blue and FTX Avalon Airport (YMAV).

Circuit Discussion

The circuit should be flown with plenty of "eyes outside" time. It can become difficult to try and avoid "flying the numbers"; indeed at some point during practice I encourage you to fly an entire circuit from the spot view with just the basic shift-z information of Heading, Altitude and Airspeed displayed at the top of the screen. You may find that it is easier than being in the cockpit chasing all the instruments.

The use of some automatics can be tried in the circuit if desired; you should include combinations of A/P HDG SELECT, A/T MCP SPEED and CWS to familiarise yourselves with these aids as you practise circuits.

Handling notes

If you are using a joystick (moulded for right hand use), then it can be awkward smoothly reaching for some of the Mode Control Panel automatics such as MCP SPD and HDG SEL with the mouse... unless you are adept using the mouse left-handed. For this reason, it can be easier flying circuits manually when using a joystick.

If you have a control yoke you will be flying with your left hand, leaving your right hand free to operate controls on the MCP via the mouse – a much more realistic option.

The takeoff segment and related activities outlined here will happen fairly quickly, so it is important to be familiar with the expected events and required actions. Our low TOW combined with sea level operation will result in impressive climb performance that can make it hard for the trainee to keep up. To counter this, we use a 22K derate and assumed temperature thrust reduction to limit the performance to manageable proportions on the takeoff segment.

To further reduce workload during initial practice, I have suggested a variation on the climb-out where runway heading is maintained until circuit height is reached. (See Upwind Leg Method One). This will provide a nice long downwind leg to get comfortable with the aircraft. If this doesn't suit you, just use Upwind Leg Method 2.

Double Derated Takeoff

We will use a combination of T/O Derate and Assumed Temperature to reduce our takeoff power setting to a minimum. This is used to reduce engine wear and tear by reducing internal temperatures. It will also make our climb performance more manageable.

Without any reduction, ie 26K, we see that N1 will be set to 98.8%.

TO-2 Derate

N1 is reduced from 98.0 (26K) to 92.4 using 22K TO-2 Derate.

Assumed Temperature Thrust Reduction

N1 is further reduced from 92.4 to 86.0 using an assumed temperature of 60°C

Initial Takeoff (First circuit)

Our takeoff will be a 22K derate takeoff, with assumed temperature method reduced thrust. V2=121 kts is set in the MCP Speed window for takeoff. **We will set takeoff power manually to 86% N1[6].**

Brakes are released and the throttles are firstly set to 40% N1 and both engines are observed to stabilize symmetrically, then the throttles are advanced to 86% N1.

Maintain slight forward pressure on the controls until 80 kts.
Call "80 knots" and relax the elevator to neutral.

Rotate at VR, (118kt) - you should rotate smoothly and at medium pace over about 7 seconds to approximately 15° pitch up. (The aircraft should lift off after 4+ seconds at around 7 deg pitch up).

> *Caution – do not rotate too quickly as tail strike will occur at 10 deg pitch in the 737-800 while the main gear is on the ground.*

Initial Climb

Once airborne establish pitch 15 deg, confirm a positive rate of climb then retract the gear. "Positive Rate, Gear up" called out. (Approx 100 ft AFE).

After liftoff, use the attitude indicator as the primary pitch reference, but be familiar with the visual pitch attitude.

[6] FMC values used. FCOM vol1 Assumed Temperature Reduced Thrust (22K Derate) calculates 86.0% N1.
Assumed temp of 60 (61 is max) gives 88.7% N1. Less OAT of 15 in table 3 for temperature adjustment corresponds to additional % N1 adjustment of -2.7 = 86.0

Upwind Leg Method One

I suggest you use this for your initial circuits to gain practice. In this method, upwind is extended until circuit height is attained so as to reduce the number of concurrent tasks; this also has the additional benefit of creating a longer downwind leg that provides extra time for stabilization, spacing, checklists etc. The base turn and approach will be the same with either method.

As the gear retracts adjust pitch as required to maintain V2+20 = 141 kts. This will be approximately 15 deg pitch.

> *It is possible by this stage you will have temporarily exceeded V2+20 as the aircraft is at such a low gross weight. If this is the case, pitch up to stop any further speed excursions, but do not attempt to reduce it back to V2+20.*

At 1,000 ft AFE, pitch forward slightly to allow the speed to increase and select Flaps 5.
(Note 150 kts is the Flaps 5 maneuver speed at our weight).

At around 1,300 ft, anticipate the level-off - reduce power to approx 55% N1 and reduce pitch to level off at 1,500 AFE at about 170 kts and trim the aircraft. Make a level turn to downwind (continuous turn through crosswind, do not square off).

Upwind Leg Method Two

Use this method for a tighter circuit once you have mastered the takeoff segment.

As the gear retracts adjust pitch up to maintain V2+20 = 141 kts.

At 800 ft, start the crosswind turn, (you are probably still over the upwind end of the runway at this point), pitch to allow the speed to increase and passing 1,000 AFE select Flaps 5.

Crosswind Leg – if you are using Upwind Method Two

At around 1,300 ft, anticipate the level-off - reduce power to approx 55% N1 and reduce pitch to level off at 1,500 AFE at about 170 kts. Trim the aircraft.

Continue the turn to downwind and adjust power to maintain around 175 kts.

Downwind Leg

Fly at an altitude of 1,500 ft AFE and trim the aircraft.

> *Do the after Takeoff & Descent Checklists*

Maintain a track parallel to the landing runway approximately 2 NM abeam. Reduce N1 to around 50% and pitch around 2.5 degrees for approximately 175 kts. Trim the aircraft (Approx 5.0 units).

> *Do the Approach checklist.*

Abeam the landing threshold plus 15 seconds, extend the landing gear and select Flaps 15. As speed reduces towards to 160 kts, begin the base turn.

> *Do Not Arm the speedbrake or autobrake if planning a Touch & Go.*

Base

For initial descent, **control speed with pitch and rate of descent with thrust**.

Descend at approximately 600-700 fpm. About 1-2 deg nose up (between horizon and first mark on the attitude indicator) and 50% N1 should suffice.

> *Note the pitch attitude should not be below the horizon at any point – this will result in speed excursion and create descent rates in excess of 1,000 fpm.*

Mid-base, extend landing flaps (30 degrees). Adjust pitch and power if needed for the approach speed of 132 kts (V_{ref30} + wind correction) and trim the airplane.

> *Power should be about 50% N1 and pitch should be about 1-2 deg nose-up.*

Begin the turn to final when about 1nm from the extended centreline.

Final Approach

Roll out of the turn to final on the extended runway centerline (*initially aim for the inner left side*) and maintain the approach speed of 132 kts.

For final approach, **control speed with thrust and rate of descent with pitch**.

An altitude of approximately 300 feet AFE for each NM from the runway provides a normal approach profile. (ie 750 feet for the 2 1/2 nm final).

Boeing suggest (see QRH) 0.5 deg pitch up and 48% N1 flaps 30 final approach (Vref30+10=137 kts) for our weight.

If you are on a longer final due to delayed base turn, you may need to set around 55% N1 and a higher pitch attitude initially.

Stabilize on the selected approach airspeed with an approximate rate of descent between 700 and 900 feet per minute on the desired glide path, in trim. Ensure stabilized by 500 feet AFE. *Go around if not stabilized.*

Disconnect the A/T and CWS at 200 ft if engaged.

Below 200 ft the landing is primarily visual (eyes outside), with some instrument support – eg airspeed and rate of descent.

Avoid descent rates greater than 1,000 fpm.

Landing and Subsequent Takeoff (Touch and Go)

Perform a normal final approach and landing. This means that the throttles should be retarded at 30 ft, and a gentle 2 deg flare should be initiated.

Remember, you are aiming for a firm landing in the touchdown zone, not a smooth landing before or after the zone.

At low weights, the NGX floats very easily, so ensure the pitch adjustment for the flare is minimal.

After touchdown

- ✈ Select flaps 15
- ✈ Set stabilizer trim
- ✈ Ensure speed brakes are down
- ✈ Move the thrust levers to approximately 40% N1 (the vertical position) *"Stand them up"* (to allow the engines stabilize *symmetrically* before applying takeoff thrust).

The takeoff configuration warning horn may sound momentarily if the flaps have not completed retraction to higher than flaps 25 and the thrust levers are advanced to approximately the vertical position.

- ✈ When the engines are stabilized at 40% N1, set takeoff thrust. "*Push them up*".

At Vref15 (133 kts) rotate smoothly to approximately 15° pitch and climb at V_{REF} + 15 = 148 kts.

To keep in mind...

Circuit training is primarily used for approach and landing practice, the emphasis is not on takeoff and climb. Nevertheless, you can "feel" a good circuit is underway when

1. You stabilize onto downwind early at target altitude and speed
2. You have not exceeded altitude or speed in reaching (1) above.
3. Lateral spacing is good
4. Trim is set and the aircraft can fly hands-off
5. There is time to relax and look outside the cockpit on downwind
6. You have time to review the descent and approach
7. You are “ahead” of the aircraft

Cockpit Warning Horn notes

The 737 cockpit warning horn can be a source of confusion so it is worth a review. The horn operates in 3 situations, as follows:

On the ground – intermittent horn

- ✈ Takeoff Config warning
  - trailing edge flaps are not in the 1 to 25 position for take off
  - leading edge devices are not configured for take off
  - speed brake lever is not in the down position
  - spoilers are not down with the speed brake lever in the down position
  - parking brake is set
  - stabilizer trim is not set in the take off range.

In the air – intermittent horn

- ✈ Cabin pressurisation warning
  - Cabin altitude at 10,000 ft or higher

In the air – steady horn

- ✈ Landing Config warning (Gear not down & locked)
  - flaps up through 10 and below 800 ft RA with thrust levers less than 20°
  - flaps 15 through 25 with thrust levers less than 20°
  - flaps > 25 and below 800 ft RA with thrust levers less than 20°

Autopilot notes - Control Wheel Steering (CWS)

CWS is a powerful autopilot mode that is not discussed very frequently and is often overlooked.

Indeed, in a computer flight simulator where control pressures are absent, CWS can be thought of as “magic trim” function. It’s possible that CWS adds more “value” to a flight simulator than a real aircraft, but in any case, it is a flight control mode that can be very satisfying to use.

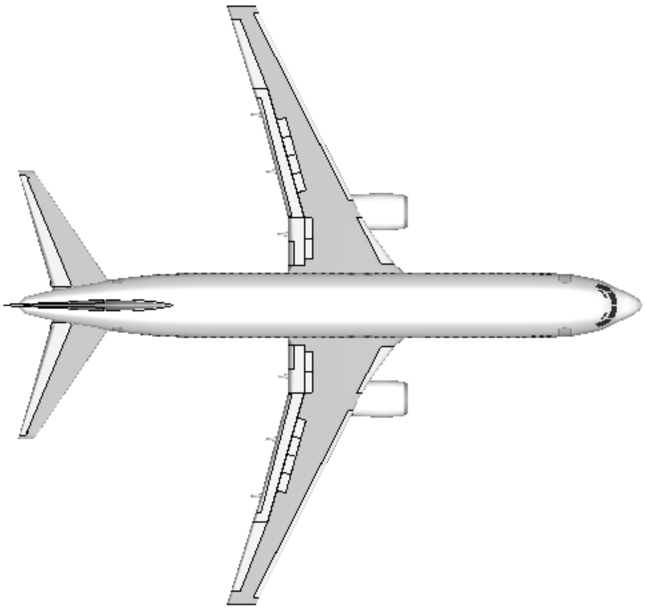
In a nutshell, CWS will hold the pitch and roll that you set with the control wheel (or joystick) when you release all control pressure.

I highly recommend familiarising yourself with CWS in the PMDG 737NGX; it’s an amazing augmentation to hand flying and will greatly assist you in your circuit training exercises by reducing pilot workload in the busy circuit environment especially when flying as single-pilot!

From FCOM vol 2 (4.10.18) - Notes on CWS:

> When control pressure released, A/P holds existing attitude. If aileron pressure released with 6 degrees or less bank, the A/P rolls wings level and holds existing heading.
>
> Heading hold feature inhibited below 1500 feet RA with gear down.

Airwork – Flight session

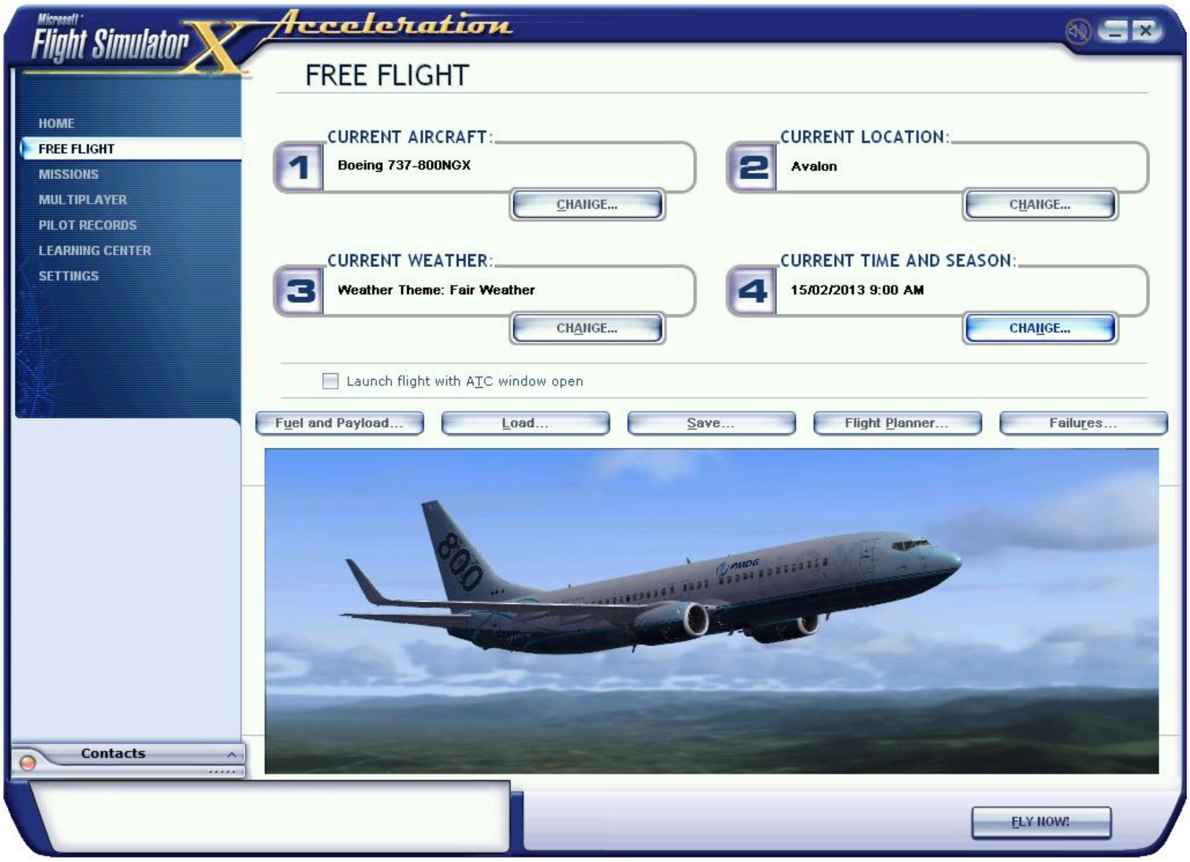


Airwork – Flight session

OK, now that you have completed the ground briefing let's finally board our 737 aircraft.

Load FSX and setup for our flight

Start FSX, select "Free Flight"



Current Aircraft

Select the PMDG 737NGX 800WL House Livery – you can use any livery, but note this can introduce differences in the cockpit setup.

Current Location

Select Country: **Australia**, State: **Victoria**, Airport: **Avalon** (YMAV), Starting Position: **PARKING 5 -- RAMP GA LARGE**, which will put us on the main apron (see diagram), away from the small passenger terminal.

Current Weather

Select Fair Weather

Current Time and Season

Select 9am, and a date of your choosing; I picked Feb 15 to get the FTX summer textures shown in the accompanying pictures.

Press "**Fly Now**"

On the ramp at Avalon.

Our aircraft on ramp parking at Avalon - the 737NGX-800WL in the PMDG House livery

Cockpit Preparation

Load the panel state **NGX SHORT** which has the aircraft running on APU power.

FMC / CDU – Fuel & Payload Setup

Fuel - Set 6,900 kg.
Payload - select Empty

FMC - Position & Navigation

Position YMAV
FIX – Insert FIX **YMAV** RAD 176/3nm (To assist with turning final).

MCP Setup

Even for manual flying, it is useful to set these numbers as reminder cues

- ALT 1500
- HDG 356
- MCP Speed 121 (V2)
- COURSE 176 (Downwind reminder only)

Center Panel Manual Performance Controls

Performance and speed reference values can be set here if the FMC is not being used.

- V1, VR are set to enable the auto-callouts. (Both to 118 kts).
- Set Weight to 48,500 to calc Maneuver speeds and V_{Ref30}, V_{Ref40} speeds.

Flight Instruction

Today's Circuits

First Circuit review:

- ✈ Extended upwind circuit (climb upwind to circuit height) to reduce the cockpit workload whilst gaining familiarity with the aircraft
- ✈ Touch and go

Second Circuit review:

- ✈ Normal circuit (within 3 nm radius) with some use of automatics.
- ✈ CWS
- ✈ A/T – MCP Speed
- ✈ Full stop

Complete the cockpit pre-flight and then confirm the key checklist items below.

PREFLIGHT Checklist

Oxygen	Tested, 100%
NAVIGATION transfer and DISPLAY switches	NORMAL, AUTO
Window heat	On
Pressurization mode selector	AUTO
Flight instruments	Heading___, Altimeter___
Parking brake	Set
Engine start levers	CUTOFF

- ✈ If you have not done so, load up the FMC or Performance panel now as outlined in the previous section

BEFORE START Checklist

Flight deck door	Closed and locked
Fuel	___ LBS/KGS, PUMPS ON
Passenger signs	___
Windows	Locked
MCP	V2___, HDG___, ALT___
Takeoff speeds	V1___, VR___, V2___
CDU preflight	Completed
Rudder and aileron trim	Free and 0
Taxi and takeoff briefing	Completed
ANTI COLLISION light	ON

- ✈ Start the engines via the normal start procedure

Ok, we're just about ready now. Ensure the pre-taxi items are completed. After running through them, confirm via the checklist.

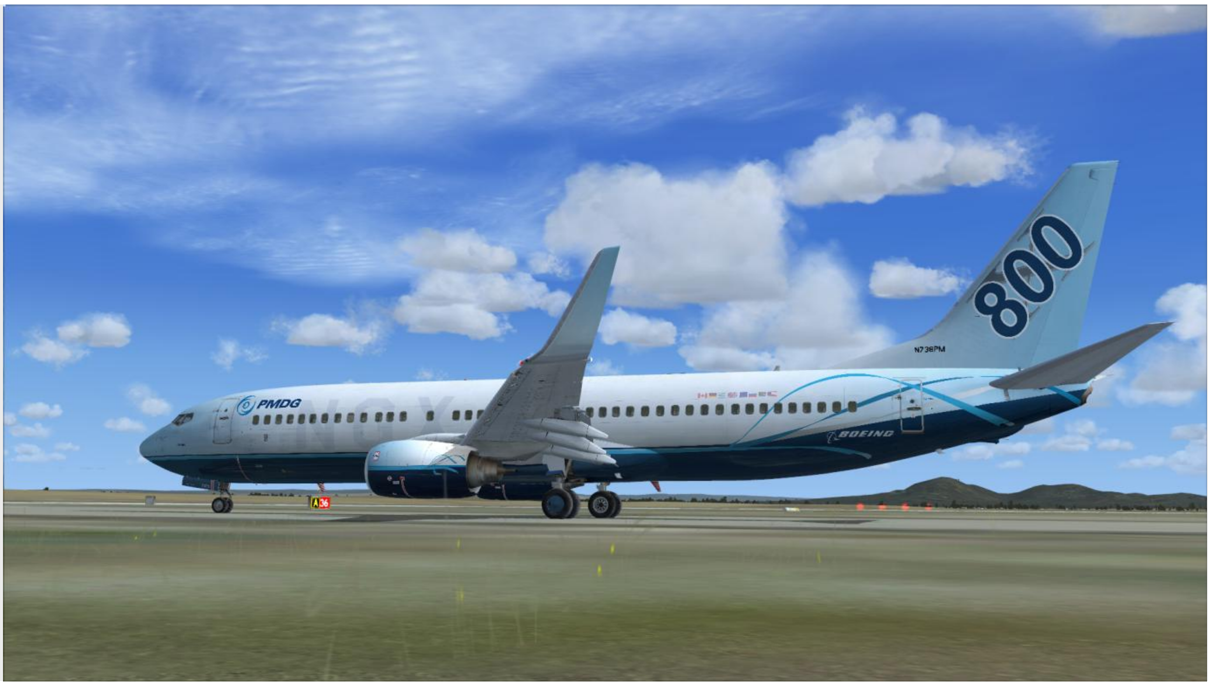
BEFORE TAXI Checklist

Generators	On
Probe heat	On
Anti-ice	___
Isolation valve	AUTO
ENGINE START switches	CONT
Recall	Checked
Autobrake	RTO
Engine start levers	IDLE detent
Flight controls	Checked
Ground equipment	Clear

Taxi out

Release the parking brake and taxi out to the holding point for runway 36.

- Set Flaps 15
- Set the Trim to 3.16



It's a fairly long taxi out to runway 36, so take the time for a review of your takeoff actions.

Stop at the holding point

Do the before takeoff checks

BEFORE TAKEOFF Checklist	
Flaps	___, Green light
Stabilizer trim	___ Units

Checklist Variation

As the circuit training environment is very busy and it is a repetitive exercise, there are a few after takeoff/descent/approach/landing check items that you may elect to do once, <u>before takeoff</u> (i.e. now), namely:

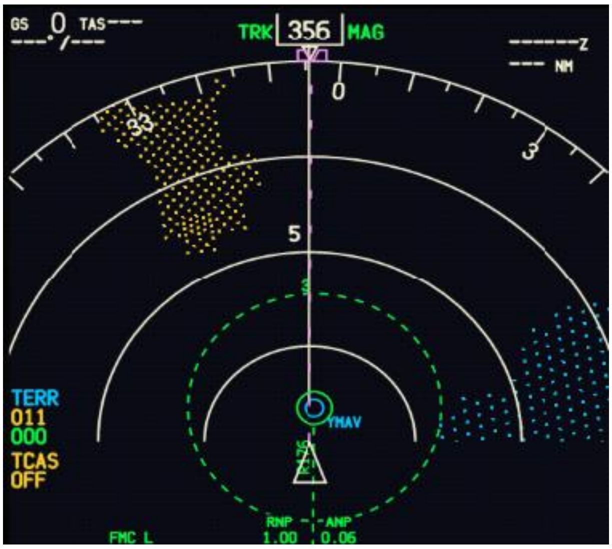
Engine bleeds	On
Packs	AUTO
Pressurization	LAND ALT___
Altimeters	___
ENGINE START switches	CONT

These items can be left checked & set for the duration of the session.

Line up

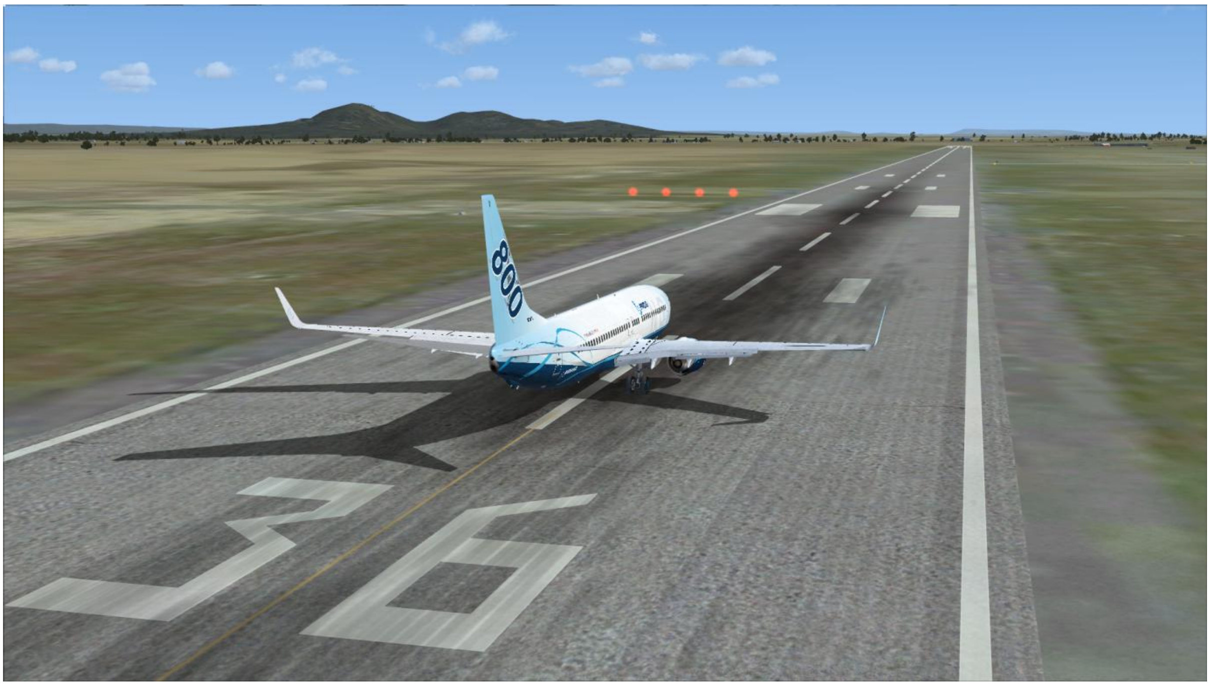
- Parking brake OFF
- Landing Lights ON
- Strobe Lights ON

View the TERRAIN display. Take note of the high ground (elevation 1,100) to the NNW about 6 nm distant from the airfield. The turn to crosswind should be completed well before this hill.



Note the Avalon YMAV Fix with 3nm radius and final approach guidance (Radial 176). For the initial circuit with extended upwind, we will go outside this reference circle but remain within 5 nm, well clear of the terrain.

Initial Takeoff – straight ahead to 1,500



Lined up for takeoff. Note the high terrain 6 nm to the NNW of the field.

Do the takeoff…

- ✈ Release brakes
- ✈ Advance throttles to 40% N1 and stabilize for 2 sec whilst rolling
- ✈ Advance throttles to 86.0% N1
- ✈ Rotate at VR = 118 kts and smoothly pitch 15° nose-up

Passing 7 degrees pitch up on rotation – just prior to lift-off

Note the tail clearance.

The same moment, from the cockpit.

After Takeoff

- Confirm positive rate..then Gear UP
- Pitch for V2 + 20 = 141 kts

Upwind Leg

Maintaining climb out speed of V2+20 = 141 kts requires a pitch attitude of around 15 degrees. Take a visual reference from the outside horizon. Also note that 141 kts is below the flap 5 maneuvering speed which is bugged at 150 kts.

- Passing 1,000' AFE Lower pitch to around 10 deg; as speed increases through 150 kts select Flaps 5 and reduce N1 to around 60% to keep speed below 170kts.
- At 1,300' begin level off to circuit height, reduce power to 55% N1.
- Trim the aircraft

Crosswind Leg

- When leveled off at 1,500 ft, make a continuous left turn to downwind

Start of Downwind

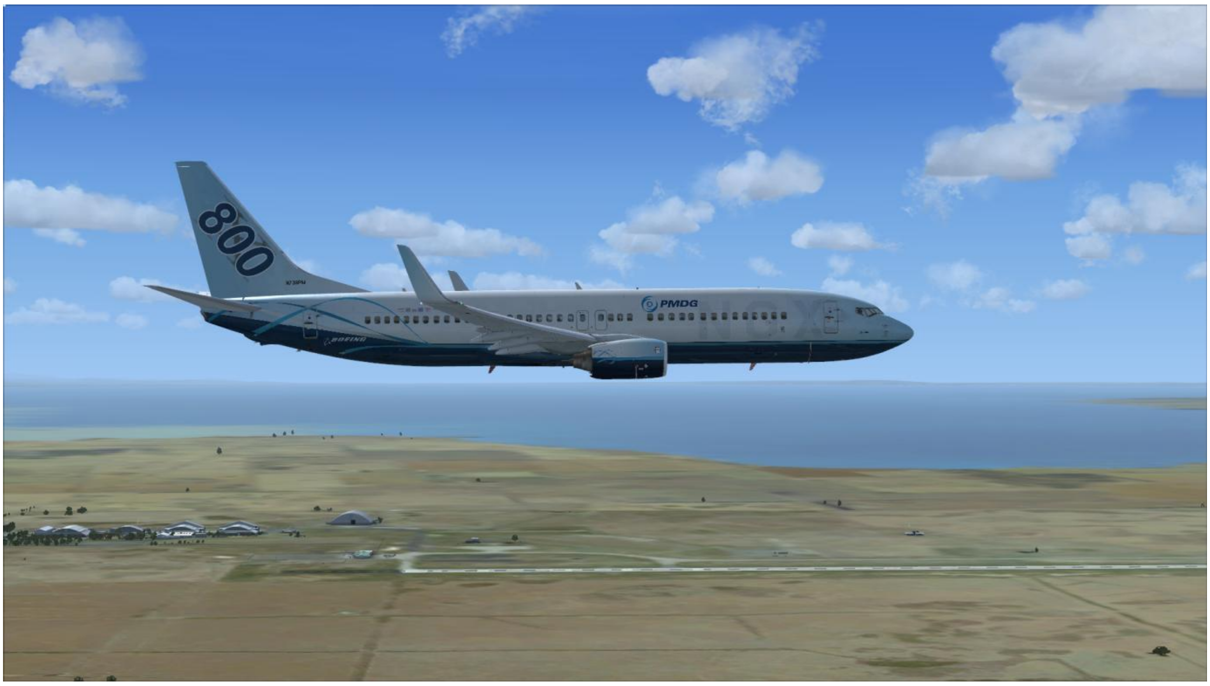
- Maintain 1500' AFE, heading 176°, 170-180 kts - reduce power to approx 50% N1, trim for approx 2.5° pitch attitude
- Check spacing – should be 2 NM abeam
- Do the After takeoff and Descent checklists

AFTER TAKEOFF Checklist

(Engine bleeds	On)
(Packs	AUTO)
Landing gear	UP and OFF
Flaps	5

Approach briefing

Approach briefing: Vref 127 + 5kts = 132 kts threshold speed at Flap 30
Landing will be a **touch and go**; if approach not stable by 500 AFE we will go around



DESCENT Checklist

(Pressurization	LAND ALT___)
Recall	Checked
Autobrake	Do Not Arm
Landing data	VREF 127, Minimums 500
Approach briefing	Completed

APPROACH Checklist

(Altimeters	___)

Late Downwind - abeam landing threshold + 15 secs

- Lower the landing gear
- Select Flaps 15
- Autobrake off, do not arm speedbrake.
- Maintain 1,500
- As speed reduces towards to 150 kts, begin the base turn.

Abeam threshold + 15 secs, gear extension and selection of flaps 15

Turning Base - descending

Nose attitude is always above the horizon to avoid speed excursions and excessive descent rates.

Base Leg

- Roll out on 086deg
- Descend at 600-700 fpm using power control, maintain about 2.5 deg pitch

Mid-Base

- Select Flaps 30 and monitor speed reduction
- Briefly hold square pattern 086 deg, looking for 140 kt and 700 fpm descent - trim
- No continuous turn due to reduced speed, hold base hdg for approx 10 secs

Do the Landing checklist.

LANDING Checklist	
(ENGINE START switches	CONT)
Speedbrake	Do Not Arm
Landing gear	Down, green lights
Flaps	30, green light

- Aim to turn Final at about 750 AFE – you should be on a 2.5nm final

Final

When established in the landing configuration, maneuvering to final approach may be accomplished at final approach speed = 132 kts.

Make small control movements, ensure the approach is stable.

- Aim for inside left edge of the runway initially to avoid overshooting the centerline
- Roll out onto final, heading 356 deg
- Maintain stable profile, 700 fpm descent rate
- Power for speed, pitch for rate of descent
- Small control inputs and profile adjustments
- 500 AFE - Landing decision point – continue if stable

Landing

- 30 AFE Retard throttles
- Gently flare by increasing pitch 2 deg nose up only.

Rollout and Takeoff

- Eyes to the end of the runway, maintain runway alignment

After touchdown

- Flaps 15
- Trim to 3.5
- Stand the throttles up for symmetric stabilization (~40% N1) for 2 seconds

Note it is likely that the Takeoff Config Warning Horn will sound briefly whilst the flaps retract through 25° on the way to the 15° position

- Advance throttles to 86% N1

Second Takeoff – climb upwind to 800 then turn crosswind

- Rotate at VREF15 = 118 kts and smoothly pitch 15° nose-up

After Takeoff

- Confirm positive rate..then Gear UP
- Pitch for V2 + 20 = 141 kts
- At 500 AFE engage CWS

Upwind Leg

Maintaining climb out speed of V2+20 = 141 kts

- When ready at 800 ft, start a continuous (climbing) turn to downwind

Crosswind Leg

- Passing 1,000 AFE Lower pitch to around 10 deg; as speed increases through 150 kts select Flaps 5 and reduce N1 to around 60% to keep speed below 170kts.
- Continue the turn
- At 1,300' begin level off to circuit height, reduce power to 55% N1.
- Set MCP SPEED to 175 kts and engage A/T

2nd Circuit Start of Downwind

Note this will be a much shorter downwind leg due to the earlier crosswind turn

- Maintain 1500' AFE, heading 176°, 160 kts
- Check spacing – should be 2 NM abeam
- Do the After takeoff and Descent checklists

AFTER TAKEOFF Checklist

(Engine bleeds	On)
(Packs	AUTO)
Landing gear	UP and OFF
Flaps	5

Approach briefing

Approach briefing: Vref 127 + 5kts = 132 kts threshold speed at Flap 30
Landing will be a **full stop**; if approach not stable by 500 AFE we will go around

DESCENT Checklist

(Pressurization	LAND ALT___)
Recall	Checked
Autobrake	Arm
Landing data	VREF 127, Minimums 500
Approach briefing	Completed

APPROACH Checklist

(Altimeters	___)

Late Downwind - abeam landing threshold

- Lower the landing gear
- Select Flaps 15
- Maintain 1,500
- As speed reduces towards to 160 kts, begin the base turn.

Base Leg

- Roll out on 086deg
- Descend at 600-700 fpm using power control, maintain about 2.5 deg pitch

Mid-Base

- Select Flaps 30 and monitor speed reduction
- Hold square pattern 086 deg, looking for 140 kt and 700 fpm descent - trim
- No continuous turn due to reduced speed, hold base hdg for approx 15 secs

Do the Landing checklist.

LANDING Checklist

(ENGINE START switches	CONT)
Speedbrake	Arm
Landing gear	Down, green lights
Flaps	30, green light

- Aim to turn Final at about 750 AFE – you should be on a 2.5nm final

Final

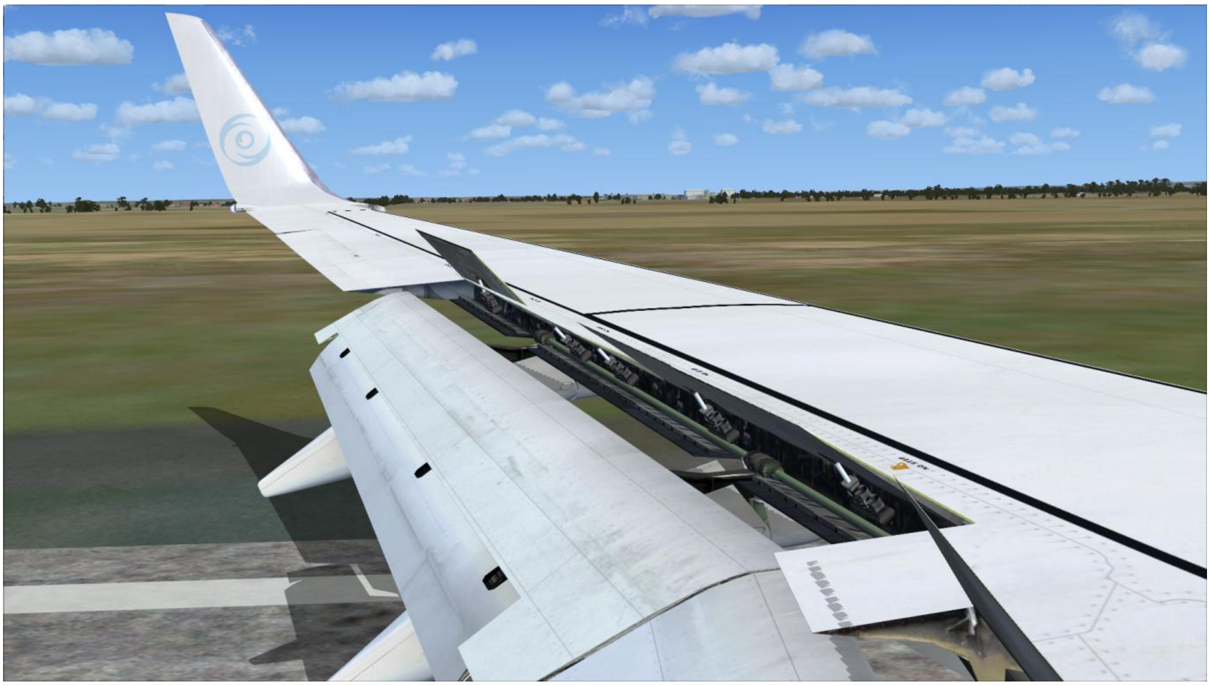
When established in the landing configuration, maneuvering to final approach may be accomplished at final approach speed = 132 kts.

Make small control movements, ensure the approach is stable.

- Aim for inside left edge of the runway
- Roll out onto final, heading 356 deg
- Maintain stable profile, 700 fpm descent rate
- Pitch for rate of descent
- Small control inputs and profile adjustments
- 500 AFE - Landing decision point, disconnect A/T[7] and CWS, monitor airspeed

Landing

- 30 AFE Retard throttles
- Gently flare by increasing pitch 2 deg nose up only.



[7] Ensure that your throttle position matches the current power setting by referencing the blue guide marks on the engine N1 display. (This feature must be enabled in the aircraft config).

Taxi back to the apron

Well done – time to head back and review the exercise!

Once parked, Shutdown the aircraft.

SHUTDOWN Checklist	
Fuel pumps	Off
Probe heat	Off
Hydraulic panel	Set
Flaps	Up
Engine start levers	CUTOFF
Weather radar	Off

Author's Note

I hope you have found this guide useful, and I welcome questions and feedback.

Happy Circuit Training!

Credit

In addition to my own light aircraft flying and 737 simulator experiences, I have drawn extensively on the PMDG training material to learn handling techniques. Much of this material in turn, originates from Boeing.

My simulator time was spent in these two 737-800 simulators located in/near Sydney.

- VS Jet, Katoomba – 6-axis motion simulator
- Flight Experience, Darling Harbour, Sydney – fixed base simulator

Once again, I hope you find this material useful and I welcome any feedback or corrective suggestions.

Other References

"Approach and Missed Approach" in *The Boeing Company: 737 Flight Crew Training Manual*, 2008.

"Climb, Cruise, Descent" in *The Boeing Company: 737 Flight Crew Operations Manual*, 2008.

"Pilots Notes" in *Chris Brady: The Boeing 737 Technical Guide*, version 65, Feb 2003, www.b737.org.uk