FUEL MANAGEMENT FOR COMMERCIAL TRANSPORT

1. Introduction

An aeroplane shall carry a sufficient amount of usable fuel to complete the planned flight safely and to allow for deviation from the planned operation.

In this document we will present only the ICAO requirements. Other areas of the world like FAA, Europe can have additional requirements and restrictions.

2. Fuel requirements

The amount of usable fuel carried shall, as a minimum, be based on:

- Aeroplane specific data from a fuel consumption monitoring system or aeroplane manufacturer data
- Operating conditions for the planned flight (mass, weather reports, air traffic services procedures and restrictions, NOTAM …)

The pre-flight calculation of usable fuel required shall include:

- Taxi fuel
- Trip fuel
- Contingency fuel
- Destination alternate fuel
- Final reserve fuel
- Additional fuel
- Discretionary fuel

2.1. Taxi fuel

It is the amount of fuel expected to be consumed before take-off during start-up and taxi operation.

2.2. Trip fuel

It is the amount of fuel required to enable the aeroplane to fly from take-off, or the point of in-flight re-planning, until landing at the destination aerodrome taking the operating conditions into account.

2.3. Contingency fuel

It is the amount of fuel required to compensate for unforeseen factors.

It shall be **5% of the planned trip fuel** based on the consumption rate used to plan the trip fuel and it shall not be lower than the amount required to fly for 5 minutes at holding speed at 450m (or 1500ft) above the destination aerodrome in standard condition.

Unforeseen factors could have an influence on the fuel consumption or could be in deviation of the expected fuel consumption like deviations from forecast meteorological conditions, extended taxi time, extra holding procedures, deviation from planned routing or different cruising levels.

2.4. Destination alternate fuel

It is the amount of fuel required, where a destination alternate aerodrome is required or planned:

- To perform a **missed approach** at the destination aerodrome
- To **climb** to the expected cruising altitude between destination aerodrome and alternate aerodrome
- To **fly the expected route** between destination aerodrome and alternate aerodrome
- To **descend** to the point where the expected approach is initiated
- To **conduct the approach and landing** at destination alternate aerodrome

Where two destination alternate aerodromes are required, the amount of fuel calculated shall take into account the aerodrome which requires the greater amount of alternate fuel.

Where a flight is operated without a destination alternate aerodrome, the amount of fuel required to enable the aeroplane to fly for **15 minutes at holding speed at 1500ft or 450m above destination aerodrome elevation in standard conditions.**

Where the destination aerodrome is an isolated aerodrome: (rare cases)

- For a reciprocating engine aeroplane, the amount of fuel required to fly for **45 minutes** plus **15% of the flight time planned to be spent at cruising level** including the final reserve fuel or 2 hours, whichever is less
- For a turbine-engined aeroplane, the amount of fuel required to fly **2 hours at normal cruise consumption** above the destination aerodrome, including the final reserve fuel.

2.5. Final reserve fuel

It is the amount of fuel calculated using the estimated mass on arrival at the destination alternate aerodrome, or destination aerodrome when no destination alternate aerodrome is required

- For a reciprocating engine aeroplane, the amount of fuel required to **fly for 45 minutes** under speed and altitude specified by the operator of the aircraft
- For a turbine-engined aeroplane, the amount of fuel required to **fly 30 minutes at holding speed at 1500ft or 450m above destination aerodrome elevation in standard conditions.**

2.6. Additional fuel

It is the amount of fuel required if the minimum fuel calculated in Trip + Contingency + Destination alternate + Final reserve fuel is not sufficient to:

- Allow the aeroplane to descend as necessary and proceed to an alternate aerodrome in the event of engine failure or loss of pressurization on the assumption that such a failure occurs at the most critical point along the route
- Fly 15 minutes at holding speed at 1500ft or 450m above destination aerodrome elevation in standard conditions
- Allow EDTO (extended diversion time operations) critical fuel scenario
- Allow other restrictions not covered by previous requirements

2.7. Discretionary fuel

It is the extra amount of fuel to be carried at the discretion of the pilot-in-command.

This fuel can be extra fuel you may carry to perform a pilot exam in order to cover all planned exercises, or it can be the extra fuel, you may carry to perform a flight during an ATC exam covering extra holding patterns due to traffic flow.

3. Management

The fuel should be monitored through all the phases of the flight; it is really important for the pilot in command to ensure the best methods and techniques in order to guarantee a proper operation and the safety of the flight.

3.1. Pre-Flight

The pilot in command shall ensure that there is enough fuel to complete the flight including:

- Ground services vs APU start (Increased fuel burn).
- Departure delays that could result in more use of fuel through the taxi operation. (Weather, delays, NOTAMS should be read in order to get the latest information of the aerodrome)
- De-icing (If De-icing will be performed at a remote position, the taxi fuel should be increased in order to achieve the taxi time fuel for departure)
- Route from the destination airfield to the worst alternate

Weight and balance should be checked in order to ensure the proper distribution of the payload and fuel.

3.2. Start and Taxi

The pilot in command shall take into account these parameters:

- Push-back time should be taken into account, at the same time, the engine start should be delayed until close to or reaching the tug disconnection position to conserve fuel.

In the event of some delays, weather situations, emergencies, traffic flow, the pilot in command should be aware of his minimum brake release fuel, some actions like shut down one engine; change the predicted fuel profile will ensure a better fuel conservation.

3.3. Take-Off

When possible, the pilot in command should consider:

- A de-rated take-off.
- The SID route (Opposite direction departures)

Check your V-Speeds and Flaps configuration in order to achieve the planned performance/fuel consumption over the runway.

The PIC should know that the take-off manoeuvre demands a high fuel flow operation from the aircraft. Optimized thrust vs optimized flaps will ensure a conservative fuel flow.

3.4. Climb

The pilot in command should use:

- Cost index and planned climb speed (must be used all the time).
- High speed climb and altitude level offs increase the fuel consumption, if it is necessary reduce the airspeed, this way the fuel penalty will be decreased.

3.5. Cruise

The pilot in command shall adjust the cruise profile when necessary to achieve the best profile:

- Compare cruise profile versus the wind, temperature and weight.
- Over the top of descent, check your fuel reserves in order to be satisfied with the minimum legal fuel required for the approach.

If the optimum cruise altitude could not be reached adjust the cost index/speed to reach a best profile.

3.6. Descent

The pilot in command shall consider:

- Reduced airspeed through descent guarantees low fuel consumption
- A descent before the top of descent in order to achieve the low speed descent.

The optimum descent profile is the one that it is performed at idle speed.

3.7. Holding Procedure

Once the holding clearance has been received, the pilot should start a speed decrease in order to reduce the fuel consumption at the hold.

It is important to be familiarized with the fuel reserves; this way the pilot could decide if he would be able to hold until the expected further clearance time (EFC). If there is insufficient fuel, the holding clearance must be refused or negotiated to get a better EFC.

A diversion should be initiated if the fuel reaches the diversion requirements.

3.8. Approach & Landing

The pilot in command should try to maintain a clean configuration as long as practical.
The pilot in command should consider:

- Reduced final flap setting for the approach (Less drag)
- Reduced landing flap setting which increases the fuel conservation.
- Idle reverse instead of full reverse thrust which results in fuel savings.

It is important to know that a low use of the reverse could result in a higher brake use.

3.9. Taxi and Parking

On the ground, the pilot in command shall reduce the APU start time, if possible request the ground services; this will reduce the fuel penalty created by the APU usage.

Pilots should be aware of their fuel regulations and policies in order to achieve the highest standards of safety and awareness.

4. In-Flight Management and Decision Making

The pilot in command must verify that fuel checks are performed in-flight at several intervals.

The fuel at the destination aerodrome should not be less than the required alternate fuel plus the final reserve fuel, if no alternate aerodrome is required it should not be less than the final reserve fuel.

If during a fuel check the expected fuel at the destination aerodrome will be less than the alternate fuel plus the final reserve fuel, the pic should take the decision to continue taking into account the future factors (delays, ATC instructions …) or divert to the nearest aerodrome.

On the other side, if alternate aerodrome is not required, the pic should be aware that he should not land below the final reserve fuel.

Diversion factors could be:

- Route alteration due to meteorological effects
- Depiction to a lower flight level
- Different route by ATC
- Engine complete or partial failure

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Aircraft: Cessna Skylane RG

	Cruise	Climb	Descent	Touch Down
Altitude [ft]:	10000			
TAS [kts]:	142	95		70
Rate [fpm]:		550	600	
Fuel flow [Gal/h]:	10	14	5	

Id	Location	Type	Freq	Head	TAS	VSpeed	Altitude	Distance	ETE	Fuel [Lbs]
KLBL	Liberal Mun	Airport		-	-	-	2881	0.0	00 00' 00"	0.0
HQG	HUGOTON	NDB	365.0	281	120	497	8324	21.1	00 10' 57"	17.4
	End of Climb	EOC		319	139	319	10000	12.0	00 05' 15"	8.3
JHN	BEAR CREEK (JOHNSON)	NDB	341.0	319	142	0	10000	21.1	00 08' 55"	10.1
LAA	LAMAR	VORTAC	116.90	297	142	0	10000	56.3	00 23' 47"	27.0
LHX	LA JUNTA	NDB	239.0	248	142	0	10000	45.0	00 19' 00"	21.5
PUB	PUEBLO	VORTAC	116.70	281	142	0	10000	40.9	00 17' 16"	19.6
PU	PU	NDB	302.0	256	142	0	10000	10.3	00 04' 20"	4.9
	Beginning of Descent	BOD		341	142	0	10000	19.2	00 08' 07"	9.2
CO	CO	NDB	407.0	341	130	-599	8468	5.6	00 02' 33"	1.5
35L	City Of Colorado Springs Mun - ILS/GS: IC	Runway	109.90	349	92	-600	6181	6.0	00 03' 48"	2.2
KCOS	City Of Colorado Springs Mun	Airport		-	-	-	6181	0.0	00 00' 00"	0.0
							TOTAL :	237.5	01 44' 01"	121.7

Table shows a route plan with the time and trip fuel expectation in lbs