3 Fuel Policy for Transport Flights and Single Engine Piston Aeroplane (SEP)

3.1 Fuel Policy for all Transport Flights with SEP, MEP and JET Aeroplanes

JAR-OPS 1 applies to all Commercial Air Transportation (Aeroplane) Operations. For the purposes of 030/033 Flight Planning and Monitoring reference must be made to JAR-OPS 1.255, 1.295, 1.375. The student must therefore be familiar with "fuel policy" as outlined in JAR-OPS:

a) An operator must establish a fuel policy for the purpose of flight planning and in-flight replanning to ensure that every flight carries sufficient fuel for the planned operation and reserves to cover deviations from the planned operation.

b) An operator shall ensure that the planning of flights is only based upon:
- Procedures and data contained in or derived from the Operations Manual or current aeroplane specific data; and
- The operating conditions under which the flight is to be conducted including:
- Realistic aeroplane fuel consumption data
- Anticipated masses
- Expected meteorological conditions; and
- Air Navigation Services provider(s) procedures and restrictions.

c) An operator shall ensure that the pre-flight calculation of usable fuel required for a flight includes:
- Taxi fuel
- Trip fuel
- Reserve fuel consisting of:
  1. Contingency fuel
  2. Alternate fuel, if a destination alternate aerodrome is required. (This does not preclude selection of the departure aerodrome as the destination alternate aerodrome)
  3. Final reserve fuel
  4. Additional fuel, if required by the type of operation (e.g. ETOPS).

3.1.1 Fuel Policy

An operator should base the company fuel policy, including calculation of the amount of fuel to be carried, on the following planning criteria, *see fig. FP 3.1.*:

The Amount of:

Taxi fuel. This is a fixed amount of fuel to be used for taxi at the departure aerodrome to the Take Off runway. Taxi fuel should not be less than the amount, expected to be used prior to take-off. Local conditions at the departure aerodrome and APU consumption should be taken into account. This is done by dispatch.

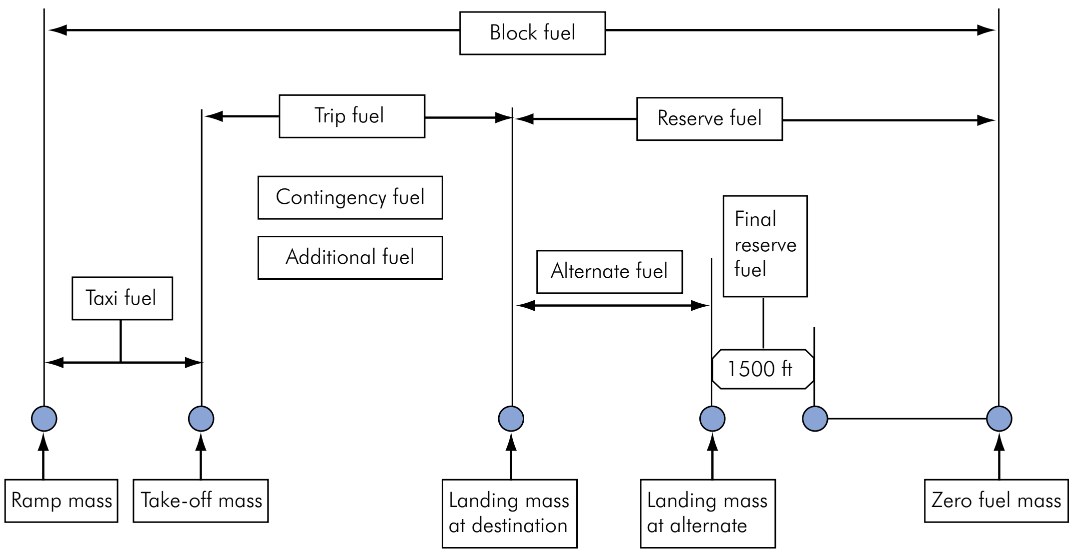


Fig. FP 3.1 Fuel loading according to JAR-OPS

Trip fuel, which should include:

a) Fuel for take-off and climb from aerodrome elevation to initial cruising level/altitude, taking into account the expected departure routing;

b) Fuel from top of climb to top of descent, including any step climb/descent;

c) Fuel from top of descent to the point where the approach is initiated, taking into account the expected arrival procedure; and

d) Fuel for approach and landing at the destination aerodrome.

Contingency fuel. The fuel required to compensate for unforeseen factors which could have an influence on the fuel consumption to the destination aerodrome such as deviations of an individual aeroplane from the expected fuel consumption data, deviations from forecast meteorological conditions and deviations from planned routings and/or cruising levels/altitudes. Contingency fuel should be the higher of (a) or (b) below:

a) Either:

- 5% of the planned trip fuel or, in the event of in-flight replanning, 5% of the trip fuel for the remainder of the flight; or
- Not less than 3% of the planned trip fuel or, in the event of in-flight replanning, 3% of the trip fuel for the remainder of the flight provided that an en-route alternate is available. The en-route alternate should be located within a circle having a radius equal to 20% of the total flight plan distance, the centre of which lies on the planned route at a distance from the destination of 25% of the total flight plan distance, or at 20% of the total flight plan distance plus 50

NM, whichever is greater (See example in Appendix 1 to AMC OPS 1.255); or

- An amount of fuel sufficient for 20 minutes flying time based upon the planned trip fuel consumption provided that the operator has established a fuel consumption monitoring programme for individual aeroplanes and uses valid data determined by means of such a programme for fuel calculation; or

b) An amount to fly for 5 minutes at holding speed at 1500 ft (450 m) above the destination aerodrome in Standard Conditions.

Alternate fuel, which should be sufficient for:

a) A missed approach from the applicable MDA/DH at the destination aerodrome to missed approach altitude, taking into account the complete missed approach procedure;
b) A climb from missed approach altitude to cruising level/altitude;
c) The cruise from top of climb to top of descent;
d) Descent from top of descent to the point where the approach is initiated, taking into account the expected arrival procedure; and
e) Executing an approach and landing at the destination alternate aerodrome.
f) If two destination alternates are required, alternate fuel should be sufficient to proceed to the alternate aerodrome which requires the greater amount of alternate fuel.

Final reserve fuel, which should be:

a) For aeroplanes with reciprocating engines, fuel to fly for 45 minutes; or

b) For aeroplanes with turbine power units, fuel to fly for 30 minutes at holding speed at 1500 ft (450 m) above aerodrome elevation in standard conditions, calculated with the estimated mass on arrival at the alternate aerodrome or the destination, when no alternate aerodrome is required.

Minimum additional fuel which should permit:

a) Holding for 15 minutes at 1500 ft (450 m) above aerodrome elevation in standard conditions, when a flight is operated under IFR without a destination alternate, and following the possible failure of a power unit or loss of pressurisation, based on the assumption that such a failure occurs at the most critical point along the route, the aeroplane to descend as necessary and proceed to an adequate aerodrome; and
- Hold there for 15 minutes at 1500 ft (450m) above aerodrome elevation in standard conditions; and
- Make an approach and landing.

Except that additional fuel is only required, if the minimum amount of fuel calculated in accordance with sub-paragraphs above is not sufficient for such an event.

Extra fuel if required by commander.

3.1.2 In-Flight Fuel Management

An operator must establish a procedure to ensure that in-flight fuel checks and fuel management are carried out according to following criteria:

In-flight fuel checks

A commander must ensure that fuel checks are carried out in-flight at regular intervals. The usable remaining fuel must be recorded and evaluated to:

- compare actual consumption with planned consumption;
- check that the usable remaining fuel is sufficient to complete the flight, in accordance with paragraph 'In-flight fuel management' below; and
- determine the expected usable fuel remaining on arrival at the destination aerodrome.

The relevant fuel data must be recorded.

In-flight fuel management

1) The flight must be conducted so that the expected usable fuel remaining on arrival at the destination aerodrome is not less than:
   - the required alternate fuel plus final reserve fuel, or
   - the final reserve fuel if no alternate aerodrome is required

2) However, if, as a result of an in-flight fuel check, the expected usable fuel remaining on arrival at the destination aerodrome is less than:
   - the required alternate fuel plus final reserve fuel, the commander must take into account the traffic and the operational conditions prevailing at the destination aerodrome, at the destination alternate aerodrome and at any other adequate aerodrome, in deciding whether to proceed to the destination aerodrome or to divert so as to perform a safe landing with not less than final reserve fuel, or
   - the final reserve fuel if no alternate aerodrome is required, the commander must take appropriate action and proceed to an adequate aerodrome so as to perform a safe landing with not less than final reserve fuel. Reasons for deviation of the planning can be a alteration in meteorological data, depiction to a lower flight level or different route by ATC.

Declare emergency

The commander shall declare an emergency when calculated usable fuel on landing, at the nearest adequate aerodrome where a safe landing can be performed, is less than final reserve fuel.

3.2 Single Engine Piston (SEP) Data Sheets - CAP 697 CAA JAR-FCL Examinations Flight Planning Manual

Section 1 - GENERAL NOTES

Introduction

Important Notice:
These data sheets are intended for the use of candidates for the European Professional Pilot's Licence Examinations.

The data contained within these sheets is for examination purposes only. The data must not be used for any other purpose and, specifically, are not to be used for the purpose of planning activities associated with the operation of any aircraft in use now or in the future.

3.3 Aircraft Description

The aircraft used in these data sheets are of generic types related to the classes of aircraft on which the appropriate examinations are based. Candidates must select the correct class of aircraft for the question being attempted. To assist in this, the data for each class is presented on different coloured paper.

Generic Aircraft

- Single engine piston - not certified under JAR 25 (Light Aeroplanes) Performance Class B SEP1 (Beechcraft Bonanza)
- Multi engine piston - not certified under JAR 25 (Light Aeroplanes) Performance Class B MEP1 (PA 34-220T Seneca III)
- Medium range jet transport certified under JAR 25 Performance Class A MRJT1 (Boeing 737-400).

3.4 Layout of Data Sheets

Each set of data sheets will consist of an introduction that will contain some pertinent information relating to the aircraft and subject being examined. This data will include (but not be limited to) a list of abbreviations and some conversion factors.

This will be followed by a selection of graphs and/or tables that will provide coverage suitable for the syllabus to be examined. A worked example will accompany each graph/table and will demonstrate typical usage.

3.5 Nautical Air Miles

A number of the graphs and tables used in the data sheets for flight planning refer to Nautical Air Miles (NAM). A NAM is the measure of distance flown in still air conditions i.e. no wind component blowing along the aeroplane's heading vector. To put it another way it is the distance flown at the True Air Speed (TAS) of the aeroplane. In still air conditions NAM flown will be equal to Nautical Ground Miles (NGM) flown.

However, the air is very rarely still and an aeroplane flying through moving air will fly a different distance over the ground. If the air is moving in the same direction as the aeroplane (a tailwind or plus component) then the aeroplane will fly more NGM than NAM, *see fig. FP 3.2.*

If the wind is blowing in the opposite direction to the aeroplane (a headwind or minus component) then the aeroplane will fly more NAM than NGM, *see fig. FP 3.3.*

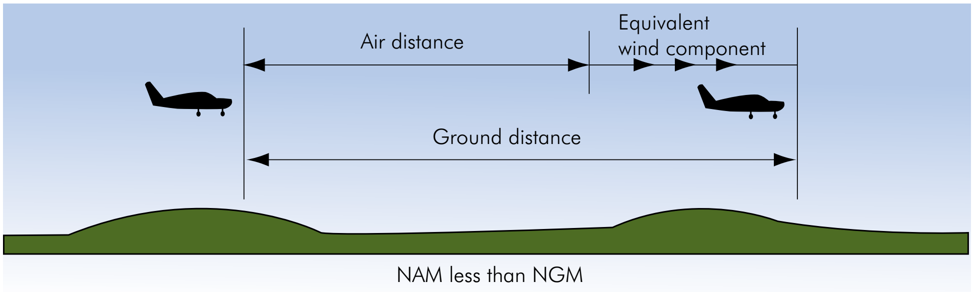


Fig. FP 3.2 Relationship of nautical air miles, wind component and ground distance flown (tail wind)

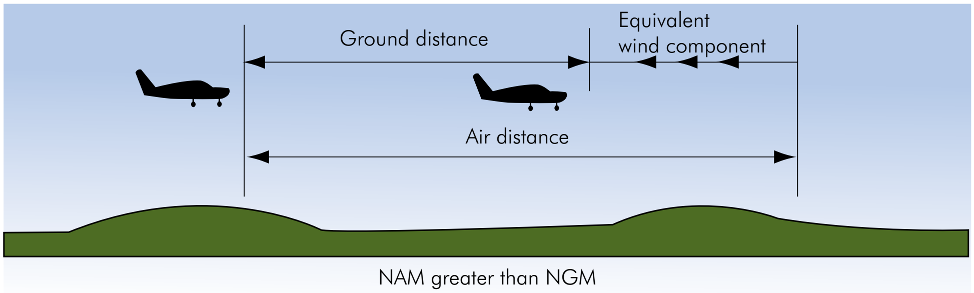


Fig. FP 3.3 Relationship of nautical air miles, wind component and ground distance flown (head wind)

The relationship between NAM, NGM, TAS, Groundspeed (GS) and Equivalent Wind Component (EWC) is:

$$\frac{NGM}{NAM} = \frac{GS}{TAS} = \frac{TAS \pm EWC}{TAS}$$

Example 1:
If an aeroplane flies at a TAS of 150 kt for 35 NAM, with a EWC of +20kt, how many NGM does it fly?

$$\frac{NGM}{35} = \frac{150 + 20}{150}$$

$$NGM = \frac{170 \times 35}{150}$$

$$NGM = 39.7$$

$$NGM = NAM +/- (EWC \times Time\ [minutes] / 60$$

Another type of calculation required is working out the NGM given NAM, time, TAS and EWC.

Exercise

	TAS	EWC	GS	NGM	NAM	Time
1	150	+ 20		56		xxxxxx
2		- 25	210		165	xxxxxx
3	345		422		308	
4	xxxxxx	- 35	xxxxxx	99		44
5	xxxxxx	+ 22	xxxxxx		216	79
6	xxxxxx	+ 65	xxxxxx		126	37

Table FP 3.1 Exercise

Answers

	TAS	EWC	GS	NGM	NAM	Time
1	150	+ 20	170	56	49.4	xxxxxx
2	235	- 25	210	147.5	165	xxxxxx
3	345	+ 77	422	377	308	54
4	xxxxxx	- 35	xxxxxx	99	125	44
5	xxxxxx	+ 22	xxxxxx	245	216	79
6	xxxxxx	+ 65	xxxxxx	166	126	37

Table FP 3.2 Answers

Example 2:
An aeroplane descends from cruising level to circuit height in 12.5 minutes, covering 36.5 NAM. If the EWC is -25 kt, how many NGM are flown in the descent?

$$NGM = NAM \pm \frac{(EWC.x.time)}{60}$$

$$= 36.5 - \frac{(25 \times 12.5)}{60}$$

$$NGM = 31.3$$

3.6 Data for Single Engine Piston Aeroplane (SEP)

The SEP is a monoplane with a reciprocating engine. It has a constant speed propeller. The pilot via a RPM (or Pitch) lever controls the propeller RPM. The fuel/air mixture may be “rich “ (more fuel) or “lean” (less fuel). Total fuel/air mixture going into the engine is adjusted by varying the manifold pressure; the higher the manifold pressure, the more mixture being burnt.

The SEP manifold pressure is measured in inches of mercury; e.g. “25.0 In. Hg”. As the aircraft climbs, the throttle lever must be advanced, manually, in order to maintain a desired pressure. On some engines there may be a device that can add more fuel/air mixture automatically, without the pilot moving the throttle lever. Eventually, in the climb, an altitude will be reached where manifold pressure can no longer be maintained. In this case, the throttle lever will remain at “maximum forward” and manifold pressure will start to reduce. This altitude is called “full throttle height” and the power is said to be at full throttle.

The SEP has a retractable undercarriage. The tables assume that the undercarriage is at the appropriate position for the stage of flight ie “down or extended” for landing and take off, “up or retracted” for climb, cruise and descent. There is no requirement to consider abnormal cases.

3.7 Aeroplane Details

Maximum Take-off Mass (MTOM)	3650 lb
Maximum Landing Mass (MLM)	3650 lb
Maximum fuel load	74 US gal/ 444 lb
Fuel density	6 lb/US gal (unless advised otherwise)

There are 7 tables/graphs for the SEP:

1 Time, fuel and distance to cruise climb
2 Recommended cruise power settings (25.0 In.Hg @2500 RPM)
3 Recommended cruise power settings (25.0 In.Hg @2100 RPM)
4 Recommended cruise power settings (23.0 In.Hg @2300 RPM)
5 Economy cruise power settings (21.0 In.Hg @2100 RPM)
6 Range profile
7 Endurance profile.

Pages 2 and 3 of CAP 697 contain some useful definitions, which are likely to be examined.

3.8 Conversions Used in Data Sheets

Mass Conversion:
Pounds (lb) to Kilograms (kg)
Lb × 0.45359237 kg

Kilograms (kg) to Pounds (lb)
Kg × 2.20462262 lb

Volume Conversion:
Imperial Gallons to Litres (l)
Imp. gal × 4.546092

US Gallons to Litres (L)
US gal × 3.785412

Imperial Gallons to US Gallons
Imp. gal × 1.2048192

Lengths:
Feet (ft) to Metres (m)
Feet × 0.3048

Metres (m) to Feet (ft)
Metres × 3.2808

Distances:
Nautical mile (NM) to Metres (m)
NM × 1852

All the above conversions can be done on the CRP5 computer as described in the Navigation notes.

3.9 Fuel, Time and Distance to Climb

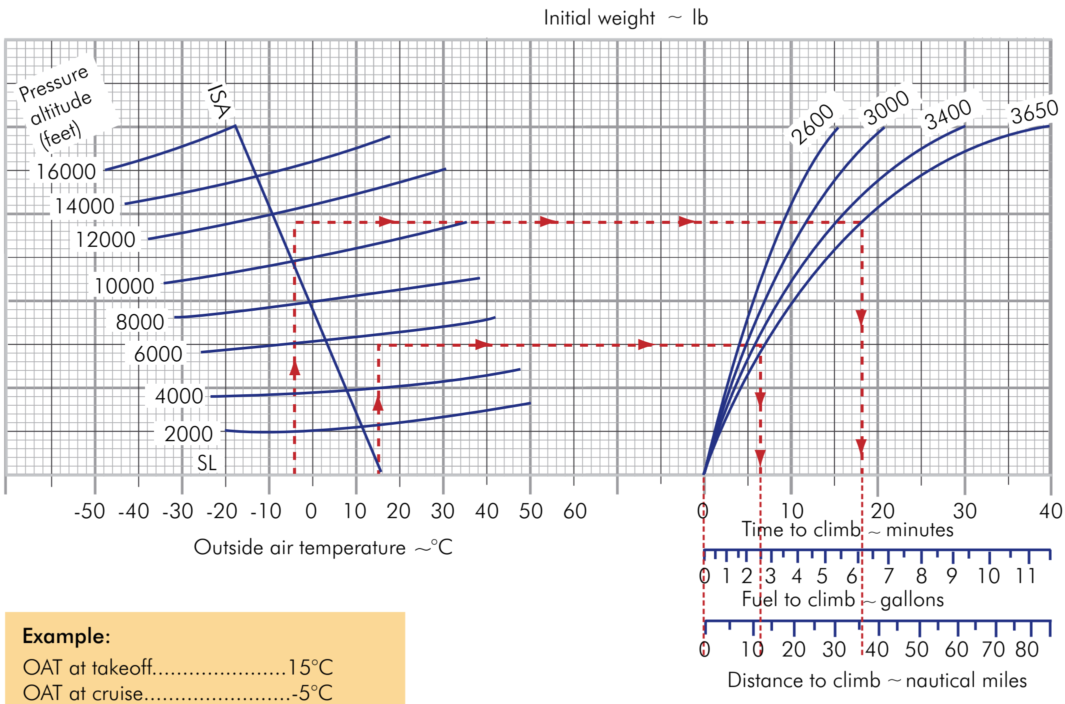
See fig. FP 3.4 and CAP 697 page 9.

The graph shows time, fuel and distance (NAM) to climb to any height from mean sea level (MSL).

TIME, FUEL AND DISTANCE TO CRUISE CLIMB
Climb speed: 110 knots all weights

Associated conditions:

Power..........................full throttle, 2500 rpm
Fuel density..................6.0 lb/gal
Mixture.........................full rich
Cowl flaps....................as required



Example:

OAT at takeoff......................15°C
OAT at cruise........................-5°C
Airport pressure altitude..........5653 ft
Cruise pressure altitude..........11,500 ft
Initial climb weight.................3650 lb

Time to climb (18-6.5)...........11.5 min
Fuel to climb (6.0-2.5)...........3.5 gal
Distance to climb (36-12.5)...23.5 NM

Fig. FP 3.4 SEP1, time, fuel + distance to climb

Enter graph as follows:

a) From OAT at take off move vertically to airport or start of climb pressure altitude.

b) Move horizontally to aeroplane mass.

c) Move vertically down and read time, fuel and distance respectively.

d) Enter with OAT at cruise altitude. From there move vertically to cruise altitude.

e) Move horizontally to aeroplane mass.

f) Move vertically downwards and read time, fuel and distance respectively.

g) Subtract c from f to obtain climb time, fuel and distance respectively.

Example

OAT at take-off	15°C
OAT at cruise	-5°C
Airport pressure altitude	5653 ft
Cruise pressure altitude	11 500 ft
Initial climb weight	3650 lb

- Enter at bottom left with OAT at take-off (+15°C) move vertically to airport pressure altitude (5653 ft)
- Move horizontally to initial climb aeroplane mass (3650 lb)
- Move vertically down and read time (6.5min), fuel (2.5 gal) and distance (12.5 NAM) respectively
- Enter with OAT at cruise altitude (-5°C). From there move vertically to cruise altitude (11 500 ft)
- Move horizontally to aeroplane mass (3650 lb)
- Move vertically downwards and read time (18min), fuel (6.0) and distance (36NAM)respectively
- Subtract c from f to obtain:

  climb time 18 - 6.5 = 11.5 min

  climb fuel 6.0 - 2.5 = 3.5 gal

  climb distance 36 -12.5 = 23.5 NAM

Single Engine Piston (SEP) Exercise 1- Climb

Using *table FP 3.3* calculate for each leg the time, fuel and distance. Convert the distance Nautical Air Miles (NAM) into Nautical Ground Miles (NGM).

The answers may be found in *table FP 3.4.*

Exercise 1- Climb

Leg no	Take-off airfield	Pressure altitude T/O Airfield	Temp on ground	Pressure altitude cruise	Temp at cruise	Initial weight
1	A	1000	+ 20°C	6000	+ 5°C	3600
2	B	4000	- 10°C	7500	- 20°C	3000
3	C	4623	- 15°C	9500	- 25°C	3200
4	D	3780	+ 15°C	8500	0°C	3525

From	To	P/alt	Wind comp	NAM	NGM	Time	Fuel reqd
A	TOC	6000	+ 15 kt				
B	TOC	7500	- 15 kt				
C	TOC	9500	- 10 kt				
D	TOC	8500	+ 13 kt				

Table FP 3.3 Exercise 1. SEP data + answer sheet

Answers for Exercise 1- Climb

Leg no	Take-off airfield	Pressure altitude T/O Airfield	Temp on ground	Pressure altitude cruise	Temp at cruise	Initial weight
1	A	1000	+ 20°C	6000	+ 5°C	3600
		0.8 0.2 1		6.5 2.5 12		
2	B	4000	- 10°C	7500	- 20°C	3000
		2.8 1.1 5		6.5 2.2 10		
3	C	4623	- 15°C	9500	- 25°C	3200
		4.0 1.5 7		8.5 3.1 17		
4	D	3780	+ 15°C	8500	0°C	3525
		3.6 1.3 7		10 3.8 21		

From	To	P/alt	Wind comp	NAM	NGM	Time	Fuel reqd
A	TOC	6000	+ 15 kt	11	12.4	5.7	2.3
B	TOC	7500	- 15 kt	5	4.1	3.7	1.1
C	TOC	9500	- 10 kt	10	9.2	4.5	1.6
D	TOC	8500	+ 13 kt	14	15.4	6.4	2.5

Table FP 3.4 Answers to SEP exercise 1