

From Warsaw to Krakow with ERJ-170

Leos Urban, October 7, 2012 (version October 13, 2012)

We will simulate scheduled flight LO3913 of LOT airlines, operated by ERJ 175, from Warsaw to Krakow in Poland, EU (flight selected from LOT timetable 2012).

LOT, Polskie Linie Lotnicze, LOT Polish Airlines, is flag carrier of Poland. It is based in Warsaw on Warsaw Chopin Airport (EPWA). Airlines are part of Star Alliance. And for us is important, that LOT is using twenty Embraers 170/175.

L03913 - KRAKOW | LASTCALL | G14

Scheduled departure is at 15:15 from Warsaw. This time is End Of Block time (EOBT), it means when aircraft leaves its stand/gate. Planned arrival to Krakow is at 16:10. Again, this is time of planned stop of aircraft on its stand/gate. Time of flight is 55 minutes.



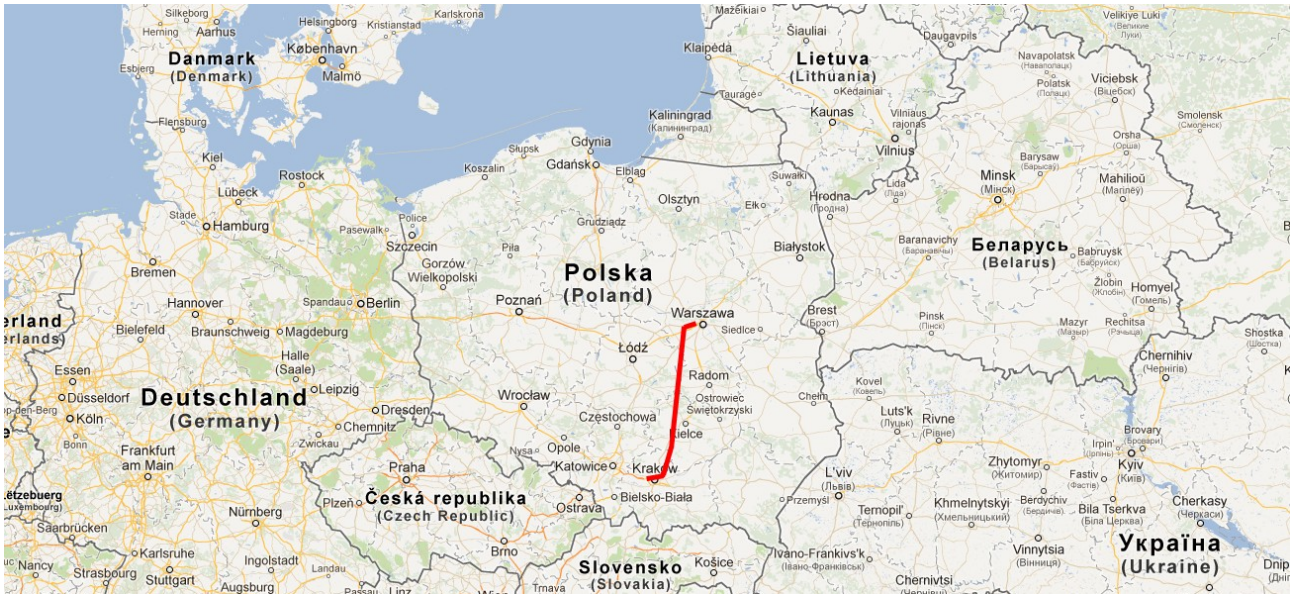
Warsaw is capital of Poland and largest city in this country. With 1.7 millions residents it is 9th most populous city in European Union.

Krakow is second largest city in Poland. Highly valued is town historical centre and Wawel castle. There are 28 museums. The woman from Leonardo da Vinci's oil-paint "Lady with an Ermine", exhibited in Czartoryski museum, is on tail of LOT repaint in distributed SSG package.

(source: Wikipedia)

ROUTE

Use <http://rfinder.asalink.net/free/> for EPWA – EPKK in FL180.



Source of map: maps.google.com

Route will be EPWA SID EVINA JED POBOK STAR EPKK, 135 nm.

Note: this route is too short to be typical for regional jets. Short routes up to 300 nm are typically operated by turbojets, for example ATR-42, ATR-72 or DHC8 Q400. On these routes is not slowness of turbojets too important (acceptable difference) and they have better efficiency (and are cheaper). Only for information, as I selected this flight right because it was short (and real).

Alternate airport is airport near destination but in distance, that alternate airport will not be in same area of bad weather (snow storm over destination for example). This airport must be able to receive our aircraft. You can plan more alternate airports and you can use departure airport as one of alternate airports. Of course you must have on board fuel to reach most distant alternate.

Alternate airport will be Katowice, route will be EPKK BALOS MYSKO EPKT, 43 nm.

FUEL

How many fuel we need for our trip? We must have enough fuel to reach our destination, to have fuel if we need fly to another airport (because landing in destination will be impossible), and we must have some fuel as required reserve if something will going wrong.

Why do not have full tanks? For two reasons. Firstly, because we are limited with maximum takeoff weight and most aircrafts cannot fly with full payload and full fuel. Secondly, every needless pound of fuel has effect to our efficiency and cost of flight.

Taxi fuel:	500 lbs	/departure 250 lbs, destination 250 lbs, taxi+APU/
Trip climb:	840 lbs	/ 7 minutes with 120 ppm (used 2500 fpm)/
Trip cruise:	1485 lbs	/ 135nm a 300kts = 27 minutes * 55 ppm (FL180) /
Trip descend:	210 lbs	/ 7 minutes with 30 ppm (used 2500 fpm)/
Trip fuel (sum):	2380 lbs	/departure to destination /
Contingency fuel:	119 lbs	/min 5% trip fuel – track reserve (wind, ATC requests) /
Alternate fuel (sum):	495 lbs	/43nm a 300kts = 9 minutes * 55 ppm/

Final reserve fuel: 1350 lbs /30 minutes in 1500ft a 45 ppm, required by authority/
Extra Commander: 0 lbs /optional fuel (snow over destination,...)/
Summary: 4844 lbs /max fuel 20580 lbs/

Probably more fuel than needed, but better more fuel than declare emergency.

In real world this is computed by special software and it is more difficult.

If aircraft is holding over destination and fuel level is close to Alternate+Final Reserve fuel then pilot must decide, if landing here is possible. For example, if in holding pattern are many aircrafts but all is going fine and weather is fine, then pilot will stay here and will consume ALTERNATE fuel. But if does exist any doubt, for example airport is closed because runway is covered by snow and snow is still falling down, then is needed immediately continue to alternate airport.

If aircraft is **close to** Final reserve fuel, then pilot will give information to ATC, „Minimum fuel“. This is not emergency, it only says that aircraft has limited fuel. ATC will have it in mind and optimize (or not) traffic as needed.

If aircraft is **consuming** Final reserve fuel, then pilot must immediately declare emergency with „Mayday, mayday, Emergency fuel“. ATC allows priority emergency landing. And when is aircraft safely down, all is very carefully investigated and result will have some consequences for pilots and airline.

PAYLOAD

Aircraft (LOT configuration) has 70 seats for passengers.

Standard passenger weight is 200 lbs - I have bigger „standard“ :)

Typically has passenger some carry-on baggage in cabin, weight about 20 lbs.

Suitcases are computed separately, we can assume that typical weight is 50 lbs.

So result for 55 passengers with 30 suitcases is:

55x passenger a 200 lbs + 55x carry-on baggage a 20 lbs + 30x suitcase a 50lbs

11000 + 1100 + 1500 (lbs)

13600 lbs

Now we must verify, that we do not have bigger weight than is allowed:

BOW: 44422 lbs (basic operating weight, empty aircraft with crew)

Fuel: 4844 lbs (max fuel 20580 lbs)

Payload: 13600 lbs (max payload 20000 lbs)

=====
Takeoff Weight: 62866 lbs (Maximal Takeoff Weight 82000 lbs)

In aircraft are the following doors (not openable in XPLANE model):

- passenger and crew forward door on right side
- passenger aft door on right side
- service forward door on left side
- two bottom baggage doors on left side

ADDONS

If you want you can download (free) Ground Services plugin here:

<http://forums.x-plane.org/index.php?app=downloads&showfile=14790>

It can do refuelling, GPU, stairs and pushback.

You need to install Python, PythonInterface and OpenSceneryX too.

Note: this addon is not needed to use aircraft. But if you have installed it, you can follow „**GS**:“ in this tutorial for better visual effect.

MISSION



Check, that you have unset „Start each flight with engines running“, we need cold and dark aircraft.

Load aircraft ERJ 170 on EPWA Warsaw airport.

Change to parking/stand 10.

Change livery to LOT.

Set payload to 13600 lbs (13590 lbs) /Aircraft, Weight and Fuel, payload weight/

Set fuel on 4844 lbs (4930 lbs) /Aircraft, Weight and Fuel, Fuel total/

Set local time to 15:00 (departure time is 15:15, so we will have 15 minutes to prepare aircraft).

GS: Request stairs

POWER UP



At night use night vision goggles [SHIFT+N] to see in cockpit.

Set first battery BAT1 to ON and second battery BAT2 to AUTO.
Batteries are NiCd type and have voltage 24V and capacity 27Ah.

If Ground Power Unit (GPU) is available (always in XPL):

GS: GPU

Click GPU button, aircraft will use external power, on button will be AVAIL IN USE.

GPU must be used:

- if does exist airport limitation of using APU
- if battery voltage is below 22.5V
- if battery temperature is below -20C.

In real aircraft, if (correct) GPU is connected to aircraft, then AVAIL is displayed. In SSG model this is simplified and AVAIL is using with IN USE together.

Turn on all electrical fuel pumps (2xAC and 1xDC).

If GPU is not available (small airports):

hold for 2s APU selector in START position to start APU. You can monitor starting on EICAS.

EXTERNAL INSPECTION



Use circle view [SHIFT+4] and rotate around aircraft.

You can switch to FreeCamera [C] if you want to see more details (use arrow to move).

BEFORE START

Note time and fuel (4930 lbs).

On ELECTRICAL PANEL set both IDGs to AUTO position, set AC BUS TIE and DC BUS TIES selectors are in AUTO, set TRU1, TRU ESS and TRU2 all in AUTO.

Set NO SMOKING and FASTEN BELTS signs for passengers.
As far as I know all commercial flights in EU are completely „no smoking“.

Start APU if not started. We will need BLEED (compressed air) from APU to start engines.
When APU is started, it is creating 115V/400Hz power and bleed (compressed air). It can be used for engine starting and air condition.

On EICAS APU section monitor rotations (%) and ITT (C deg).
In ERJ-170 is used APU type Sunstrand APS 2300.

Turn off GPU and disconnect it, if was used.

GS: choosing GPU will send currently attached GPU back.

Note: you can ask, why to use GPU if immediately is started APU. In real world is time between POWERUP and BEFORE START longer, it is for example 20 minutes or more. Remember, that all must be checked and passengers and baggage must be loaded.

Turn on NAV lights. Turn on LOGO light at night time or in low visibility conditions.

On HYDRAULIC PANEL set all electrical hydraulic pump to ON. In real world pump is 3A pump off.

Set ICE PROTECTION mode to AUTO.

On AIR CONDITION/PRESSURIZATION panel set cockpit and cabin temperature as required.
Turn off XBLEED.

Set BARO to QNH on this airport. Use BaroPres at closes airport in WeatherMenu (or real ATIS).

Set cruise altitude ALT SEL to 18000. /More real is set initial altitude, not cruise level./

Set speed to 230 kts (in real world is recommended starts with 210 kts)

Set HDG to 290 degrees, takeoff runway heading.

Status ... **FPA**

Click FD to activate Flight Director.

Status ... AP **FPA** ALT

Set source to FMS.

Set both ignition switches to AUTO.

Verify that both throttle levers are in IDLE, use [F1] in needed to move.

Insert route into MCDU/FMC:

APT EPWA, NEXT, CLR

LATLON +51.388 +020.360, NEXT, CLR // EVINA

VOR JED, NEXT, CLR

FIX POBOK, NEXT, CLR // end of route

NDB KRW, NEXT, CLR // part of Standard Arrival, holding pattern entry

In real world are used Standard Departure (SID) and Standard Arrival (STAR).

Check fuel quantity.
(Something about 4900 lbs)

Set required performance in MCDU/FMC with THRUST SEL

ATTCS ON

TO-1

When hot weather, takeoff can be done with less of power. And less of power means higher life of engines (your company will be happy), low noise (airport will be happy) and low fuel consumption (your wallet will be happy if employed in some airlines). Required performance is computed by FADEC, using outside temperature. You can enforce this performance by setting in FMC. Be warned, when used inappropriate then will be required longer length of runway. So there some limitations does exist.

Thrust mode TO-1 is highest thrust, 13800 kN, use it on wet or short runways or in cold weather.

Thrust mode TO-2, 13000 kN

Thrust mode TO-3, 11700 kN, use it only on dry and long runways and in hot weather

If any doubt then use TO-1.

All TO-1, TO-2 and TO-3 are limited to five minutes.

status ... AP, **FPA**, ALT /ATTCS TO-1/

Set on MCDU/FMC in RADIO section transponder to SQUAWK code and transponder to STBY.

GS: remove stairs with calling „Request stairs“ again

PUSHBACK



Time is circa 15:15 (End of Block Time).

GS: Request Pushback, distance 80m, rotation 90 deg, NoseRight checked, REQUEST and close.
Wait for pushback vehicle.

Deactivate PARKING BRAKE, use [V].

ENGINE START

Activate PARKING BRAKE, use [V].

Turn on RED BEACON.

Note time and fuel (4895 lbs).

Hold START/STOP selector for 2 seconds (monitor N1) and release. Engine will be started, selector will return from START to RUN and guard will close.

Monitor engine parameters on EICAS. Normally is FADEC detecting failure and aborts start if needed, but there are some situations, when manual abort is required. For example, if no oil pressure and N2 is raising, if no ITT indication within 5s after fuel is applied on ground (30s in flight), if ITT is increasing over 815C (hotstart), if oil pressure stabilizes bellow limits, if no stable idle speed N1/N2, if starter malfunction.

TODO: check if is acceptable short time ITT over 815C. In model this is going over 1000C.

Repeat these steps for second engine.

AFTER START

Shutdown APU (move selector to OFF) if not needed.

Move FLAPS to takeoff position, use [2], and monitor on EICAS.

Check free moving of flight controls, use System/FltCtrls for it.

DEICING

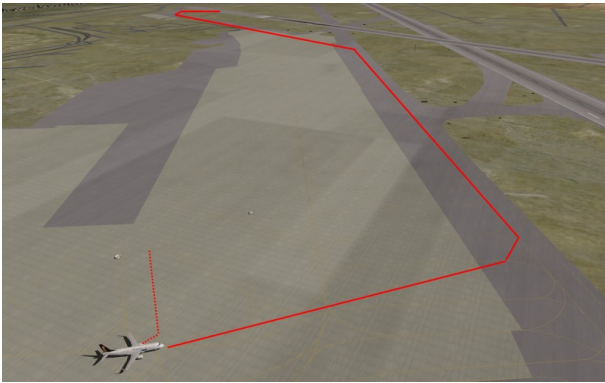
De-icing is performed if icing condition does exist. Special vehicle on de-icing stands is applying de-icing fluid on the aircraft.

Icing conditions exist when outside temperature (SAT on ground, TAT on flight) is below 10C and visible moisture is present (clouds or fog with low visibility, rain, snow).

There is time limit, how long applied fluid is working, so takeoff must be done in this interval.

In time of applying, BLEEDS must be OFF, STAB TRIM must be FULL NOSE DOWN, FLAPS must be UP, engines/APU can stay running.

TAXI



Note time and fuel (4830 lbs).

Turn on TAXI lights.

Rain: turn on windshield wipers.

Deactivate PARKING BRAKE, use [V].

Add throttle using [F1/F2], aircraft starts move.

Note: do not use joystick throttle. It works on NONE/MAX base.

Tip: you can use external view [SHIFT+4] and rotate with right button for back view for better orientation.

Normal taxi speed is 30 kts.

Stop at holding point of the runway.

BEFORE TAKEOFF



On runway holding point:

In MCDU/FMC in RADIO section set transponder to RATX mode.

Turn off TAXI lights.

Turn on LANDING and STROBE lights.

Do not use strobe lights if low visibility (rain, fog, heavy snow).

TAKEOFF (RUNWAY 29)



Line-up with center line of runway.

Note time and fuel (4600 lbs).

Check TAKEOFF CONFIGURATION:

- FLAPS in takeoff position (check EICAS)
- PARKING BRAKE off (check EICAS, check visually lever)
- PITCH TRIM in green (check EICAS, takeoff position)
- SPOILERS are not deployed (check EICAS, no SPDBRK, check lever)
- no error or warning indication on EICAS

In real aircraft this can be done by TAKEOFF CONFIG button.

click TOGA to turn on TOGA mode (in model is not on throttle levers but on TO CONFIG button).
status ... **HOLD**, AP, **TOGA**, ALT /ATTCS TO-1/

click AT to turn on autothrottle, aircraft will start rolling.
status ... **HOLD**, AP, **TOGA**, **SPDT**, **AT**, ALT /ATTCS TO-1/

Roll

Check and correct movement with center line of runway.

At Vr:

pull controls slightly back to rotate

click AP to activate autopilot (optimally by mapped button servos_toggle)

status ... **HOLD**, AP, **TOGA**, **SPDT**, **AT**, ALT /ATTCS TO-1/

TODO: is this needed in model? Probably true.

Move GEAR up with [G] (max 250 kts)

At 400ft above field elevation:

click HDG to ask autopilot to follow (runway) heading

status ... **HOLD**, AP, **HDG**, **TOGA**, **SPDT**, **AT**, ALT /ATTCS TO-1/

At 1000ft above field elevation:

click FLCH and set SPEED to requested speed (max 250kts before FL100).

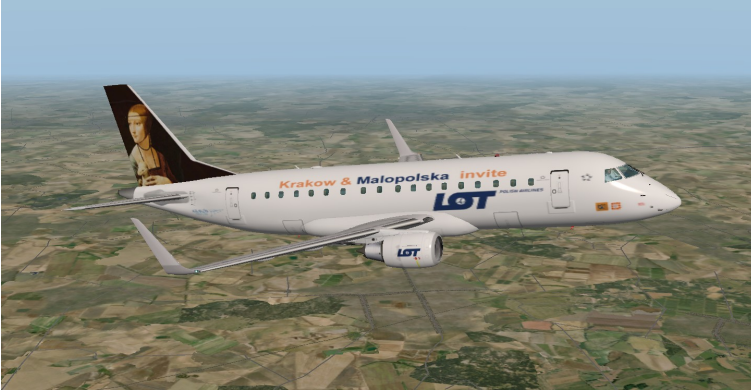
status ... **AP**, **HDG**, **FLCH**, **SPDE**, ALT /ATTCS CLB-1/

Move FLAPS up with [1] (max 230 kts).

click NAV to turn on lateral navigation, aircraft will use route from MCDU/FMS.

status ... **AP**, **RNAV**, **FLCH**, **SPDE**, ALT /ATTCS CLB-1/

CLIMB



Set speed to 250 kts if lower. /250 kts is limit to FL100/.

Check AIR CONDITION and PRESSURIZATION systems.
See CABIN DELTA PRESSURE, as aircraft climbs, it must raising.

If needed, you can use APU.

Rain: turn off windshield wipers, they are limited to 250 kts.

At TRANSITION ALTITUDE (for EPWA 2000m/6500ft):
Click BARO knob to set altimeter to STANDARD.

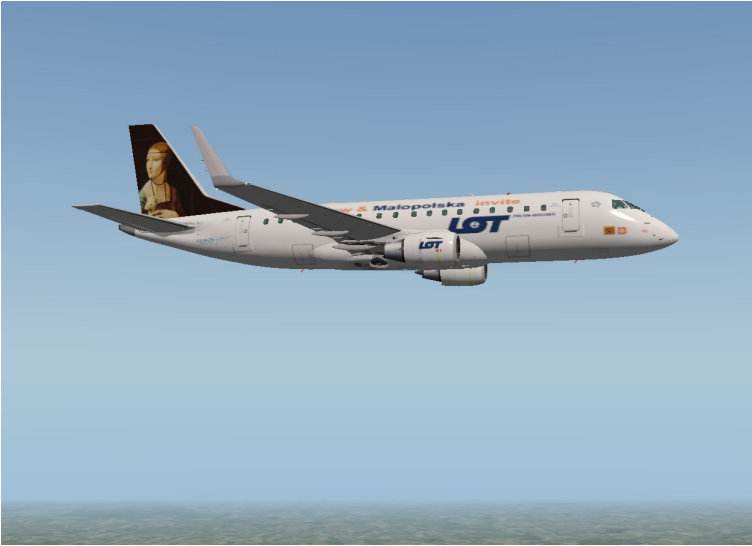
At FL100:

Turn off LANDING LIGHTS.

Turn off FASTEN BELTS (if no turbulence), passengers can freely walk within cabin.

Set SPEED to 300 or as required /after FL100 is no 250kt limit/.

CRUISE



When aircraft is flying in cruise level:

status... **AP**, **LNAV**, **ALT**, **SPDT**, **AT** /ATTCS CRZ/

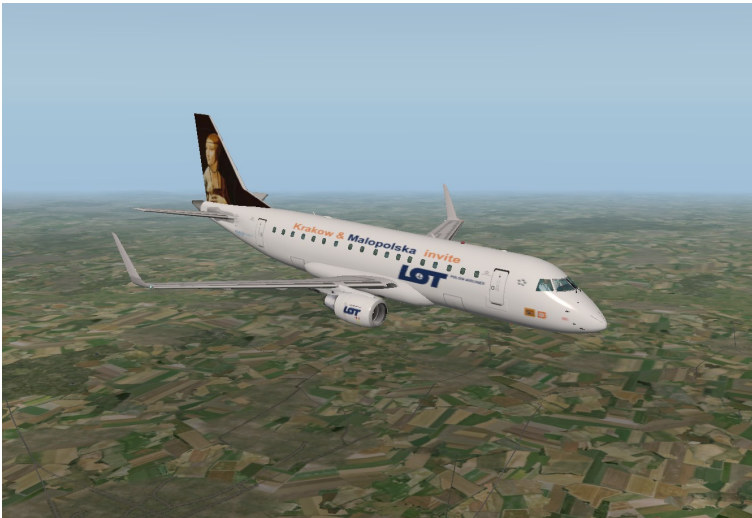
It means: aircraft is controlled by autopilot, using lateral navigation, in current altitude, with preset speed and autothrottle. For now is used performance mode CRZ.

Note time and fuel (3800 lbs).

Periodically check:

- that on EICAS are no errors and warnings
- pressurization is working (CABIN ALT, DELTA P)
- fuel level
- parameters of engines

DESCEND



*When to descend? Use 1:3 rule. For 10 flight levels use 3 nm. If you plan descending from cruise level FL180 to FL030 use $(18-3)*3 = 15*3 = 45\text{nm}$ before point where you want be at FL030 (KRW). In real world this is computed by MCDU/FMC and displayed as TOD (Top of descend) on map too. I am adding some reserve for FLCH.*

Note time and fuel (3350 lbs).

Start descend 15nm before JED.

Theory: there are two possibilities (excl. VNAV) how to descend with AUTOTHROTTLE.

- holding vertical speed (fpm) by thrust, indicated as SPDT (SPEED BY THROTTLE). To activate set target altitude 3000 ft with ALT SELECTION, click VS and choose VERTICAL SPEED with knob (here 2500 fpm, blue arrow down). Aircraft will start descend and hold vertical speed at preset value. Throttles are used automatically as needed. status... **AP**, **LNAV**, **VS**, **SPDT**, **AT**, ALT /GA/

OR

- holding speed (kts) by elevator, indicated as SPDE (SPEED BY ELEVATOR) To activate set target altitude 3000 ft with ALT SELECTION, set desired SPEED (300) and click FLCH. Aircraft will start descend and hold airspeed at preset value. Throttles are set to IDLE as needed (when is used FLCH to descend, you can use it for climb too). status... **AP**, **LNAV**, **FLCH**, **SPDE**, ALT /GA/ This mode is more comfortable for passengers, and has low fuel consumption. Because it protects airspeed and altitude, is this mode preferred for rapid/emergency descend.

Note: target altitude is set to 3000 ft because this is altitude of holding pattern over KRW.

Before FL100:

Set airspeed SPEED to required value, remember: only 250kts is allowed below FL100.

Use speedbrakes with [4] if needed.

At FL100:

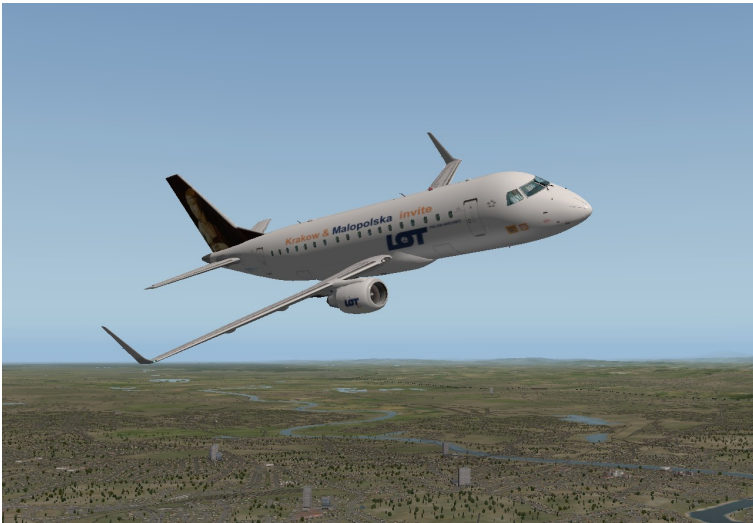
Turn on LANDING LIGHTS.

Turn on FASTEN BELTS.

At TRANSITION LEVEL (in real world it is published in ATIS):

Set BARO to QNH of destination airport.

BEFORE APPROACH



About 10nm to KRW:

We plan land on runway 25 of EPKK.

For this runway is available ILS approach, frequency is 110.3 MHz, course 254 degrees.

Certification is CAT-I and OCH/DH 63m/210ft (ERJ 170 is Approach Category C).

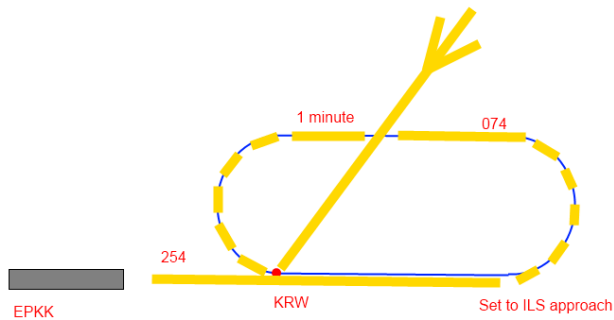
Entry altitude for ILS is 850m (2800ft) AMSL.

Click RADIO button on MCDU/FMS and set into NAV1 frequency for ILS beacon of target runway and set OBS by CRS of this ILS too. Set DH by MINIMUMS knob to 210 (see PFD).

NAV1 110.30 MHz /EPKK ILS25/, CRS/OBS 254 degrees.

Set speed to 230 kts.

HOLDING PATTERN OVER KRW



Close to KRW (5nm):

Set HDG to current track (click HDG knob) and then click HDG button to activate HDG mode.

Current mode LNAV will change to HDG.

status... **AP, HDG, ALT, SPDE** /ATTCS GA/ či **AP, HDG, ALT, SPDT, AT** /ATTCS GA/

When aircraft is passing KRW:

Set HDG to 344 degrees. Aircraft start turn to right, but before aircraft finishes this turn set HDG to 74 degrees. Aircraft will fly „back“, see map.

When aircraft enters track 074:

On watches firstly click SET knob to change mode to 0:00:00.0, then RESET (left,top) and then right bottom button to start watches. We will fly right one minute.

In the meantime:

Set ALT SEL to 2800.

Set VS button to activate VS mode and set vertical speed to -1000. Or use FLCH.

After one minute:

Set HDG to 164 degrees. Aircraft start turn to right, but before aircraft finishes this turn set HDG to 254 degrees. If all is correctly and is good visibility, runway 25 is circa 9nm before aircraft.

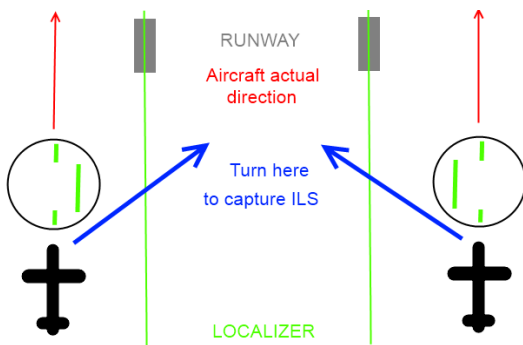
APPROACH



Click SRC VL, choose VOR1, click APP for approach mode:
status... APPR1, **AP, HDG, ALT, SPD, AT**, LNAV, GS /GA/

It means: aircraft is flying in current altitude and heading and is waiting for ILS signal.

Note: aircraft MUST intercept localizer to capture it, so change heading (HDG) if needed. If middle boom (in bottom part of PFD) is on right from runway direction then turn to right (see picture).



When localizer and glideslope is captured (is green):

status... **APPRI, AP, LOC, GS** /GA/

It means: HDG and ALT is off and altitude and heading is now controlled by ILS LOC and GS.

Set speed to 150 kts (Vref+20) and apply FLAPS as needed (see below)

Tip: if aircraft is too fast use speedbrakes [4]. It is not too comfortable for passengers but effective.

Use [G] to move GEAR down, be sure that your speed is lower than 250 KIAS.

Move down FLAPS:

Pos 1 / 230 KIAS, 2 / 215 KIAS, 3 / 200 KIAS, 4 and 5 / 180 KIAS, FULL / 165 KIAS

AutoBrake LO , check indication on EICAS.

Use mode MED if runway is short/wet and HI in emergency.

Rain: turn on windshield wipers, they are limited to 250 kts.

At decision height DH (200ft above ground):

click AT off to turn off autothrottle and move throttles to IDLE mode [F1].

click AP off (optimally with mapped button `servos_toggle`)

Note: real aircraft can be certified for autoland (CAT-III). Of course, EPKK has only CAT-I.

LANDING



Flare at 20ft above runway with pitch 1-2 degrees nose up.

Touchdown to main gear first, use aft control pressure to fly nose wheel above runway and soft landing.

Activate reverse thrust (optimally by mapped button `thrust_reverse_toggle`).

Use it only when speed is greater then 30 kts (otherwise you risc that engines suck something from runway).

Using of REVERSE on some airports limited or not allowed (excl emergency). Reason of this limitation is noise, for example, in EPWA is by AIP reccommended do not use REV at night:

Except in emergency situations, ACFT are recommended to reduce the application of reverse thrust between 2200-0600LT.

In real world is automatically raised SPEEDBRAKES. We need raise them manually with [4].

Use brakes as required to slow aircraft.

AFTER LANDING

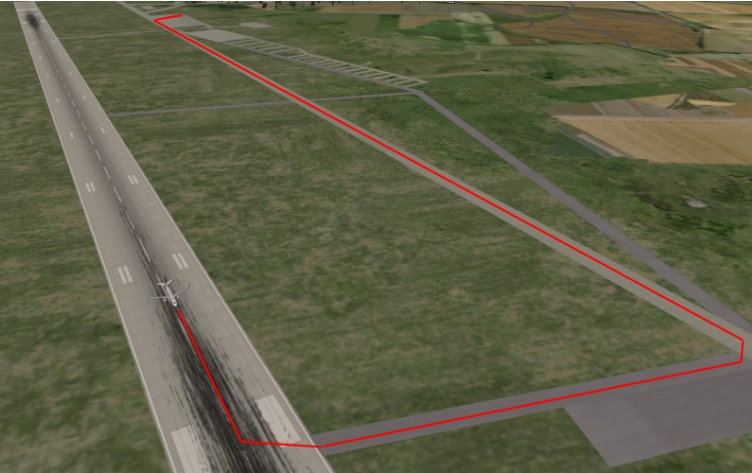


Move FLAPS up, check position on EICAS.

Turn off LANDING and STROBE lights.

Turn off transponder. On some very big airports is required to have active transponder to final stand.

TAXI TO STAND



Status: AP, **FPA**, ALT

Turn on TAXI lights.

Use taxi speed as required, normal speed is 30 kts on taxiways.

Use APU if required for heating/cooling.

SHUTDOWN



On stand use PARKING BRAKE to secure aircraft.

If on your clock is 16:10, you are Number ONE :)

Turn off TAXI lights.

Rain: turn off windshield wipers.

Turn off HYD ELEC PUMP. In real world only one of pumps (3A) is turned off.

GS: Request GPU.

If available, use external power GPU. **But there is bug in model, because GPU cannot be connected when engines are running.**

If no GPU available hold for 2 seconds APU selector in START position to start APU, check EICAS to know, when APU will be ready.

Check and move if needed both throttle levers into IDLE position.

Click START/STOP selectors and wait while engines not stopped.

Turn off RED BEACON light. Aircraft is now safe – stopped with no engines running.

GS: Request stairs.

Turn off indication FASTEN BELTS, so passengers can leave our aircraft.

Check remaining fuel.

If fuel level is low than FINAL RESERVE+ALTERNATE then you have problem and you will be investigated, because safety of your flight was lower than was acceptable :)

Shutdown APU by moving its selector to position OFF and wait while it will be stopped.

Or disconnect external power GPU if was used.

GS: Request GPU to remove it.

Turn off NAV lights.

Now we switch off both batteries BAT2 and BAT1 and can leave aircraft.

RELEASE INFORMATIONS

2012-10-09

Described fuel emergency

Added alternate airport

Added Level Change climb

Added variants VS/FLCH to descend, including descriptions

Described payload

Described fuel planning

Added check for fuel after flight

2012-10-07

Added GroundService support.

Added icing definition.

Added operations in rain

Described TO thrust modes

Document structured to parts (page breaks).

2012-10-05

First version

Konec