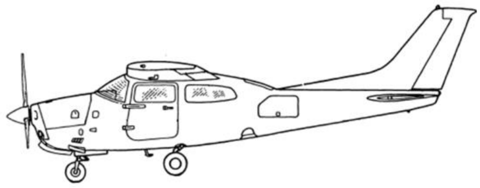
ANNEX A to AC 91-15

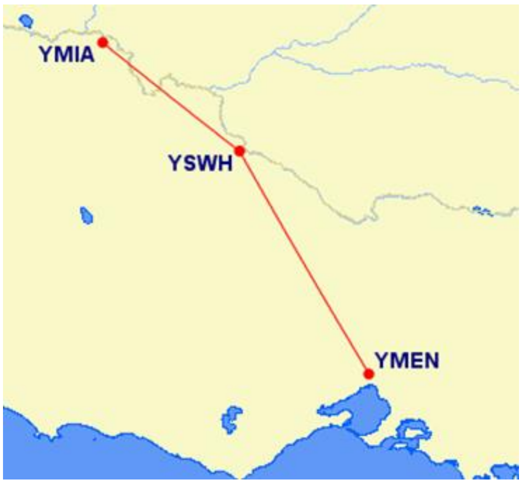
Guidelines for aircraft fuel requirements

Sample fuel calculations – Single-engine piston aeroplane (Cessna 210)

Scenario and conditions



Flight route scenario is from Essendon to Swan Hill in a Cessna 210 (C210). Mildura is selected as the destination alternate aerodrome for the scenario development where a destination alternate aerodrome is required.



Route distance: 161 NM

Destination alternate distance: 100 NM

Aircraft take-off weight: 3,750 lbs

Usable fuel capacity: 543 lbs

Climb wind and temp: 20 kt headwind,

ISA +15 deg

Cruise wind and temp: 20 kt headwind,

ISA +15 deg

Note: Wind and temperature for climb is generally taken at 2/3 of the cruise height. For descent, it is generally taken at ½ of the descent height.

Performance data – from POH

Extracted from Cessna 210 POH Section 5.

Units of Measurement

The unit of measurement for fuel values will be pounds (lbs) according to the C210 POH. In these examples, fuel uplift information has been stated in litres (L). The conversion of AVGAS (specific gravity 0.720 at sea level ISA conditions) from lbs to L is based on a conversion factor of 1.58.

Note: Where fuel values contain varied units of measurement, care must be taken to ensure that the conversion of those values is based on correct information and accurately performed.

Usable fuel required at the commencement of a flight

Part 91 of CASR prescribes that the following amounts of fuel must be on board at the commencement of a flight:

- taxi fuel
- trip fuel
- destination alternate fuel (if required)
- holding fuel (if required)
- contingency fuel (if applicable)
- final reserve fuel
- additional fuel (if applicable).

Essendon to Swan Hill – day VFR – without destination alternate aerodrome

Taxi fuel

From the C210 POH, 12 lbs is the engine start, taxi, and take-off allowance. This should be taken as the minimum figure. In situations where extended taxi or ground delay after starting can be anticipated, this value should be increased accordingly.

As take-off fuel is a component of trip fuel, a simple proportional estimate can be used to determine the start and taxi (and run-up if required) and take-off.

- Start and taxi: 6 lbs

Note: This is NOT part of trip fuel. While the AFM refers to 'start and taxi', for these calculations that amount of fuel will be referred to only as 'taxi'.

- Take-off: 6 lbs

Note: Take-off fuel IS part of trip fuel.

Table 1: Taxi fuel

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4

Trip fuel

Trip fuel means the amount of fuel required to enable an aircraft to fly from any point along a route until landing at a destination aerodrome including (as applicable) the following:

- fuel for take-off and climb from departure aerodrome elevation to initial cruising level or altitude, taking into account the expected departure routing
- fuel for cruise from top of climb to top of descent, including any step climb or descent
- fuel from top of descent to the point where the approach is initiated, taking into account the expected arrival procedure
- fuel for executing an approach and landing at the planned destination aerodrome.

Fuel for take-off and climb

Data time, fuel, and distance to climb (nil wind) are provided in the C210 POH.

Given the visual flight rules (VFR) nature of the flight, the planned cruising level is 8 500 ft, so it is suggested that the data be interpolated to achieve an accurate figure.

Calculation of fuel for take-off and climb is shown in Table 2.

Data from the POH/AFM is interpolated between 8 000 ft and 10 000 ft lines. Temperature adjustment is made in accordance with POH/AFM instructions. To apply wind correction, climb wind is used to adjust the distance to climb (the result is called top of climb or TOPC).

Essendon airport is situated at an elevation of 282 ft AMSL. However, because the difference in aircraft performance between sea level and 282 ft is negligible, it has been taken to be at sea level.

SECTION 5
PERFORMANCE

CESSNA
MODEL 210M

TIME, FUEL, AND DISTANCE TO CLIMB

NORMAL CLIMB - 100 KIAS

CONDITIONS:
Flaps Up
Gear Up
2550 RPM
25 Inches Hg or Full Throttle
Cowl Flaps Open
Standard Temperature

MIXTURE SETTING	
PRESS ALT	PPH
S.L. to 4000	108
8000	96
12,000	84

NOTES:
1. Add 12 pounds of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
3. Distances shown are based on zero wind.

WEIGHT LBS	PRESS ALT FT	RATE OF CLIMB FPM	FROM SEA LEVEL		
			TIME MIN	FUEL USED POUNDS	DISTANCE NM
3800	S.L.	670	0	0	0
	2000	670	3	5	5
	4000	660	6	11	10
	6000	560	9	17	16
	8000	455	13	23	23
	10,000	355	18	31	33
	12,000	255	25	41	46
3500	S.L.	780	0	0	0
	2000	780	3	5	4
	4000	770	5	9	9
	6000	665	8	14	14
	8000	555	11	20	20
	10,000	445	15	26	28
	12,000	340	21	33	38
3200	S.L.	910	0	0	0
	2000	910	2	4	4
	4000	900	4	8	7
	6000	785	7	12	12
	8000	665	10	17	17
	10,000	550	13	22	23
	12,000	435	17	28	31

Table 2: Calculation of time, fuel and distance to climb

Scenario data	Data from POH/AFM (normal climb data)	Temperature adjustment	Wind correction
Aircraft take-off weight: • 3 750 lbs	Time: • 14 min	Time: 14 min x 1.15 = 16 min (0.27 hr)	TAS (distance/time): • 29.33 NM / 0.27 hr = 109 kt
Climb wind and temp: • 20 kt headwind, ISA +15 deg	Fuel: • 25 lbs	Fuel: 25 lbs x 1.15 = 29 lbs	Ground speed (GS) (TAS – headwind): • 109 kt – 20 kt = 89 kt
Departure elevation: • sea level	Distance (nil wind): • 26 NM	Distance (nil wind): 26 NM x 1.15 = 29 NM	Wind-corrected distance to descend, TOPD (GS x time): • 89 kt x 0.27 hrs = 24 NM

If the departure includes extended departure tracking, or airborne holding during the departure is anticipated, fuel and time should be adjusted to allow for those anticipated conditions. Although not required, this allowance could be called contingency fuel.

Fuel for cruise

Cruise data is provided in the C210 POH. Tabulated data is again provided for 2 000 ft intervals. The table has % power, TAS and fuel flow for standard temperature and at 20 degrees above and below the standard temperature. Given the VFR planned cruising level is 8 500 ft, the data in the 8 000 ft table can be used (rounding down from 8 500 ft) as the approximation will be conservative with respect to fuel usage.

The data used in this scenario is shown in Table 3.

SECTION 5
PERFORMANCE

CESSNA
MODEL 210M

CRUISE PERFORMANCE

PRESSURE ALTITUDE 8000 FEET

CONDITIONS:
3800 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

> NOTE
> For best fuel economy at 65% power or less operate at 6 PPH leaner than shown in this chart or at peak EGT if an EGT indicator is installed.

		20°C BELOW STANDARD TEMP -21°C			STANDARD TEMPERATURE - 1°C			20°C ABOVE STANDARD TEMP 19°C		
RPM	MP	% BHP	KTAS	PPH	% BHP	KTAS	PPH	% BHP	KTAS	PPH
2550	22	74	169	93	71	171	90	69	172	87
	21	70	165	88	67	167	85	65	168	82
	20	66	161	82	63	162	80	61	163	77
	19	61	157	77	59	157	75	57	157	72
2500	22	72	167	90	69	169	87	67	170	84
	21	68	163	85	65	164	82	63	165	79
	20	63	159	80	61	160	77	59	160	75
	19	59	154	75	57	155	72	55	154	70
2400	22	67	163	84	65	164	81	62	165	79
	21	63	159	80	61	160	77	59	160	74
	20	59	154	75	57	155	73	55	155	70
	19	55	150	70	53	149	68	51	148	66
2300	22	63	158	79	61	159	77	59	160	74
	21	59	154	75	57	155	72	55	155	70
	20	55	150	71	53	150	68	52	149	66
	19	52	144	66	50	143	64	48	142	62
2200	22	58	153	74	56	154	71	54	153	69
	21	55	149	70	53	149	68	51	148	66
	20	51	144	66	49	143	64	48	142	62
	19	48	138	62	46	137	60	44	135	58
	18	44	131	58	43	130	56	41	128	55

Figure 5-7. Cruise Performance (Sheet 4 of 6)

5-20

Table 3: Calculation of fuel for cruise

Scenario data	Data from AFM (interpolated)	Calculations
Power setting: • 2400 RPM @ 22" MP	% power: • 63%	Cruise distance (route distance – TOPC): • 161 NM – 24 NM = 137 NM
Cruise wind and temp: • 20 kt headwind, ISA +15 deg	TAS: • 165 kt	GS (TAS - headwind): • 165 kt – 20 kt =145 kt GS
Cruise level: • 8 500 ft	fuel flow: • 80 lbs/hr (POH Note – 6 lbs/hr reduced fuel flow)	cruise time (cruise distance / GS): • 137 NM/145 kt = 0.94 hr
		Fuel for cruise (cruise time x fuel flow): • 0.94 hr x 80 lbs/hr = 76 lbs.

Note: Cruise time in minutes = 0.94 hours x 60 minutes = 56 minutes.

Fuel for descent, approach and landing

The C210 POH does not provide descent data. Cruise fuel planning from the previous section provides the amount of fuel required for cruise from the TOPC to overhead the planned destination aerodrome. If the descent and approach to the planned destination aerodrome is anticipated to consume more fuel than would be used to cruise the same distance at cruise level, it would be prudent to include an approach allowance in the cruise fuel. This may be calculated at an intermediate level and at an appropriate power setting for the anticipated circumstances.

Total trip fuel – VFR

Having calculated the climb, cruise, descent and approach fuel amounts, the elements of trip fuel are known and can be summed. In the scenario presented, the calculation of total trip fuel is shown in Table 4.

Table 4: Calculation of total trip fuel - VFR

Trip scenario	Calculations	Total
Fuel amount	T/O (6 lbs) + climb (29 lbs) + cruise (76 lbs) + descent (0 lbs)	= 111 lbs
Time	Climb (16 min) + cruise (56 min)	= 72 mins

Table 5: Total trip fuel

Item	Fuel amount	Minutes	lbs	Litres
b	Trip fuel	70	111	70

Destination alternate fuel

Not required for this part of the scenario.

Holding fuel

Not required for this part of the scenario.

Contingency fuel

Not required for operations in this aeroplane.

Additional fuel

Not required for operations in this aeroplane.

Final reserve fuel

The final reserve fuel for this operation is fuel to fly for 30 minutes (0.5 hr), calculated at the anticipated weight at holding speed 1 500 ft above the planned destination aerodrome in ISA conditions.

While it does not provide fuel consumption rates for holding, the C210 POH does suggest that holding be conducted using 45% power.

The data used in this scenario is shown in Table 6.

CESSNA
MODEL 210M

SECTION 5
PERFORMANCE

CRUISE PERFORMANCE

PRESSURE ALTITUDE 2000 FEET

CONDITIONS:
3800 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

NOTE
For best fuel economy at 65% power or less operate at 6 PPH leaner than shown in this chart or at peak EGT if an EGT indicator is installed.

		20°C BELOW STANDARD TEMP -9°C			STANDARD TEMPERATURE 11°C			20°C ABOVE STANDARD TEMP 31°C		
RPM	MP	% BHP	KTAS	PPH	% BHP	KTAS	PPH	% BHP	KTAS	PPH
2550	25	- - -	- - -	- - -	78	166	98	76	168	95
	24	77	162	96	74	163	93	71	165	90
	23	72	158	91	70	160	88	67	161	85
	22	68	155	85	65	156	82	63	157	80
2500	25	78	163	98	76	164	95	73	166	92
	24	74	160	93	72	161	90	69	163	87
	23	70	156	88	68	158	85	65	159	82
	22	66	153	83	64	154	80	62	155	78
2400	25	73	159	92	71	161	89	68	162	86
	24	69	156	87	67	157	94	65	159	82
	23	66	153	83	63	154	80	61	155	77
	22	62	149	78	59	150	75	57	151	73
2300	25	69	155	86	66	157	84	64	158	81
	24	65	152	82	63	153	79	61	154	77
	23	61	149	77	59	150	75	57	150	73
	22	58	145	73	56	146	71	54	146	69
2200	25	64	151	80	61	152	77	59	153	75
	24	60	147	76	58	148	74	56	149	71
	23	57	144	72	55	145	70	53	145	68
	22	53	140	68	51	140	66	50	140	64
	21	50	136	64	48	135	62	46	134	60
	20	46	130	60	45	130	58	43	129	57

Figure 5-7. Cruise Performance (Sheet 1 of 6)

Table 6: Calculation of final reserve fuel

Scenario data	Data from AFM	Calculations
Anticipated aircraft weight: • 3 800 lbs	Power: • 2200 RPM @ 20" MP	Final reserve fuel (fuel flow x time): • 58 lbs/hr x 0.5 hr = 29 lbs
Holding speed: • determined using 45% power	TAS: • 130 kt	
Temp: • ISA	Fuel flow: • 58 lbs/hr	
Aerodrome elevation: • 234 ft		

Table 7: Final reserve fuel

Item	Fuel amount	Minutes	lbs	Litres
e	Final reserve fuel	30	29	18

Note: The amount of fuel that results from the 30-minute calculation under the conditions above DOES NOT ASSURE 30 MINUTES OF FLIGHT TIME IN ALL CONDITIONS. Should the actual aircraft fuel consumption rate exceed the rate calculated, such as for repeated circuits or approaches, somewhat less than 30 minutes of flight time may be available. For example, continuous application of full power at 2 000 ft would result in a fuel flow of greater than 100 lbs/hr (e.g. a C210 would consume 29 lbs of fuel in approximately 17 minutes at full power).

Usable fuel required at the commencement of a flight

Having calculated the fuel elements in the previous section, the minimum fuel required to conduct the flight, in this instance, is shown in Table 8.

Table 8: Usable fuel required at the commencement of the day VFR flight

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4
b	Trip fuel	72	111	70
c	Contingency fuel	0	0	0
d	Destination alternate fuel	0	0	0
e	Final reserve fuel	30	29	18
f	Additional fuel	0	0	0
g	Holding fuel	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	102	146	92

Margin fuel and endurance

Having determined the fuel and time for the planned flight, a calculation of the fuel that is in excess of the fuel quantity required allows margin fuel to be calculated. The starting point for this calculation is the amount of fuel planned to be on board the aircraft when the flight commences. In this example, we will use full tanks for the scenario C210 (543 lbs of usable fuel).

Having determined the usable fuel required at the commencement of a flight, we simply deduct the required amount from the usable fuel capacity (or payload limited capacity). This margin fuel can then be converted to a useful value of time (for a given parameter), such as at cruise fuel consumption or holding consumption. By convention (for flight plan endurance calculation), the margin fuel is converted to time at the last en-route cruise consumption rate.

Table 9: Calculation of margin fuel and endurance

From the AFM and Table	Calculations
Total usable fuel: • 543 lbs	Margin fuel (total useable – useable required): • 543 lbs – 146 lbs = 397 lbs
Useable fuel required: • 146 lbs	Margin time (margin fuel / fuel flow): • 397 lbs / 80 lbs/hr = 4.96 hr (298 min)
	Endurance (total useable fuel / fuel flow): • 543 lbs/80 lbs/hr = 6.79 hr (407 min)

Table 10: Margin and endurance

Item	Fuel amount	Minutes	lbs	Litres
h	Fuel required	299	2,911	1,654
i	Discretionary fuel	0	0	0
j	Margin fuel	66	734	417
k	Endurance	365	3,645	2,071

Overall fuel analysis

The overall fuel analysis for this journey is shown in Table 11 and Figure 1.

Table 11: Fuel analysis — day VFR (no destination alternate aerodrome

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4
b	Trip fuel	72	111	70
c	Contingency fuel	0	0	0
d	Destination alternate fuel	0	0	0
e	Final reserve fuel	30	29	18
f	Additional fuel	0	0	0
g	Holding fuel	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	102	146	92
i	Discretionary fuel	0	0	0
j	Margin fuel	298	397	251
k	Endurance (h+i+j)	407	543	343

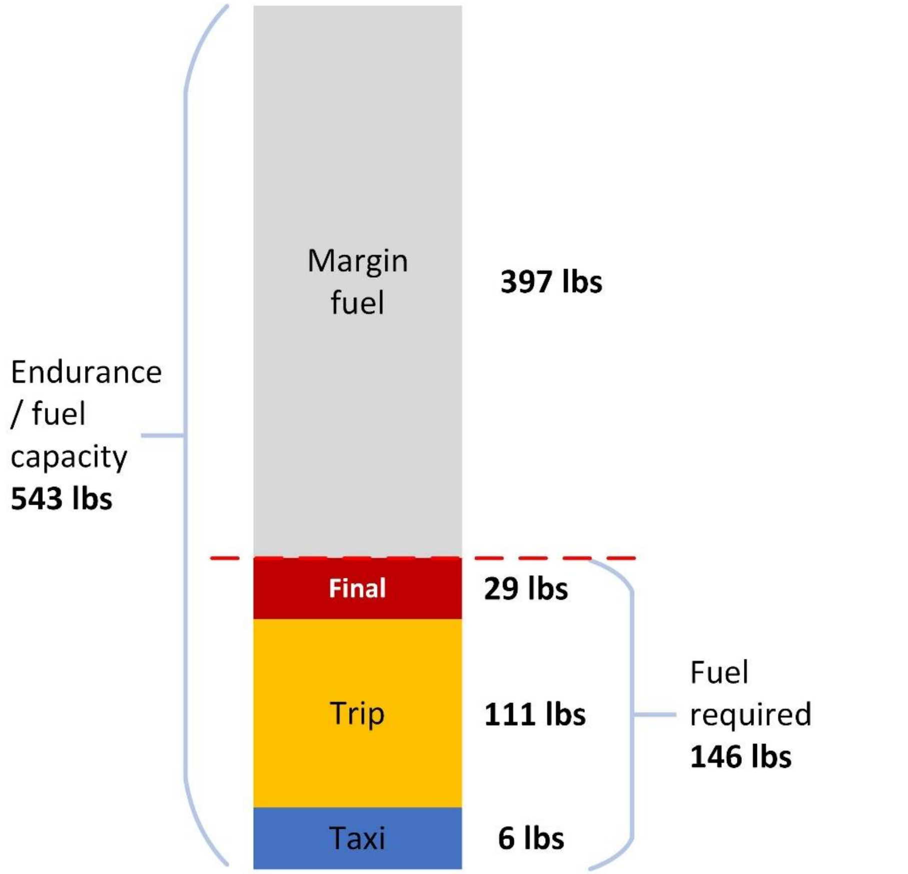


Figure 1: Fuel analysis — day VFR (no destination alternate aerodrome)

Essendon to Swan Hill – IFR – with destination alternate

When conducting this flight in a C210 under the IFR instead of the VFR, differences in fuel amounts will apply to trip fuel and final reserve fuel.

Trip fuel will be affected because of the requirement to cruise at a specified IFR cruising level and the inclusion of an allowance for the conduct of an instrument approach procedure.

Final reserve fuel will be affected because Part 91 of CASR states that the final reserve fuel for an IFR flight is 45 mins (instead of 30 mins as for VFR operations).

Taxi fuel

Fuel requirements are the same as for VFR operations.

Table 12: Taxi fuel

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4

Trip fuel

Total trip fuel – IFR

In this example, the selected cruising level is 6,000 ft. The C210 POH does not contain fuel flow data for instrument approaches, so a notional figure of 10 minutes (13 lbs) is included in the calculation of trip fuel.

Using the methods described in the section above for a VFR flight and the applicable C210 performance data, the elements of trip fuel can be determined. In the scenario presented, the calculation of total trip fuel is shown in Table 13.

Table 13: Calculation of total trip fuel - IFR

Trip scenario	Calculations	Total
Fuel amount	T/O (6 lbs) + climb (20 lbs) + cruise (81 lbs) + approach and landing (13 lbs)	= 120 lbs
Time	Climb (10 mins) + cruise (62 mins) + approach and landing (10 mins)	= 82 mins

Table 14: Trip fuel

Item	Fuel amount	Minutes	lbs	Litres
b	Trip fuel	82	120	76

Destination alternate fuel – Mildura

If the flight were conducted under such conditions that a destination alternate aerodrome was required by regulation 91.235 of CASR, the destination alternate fuel would need to be calculated. This is done in a similar manner to the calculation of trip fuel (but without the take-off element).

Destination alternate fuel is the amount of fuel required to enable an aircraft to do the following in a sequence:

- perform a missed approach at the destination aerodrome
- climb to the expected cruising altitude
- fly the expected routing to the destination alternate aerodrome
- descend to the point where the expected approach is initiated
- conduct the approach
- land at the destination alternate aerodrome.

For the scenario, the destination alternate aerodrome is 100 NM from the planned destination aerodrome.

Fuel for missed approach and climb

The C210 POH does not provide performance data for the conduct of a missed approach, so data for a normal climb (100 KIAS) are used. In the case of fuel for take-off and climb, data is obtained for a climb from aerodrome elevation to cruise altitude. However, in the case of fuel for a missed approach and climb, data is obtained for a climb from the missed approach altitude to cruise altitude.

Data is taken from the Normal Climb table and is determined for climb from 1 000 ft to 6 000 ft. Data is based an aircraft weight of 3 800 lbs for conservative calculations.

In this scenario, the calculation of total trip fuel is shown in Table 15.

SECTION 5
PERFORMANCE

CESSNA
MODEL 210M

TIME, FUEL, AND DISTANCE TO CLIMB

NORMAL CLIMB - 100 KIAS

CONDITIONS:
Flaps Up
Gear Up
2550 RPM
25 Inches Hg or Full Throttle
Cowl Flaps Open
Standard Temperature

MIXTURE SETTING	
PRESS ALT	PPH
S.L. to 4000	108
8000	96
12,000	84

NOTES:
1. Add 12 pounds of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
3. Distances shown are based on zero wind.

WEIGHT LBS	PRESS ALT FT	RATE OF CLIMB FPM	FROM SEA LEVEL		
			TIME MIN	FUEL USED POUNDS	DISTANCE NM
3800	S.L.	670	0	0	0
	2000	670	3	5	5
	4000	660	6	11	10
	6000	560	9	17	16
	8000	455	13	23	23
	10,000	355	18	31	33
	12,000	255	25	41	46
3500	S.L.	780	0	0	0
	2000	780	3	5	4
	4000	770	5	9	9
	6000	665	8	14	14
	8000	555	11	20	20
	10,000	445	15	26	28
	12,000	340	21	33	38
3200	S.L.	910	0	0	0
	2000	910	2	4	4
	4000	900	4	8	7
	6000	785	7	12	12
	8000	665	10	17	17
	10,000	550	13	22	23
	12,000	435	17	28	31

Figure 5-6. Time, Fuel, and Distance to Climb (Sheet 2 of 2)

Table 15: Calculation of fuel for missed approach and climb

Scenario data	Data from AFM	Temperature adjustment (adding 15% to the time, fuel, and distance in accordance with AFM instructions):	Wind correction (the climb wind is used to adjust the distance to climb, result is called top of climb or TOPC)
Aircraft weight (take-off weight – fuel burned): • 3 750 lbs – 126 lbs = 3 624 lbs	Time (9 mins – 1.5 mins): • 7.5 mins	Time: • 8.6 mins (0.14 hr)	TAS (distance/time): • 15.5 NM / 0.14 hr = 111 kt
Climb wind and temp: • 20 kt headwind, ISA +15 deg	Fuel (17 lbs – 2.5 lbs): • 14.5 lbs	Fuel: • 16.7 lbs	GS (TAS – headwind): • 111 kt - 20 kt = 91 kt
Cruise level:	Distance (nil wind) (16 NM	Distance (nil wind):	Wind-corrected distance to

Scenario data	Data from AFM	Temperature adjustment (adding 15% to the time, fuel, and distance in accordance with AFM instructions):	Wind correction (the climb wind is used to adjust the distance to climb, result is called top of climb or TOPC)
• 6 000 ft	– 2.5 NM): • 13.5 NM	• 15.5 NM	climb, TOPC (GS x time): • 91 kt x 0.14 hr = 13 NM.
Missed app. altitude (RNP APCH RWY 26): • 840 ft (rounded up to 1 000 ft)			

Fuel for cruise

For the example, we will again use a cruise power setting of 2400 RPM/22” MP, with ISA +15 deg and interpolate the data in the 6,000 ft table with respect to temperature from the C210 POH.

CESSNA
MODEL 210M

SECTION 5
PERFORMANCE

CRUISE PERFORMANCE

PRESSURE ALTITUDE 6000 FEET

CONDITIONS:
3800 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

NOTE
For best fuel economy at 65% power or less operate at 6 PPH leaner than shown in this chart or at peak EGT if an EGT indicator is installed.

		20°C BELOW STANDARD TEMP -17°C			STANDARD TEMPERATURE 3°C			20°C ABOVE STANDARD TEMP 23°C		
RPM	MP	% BHP	KTAS	PPH	% BHP	KTAS	PPH	% BHP	KTAS	PPH
2550	24	---	---	---	78	173	97	75	174	94
	23	76	167	96	74	169	92	71	171	89
	22	72	164	90	69	166	87	67	167	84
	21	68	160	85	65	162	82	63	163	80
2500	24	78	169	98	75	171	95	73	172	91
	23	74	166	93	71	167	90	69	169	87
	22	70	162	88	67	164	85	65	165	82
	21	66	158	83	63	160	80	61	160	77
2400	24	73	165	91	70	166	88	68	167	85
	23	69	161	87	67	163	84	64	164	81
	22	65	158	82	63	159	79	61	160	77
	21	61	154	77	59	155	75	57	155	73
2300	24	68	161	86	66	162	83	64	163	80
	23	65	158	82	62	159	79	60	159	76
	22	61	154	77	59	155	75	57	155	72
	21	57	150	73	55	150	71	53	150	68
2200	24	63	156	80	61	157	77	59	158	75
	23	60	152	76	58	153	73	56	154	71
	22	57	149	72	54	149	70	53	149	67
	21	53	144	68	51	144	66	49	143	64
	20	50	139	64	48	138	62	46	137	60
	19	46	133	60	44	132	58	43	131	57

Figure 5-7. Cruise Performance (Sheet 3 of 6)

5-19

Table 16: Calculation of fuel for cruise

Data from AFM	Calculations
% power: • 62%	Cruise distance (route distance – TOPC): • 100 NM - 13 NM = 87 NM
TAS: • 160 kt	Ground speed, GS (TAS - headwind): • 160 kt - 20 kt = 140 kt
Fuel flow: • 78 lbs/hr (POH Note – allow for a 6 lbs/hr reduced fuel flow)	Cruise time (cruise distance / GS): • 87 NM / 140 kt = 0.62 hr (37 mins)
	Fuel for cruise (cruise time x fuel flow): • 0.62 hr x 78 lbs/hr = 48 lbs.

Fuel for descent, approach and landing

In this scenario, the authorised weather forecast for the destination alternate aerodrome suggests that a visual approach can be conducted. NOTAMs and the AIP do not state that unusual tracking requirements are in force. Therefore, no extra descent or approach fuel is required.

Total destination alternate fuel

Having calculated fuel for missed approach and climb, cruise, and descent and approach, the amounts can be summed. In the scenario presented, the calculation of total trip fuel is shown in Table 17.

Table 17: Calculation of destination alternate fuel

Scenario	Total
Fuel amount: • missed app and climb (17 lbs) + cruise (48 lbs) + desc (0 lbs)	= 65 lbs
Time: • missed app and climb (9 mins) + cruise (37 mins) + desc (0 mins)	= 46 mins

Table 18: Destination alternate fuel

Item	Fuel amount	Minutes	lbs	Litres
d	Destination alternate fuel	46	65	41

Holding fuel

Not required for this part of the scenario.

Contingency fuel

Not required for operations in this aeroplane.

Additional fuel

Not required for operations in this aeroplane.

Final reserve fuel

Refer to AC 91-15 of CASR for the definition of final reserve fuel. The final reserve fuel for this operation is fuel to fly for 45 minutes (0.75 hr), calculated at the anticipated weight at holding speed 1 500 ft above the planned destination aerodrome in ISA conditions.

While it does not provide fuel consumption rates for holding, the C210 POH does suggest that holding be conducted using 45% power.

In this scenario, the calculation of final reserve fuel is shown in Table 19.

CESSNA
MODEL 210M

SECTION 5
PERFORMANCE

CRUISE PERFORMANCE

PRESSURE ALTITUDE 2000 FEET

CONDITIONS:
3800 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

NOTE
For best fuel economy at 65% power or less operate at 6 PPH leaner than shown in this chart or at peak EGT if an EGT indicator is installed.

		20°C BELOW STANDARD TEMP -9°C			STANDARD TEMPERATURE 11°C			20°C ABOVE STANDARD TEMP 31°C		
RPM	MP	% BHP	KTAS	PPH	% BHP	KTAS	PPH	% BHP	KTAS	PPH
2550	25	---	---	---	78	166	98	76	168	95
	24	77	162	96	74	163	93	71	165	90
	23	72	158	91	70	160	88	67	161	85
	22	68	155	85	65	156	82	63	157	80
2500	25	78	163	98	76	164	95	73	166	92
	24	74	160	93	72	161	90	69	163	87
	23	70	156	88	68	158	85	65	159	82
	22	66	153	83	64	154	80	62	155	78
2400	25	73	159	92	71	161	89	68	162	86
	24	69	156	87	67	157	84	65	159	82
	23	66	153	83	63	154	80	61	155	77
	22	62	149	78	59	150	75	57	151	73
2300	25	69	155	86	66	157	84	64	158	81
	24	65	152	82	63	153	79	61	154	77
	23	61	149	77	59	150	75	57	150	73
	22	58	145	73	56	146	71	54	146	69
2200	25	64	151	80	61	152	77	59	153	75
	24	60	147	76	58	148	74	56	149	71
	23	57	144	72	55	145	70	53	145	68
	22	53	140	68	51	140	66	50	140	64
	21	50	136	64	48	135	62	46	134	60
	20	46	130	60	45	130	58	43	129	57

Figure 5-7. Cruise Performance (Sheet 1 of 6)

Table 19: Calculation of final reserve fuel

Scenario data	Data from AFM	Calculations
Anticipated aircraft weight: • 3 800 lbs	Power: • 2200 RPM @ 20" MP	Final reserve fuel (fuel flow x time): • 58 lbs/hr x 0.75 hr = 43.5 lbs.
Holding speed: • determined using 45% power	TAS: • 130 kt	

Scenario data	Data from AFM	Calculations
Temp: • ISA	Fuel flow: • 58 lbs/hr	
Aerodrome elevation: • 234 ft		

Table 20: Final reserve fuel

Item	Fuel amount	Minutes	lbs	Litres
e	Final reserve fuel	45	44	28

Note: The amount of fuel that results from the 45-minute calculation under the conditions above DOES NOT ASSURE 45 MINUTES OF FLIGHT TIME IN ALL CONDITIONS. Should the actual aircraft fuel consumption rate exceed the rate calculated, such as for repeated circuits or approaches, somewhat less than 45 minutes of flight time may be available. For example, continuous application of full power at 2 000 ft would result in a fuel flow of greater than 100 lbs/hr (e.g. a C210 would consume 28 lbs of fuel in approximately 17 minutes at full power).

Usable fuel required at the commencement of a flight

Having calculated the fuel elements in the previous section, the minimum fuel required to conduct the flight, in this instance, is shown in Table 21.

Table 21: Usable fuel required at the commencement of the IFR flight

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4
b	Trip fuel	82	120	76
c	Contingency fuel	0	0	0
d	Destination alternate fuel	46	65	41
e	Final reserve fuel	45	44	28
f	Additional fuel	0	0	0
g	Holding fuel	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	173	235	149

Margin fuel and endurance

Having determined the fuel and time for the planned flight, a calculation of the fuel that is in excess of the fuel quantity required allows margin fuel to be calculated. The starting point for this calculation is the amount of fuel planned to be on board the aircraft when the flight commences. In this example, we will use full tanks for the scenario C210 (543 lbs of usable fuel).

Table 22: Calculation of margin fuel and endurance

Data from AFM and Table	Calculations
Total usable fuel: • 543 lbs	Margin fuel (total useable – useable required): • 543 lbs – 235 lbs = 308 lbs
Useable fuel required: • 235 lbs.	Margin time (margin fuel / fuel flow): • 308 lbs / 80 lbs/hr = 3.85 hr (231 mins)
	Endurance (total useable fuel / fuel flow): • 543 lbs / 80 lbs/hr = 6.79 hr (407 mins).

Table 23: Margin fuel and endurance

Item	Fuel amount	Minutes	lbs	Litres
h	Fuel required	173	235	149
i	Discretionary fuel	0	0	0
j	Margin fuel	231	308	195
k	Endurance (h+i+j)	404	543	344

Overall fuel analysis

The overall fuel analysis for this journey is shown in Table 24 and Figure 2.

Table 24: Fuel analysis — IFR (with destination alternate aerodrome)

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4
b	Trip fuel	82	120	76
c	Contingency fuel	0	0	0
d	Destination alternate fuel	46	65	41
e	Final reserve fuel	45	44	28
f	Additional fuel	0	0	0
g	Holding fuel	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	173	235	149
i	Discretionary fuel	0	0	0
j	Margin fuel	231	308	195
k	Endurance (h+i+j)	404	543	344

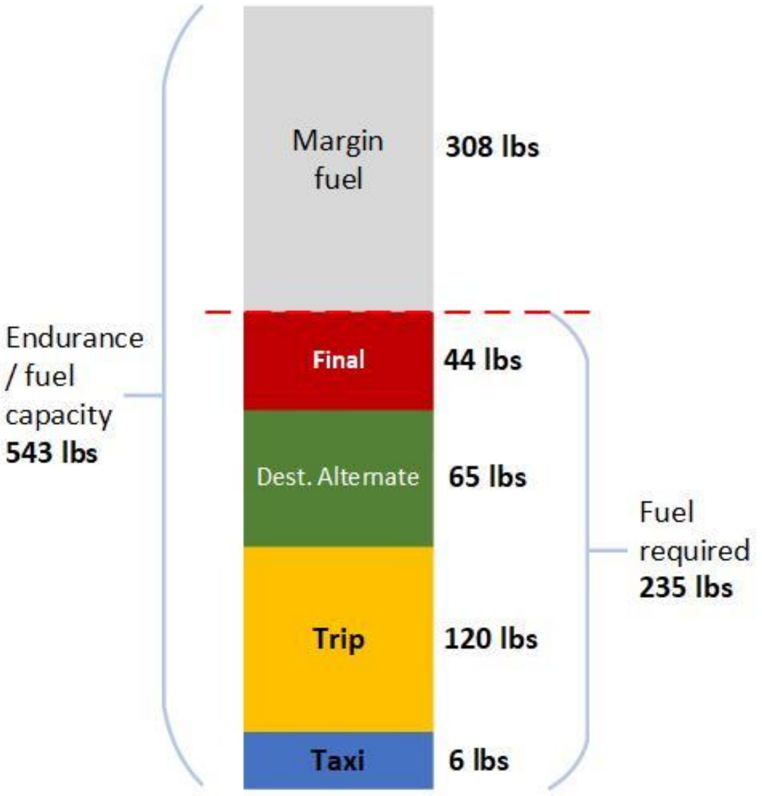


Figure 2: Fuel analysis — IFR (with destination alternate aerodrome)

Contingency fuel

Contingency fuel is an amount of fuel required to compensate for unforeseen factors. For a Part 91 operation of a small aeroplane (piston or turboprop), contingency fuel is not a legislative requirement. The pilot in command may choose to apply contingency fuel if they see fit, or they may alternatively include this value as discretionary fuel – but neither is compulsory.

Overall fuel analysis

The overall fuel analysis (including an optional contingency fuel) for this journey is shown in Table 25 and Figure 3.

Table 25: Fuel analysis — IFR with destination alternate aerodrome (optional contingency)

Item	Fuel amount	Minutes	lbs	Litres
a	Taxi fuel	0	6	4
b	Trip fuel	82	120	76
c	Contingency fuel	8	13	8
d	Destination alternate fuel	46	65	41
e	Final reserve fuel	45	44	28
f	Additional fuel	0	0	0
g	Holding fuel	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	181	248	157
i	Discretionary fuel	0	0	0
j	Margin fuel	221	295	187
k	Endurance (h+i+j)	402	543	344

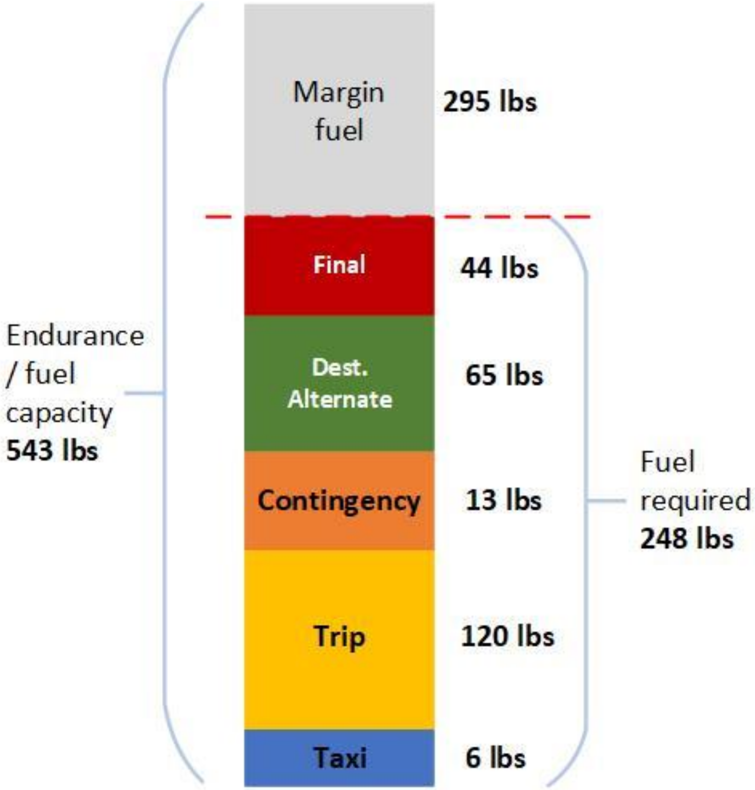


Figure 3: Fuel analysis — IFR with destination alternate aerodrome (optional contingency)

Putting it all together

The graphical representations in Figure 4 illustrate the various fuel elements calculated in the scenarios described in the preceding sections.

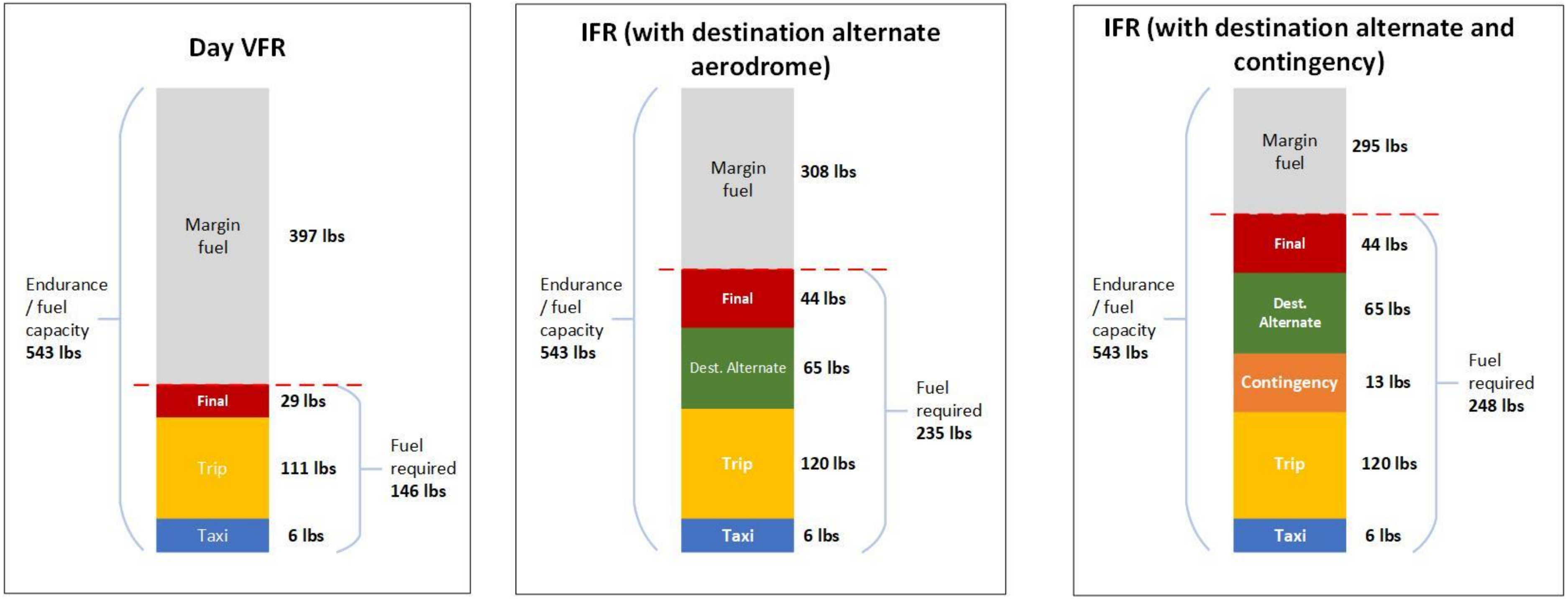


Figure 4: Fuel analysis comparison