

FUEL PLANNING GUIDE

First Edition

Edited by:

Approved by:

Wilhelm Andrei Bubeneck Division Training Coordinator Lucian Cristea Division Director

IVAO ROMANIA TRAINING DEPARTMENT									
P.001.FPG	Version 1.0	September 15, 2014	Page 2						

1. Introduction

1.1. Purpose

The purpose of this document is:

a) to familiarize pilots with the more advanced calculations done in the fuel planning of an aircraft;

b) to avoid insufficient or excessive fuel as a result of inadequate of incomplete fuel planning.

1.2. Audience

This document is aimed especially at the pilots who wish to prepare themselves for the IVAO CP and ATP exams. Nonetheless it should also be accessible to pilots holding lower ratings or anyone interested in the matter presented.

1.3. Where to find this document

This document is published solely on the official website of the RO Division (i.e. ro.ivao.aero).

1.4. Abbreviations

MAP - Missed Approach Point

APU – Auxiliary Power Unit

- PMDG "Precision Manuals Development Group" ™
- FCOM Flight Crew Operations Manual
- OEM Operating Empty Mass
- ZFM Zero Fuel Mass
- PAX Passengers
- NM Nautical Miles
- NAM Nautical Air Miles
- ALTN Alternate
- SID/STAR Standard Instrument Departure / Standard Terminal Arrival Route
- KG/KGS Kilogram/Kilograms

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 3					

2. Theoretical aspects

2.1. IVAO-specific considerations

To simplify the matter, it is considered that an alternate aerodrome is always to be filed and that the diversion to said alternate aerodrome occurs at the MAP.

This document covers only ICAO fuel regulations.

2.2. Common requirements for all aeroplanes

A flight shall not be commenced unless, taking into account both the meteorological conditions and any delays that are expected in flight, the aeroplane carries sufficient fuel to ensure that it can safely complete the flight. In addition, a reserve shall be carried to provide for contingencies.

2.3. Piston-engined aeroplanes

The fuel carried in order to comply with 2.1. shall, in the case of piston-engined aeroplanes, be at least the amount sufficient to allow the aeroplane to fly to the aerodrome to which the flight is planned (**TRIP FUEL+TAXI FUEL**) then to the farthest alternate aerodrome specified in the flight plan (**ALTERNATE FUEL**) and thereafter for a period of 45 minutes. (**RESERVE FUEL**)

2.4. Turbine-engined aeroplanes (Turboprops and Jets)

The fuel carried in order to comply with 2.1. shall, in the case of turbine-engined aeroplanes, be at least the amount sufficient to allow the aeroplane to fly to and execute an approach (**TRIP FUEL+TAXI FUEL**), and a missed approach (covered by **ALTERNATE FUEL**), at the aerodrome to which the flight is planned, and thereafter:

1) to fly to the farthest alternate aerodrome specified in the operational and ATS flight plans; (**ALTERNATE FUEL**)

2) to fly for 30 minutes at holding speed at 450 m (1 500 ft) above the alternate aerodrome under standard temperature conditions, and approach and land; (**FINAL RESERVE FUEL or HOLDING FUEL**)

3) to have an additional amount of fuel sufficient to provide for the increased consumption on the occurrence of any of the potential contingencies specified by the operator to the satisfaction of the State of the Operator. (**ROUTE RESERVE FUEL or CONTINGENCY FUEL**)

2.5. Other important considerations

In computing the fuel and oil required in 2.1. at least the following shall be considered:

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 4					

a) meteorological conditions forecast; (part of **ROUTE RESERVE FUEL** and/or **EXTRA FUEL**)

b) expected air traffic control routings and traffic delays; (part of ROUTE RESERVE FUEL)

c) for IFR flight, one instrument approach at the destination aerodrome (part of **TRIP FUEL**), including a missed approach (part of **FINAL RESERVE FUEL**);

d) any other conditions that may delay the landing of the aeroplane or increase fuel consumption. (part of **EXTRA FUEL**)

2.6. Summary

2.6.1. Piston-engined aeroplanes

a) Trip Fuel (takeoff to landing);

b) Taxi Fuel (taxi [and APU - if available]);

c) Alternate Fuel;

d) Reserve Fuel;

2.6.2. Turbine-engined aeroplanes

a) Trip Fuel;

b) Taxi Fuel;

c) Alternate Fuel;

d) Final Reserve Fuel *or* Holding Fuel;

e) Route Reserve Fuel or Contingency Fuel;

f) Extra Fuel

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 5					

3. Practical aspects

3.1. Important considerations

3.1.1. General

The following represents a practical example of fuel planning applied on a *Boeing 737-800* aircraft according to the PMDG 737NGX FCOM. You also need to take into account that the method presented in this document is specially designed for step-by-step manual calculations in order for you to understand the specific fuel requirements and may not be the fastest or easiest available. It also does *not* cover weight and balance. This will be discussed in another document. For this entire guide it is recommended to keep the PMDG 737NGX FCOM, volume 1 PDF file handy. You can find it like this:

→ Go to Start → All Programs → PMDG Simulations → PMDG 737NGX → Operating Manual Vol.1



3.1.2. Units of measure

Throughout this guide the following convention is used:

Masses are expressed as thousands of kilograms (metric tonnes), omitting the units.

The decimal separator is always a period ("point").

45600 kg = 45.600 tonnes = 45.6 (tonnes) NOT FOR REAL WORLD FLIGHT PLANNING

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 6					

3.1.3. Making interpolations

Throughout this guide you will need to work with tables that contain just some "round" values for the sake of simplicity. If you find yourself in the situation of not having a column or a row with the exact value needed, you will need to make so-called *interpolations* between adjacent columns and/or rows. Assume the growth is always linear between two adjacent cells.

Example:

Assume you have the following table, in which you input a variable "x" in order to extract a function of "x", namely f(x).

X	f(x)
300	1000
400	1500

Everything is perfect if x is 300 or 400, but what happens if x is *in-between* those values. We say $300 = x_{low}$, $400 = x_{high}$, $1000 = f(x)_{low}$ and $1500 = f(x)_{high}$ and calculate f(x) with the help of the formula:

$$f(x) = (x - x_{low}) * (f(x)_{high} - f(x)_{low}) / (x_{high} - x_{low}) + f(x)_{low}$$

If x = 330, then f(x) = (330 - 300) * (1500 - 1000) / (400 - 300) + 1000 = 30 * 500 / 100 = 1150

3.2. Step-by-step guide

A. Find the necessary loading data for the flight you will perform:

You will need:

- ✓ Number of passengers onboard (you can make this up as long as it is within aircraft limits)
- ✓ OEM (DOM) of the aircraft (in the case of the 737-800, a good value is 41.4)
- ✓ The average mass of a passenger (a good value is **0.085**)
- ✓ The average mass of a baggage (a good value is **0.01**)

B. Now calculate the ZFM using the following formulae – assume each passenger carries one bag:

PAX * (0.085 + 0.01) = PAYLOAD PAYLOAD + OEM = ZFM

C. Extract the required holding fuel from the FCOM:

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 7					

 ✓ Go to FCOM v1 → Chapter PD (Performance Dispatch) → Section 31 (Enroute) → 31.5 – Holding Planning Flaps Up

	DG-NGX-FCOMv1.	pdf - Adobe Read	er				_	-				
File I	Edit View Wind	low Help										×
J	🔁 🖻 🗎	$\ominus \square ($	373 / 10	35	155%	-	9	> 🦻	12 A	Tools	Sign	Comment
			ALI (FI)	40000	37000	36000	35000	34000	31000	30000		_ ^
		300	UEL (1000 KG)	1.7	1.8	1.9	2.1	2.2	2.3	2.4	0:50	
			ALT (FT)	41000	40000	39000	37000	35000	34000	32000		- II
		350	UEL (1000 KG)	1.9	2.0	2.2	2.3	2.4	2.0	2.7	0:56	
n.			ALI (FI)	41000	40000	40000	38000	36000	35000	33000		- II
w.		400 ^r	ALT (TOU KG)	2.1	40000	2.4	2.3	2.7	2.9	3.0	1:03	
			ALI (FI)	41000	40000	40000	38000	30000	33000	33000		- II
		450	ATT (ET)	41000	41000	40000	2.0	36000	35000	3.5	1:10	
		F	TUEL (1000 KG)	2.5	2.7	2.8	3.0	3.2	3.4	3.6		- II
		500	ALT (FT)	41000	41000	40000	38000	36000	35000	34000	1:17	
		Based on 2	280/.78 climb. Lo	ng Range	Cruise an	d .78/280/2	50 descen	t.	55000	51000		
		TT 1.1	DI .									
		Holdin	g Planning									
		Flaps U	р									
						TOTAL FU	JEL FLOV	V (KG/HR)			E.
		WEIGH (1000 K	IT G)			TOTAL FU PRESSUI	JEL FLOV RE ALTIT	V (KG/HR UDE (FT))			
		WEIGH (1000 K	IT G) 1500	5000	10000	TOTAL FU PRESSUI 15000	JEL FLOV RE ALTIT 20000	V (KG/HR UDE (FT) 25000) 30000	35000	41000	
		WEIGH (1000 K	IT G) 1500 3080	5000 3030	10000 3020	TOTAL FU PRESSUI 15000 2990	JEL FLOV RE ALTIT 20000 2970	V (KG/HR UDE (FT) 25000 2980) 30000 3080	35000	41000	
		WEIGH (1000 K 85 80	IT G) 1500 3080 2910	5000 3030 2870	10000 3020 2840	TOTAL FU PRESSUI 15000 2990 2830	JEL FLOV RE ALTIT 20000 2970 2780	V (KG/HR UDE (FT) 25000 2980 2790) 30000 3080 2860	35000 3130	41000	
		WEIGH (1000 K 85 80 75	IT G) 1500 3080 2910 2750	5000 3030 2870 2700	10000 3020 2840 2670	TOTAL FU PRESSUI 15000 2990 2830 2650	JEL FLOV RE ALTIT 20000 2970 2780 2600	V (KG/HR UDE (FT) 25000 2980 2790 2600) 30000 3080 2860 2660	35000 3130 2800	41000	
		WEIGH (1000 K 85 80 75 70	IT G) 1500 3080 2910 2750 2590	5000 3030 2870 2700 2540	10000 3020 2840 2670 2500	TOTAL FU PRESSUJ 15000 2990 2830 2650 2480	JEL FLOV RE ALTIT 20000 2970 2780 2600 2430	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420) 30000 3080 2860 2660 2470	35000 3130 2800 2550	41000	
		WEIGH (1000 K 85 80 75 70 65	IT G) 1500 3080 2910 2750 2590 2420	5000 3030 2870 2700 2540 2370	10000 3020 2840 2670 2500 2340	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310	JEL FLOW RE ALTIT 20000 2970 2780 2600 2430 2270	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230) 30000 3080 2860 2660 2470 2280	35000 3130 2800 2550 2330	41000	
		WEIGH (1000 K 85 80 75 70 65 60	IT G) 1500 2910 2750 2590 2420 2260	5000 3030 2870 2700 2540 2370 2210	10000 3020 2840 2670 2500 2340 2180	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310 2140	JEL FLOW RE ALTIT 20000 2970 2780 2600 2430 2270 2110	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230 2050) 30000 3080 2860 2660 2470 2280 2090	35000 3130 2800 2550 2330 2130	41000	
		WEIGH (1000 K 85 80 75 70 65 60 55	IT G) 1500 2910 2750 2590 2420 2260 2100	5000 3030 2870 2700 2540 2370 2210 2050	10000 3020 2840 2670 2500 2340 2180 2010	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980	JEL FLOW RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2420 2230 2050 1890) 30000 3080 2860 2660 2470 2280 2090 1910	35000 3130 2800 2550 2330 2130 1940	41000 2110	
		WEIGH (1000 K 85 80 75 70 65 60 55 50	IT G) 1500 2910 2750 2590 2420 2260 2100 1950	5000 3030 2870 2700 2540 2370 2210 2050 1890	10000 3020 2840 2670 2500 2340 2180 2010 1850	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810	JEL FLOW RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940 1780	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2420 2230 2050 1890 1730) 30000 3080 2860 2660 2470 2280 2090 1910 1750	35000 3130 2800 2550 2330 2130 1940 1770	41000 2110 1890	
		WEIGH (1000 K 85 80 75 70 65 60 55 50 45	IT G) 1500 2910 2750 2590 2420 2260 2100 1950 1790	5000 3030 2870 2700 2540 2370 2210 2050 1890 1730	10000 3020 2840 2670 2500 2340 2180 2010 1850 1690	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810 1680 1620	JEL FLOW RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940 1780 1640	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230 2050 1890 1730 1610	30000 3080 2860 2660 2470 2280 2090 1910 1750 1590	35000 3130 2800 2550 2330 2130 1940 1770 1590	41000 2110 1890 1670	
		WEIGH (1000 K 85 80 75 70 65 60 55 50 45 40	IT G) 1500 2910 2750 2590 2420 2260 2100 1950 1790 1670	5000 3030 2870 2700 2540 2370 2210 2050 1890 1730 1620	10000 3020 2840 2670 2500 2340 2180 2010 1850 1690 1560	TOTAL FU PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810 1680 1520	JEL FLOV RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940 1780 1640 1480	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230 2050 1890 1730 1610 1450) 30000 2860 2660 2470 2280 2090 1910 1750 1590 1440	35000 3130 2800 2550 2330 2130 1940 1770 1590 1420	41000 2110 1890 1670 1480	
		WEIGH (1000 K 85 80 75 70 65 60 55 50 45 40 This table	IT G) 1500 2910 2750 2590 2420 2260 2100 1950 1790 1670 includes 5% add	5000 3030 2870 2700 2540 2370 2210 2050 1890 1730 1620 litional fu	10000 3020 2840 2670 2500 2340 2180 2010 1850 1690 1560 el for hold	TOTAL FC PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810 1680 1520 ing in a ra	JEL FLOV RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940 1780 1640 1480 cetrack pc	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230 2050 1890 1730 1610 1450) 30000 3080 2860 2470 2280 2090 1910 1750 1590 1440	35000 3130 2800 2550 2330 2130 1940 1770 1590 1420	41000 2110 1890 1670 1480	
		WEIGH (1000 K 85 80 75 70 65 60 55 50 45 40 This table	IT G) 1500 2910 2750 2590 2420 2260 2100 1950 1790 1670 includes 5% add	5000 3030 2870 2700 2540 2210 2050 1890 1730 1620 litional fu	10000 3020 2840 2670 2500 2340 2180 2010 1850 1690 1560 el for hold th © The Boo	TOTAL FC PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810 1680 1520 ing in a ra	JEL FLOV RE ALTIT 20000 2970 2780 2600 2430 2270 2110 1940 1780 1640 1480 cetrack p: y. See title p	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2230 2050 1890 1730 1610 1450 attern.) 30000 3080 2860 2660 2470 2280 2090 1910 1750 1590 1440 its.	35000 3130 2800 2550 2330 2130 1940 1770 1590 1420	41000 2110 1890 1670 1480	
		WEIGH (1000 K 85 80 75 70 65 60 55 50 45 40 This table	IT G) 1500 2910 2750 2590 2420 2260 2100 1950 1790 1670 includes 5% add	5000 3030 2870 2700 2540 2370 2210 2050 1890 1730 1620 litional fu	10000 3020 2840 2670 2340 2180 2010 1850 1690 1560 el for hold tht © The Boo	TOTAL FT PRESSUI 15000 2990 2830 2650 2480 2310 2140 1980 1810 1680 1520 ing in a ra ing Compan 5-27370	JEL FLOV RE ALTIT 20000 2970 2780 2600 2430 2430 2270 2430 2430 2270 2430 24500 2450 2450 2450 2450 2450 2450 24	V (KG/HR UDE (FT) 25000 2980 2790 2600 2420 2420 2230 2050 1890 1730 1610 1450 xttern.) 30000 3080 2860 2660 2470 2280 2090 1910 1750 1590 1440 ils.	35000 3130 2800 2550 2330 2130 1940 1770 1590 1420	2110 22110 1890 1670 1480	

✓ The "weight" is your ZFM. Write down the corresponding fuel flow at 1500 ft.

Fuel flow per hour at 1500 ft / 2 / 1000 = HOLDING FUEL (tonnes)

- ✓ The holding fuel time is 30 minutes.
- D. Calculate the required alternate fuel:
 - ✓ Find a suitable alternate aerodrome for the intended flight
 - ✓ Find a suitable route from the MAP to the alternate aerodrome (in case you are unable to do so, assume a direct route)
 - ✓ Write down the distance of that route in NM
 - ✓ Check the average wind aloft on that route: What is the average head- or tailwind component? (See P.002.WCG for details on how to do this)

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 8					

✓ Go to FCOM v1 → Chapter PD → Section 31 → 31.5 – Short Trip Fuel and Time – Ground to Air Miles Conversion

PMDG	-NGX-FC	OMv1.pdf	- Adobe Rea	der							and the second			
ile Edi	t View	Window	Help											×
a	3 📝				373 / 103	5 🗩 (155%	- 🗄 🚇	🦻 📮	2	1	Fools	Sign (Comment
														^
			737-800/ FAA	/CFM56	-7B26	DC) NOT	USE FOR	FLIG	IT	Perfor	mance l	Dispatch Enroute	
0			Categor	y C Bra	kes	737 1	Flight C	rew Operati	ions Ma	nual				- 11
			Short '	Trip F	uel and	l Time								· II
			Ground	l to Air	Miles (Convers	sion							
				AIR D	ISTANCE	(NM)		GROUND		AIR D	ISTANCE	(NM)		1
			HE.	ADWIND	COMPO	NENT (K	TS)	DISTANCE	TA	ILWIND	COMPON	NENT (K	ΓS)	1
			100	80	60	40	20	(NM)	20	40	60	80	100	
			93	80	69	61	55	50	46	42	39	36	34	
			160	143	129	118	108	100	93	87	82	77	73	
			225	205	188	173	161	150	141	132	125	118	112	
			290	266	246	228	213	200	188	178	169	160	153	
			353	326	303	283	265	250	236	224	213	203	194	
			416	386	360	338	318	300	284	270	257	245	235	
			478	446	417	392	370	350	332	316	301	288	276	
			542	506	474	447	422	400	380	362	346	331	317	
			606	567	532	502	474	450	428	408	390	373	358	
			672	629	591	557	527	500	476	454	434	415	398	

- ✓ According to the table above, convert you Ground Distance (NM) in Air Distance (NAM) (Only if average head- or tailwind is more than or equal to 20 knots)
- ✓ Right below it, is another table called "Trip Fuel and Time Required". Use it to extract the alternate fuel and the optimum altitude for diversion, as well as the alternate trip time. The landing weight at the alternate will be ZFM + н

HOLDING FUEL = LANDING WE	EIGHT AT ALTN
---------------------------	---------------

🔁 PM	PMDG-NGX-FCOMv1.pdf - Adobe Reader											
File	e Edit View Window Help 🛛 🗙											
J	🥥 🔁 🗃 🖨 🖂 💿 373 / 1035 🗨 🕂 155% 🗸 🔚 🔛 🔗 🐶 📝 Tools Sign Comment											
	Trip Fuel and Time Required											
	LANDING WEIGHT (1000 KG) TIME										1	
		All		40	45	50	55	60	65	70	(HRS:MIN)
		50	FUEL (1000 KG)	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.14	1
Ø		50	ALT (FT)	12000	12000	11000	11000	9000	9000	8000	0.11	
		100	FUEL (1000 KG) ALT (FT)	0.8 19000	0.9	0.9	1.0 18000	1.0 17000	1.1 17000	1.1 17000	0:22	
		150	FUEL (1000 KG) ALT (FT)	1.1 26000	1.1 25000	1.2 25000	1.3 24000	1.3 23000	1.4 22000	1.5	0:30	
		200	FUEL (1000 KG) ALT (FT)	1.3 35000	1.4 30000	1.5 28000	1.6 27000	1.6 26000	1.7 26000	1.8 26000	0:37	
		250	FUEL (1000 KG) ALT (FT)	1.5 40000	1.6 37000	1.7 36000	1.8 35000	1.9 34000	2.0 31000	2.1 30000	0:44	1
		300	FUEL (1000 KG) ALT (FT)	1.7 41000	1.8 40000	1.9 39000	2.1 37000	2.2 35000	2.3 34000	2.4 32000	0:50	
		350	FUEL (1000 KG) ALT (FT)	1.9 41000	2.0 40000	2.2 40000	2.3 38000	2.4 36000	2.6 35000	2.7 33000	0:56	
		400	FUEL (1000 KG) ALT (FT)	2.1 41000	2.2 40000	2.4 40000	2.5 38000	2.7 36000	2.9 35000	3.0 33000	1:03	1
		450	FUEL (1000 KG) ALT (FT)	2.3 41000	2.5 41000	2.6 40000	2.8 38000	3.0 36000	3.1 35000	3.3 34000	1:10	1
		500	FUEL (1000 KG) ALT (FT)	2.5 41000	2.7 41000	2.8 40000	3.0 38000	3.2 36000	3.4 35000	3.6 34000	1:17	
		Based on	280/.78 climb, Lo	ng Range	Cruise an	d .78/280/2	50 descen	ıt.				-

E. Calculate the required trip fuel for the main route:

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 9					

- Find a suitable route from the departure aerodrome to the destination aerodrome – including SID and STAR (in case you are unable to find a SID and/or STAR, assume direct route from first/last waypoint to departure/destination aerodrome)
- ✓ Write down the distance of that route in NM
- ✓ Check the average wind aloft on that route: What is the average head- or tailwind component? (See P.002.WCG for details on how to do this)
- ✓ Go to FCOM v1 → Chapter PD → Section 31 → 31.5 Short Trip Fuel and Time – Ground to Air Miles Conversion

DMDG-NGX-FCOM	lv1.pdf - Adobe Read	der			-		_	_	A THE			
File Edit View W	'indow Help											×
🧔 🖏 🖻 E	B 🖨 🖂 🤆		373 / 103	5 🗩 (155%	- 🗄 🛱	9 📮	2	1	Fools	Sign	Comment
												*
	737-800/ FAA	CFM56	-7 B 26	DC) NOT	USE FOR	FLIG	HT	Perfor	mance	Dispatel Enrout	n e
0	Categor	y C Bra	kes	737 1	Flight C	rew Operati	ions Ma	nual				
	Short 7	Trip F	uel ano	l Time								· II
	Ground	l to Air	Miles	Conver	sion							_
		AIR D	ISTANCE	E (NM)		GROUND		AIR D	ISTANCE	E (NM)		
	HE.	ADWINE	COMPO	NENT (K	TS)	DISTANCE	TA	ILWIND	COMPON	VENT (K	TS)	4 11
	100	80	60	40	20	(INIVI)	20	40	60	80	100	4 11
	93	80	69	61	55	50	46	42	39	36	34	
	160	143	129	118	108	100	93	87	82	77	73	
	225	205	188	173	161	150	141	132	125	118	112	
	290	266	246	228	213	200	188	178	169	160	153	
	353	326	303	283	265	250	236	224	213	203	194	
	416	386	360	338	318	300	284	270	257	245	235	
	478	446	417	392	370	350	332	316	301	288	276	
	542	506	474	447	422	400	380	362	346	331	317	
	606	567	532	502	474	450	428	408	390	373	358	
	672	629	591	557	527	500	476	454	434	415	398	

- ✓ According to the table above, convert you Ground Distance (NM) in Air Distance (NAM) (Only if average head- or tailwind is more than or equal to 20 knots)
- Right below it, is another table called "Trip Fuel and Time Required". Use it to extract the trip fuel and the optimum cruising altitude, as well as the trip time. The landing weight at the will be ZFM + HOLDING FUEL + ALTERNATE FUEL = LANDING WEIGHT AT DESTINATION

IVAO ROMANIA TRAINING DEPARTMENT								
P.001.FPG	Version 1.0	September 15, 2014	Page 10					

T PMDG-NGX-FCOMv1.pdf	PMDG-NGX-FCOMv1.pdf - Adobe Reader										
File Edit View Window Help *											
🥥 🔁 🗃 🖨 🖂 💿 373 / 1035 😑 🛊 155% 🔹 🔚 🔛 🦻 🐼 Tools Sign Comment											
Trip Fuel and Time Required											
	ΔΤ	R DIST (NM)		I	ANDING	WEIGHT	(1000 KG)		TIME	
	A	(CDIST (INN)	40	45	50	55	60	65	70	(HRS:MIN)
	50	FUEL (1000 KG)	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.14	
	50	ALT (FT)	12000	12000	11000	11000	9000	9000	8000	0.14	
	100	FUEL (1000 KG)	0.8	0.9	0.9	1.0	1.0	1.1	1.1	0.22	
	100	ALT (FT)	19000	18000	18000	18000	17000	17000	17000	0.22	
	150	FUEL (1000 KG)	1.1	1.1	1.2	1.3	1.3	1.4	1.5	0.30	
	150	ALT (FT)	26000	25000	25000	24000	23000	22000	22000	0.50	
	200	FUEL (1000 KG)	1.3	1.4	1.5	1.6	1.6	1.7	1.8	0.37	
	200	ALT (FT)	35000	30000	28000	27000	26000	26000	26000	0.57	
	250	FUEL (1000 KG)	1.5	1.6	1.7	1.8	1.9	2.0	2.1	0-44	
	250	ALT (FT)	40000	37000	36000	35000	34000	31000	30000	0.44	
	200	FUEL (1000 KG)	1.7	1.8	1.9	2.1	2.2	2.3	2.4	0.50	
	300	ALT (FT)	41000	40000	39000	37000	35000	34000	32000	0.50	E
	350	FUEL (1000 KG)	1.9	2.0	2.2	2.3	2.4	2.6	2.7	0.56	
	550	ALT (FT)	41000	40000	40000	38000	36000	35000	33000	0.50	
	400	FUEL (1000 KG)	2.1	2.2	2.4	2.5	2.7	2.9	3.0	1.03	
	400	ALT (FT)	41000	40000	40000	38000	36000	35000	33000	1.05	
	450	FUEL (1000 KG)	2.3	2.5	2.6	2.8	3.0	3.1	3.3	1:10	
	450	ALT (FT)	41000	41000	40000	38000	36000	35000	34000	1.10	
	500	FUEL (1000 KG)	2.5	2.7	2.8	3.0	3.2	3.4	3.6	1.17	
	300	ALT (FT)	41000	41000	40000	38000	36000	35000	34000	1.17	
	Based or	1 280/.78 climb, Loi	ng Range	Cruise and	d .78/280/2	250 descen	it.				

✓ Take into account the following *corrective factors*:

- **0.13** to account for a go-around and missed approach
- o **0.06/min** to account for additional flight time with gear an flaps down
- ✓ Note: The trip fuel time is computed without the corrective factors above.
- F. Calculate the contingency fuel:
 - ✓ The contingency fuel will be 5% from the trip fuel
 - ✓ Use the following formula: TRIP FUEL * 0.05 = CONTINGENCY FUEL
 TRIP FUEL * 60 / 2.7 = CONTINGENCY FUEL TIME (minutes)
- G. Calculate the taxi fuel:
 - ✓ Normally, use 30 minutes APU time (0.0018/min)
 - Normally, use 10 minutes Taxi time (0.0122/min)
 TAXI FUEL = APU FUEL + TAXI FUEL = 0.0018 * APU TIME + 0.0122 *
 TAXI TIME
- H. Calculate the extra fuel:
 - ✓ Although the extra fuel can be added at the discretion of the captain, there are some standard amounts that should be taken into account:
 - o **0.26** for extra go-arounds
 - Approx. 0.45 for a circling approach
 - Extra holding fuel according to the table in the FCOM v1, Chapter PD, Section 31.5 – Holding Planning (this time input the landing weight at destination)

IVAO ROMANIA TRAINING DEPARTMENT							
P.001.FPG	Version 1.0	September 15, 2014	Page 11				

- Calculate the approximate extra fuel time:
 EXTRA FUEL * 60 / 2.7 = EXTRA FUEL TIME
- I. Calculate the grand total:
 - ✓ Add up all the fuel masses from steps C, D, E, F, G and H. This is your BLOCK FUEL – the total fuel that needs to be loaded into the aircraft tanks. Round it up to the next highest 100 KGS (0.1).
 - ✓ Add up all the corresponding flight times from steps C, D, E, F and H (note: without G). This is your ENDURANCE that needs to be included in the Fligh Plan.

3.3. Step-by-step example

- A. Find the necessary loading data for the flight you will perform:
 - ✓ PAX = 95
 - ✓ OEM = 41.4
 - ✓ 0.085 / PAX
 - ✓ 0.01 / BAG

B. Now calculate the ZFM – assume each passenger carries one bag:

PAYLOAD = 95 * (0.085 + 0.01) = 9.025

ZFM = 9.025 + 41.4 = 50.425

C. Extract the required holding fuel from the FCOM:

FUEL FLOW PER HOUR AT 1500ft = (50.425 - 50) * (2.1 - 1.95) / (55-50) + 1.95 =

= 0.425 * 0.15 / 5 + 1.95 = 1.963

HOLDING FUEL = 1.963 / 2 = 0.982

D. Calculate the required alternate fuel:

- ✓ The intended flight will be from LOWW to LOWI. A suitable alternate is EDDM.
- ✓ Assuming a direct route. Distance from LOWI to EDDM is **70 NM**.
- $\checkmark~$ On average, we will have a 20 knots headwind $\rightarrow~$

AIR DISTANCE = (70 - 50) * (108 - 55) / (100 - 50) + 55 =

= 20 * 53 / 50 + 55 = 76 (approx.)

✓ LANDING WEIGHT AT ALTN = 50.425 + 0.982 = 51.4 (approx.)

IVAO ROMANIA TRAINING DEPARTMENT							
P.001.FPG	Version 1.0	September 15, 2014	Page 12				

✓ Firstly, we will interpolate the two adjacent rows for both columns, then the columns for both rows (calculating both fuel and altitude)

Trip Fuel and Time Required

AIR DIST (MM)				ANDING	TIME				
All		40	45	50	55	60	65	70	(HRS:MIN)
50	FUEL (1000 KG)	0.5	0.5	0.0	0.0	0.7	0.7	0.7	0.14
50	ALT (FT)	12000	12000	11000	11000	9000	9000	8000	0.14
100	FUEL (1000 KG)	0.8	0.9	0.9	1.0	1.0	1.1	1.1	0.22
100	ALT (FT)	19000	18000	18000	18000	17000	17000	17000	0:22

First red, then blue, then orange.

Red:

(76 - 50) * (0.9 - 0.6) / (100 - 50) + 0.6 = 26 * 0.3 / 50 + 0.6 = 0.756(76 - 50) * (1.0 - 0.6) / (100 - 50) + 0.6 = 26 * 0.4 / 50 + 0.6 = 0.808(76 - 50) * (18000 - 11000) / (100 - 50) + 11000 = 26 * 7000 / 50 + 11000 =15000 (approx.) (76 - 50) * (18000 - 11000) / (100 - 50) + 11000 = 26 * 7000 / 50 + 11000 =15000 (approx.) Blue: (51.4 - 50) * (0.808 - 0.756) / (55 - 50) + 0.756 = 1.4 * 0.052 / 5 + 0.756 =0.771 (51.4 - 50) * (15000 - 15000) / (55 - 50) + 15000 = 0 + 15000 = 15000Orange: (76 - 50) * (22 - 14) / (100 - 50) + 14 = 26 * 8 / 50 + 14 = 18 (approx.) Final results: Alternate fuel: 0.771 Optimum altitude for diversion: 15000 ft / FL150 Diversion time: 00:18

E. Calculate the required trip fuel for the main route:

- ✓ Distance of the route from LOWW to LOWI is 235 NM.
- ✓ On average, we will have a 20 knots tailwind →

AIR DISTANCE = (235 - 200) * (236 - 188) / (250 - 200) + 188 =

= 35 * 48 / 50 + 188 = 222 NM (approx.)

 ✓ LANDING WEIGHT AT DESTINATION = 50.425 + 0.982 + 0.771 = 52.2 (approx.)

IVAO ROMANIA TRAINING DEPARTMENT							
P.001.FPG	Version 1.0	September 15, 2014	Page 13				

Trip Fuel and Time Required

A.T.	DIST (MM)		LANDING WEIGHT (1000 KG)							
All	K DIST (INNI)	40	45	50	55	60	65	70	(HRS:MIN)	
50	FUEL (1000 KG)	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.14	
50	ALT (FT)	12000	12000	11000	11000	9000	9000	8000	0.14	
100	FUEL (1000 KG)	0.8	0.9	0.9	1.0	1.0	1.1	1.1	0.22	
100	ALT (FT)	19000	18000	18000	18000	17000	17000	17000	0.22	
150	FUEL (1000 KG)	1.1	1.1	1.2	1.3	1.3	1.4	1.5	0.20	
150	ALT (FT)	26000	25000	25000	24000	23000	22000	22000	0.50	
200	FUEL (1000 KG)	1.3	1.4	1.5	1.6	1.6	1.7	1.8	0.27	
200	ALT (FT)	35000	30000	28000	27000	26000	26000	26000	0.57	
250	FUEL (1000 KG)	1.5	1.6	1.7	1.8	1.9	2.0	2.1	0.44	
230	ALT (FT)	40000	37000	36000	35000	34000	31000	30000	0.44	
						-				

 \checkmark We will interpolate: First red, then blue, then orange.

Red:

(222 - 200) * (1.7 - 1.5) / (250 - 200) + 1.5 = 22 * 0.2 / 50 + 1.5 = 1.588(222 - 200) * (1.8 - 1.6) / (250 - 200) + 1.6 = 22 * 0.2 / 50 + 1.6 = 1.688(222 - 200) * (36000 - 28000) / (250 - 200) + 28000 = 22 * 8000 / 50 + 28000 = 31500 (approx.)

(222 - 200) * (35000 - 27000) / (250 - 200) + 27000 = 22 * 8000 / 50 + 27000 = 30500 (approx.)

Blue:

(52.2 - 50) * (1.688 - 1.588) / (55 - 50) + 1.588 = 2.2 * 0.1 / 5 + 1.588 = 1.632(52.2 - 50) * (30500 - 31500) / (55 - 50) + 31500 = 2.2 * (-1000) / 5 + 31500 = 31000 (approx.)

Orange:

(222 – 200) * (44 – 37) / (250 – 200) + 37 = 22 * 7 / 50 + 37 = 40 (approx.) Final results: Trip fuel: 1.632 Optimum trip altitude: 31000 ft / FL310

Trip time: 00:40

Due to the challenging approach at LOWI and the ever-present possibility of a goaround or a circle to land or even both, we need to add the following corrective factors:

Go around and missed approach: 0.13

Gear and flaps down correction for starting lowering the gear and flaps earlier due to the circling: 0.06 * 3 = 0.18

Total trip fuel: 1.632 + 0.13 + 0.18 = 1.942

F. Calculate the contingency fuel:

CONTINGENCY FUEL = 1.942 * 0.05 = 0.097

CONTINGENCY FUEL TIME = 0.097 * 60 / 2.7 = 2 minutes (approx.)

G. Calculate the taxi fuel:

IVAO ROMANIA TRAINING DEPARTMENT							
P.001.FPG	Version 1.0	September 15, 2014	Page 14				

TAXI FUEL = 0.0018 * 30 + 0.0122 * 10 = 0.176

H. Calculate the extra fuel:

We may need to perform an extra go-around and missed approach, so we add: **0.26**

There is also a great chance we will have to perform a circle-to-land procedure, so we will add: **0.45**

EXTRA FUEL = 0.26 + 0.45 = 0.71

EXTRA FUEL TIME = 0.71 * 60 / 2.7 =

I. Calculate the grand total:

- ✓ Add up all the fuel masses from steps C, D, E, F, G and H. This is your BLOCK FUEL – the total fuel that needs to be loaded into the aircraft tanks.
- ✓ Add up all the corresponding flight times from steps C, D, E, F and H (note: without G). This is your ENDURANCE that needs to be included in the Flight Plan.

	MASS	AIR TIME
C. Holding fuel	0.982	00:30
D. Alternate fuel	0.771	00:18
E. Trip fuel	1.942	00:40
F. Contingency fuel	0.097	00:02
G. Taxi fuel	0.176	-
H. Extra fuel	0.710	00:15
BLOCK FUEL	4.678 → approx. 4.7	01:45

END RESULT :

In the aircraft tanks need be loaded 4700 KGS of fuel.

The endurance to be entered in the FPL is 01:45 (one hour and forty-five minutes).

The optimum FL for cruise is FL310 and the optimum FL for diversion is FL150.