

Advanced Operations Tutorial

PMDG 737NG



by

Timothy M. Metzinger

Revision History

Date	Version	Notes
09/03	1.01	Initial Release
	1.02	Inverted FMC pics for clearer printing, added info on fuel management. Additional appendices added.
02/2004	2.0	Completely Redone for PMDG SU3

About the Author



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I'm a US pilot, holding a commercial certificate, with ratings for single and multiengine land aircraft, and an instrument rating. I am a computer systems professional, and fly mostly for pleasure in small aircraft (Mooney, Cessna, Socata). Occasionally I fly Cessna Caravan's for a regional FedEx operator, and I do maintenance flight-testing and ferry work as well. My experience with the 737 is limited to about 3 hours in a 737-200 simulator as part of the ATOP (www.b737.com) program, and (so far) 60 hours of ground school in systems on the -200 and -700. When I finally reach the necessary 1500 hours of flight time to take the ATP exam, I plan on combining the ATP exam with a 737 type rating exam.

Acknowledgements

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Finally, thanks go to my wife Catherine, who put up with all the lost time spent creating this. Writing is one of the most antisocial activities a person can do, and her patience has been tremendous.

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Introduction

In Microsoft's Flight Simulators, the big jets are just bigger, heavier, faster versions of the smaller aircraft – you operate them in the same way; load them up, start the engines, and take off and fly around, and eventually land. It's a little odd that the autopilot in the 737 or 747 or 777 doesn't do anything more than the autopilot in the Baron or the Lear, isn't it?

On the other hand, a sophisticated aircraft add-on such as the PMDG 737NG is designed for people who want to more fully experience the complexity of the transport airplanes. The good news is that you can master the various systems and methods of operation to fly the airplane. The bad news is that you must master the various systems and methods of operation before you can fly the airplane.

This guide is designed to take you through a short course to bring you up to speed on the airplane and its systems. In five flights, you'll learn:

- How to start with a cold and dark cockpit and bring the airplane to life.
- How to extend and retract the airstairs.
- How to fly the airplane without using the FMC.
- How to program the FMC with your basic route.
- How to store the route and retrieve it.
- How to add a departure or arrival procedure to the route.
- How to modify a route by adding/deleting waypoints, and assign speed and altitude constraints.
- How to select an approach procedure.
- How to construct a transition from your arrival to the approach
- How (and when) to use LNAV and VNAV, and how and when to fly using the "dumber" modes like HDG, VS, LVL CHG.
- How to add a new waypoint in relation to an existing waypoint.
- How to intercept a course.
- How to use holds (present position, flightplan waypoint, or creating a new waypoint)
- How to fly a single-channel ILS approach.
- How to fly an autoland ILS approach.
- How to fly a non-precision approach using LNAV and VS.

I strongly suggest you read each flight all the way through before starting the sim – you'll do a much better job of keeping up if you have an overall idea of what will be happening as you fly.

Requirements

You'll need:

This guide (printed out is best)

Flight Simulator 2002 or Flight Simulator 2004

The PMDG 737-The Next Generation Add-on with SU3

All the PMDG Documentation from their website.

NavData (0313) and the PMDG 0401 SID-STARS.

A few hours of time

Plenty of patience

Installation

Place the KTNT.TXT file into the FSroot/PMDG/SIDSTARS directory.

Installing the base scenario:

FS9:

Place the FS9 NG Tutorial Default Aircraft.flit situation file with your other FS9 situation files (usually my documents\flight simulator files).

FS2002:

Place the FS2002 NG Tutorial Default Aircraft.flit situation file with your other FS2002 situation files.

Scenario Background

You're a newly rated pilot on the 737-700, and you are reporting to the Dade-Collier Training and Transition facility near Miami, Florida. Your airline has sent you here for some final polishing and Line Oriented Flight Training (LOFT) on the autoflight systems before they turn you loose on the line flying passengers. This phase of training costs a lot of money, so you're expected to knuckle down and concentrate. The crew hotel and training classrooms are right on the field, so there won't be any opportunities to go into "town" to drink, swap lies, and chase the natives. In five flights you'll be expected to learn how to operate the autoflight systems with sufficient proficiency that you won't aggravate ATC or scare the cattle in the back of the airplane.

Prerequisites

It is expected that you're already an accomplished flight simulator pilot, and have some hours in the simulator with the default airplanes, so that we don't need to teach you how to fly.

It's also expected that you have become familiar with all the controls and systems of the NG. If you are not, please get the 737 Flight Manual from the PMDG web site and learn the buttons and switches and what they do. Fred Clausen's tutorial 2.0 on Avsim is a good place to start.

You'll occasionally be instructed to pause the simulator if there's a lot of FMC programming to be done. Don't hesitate to pause the sim on your own if you need to take a moment to get your head wrapped around a concept. When I went through Caravan school, we paused the sim a LOT to discuss systems and the implications of what we were doing. One of the reasons simulators are such good training tools is because you can stop time right before or after a mistake is made, and correct it while it's still fresh. As you get proficient, you'll get faster and won't need to pause the sim.

Conventions

Writing Style

The manual is written as if I were a Training Captain flying in the right seat in the aircraft, so the words “we’ll do this” indicate things that you should do on your sim.

Special Type Styles

ATC clearances, vectors, etc. will appear like this

CHECKLISTS WILL APPEAR LIKE THIS

Anytime I’m dropping out of the check airman role to speak directly to you, it will appear like this. Usually, I’ll be giving tidbits about a flight system, or a warning of something to come.

Graphics

The screen shots here, particularly those of the FMC, are typically used to show important details, and are NOT a button-by-button sequence. They primarily serve as a sanity check. It’s likely that there will be small differences in the screens in the book and what you see on the screen.

The FMC shots were converted to grayscale, and then inverted to provide better clarity when printed.

I fly with the single-cue flight director instead of the “classic” crosshairs, so you’ll notice that difference. You’ll also notice some additional panel buttons belonging to some of the add-ons I use – an appendix details them as well as the modifications I’ve made to panel.cfg to install them.

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Day One

Arrival and Check-in

As you arrive to this single-runway field out in the middle of nowhere, and head for the housing facility, you get a glimpse of the aircraft you're expected to master. A shiny new 737-700 sits on the small ramp. You check into the dorm, unpack your stuff, and get ready for school – your first lesson starts in 15 minutes!



Figure 1 - Welcome to Dade-Collier (FS9 Image)

Lesson 1 – Baseline Setup, Airfield Familiarization

We're going to set up the simulator for all our future flights, by setting the aircraft loading, positioning the airplane where we want it, loading fuel, and saving the situation.

<p><u>Programmed Goals</u></p>	<p>Positioning the Aircraft Selecting the Aircraft Clearing Weather Setting Basic Weight and Balance Fueling the Aircraft Saving a Flight Situation</p>	<p>Airfield and Area Familiarization</p>
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Airfield Familiarization

Pull out your charts for the Dade Collier Airport and we'll go over the features of the field.

The airfield has a single east-west runway, 9/27, that's 10,499 feet long and 150 feet wide. That should give you plenty of room to work with. Runway 9 is the calm-wind runway, and is serviced by an ILS approach with the localizer on 108.3. There is also a locator marker beacon about 5 miles west that serves as the basis for an NDB approach for runway 9. This approach is flyable using GPS as well.

The airfield is uncontrolled, so there is no tower or ground control – be sure to keep your head up and make good announcements of your intentions on the radio. The normal pattern altitude we'll use is 1500 feet, and look out for little airplanes at 1000.

Aircraft Loading and Sim Setup

Aircraft Loading

Open up your 737 load manager, select the 737-700 Mixed configuration and set up your aircraft config as shown in the picture below. Save the configuration and exit the load manager.



Figure 2 - Load Manager Setup

Creating the Base Scenario

Start Flight Simulator

Select the NG Tutorial Default Aircraft situation. You should be in the Cessna at Dade-Collier Field (KTNT).

Alternatively, you can create your own situation file by parking a Cessna on the ramp at KTNT and then changing to the PMDG airplane

Turn off the Battery, Generators, Lights, etc to make the default aircraft cold and dark. Be sure to leave the Avionics master ON, as the PMDG doesn't have an avionics master switch.

Now, select the PMDG 737-700 aircraft with winglets and stairs aircraft (2D cockpit). You should end up with a cold and dark cockpit.



Figure 3 - Cold and Dark Cockpit

Next, clear all the weather, and disable any internet or internal weather generating programs.

Set the Date to August 1st and the local time to 10:00 am

Turn off all AI traffic.

Go to the fuel menu and load fuel as shown below.

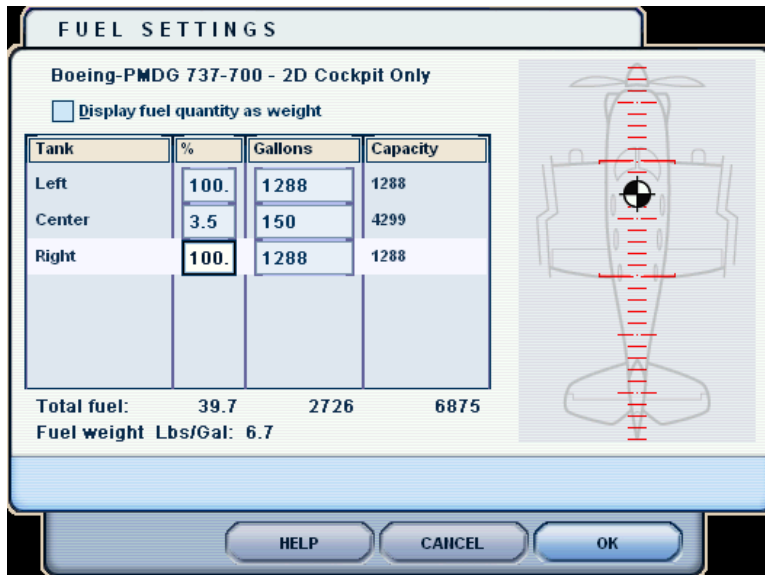


Figure 4 - Fuel Loading

We put the 150 gallons in the center tank to cover the wiring – that’s about 1000 lbs. If there’s more than 1000 lbs in the center tank, the wing tanks must be full.

Click OK until you’re back at the main panel

Finally, save this situation as “NG Tutorial Base Scenario”.

Change to another saved situation and then back to the base scenario to ensure it works properly.

When you’re confident you can get to the NG at KTNT, exit flight simulator.

Lesson Two – Flight 1 – Local

Ground School

No Ground School for this lesson

Pre-Flight Briefing

This flight will reinforce your understanding of systems and normal flight operations without using the FMC.

You will accomplish a normal startup, taxi, takeoff and landing, using the autopilot in heading and altitude mode and the autothrottles in speed mode. You'll also fly the ILS approach in single channel mode by manually tuning the radios and engaging the autopilot.

The flight route

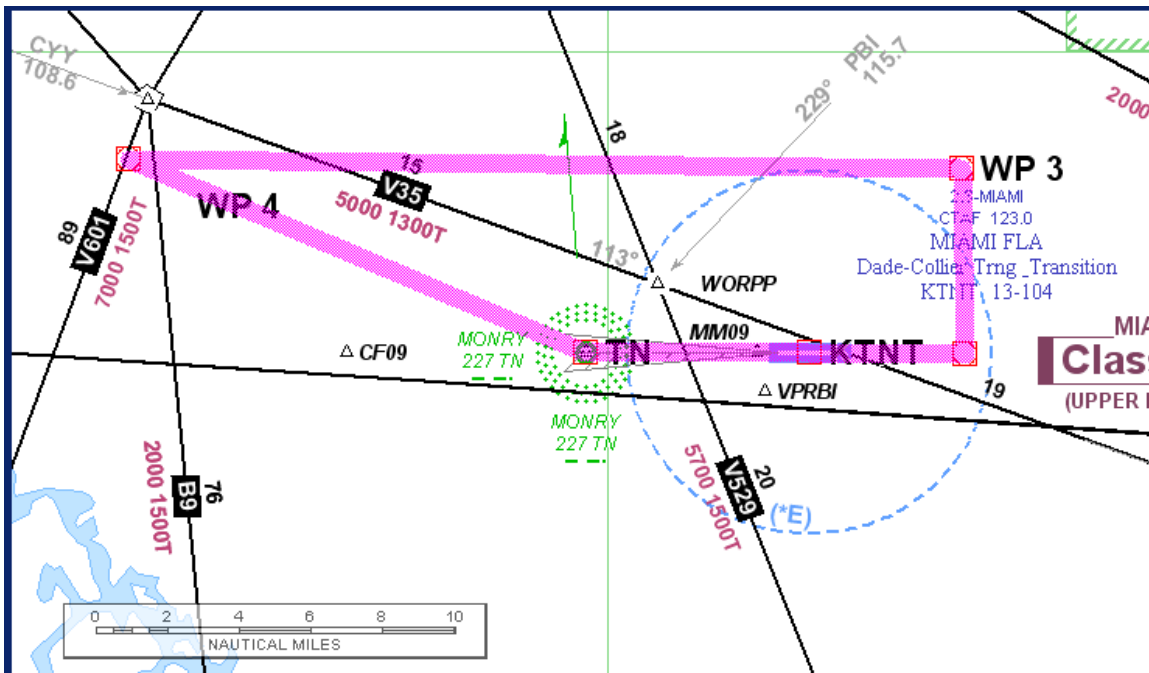


Figure 5 - Flight Route

Programmed Goals

Preflight Inspection	Taxi
Door and Airstair Operation	Takeoff
Cockpit Initialization for Flight	Climb procedures
Ground Power Engagement	ILS Approach
APU Starting	Landing
Engine Starting Sequence	Taxi
Setting V speeds manually	Shutdown

The procedures here correspond with those in the PMDG 737NG AOM, Section 5 – Normal Procedures. There is a checklist provided with this package that's a pretty close match to the AOM – we'll be using this checklist in future flights.

Begin by starting up flight simulator and selecting the base scenario you'd created in lesson 1. Check the fuel load – sometimes it isn't retrieved properly. You should have 3.5% in the center tank and 100% in the wings.

The Flight

Exterior Safety Inspection

Switch to an exterior view, and take a look at the airplane. Pretty, isn't she? You're looking for just a few things in this cursory inspection. First, make sure you've got the right airplane! Not a problem here, as it's the only one on the ramp, but more than one crew has walked out the wrong gate at an airport and preflighted some other crew's airplane. Next, make sure the airplane looks correct, with no pieces missing and no control surfaces hanging down. Make sure that there's nobody working on the plane anywhere and nothing in or around any of the moveable surfaces. You'll be pressurizing the hydraulic systems soon and missing something now could mean a damaged airplane or (worse) an injured person. Finally, look for any fluids on the aircraft or the ground underneath. You won't find any I'm sure as this airplane is just in from acceptance testing. Now, of course, you and I need to get INSIDE the airplane, so open the doors, and deploy the airstairs.

The Doors and the Airstairs

Using the door command on the PMDG opens the main forward door. To open the rear door and the cargo hatches on the right side of the airplane, you need to press the door key and follow it with the 2 key. This is nearly impossible to do, but there are some workarounds – see the PMDG support web site.

To deploy and stow the airstairs you need to use the commands to extend and retract the Concorde nose. Most people do not have a key combination assigned to the proper Concorde nose command. To set this command and use the cool stairs:

Click on Options.

Click on Controls, then Assignments.

Select the General Aircraft Commands section, and find the "Extend Concorde Nose/Visor Fully" command as shown.

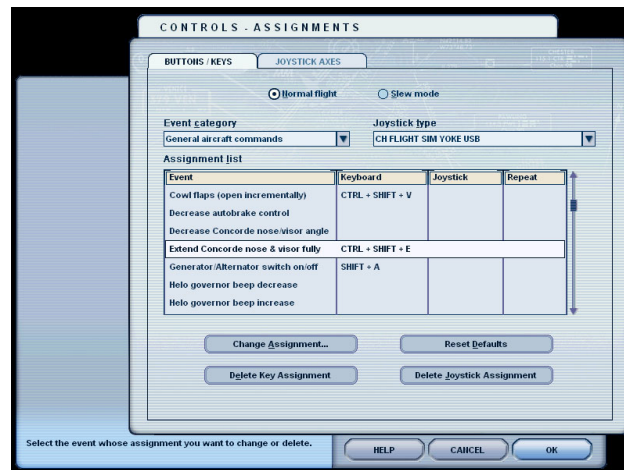


Figure 6 - Configuring the Keyboard Shortcut for Stair Extension

The keystroke command for this function will extend the stairs. If there's no keystroke assigned (and the command shown above is NOT the default), you need to make up and enter a new keystroke command here.

Now find the “Retract Concorde Nose/Visor Fully” command, and set a keystroke command if necessary, this command will retract the stairs.

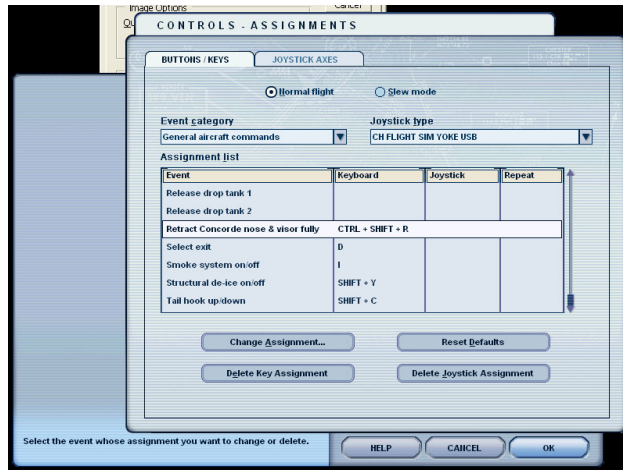


Figure 7 - Configuring the Keyboard Shortcut for Stair Retraction

Using the command you found or set, extend the stairs. You should hear the rumbling as the stairs extend.

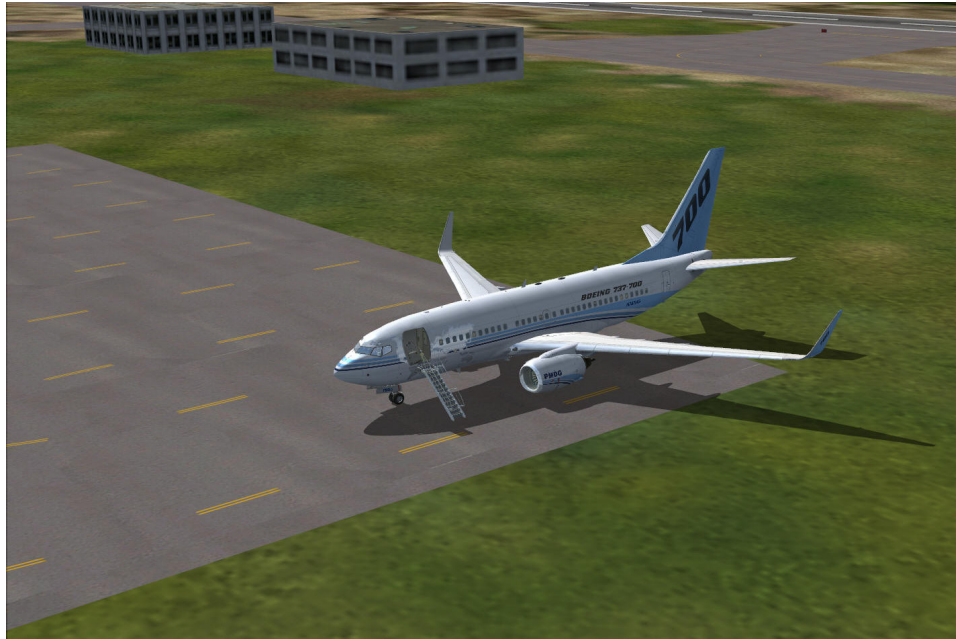


Figure 8 - Ready for Boarding

Welcome aboard, captain! Make your way to the cockpit, take off your jacket, and get comfortable, there’s a lot of work to be done to bring this lady to life.

Cockpit Preparation

Switch to the cockpit view and set the parking brake. Then bring up the overhead panel – it should look similar to this one. Correct any switches in your panel that don't match this one.



Figure 9 - Cold and Dark Overhead Panel

First, turn on the Battery. This brings power to the cockpit, but the battery will only last for a little while, so let's keep going.

Next, make sure the electric hydraulic pumps are off, you don't want that system energized when you bring on the external power

Jump back to the main view and make sure your gear lever is down, then open the throttle panel.

On the throttle panel, move the start levers under the throttle up to idle and back to cutoff. This ensures that the fuel valves are closed. Close the throttle panel and go back to the overhead.



Figure 10 - Engine Start Levers in CUTOFF

The ground power available light is lit, so turn it on by clicking below the switch. Check that the Transfer Bus Source Lights go out, and that the BAT Discharge Light is out

Switch back to the Main Panel, and bring up the Center Throttle Pedestal. Make sure that the Overheat Detector Switches (at the bottom of the pedestal) are in NORMAL, then hold the test switch to the left FAULT INOP position, look for the fault lights to illuminate. Next, test the fire warning system by moving the test switch to the right. A loud bell and red lights on all three handles should scare you. The lights will go off automatically, but you need to silence the cockpit bell by clicking on the master fire warning light on the main panel. Finally, move to the right of the bottom panel and use the Extinguisher check switch to both extinguisher circuits. You should get three green lights in both positions.



Figure 11 - Ground Power Switch



Figure 12 - Overheat Detector Test Switch



Figure 13 - Extinguisher Test Switch

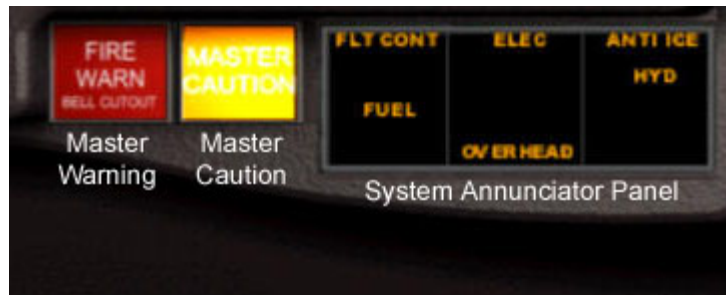


Figure 14 - Glareshield Alerting Section

Turn on the power for the cabin using the CABIN/UTIL and IFE/PASS switches. Arm the emergency exit lights, and turn on the no smoking and seat belt signs. Be sure the recirculation fan is set to AUTO.



Figure 15 - CAB/UTIL and IFE/PASS



Figure 16 - Exit and Signs



Figure 17 - Recirculation Fan

At this point in the process, you're ready to start passenger boarding. Even though there are no "cattle" on this trip, build the habit anyway. Tell the imaginary cabin crew that they can begin boarding at their convenience.

We're going to start the APU, so we can disconnect from ground power. Move the APU switch to the start position, and the APU low oil pressure light will come on, and then go out as the APU spins up. You'll also see the APU EGT rise, peak, and fall back. A successful start is achieved when the APU GEN OFF BUS lights come on. Once the APU is running, turn on both APU generator switches, and the APU Bleed switch on the pneumatics panel. You should see pressure on the gauge.



Figure 18 - APU Off



Figure 19 - APU Starting

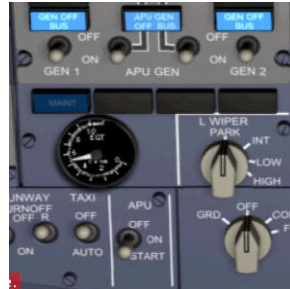


Figure 20 - APU Running

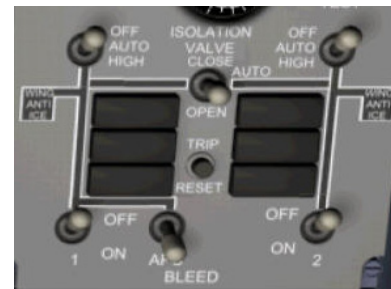


Figure 21 - APU Bleed Switch

On the flight control panel (upper left), make sure that all five switches are in the closed position, the ALTERNATE FLAPS switch is off, and turn the Yaw Damper on.

On the Fuel Panel, ensure that the Engine and Spar Valve Lights are dim (showing that the valves are closed), and that the Crossfeed Valve is closed (and the light is off). Cycle the crossfeed valve on and off and ensure that the light works. Turn on the fuel pumps for all tanks that have useable fuel (left and right in this case – the fuel in the center tanks is the bare minimum) and ensure that the low-pressure lights are off. Note that center tank has a gravity feed pickup, and the low-pressure lights for the center tank will only illuminate when the tanks are empty.



Figure 22 - Flight Controls Section



Figure 23 - Fuel Controls Section

Back on the Overhead Panel, we work on the electrical panel. We check that the Standby Power Switch, the Generator Drive Disconnect Switches, and the Bus Switches are all in their stowed (closed) positions. We check that the Equipment Cooling Switches are in Normal, and that the Cooling Off Lights are extinguished.

Moving to the next "row" in the overhead, we make sure the Window Heat Switches are On, the Probe Heat Switches are Off, and the Wing and Engine Anti-Ice switches are OFF with lights out.



Figure 24 - Window Heat



Figure 25 - Probe Heat



Figure 26 - Anti-Ice

Next, we turn on the A and B Hydraulic Systems by turning on the engine and electrical pumps. The Low Pressure Lights on the electric pumps should extinguish. The A and B system lights on the flight control panel should also extinguish.



Figure 27 - Hydraulic Pumps

We check the air conditioning panel, making sure that the switches are pointing up to AUTO.

In the next section we turn on the air conditioning packs if desired, set the isolation valve to OPEN, and make sure the engine bleeds are off.



Figure 28 - Air Conditioning



Figure 29 - Pneumatics Section

We set the pressurization panel by setting the flight altitude and landing altitude in the appropriate boxes and make sure that the system switch is in AUTO. We're not going high enough today to require pressurization, so leave this alone on this flight.



Figure 30 - Pressurization

Then, we turn on any exterior lights (none in the daytime) needed, and make sure the ignition switch is in L or R.

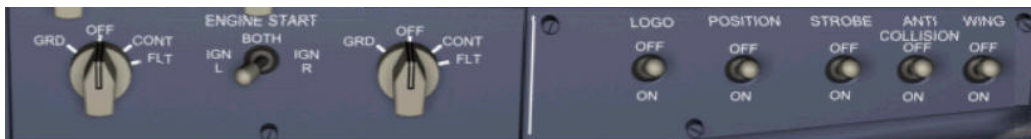


Figure 31 - Lights and ignition

Back on the Main Panel, Set the Altimeter to local pressure (29.92). Turn on the Flight Director, set the runway heading (095) in the heading window, and set the MCP altitude to 1500. Set the ILS course (095) in the course window. Place the Autobrake selector in RTO.

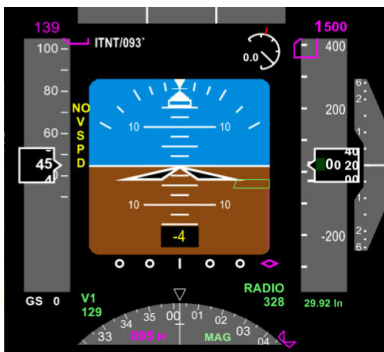


Figure 32 - PFD with Altimeter



Figure 33 - MCP

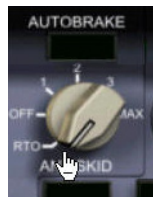


Figure 34 - Autobrake Setting

Bring up the radio panel and set the ILS frequency of 108.3 into NAV1. Set the ADF to 227. Set the Transponder to 1200. Close the radio panel.

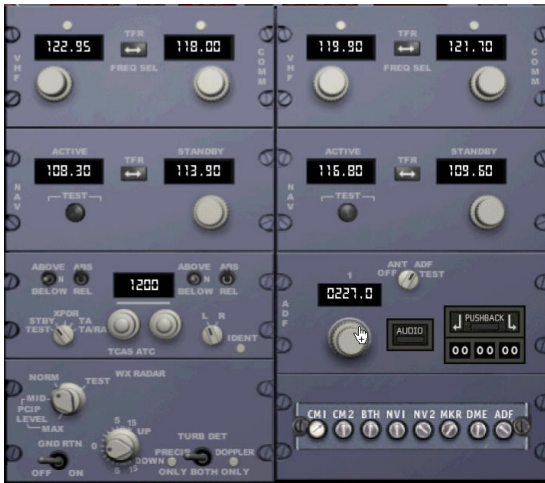


Figure 35 - Radio Panel

You're probably wondering about the extra doodads on my radio panel.

They're the Default 737 Audio Panel, and the Pushback Gauges.

I've also got a couple of extra icons on the main panel glareshield as well – they're the FSMeteo weather display system, and a neat sound system with in-flight music and announcements.

Information on where to get these add-ons, and how to install them by editing panel.cfg, is located in an appendix. However, be warned – neither I nor PMDG will support these modifications, so keep a backup of your original files!

Normally, we'd start programming the FMC right here, but in this case, we're doing it by hand, so we're going to crack the books.

We need to calculate our Trim and Vs speeds, so the first thing we need is our weight. We should be right around 129,500 lbs. We will also calculate for a flaps 5 takeoff. Our CG is at 24% MAC (this is a best guess)

To determine the Vs speeds, turn to page 1-10 of the PMDG AOM. Looking at the table for 130,000 lbs and flaps five, we get

V1 – 123

VR – 126

V2 – 134

Next, on page 1-11, we see that for flaps 5 at our weight and CG we should be setting trim at 5.5 units.

Next, we need to set the V Speeds manually, using the control just above the engine display on the main panel. Clicking on the outside ring of the knobs will move the selector from Auto to V1. Then right-clicking on the center knob will increase the speed, and left clicking will decrease it. Set V1 and VR, then set V2 (134) in the MCP speed window.

Last, set the trim using the needle on the throttle pedestal as a reference.



Figure 36 - Speed Reference Knob



Figure 37 - V1 setting window on PFD

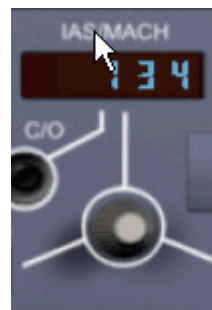


Figure 38 - MCP Speed Window



Figure 39 - Stabilizer Trim Needle

At this point, we're ready to close up the airplane and start the engines. In future flights you'll do all these steps (except setting the Vs speeds) and will set up the FMC as well.

Starting

The steps to start the engines:

PASSENGER BOARDING COMPLETE
 PASSENGER DOORS CLOSED AND LOCKED
 CLEARANCE FOR PUSH OBTAINED
 THROTTLES..... IDLE
 START LEVERS OFF
 PACKS..... OFF
 APU..... RUNNING
 BLEED AIR PRESSURE CHECKED
 FUEL PUMPS..... ON
 ANTI-COLLISION LIGHT..... ON
 PARKING BRAKE..... RELEASED
 PUSHBACK COMPLETE
 PARKING BRAKE SET
 GROUND CREW..... READY FOR START
 #2 STARTER GROUND
 #2 N2 20%
 #2 START LEVER IDLE
 #2 EGT..... MONITORED
 #2 STARTER AUTO-OFF
 #1 STARTER GROUND
 #1 N2 20%
 #1 START LEVER IDLE
 #1 EGT..... MONITORED
 #1 STARTER AUTO-OFF

After Start

ENGINE GENERATORS ON
 PROBE HEAT ON/TESTED
 ANTI-ICE..... AS REQUIRED
 ENGINE BLEEDS ON
 PACKS..... AUTO
 ISOLATION VALVE AUTO
 APU BLEED..... OFF
 APU SWITCH AS REQUIRED
 EXTERNAL LIGHTS AS REQUIRED
 MASTER CAUTION LIGHT OFF
 RECALL CHECKED CLEAR

A note about the bleeds. When you turn on the engine bleeds – you get a DUAL BLEED light on the pneumatics panel. That's because you have two sources of bleed air into the left duct. This is fine at idle speeds, but if you advance the throttles, you can damage the duct system. Turning off the APU bleed clears this condition

Taxi

Before you taxi, ensure the area is clear and make an announcement on the radio – “Dade-Collier Traffic, PMDG Seven November Golf is taxiing to runway 9”. Advance the throttles to 30% N1 to get moving, and settings between 25-30% will keep you rolling along.

As you taxi to runway 9, you're expected to complete the before takeoff checklist “to the line”:

MASTER CAUTION LIGHT OFF
 RECALL CHECKED CLEAR
 FLIGHT CONTROLS CHECKED
 FLAPS..... SET
 TRIM CHECKED
 FLIGHT DIRECTOR ON
 TAKEOFF BRIEFING COMPLETE

I'll now give the takeoff briefing: *This is a takeoff on Runway 9, length is 10500. V1 is 123, rotate at 126, V2 at 134. We'll abort for bells or swerves only above 80 knots, and if we have to come back here right away, the ILS is tuned.*

Before Takeoff

Once cleared for takeoff, before rolling onto the runway, the Before Takeoff Checklist is completed:

- TAKEOFF CLEARANCE OBTAINED
- STROBE LIGHTS ON
- WING LIGHTS ON
- LANDING LIGHTS ON
- RUNWAY TURNOFF LIGHTS ON
- ENGINE START SWITCHES CONT
- AUTO THROTTLE ARM
- TRANSPONDER TA/RA

The Takeoff

Once aligned with the runway, the throttles are advanced smoothly forward. Once the engines pass 40% N1, press the TO/GA switch (the upper left black screw on the MCP) to engage the autothrottles and the flight director.

Rotate at Vr (no voice prompt since you're not using the FMC). Pitch up smoothly to follow the flight director bars, at about 11 degrees.

- POSITIVE CLIMB GEAR UP
- 400 FT ROLL MODE SELECTED
- CLIMB SPEED V2+20
- 800 FT REDUCE PITCH
- SPEED 220/230
- RETRACT FLAPS ON SCHEDULE
- 1000 FEET ENGAGE AUTOPILOT
- 3000 FEET SPEED TO 250
- GEAR OFF
- AUTO BRAKES OFF
- ENG STARTERS OFF

Notes:
 Use the heading mode as the roll mode by pressing HDG. Engage the autopilot by pressing the CMD A button - you should be in HDG and SPD as you approach 1500 feet.
 When you engage the autopilot, the MCP speed will automatically jump 20 knots.

As you level off at 1500 feet, set the heading bug to 005 and you'll enter a left turn.

As you roll level, set the speed to 240 knots. Set the MCP altitude to 2500 feet and press LVL CHG.

As you reach 2500 feet, set the heading to 275, again turning left.

After Takeoff

As you're leaving the airport area, you need to accomplish the After Takeoff Checklist:

- AIR CONDITIONING PACKS AUTO
- APU OFF
- LANDING GEAR UP AND OFF
- FLAPS UP

You're probably thinking "I already did this", but this is a double check. If you get busy on a departure, you may not remember to do this automatically.

The Climb

We won't be climbing on this flight, but there are just a few things to remember:

- Speed 250 or less below 10000 (in the USA)
- At 10000, landing lights OFF, you can also turn off the seat belt signs, allow passengers to use their portable electronics, and begin meal service and a movie.
- As you reach the transition altitude for flight level flying (18000 in the USA), set the altimeter to STD (29.92)
- Turn off Center Fuel Tank Pumps when fuel is less than 1000 lbs.

The Cruise

We're going to cruise along here on the downwind for a couple of minutes, while we get set up for the approach. Turn on the ADF pointer, and set the Navigation Display to APP mode with a centered display (get the centered display mode by pressing the middle of the rotating switch). The ADF is pointing to the outer marker, so we'll use that as a reference on when to start back to the airport.

Figures showing this are on the next page.

The Approach

We're shooting the ILS for runway 09. The inbound course is 095, and our 30 degree flaps reference speed for 130,000 LBS is 142 knots. We'll be at 2500 until glidepath intercept. This will be a single-channel approach – no autoland.

We'll fly at 275 until the ADF shows the marker beacon at 130 degrees (behind and to our left)



Figure 40 - EFIS Control Panel – ADF selected



Figure 41 - ND Display, ADF at 130

When the ADF pointer pointing to about 130 degrees, set the heading to 135, and set the speed to 200 knots. As you roll level, you should press the VOR/LOC button to ensure that you'll capture the localizer. As you reach 200 knots, set the flaps to 5 and set the speed to 180 knots. As you intercept the localizer, set flaps 10 and 160 knots.

You may see the yellow FMC alert light come on – ignore it, it's reminding you to use the FMC to calculate Vref. We should be able to manually set Vref just like we did V1 and Vr, but this functionality isn't working correctly.

Once on the localizer, press the APP button to arm the glideslope interception. The APP button light will go out once we intercept the glideslope, but that doesn't mean we're not tracking it. As you intercept the glideslope, drop the gear, reduce the speed to 140 knots, and set the flaps gradually to 30 degrees.

I pulled the 140 knots figure by looking up our Vref for 30,000 lbs (134) in the table, and I added a cushion. The AOM doesn't have a section for calculating Vref, and I expect that to be fixed with the release of the 800/900 update.

Set the autobrake to 2, and arm the autospoilers.

At 220 feet, click off the autopilot by hitting the disconnect bar.

Vref Speeds			
Weight	Flaps		
(1000 Lbs)	15	30	40
170	159	153	151
160	155	149	147
150	150	144	142
140	145	140	137
130	139	134	132
120	133	129	126
110	127	123	120
100	121	117	114
90	115	111	108

Figure 42 - Vref speeds



Figure 43 - Rolling into the Intercept

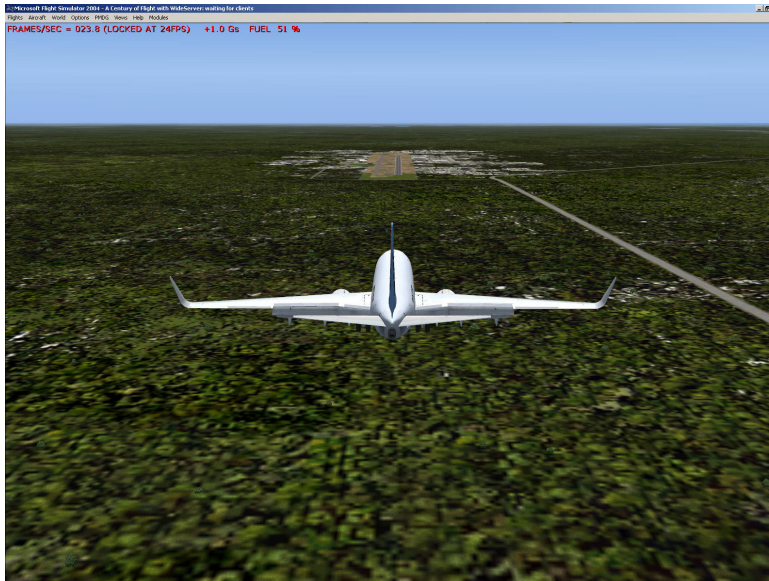


Figure 44 - Looking Good on Final



Figure 45 - Final Approach View

The Landing

Begin your flare at 50 feet.

If you have a throttle control, be sure it's back at idle

As you touch down, the autothrottles will disconnect automatically. Press F1 to ensure your throttles are at idle. This will cause the autospoilers to deploy and the autobrakes will begin working. Gently lower the nose.

Activate the thrust reversers (F2 from idle throttle)

As you slow below 80 knots, return the throttles to idle (F1).

Once you stop or slow to your satisfaction, advancing the throttles a little will retract the spoilers and disarm the autobrakes. As you clear the runway, Complete the Taxi Checklist

SPEED BRAKE LEVER..... UP
 FLAPS..... UP
 PROBE HEAT OFF
 ENGINE START SWITCHES OFF
 LANDING LIGHTS OFF
 TAXI LIGHTS AS REQUIRED
 STROBE LIGHTS OFF
 FLIGHT DIRECTOR OFF
 TRANSPONDER SBY
 APU..... START IF NEEDED

Taxi back to the ramp, and park the airplane. Don't worry about how it's oriented, the line crew will reposition it for us.

Shutdown

Accomplish the Shutdown Checklist

PARKING BRAKE..... SET
 ENGINE START LEVERSCUTOFF
 ANTI COLLISION LIGHT OFF
 FUEL PUMPS OFF
 GROUND POWER AS DESIRED
 DOORS..... OPEN
 STAIRS AS NEEDED
 WINDOW HEAT..... OFF
 ELECTRIC HYDRAULIC PUMPS..... OFF
 PACKS..... AUTO
 ISOLATION VALVE CLOSED
 ENGINE BLEED AIR OFF
 APU BLEED AIR..... AS REQUIRED
 EXTERIOR LIGHTS..... AS REQUIRED
 ANTI ICE..... OFF
 AUTO BRAKE..... OFF

Securing

Once everybody's off:

EMERGENCY EXIT LIGHTS..... OFF
 CAB/UTIL POWER OFF
 IFE/PASS POWER OFF
 EXTERIOR LIGHTS..... OFF
 APU..... OFF
 GROUND POWER OFF
 BATTERY OFF

Post Flight Briefing

You've successfully completed a flight in the 737-700, reviewing basic procedures. You should repeat this flight until you are comfortable operating the basic systems of the airplane. Try flying it without the autopilot. All future flights will be concentrating on the use of the FMC and real world procedures. We'll be using the included two page checklist to cover all the basics, and only going through details when dealing with unique situations.

Homework Assignment

You should review the section on the navigation display in the PMDG 737 systems and cockpit overview.

Your test questions are:

Where can you find your distance to the next waypoint on the ND?

Where do you find your true airspeed and groundspeed on the ND?

Get a good night's sleep, tomorrow will be intense, we're going to take a tour of southern Florida and give the autopilot a workout.

Day Two

Lesson Three – Flight Two – Florida Tour

Ground School

Test Answers

You'll see information on the active waypoint in the upper right corner of the ND. If you're in MAP mode, you'll see the waypoint name, the ETA, and the distance to go. In NAV or APP mode, you'll see the information about the station you've tuned including identifier, course, and DME if available.

You'll see air and groundspeed in the upper left corner of the ND. Also here is wind speed and direction info, along with an arrow that shows the relative wind.

Cross Country Flying and Flight Planning

Every normal revenue flight has six distinct phases:

- Takeoff
- Departure and Climb
- Cruise
- Descent and Arrival
- Approach
- Landing

You can think of the airspace as being made up of two different structures:

The **Terminal Airspace** is the airport, the fixes and navigation aids (intersections, VORs, ILSes, NDBs) that make up approaches, and the ATC facilities (Approach/Departure, Tower, and Ground) that manage the airspace.

The **Enroute Airspace** is made up of the fixes, navigation aids (intersections and VORs usually), the airways made up of those fixes and nav aids, and the ATC Facilities (Approach/Departure, and Centers) that manage the airspace.

So, normally:

- Takeoff – Terminal Airspace
- Departure and Climb – Terminal and Enroute Airspace
- Cruise – Enroute Airspace
- Descent and Arrival – Enroute and Terminal Airspace
- Approach – Terminal Airspace
- Landing – Terminal Airspace

As an experienced pilot, you know that there are ground-based navigational aids like *VORs* and *NDBs* that you can use to make up routes between airports, as well as *intersections* defined by specific distances and bearings from a ground navaid. You should also know that there are already defined highways in the sky. These pre-defined routes are called *airways*, and an instrument flight of any reasonable length will usually include some flying along an airway. Airways in the US come in two flavors - Hi Altitude airways, called *Jet Airways* (their numbers start with a J), are flown at altitudes above 18000, while Low Altitude airways, called *Victor Airways* (because their numbers start with a V) are used below 18000 feet (this split doesn't occur at the same altitude in every country, in some it's as low as 5000 feet!). How does an airway work? Well, here are two routes between Baltimore and Boston:

Point to point routing	Airway routing
KBWI-BAL-BELAY-MXE-SBJ-FALLZ-CMK-BDL-WITNY-BOS-KBOS	KBWI-BAL-V378-MXE-V419-BOS-KBOS

These routes are EXACTLY the same, but V419 (Victor four-nineteen) includes all the waypoints between MXE and BOS. If you were to program this into a GPS in a small airplane, you'd have to

take a chart and look up the waypoints and plug them in one-by-one. We're lucky, however, because (as you'll soon see), our FMC database already "knows" about airways, which will save us a lot of button pushing.

So, in real life, you'll typically file a route using airways, and ATC will typically refer to airways in giving you clearances and routing instructions.

Of course, you need to get from the airport to the beginning of your airway route, and you need to get from the end of your airway route to the destination airport. This can often happen by going direct, or with ATC vectors. But at large busy airports, the airspace managers have often worked up standard routes in and out of the airports, and these routes are called a *SID or DP (Standard Instrument Departure or Departure Procedure)*, or a *STAR (Standard Terminal Arrival Route)*. These routes are published and offer a sort of shorthand that can be used, just like an airway clearance. They typically convey you from the Terminal structure to the Enroute structure, or vice versa. All of these procedures ensure that ATC and the aircraft are "in sync" with each other, and keep the busy airspace around the airport organized and safe.

So, a typical flight will often start with a SID/DP, have an enroute segment made up of airways, and end with a STAR that culminates in an instrument approach to an airport.

Professionals called Dispatchers usually do flight planning, but this is to relieve you of work, not relieve you of responsibility. You, the captain, share responsibility for flight planning with the dispatcher and are expected to review and approve the route, contingency airports, and the planned fuel load.

So, you may be asking – how can I do sophisticated flight planning? If you're a real-world pilot you probably already have spent some serious money on a flight planning program, such as Jeppesen's FliteStar, which I'm using to generate the plans for this tutorial. You can also use the MSFS flight planning system (be sure to tell it to use airways) but you'll miss out on the SID/STARs. A good value for Flight Simmers is FSBuild (www.fsbuild.com) - it generates routes using SID/STARs and airways, and can even export those routes into the PMDG FMC. There are also other resources out there – a search for "flight planning" on the PMDG support forum will yield some good recommendations.

Rejected Takeoff Procedures

A rejected takeoff can be a very dangerous event, particularly late in the takeoff roll. Let's start with runway requirements and V-speeds.

In a nutshell, we are required to be able to accelerate, have an engine failure, abort the takeoff, and stop on the remaining runway, **or** accelerate, have a failure, and continue the takeoff on a single engine. This requirement sets up your minimum runway length, and also creates our first V speed.

- V1 is the speed we use for an "abort or fly" decision. If we decide to abort a takeoff before V1, we should be able to stop on the remaining runway. After V1, we should have sufficient runway and energy to make a single engine takeoff, and we may NOT have sufficient runway to abort the takeoff.
- Vr is the rotate speed – this is the speed that we use as your cue to begin the rotation – if we smoothly pitch to the takeoff attitude, we'll have enough energy to lift off and continue rotation.
- V2 is the initial climb speed or takeoff safety speed – it assures a safe envelope for operations on a single engine.

Thus, it would make sense to abort a takeoff for any problem that occurs below V1, and to continue flying for any problem that occurs at or after V1. But history has shown that lots of accidents with serious damage or loss of life occur when trying to make a high-speed abort. Standard procedure nowadays is to abort for cautions below 80 knots, and to abort only for bells (fire warnings) or swerves (indicating asymmetric thrust or flight control problems) between 80 knots and V1. After V1, we take our problems into the air with us, get to a safe minimum altitude and airspeed, and work the problem at that time.

Our NG has a simple and effective autobrake system, with a Rejected TakeOff (RTO) setting. For takeoff, we need to remember that the autobrakes do NOT activate until we reach 90 knots with the throttles advanced. So for aborts below 90 knots, we're on our own for brakes. At 90

knots, retarding the throttles will result in 3000 PSI being applied to all brakes, and we WILL stop quickly. We may also start a fire on our wheels due to all the energy, so call the tower and have them roll the trucks.

In the sim, before we yank back the throttles, we have to disengage the TOGA function if we activated it. Right-clicking on the TOGA screw disengages it.

Automatic Flight Systems – Part 1

The 737 has a relatively sophisticated autoflight system. The system can control the pitch of the airplane, the roll of the airplane, and the thrust generated by the engines. The yaw damper system keeps the airplane coordinated in the yaw axis. With full control of the airplane, it becomes possible to give the autopilot “goals”, telling it what you want to accomplish and how you want to accomplish it. The various **modes** of the system define what is important. You set goals on the MCP by dialing in speed, course, heading, altitude, and VS numbers and pressing buttons, or in the FMC, and the autopilot selects the appropriate modes for the systems and displays the modes on the PFD. The autoflight system drives the flight directors and the autothrottles, and (if you have an autopilot engaged) the actual airplane.

There are three autoflight systems, and they have different modes.

The autothrottle has seven modes, and they're displayed in the left column on the PFD:

- N1 – the autothrottle tries to maintain the FMC or manually set N1 thrust setting.
- GA – The autothrottle is maintaining the programmed takeoff thrust
- RETARD – The autothrottle is retarding the throttles to flight idle
- FMC SPD – The autothrottle adjusts thrust to maintain a certain FMC-commanded airspeed.
- MCP SPD – The autothrottle adjusts thrust to maintain the speed set on the MCP.
- THR HLD – The autothrottle is disengaged from the throttles, they can be moved manually.
- ARM – The autothrottle is engaged but no mode is selected, and the throttles can be moved manually. This mode insures underspeed protection.

There are three roll modes, displayed in the middle column of the PFD:

- HDG SEL – the autopilot rolls the airplane to capture and maintain the selected heading.
- VOR/LOC – the autopilot rolls the airplane to capture and maintain the MCP selected VOR/LOC course.
- LNAV – the autopilot rolls the airplane to capture and maintain the FMC track.

There are ten pitch modes, displayed on the right column of the PFD:

- TO/GA – the airplane pitches appropriately for takeoff or go-around.
- V/S – the airplane pitch is used to maintain a selected vertical speed.
- ALT ACQ – the airplane pitch is used to capture a selected altitude.
- ALT HOLD – the airplane pitch is used to maintain the current altitude.
- VNAV PTH – the airplane pitch is used to maintain the FMC-commanded vertical path.
- VNAV SPD – the airplane pitch is used to maintain the FMC-commanded airspeed.
- VNAV ALT – the airplane pitch is used to maintain the FMC-commanded altitude.
- MCP SPD – the airplane pitch is used to maintain the speed in the MCP window.
- G/S – the airplane pitch is used to track the glideslope
- FLARE – the airplane pitch is used to flare the airplane.

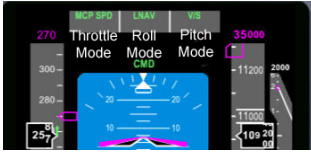


Figure 46 – PFD mode annunciators



Figure 47 - Mode Control Panel

In this example, the airplane is using the engines to maintain 270 knots (MCP SPD), rolling to follow the FMC track (LNAV), and pitching the airplane to maintain the 2000 foot per minute climb (V/S).

A mode shown in green means the mode is active, a mode in white shows the mode is armed, and will become active when possible. For instance, it's possible for the pitch to be showing a green ALT HOLD and right below it a white G/S, when you're maintaining an altitude and intercepting the glideslope. A mode will get a highlight box around it for 10 seconds when it's engaged or changes, to alert you to the event.

Always look at the PFD to see what the autoflight system is doing. The MCP generally does NOT control flight modes.

Navigation Systems

One of the first things a pilot new to modern transport airplanes asks is "Where's the GPS"? Rest assured, the 737-700 HAS a GPS, in fact it has a couple. But there are no visible signs of it because the GPS is just another sensor to the autoflight system. In flight, the system uses multiple sensors to determine it's position, including:

- Inertial Reference System
- VOR/VOR (cross radials)
- VOR/DME
- DME/DME
- GPS

The system has the ability to monitor these systems and choose the most optimum solution for navigation. Thus, there is no need for any sort of user interface besides the FMC to work with the onboard GPS'.

Pre-Flight Briefing

We'll first practice a high speed Rejected Take Off, then once we receive maintenance clearance, we'll conduct a short flight around the Enroute structure and return here. We'll be using the FMC to define our route, and the autopilot in various modes.

The flight route

This flight will be a trip around southern Florida. We'll depart the field, head east over Miami, follow J79 over Palm Beach and up to Vero Beach, then head southwest to Fort Myers and then south to Marci intersection, where we'll get vectors to join the ILS back into Dade-Collier.

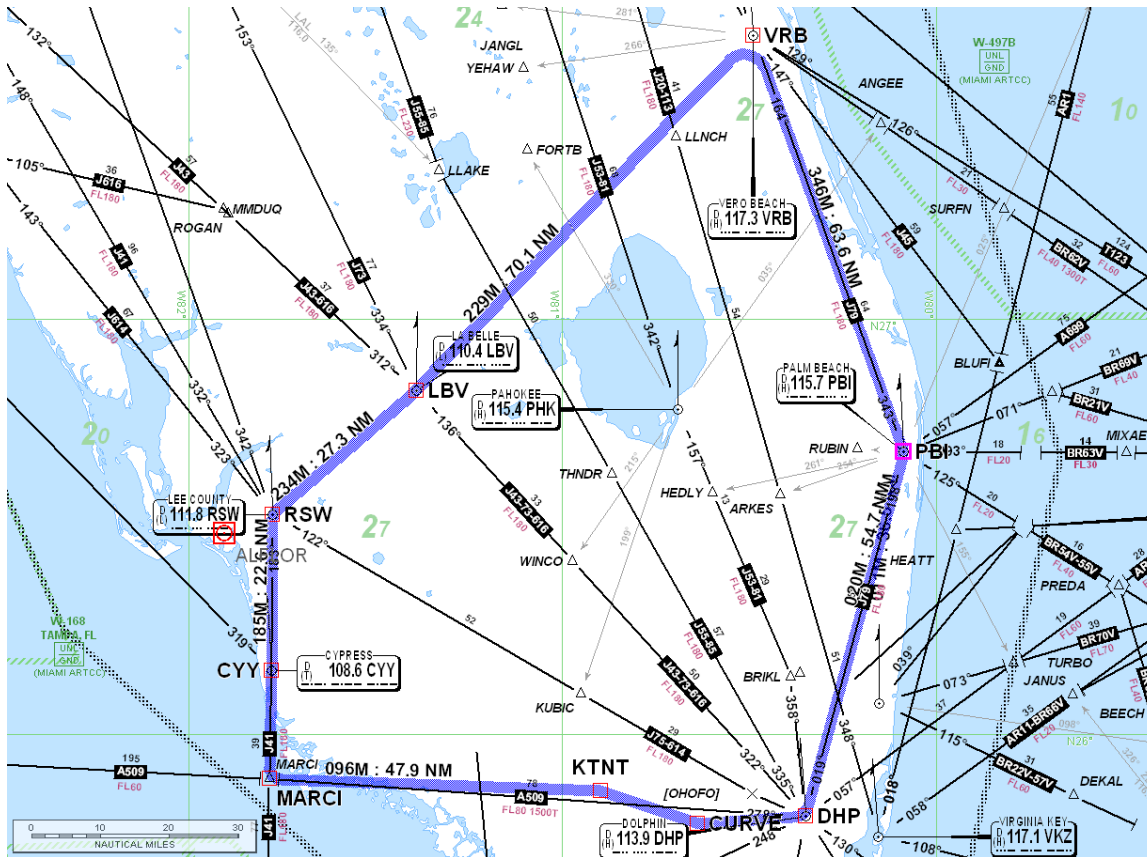


Figure 48 - Flight Two Route

The route filed by the school dispatcher is
 KTNT CURVE V35 DHP J79 VRB LBV RSW CYR MARCI KTNT at 27,000 feet

Programmed Goals

- | | |
|------------------------------|---------------------------------|
| FMC initialization | Climb |
| Route Programming | Use of Autopilot |
| Saving and Retrieving Routes | Descent |
| Rejected Takeoff | Coupled (autoland) ILS approach |
| Normal Takeoff | Landing |

Since you're now an expert on the normal preflight activities you learned yesterday, we won't cover them in detail – you're expected to use the two-page checklist and take the necessary steps on your own.

Begin by starting up flight simulator and selecting the base scenario you'd created in lesson 1. Check the fuel load – sometimes it isn't retrieved properly. You should have 3.5% in the center tank and 100% in the wings.

The Flight

Begin by completing the Checklist through the Overhead Setup Section. Switch to the Main Panel.

We should be sitting in the cockpit with the APU running and providing power to the aircraft.



Figure 49 - Warm Cockpit

Now, before we continue up with the FMC setup, let's get our clearance and the departure runway (it is 9 in this case), and get our clearance. At a controlled field, we'd call ground control or clearance delivery for this. At an uncontrolled field like Dade-Collier, they have a radio outlet that's connected to the appropriate approach facility, and a controller there handles our clearance.

Our Clearance

Us: Miami Clearance, PMDG 737, IFR from Dade Collier round robin to Dade Collier, ready to copy.

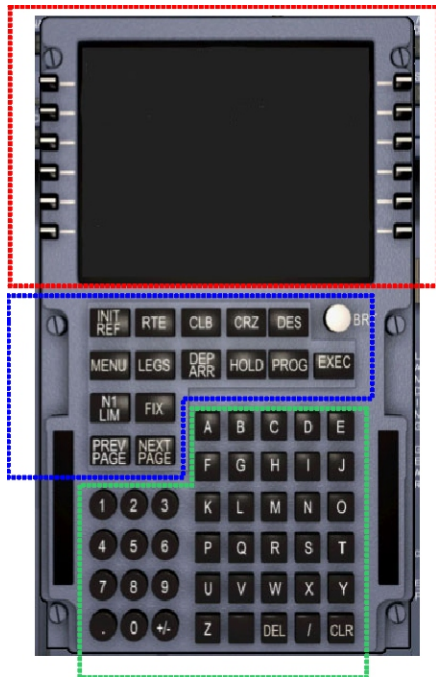
ATC: PMDG 737, you are cleared to Dade-Collier. Upon entering controlled airspace, proceed direct to CURVE for radar identification, then as filed. Climb and maintain 5000, expect flight level 270 in ten minutes. Departure Frequency is Miami Center, 132.4. Squawk 1715.

So we got our filed route, and we can now start programming it.

Bring up the FMC.

The FMC

FMC Layout



Display Area
&
Line Select
Keys

FMC
Function Keys

Alphanumeric
&
Editing Keys

Figure 50 - FMC Layout



Figure 51 - FMC Annunciator on Main Panel

The FMC has three major areas:

A display area that shows 6 data fields per side with corresponding Line Select Keys (LSKs) on each side of the display. A *Scratchpad* takes up the seventh line of the display, and it's where anything we input will display. The scratchpad is also where any FMC messages will display. To enter a value into a field in the FMC, we first type it on the scratchpad by pressing the alphanumeric keys, and then press the corresponding LSK. Conversely, pressing an LSK by itself will usually transfer the contents of the corresponding field into the scratchpad. The CLR key acts as a backspace key for the scratchpad when we're entering data, and will also clear any messages the system puts up. If you hold the CLR key for a few seconds the entire scratchpad is cleared. The DEL key is useful if we want to delete an entry in a field – just press the DEL key, which will put "DELETE" in the scratchpad, then press the appropriate LSK to delete the contents of the field. The EXEC key tells the FMC to accept any changes you just made – it lights up when you make a change that requires recalculation.

Additionally, an annunciator on the main panel lights up whenever an FMC message is generated. If you see this lit, you need to check the FMC.

There's also a way to use the PC keyboard instead of clicking on each key with the mouse. If you click on the black bar to the right of the Alphanumeric keys, the letters KBD will appear on the right side of the scratchpad and you'll be able to type directly. But be sure to turn this feature off when you're done, because it intercepts ALL keyboard commands, which could interfere with operating other aircraft systems.



Figure 52 - FMC with Keyboard Entry Enabled

Here's the basic flow for the preflight of the FMC:

- The initial start-up page is examined to be sure the right version of the software and navigational data is used.
- The POS INIT page is used to tell the FMC where the airplane is located on the earth.
- The ROUTE page is used to enter or load a saved route.
- The DEPARTURE page is used to select the departure runway and SID if used.
- The LEGS page is checked to see that the route in the FMC matches the clearance, and any necessary modifications to the route or altitude/speed constraints are made.
- The PERF INIT page is used to enter the aircraft weight, cruise altitude, and wind info if available.
- The N1 LIMIT page is used to select takeoff power settings.
- The TAKEOFF page is used to enter the takeoff flap settings and calculate or set the V speeds.
- The CLIMB page is used to check and modify climb settings.

Initial CDU page

The CDU comes up with various options for systems. Press LSK1L to access the FMC.



The initial FMC page

Looking at the display, we see the aircraft model and engine info, the current NAV DATA cycle and effective dates, and the FMC software version.

LSK 6 on the right side (6R), will take us to the POS INIT page when pushed – go ahead and push it now.



The POS INIT page

Using the FMC keyboard, enter KTNT then press the LSK 2L key and we'll see it appear under the REF airport.

Also, check that the clock on 5L matches the correct time.

Then press LSK 6R to go to the ROUTE page.



The RTE page

When we first bring up the Route page, we'll notice that KTNT is still in the scratchpad. If it's not in the scratchpad, type it in, then go ahead and press LSK 1L, and put it in the Origin field.

Then enter KTNT and press the LSK 1R key to enter it as the Destination.

A little later we'll save the route and reload it.



The Departure page(s)

Press the DEP/ARR key, and we'll see a page that looks like this. Our departure and destination airports from the ROUTE 1 page are displayed. Since we want to set up for our departure from KTNT, we'll press LSK1 to take us to the KTNT departure page.



The KTNT Departure page comes up. We need to select our departure runway, so we'll need to find runway 09 and press the appropriate LSK to select it. Then press LSK6R to go back to the route page. Press NEXT PAGE to get to RTE page 2



Entering the Route

The second (and third and fourth) RTE pages are where we enter your planned route. The left side shows VIA (how we get to a waypoint) and the right side shows TO (the waypoint we'll be flying towards).

Since our first waypoint is CURVE, type it in and use LSK1R to enter it.

Note that the VIA entry for CURVE says DIRECT, because we didn't put in a route.

Also note that LSK6R now shows ACTIVATE. This is because we've now given the FMC enough information to fly a route. We've given it a departure, a destination, and a point along the way. That's the bare minimum needed for the FMC to function.

Since we have the rest of our route to enter, we won't ACTIVATE it yet.

Since our flight plan after CURVE is to follow V35 to DHP, we type V35 in the scratchpad and LSK2L to put it in, and then type DHP in the scratchpad and LSK2R to put it in. We've just defined a path from CURVE to DHP, telling the FMC to follow V35. If either CURVE or DHP weren't in the FMC database as being part of V35, we'd have gotten an error message.

We can put in the next leg by putting J79 in LSK3L and VRB into LSK3R. Then since we go direct to LBV, we put LBV in LSK4R, and DIRECT pops up in 4L. Put RSW in 5R.

Now we're out of lines. No fear, we press NEXT PAGE and we get more blank space for the routing.

Enter CYY in 1R, and then Enter MARCI in 2R

Whoops! Don't panic, this is what happens when the waypoint we enter is ambiguous. Apparently there's more than one MARCI intersection in the world.

The FMC will display a list of all the matching waypoints in its database, in order of distance from the last waypoint – closest first. Press LSK1L to select **our** MARCI intersection.

Since that's the last waypoint of the route – press L6R to ACTIVATE it, and then press EXEC.

Making sure you've got the right waypoints inserted is **critical** to the safety of the flight. In 1995, an American Airlines 757 flew under perfect autoflight control – right into the side of a mountain – because the flight crew entered (and did not catch) the wrong navigational aid into the FMC. Your flight plan documents will normally have the latitude and longitude of the waypoint listed – cross check it in this type of situation.



Notice that the route page header now says ACT RTE – this means that the route is active.

Also, we now have a new prompt in 6R. If we pressed LSK6R we'd go to the PERFORMANCE INITIALIZATION page.

But, for now, let's save the route. Press NEXT PAGE and we'll be back at the first RTE Page



There's a new prompt – LSK 5L will save our route! Let's press it.

Saving a route

The active route page 1 comes up. If we press LSK 5L, we'll see a message come up. KTNTKTNT001 SAVED.

KTNTKTNT001 is the name the FMC has automatically assigned to this route, and there is now a .rte file by this name in the FSRoot/PMDG/Flightplans directory on the hard disk. If we already have a route with these waypoints, the number is incremented (001, 002,...)

Also, note that only the airport, runway, and lateral route is stored. Things like cruise altitude, climb profiles, etc are not stored.

We've still got the message in the scratchpad, so press the CLR key to remove it.

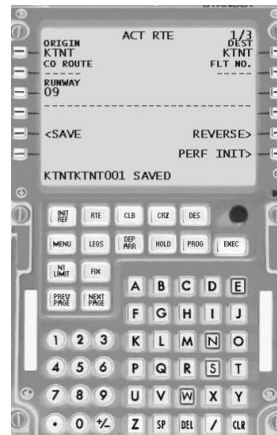
Loading a Route

If we ever want to load a previously saved route, we simply type the name of the route into the scratchpad, then on the RTE 1 page, press the LSK 2L (CO ROUTE) button. The route, including runways, SIDs, STARs, and any other info we put in, will be loaded, and we'll likely need to ACTIVATE and EXEC it.

Now, press the LEGS page button – we're going to recheck the routing.

The LEGS page

The LEGS page is where we check to see that the route the airplane is going to take is the route we want the airplane to fly. While the route page often has airways between points, the LEGS page will show every single waypoint. A route could only be a couple of RTE lines long, but fill up 3 pages of LEGS. Take out the flight plan and scroll through the pages, and we'll see that the waypoints match up. The speed and altitude blocks on the right side are empty, because we haven't yet given the FMC enough info to calculate the vertical path.



The LEGS page and EFIS MAP mode

One of the neat things about our airplane is the ability to see the route in a plan mode on the ND. Let's put the EFIS in PLAN and set the range to 80 NM.

The first thing we'll see is the route of the airplane on the ND, with all the waypoints displayed.

On the FMC, you'll see that LSK6R now is a STEP prompt, and there's a <CTR> mark under CURVE. This indicates we can shift which point is at the center of our plan, by pressing LSK6R. This is very handy when we have to modify a route in flight, if we get new directions from ATC.



Let's press the LSK6R until LBV is the center point. Now the whole route shows up pretty well. But how come the line doesn't come all the way back to KTNT? Because we haven't picked a runway and approach yet – we'll get to that later.

For now, put the EFIS back in MAP mode, and press the RTE key. That takes us back to the RTE page 1, so press LSK6R, it's time for us to do our PERF INIT.

The PERF INIT page

The PERF INIT page is where we tell the airplane how much it weighs, how much fuel we want to hold in reserve, how important economy is, and our cruise altitude and estimated cruise winds.

First, we'll see the airplane already knows how much fuel is onboard, since 2L is already populated. We'd normally enter the Zero Fuel Weight or the Gross Weight, and the FMC would calculate the other value.

In the sim, however, just press LSK 1L and the FMC will autopopulate the weight data.

Next, put 5 in the scratchpad, and LSK 4L to tell the FMC that we want to hold 5000 lbs of fuel in reserve.

Then, enter 150 and LSK 5L which tells the airplane the cost index (a number that defines which is more important – saving fuel or saving time).

The COST INDEX is not modeled in the sim yet so any number will give the same result).

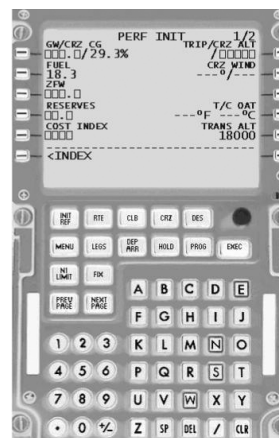
When we enter the cost index, the FMC calculates an optimum trip altitude based on the length of our flight and our weight and fuel – in this case FL354. We're going to cruise at FL270, so enter 270 in the scratchpad and use LSK 1R to put it in the cruise altitude setting.

We can also tell the FMC what we expect our cruise winds to be – this helps it plan our descent point better. Since we know we have no winds for this trip, enter 360/0 on 2R.

If we have a prediction for the Outside Air Temperature (OAT) at our cruise altitude, we can enter it at 4R. It also helps the FMC compute our climb path better.

There's another important setting on this page, the TRANSition ALTitude. This is the altitude where the flight levels begin, and varies from country to country. Why is it important? Because in the flight levels, every aircraft sets the altimeter to 29.92, while below the flight levels local altimeter settings are used. In the USA, 18000 feet is the transition altitude, so we'll leave it alone, but we could enter another altitude value here.

The EXEC light comes on, because we've told the FMC something important and it wants us to confirm it. Press the EXEC key, and we'll see the N1 LIMIT prompt come up. Press LSK 6R to go to the N1 Limit page, or press the N1 LIM key.



The N1 LIMIT page

This page is where we could select de-rated thrust settings for takeoff, and our climb, perhaps for noise abatement or different climb profiles. Selecting reduced thrust also increases engine life, so it's a normal practice to use reduced thrust.

Pressing the various LSKs will change the takeoff thrust rating, and the climb profiles. Since we're going to reject the first takeoff, we're happy with max thrust, but we'll select a derated climb profile by pressing LSK3R.

Press LSK 6R to go to the TAKEOFF page.



The TAKEOFF page

On this page, we need to tell the FMC what our flap setting will be, and we can also tell it our V-Speeds or let it calculate them for us.

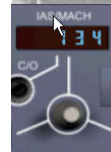
We'll use 5 degrees of flaps, so put 5 in the scratchpad and LSK 1L.

Then press LSK 1R, 2R, 3R, and the FMC will populate the Vspeeds based on the aircraft weight, thrust, outside temp, and flap settings.

While this page is still up, set the calculated V2 speed of 134 in the MCP speed window – it's critical for takeoff.

Finally, make a note of the TRIM setting indicated here, we'll want to make sure that is set before takeoff.

We'll note that the PRE-FLT COMPLETE message is up, if we'd forgotten to enter anything critical, we'd have a prompt to another page on the display. But because we followed a logical progression, we're done. We'll take a quick look at the climb page, and then we can close the FMC.



The CLB (climb) page

Press the CLB button to bring up the climb page.

This page is where we can review and alter the FMC settings for the climb phase of the flight.

Starting at the top, we'll see ECON climb – this means that the settings shown are for best economy. If we were to press the LSK by MAX RATE (LSK 5L) or MAX Angle (LSK 6L), we'd see the target speed change.

Also important on this page is the SPD REST entry. If the country we fly in has a specific speed restriction (the USA has the 250 KIAS below 10000 feet shown here), we could enter it here and the FMC will respect it in the climb. Note that this is ONLY for the climb, and setting the speed restriction here will NOT activate it for the descent.

That completes the initial set up of the FMC.

If we did change the climb profile, we'll be sure and change it back to ECON, then close the FMC.

Since we're going to close the FMC, we're sure to turn OFF the keyboard shortcut if we've had it on. Then close the FMC



This section probably took a while – don't worry, in the future you'll be able to complete the FMC setup in about 5-10 minutes depending on how complex your route is.

Preparing for Departure

Now that we've completed the FMC initial set up, we need to finish up the rest of the cockpit. Just like we've done before, we'll work through the main panel setup.

- Set the EFIS Minimums on BARO and the altitude to 220. We do this by clicking on the word MINS to switch from RADIO to BARO, and then clicking on the sides of knob to raise or lower the level to 220. Clicking on the center will set the altitude to the "standard" altitude of 200 feet. This setting triggers the "minimums" call out and also puts a line on the altitude tape.
- Set the Flight Path Vector (FPV) on if desired by clicking on the FPV button. The Flight Path Vector shows a blue outline of the predicted flight path of the airplane in relation to the horizon.
- Ensure the Autothrottle is Off
- Set the runway heading (095) in the heading window.
- Set our initial cleared altitude (5000) in the altitude window.
- Ensure the Autopilots are OFF (they're inhibited on the ground, but we'll check anyway).
- Make sure there are no flags on the PFD.
- Set the Autobrake to RTO
- Set the NAV1 radio active frequency to 113.9, and the standby to 108.3, so we'll have Dolphin (DHP) tuned and the ILS ready.
- Set the transponder to our assigned code (1715) and ensure it's in standby.
- On the center pedestal, make sure the trim is set (5.5), the speedbrakes are stowed, the throttles are at idle, and the engine thrust levers are set to cutoff. Make sure the parking brakes are set.

Engine Start and Taxi

There's no pushback needed (those line guys are so nice to put our airplane back for us), so we're ready to start. Make sure the doors are closed and the stairs are up, and the area is clear.

Start Engine 1 first, than Engine 2. You remember the sequence - Start Switch to Ground, then Start Lever to Idle at 20% N2.

Once the engines are running, we'll complete the After Starting Checklist, and taxi to Runway 9

As we approach Runway 9, we complete the Before Takeoff checklist to the line. Our takeoff briefing is:

This will be a rejected takeoff on runway 9. After brakes released, we'll wait until 100 knots and then retard the throttles. The autobrakes are set to RTO, flaps 5.

Next, we call ATC and ask for a release, with a void time in 20 minutes. ATC comes back:

PMDG 737, you're released at this time. No traffic in the vicinity. Clearance Void in two zero minutes. If not off, call us back no later than two five minutes.

At an uncontrolled field, there's no tower to clear you for takeoff and "hand you off" to the departure facility. So what happens is you call ATC directly and get a **release**. The release means they've cleared the terminal airspace around your airport of other IFR traffic, and they expect you to get airborne. They'll only hold the airspace for so long, so you get a void time (20 minutes in this case). If you don't take off and show up on their radar, or call them back by the time given (25 minutes in this case), they assume you crashed on takeoff and start the Search and Rescue process. So it's VERY VERY important to make your void time or call them back. A normal void time is 5-10 minutes. We asked for longer so we'd have time to practice our rejected take-off.

Takeoff and RTO



Figure 53 - Ready for Takeoff

As we taxi onto the runway, we complete the final items of the before takeoff checklist. Once we're aligned with the runway, we smoothly advance the throttles, and we do NOT engage TOGA mode.

At 100 knots, we pull the throttles to idle. We feel the brakes come on and we decelerate rapidly. We call on the UNICOM frequency for the fire trucks to come inspect us. They inform us that there's no fire, and we're cleared to leave the runway. Once clear of the runway, we stop for a moment and a ground crewman inspects our wheels using binoculars. He gives us the OK (no blown tires, no smoke) to taxi back for our departure. We go through a short takeoff briefing once more

This will be a normal takeoff on runway 9. V1 is 123, rotate at 126, and initial climb out at 1134. We'll maintain runway heading till 3000 and then head for CURVE. Our initial altitude limit is 5000 feet.

As we taxi back to runway 9, we run through the before takeoff checklist once more making sure that our autobrakes are still set for RTO. We're still within our release window, so we taxi right on to the runway for departure.

Takeoff Again

This time, as we advance the throttles and engage TOGA, we focus on a smooth rotation at the call. We raise the gear, engage HDG mode and follow the flight director on our climb out. At 1000 feet we engage the autopilot in HDG and LVL Change mode, and as we clean up the airplane, we increase our speed setting to 250 knots.

The Departure and Climb

Passing through 3000 feet, we turn the heading bug right until the lubber line sits on CURVE and the airplane follows.



Figure 54 - Departing towards CURVE

We then call ATC:

Us: Miami Center, PMDG 737 is 3600 climbing 5000, direct CURVE.

ATC: PMDG 737, radar contact, climb and maintain 10000, direct CURVE, then resume own navigation.

Us: Direct CURVE, up to 10000, own nav, PMDG 737.

We set our MCP Altitude to 10000, and press LVL CHG if it's not lit.

Pause the Sim, we're going to do a little FMC programming here

FMC – Going Direct to a flight plan waypoint.

To go direct to a fix using the FMC is simple. Just put the fix in line 1 of the LEGS page and EXEC the change. Then if we put the autopilot in LNAV, it will fly the airplane to the fix.

Open the FMC and click on the LEGS button.

CURVE is showing as our first waypoint, but the calculated path is from the airport to CURVE, not necessarily from our current position to CURVE. So we press LSK1L and it transfers CURVE into the scratchpad. We press LSK1L again, and it puts CURVE right back into the plan, and lights the EXEC key. If we look at your ND map, we'll see a new, slightly different colored line drawn. The page title also changes to MOD RTE legs, indicating we're making a change that isn't EXEC'ed yet.



Pressing EXEC commits us to this change, and the line turns magenta.

Now unpause the sim, and close the FMC.

LNAV mode

To have the autopilot follow the FMC for Lateral NAVigation, we press the LNAV key, and the airplane tracks toward CURVE. We're still in LVL change on the MCP, which means the autopilot will climb at the pre-set thrust we selected until we reach the MCP altitude. Note how the autothrottles are in N1, roll is in LNAV, and pitch is in MCP speed. That means that the autoflight system is keeping the engines at programmed climb thrust, and using pitch to maintain the selected speed.



Figure 55 - LNAV and LVL CHG

Take the time to finish the After Takeoff Checks and the Departure Checks.

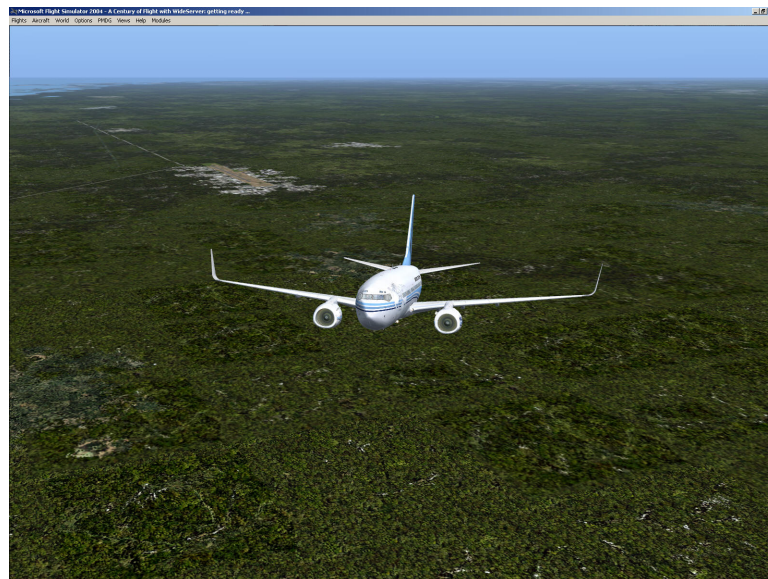


Figure 56 - Climbing out

As we approach CURVE, the autopilot leads the turn smoothly and we begin tracking towards DHP. At 10000 feet, we level off automatically, and the MCP changes to SPD, holding 250 knots. ATC comes in soon after.

ATC: PMDG 737, climb and maintain flight level 270.

VS, SPD, and LVL CHG buttons

We acknowledge the instruction, and set 27000 in the MCP altitude window. We're in altitude hold, and we elect to start a 2000 foot per minute climb. We use the VS knob to set the +2000 FPM and our airplane starts to climb. Since we're above 10000, we can increase our speed, so we set the speed window to 270 knots. We also take the time to shut down the APU, turn off the landing lights, and turn off the seat belt signs.

Now the autopilot has two goals, to maintain our speed at 270 by adjusting our thrust, and our climb at 2000 FPM by adjusting the pitch. We see the autothrottles are in MCP SPD, and the pitch is in VS.



Figure 57 - MCP SPD AND VS



Figure 58 - MCP setup for VS climb

We'll soon see by the engine gauges (they're showing less than full power) that we've got power to spare, so at 12000 feet we push the LVL CHG button and dial in the speed at 290. This erases our vertical speed setting and switches the autothrottles to N1, because in this mode the goal of the autopilot is to use the full amount of climb thrust, and the pitch mode becomes MCP SPD to maintain the selected airspeed. This results in a climb rate that varies with altitude.



Figure 59 - N1 AND MCP SPD



Figure 60 - MCP setup for LVL CHG climb

Setting the STD altitude

As we cross through the transition altitude (18000), our altimeter on the PFD turns yellow, to remind us to set the altimeter to the STD setting. We do this by pushing the barometer setting button.

Switching to Mach speed settings

Once we're above 20,000 feet, we can press the C/O (Change Over) button which shifts the display from knots to Mach. We also set the speed window for a .72M climb. The nose lowers as we accelerate to the new speed.

At 26,000 feet, we set the speed to our cruising speed - .78M. This reduces our climb a little but we're almost there anyway.

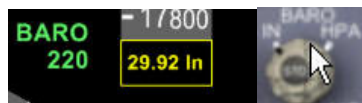


Figure 61 - Altimeter Setting Warning and Baro Knob



Figure 62 - MCP Speed Window in IAS and MACH modes

As we reach 26900, we'll see the PFD pitch mode change to ALT ACQ, and when we level off at 27000, the pitch mode will change to ALT HOLD.



Figure 63 - Cruising at FL270

The Cruise

As we reach our cruising altitude, we'd normally run through the cruise checklists, take a moment to let the passengers know our altitude and expected time to landing, and then gossip about airline politics and whether the flight attendants are worth pursuing. But, unfortunately, there are no passengers, no flight attendants, and your sole political concern is making it through this course. So instead, we're going to learn more about the FMC functions. Let's open the FMC.

The PROG (progress) page

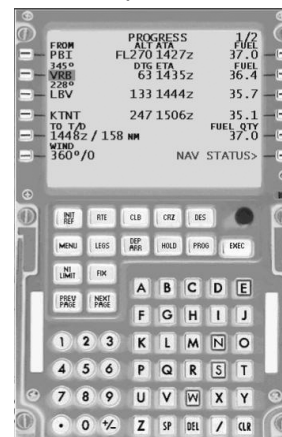
A handy function of the FMC is the PROGRESS page – press the PROG key to bring it up

This page is where we can review our progress along our route. The progress page shows:

- The waypoint we just passed, our altitude there, the time we passed, and our fuel state at that point.
- Our next waypoint, the distance to go (DTG), our estimated time of arrival, and our estimated fuel state at that waypoint.
- The same information for the following waypoint
- The same information for our destination.

The next line shows our Top of Descent (T/D) information on the left, both the estimated time of arrival, and our distance to that point. On the right, we see our current fuel state.

This information is particularly useful if we encounter strong headwinds or get an unexpected holding pattern.



The Descent

As we cross VRB, we call ATC and ask for clearance to descend

Us: Miami Center, PMDG 737, we'd like to start our descent.

ATC: PMDG 737, descend and maintain 10000.

Us: down to 10000, PMDG 737

We're cleared for 10000, so set the MCP altitude to 10000 and press LVL CHG.



Figure 64 – ARM (Idle) and MCP SPD



Figure 65 - MCP setup for LVL CHG descent at Mach .76

We'll see the autothrottle setting on the PFD go to RETARD, then ARM, and the pitch setting go to MCP SPD.

The trick in a manual descent like this is to manage the airspeed. Right now the throttles are at idle (ARM), and the pitch of the aircraft is used to maintain the speed we've got set (.78M). A normal descent will be .76M and that will change to 280 knots when the two speeds equal.

Set .76M on the MCP speed window, and then keep an eye on the MCP speed window as we descend. When the window automatically changes to read in knots, set the airspeed to 280.

Be sure and set the altimeter back to 29.92 as we pass through 18000 feet.

As we level off at 10000, set the MCP speed to 240, and we'll decelerate.



Figure 66 –MCP SPD and ALT HOLD



Figure 67 - MCP setup for deceleration at 10000.

It's important to note that even though the autopilot is maintaining our altitude (ALT HOLD in the PFD), ALT HOLD is NOT lit on the MCP. Again, always look to the PFD to see what the autopilot is actually doing.

As we leave LBV, ATC calls us:

ATC: PMDG 737, descend and maintain 5000, expect the ILS 09 approach into Dade-Collier

Set the MCP altitude to 5000 feet, and then press LVL CHG.

The Arrival

Since we've begun our descent from 10000, turn on the landing lights and the seat belt sign. We know what approach we're going to get, so it's time to set up for the arrival.

Open up the FMC.

The ARR (arrival/approach) page

Pause the sim.

Press the DEP/ARR button

Press the LSK for the KTNT ARR

This is the Arrivals page. On the left side we'd see any STARs for this airport, and on the right side we see the known approaches and runways. Since there are often lots of arrivals and approaches, the NEXT PAGE key can be used to cycle through them.

There are no arrivals for KTNT, but we do want the ILS09 approach, so press the LSK for that approach.

When we select the approach, we get a message that disconnects were inserted into the flight plan. This is normal, because there is no common waypoint between what's already in our flight plan and the waypoints on the approach.

We need to join the approach to the flight plan, so clear the message with the CLR key, and press the LEGS button

Closing the DISCO

If we go to the legs page, and scroll through them, we'll eventually see a waypoint that shows up as , then a line saying Route Discontinuity, then MONRY as the next waypoint. MONRY is the initial and final approach fix for the ILS.

This is a DISCO. It means that the waypoints we just entered don't have an obvious relationship to the rest of the plan. We have to "close the DISCO" before the FMC can resume automatic sequencing.

Since we know that we want to go direct from MARCI to MONROY, we can close this DISCO pretty quickly. Just press the LSK next to Monroy, and then press the LSK next to the DISCO boxes, and voila!, we've closed the DISCO. Press EXEC to confirm the changes, and our LNAV will guide us to MONRY after MARCI.



Figure 68 - The DISCO

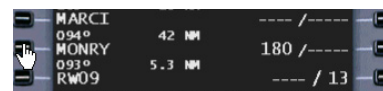


Figure 69 - The DISCO, closed.

There's another DISCO later on the missed approach, but we won't close it now as it's a clear day and we know we won't be flying the missed.

The INIT REF page

Press the INIT REF button to bring up the page. This page shows landing info, including the selected runway, the ILS if any, and three buttons for flap settings with Vref speeds next to them based on current weight. Since we'll be using flaps 30, press the LSK for 30 and you'll see the number turn big. This also sets the ref bug on the airspeed indicator.

Close the FMC and unpause the sim



As we cross RSW at 5000 feet, ATC comes on and says:

ATC: PMDG 737, descend and maintain 2500.

This is old hat to us by now, we set 2500 on the MCP and hit LVL CHG.

As we reach 2500 feet, we hear:

After MARCI, proceed direct MONRY. After MARCI, Descend and Maintain 1800 feet until established on the localizer, cleared for the ILS 09 approach into Dade-Collier, report canceling IFR in the air with me, or on the ground.

We need to break that clearance down a little. ATC has cleared us to MONRY after MARCI, which means we can leave the autopilot flying the airplane since we have that in our plan. We should also descend to 1800 after we cross MARCI, and we have to stay at 1800 until we're on the localizer. We're also cleared for the approach, and since the field is uncontrolled we have to either cancel IFR with ATC when we know we can make it to the field visually (canceling in the air), or we have to call ATC once we've landed.



Figure 70 - Approaching MARCI at 2500

The Approach

We need to set up our radios. Since this will be an autoland approach, we need to set 108.3 in both nav radios.

On the MCP, we make sure we have 095 set in the course window – this is our inbound course.

As we pass MARCI and begin our turn, set the MCP altitude window to 1800 and press LVL CHG. Arm the speedbrakes and set the autobrake to 2.

As we reach 1800 feet, dial the MCP speed back to 220 knots.

Now we wait to intercept the localizer. In about 25 miles, the localizer scale on the PFD comes alive (the dot turns solid), press the VOR/LOC button and the words VOR/LOC will show up in white on the PFD roll annunciator, indicating that the system is ready to capture.



Figure 71 - 1800 feet, 220 knots, Localizer alive and Armed

As we reach 10 NM from MONRY, reduce the speed to 180 knots, and set flaps 5.

As the localizer is captured about 1 nm from MONRY (VOR/LOC turns green on the PFD), press the App Button. The GS indicator will show up in white, and the words SINGLE CHANNEL will appear in yellow, indicating that we're operating on one autopilot.



Figure 72 - Intercepting Glideslope - Approach mode armed, single channel

The Landing

As the glideslope comes alive, lower the gear, set the MCP speed to $V_{ref}+15$ (indicated by the white bug), and set flaps to 15 degrees one notch at a time. The way to do this is to set the flaps to the next notch when the number for the current setting passes on the airspeed indicator. Thus, when the 5 number rolls by, set flaps 10. As 10 rolls by, set flaps 15, and so on. As we intercept the glideslope and start to descend, set the MCP speed to the green REF bug + 5 knots, and set the flaps to 30.

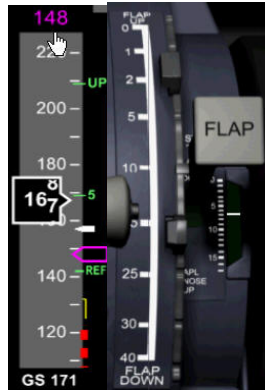


Figure 73 - Set Flaps 10 as the Flaps 5 bug goes by

At flaps 30, press CMD B to activate the second autopilot. The mode annunciator should show the word FLARE in white below the green GS in the pitch column.



Figure 74 - Dual Channel, Autoland

We're now ready for an autoland. At this point there's nothing to do but wait.

At 50 feet, the airplane will reduce thrust to idle and flare gently. Once we touch down, we have to deactivate the autopilot, and press gently on the control column to fly the nose down, and activate the thrust reversers. Deactivate the reversers at 80 knots and the autobrakes will stop us.



Figure 75 - The Touchdown

As we come to a stop, turn off the autobrakes. As we advance the throttle the spoilers will retract, and once clear of the runway, we run through the after landing checklist.

Taxi/Shutdown

We call ATC:

Us: Miami Clearance, PMDG 737 on the ground at Dade-Collier, cancel IFR.

ATC: PMDG 737, cancellation received

Taxi to the ramp and perform the shutdown/secure checklist.

Post-Flight Briefing

We learned how to setup the FMC for flight, and to save and retrieve routes. We successfully flew using the FMC to manage the flight and exercised all the MCP functions except for VNAV. We learned how to navigate directly to a flight plan waypoint. We performed an autoland dual-channel approach.

Homework Assignment

You should review the section on VNAV in the PMDG 737 systems and cockpit overview.

Your test question is:

What message will you see on the FMC if the FMC determines that you have an unexpected tailwind and therefore have difficulty maintaining the descent path? What can you expect to happen if you ignore that message?

Tomorrow, we'll repeat this route using LNAV/VNAV, and will fly a non-precision approach.

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Day Three

Lesson Four – Flight Three – Florida Tour 2

Ground School

Test Answers

You'll get the "DRAG REQUIRED" message on the FMC if the airplane is flying too fast for the programmed descent path. You should use the speedbrakes to add drag and slow down. Should you fail to do so, the autoflight system will maintain the programmed path until the airspeed is one knot short of the barber pole, and then will disconnect VNAV and revert to LVL CHG, causing an abrupt pitch up as the airplane attempts to slow to the programmed airspeed.

Automatic Flight Systems – Part 2 – Vertical Navigation (VNAV)

In our last flight, we had things pretty easy, but we did spend some time managing our altitude and airspeed. VNAV has the potential to manage that for us, but we need to understand what it does, and how it does it, so we'll be alert to potential mishaps.

The flight management system takes the information you provide via the FMC and calculates the optimum flight profile for all phases of flight. In the climb, it can manage the altitude limits on a SID, match airspeed to flap settings, manage the airspeed restrictions on climb (250 below 10,000), the adjustment for a smooth transition from knots to mach, and can even automatically climb to higher altitudes as you burn off fuel and weight. In descent, it can manage step down restrictions on a STAR, crossing restrictions, and even provide a glideslope-like experience on a non-precision approach, and match airspeed to flap and gear settings.

VNAV does this just as a real pilot would – by managing pitch and power. When you're in VNAV, pay close attention to the throttle and pitch annunciators on the PFD – they're your only way of knowing what the FMC is considering important at any given time.

VNAV is always calculating the vertical path it wants to fly, and typically uses aircraft pitch to adhere to that path. It manages airspeed then by adjusting the autothrottles. There are two main causes for VNAV to fail. In a climb situation, VNAV can look at the path you've asked for (perhaps by setting an altitude constraint at a future waypoint), and it will determine that there's no way to climb that steeply without stalling, and disconnect. In a descent situation, VNAV may predict the required descent is too steep. Or, it may feel the path is achievable, and put the nose down to follow it, and retract the throttles to idle, and still be unable to fly as slowly as it expected, resulting in an increasing airspeed. This will cause the aforementioned "drag required" message, and can result in a disconnect if the airplane approaches the max operating speed.

There is a VNAV SPD descent mode. It works much like LVL CHG, the aircraft's pitch is used to maintain the FMC calculated airspeed, and thrust is used to attempt to conform to the calculated path. In this mode, planned speed changes associated with waypoints will be executed automatically, and the FMC will post a message if it cannot meet an altitude restriction. The potential disadvantage of this mode is that should you need to make a speed change, you must either select LVL CHG or reprogram the new speed into the FMC.

When VNAV disconnects, the autoflight system usually reverts to the LVL change mode, where airspeed becomes the driver for pitch. This keeps the airplane from stalling or overspeeding, but you may miss your planned altitudes. As with any other unplanned autoflight issue, the first priority is to fly the airplane.

The use of VNAV varies widely amongst operators. I'm aware of some that have intentionally disabled it altogether. Others allow it for use in climb and cruise, and initial descent, but not for arrivals and approaches.

Typically, the busier the airspace, the more likely you're going to have your airspeed and altitude managed by ATC, and the more likely you'll be to use the MCP in LVL CHG mode for a while.

The MCP altitude setting CONSTRAINS VNAV. VNAV will not fly "past" the MCP altitude in a climb or descent. VNAV will disconnect and revert to the ALT HOLD mode. Thus, if your flight plan calls for a climb to FL350 and your MCP ALTITUDE is set to FL290, you'll level off at FL290. The FMC will present a warning message "CHECK MCP ALTITUDE" when it detects an impending conflict. This bites most captains on the butt during the descent. When you're about 5 minutes from your descent point and you have clearance to descend, set the MCP altitude to your next cleared altitude. That will ensure you descend on time and don't bust your clearance

Regardless of whether you actually engage VNAV or not, the FMC still calculates the vertical profile, and when you cross into the descent portion of the profile, it activates a path indicator on the side of the navigation display in the MAP mode. This path indicator looks a lot like a glideslope indicator, and if it "pegs" on either end of the scale, you'll see numbers above or below indicating just how high or low you are in relation to the calculated profile. Of course, as you change things on the FMC pages, you'll force a recalculation, which may result in that indication changing.



Figure 76 - Vertical Path Indicator

Creating New Waypoints in the FMC.

We've seen how to enter waypoints that are in the database – just type in the waypoint name/id, and if there are multiple waypoints with the same name/id, you'll get to choose one from a list.

But you can also enter waypoints that aren't in the database. There are several ways to do this:

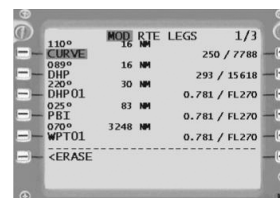
You can put in raw latitude and longitude, by using the following format to enter data into the scratchpad: NDDMMM WDDDMMM. Leading zeros are required. For instance, to enter N33 40.5 W17 02.1, you'd type N33405W01702.1.

You can define a waypoint as a bearing and distance from another waypoint. To create a Place/Bearing/Distance (PBD) waypoint, enter it as FIXBBB/DDD.D. As an example, for a waypoint 25 NM northeast of the FDK VOR, you'd type FDK045/25.

You can define a waypoint as a pair of bearings from two different other waypoints. This is VERY helpful when you're flying airways, as many fixes that join two airways may not be in the database. These fixes are called Place Bearing/Place Bearing (PB/PB) and are entered as FIXBBB/FIXBBB. For instance, the PBI VOR could be entered as DHP019/VRB164, as it is the intersection of the DHP 019 radial and the VRB 164 radial.

Finally, if you are creating a new waypoint that lies along your route (perhaps for a crossing restriction), you can create an Along Track Offset (ATO waypoint) that references an existing waypoint and a distance. The waypoint you enter must lie between its reference waypoint and the waypoint before or after the reference waypoint. These waypoints are entered as FIX±DDD.D A negative distance indicates that the new waypoint comes before it's reference, a positive distance indicates that the new waypoint comes after the reference waypoint. As an example, if you wanted to create a waypoint 15 NM before PBI on our route, you'd enter it as PBI/-15. If you wanted to create a waypoint 10.4 NM after PBI, you'd enter it as PBI/10.4. This type of waypoint is very useful when you get holds, or speed/altitude restrictions and ATC assigns a point along your route instead of a normal fix.

When you enter a fix into the FMC using any of these methods, what will be entered into your flight plan will NOT be exactly what you typed. If you enter a lat/long waypoint, such as the one after PBI on the right – it will show up as WPTXX. If you enter a waypoint in reference to another waypoint, it will show up as FIXXX, like the one after DHP on the right.



Non-precision approaches

The ILS we've flown earlier is a *precision* approach. It provides constant lateral and vertical guidance with a high degree of accuracy. The "window" of the localizer and glideslope is about 100 feet tall by 1000 feet wide at the 200 foot decision height. A non-precision approach is one that provides no vertical guidance, such as a VOR, LOC, BC, NDB or GPS approach. The lateral guidance for VOR and NDB is nowhere near as precise as an ILS, but GPS/FMS systems come very close. For vertical guidance on a non-precision approach, one or more stepdown fixes are used. These fixes define a particular altitude for a segment of the approach.

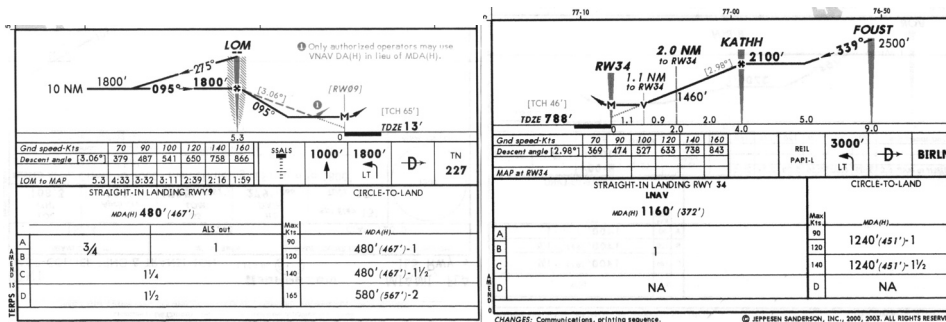


Figure 77 - Vertical profiles for KTNT GPS 09 and KDMW RNAV 34

In the case of the NDB or GPS 09 approach, the vertical profile shows a requirement to stay at 1800 until reaching the fix (MONRY or the NDB) and then one can descend to the MDA of 480 feet. By contrast, on the GPS 34 approach into Westminster MD, there are two stepdown fixes. After FOUST, one can descend to 2100, until KATHH. After KATHH, one can only descend to 1460 until 2 miles from the runway, at which point one can descend to the MDA.

There are two ways to fly non-precision approaches in a "coupled" mode using the autopilot. Both use LNAV for lateral guidance, and differ in the way speed and pitch are managed

VNAV PATH mode works if all the stepdown fixes that make up the approach are programmed, and generally results in a smooth descent. But because of the need for "heads down" monitoring of the system, many operators forbid the use of VNAV on non-precision approaches.

Alternatively, we can use MCP SPEED and V/S to control the pitch and speed of the airplane. By choosing an appropriate descent rate of around 1000 FPM, the airplane descends and levels off before the next stepdown fix. The process is repeated until reaching the MDA. One advantage to this approach is that it can afford more time at the MDA to spot the airport and continue the approach, particularly when the cloud ceiling is right around the MDA. It also has the advantage of being more of a "heads up" procedure. The chief disadvantage is that it can be a bit uncomfortable for the passengers, particularly if there are a lot of stepdown fixes.

Pre-Flight Briefing

We'll make a normal takeoff and fly the same route as yesterday, using VNAV for airspeed and altitude control. We should expect some new instructions from ATC that will force us to show our mastery of the FMC.

The flight route

This flight will be a trip around southern Florida. We'll depart the field, head east over Miami, follow J79 over Palm Beach and up to Vero Beach, then head southwest to Fort Myers and then south to Marci intersection, where we'll get vectors to join the ILS back into Dade-Collier.



Figure 78 - Flight Three Route

The route filed by the school dispatcher is
 KTNT CURVE V35 DHP J79 VRB LBV RSW CYA MARCI KTNT at 27,000 feet

Programmed Goals

- Use of VNAV
- Retrieving a stored flight plan
- Non Precision Approach Procedure

Since you're now an expert on the normal preflight activities you learned yesterday, we won't cover them in detail – you're expected to use the two-page checklist and take the necessary steps on your own.

Begin by starting up flight simulator and selecting the base scenario you'd created in lesson 1. Check the fuel load – sometimes it isn't retrieved properly. You should have 3.5% in the center tank and 100% in the wings.

Remember If you get a VNAV disconnect at any time, don't panic! Press VNAV to re-engage it, and then check for an FMC message – you may have to add drag, or reset your MCP altitude. After you correct the problem, you may have to press VNAV once more to re-engage it.

The Flight

Preflight

Begin by completing the Checklist through the Overhead Setup Section Switch to the Main Panel. We should be sitting in the cockpit with the APU running and providing power to the aircraft.



Figure 79 - Warm Cockpit

Now, before we continue up with the FMC setup, let's get our clearance and the departure runway (it is 9 in this case), and get our clearance.

Our Clearance

Us: Miami Clearance, PMDG 737, IFR from Dade Collier round robin to Dade Collier, ready to copy.

ATC: PMDG 737, you are cleared to Dade-Collier. Upon entering controlled airspace, proceed direct to CURVE for radar identification, then as filed. Climb and maintain 5000, expect flight level 270 in ten minutes. Departure Frequency is Miami Center, 132.4. Squawk 1715.

FMC setup

Bring up the FMC. Since we've got the same route as the last flight, our workload will be significantly easier. Perform the first two steps of the initialization by checking the FMC page data and then setting KTNT on the POS INIT page.

Retrieving a stored route.

On the POS INIT page, we'll see a button marked INDEX. Let's press it.



The INDEX Page

The Index page is a way to get directly to certain pages, and there are some “hidden treasures” here as well. One of these is the NAV DATA Page. Press it.

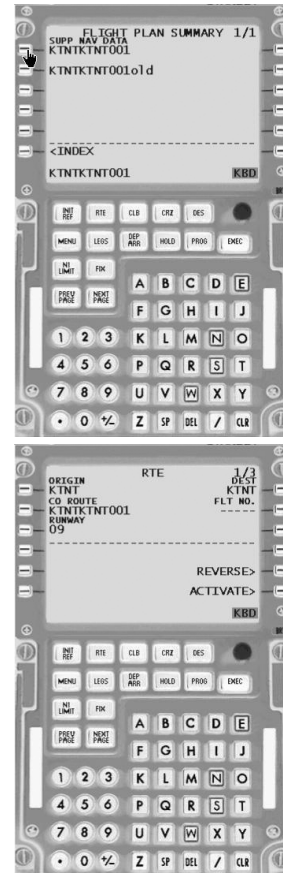
The NAV DATA Page

This page has several useful functions. It allows you to query the navigational database for information about a specific fix, VOR, or airport. Just put the ID in the appropriate field and you'll get whatever info the database has – lat/long, the frequency, airport elevation and runway length, and mag variation.

What we're really interested in, though, is the FLT PLANS button. Press this button and we'll get a list of all stored flight plans in the system.

Selecting a saved flight plan

Use the PREV PAGE and NEXT PAGE to go through the list of saved plans, and then press the button for the one we want – KTNTKTNT001. That transfers the plan name to the scratchpad. Press the RTE button to bring up the Route page



On the Route page, just press LSK2L to insert the flight plan name into the CO ROUTE field. Now your saved flight plan is loaded. Be sure to activate and EXEC it.

Now that the route is loaded, work your way through the rest of the FMC initialization. Validate the LEGS, complete the PERF INIT page with a 5000 pound fuel reserve, a cost factor of 150, and a cruising altitude of 27,000 feet. The runway's already set, so no need for the departure page. Select a reduced thrust takeoff (22K) and a CLB-1 profile on the N1 page, and a flaps 5 takeoff. Remember to set the V speeds and put V2 into the MCP speed window. When you have the preflight complete message on the takeoff page, close the FMC.



Figure 80 - Reduced Thrust Takeoff and Climb

Start, Taxi and Takeoff

Work through the rest of the routine and taxi to runway 09. Make a standard takeoff, and head direct for CURVE as you pass through 3000 feet. You do remember how to use the FMC and

LNAV to go direct to a waypoint, don't you? We should be in LNAV and LVL CHG. Call ATC as you pass through 4000 on the way to CURVE:

Departure

Us: Miami Center, PMDG737, 4000 climbing 5000, direct CURVE

ATC: PMDG737, radar contact, after CURVE, resume own navigation. Climb and Maintain FL270, Cross Dolphin at 15000.

We've gotten a crossing restriction. ATC has cleared us all the way up to FL270, but they've made it clear we have to be at 15000 when we cross the Dolphin (DHP) VOR. They must have a traffic conflict higher and want to keep us lower. There are a couple of ways we can handle this. We can stay in LVL CHG and set the MCP altitude to 15000. But this will require us to manage the airspeed all the way up, AND remember to set the altitude to FL270 as we cross DHP.

A better way to do this is to use VNAV, and put the crossing restriction in the plan.

So, set the MCP altitude to FL270, and press the VNAV button. Notice how the speed window goes blank, and look at the PFD annunciators, showing N1 for the autothrottles and VNAV SPD for pitch



Figure 81 - VNAV Climb PFD annunciators



Figure 82 - VNAV Climb MCP

While we're climbing, we better put that restriction in! Open the FMC to the LEGS page.

Entering constraints on the LEGS page

On the legs page, we see DHP in the top line. We need to put an altitude constraint in on the right side.

Type /15000 in the scratchpad and then use the LSK1R button to add it.

The EXEC light comes on to indicate we've made a change. Push it to confirm the change.

You'll notice that the /15000 shows in big numbers. That signifies a hard constraint. All the small numbers are *predicted* values, and may change.

We can enter constraints in several ways:

We can enter a speed constraint by itself, by putting in a speed followed by a slash, i.e. 250/. Mach entries are not permitted.

We can enter an altitude constraint by itself, by putting in a slash followed by an altitude, i.e. /4000 or /190. Use four digits for low altitudes, i.e. /0300 for 300 feet.

We can enter them together, i.e. 270/15000 for 270 knots at 15000 feet.

Note that entering this constraint altered the altitude prediction for the PBI, the next waypoint.



PMDG doesn't yet support "soft" constraints, such as "at or below FL190" or "at or above" 190. This means that the autoflight system will try to hit your constraint altitude EXACTLY. I believe this feature will be implemented in the revision that comes out with the 800/900.

Close the FMC, and watch as the aircraft hits the mark. Note how the nose is automatically lowered to accelerate at 10,000 feet, and thrust is reduced to slow the climb to capture 15000.



Figure 83 - PFD at the level-off at 15000

As you pass DHP you'll resume your climb to FL270 at normal rates. Remember to run through the climb checklist.

The Cruise

One of the marks of a good pilot is that he is always asking himself “What comes next”? In our case, as we level off in the cruise, we need to think about the descent. We know that the FMC PROGRESS page will predict the distance to the top of our descent. But what is that descent profile based on? For the answer, we go to the DEScent page

Pause the Sim.

The DES Descent Page

Open the FMC and press the DES key, and the descent page comes up. This page gives you information on how the FMC is calculating your descent profile, the VNAV descent mode you’ll use (speed or path), and the next speed and altitude constraints.

The first thing to notice is the title on the page. If it says ECON PATH DES, it means we’re in a PATH mode. If it says ECON SPD DES, then we’re (obviously) in a SPD mode for descent planning

In the top line on the left is our current E/D (end of descent) altitude. It’s what the system is using as the “end” of your descent profile. On the right is our first constraint, showing the waypoint and speed. Since we don’t have any constraints yet, it’s showing the field elevation at KTNT.

The second left line shows our planned descent speeds. Remember that if we’re in PATH mode, the autoflight system doesn’t try to maintain these speeds – they’re estimates. In SPEED mode they’ll be maintained. On the right is another readout of our top of descent point.

The third left line shows any airport speed restriction. This defaults to 240 below 10000, which gives a 10 knot cushion on descents. In the approach phase, it will show XXX/FLAPS as we change flap settings, where XXX is the maneuvering speed. On the right we see the waypoint and altitude constraint from the LEGS page.

Function buttons include SPEED (LSK5R), which changes our mode to SPEED (and the button changes to PATH in case we wish to change back), DES NOW (LSK6R), which allows us to start a descent early at 1000 feet per minute until we intercept our programmed path.

FORECAST (LSK6L) takes us to a very useful page

Forecast Page

The forecast page allows us to enter three different altitudes and expected wind direction and speeds. This helps the FMC compute an accurate descent profile. We don’t expect any significant winds at this point, so leave this page empty.

If you fly with real-world weather, using this forecast can help avoid VNAV disconnects, due to unplanned tailwinds.



Unpause the sim.

The other “think ahead” activity we have during the cruise phase is coordinating our arrival. We don’t have any STARs for our destination airport, so no programming is required at this time. Close the FMC.

Ten miles from Vero Beach (VRB), ATC calls:

ATC: PMDG737, fly heading 340, vectors for traffic, maintain flight level 270.

Us: heading 340, maintain flight level 270.

Hmm... must be getting busy west of here. So we dial in 340 in the MCP heading window and we push the HDG button.

After five minutes on this heading, ATC comes back to us:

ATC: PMDG737, traffic no factor, turn direct La Belle. Descent your discretion, cross LaBelle at 12,000, Cross Lee County at and maintain 7,000.

Us: Direct La Belle, descent our discretion, La Belle 12,000, Lee County at and maintain 7000.

The Descent

Entering Descent Constraints

We open the FMC, bring up the legs page, and select LBV, and put it back into LSK1L to go direct. We EXEC the change and press LNAV on the MCP to head direct. Then we enter the crossing restriction of 12000 at LBV in LSK1R, and put 7000 at RSW into LSK2R. We EXEC those changes as well.



We then switch to the DES page and see our new constraints showing on the page. We've got a way to go until T/D, so we close the FMC

With the ND in Map Mode, we'll see a little green circle labeled T/D as we approach our Top of Descent Waypoint. As we get close to it, we should set our MCP altitude to 7000 (our cleared altitude) so that we won't constrain the autoflight system from descending at the calculated point. If we forget, the FMC message light will go on, and there will be a reminder.

As we cross the T/D point, the throttles will go to idle and we'll see the vertical deviation indicator pop up on the N/D. From here on we have to keep a close eye on our airspeed and watch out for any "DRAG REQUIRED" messages.



Figure 84 - PFD and ND during Descent

As we descend, bring up the FMC and the DES Page. On line 4, there is a very useful information display. This shows the deviation from the computed path, the flight path angle (FPA) of our airplane, and the vertical bearing (V/B) and descent rate of our computed flight path. This can help us set a VS descent to meet the profile



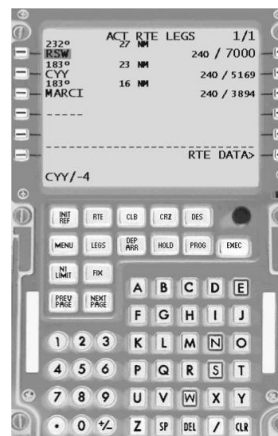
As we cross La Belle, ATC comes back with more restrictions:

ATC: PMDG 737, after Lee County, cross four miles north of Cypress at 4000 and 200 knots. Maintain 4000. Expect the GPS 09 approach into Dade Collier after MARCI.

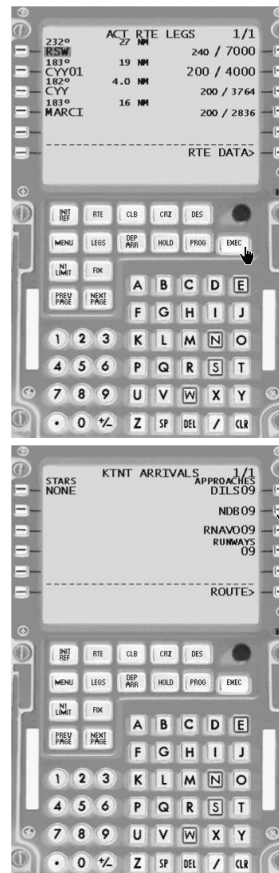
Us: After Lee County, cross four north of Cypress 4000 and 220 knots, maintain 4000. Expect GPS 09 after MARCI.

So, after we cross RSW, we've got to hit a specific point north of the Cypress VOR at 4000 feet and 200 knots. It's time for some more FMC work on the LEGS page.

This is a perfect choice for an along path waypoint. Press the LSK next to CYY to transfer it to the scratchpad, then type in /-4.



Press the LSK for CYY again to insert this point ahead of CYY. We'll see it displayed as CYY01. Then put in the speed constraint of 200/4000 into the right side of that waypoint, and EXEC all the changes.



We've also been told to expect the GPS 09 after MARCI, so use the ARR page to select it (it's the RNAV09), then go back to the LEGS page and close the disco after MARCI. Don't forget to bring up the INIT REF page and set the flaps 30 speed.

Since we know we're cleared to 4000, set 4000 in the MCP altitude window. We'll continue our descent to cross RSW at 7000.

As we cross CYY at 4000, ATC comes in:

ATC: PMDG737, after MARCI, proceed direct to MONRY, descend pilot's discretion to 1800, cleared GPS 09 approach. No procedure turn is expected, cancel with us in the air or on the ground

Us: After MARCI, direct MONRY. Pilot's discretion to 1800, cleared GPS 09 approach, no procedure turn. We'll call you on the ground.

The Approach

We know we've got the leg from MARCI to MONRY entered, so after we cross MARCI we can set the MCP altitude to 1800, and that will let VNAV take us down to that altitude when we intercept the planned profile. Since this is a non-precision approach, we can fly it in VNAV or V/S, but we'll have to make the landing manually. We'll fly it using VNAV – it will give us a more stabilized approach.

Let's open up the FMC and make sure we have the legs correct. The LEGS page should show MONRY, and then the next waypoint should be RW09 at 13. Let's set up the crossing altitude for MONRY at 1800 by entering 180/1800 and EXECing the change. We should also close up the DISCO on our missed approach as well. Since we know our MDA for this approach is 480, so we should set the BARO MINIMUMS setting to 530, so that we have a cushion from the time the system calls "Minimums" and the actual MDA.



We can close the FMC, and do a quick scan of the Approach Checklist. We confirm that the MCP is set for LNAV/VNAV, and as we get about ten miles from MONRY, we set flaps 5. Since we're in VNAV, the FMC will automatically set the flaps 5 maneuvering speed. When we're three miles from MONRY, we drop the gear and set flaps 15. We arm our speedbrake, and we set our MCP altitude to the MDA (500 works). Gradually we extend landing flaps so that we have them out as we cross MONRY.



Figure 85 - Descending from Monry

The Landing



Figure 86 - The Landing.

Once we have the runway in sight, we disconnect the autopilot and land manually, beginning our flare at 50 feet. Remember that the MCP altitude will constrain us at 500 feet, so click that autopilot off as soon as you know you can land safely. If we did not have the field in sight at the “Minimums” Call, we’d have engaged TOGA and begun the missed approach procedure.

Taxi/Shutdown/Secure

By now, you’re an expert – put the plane away, Captain!

Post-Flight Briefing

We learned how to use VNAV to manage altitude constraints, learned about the DES page, and flew a non-precision approach.

Homework Assignment

You should review the section on FMC Flight Plan Modification in the FMC User’s Manual (pages 8-33 onwards to 8-36). Also study the Go-Around procedure on page 5-15 of the AOM, and memorize the Missed Approach section of the Quick Reference Checklist.

Your test question is:

If, instead of heading direct to a waypoint, you wish to fly a specific course to that waypoint, where would you enter that course after inserting the waypoint in Line 1L on the LEGS page?

Have your bags packed and bring them tomorrow morning. No, you haven’t busted the course, but tomorrow we’re going to fly to Orlando, and the next day, it’s off to Atlanta for your graduation flight! You’ll be able to catch a flight home from Atlanta.

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Day Four

Lesson Five – Flight Four – Scenic Tour

Ground School

Test Answers

When you put a waypoint in line 1 of the LEGS page, the default intercept course from your route is placed at 6R. You can enter in a new course there, or you can just press LSK6R to “make it big”. Pressing EXEC without modifying 6R or making it big results in a direct route to the waypoint from the present position.

In-flight Route Modifications

We’ve already seen that ATC may vector you around for traffic or spacing – these are usually short departures from your route and end with a clearance back to your route or direct to your next waypoint. But ATC can also give you shortcuts by eliminating part of your route, or give you a new route altogether.

When you get a whole new route in flight – you’ll always get a new clearance to your destination from your present position, with the usual mix of airways and direct legs. This is why it’s important to have charts ready in the cockpit – you may have to look up waypoints and enter them on the fly.

As far as programming the FMC is concerned, remember that until you EXEC a change, you can always ERASE it and revert to the previous route by pressing the appropriate key. You can see your new route on top of your old route in MAP and PLAN modes (the new route is in white), but you can’t step through the route in PLAN mode until it’s EXEC’ed.

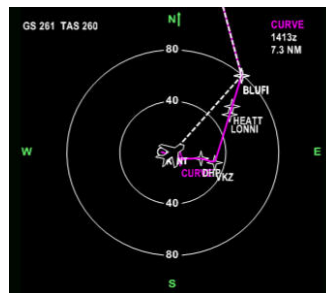


Figure 87 - ND display of old and new route

You may end up using the RTE pages to modify your route, particularly if there are a lot of airways involved.

Always delete the old legs or RTE page entries before entering the new ones – it will minimize confusion – just don’t press EXEC until you’re happy with the change.

Holding Procedures

The autoflight system has the ability to fly holding procedures. Holds are managed in the FMC by pressing the HOLD key. While setting up a hold is fairly straightforward, and we'll cover it in flight, the HOLD key itself is probably the most confusing function in the FMC. You can get three different screens when you press the HOLD key. Because it's so confusing, here's a flowchart.

FMC HOLD Key Flow Chart

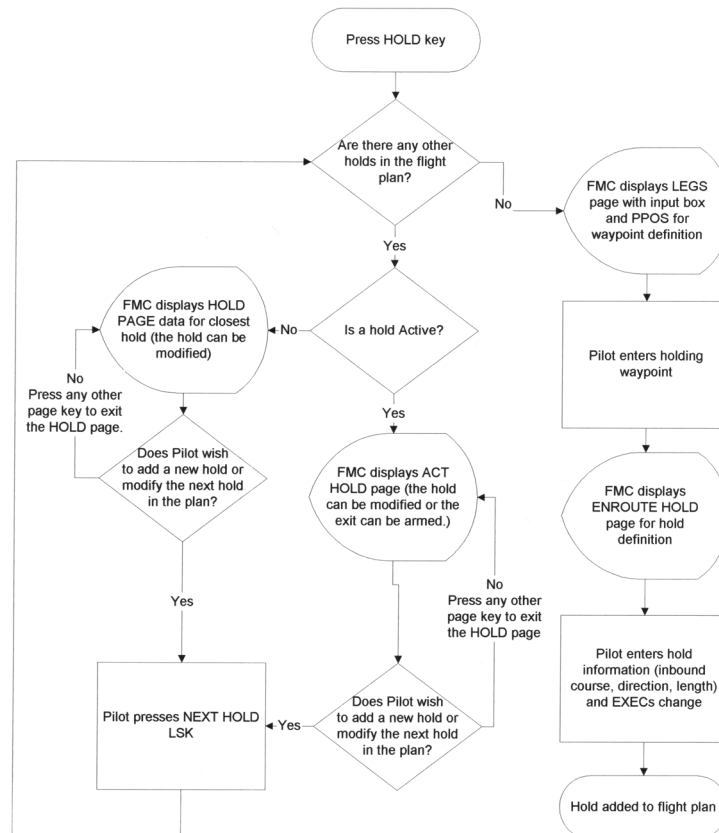


Figure 88 - FMC HOLD Flowchart

Go-Arounds and Missed Approaches

A Go-Around is a maneuver that requires careful attention to detail, particularly on a precision approach where you may be very close to the ground. Here are the initial steps to be followed for executing a Go-Around or “balked landing”:

- Activate TOGA – this does three things. It advances the throttles to provide thrust, and it sets the go around attitude on the flight director. It also disconnects the autopilot in a single channel approach
- Manually pitch the aircraft to follow the flight director. This is **critical** to minimize altitude loss.
- Raise the flaps to 15 degrees.
- When you have a positive climb established, raise the gear.

Now you're pretty much back to a normal takeoff situation. Select a roll mode at 400 feet (LNAV is best if you have the missed approach programmed in the FMC), and engage the autopilot at 1000 feet – LVL CHG is a good idea. Continue to clean up the airplane and increase the speed as you head for your missed approach holding point.

The missed approach is almost always part of the stored approach procedure that you retrieve from the database, but ATC can and will give you alternate instructions. Before you begin the initial approach, be sure you have the lateral portions of the missed approach route entered (from the database or manually) with no DISCOs in the LEGS page of the FMC.

Once you maneuver clear of the airport, missed approaches are best flown in LNAV and LVL CHG. Diverting to another airport is done easily by replacing the destination on the RTE 1 page. You can then build your new route to your alternate airport in the usual way, but VNAV function will not be available.

VNAV is NOT supported yet in the PMDG Sim for the missed approaches. It's also not available for diversion to an alternate airport – you'll be LNAV and LVL CHG all the way. It's still a good idea to put the speed/altitude constraints in the LEGS pages though as a handy reminder.

Pre-Flight Briefing

Today we have a whole new route, designed to do a little fun flightseeing along the coast. You should have brought your overnight bag, as we'll be RON (Remain Over Night) tonight in Orlando. Yes, there will be time for you to go to DisneyWorld.

The flight route

This flight will have our “standard” departure and trip to CURVE for radar identification, then over to Miami, a slight dogleg to the southeast to Virginia Spring, then up along and around the coast with a flight by NASA Cape Canaveral. This flight's going to be at 4000 feet.



Figure 89 - Flight Four Route

The route filed by the school dispatcher is
 KTNT CURVE V35 DHP JVKZ AR1 BLUFI COMET ATHOL OMN KIZER ORL KMCO
 at 4,000 feet

Programmed Goals

LNAV course intercept
Holding procedures
Missed Approach

Since you're now an expert on the normal preflight activities, we won't cover them in detail – you're expected to use the two-page checklist and take the necessary steps on your own.

Begin by starting up flight simulator and selecting the base scenario you'd created in lesson 1. Check the fuel load – sometimes it isn't retrieved properly. You should have 3.5% in the center tank and 100% in the wings.

Remember - If you get a VNAV disconnect at any time, don't panic! Press VNAV to re-engage it, and then check for an FMC message – you may have to add drag, or reset your MCP altitude. After you correct the problem, you may have to press VNAV once more to re-engage it.

The Flight

Preflight

Begin by completing the Checklist through the Overhead Setup Section Switch to the Main Panel. We should be sitting in the cockpit with the APU running and providing power to the aircraft.



Figure 90 - Warm Cockpit

Now, before we continue up with the FMC setup, let's get our clearance and the departure runway (it is 9 in this case).

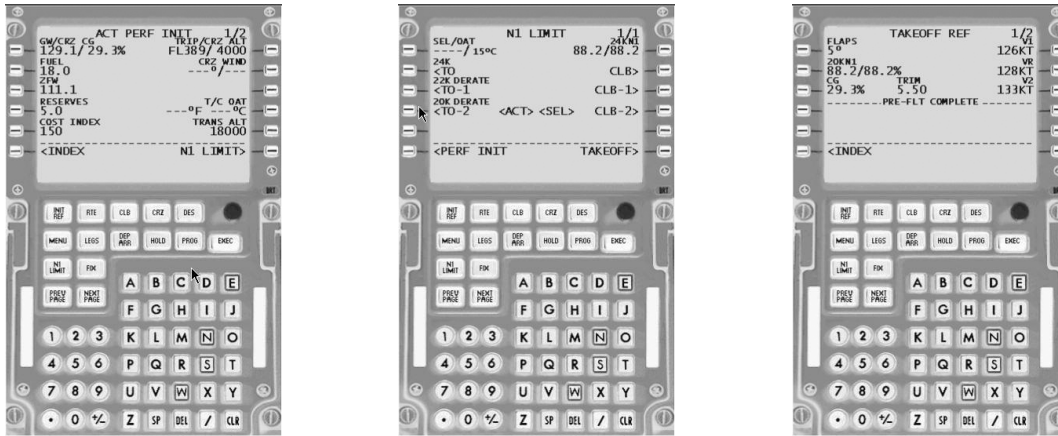
Our Clearance

Us: Miami Clearance, PMDG 737, IFR from Dade Collier to Orlando, ready to copy.

ATC: PMDG 737, good morning, you are cleared to Orlando International. Upon entering controlled airspace, proceed direct to CURVE for radar identification, then as filed. Climb and maintain 4000, that will be your final altitude. Departure Frequency is Miami Center, 132.4. Squawk 1715.

FMC setup, Start, and Taxi

Bring up the FMC and go through the initialization process. Use the included navigation log as a reference for the filed route and to check your legs. Complete the PERF INIT page with a 5000 pound fuel reserve, a cost factor of 150, and a cruising altitude of 4,000 feet. Use a 20K thrust rating and CLB-2 profile since we're not going high at all. Be sure and set the MCP altitude accordingly. Complete all the remaining checklists and taxi to the runway for takeoff.



Takeoff

Make a standard takeoff, and use LNAV and VNAV in the climb to head for CURVE. As you pass through 3000 feet, call ATC.

Departure and Cruise

- Us: Miami Center, PMDG737, 3000 climbing 4000, direct CURVE*
- ATC: PMDG737, radar contact, fly heading 055 and join AR1 north of Virginia Key. Maintain 4000.*
- Us: 055 to join AR1 north of Virginia Key, maintain 4000, PMDG737.*

The very first thing we do is set 055 on the MCP heading and switch to HDG mode. Then open the FMC to the LEGS page.

Pause the Sim

Intercepting a course

On the LEGS page, our first few waypoints show up. We know we want to join AR1 north of VKZ, so our intercept will be on the leg **from VKZ to BLUFI**. Since the FMC only calculates “to” waypoints, we know we have to specify an intercept to BLUFI.

Put the ND in PLAN mode and set the range to 160 NM.

Then press the LSK next to BLUFI to transfer BLUFI to the scratchpad. Press LSK1 to put BLUFI in the first line. You’ll see a new line drawn direct from the airplane to BLUFI. Do NOT hit EXEC at this time.



Look down on line 6R, you’ll see an INTC CRS prompt and 020 in small letters. This is the previous intercept course to BLUFI from VKZ. Since this course represents the AR1 airway, press LSK6R to “Make it BIG”. Now your new course line on the ND matches the airway, so press EXEC. Close the FMC



Unpause the sim.

Change the ND back to map mode, and you’ll see the heading line leading out to intercept the course line. Press LNAV on the MCP, and it will light, but the airplane doesn’t change course. What’s happening is the FMC will maintain the present heading until we intercept the course.

Why did we get this shortcut? Probably because our flight route is at 4000, and ATC would rather not have us blow through the Miami International approaches at 4000 feet and 250 knots. By turning us a bit north they keep us out of the way.



We've been working hard for the past few days, so for now, tidy up the climb and cruise checklists and take some time to enjoy the scenery. Don't worry about how much fuel we're burning down here – this "luxury" is planned in the course.

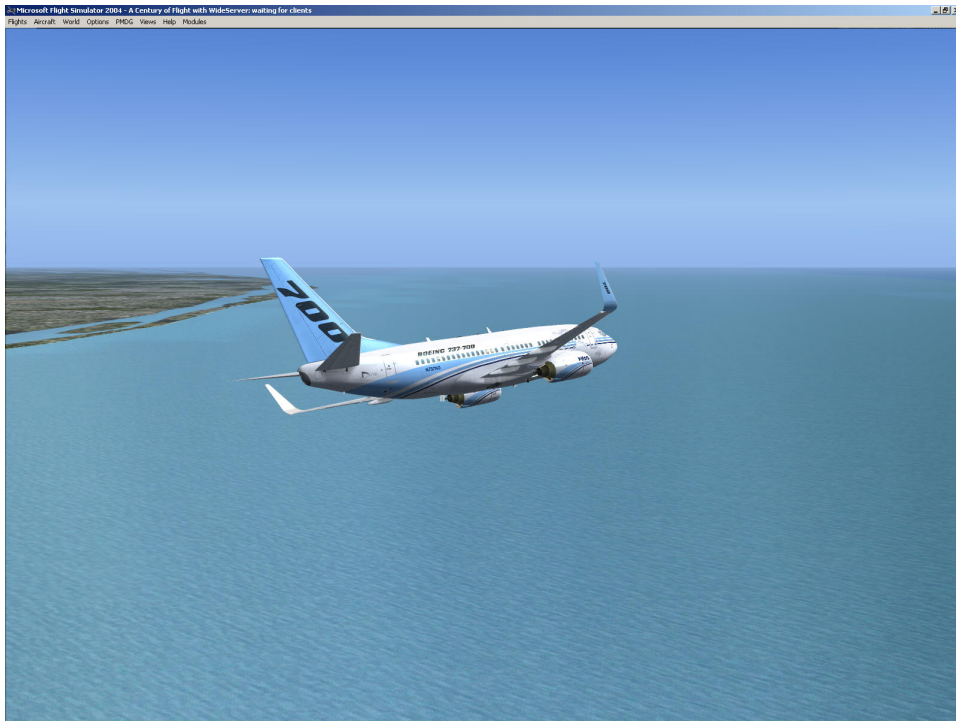


Figure 91 - Intercepting AR1 to BLUFI

I do have a good idea, though. Let's set up a holding pattern along the path from COMET to ATHOL. That will let us each get a good look at the Space Center. If we do it correctly, when it comes time to depart we'll be right on our course anyway. I'll ask ATC for permission to loiter:

Us: Miami Center, PMDG 737, request

ATC: PMDG 737, Center, go ahead, sir.

Us: Center, PMDG 737 would like to loiter off of Cape Canaveral. We'll set up a racetrack between COMET and ATHOL and would like a few turns.

ATC: PMDG 737, approved as requested, maintain 4000. Call me back when you wish to proceed past ATHOL.

Us: Wilco, PMDG 737.

Programming a Hold

In order to fly a holding pattern, the FMC requires the following information

- The fix that serves as the holding point
- The inbound course to that fix
- The length (in time or miles) of the hold
- The direction (right or left) of the hold.

Optional information includes the hold speed and altitude.

Since we want to hold on the leg to ATHOL, ATHOL will be our holding point. If we look at the navigation log for the trip, we'll see our inbound course to ATHOL is 323 degrees. The distance from COMET to ATHOL is 9.7 miles, so we'll use 7 mile legs (this allows room for the turns). Let's use left turns (standard holds are right turns) so that we'll be closer to the shoreline on the outbound leg.

The easiest way to program this hold is to do it from the LEGS page. Open the FMC

FMC Hold Function

On the LEGS page, press the HOLD button. Press the LSK next to ATHOL in the plan. An input box appears at 6L, and 6R shows PPOS (present position).

Since we want to hold at ATHOL, we can use the LSK next to ATHOL to transfer it to the scratchpad, and then press LSK 6L to put in the HOLD input box.

Hold Page

The holding page appears. Note that the default inbound course is already 322, so we won't change it for the sake of one degree. We enter the appropriate information (Left Turns, 322 for the inbound course, 10 mile legs) and press EXEC.

Going back to the LEGS page, we now see a new entry is after ATHOL, indicating a hold. We also see the hold depicted on the ND map



Deleting a hold from the flight plan LEGS page is simple. Press the DEL key, and then the LSK next to the hold. Then EXEC the change.

As we reach ATHOL, the airplane smoothly turns left and begins flying the racetrack pattern.

We also need to slow down – in the USA the max speed for a holding pattern below 6000 feet is 200 knots. Even though this isn't an ATC-assigned hold, we'll slow down. Press ALT HOLD to take us out of VNAV and set the MCP speed to 200 knots.

We should be able to enter this speed restriction into the FMC and have the airplane decelerate automatically in VNAV, but that doesn't work at present – hopefully it will be fixed in the 800/900 update.

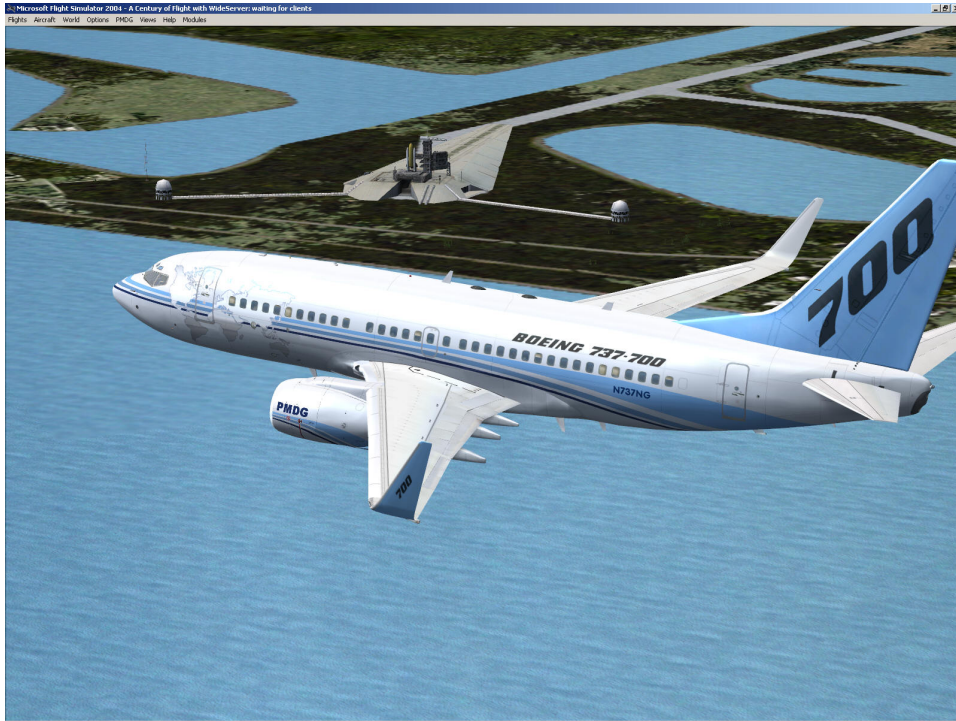


Figure 92 - In the hold passing Cape Canaveral

Let's go around at least once, and then we'll exit the hold. I'll call ATC:

Us: Miami Center, PMDG 737, request

ATC: PMDG 737, Center, go ahead, sir.

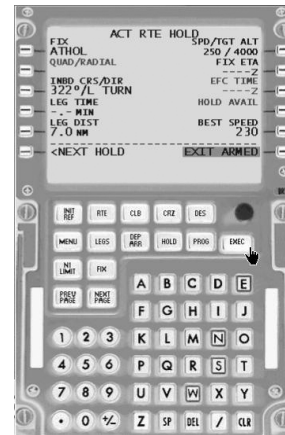
Us: Center, we're done sightseeing here, sir, we'd like to proceed on our route to Orlando. Thanks for indulging us.

ATC: PMDG 737, You're welcome, resume cleared route to Orlando. Contact Orlando Approach on 127.32

Us: Resume cleared route, Orlando approach 127.32, PMDG 737

Exiting a hold

Pressing the HOLD button while actually flying a hold will bring up the ACT RTE HOLD page. It looks exactly like the earlier hold page, except for line 6R, which says EXIT HOLD. Pressing LSK6R will alert the FMC to turn back to the holding waypoint, and then proceed with normal sequencing on the flight plan. 6R will change to read EXIT ARMED.



The Arrival

As we leave ATHOL, we re-engage VNAV (and accelerate) and call ATC:

Us: Orlando Approach, PMDG 737, maintaining 4000.

ATC: PMDG 737, good morning sir, expect the ILS 18R into Orlando, maintain 4000.

Us: Expect the ILS 18R, maintain 4000. Sir, we'd like to miss the first approach at Orlando, then come back for another, PMDG 737.

ATC: PMDG 737, I'll try to work that with the tower and let you know.

Us: Roger, PMDG 737.

Open the FMC and load the KMCO 18R approach into the flight plan.

Press the DEP/ARR button and then work through the approaches to select the ILS18R. Then go to the LEGS page



Since we don't know exactly how we'll join the approach yet, just exec the changes and don't clean up any of the DISCOs.



Use the INIT REF page on the FMC to get our Vref speed for flaps 30.

As we sequence up to Ormond Beach, it's time to get the weather. The ATIS at KMCO says

ATIS: Orlando Information Yankee. Wind Calm, Visibility 10, sky clear. Altimeter 29.92. ILS 18R in use. Landing and departing 18L and 18R.

As we make the turn at Ormond Beach, ATC calls:

ATC: PMDG 737, Orlando Approach, reduce speed to 220 knots. Cross KIZER at 200 knots, then proceed direct HAMMY. Maintain at or above 2200 feet until established on the Localizer, cleared ILS 18R approach. Tower says you can have the missed.

Us: Reduce to 220 knots, Cross KIZER at 200 knots, then direct HAMMY. At or above 2200 until established, cleared ILS 18R PMDG 737.

We need to reduce our speed now to 220, so let's exit VNAV by pushing the ALT HOLD button and setting the MCP speed to 220. There's no need to slow further at this time or to begin our descent yet. We can open up the FMC and close our DISCO though, as we now know our arrival route.

On the LEGS page, we select the LSK for HAMMY and copy HAMMY into the scratchpad.



Then we insert HAMMY after KIZER, and the DISCO is closed. We close the FMC



At about 5 NM from KIZER, we set the MCP speed to 200, and approach calls us:

ATC: Contact Tower now 124.3

Us: Over to tower 124.3

Us: Orlando Tower, PMDG 737 for the ILS 18R with Yankee

ATC: PMDG 737, Orlando Tower, Wind Calm, fly published missed, cleared for the option.

Us: Published missed, cleared for the option, PMDG 737

The Approach

We're cleared for the approach, and we have one restriction - we can't descend below 2200 until we're on the localizer. We'll set this up by putting 2200 in the MCP altitude window. As we cross KIZER, we hit LVL change to descend to 2200.

Briefing the approach:

This is an ILS to runway 18R. Localizer frequency is 111.9, inbound course 184.

Glideslope intercept at TUFFE is 2200, decision height 294 feet. Missed approach is a climb to 500, then climbing right turn to 2000 direct to the ISM NDB.

We can do a quick scan of the Approach Checklist. We tune NAV 1 to the localizer frequency, 111.9, and set the Minimums to BARO/300. We confirm that the MCP course is set to 184, and that we're in LNAV. We arm the localizer. At 10 miles from HAMMY, we reduce speed to 180 knots and set flaps 5. We set the autobrakes (2) and autospoilers, and the engine start switches.



Figure 93 - Approaching the Intercept at HAMMY

At HAMMY, we drop the gear and set flaps 15, reducing speed as required. We arm the APP mode in single channel. As the glideslope comes alive, reduce speed and extend landing flaps. As we intercept the glideslope and descend, we set the MCP altitude to 2000 feet, our missed approach altitude.



Figure 94 - On Final

Missed Approach

As we pass through 300 feet and hear the “minimums” call out, we hit TOGA and manually pitch the airplane up to follow the flight director. We reduce the flaps to 15, and at a positive rate, we retract the gear. Once above 400 feet we select LNAV for roll mode and continue to reduce the flaps and accelerate. At 1000 feet, engage the autopilot in LNAV and LVL CHG, with the MCP speed at 200 knots. I'll handle ATC.

- Us: Orlando Tower, PMDG 737 is on the missed approach, climbing to 2000.
- ATC: PMDG 737 roger, contact approach 124.3
- Us: Approach 124.3, PMDG 737
- Us: Orlando Approach, PMDG 737 on the missed, climbing to 2000.
- ATC: PMDG 737, Orlando Approach, enter the hold as published, expect vectors back for ILS RWY 18R in five minutes.
- Us: Hold as published, expect vectors in five, PMDG 737.



Figure 95 – Go-Around PFD

The airplane will continue to climb to 2000 feet and level off and follow the missed approach guidance, entering the hold. We should take the time to run the after takeoff checklist to make sure we haven't forgotten anything. Check the FMC and clear any messages.

After we've gone around the hold once, ATC calls:

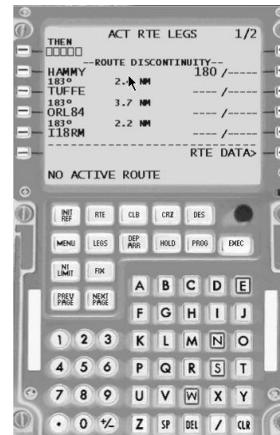
- ATC: PMDG 737, fly heading 360, climb and maintain 3000, vectors for the approach. Speed at or below 240, please
- Us: Heading 360, climb and maintain 3000. Speed 240 or less, PMDG737

We set 360 on the MCP heading, 240 on the MCP speed, and 3000 on the MCP Altitude, and press HDG and LVL CHG. We climb to 3000 and level off, heading north. It's now time to load the approach again.

Press the DEP/ARR button and then work through the approaches to select the ILS18R. Then go to the LEGS page



Open up the LEGS page and ensure that the approach legs are present. Don't worry about any DISCOs at the moment – we really only want this in the FMC as a reference and to drive the map display, since we're expecting radar vectors back to the approach. EXEC the change and clear the NO active route message by pressing the CLR button.



Set the ND to MAP mode and the Range to 40

As HAMMY passes behind us on the right, ATC calls:

ATC: PMDG 737, turn right heading 140, descend and maintain 2200 until established on the localizer, cleared ILS 18R.

Us: Right to 140, descend and maintain 2200 until established, cleared for the ILS 18R,

ATC: PMDG 737, Contact Tower 124.3

Us: Over to Tower, PMDG 737



Figure 96 - Passing HAMMY on Vectors

We set 140 on the MCP heading, 2200 on the MCP Altitude, and press LVL change. As the localizer comes alive, we arm LOC on the MCP, and reduce speed to 180 and set flaps 5. I'll check in with the tower.

Us: Orlando Tower, PMDG 737 is on the ILS 18R approach.

ATC: PMDG 737, Tower, Cleared to land 18R.

Us: Cleared to Land, PMDG 737.

Let's review the approach one more time.

This is an ILS to runway 18R. Localizer frequency is 111.9, inbound course 184. Glideslope intercept at TUFFE is 2200, decision height 294 feet. Missed approach is a climb to 500, then climbing right turn to 2000 direct to the ISM NDB.

Now, run through the approach checklist to be sure we didn't miss anything.

At HAMMY, we drop the gear and set flaps 15, reducing speed as required. We arm the APP mode in single channel. As the glideslope comes alive, reduce speed and extend landing flaps.

As we intercept the glideslope and descend, we set the MCP altitude to 2000 feet, our missed approach altitude.

The Landing

At minimums (or whenever we feel like hand-flying), disconnect the autopilot and land.



Figure 97 - The Landing Rollout with Autospoilers

Turn off on a LEFT taxiway, and contact Ground on 121.9

Us: Orlando Ground, PMDG 737 clear of 18R, request taxi to the gate

ATC: PMDG 737, cross 18L and taxi to the gate.

Us: Cross 18L, taxi to the gate, PMDG 737

As we taxi, be sure to raise the flaps before we reach the ramp area. Taxiing into the ramp with the flaps down is a signal that you wish to be met by armed law enforcement personnel.

Taxi to a gate (pick any one), and shutdown and secure the airplane.



Figure 98 - At the Gate in Orlando

Save your parked airplane as a new situation – call it NG Tutorial-Orlando.

Post-Flight Briefing

We used the FMC to intercept an airway, created and flew a holding procedure, and executed a missed approach procedure.

Homework Assignment

Tomorrow is graduation day! This will be a formal check flight from here to Nashville, and for most of the route I'll be doing little more than prompting you to run the checklists, although you can expect some new things to arise as we deal with ATC. When we land, assuming you meet standards, you'll get a graduation certificate, a handshake, and a ticket home while you await your line assignment.

Review the AOM section on fuel planning 2-8 through 2-11. Your test questions are:

What is the standard reserve fuel?

What is the standard holding fuel?

What is the standard taxi fuel?

There's a crew car available to you here. Enjoy Disney World, but avoid the hot dogs and alcohol – you need to fly tomorrow

Day Five

Lesson Six – Flight Five – Line Check

Ground School

Test Answers

Standard Reserve Fuel is 1800 Lbs. This is probably NOT enough to meet legal FAA minimums, as the FAA requires that a flight under IFR to be able to fly to destination, divert to alternate, and have 45 minutes of fuel at normal cruising speed remaining. Since our airplane can burn as much as 6000 lbs per hour at cruise, a safer reserve fuel would be 4500 lbs.

Standard holding fuel is 2000 Lbs, and this figure provides about 20 minutes of holding. Of course, if weather is a real concern, you want to load more fuel.

Standard taxi fuel is 500 lbs. If you expect departure delays and can't hold at the gate, you may want to double this.

Fuel Planning

Fuel planning is a balancing act between safety and economics. It costs money to operate the airplane, and the heavier you are, the more it costs. Thus captains are discouraged from carrying too much fuel. This practice, called *tankering*, is normally only approved when cheap fuel is not available at your destination, and the price difference for the available fuel is more than the cost of tankering it.

On the other hand, crashing short of your destination costs the airline money too, so captains are discouraged from carrying too little fuel, both by the airlines and the FAA. I mentioned earlier the FAA requirement for planning to arrive at your destination or alternate with at least 45 minutes of fuel. This, however, is a PLANNING requirement, and if you run into unforecast winds, or are forced to hold longer than expected, you won't be in trouble with the FAA if you land with less than 45 minutes of fuel on board. You'll probably annoy your employer, however.

A dispatcher usually plans the fuel load for a commercial flight, calculating the fuel required to reach the destination, and the fuel to go to an alternate if required (if the weather at your destination is predicted to be below certain standards, you MUST plan for and file an alternate airport where the weather is better). He also adds a standard reserve, and then some more fuel for enroute holding, based on his experience.

He then takes this fuel plan to you for your concurrence, and the two of you work out any differences. Many airlines allow for "captain's fuel" where the captain is allowed to add fuel on the top of the planned load by the dispatcher.

Let's work out our fuel requirement for this flight to Nashville. Grab your flight plan.

- Fuel to destination: The airway route planned is 560 NM and we're flying at FL350, so if we look at the chart, we should plan for about 7500 lbs of fuel.
- Fuel to alternate: The weather today is beautiful, so no alternate is required. 0 Lbs
- Holding fuel: With the weather good, the chance of delays is slight. However, better safe than sorry, so let's plan on 2000 lbs.
- Reserve Fuel: Let's use the standard 4500 Lbs.
- Let's also add the 1000 lbs we like to leave in the center tank.

If we total this up, we end up with 15,000 lbs to put in our airplane. With 1000 lbs in the center, we should get by with 7000 lbs, or 1045 gallons, per side.

There's a fairly easy way to do this. If you use FSBuild, it will calculate fuel for you. Ross Carlson also has a free fuel planner that can read your load from flight sim, and you can fill in your information on destination and alternates (one drawback is that there's no way to plan without an alternate), and the planner will calculate your fuel load and even pump it for you!

Figure 99 - Fuel Planner (note no holding fuel because alternate is planned)

Automatic Flight Systems - Part 3 - Control Wheel Steering

There are certain times when you may want to hand-fly the airplane without disconnecting the autopilot, so that the airplane can resume it's programmed route with ease. Or, you may want to put the airplane into a specific attitude and have the autopilot keep it there. Some times when this can be helpful are:

- Flying in turbulence.
- Dodging a cloud and returning to the original route - airliners do this all the time, not because the pilots don't like to fly in clouds, but because it provides a smoother ride to the passengers.
- Deviation for traffic.

For all of these reasons, Control Wheel Steering (CWS) is available to you. CWS is activated:

- By selecting the CWS A or B button (duh)
- By engaging the autopilot with no pitch or roll mode (TOGA is a pitch mode) active in the flight director.
- By disengaging an autopilot pitch or roll mode.
- By overpowering the flight control column (yoke).

You can tell the CWS mode by looking at the PFD. It is possible to be in CWS for one (pitch or roll) mode, and not the other. As with all other autoflight systems, **look at the PFD to determine what's going on.**



Figure 100 - CWS annunciation

What CWS does is control the autopilot servos in response to your control pressures, without "forgetting" the pre-existing autopilot modes. In pitch, when you relax the control pressure, the autopilot will maintain the pitch attitude. In roll, when you relax pressure, the autopilot will maintain the bank angle if that angle is more than six degrees. If it's less than six degrees, the autopilot will roll to wings level and maintain the existing heading. Since the airplane's physical path can be different from it's attitude, using the Flight Path Vector (FPV) feature of the PFD is recommended when using CWS.

CWS does not “respect” the MCP altitude setting, and will not capture an altitude – watch your altitude closely in a CWS climb or descent.

CWS does not affect autothrottle settings – the autothrottle will remain in the previously selected MCP or FMC-commanded mode.

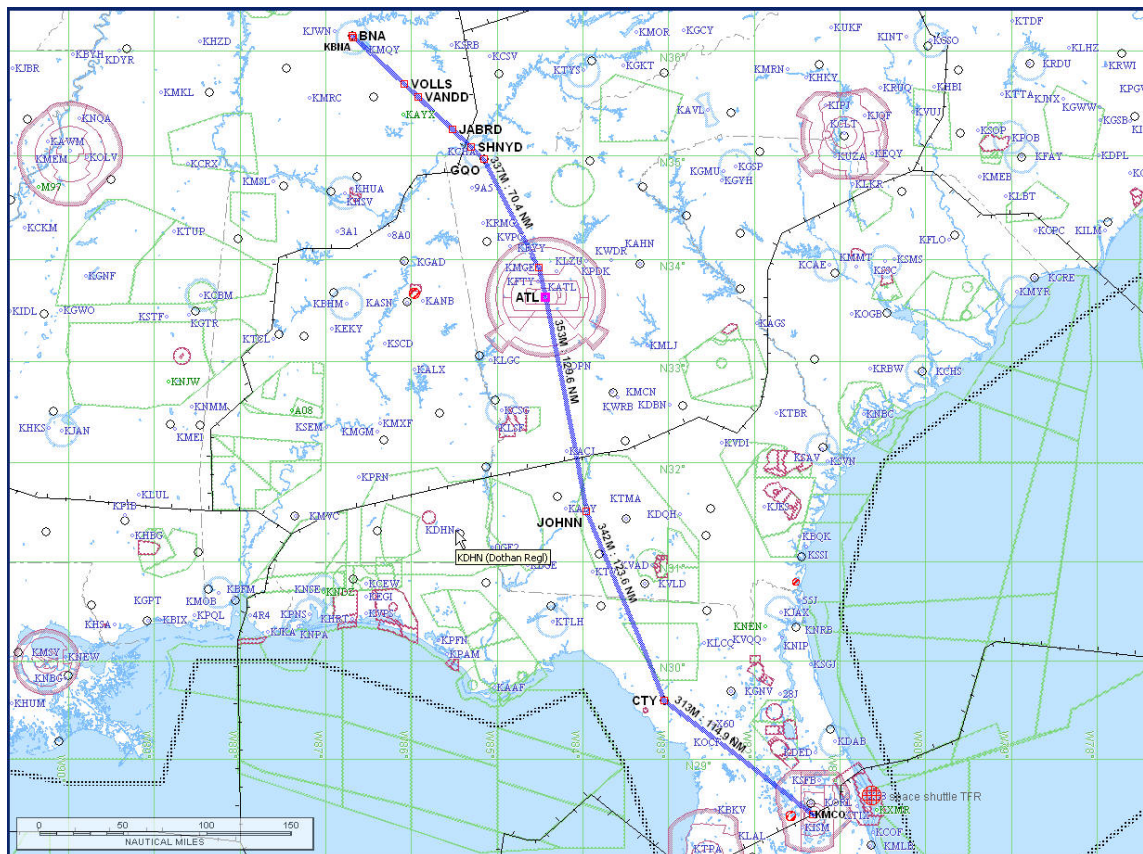
The Flight Director will continue to show any MCP/FMC directed commands, not the CWS commands.

If you exit CWS by re-engaging the autopilot using one of the CMD buttons, the autopilot will resume the appropriate modes, following the flight director. Pressing CWS to disengage it will result in turning the autopilot OFF.

Pre-Flight Briefing

Today’s flight is based on Southwest flight 2520, which leaves Orlando at 2:05 PM and arrives at Nashville, Tennessee at 3:00 PM. There’s a one-hour time change between Orlando and Nashville, so total time for the trip is programmed at 1 hour and 55 minutes. You have actual passengers on this trip – we’re operating as a charter – so no aerobatics, no pinching the flight attendants, and NO SHOWING UP AT SECURITY WITH ALCOHOL ON YOUR BREATH; This is NOT Northwest Airlines. Report to the airplane at 13:00 – you need time for a thorough exterior preflight so that you can begin boarding at 13:20.

The flight route



Our route is northwest to Cross City, then up to Atlanta, and finally across Chattanooga into Nashville. The filed route is

KMCO CTY J91 ATL.VOLLS6 KBNA at 35,000 feet.

The .VOLLS6 signifies a Standard Terminal Arrival (STAR). It’s a prepackaged arrival sequence starting at the ATLanta VOR, and funneling into BNA. We’ll discuss it during the cruise.

Programmed Goals

Line Check Flight
 Standard Instrument Departure
 Standard Terminal Arrival
 Control Wheel Steering.

Since you're now an expert on the normal preflight activities, we won't cover them in detail – you're expected to use the two-page checklist and take the necessary steps on your own.

Begin by starting up flight simulator and selecting the Orlando scenario you'd created the last lesson. Load the fuel as calculated in the ground school session, remembering to keep 1000 Lbs in the center tank. Set the time to 1:25 PM – you have 40 minutes to be ready for pushback. Try NOT to pause the sim during this flight unless you get behind.

Remember - If you get a VNAV disconnect at any time, don't panic! Press VNAV to re-engage it, and then check for an FMC message – you may have to add drag, or reset your MCP altitude. After you correct the problem, you may have to press VNAV once more to re-engage it.

The Flight

Preflight

After we've got the initial acceptance checks out of the way, we can start boarding the passengers.

We need to get the ATIS for Orlando, so I'll tune it in:

ATIS: Orlando International Information Tango. Wind calm. Sky clear. Visibility greater than ten. Altimeter 29.92. Arriving runway 18R, Departing runway 18L. Contact clearance delivery for VFR and IFR departure instructions. Read back all hold short instructions. Advise on initial contact you have Tango

Our Clearance

Us: Orlando clearance, PMDG 737, IFR to Nashville, ready to copy.

ATC: PMDG 737, Orlando clearance, you are cleared to Nashville, via the Citrus Five Departure, as filed. Expect Flight level 350. Squawk 2122.

Us: Cleared to Nashville. Citrus Five, then as filed, flight level 350. Squawk 2122, PMDG 737.

ATC: Readback correct, contact ground for your push and start, have a good flight.

Standard Instrument Departure

Hmm... we didn't file a SID, but we got one – better pull out the chart for the CITRUS FIVE departure.

Ah. SIDs come in two styles. The “pilot nav” SID describes a specific route, with headings, courses to nav aids, and altitudes, and the pilot is expected to fly the correct route and vertical profile to the specific fix that joins the enroute structure. These SIDs are part of the FMC database.

The “vector” SID relies on ATC to vector you to a specific fix. Using a SID to publish the instructions relieves the controllers from having to give you climb, initial altitude, and frequency information. These SIDs are usually NOT part of the FMC database. The CITRUS FIVE departure is a vector SID.

By looking at the CITRUS FIVE departure and our flight plan, we can expect vectors to CTY (it's on the SID and the start of our route), the departure frequency will be 119.4 (we'll be departing to the south) and the instructions for our initial climb are to fly assigned heading for vectors, maintain 1500.

KMCO/MCO			19 DE
ORLANDO INTL			
ORLANDO Departure (R)			
311°-060° 5500' & Below	061°-180° 5000' & Below	181°-310° 5500' & Below	
121.1	127.32	119.4	

Figure 101 - SID Frequency Assignments

INITIAL CLIMB	ALTITUDE
All aircraft climb on heading as assigned for vectors to appropriate fix.	MAINTAIN 1500'.
ROUTING	
EXPECT further clearance to filed altitude/flight level 10 minutes after departure.	

Figure 102 - SID Climb Instructions

FMC setup, Start, and Taxi

While the passengers are boarding, bring up the FMC and go through the initialization process. Use the included navigation log as a reference for the filed route and to check the legs. Use runway 18L for departure for now – if need be we'll change it later. Also be sure and select the VOLLS 6 arrival with the ATL transition!

Selecting a STAR and transition

After entering the initial route as far as ATL, press the DEP/ARR key and bring up the arrival page for BNA. On the left side of the screen we'll see the arrivals. Press the LSK for VOLLS6.



Now we'll see a list of transitions on the left. Select ATL. Then let's go back to the RTE pages to check the routing, which should look as shown here.

With the route complete, complete the PERF INIT page with a 4500 pound fuel reserve, a cost factor of 150, and a cruising altitude of 35,000 feet. Use a 22K thrust rating and CLB-2 profile..



The RESERVES field in the PERF init page triggers the FMC to alert us to a low fuel condition. We've figured 4500 lbs for our 45 minute reserve. By putting in 4500 lbs in the RESERVES field, we'll get an alert whenever the FMC predicts will have less than 4500 lbs at our destination. It's a good practice to put the total of reserve fuel, alternate fuel, and "captain's fuel" in this field.

Startup and Taxi

By 2:00 we should be ready for departure. Contact ground control and get permission for push, start, and taxi.

Us: Orlando Ground, PMDG 737, ready for push, start, and taxi, we have Tango

ATC: PMDG 737, Orlando Ground, push and start approved, taxi to runway 18R, hold short of 18L.

Us: push, start, and taxi to 18R, hold short of 18L, PMDG 737

We've gotten a change in runway, and we need to fix that in the FMC. This can be done in two ways:

- On the initial RTE page, we can enter 18R in the RUNWAY FIELD.
- On the DEP page for KMCO, we can deselect runway 18L by pushing the LSK 1R button, then selecting 18L.

In either case, we'll get a message that the V speeds have been deleted. We have to clear that message and then go to the TAKEOFF page and reselect the V speeds.



Close the doors, and proceed with the pushback and start by 2:05 for an on time departure. Then taxi to runway 18R, being sure to call ground as we hold short of 18L.

Us: Orlando Ground, PMDG 737, holding short 18L

ATC: PMDG 737, cross 18L, over to tower for 18R.

Us: Cross 18L, over to tower for 18R, PMDG 737.

As we approach 18R, we complete the checklists, ensuring our transponder is set to 2122 and in TA/RA, and call the Tower.

Us: Orlando Tower, PMDG 737, 18R ready for departure.

ATC: PMDG 737, fly heading 220, cleared for takeoff

Us: Fly heading 220, cleared for takeoff, PMDG 737.

We do a final MCP check – heading at 220, altitude at 1500 (from the SID), and proceed with the takeoff.



Figure 103 - MCP set for takeoff

Takeoff

As we rotate, we're conscious that we have to level off at a fairly low altitude – 1500, so we engage the autopilot in HDG and LVL CHG as soon as we pass through 1000 feet. We notice an FMC alert light, but at this phase we're very busy, so we ignore it. Once we've cleaned up the airplane and accelerated to 250 knots, we hear from ATC.

Departure and Climb

ATC PMDG 737, contact departure.

Us: Over to departure, PMDG 737

Us: Orlando departure, PMDG 737, maintaining 150, 220 assigned.

ATC PMDG 737, departure, good afternoon, radar contact, turn right heading 340, climb and maintain 11,000.

Us: Right turn heading 340, up to 11,000, PMDG 737.

Set the MCP heading to 340, and set the MCP altitude to 11,000, and press VNAV. VNAV's a good choice because we're climbing above 10,000, and VNAV will manage the acceleration past 250 knots as we pass through 10,000.



Figure 104 - PFD annunciators, climbing to 11000

Now we have a minute to check the FMC and see if the alert is still valid. If it's still there, it's probably an insufficient fuel alert. When we get an insufficient fuel alert during the departure, it's usually because the FMC is "thinking" that the takeoff fuel burn will last through the climb. It's a fairly normal occurrence, so we clear the alert and see if it comes back.

As we pass through 9,000, ATC calls:

ATC: PMDG 737, climb and maintain FL350, direct Cross City, contact Center.

Us: Climb and maintain FL350, direct Cross City, over to center, PMDG 737.

We set the MCP altitude to 35,000, and bring up the FMC LEGS page to go direct to Cross City (CTY). Once that's entered, we select LNAV, and call Center.

Depending on when you change the MCP altitude, you may have already entered the ALT ACQ mode, and changing the MCP altitude will change the mode to VS/SPD. Press VNAV to resume that mode.

Us: Jacksonville Center, PMDG 737, climbing to FL350.

ATC: PMDG 737, Jax Center, roger.

The Cruise

As we pass CTY, we decide to play with CWS a bit. I'll call ATC and get clearance to maneuver.

Us: Center, PMDG 737, we'd like to do a few maneuvers here if possible. Can we get a block of airspace from FL 330 to 370 for the next 30 miles?

ATC: PMDG 737, approved as requested, no traffic in your vicinity. Maintain flight level 330 block 370.

Us: 330 block 370, PMDG 737.

Press the CWS A button. The CWS pitch and roll annunciators illuminate, but note that the a/p annunciators remain in LNAV and VNAV ALT. Note that the CMD setting has changed to FD.



Figure 105 - PFD in CWS



Figure 106 - Altitude alert while in CWS

Now, put the airplane in a ten-degree bank to the right, and release the yoke. Note how the airplane maintains the bank. Pull the nose up a little and release the yoke. See how the new pitch angle is maintained. Notice that when we deviate significantly from our MCP altitude, the PFD puts yellow boxes around the altitude window and set altitude on the PFD. Put the nose back down before we climb above 36,500, we don't want to bust our block!

Roll the airplane back to wings level, and let go. If you let go with less than six degrees of bank, the airplane will roll level and maintain the present heading.

Press CMD A and the airplane will return to the programmed course and altitude.

Us: Center, PMDG 737, maneuvering complete, thank you

ATC: PMDG 737, roger, maintain flight level 350.

Us: Maintain flight level 350, PMDG 737.

We've got some time to kill here, take a quick look through the checklist to make sure we're good, and then we can start BSing. Check the FMC PROG page to ensure that we'll arrive on time or early, with plenty of fuel.

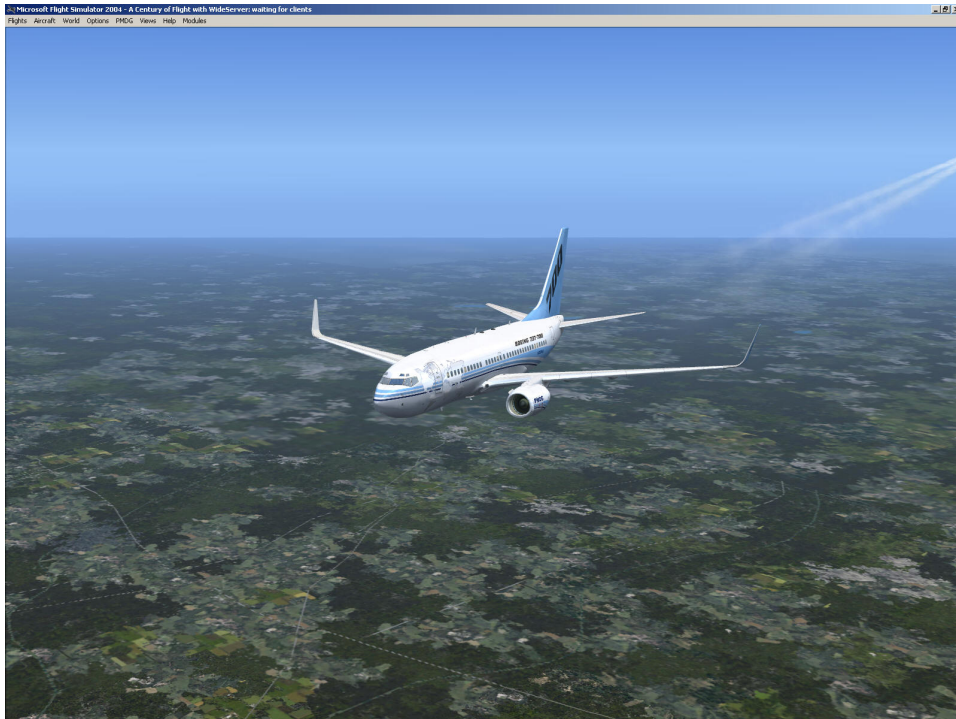


Figure 107 - Cruising at 35,000.

As we cross JOHNN, we need to review the arrival, as we'll be joining it at ATL.

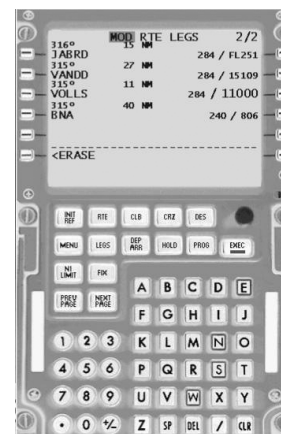
The arrival takes us from Atlanta, outbound on the 347 radial to intersect the 152 radial from Choo Choo (GQO – Chattanooga). We then fly inbound on the 152 radial (course 332) to Choo Choo, then proceed in a more or less straight line to VOLLS intersection. After VOLLS, the procedure continues to the Nashville (BNA) VOR, with a note to expect vectors to the final approach course. There is one altitude restriction at VOLLS; Turbojets should expect 11,000 feet, and if landing to the east on runways 2L, 2R, 2C, or 13, there is a 250 knot speed restriction at VOLLS as well.

```

VOLLS
N35 40.9 W086 05.0
TURBOJETS
EXPECT clearance to cross at
11000'.
EXPECT clearance to cross at
250 KT when landing
Nashville Intl Runways 2L, 2C,
2R, or 13.
    
```

Figure 108 - STAR crossing restriction

On the LEGS page, we check to see that the 11,000 feet altitude constraint is present for VOLLS, and if not, we enter it. We'll enter the speed restriction later, after we've gotten the BNA weather and know what weather to expect



The Arrival

As we cross Atlanta (ATL), ATC clears us to descend:

ATC: PMDG737, begin your descent now, cross VOLLS at 11,000, 250 knots, they're landing east today.

Us: Pilot's discretion, cross VOLLS at 11,000 and 250, PMDG 737.

We set the speed and altitude restriction (250/11000) for VOLLS on the LEGS page of the FMC, and set the MCP altitude to 11,000



Our profile doesn't call for a descent yet, but ATC wants us to start down. We could use LVL CHG or VS to head down now, but let's stay in VNAV and use the DES NOW function

DES NOW

Open up the FMC and press the DES Key.

The descent page comes up, and on line 6R we see DES NOW.

Pressing this key starts a 1000 foot-per-minute descent until we intercept the planned profile, then normal descent rates are resumed.

Press the DES NOW key, and then EXEC it.

We'll see the path deviation indicator show up on the ND, and we'll appear to be deviating below the path – this is expected, as we've started our descent early. This deviation will grow until we reach our computed Top of Descent (T/D) point near GQO, and then it will start to shrink as our computed path and actual path converge.



As we cross Choo Choo (GQO), we get the Nashville ATIS:

ATIS: Nashville information echo, wind calm, sky clear, visibility 10. Altimeter 29.92, landing and departing 2L, 2C, and 2R. Advise controller on initial contact you have echo.

As we cross VANDD, ATC calls:

ATC: PMDG 737, contact approach 127.17.

Us: over to approach 127.17, PMDG 737

Us: Nashville approach, PMDG 737, descending for 11,000 with echo.

ATC: PMDG 737, expect the ILS 2L approach, vectors at VOLLS

Us: Expect the ILS 2 left, vectors at VOLLS, PMDG 737

We need to load and EXEC the ILS 2L approach on the FMC, but not worry about DISCOs at the moment

Open up the FMC and press the DEP/ARR page, and select BNA.

Then scroll through the approaches page by page and select the DILS02L approach, and then select the FIDDS transition. EXEC the changes, and clear the DISCO message.

The DISCO referred to here is on our missed approach, because it involves a sharp turn.



You may get an FMC message warning you that you haven't selected INIT REF yet. Clear it, we're going to do that in a second.

The Approach

We level off at 11,000 about X miles before VOLL5, and decelerate to 250 knots. As we cross VOLL5, ATC calls:

ATC: PMDG 737, turn left heading 285, descend and maintain 4000.

Us: Left to 285, descend and maintain 4000.

We set the MCP heading and altitude, and select HDG and LVL CHG, dialing the speed back to 240 knots.

We check the INIT REF page, and get our localizer frequency (109.9) from it, making sure it matches the chart. We set our flaps 30 Vref, and set the radios and course (020) into the MCP course window. We then brief the approach:

*This is the ILS 2 Left approach into Nashville. The localizer's on 109.9, course is 020.
We intercept the glideslope at DOBBS at 2430 feet, and our decision altitude is 800 feet.
The missed approach is a climb to 1200, then a climbing left turn to 4000 feet,
intercepting the Nashville 270 radial to BEVEE and hold.*

We set the minimums selector to BARO at 800.

As we reach 4000, ATC calls:

ATC: PMDG 737, proceed direct FIDDS, cleared for the ILS 2L approach

Us: Direct FIDDS, cleared ILS 2L, PMDG 737

We open up the FMC LEGS page, select FIDDS and put it in 1L, and EXEC the change to go direct. We set the MCP to LNAV, and the airplane turns to proceed direct to FIDDS.

We also clean up the remaining DISCOs on the LEGS page for the missed approach

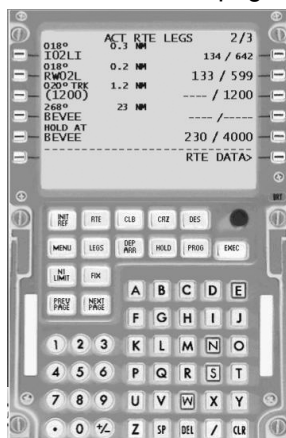


Figure 109 - The legs with no DISCO.

As we approach FIDDS, we arm the VOR/LOC intercept on the MCP, and set the speed to 180 and extend flaps 5.

Crossing FIDDS, ATC calls:

ATC: PMDG 737, descend and maintain 2,500, contact tower.

Us: Descend and Maintain 2500, over to tower, PMDG 737

We set 2500 on the MCP and press LVL CHG. We lower the gear, reduce speed, set flaps 15, arm the autobrakes (2) and autospoilers, and set the engine start switches to CONT. When we reach 2500, we arm the glideslope intercept by pressing the APP button on the MCP. We run through the approach checklist -. As we approach Dobbs, we reduce to Vref+5, and set flaps to 30. We capture the glideslope and start our final descent. Then we call the tower.

Us: Nashville Tower, PMDG 737, inbound ILS 2L

ATC: PMDG 737, tower, cleared to land.

Us: Cleared to land, PMDG 737.

This is a tight descent. We're descending through the glideslope to capture it from below, and we've got to get the APP mode armed as soon as we reach 2500.



Figure 110 - Final, ILS 2L

The Landing

At minimums (or whenever we feel like hand-flying), we disconnect the autopilot and land. Tower calls us.

ATC: PMDG 737, roll all the way to the end, please, contact ground 121.9 as you exit.

Us: All the way to the end, ground as we exit, PMDG 737.

Taxi, shutdown and secure.

As we clear the runway, we call ground while we perform the after landing checklist.

Us: Nashville Ground, PMDG 737, clear of 2L, taxi to the gate, please.

ATC: PMDG 737, Ya'll are welcome to Nashville, taxi to the gate.

As we taxi to Concourse A, we make the standard "sit down until we're stopped" announcement, and thank them for flying with us.

Once at the gate, we shut down the engines, and wait until the ground power light comes on. We then engage the ground power, open the doors, and turn off the signs, completing the shutdown/secure checklist.

What time did you arrive? Did you arrive early or on time? The time in Nashville should be 3:00 PM or earlier. How much fuel do you have left?

Post-Flight Briefing

Captain, you met standards for flying the 737-700, congratulations! A training staff member, who'll give you your boarding pass for your flight back to your home base, will meet you at the gate. Your airline will contact you soon with your new flight schedule

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Appendix - Add-ons I use in FS2004

Introduction

You've noticed the various icons added to my PMDG panel. I'll try to cover them one by one here. I'll explain the various changes I've made, where to get the add-on products, and show the modifications I've made to my panel configuration files.

Before we get into that, however, I need to make this disclaimer.

Neither I, nor PMDG, will offer you any support for any modifications you make to your panels. You are prohibited from making any changes to PMDG binary files like gauges. You are strongly urged to make a backup copy of your original panel.cfg files. Should you need support, you must restore the original files before seeking help.

The Panel files

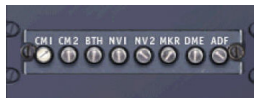
There are two panel files you need to edit. In the FltSimroot\Aircraft\PMDG737-700 directory, there are two folders, "panel" and "panel.VC". These folders control the panel for both the standard 2D and virtual cockpit, there is a file called panel.cfg in each one. You should make the same changes to both files

Panel files follow a standard layout. First, individual *windows* are defined. Then, a *views* section defines the eyepoints and views. Next, each window is detailed with the bitmap for its background and its gauges.

Thus, if you're adding a new window (like a weather display), you first have to add the window itself, and then start adding gauges. Finally, you may then need to add a button gauge to one of the existing windows to bring up the new window.

It's a really good idea to comment your modifications. "//" represents a comment

Audio Panel



The Audio Panel is the simplest addition, as it uses the audio panel gauge from the default 737-400. Since it's only a gauge addition, we just modify the radio panel window:

```
//-----
[Window08] // PMDG_RADIO_STACK_PANEL
file=737NG_RADIO_BACKGROUND.bmp
file_1024=737NG_RADIO_BACKGROUND.bmp
size_mm=600,540
position=8
visible=0
Background_color=0,0,0
ident=RADIO_STACK_PANEL
gauge00=PMDG_737NG_Main!RadioStack, 0, 0, 600, 540
gauge01=737-400!Audio, 315, 430, 250 //TMM add audio panel
```

Groundhandling Gauges



This gauge set is from Rob Barendregt. It offers pushback with a variable angle, as well as audio enhancements of the process. You can download it from AVSIM at <http://library.avsim.net/sendfile.php?DLID=38809>.

Once you have the contents unzipped, you can add the gauges to the radio stack by:

```
//-----
[Window08] // PMDG_RADIO_STACK_PANEL
file=737NG_RADIO_BACKGROUND.bmp
file_1024=737NG_RADIO_BACKGROUND.bmp
size_mm=600,540
position=8
visible=0
Background_color=0,0,0
ident=RADIO_STACK_PANEL
gauge00=PMDG_737NG_Main!RadioStack, 0, 0, 600, 540
gauge01=737-400!Audio, 315, 430, 250 //TMM add audio panel
gauge02=rcb_groundhandling!XMLSoundSwitch, 413, 339, 50, 36 //TMM add groundhandling
gauge03=rcb_groundhandling!PushbackDisplay, 473, 325, 86, 64 //TMM add groundhandling
gauge05=rcb_groundhandling!PushbackStates, 0,0 //TMM add groundhandling
gauge06=rcb_groundhandling!XMLSoundServer,0,0 //TMM add groundhandling
gauge07=rcb_groundhandling!BrakeSound, 0,0 //TMM add groundhandling
gauge08=rcb_sound!sound,0,0,,,9998 9999 100 // 95:Default overall sound volume - TMM add
groundhandling
```

Flight Deck Sound Effects



This is from Marcus Thompson, and offers additional sounds to enhance your flight experience, including gate noise, the various cabin announcements, captain PA addresses, etc. You can download it from AVSIM at <http://library.avsim.net/sendfile.php?DLID=41196>.

This add-on requires a new window, window setup, and there's a button to be added to the main and zoom panels.

The window definition:

```
Window17=FlightDeck Sound Effects //TMM - For sound panel
```

The window setup:

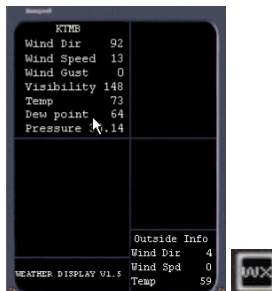
```
[Window17]
file=FDSFX.bmp
size_mm=500
position=0
visible=0
ident=122757

gauge00=FDSFX_01_gate!switch, 49,89,30,51
gauge01=FDSFX_02_airport!switch, 111,89,30,51
gauge02=FDSFX_03_muzak1!switch, 174,89,30,51
gauge03=FDSFX_04_muzak2!switch, 235,89,30,51
gauge04=FDSFX_05_muzak3!switch, 295,89,30,51
gauge05=FDSFX_06_turbulence on!switch, 357,89,30,51
gauge06=FDSFX_07_turbulence off!switch, 419,89,30,51
gauge07=FDSFX_08_gate departure!switch, 49,190,30,51
gauge08=FDSFX_09_pushback!switch, 111,190,30,51
gauge09=FDSFX_10_safety message!switch, 174,190,30,51
gauge10=FDSFX_11_safety video!switch, 235,190,30,51
gauge11=FDSFX_12_takeoff!switch, 295,190,30,51
gauge12=FDSFX_13_climb!switch, 357,190,30,51
gauge13=FDSFX_14_cruise!switch, 419,190,30,51
gauge14=FDSFX_15_meal service!switch, 49,298,30,51
gauge15=FDSFX_16_movie!switch, 111,298,30,51
gauge16=FDSFX_17_begin descent!switch, 174,298,30,51
gauge17=FDSFX_18_on approach!switch, 235,298,30,51
gauge18=FDSFX_19_on final!switch, 295,298,30,51
gauge19=FDSFX_20_taxi to gate!switch, 357,298,30,51
gauge20=FDSFX_21_gate arrival!switch, 419,298,30,51
```

The main and zoom panel files:

```
Gauge25=FlightDeckSFX!Icon_FlightDeckSFX, 32,430,25,25 //TMM add button for sound
```

FSMeteo



This application is payware, from <http://www.fsmeteo.com>.

It's also a window, gauge, and button setup. The button is one I created – if you want the file, send me an e-mail

The window definition:

```
Window16=Weather Display //TMM- For FSMeteo
```

The window setup:

```
//-----
[Window16] // FSMeteo Display - TMM
file=737fsmwd.bmp
file_1024=737fsmwd.bmp
size_mm=300,339
window_size_ratio=1.000
position=0
visible=0
ident=110
render_3d_window=0
window_size= 0.160, 0.290
window_pos= 0.570, 0.700
```

```
gauge00=fs_meteo, 0,0,300,339
```

The main and zoom panel files:

```
gauge24=NewGauge!Weather Display Icon, 6,430,25,25 //TMM add button for weather
```


Appendix - Helpful Resources

Web Resources:

PMDG Website – www.precisionmanuals.com

AvSim – www.avsim.net

Bill Bulfer's Manuals – www.fmcguide.com

Lots of 737 system info – www.smartcockpit.com

Airline Training Orientation Program (ATOP) – www.b737.com

NavData – www.navdata.at

FSUIPC – www.schiratti.com/dowson.htm

Virtual ATC

VATSIM. – www.vatsim.net

IVAO – www.iva.org

Books and Video

737 Cockpit Companion – Bill Bulfer

737 FMC Guide – Bill Bulfer

The Boeing 737 Super Guppy (300-400-500) Simulator Checkride Survival Manual – Mike Ray

Flying the Big Jets – Stanley Stewart

Airways Magazine

Airliners Magazine

The Turbine Pilots Flight Manual – Gregory Brown and Mark Holt

Flying Jets – Linda Pendleton

Redefining Airmanship (and others) – Tony Kern

Retail Outlets

Sporty's Pilot Shop – www.sportys.com

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Appendix – Online Flying

Introduction

As realistic as the PMDG 737 is, you can still “kick it up a notch” (thanks, Emeril!) by using your internet connection. You can get real-time actual weather downloads to add unpredictability to the flight environment, and you can join an online sim community or virtual airlines.

Online Weather

FlightSim offers “real” weather out of the box, but it’s often delayed significantly in most parts of the world. There are a couple of market leaders in weather add-ons.

FSMeteo (www.fsmeteo.com) and ActiveSky (www.hifisim.com) both serve up weather gleaned from various sources (worldwide METAR reports, terminal forecasts, etc). The programs run on your pc in addition to flight simulator, and periodically (you choose how often) go out and get updates, then send those updates to the sim using the FSUIPC interface. ActiveSky offers a weather radar option as well!

Both of these programs work well, and can provide you a much nicer experience than using the FS default weather generator. There are some problems, however

They both try and mostly succeed in working around a problem in the FS weather engine. Because the FS “world” is broken up into little “cells”, these programs can populate the “cells” with different weather, particularly in the upper winds. When the flight sim crosses a border between “cells”, there can be dramatic changes in wind direction and velocity. This wind shear can cause the airplane to overspeed or stall, and the poor autoflight system goes nuts trying to keep up. **This is the number one cause of poor VNAV performance.** The good news is that they keep improving the way the weather is written to the simulator to minimize these issues. If you have the registered version of FSUIPC, you can also set limits on how rapidly winds change. This helps, but does not eliminate the problem. You need to remember to be patient and don’t let a VNAV disconnect panic you when flying with online weather. Just fly the airplane; let it recover from the shear, and then try re-engaging VNAV. You certainly know by now all the alternate ways to make the airplane do what you want, so don’t hesitate to engage LVL CHG or VS.

Air Traffic Control

We all know that the ATC that comes with flight sim is better than nothing, but it's not up to working with our jet. It doesn't know about SIDs and STARs, can't give decent vectors, and generally is too "stupid" to immerse you in the flying experience.

Fortunately, there are a couple of online ATC networks. Both VATSIM (www.vatsim.net) and IVAO (www.iva.org) provide a series of servers that you can connect to, and receive real-time ATC from a real live person who likes controlling as much as you like flying. You'll have other airplanes in the airspace around you, and get vectors, holds, "slam-dunk" approaches, and other nasty ATC tricks.

There's too much to cover on this topic for this short appendix, but I'll try and give you an idea how these networks operate. First, you go to one of the networks and join the community. Once you've registered, you can download an application like Squawkbox (www.squawkbox.ca), which connects to the network and allows you to file flight plans, and communicate with controllers. It also updates the weather from the network servers, so that your weather and the controller's weather are the same.

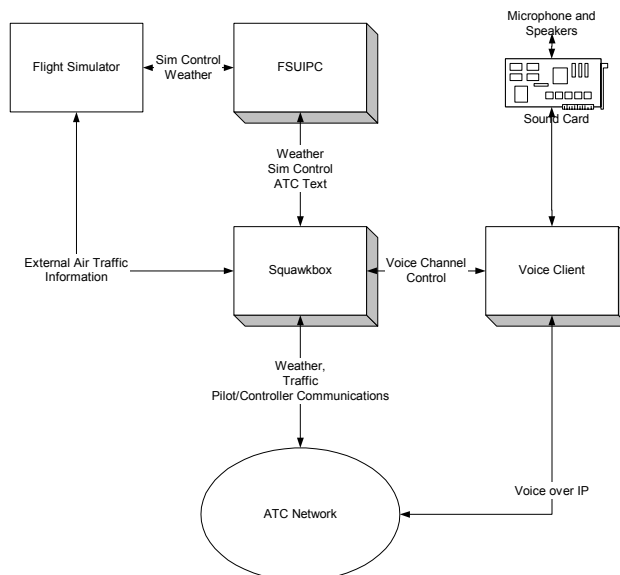


Figure 111 - Virtual ATC diagram

Depending on ATC coverage, you may end up working with separate ground, tower, approach, and center controllers, being handed off as your flight progresses through the system.

You also get to see other airplanes with proper liveries, etc (what you see are AI models called from a specific library for the network), so when you get told to "follow the Delta jet to the runway", you'll be able to do just that.

There are even voice-over-IP clients that allow you to talk to and hear the controllers. This takes the reality factor about as high as it can go, including people "stepping" on each other, and real-life personalities.

There are only two drawbacks to the networks – the applications require CPU cycles, so if the PMDG 737 is a marginal performer on your system, adding the Virtual ATC software will only make it worse. The second is that ATC coverage is sometimes spotty, depending on time of day or week. Different centers or airports periodically host events, where they fully staff ATC and invite everyone to fly in. This afternoon, I flew into Cleveland as part of a VATSIM event, and there were well over a hundred aircraft entering or exiting the Cleveland center airspace under control. I didn't even get a hold, although an airplane landed no more than 2 minutes behind me, so they were busy.



Figure 112 – Cleveland Fly In - other airplanes from the VATSIM ATC network.

Virtual Airlines

A virtual airline is a group of people who enjoy flying airline routes, usually modeled after a specific airline. They vary widely, but generally:

- They have a specific set of routes and aircraft types.
- They may simulate the “bidding” process for routes, where captains with more seniority get to choose their routes first.
- There may be a formalized route assignment process from a central scheduling office.
- They require you to fly at least one trip a month, and report your time.
- They promote you based on the number of hours you fly.
- They may host online ATC events.

A google search on “virtual airline” will provide lots of listings. Many have a waiting list – be persistent! For us 737 drivers, there are lots of choices. I belong to SimSouthwest (www.simsouthwest.com) and am a Captain in the east coast hub.

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