Australian Government
Civil Aviation Safety Authority

CIVIL AVIATION ADVISORY PUBLICATION

CAAP 234-1(2)

Guidelines for aircraft fuel requirements

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This Civil Aviation Advisory Publication (CAAP) provides guidance, interpretation and explanation on complying with the Civil Aviation Regulations 1988 (CAR) or a Civil Aviation Order (CAO).

This CAAP provides advisory information to the aviation industry in support of a particular CAR or CAO. Ordinarily, the CAAP will provide additional 'how to' information not found in the source CAR, or elsewhere.

Civil Aviation Advisory Publications should always be read in conjunction with the relevant regulations/orders and the associated explanatory documents.

Audience

This Civil Aviation Advisory Publication (CAAP) is of interest to:

- all operators of Australian registered aircraft.

Purpose

The purpose of this CAAP is to provide information on fuel requirements for aircraft required by regulations 220 and 234 of CAR.

For further information

For further information on this CAAP, contact CASA's Flight Standards Branch (telephone 131 757).

Status

This version of the CAAP is approved by the Manager, Flight Standards Branch.

Note: Changes made in the current version are not annotated. The document should be read in full.

Version	Date	Details
(2)	November 2018	This is the second revision of this CAAP and supersedes CAAP 234-1(1) published November 2006. The changes in this revision are to: • more closely align Australian legislation with ICAO Annex 6 Standards and Recommended Practices • address recommendations from the Australian Transport Safety Bureau (ATSB) investigations into fuel related incidents and accidents • adopt international standards for in-flight fuel management • provide detailed guidance on the application of in-flight fuel management techniques. The major changes included in this revision are: • clarification of existing definitions and new definitions • reference to *Civil Aviation (Fuel Requirements) Instrument 2018* as the legislative basis for fuel requirements • inclusion of additional fuel quantity • expanded description of methods of determining fuel quantity • inclusion of a detailed description of in-flight fuel management procedures and practices • inclusion of sample fuel calculations and detailed worked examples.
(1)	November 2006	This is the second CAAP to be written on this subject.
(0)	March 1991	This CAAP is the first issue of CAAP 234-1; there are no previous issues to cancel.

Contents

The following Annexes are published as separate documents to this CAAP

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this CAAP are listed in the table below.

Acronym	Description
AOC	Air Operators Certificate
ATC	Air Traffic Control
ATS	Air Traffic Services
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CP	Critical Point
DP	Decision Point
EDTO	Extended Diversion Time Operations
ETP	Equi-time Point
ERA	En-route Alternate
FCM	Fuel Consumption Monitoring
FQIS	Fuel Quantity Indicating Systems
ISA	International Standard Atmosphere
IFR	Instrument Flight Rules
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List
OEI	One-engine Inoperative
OEM	Original Equipment Manufacturer
PIC	Pilot in Command
PNR	Point of No Return
RPT	Regular Public Transport

1.2 Definitions

Terms that have specific meaning within this CAAP are defined in the table below.

Term	Definition
Additional fuel	The supplementary amount of fuel required if the minimum fuel calculated in accordance with paragraphs 4.2.1 and 4.3.1 is not sufficient to allow the aircraft to descend as necessary and proceed to an alternate aerodrome in the event of engine failure or loss of pressurisation (if applicable)—whichever requires the greater amount of fuel based on the assumption that such a failure occurs at the most critical point along the route—then fly for 15 minutes at holding speed at 1,500ft above aerodrome elevation in international standard atmosphere (ISA) conditions; and make an approach and landing. See Appendix A - Additional fuel calculation for further information. **Note:** Fuel planning for a failure that occurs at the most critical point along a route may place the aircraft in a fuel emergency situation.
Alternate aerodrome	An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the destination aerodrome and where the necessary services and facilities are available, where aircraft performance requirements can be met and which is operational at the expected time of use. **Note:** For definitions using the term 'aerodrome' CAR 92(1) provisions apply.
Alternate fuel	The amount of fuel required to enable the aircraft to perform a missed approach at the destination aerodrome, fly the expected routing to the destination aerodrome, conduct the approach and landing at the destination alternate aerodrome.
Ballast fuel	Fuel that may be required to be carried to maintain the aircraft centre of gravity within limits. In certain aeroplanes, a zero fuel weight above a defined threshold requires that a minimum amount of fuel be carried in the wing fuel tanks through all phases of flight to prevent excessive wing bending. When ballast fuel is required, that fuel is considered ballast and is not considered part of the usable fuel load for the flight.
Critical point	The point along a route which is most critical from a fuel requirement point of view. The critical point is usually, but not always, the last ETP, between the final en-route alternate (ERA) and the destination, along a route. **Note:** The critical point may, dependent upon the circumstances, coincide with a decision point.
Decision point	A point along a route from which an aircraft can complete the flight to the destination aerodrome while maintaining the required amount of fuel to proceed to the destination aerodrome, or if insufficient to continue to the destination aerodrome, divert to an en-route alternate (ERA) while maintaining the required amount of fuel.**Note:** For the purpose of fuel requirement calculations and decision making, the terms, 'point of in-flight replanning', 're-release point', 're-dispatch point' and 'decision point' are interchangeable. **Note:** Where no destination alternate is required, once past the final decision point, the flight may not have the ability to divert and may be committed to landing at the destination aerodrome.
Destination aerodrome	The aerodrome to which a flight is planned at the commencement of the flight.
Destination alternate	An alternate aerodrome at which an aircraft would be able to land should it become either impossible or inadvisable to land at the destination aerodrome.

Term	Definition
	Note: The aerodrome from which a flight departs may also be an en-route alternate or destination alternate aerodrome for that flight.
Discretionary fuel	The extra amount of fuel to be carried at the discretion of the pilot-in-command (PIC).
Emergency fuel	Is a situation of fuel emergency which arises when the calculated usable fuel predicted to be available upon landing at the nearest aerodrome where a safe landing can be made is less than the fixed fuel reserve. **Note:** The emergency fuel declaration is a distress message.
En-route alternate	An alternate aerodrome at which an aircraft would be able to land in the event that a diversion becomes necessary while en-route.
Equi-time point	A point along the planned route that is located at the same flight time from two points. **Note:** Equi-time point may also be referred to as the Equal time point.
Fixed fuel reserve	The amount of fuel, expressed as a period of time, for a helicopter conducting an IFR flight, an aeroplane or an airship, required to fly at holding speed at 1,500 feet above aerodrome elevation at ISA conditions, or for a helicopter conducting a VFR flight, required to fly at best-range speed, calculated with the estimated weight on arrival at the destination alternate aerodrome, or the destination aerodrome when no destination alternate aerodrome is required, that would be useable fuel remaining in the fuel tanks until completion of the final landing. **Note:** The values of fixed fuel reserve to be applied by type and category of operation are contained in column 3 of Table 1.
Holding fuel	The quantity of fuel that will allow an aircraft to fly for a specified period of time calculated at the holding fuel consumption rate established for the aircraft for the anticipated operational conditions, environmental conditions or ISA.
Margin fuel	The quantity of usable fuel in excess of the fuel required.
Master minimum equipment list	A list established for a particular aircraft type by the original equipment manufacturer (OEM) responsible for the type design, which is then approved by CASA to contain items that are permitted to be unserviceable at the commencement of a flight. The MMEL may be associated with special operating conditions, limitations or procedures.
Minimum fuel	Occurs when, having committed to land at a specific aerodrome, the PIC calculates that any change to the existing ATC clearance to that aerodrome may result in landing with less than fixed fuel reserve. **Note:** The declaration of MINIMUM FUEL informs air traffic control (ATC) that all planned aerodrome options have been reduced to a specific aerodrome of intended landing and any change to the existing clearance may result in landing with less than fixed fuel reserve. This is not an emergency situation but an indication that an emergency situation is possible should any additional delay occur. Pilots should not expect any form of priority handling as a result of a MINIMUM FUEL declaration. ATC will, however, advise the flight crew of any additional expected delays as well as coordinate when transferring control of the aircraft to ensure other ATC units are aware of the aircraft's fuel state.
Point of no return	The last possible geographic point at which an aircraft can proceed to an available en-route alternate (ERA) aerodrome for a given flight. It is the point beyond which diversion to the en-route alternate aerodrome is no longer

Term	Definition
	possible and the PIC is committed to proceeding to the destination aerodrome.
Remote island	Christmas Island, the Cocos (Keeling) Islands, Lord Howe Island or Norfolk Island.
Take-off alternate	An alternate aerodrome at which an aircraft would be able to land should this become necessary shortly after take-off and it is not possible to use the departure aerodrome.
Taxi fuel	The amount of fuel expected to be used prior to take-off. Local conditions at the departure aerodrome and auxiliary power unit consumption (if applicable) shall be taken into account. **Note:** For helicopter operations requiring a take-off prior to taxi, such as hover taxi from a confined helipad, taxi fuel would be the fuel expected to be consumed prior to the commencement of the departure.
Trip fuel	The amount of fuel required to enable the aircraft to fly until landing at the destination aerodrome, taking into account the operating conditions in paragraph 3.3. This includes (as applicable): a. fuel for take-off and climb from departure aerodrome elevation to initial cruising level/altitude, taking into account the expected departure routing, and b. fuel for cruise from top of climb to top of descent, including any step climb/descent, and 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 conducting an approach and landing at the destination aerodrome.
Unforeseen factors	Factors that could have an effect on fuel consumption to the destination aerodrome, such as deviations of an individual aircraft from the expected fuel consumption data, deviations from forecast meteorological conditions, extended delays and deviations from planned routings and/or cruising levels.
Unusable fuel	The quantity of fuel which is on board the aircraft but is unable to be used due to fuel tank design/construction. **Note:** Unusable fuel is included in the basic weight and maximum zero fuel weight as apply.
Usable fuel	The quantity of fuel which is available in the fuel tanks for supply to the engine(s).
Variable fuel reserve	The amount of fuel required to compensate for unforeseen factors. It shall be the highest of the percentage of the planned trip fuel specified in column 4 of Table 1 for the applicable category and class of aircraft or, in the event of in-flight re-planning, the percentage specified in column 4 of Table 1 for the trip fuel from the point of in-flight re-planning, or the fuel required to fly for 5 minutes at holding speed at 1,500 ft above the destination aerodrome elevation in ISA conditions (as applicable). **Note:** Variable fuel reserve does not apply to alternate fuel. **Note:** ICAO terminology equivalent to variable fuel reserve is *contingency fuel*.

1.3 References

Regulations

Regulations are available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Regulation 92 of CAR	Use of aerodromes
Regulation 138 of CAR	Pilot to comply with requirements etc of aircraft's flight manual etc
Regulation 220 of CAR	Fuel instructions and records
Regulation 234 of CAR	Fuel requirements
CAO 20.2	Air service operations — safety precautions before flight
CAO 82.0	Civil Aviation Order 82.0
CAO 95.4	Civil Aviation Order 95.4
Instrument Number CASA - 29/18	CASA 29/18 — Civil Aviation (Fuel Requirements) Instrument 2018
Annex 6, Part 1,	Operation of Aircraft - International Commercial Air Transport - Aeroplanes (11th edition No. 43 2018)
Annex 6, Part 2	Operation of Aircraft - International General Aviation - Aeroplanes (10th edition No. 36 2018)
Annex 6, Part 3	Operation of Aircraft - International Operations - Helicopters (9th edition No. 22 2018)
ICAO Document 9976	Flight Planning and Fuel Management (FPFM) Manual (1st edition 2016)
ICAO Doc 4444 PANS-ATM	Air Traffic Management (16th edition No. 7A 2016)

Advisory material

CASA's Civil Aviation Advisory Publications are available at http://www.casa.gov.au/CAAP

Document	Title
CAAP 82-1(1)	Extended Diversion Time Operations (EDTO)
CAAP 215-1(2)	Guide to the preparation of Operations Manuals

2 Introduction

2.1 Aircraft fuel management

2.1.1 The primary goal of effective fuel management is to ensure protection of fuel reserves to allow safe completion of flight, with a secondary goal of improving operational efficiency by reducing unnecessary fuel uplift.

2.1.2 The total quantity of usable fuel required to be carried on board an aircraft must be sufficient for the planned flight and must include a safe margin for deviations from the planned operation.

2.2 Basic principles

2.2.1 Legislation requires fuel to be planned, uplifted and managed to allow an aircraft to land with fixed fuel reserves intact. The basic principles of aircraft fuel management are divided into four broad topics that address fuel-related considerations and procedures:

- the matters to be considered in determining sufficient fuel quantity for flight (section 3)
- determining the quantity of fuel that must be carried for a flight (section 4)
- determining, recording and monitoring fuel quantity (section 5)
- procedures to be followed in the event of fuel quantity below specified levels (section 6).

3 Matters to be considered in determining sufficient fuel quantity for a flight

3.1 General

3.1.1 To mitigate some of the risks posed by the variability of the aviation environment, a range of fuel-related matters must be referred to[1] in order to ensure that a fuel quantity sufficient to ensure the safe completion of flight is determined before the flight is commenced and thereafter continued.

3.2 Aircraft-specific fuel consumption data

3.2.1 Effective fuel planning and fuel management rely on the accuracy of the predicted fuel consumption rate. The accuracy of the fuel consumption data used for planning and decision-making varies according to the source of the data.

3.2.2 Where available, current aircraft-specific fuel consumption data derived from a fuel consumption monitoring (FCM) system must be used[2]. In the absence of such data, the original equipment manufacturer's (OEM) fuel consumption data must be used. Where the OEM aircraft flight manual or pilot's operating handbook does not contain such data, the engine manufacturer's fuel consumption data should be used.

Note: This may be the case for certain reciprocating engine helicopters.

3.2.3 Where no specific fuel consumption data exists for the precise conditions of the flight, the aircraft may be operated in accordance with known or estimated fuel consumption data.

3.3 Operating conditions for the planned flight

3.3.1 The following operating conditions potentially affect the predicted fuel consumption for a planned flight:

- anticipated weight of the aircraft
- Notices to Airmen
- meteorological reports and forecasts (i.e. temperature, wind, turbulence, icing, smoke)
- ATC procedures, restrictions and anticipated delays
- effects of deferred maintenance items and/or configuration deviations e.g. configuration deviation list or supplementary type certificate.

Note: Any fuel consumption performance penalties associated with unserviceable items, usually permitted in accordance with the MEL or MMEL, should be applied to the planned flight.

[1] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 4
[2] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 4(a)

3.4 Potential deviations from planned flight path

3.4.1 The pre-flight planning stage should produce an efficient flight plan that provides minimum sector time (and associated minimum fuel consumption) on the best possible route that avoids adverse weather conditions and follows all air traffic management requirements.

3.4.2 Pilots and operators must consider the adverse effects on fuel consumption of potential or likely deviations from the optimum planned path or flight conditions. To this end, flight planning must be based on realistic assumptions and assessments. When potential or likely deviations from planned fuel consumption are not well considered, there is an increased likelihood that the actual fuel consumption may exceed planned consumption, with possible erosion of safety margins.

Note: Not all flights will seek to minimise sector time between departure and destination aerodromes. e.g. scenic, surveillance or survey operations. Those types of flights should, however, consider the optimum flight path for the final route segment when returning to land and the potential for deviations from that routing.

4 Quantity of fuel that must be carried for a flight

4.1 Fuel reserves

4.1.1 The quantities of fixed fuel reserve and variable fuel reserve required for a flight are prescribed in *Civil Aviation (Fuel Requirements) Instrument 2018* and reproduced in Table 1.

Item	Column 1	Column 2	Column 3	Column 4
	Aircraft	Flight Rules	Fixed Fuel Reserve	Variable Fuel Reserve
Other than RPT and charter (e.g. Private, aerial work and flying training)				
1	Small aeroplane (piston or turboprop)	Day VFR	30 minutes	N/A
2	Small aeroplane (piston or turboprop)	IFR or Night VFR	45 minutes	N/A
3	Turbojet & Large Aeroplane (turboprop)	IFR or VFR	30 minutes	5%
4	Large Aeroplane (piston)	IFR or VFR	45 minutes	5%
5	Helicopter	VFR	20 minutes	N/A
6	Helicopter	IFR	30 minutes	N/A
7	Airship	IFR or VFR	30 minutes	N/A
RPT and charter				
8	Piston aeroplane	IFR or VFR	45 minutes	10% (not less than 5 minutes)
9	Turbojet or turboprop aeroplane	IFR or VFR	30 minutes	5% (not less than 5 minutes)
10	Helicopter	VFR	20 minutes	10%
11	Helicopter	IFR	30 minutes	10%
12	Airship	IFR or VFR	30 minutes	N/A

Table 1: Fixed fuel reserve and variable fuel reserve requirements

Note: Variable fuel reserve for RPT and charter operations in aeroplanes is the higher of either:

a) the specified percentage (%) of trip fuel (as time), or

b) an amount of fuel to fly for 5 minutes at holding speed at 1,500 ft above the destination aerodrome elevation in ISA conditions.

4.1.2 When variable fuel reserve is required and the specified minimum value of 5 minutes applies, it is intended to mitigate the risk of unforeseen factors that are not proportional to the length of flight, but to a per-sector occurrence, such as unexpected holding, delays or additional tracking (such as to avoid traffic or weather) within the arrival terminal area.

4.2 Usable fuel quantity required at the commencement of a flight

4.2.1 The pre-flight planning process must[3] include a calculation of the quantity of usable fuel an aircraft must carry before the flight commences. The quantity of usable fuel required to be on board at the commencement of a flight must include:

- taxi fuel
- trip fuel from take-off
- variable fuel reserve (if specified in Table 1)
- alternate fuel (if required)
- fixed fuel reserve
- holding fuel (as required)
- additional fuel (if applicable).

4.2.2 The commencement of a flight, for the purposes of fuel requirements is when the aircraft first moves under its own power for the purpose of take-off. There may, however, be helicopter operations that, for the purposes of departing the aerodrome, require an airborne segment of the taxi before take-off.

4.3 Usable fuel quantity required to continue a flight

4.3.1 The quantity of usable fuel required to be on board from a decision point or from a point of in-flight re-planning must[4] include:

- trip fuel from the decision point or point of in-flight re-planning
- variable fuel reserve (if specified in Table 1)
- alternate fuel (if required)
- fixed fuel reserve
- holding fuel (as required)
- additional fuel (if applicable).

4.3.2 The quantity of usable fuel required to be on board to continue a flight must[5] include:

- trip fuel from that time
- alternate fuel (if required)
- fixed fuel reserve
- holding fuel (as required)
- additional fuel (if applicable).

[3] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(2)
[4] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(3)
[5] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(4)

Note: The principle difference between the generic fuel requirements to continue a flight (paragraph 4.3.2) and the fuel required from a point of in-flight re-planning or decision point (paragraph 4.3.1) is the requirement for a variable fuel reserve.

4.3.3 If, during a flight, the PIC decides to use fuel for a purpose other than was intended during pre-flight planning, they must[6] conduct a re-analysis and, if applicable, adjust the planned flight to ensure continued compliance with the minimum usable fuel requirements. This will ensure that fuel that was intended or required for the continuation of the flight is not consumed during a prior flight phase without the PIC giving appropriate consideration to the consequences.

4.3.4 Consumption of taxi fuel in excess of that planned may reduce the quantity of remaining available fuel to less than the amount required to safely conduct the flight. In such a case, the flight may not proceed without re-planning. Similarly, the use of trip fuel in excess of that planned may reduce the quantity of available alternate fuel to less than the required amount, thus necessitating re-planning or diversion.

4.3.5 When planned fuel is not consumed in a prior phase, the surplus fuel may be used in a subsequent phase. For example, if a flight is planned with the requirement for a destination alternate and during the course of the flight that operational requirement is removed; the planned alternate fuel may be used for other purposes. However, the fixed fuel reserve must be preserved in all cases.

4.3.6 Circumstances may arise during a flight where the conditions at, or suitability of, the destination aerodrome, destination alternate, or en-route alternates may change. Where a flight is planned and commenced with a quantity of fuel that complies with the requirements of paragraph 4.2.1[7] to safely conduct the flight and during the course of the flight a change to conditions occurs that imposes a fuel requirement, such as an alternate requirement or a holding requirement where none existed during planning, the PIC must comply with requirements described in paragraph 4.3.2[8] as applicable to continue the flight safely.

Note: In some circumstances the PIC may be required to divert to an alternative suitable aerodrome when a requirement is imposed that was not in place prior to the commencement of the flight, placing the aircraft in-flight in a situation where fuel requirements brought about by the change in circumstances cannot be met. If this situation occurs once the aircraft is beyond the last point of safe diversion, the PIC's options will have been reduced to continuing to the planned destination with less than the required fuel.

4.4 Variable fuel reserve

4.4.1 The calculation and uplift of variable fuel reserve is a means of mitigating, to some degree, the risks associated with operational factors or hazards that cannot be planned, anticipated or controlled.

4.4.2 The broad nature of the uncertainties that lead to the requirement for a variable fuel reserve mean that there are numerous factors which can influence its use during flight. In many instances the variable fuel reserve remains unconsumed throughout flight and is remaining upon arrival at the destination. Alternatively, operational factors may

[6] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(5)
[7] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(2)
[8] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 5(4)

necessitate consumption of variable fuel reserve throughout the flight, or even before becoming airborne.

4.4.3 There are some instances where preservation of variable fuel reserve is required, such as where it forms part of the fuel quantity to meet the additional fuel calculation or EDTO critical fuel scenarios. It is helpful to consider the variable fuel reserve in terms of being protected or unprotected dependent upon the degree to which its consumption at various points throughout the flight is acceptable.

4.4.4 For example, a flight that is planned and is required to uplift a quantity of additional fuel above the basic fuel calculation requirements to meet the one-engine inoperative (OEI)/depressurised contingency from a critical point in the flight, would be required to have protected the variable fuel reserve through the flight to the critical point. Without doing so, the required worst case plan could not be achieved, if it were to eventuate.

4.4.5 In instances where variable fuel reserve is protected for a particular purpose, the consumption of any of the variable fuel reserve prior to the critical point should necessitate recalculation and, if necessary a diversion, to an ERA.

4.5 Usable fuel quantity required for flights to remote islands

Passenger-carrying aeroplane operations to remote islands—undertaken as RPT, charter or aerial work operations for ambulance functions (i.e. medical transport operations including positioning legs)—have additional specific conditions and requirements as detailed in CAO 82.0. The CAO 82.0 conditions prescribe, among other things, that when the flight commences, the aeroplane must not be carrying less than the minimum safe fuel for the flight.

4.5.1 The minimum safe fuel for a passenger-carrying flight to a remote island is the greater of:

- the amount of fuel sufficient to enable the aeroplane to fly, whatever the weather conditions, with all its engines operating, to its destination aerodrome on the remote island and then from the destination aerodrome to its destination alternate, plus any required fuel reserves

  and
- the amount of fuel that would, if the failure of an engine or loss of pressurisation were to occur during the flight, enable the aeroplane to:
  - fly to the planned destination aerodrome on the remote island or to its destination alternate for the flight, and
  - fly for 15 minutes at holding speed at 1,500 ft above that aerodrome under ISA conditions, and
  - make an approach and land at that aerodrome.

4.5.2 CASA recommends that private flights and non-passenger carrying aerial work flights to remote islands carry fuel quantities as described in paragraph 4.5.1, where possible.

4.6 Fuel quantity required for extended diversion time operations

4.6.1 Fuel quantity requirements, approvals and considerations for extended diversion time operations (EDTO), as applicable to holders of an Air Operator's Certificate, are contained in CAO 82.0 and detailed in CAAP 82-1(1).

5 Determining, recording and monitoring fuel quantity

5.1 General

5.1.1 Knowing how much fuel is on-board during the flight is essential to safety. The process of determining, recording and monitoring fuel quantity—to ensure fuel reserves are protected—is divided into three task phases in order to differentiate the priorities and consequential elements required as a flight commences and then continues:

- pre-flight fuel quantity checks (section 5.2)
- in-flight fuel quantity checks (section 5.3)
- in-flight fuel management (section 5.4)
- post-flight fuel quantity checks. (section 5.5).

5.2 Pre-flight fuel quantity checks

5.2.1 Before commencing a flight, the PIC must[9] ensure that a pre-flight determination of the quantity of useable fuel on-board the aircraft is conducted. It is of critical importance that the actual usable fuel quantity on-board an aircraft at the commencement of, and during a flight, is known with the highest level of certainty. The actual fuel quantity contained in the tanks at the commencement of the flight is the datum upon which fuel calculations and subsequent fuel-related decisions are based. For an air operator certificate (AOC) holder, the quantity of usable fuel on-board before flight commencement must be recorded[10] and for all other operators it is highly recommended that this quantity is recorded.

5.2.2 Unless assured and verified by the PIC that the aircraft fuel tanks are completely full, or a totally reliable and accurately graduated dipstick, sight gauge, drip gauge or tank tab reading can be made, the PIC should endeavour to use the best available fuel quantity crosscheck process before engine start. The crosscheck should use at least two different verification methods to determine the quantity of fuel on board. The following are examples of recommended verification combinations:

- check of visual readings (e.g. tank tab, dipstick, drip gauge, sight gauges) against fuel consumed indicator readings
- having regard to previous readings, a check of cockpit fuel quantity indications or visual readings against fuel consumed indicator readings
- after refuelling and having regard to previous readings, a check of cockpit fuel quantity indications or visual readings against the refuelling uplift readings
- when a series of flights is undertaken by the same pilot and refuelling is not carried out at intermediate stops, checking of the cockpit fuel quantity indications against computed fuel on board and/or fuel consumed indicator readings, provided the particular system is known to be reliable.

5.2.3 Where a discrepancy in fuel quantity is apparent between fuel quantity verification methods, another method should be used in order to attempt to eliminate an erroneous

[9] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 6(1)
[10] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 6(3)

figure. CASA recommends that a conservative approach be taken, using the lower quantity figure as the basis for fuel calculations and the higher figure for aircraft weight calculations. Any persisting disparity between fuel verification methods should be investigated and resolved

5.2.4 Fuel gauges, particularly on smaller aircraft, may be unreliable. Except when the fuel tank is full, it is difficult to accurately establish the quantity of fuel in a tank unless the aircraft is in the attitude recommended by the manufacturer and the manufacturer has provided an accurately graduated dipstick, sight gauge, drip gauge or fuel tank tab. Unless the aircraft is in the attitude recommended by the manufacturer, any direct reading of a partially filled tank should be discounted or rounded down to a figure consistent with the next lower tab or marking.

5.2.5 Placing sole reliance on a fuel quantity gauge to assess fuel quantity (i.e. not cross-checking fuel quantity information from a second source), exposes the PIC to the risk of being unable to determine actual fuel remaining should the fuel quantity gauge indication become faulty.

5.2.6 Given the designs and location of some aeroplane and helicopter fuel tank installations, it is often difficult to obtain a direct reading of fuel tank quantity at a level other than full. In order to ensure an accurate fuel quantity, it is imperative that flight times and fuel uplifts are recorded and routinely reconciled as part of the fuel quantity cross-checks. The accurate recording of flight times and respective fuel uplifts presents an additional means of tracking actual fuel consumption for subsequent flight planning and in-flight fuel management decision-making. Periodic filling to full, allows a baseline from which flight-time based fuel consumption tracking can be verified.

5.2.7 Modern certified fuel quantity indication systems (FQIS) can integrate fuel tank probe volume readings and fuel density measurements, combined with full authority digital engine control engine fuel consumption information, to present the flight crew with the weight of the fuel remaining in the fuel tanks. These systems may also contain independent fuel tank low fuel level warning sensors. Even so, the manufacturers of these systems still recommend that the flight crew conduct regular in-flight checks of the fuel remaining according to the FQIS to confirm anticipations and detect any discrepancies.

5.3 In-flight fuel quantity checks

5.3.1 The PIC must[11] ensure that fuel quantity checks are carried out in-flight at regular intervals. The established quantity of usable fuel remaining is evaluated to:

- compare actual fuel consumption with planned fuel consumption
- determine that the usable fuel remaining is sufficient to complete the planned flight (see paragraph 4.3.2)
- determine the expected usable fuel remaining on landing at the destination aerodrome.

[11] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 6(2)

5.3.2 The interval between in-flight fuel quantity checks should be sufficient to allow the PIC to remain aware of the aircraft fuel state. In addition to periodic fuel quantity checks, there are instances where a specific fuel check is necessary to ensure that in-flight decisions are supported by accurate fuel state awareness. For example, specific checks are needed before passing a decision point, point of no return (if applicable) or a critical point.

5.3.3 Whenever possible, the in-flight fuel quantity checks should include a reconciliation of the fuel remaining indicated from the available aircraft fuel quantity indication systems, such as debit-meters. Raw data information, such as fuel quantity gauges, should also be checked to confirm fuel balance and fuel tank quantity against known fuel usage so as to minimise the possibility of an undetected fuel leak. The maximum efficiency for fuel quantity checks is achieved when conducted at regular intervals and which follow a consistently applied methodology.

5.3.4 For AOC holders, the operator's operations manual must[12] contain procedures for recording the fuel quantity data evaluated and determined during the in-flight fuel quantity checks. CASA recommend that non-AOC holders, where possible, record the fuel quantity data determined during in-flight fuel quantity checks.

5.4 In-flight fuel management

5.4.1 In-flight fuel management can be thought of as the combination of the in-flight fuel monitoring elements described in detail in sub-section 5.3 of this CAAP and the procedures contained in section 6.

5.4.2 In-flight fuel management is the practical means, after a flight has commenced, that enables the PIC to ensure that fuel is either:

- used in the manner intended during pre-flight planning, or in-flight re-planning, or
- when conditions or fuel consumption during a flight differ from the values used in planning, used to enable an alternative course of action to safely complete the flight.

5.4.3 In-flight fuel management does not replace pre-flight planning or in-flight re-planning activities, rather, it acts to ensure continual validation of planning assumptions that influence fuel usage and required fuel reserves. Such validation serves as a trigger for re-analysis and adjustment activities that ultimately ensure that each flight is safely completed with the planned fixed fuel reserve on board where a safe landing can be made.

5.4.4 The simplified conceptual elements for in-flight fuel management include:

- determining useable fuel remaining
- comparing actual consumption and useable fuel remaining against the planned values
- analysing whether sufficient fuel remains to continue with the planned flight (if so; continue as planned)

[12] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 6(3)(b)

- where insufficient fuel remains to continue with the planned flight, re-plan to an available alternate safe landing area
- if no option exists where a landing can be accomplished at a safe landing area whilst maintain the required fuel reserves, the PIC is required to declare a fuel emergency state, 'MAYDAY Fuel' and continue to nearest safe landing area.

5.4.5 A depiction of the conceptual elements and process flow of in-flight fuel management is provided in Figure 1.

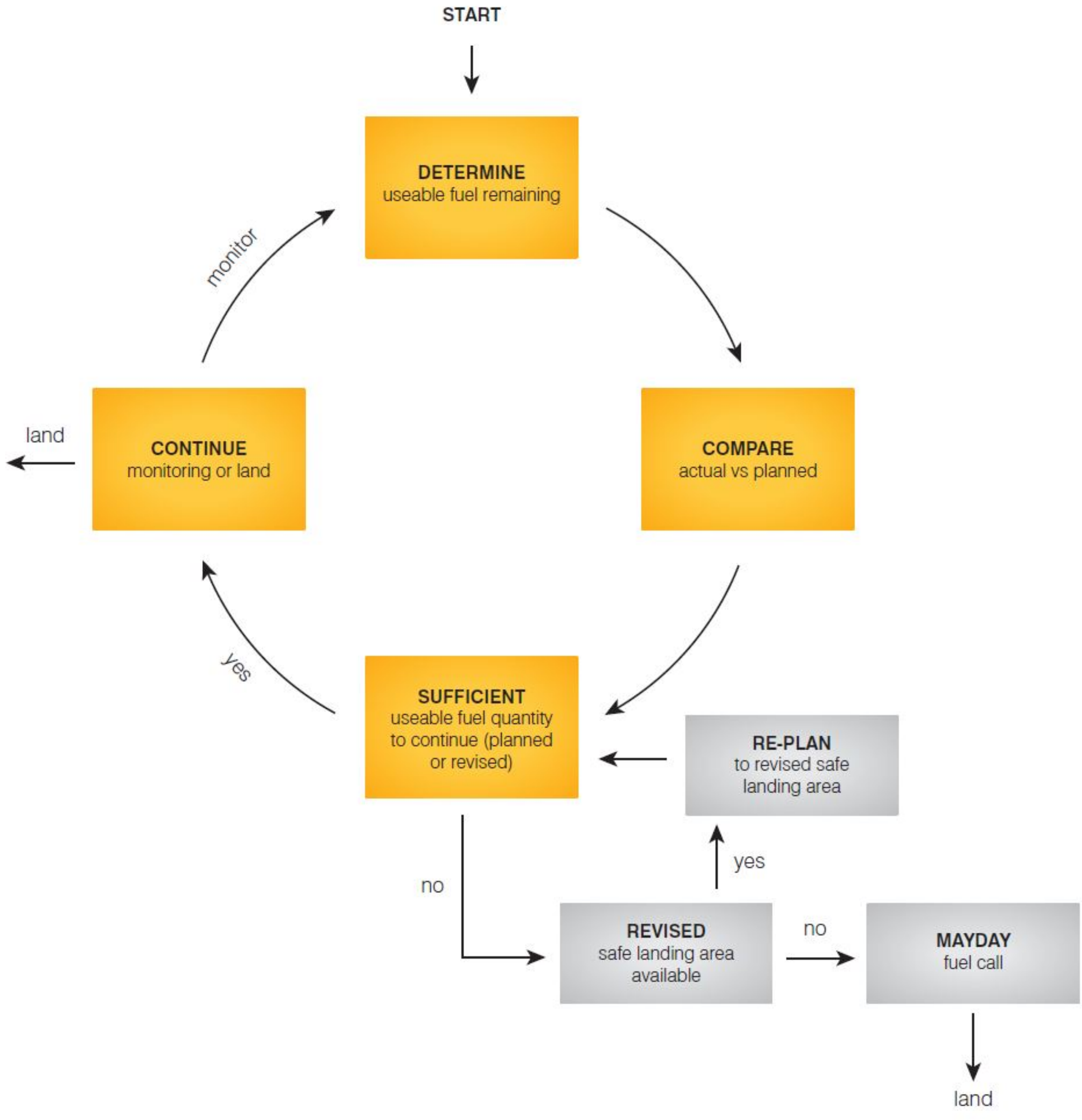

Figure 1: In-flight fuel management process diagram

5.4.6 For flights that are limited to uplifting only a small margin of fuel above minimum requirements, the PIC should ensure that a decision point (the point of last diversion to the final en-route alternate) is identified during the pre-flight planning stage. During the course of the flight, the decision point should be assessed and, if necessary, revised based upon actual fuel consumption and known or anticipated in-flight conditions. This is particularly important when operating to a remote island or other isolated aerodrome.

5.4.7 The revised decision point should be the latest point by which the PIC obtains and assesses updated destination information (i.e. meteorological conditions, traffic and other operational conditions at the destination aerodrome) in order to validate the destination planning assumptions and allow timely diversion to occur if necessary (i.e. the revised decision point is the final opportunity to assess options for preserving the required fuel reserves should the destination aerodrome no longer be available). It is recommended that the operational information for the destination alternate and ERA/s is also obtained and assessed prior to the final decision point.

5.5 Post-flight fuel management

5.5.1 Various legislative requirements exist for operations conducted under an AOC to have procedures for operators to determine and record the fuel quantity remaining in the aircraft after a flight and for the operator to verify the adequacy of fuel calculation and instructions used. It is highly recommended that the post-flight fuel quantity is determined and recorded in all instances.

5.6 Fuel quantities and associated flight manual procedures

5.6.1 Many aircraft flight manuals contain procedures to be followed in the event of fuel below specified levels. Many aircraft FQIS have gauge or indicator markings which are designed to indicate the ‘safe operating ranges’ as determined by the aircraft manufacturer, which may not necessarily be the same as those contained in *Civil Aviation (Fuel Requirements) Instrument 2018* and reproduced in Table 1.

5.6.2 Additionally, some aircraft have systems which provide independent fuel tank low fuel level warnings or cautions to the PIC. Those indicators may have associated flight manual procedures to be followed by the PIC, should the indication occur.

5.6.3 Pilots are reminded of the legislative requirements[13] to comply with an instruction, procedure or limitation concerning the operation of the aircraft that is set out in the aircraft’s manual.

Note: There may be requirements, instructions, procedures or limitations contained in aircraft flight manuals that set minimum fuel quantity values that exceed the legislative minimum values. Where these exist, the flight manual value must be complied with.

[13] *Regulation 138 of CAR (1988)*, sub-regulation (1).

6 Procedures in the event of fuel quantity below specified levels

6.1 Identification and communication of fuel states

6.1.1 Four procedural steps can be used to identify and communicate situations in which the fuel quantity falls below the threshold level for that step (Table 2). A detailed description of each step follows in sub-sections 6.2 to 6.5.

Steps to identify and communicate fuel states	
Step 1	The PIC is to continually ensure that the amount of usable fuel remaining on board is not less than the fuel required to proceed to an aerodrome where a safe landing can be made, with the planned fixed fuel reserve remaining upon landing.
Step 2	Request delay information when unexpected circumstances may result in landing at the destination aerodrome with less than the fixed fuel reserve.
Step 3	Declare “MINIMUM FUEL” when committed to land at a specific aerodrome and any change in the existing clearance may result in a landing with less than planned fixed fuel reserve.
Step 4	Declare a fuel emergency when the calculated fuel on landing at the nearest suitable aerodrome (i.e. where a safe landing can be made) will be less than the planned fixed fuel reserve.

Table 2: Steps to protect fuel reserves

6.2 Step 1: In-flight fuel check value less than planned value (not less than required)

6.2.1 If, as a result of an in-flight fuel quantity check, the actual fuel remaining is less than the planned fuel remaining and is close to the minimum amount specified—but not projected to be less than the required fixed fuel reserve for the planned flight—the PIC should endeavour to restore fuel safety margins provided by the variable fuel reserve (as applicable) by:

- flying at a more economical speed than planned
- seeking a more economical cruise level
- seeking more efficient routing from ATC
- re-routing to reduce the length of the critical diversion
- selecting a different (closer) destination alternate, if feasible.

6.3 Step 2: Expected fuel remaining is approaching minimum values

6.3.1 When the PIC recognises that unexpected circumstances may result in the aircraft landing at the destination aerodrome with less than the fuel required to proceed to an alternate aerodrome (if applicable) plus fixed fuel reserve, they should request delay information from ATC.

6.3.2 The request for delay information is not a request for assistance or an indication of urgency. It is simply a procedural means for the PIC to determine an appropriate course of action when confronted with unexpected delays.

6.3.3 There is no specific phraseology recommended for use with ATC in this case as each situation may be different. The PIC would use the information obtained from ATC to determine the best course of action, up to and including a determination of when it would be necessary to divert to an alternate aerodrome and/or make additional declarations related to the fuel state of the flight.

6.4 Step 3: Minimum fuel state

6.4.1 After a request for delay information, the minimum fuel declaration represents the third step taken by the PIC to ensure remaining fuel on board is used as planned and the fixed fuel reserve is protected. The PIC must[14] declare “MINIMUM FUEL” when, based on the current ATC clearance at the aerodrome to which the aircraft is committed, any change to the existing clearance to that aerodrome may result in landing with less than the fixed fuel reserve for the flight.

6.4.2 The minimum fuel declaration is intended to convey that, provided the current clearance is not adversely modified, the flight should be able to proceed as cleared without compromising the PIC’s responsibility to protect the fixed fuel reserve.

Note: Steps 2 and 3 only apply when operations are subject to, or likely to be subject to an ATC clearance.

6.5 Step 4: Emergency fuel situation

6.5.1 The aircraft is in an emergency fuel situation when the usable fuel predicted to be remaining upon landing at the nearest suitable aerodrome (i.e. where a safe landing can be made) will be less than the required fixed fuel reserve[15].

6.5.2 The PIC must declare an emergency fuel situation by broadcasting “MAYDAY MAYDAY MAYDAY FUEL”. This declaration provides the clearest and most urgent expression of an emergency situation brought about by an insufficient quantity of usable fuel remaining to protect the fixed fuel reserve. It communicates that immediate action must be taken by both the PIC and the ATC authority (if subject to an ATC clearance) to ensure that the aircraft can land as soon as possible.

6.5.3 The word “FUEL” is used as part of the emergency declaration simply to convey the nature of the emergency to ATC. It is also important to note that an emergency

[14] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 7(4)
[15] *Civil Aviation (Fuel Requirements) Instrument 2018*, paragraph 7(5)

declaration may make available courses of action not previously available and also allows ATC to apply extra flexibility in handling the aircraft.

6.5.4 When operations are not subject to an ATC clearance, the declaration of emergency fuel situation on Area VHF frequency notifies ATC of the emergency situation and enables aircraft in the vicinity to ensure they do not inhibit the emergency aircraft. In locations where Area VHF communication is limited, aircraft in the vicinity may be able to provide assistance through radio relay to ATC.

7 Helicopter fuel differences

7.1 General

7.1.1 Whilst the requirements for helicopters generally follow the same rules as for aeroplanes, the ability of the helicopter to land safely away from aerodromes influences the required fuel reserve quantities.

7.1.2 Flights over hostile terrain or populated areas (i.e. where precautionary landings are not possible or that present a consequential survival problem) may prompt the carriage of increased fuel reserves in order to mitigate the risks posed by the limited options for a safe precautionary landing.

Appendix A

Additional fuel calculation

A.1 Scenario 1 – Additional fuel not required

A.1.1 Figure 2 illustrates a generic scenario where the uplift of additional fuel is not required. The basic fuel calculation for the flight results in a greater quantity of fuel than the additional fuel calculation.

A.1.2 This scenario illustrates an instance where the variable fuel reserve quantity could be consumed without reducing the basic fuel calculation value to less than the additional fuel calculation value; as such, the variable fuel reserve is considered unprotected.

A.1.3 Unprotected variable fuel reserve can be consumed prior to the critical fuel point without rendering the fuel calculation for that point invalid.

A.1.4 If a portion of the variable fuel reserve was required in the basic fuel calculation to meet the additional fuel calculation, then that portion of the variable fuel reserve would be protected and could not be consumed prior to the critical fuel point, without consideration of an alternative ERA strategy or diversion.

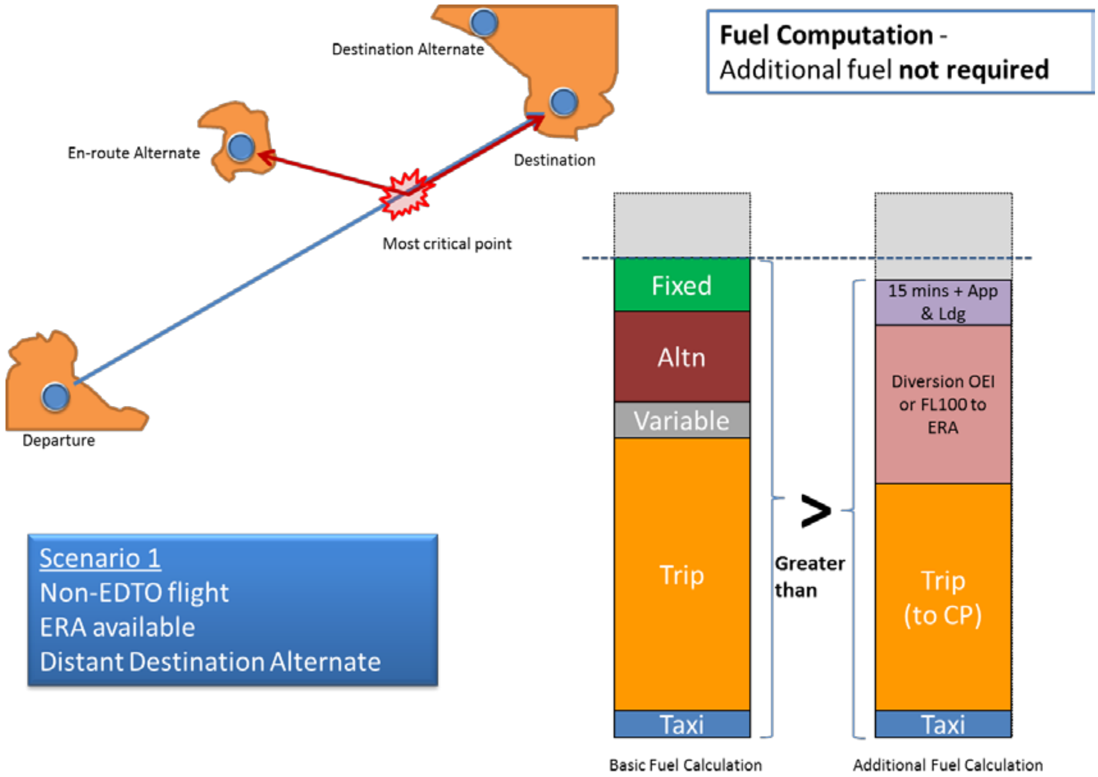

Figure 2: Fuel calculation scenario – additional fuel not required

A.2 Scenario 2 – Additional fuel required

A.2.1 The generic scenario illustrated in Figure 3 varies from Figure 2 in that the ERA is more distant from the CP and the destination alternate is closer to the destination than in the prior scenario. This generic scenario now results in a basic fuel calculation value being less than the fuel required to meet the additional fuel calculation, and therefore the flight is required to uplift a quantity of additional fuel, to meet the critical fuel scenario quantity required.

A.2.2 In this case it should be noted that all of the variable fuel reserve is required to be combined with the quantity of additional fuel uplifted to meet the critical fuel scenario value; as such, the variable fuel reserve is required to be protected.

A.2.3 On similar flights where variable fuel reserve is not required under the *Civil Aviation (Fuel Requirements) Instrument 2018*, the amount of additional fuel required to be carried would be increased to accommodate the absence of the variable fuel reserve quantity from the basic fuel calculation.

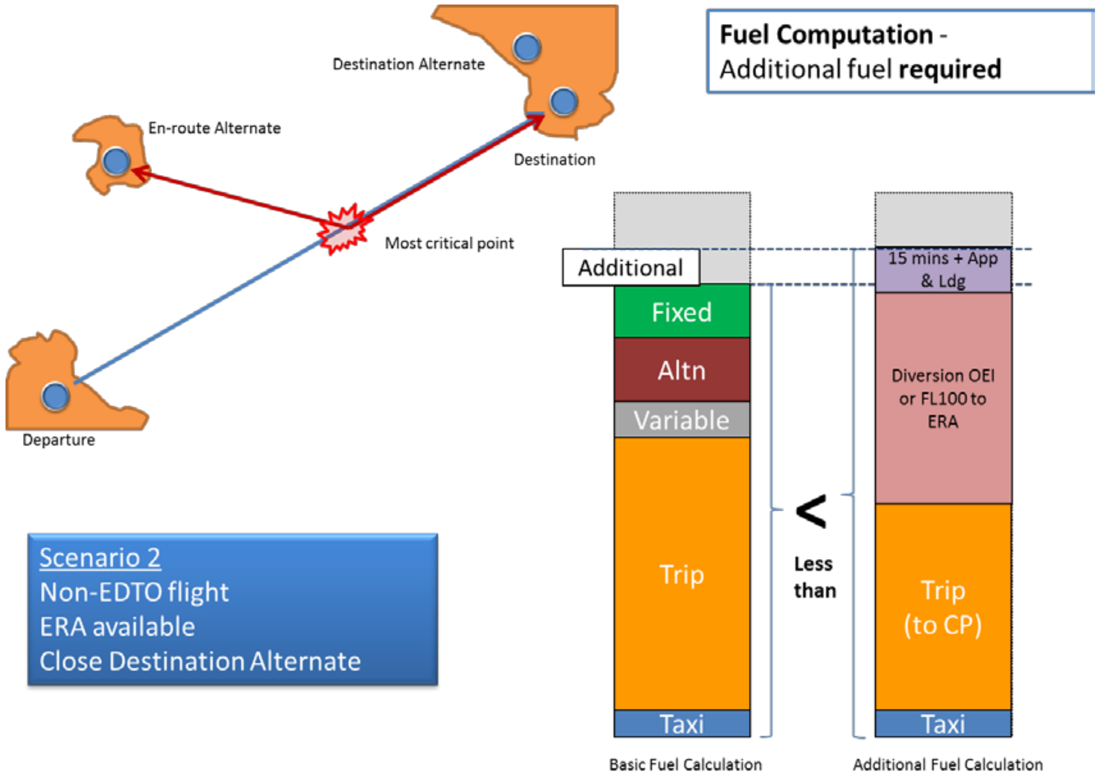

Figure 3: Fuel calculation scenario –additional fuel required

Appendix B

Sample fuel calculations

B.1 Sample Fuel Calculations

B.1.1 The following section contains several sample fuel calculations that incrementally build in complexity based on the fuel requirements legislation.

B.1.2 The intent is to provide samples that serve to illustrate the practical application of the requirements and guidance contained in the body of this CAAP.

B.1.3 Annex A contains detailed sample Cessna 210 fuel planning guidance and calculations that support the abridged scenarios contained in B.2, B.3, and B.4. The flight route for the scenario is from Essendon to Swan Hill. Mildura is selected as the destination alternate for the scenario development where a destination alternate is required.

B.1.4 Annex B contains detailed sample Super King Air B200 fuel planning guidance and calculations that support the abridged scenarios contained in B.5 and B.6. The flight route for the scenario is from Darwin to Cairns. Townsville is the destination alternate for the scenario development where a destination alternate becomes required.

B.1.5 Annex C is an advanced sample based on a Learjet 60 aircraft. The sample planning illustrates some of the concepts, methods and application of planning rules and techniques such as ETP and PSR. The flight route for the scenario is from Melbourne Essendon to Norfolk Island. Noumea is the destination alternate for the scenario development where a destination alternate is required.

B.2 Sample 1a: Private Day VFR flight - Essendon to Swan Hill

B.2.1 The flight is a private day VFR piston single-engine aeroplane flight from Essendon to Swan Hill.

B.2.2 The quantity of usable fuel required to be on board at the commencement of the flight calculated taking into consideration the factors contained in paragraph 3.3.1.

Start and Taxi: 0 mins/6 lbs

Trip Fuel: 73 mins/111 lbs

Take-off (0 mins/6 lbs), Climb (16 mins/29 lbs),

Cruise (57 mins/76 lbs), Descent and Approach (0 lbs)

Fixed Fuel Reserve: 30 mins/30 lbs

Item	Fuel calculation	Min	lbs, L or kg	Min	lbs, L or kg
a	Taxi fuel	0	6	0	4
b	Trip fuel	73	111	73	70
c	Variable fuel reserve (% of b)	0	0	0	0
d	Alternate fuel	0	0	0	0
e	Fixed fuel reserve	30	30	30	19
f	Additional fuel	0	0	0	0
g	Holding fuel	0	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	103	147	103	93
i	Discretionary fuel	0	0	0	0
j	Margin fuel	297	396	297	251
k	Endurance (h+i+j)	400	543	400	344

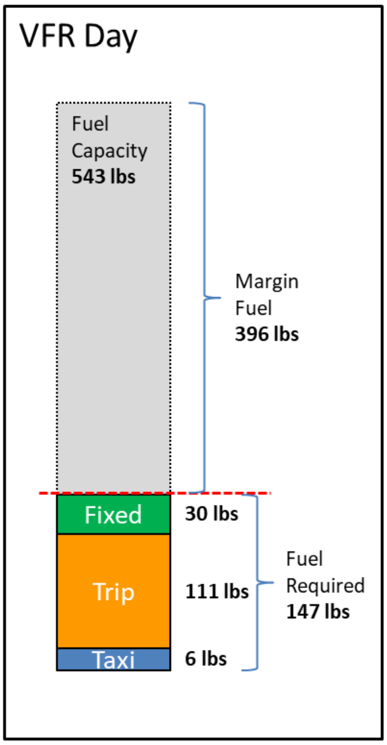

Figure 4 - Fuel analysis table and graphical depiction

B.2.3 Additional information pertaining to this sample calculation is contained in Annex A to this CAAP.

B.3 Sample 1b: Private Day IFR flight - Essendon to Swan Hill (no destination alternate)

B.3.1 In addition to the fuel calculated in Sample 1a, if the flight is conducted as an IFR flight, the inclusion in trip fuel of an appropriate allowance for an instrument approach is now required. The fixed fuel reserve is now required to be 45 minutes.

B.3.2 The resultant fuel required is shown below:

Start and Taxi: 0 mins/6 lbs

Trip Fuel: 83 mins/126 lbs

Take-off (0 mins/6 lbs), Climb (16 mins/29 lbs),

Cruise (57 mins/76 lbs), Descent and Approach (10 mins/15 lbs)

Fixed Fuel Reserve: 45 mins/45 lbs

Item	Fuel calculation	Min	lbs, L or kg	Min	lbs, L or kg
a	Taxi fuel	0	6	0	4
b	Trip fuel	83	126	83	80
c	Variable fuel reserve (% of b)	0	0	0	0
d	Alternate fuel	0	0	0	0
e	Fixed fuel reserve	45	45	45	28
f	Additional fuel	0	0	0	0
g	Holding fuel	0	0	0	0
h	Fuel required (a+b+c+d+e+f+g)	128	177	128	112
i	Discretionary fuel	0	0	0	0
j	Margin fuel	275	366	275	232
k	Endurance (h+i+j)	403	543	403	344

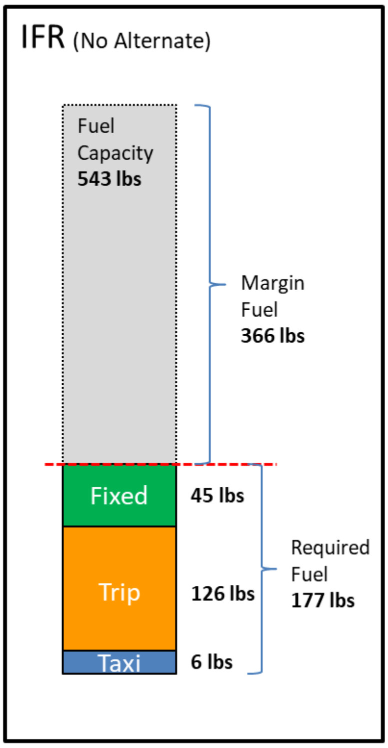

Figure 5 - Fuel analysis table and graphical depiction

B.3.3 Additional information pertaining to this sample calculation is contained in Annex A to this CAAP.

B.4 Sample 1c: Private Day IFR flight - Essendon to Swan Hill (with destination alternate - Mildura)

B.4.1 Following from the fuel calculated in Sample 1b, the flight now requires a destination alternate, in this case Mildura is selected. Alternate fuel is now required. The resultant fuel required is shown below:

Start and Taxi: 0 mins/6 lbs

Trip Fuel: 83 mins/126 lbs

Take-off (0 mins/6 lbs), Climb (16 mins/29 lbs)

Cruise (57 mins/76 lbs), Descent and Approach (10 mins/15 lbs)

Fixed Fuel Reserve: 45 mins/45 lbs

Alternate Fuel: 45 mins/65 lbs

Climb (7 mins/14 lbs), Cruise (38 mins/51 lbs)

Descent and Approach (0 mins/0 lbs))

Item	Fuel calculation	Min	lbs, L or kg	Min	lbs, L or kg
a	**Taxi fuel**	0	6	0	4
b	**Trip fuel**	83	126	83	80
c	**Variable fuel reserve** (% of b)	0	0	0	0
d	**Alternate fuel**	45	65	45	41
e	**Fixed fuel reserve**	45	45	45	28
f	**Additional fuel**	0	0	0	0
g	**Holding fuel**	0	0	0	0
h	**Fuel required** (a+b+c+d+e+f+g)	173	242	173	153
i	**Discretionary fuel**	0	0	0	0
j	**Margin fuel**	226	301	226	191
k	**Endurance** (h+i+j)	399	543	399	344

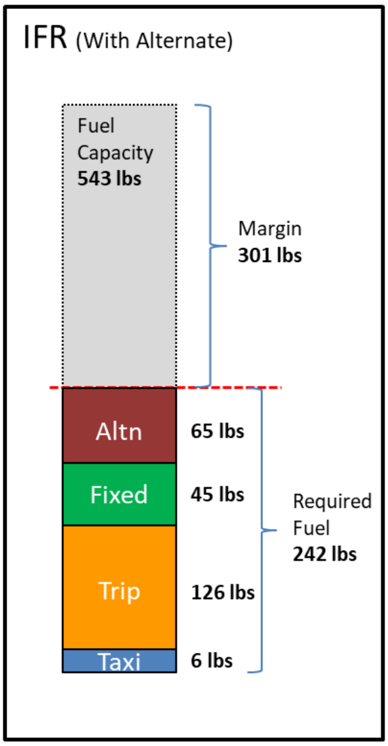

Figure 6 - Fuel Analysis Table and Graphical Depiction

B.4.2 Additional information pertaining to this sample calculation is contained in Annex A to this CAAP.

B.5 Sample 2a: Private IFR flight - Darwin to Cairns (No en-route alternate)

B.5.1 In order to illustrate a scenario where the additional fuel calculation is required the following IFR flight is provided:

B.5.2 The flight is a private IFR flight conducted in a small turbine multi-engine aeroplane from Darwin to Cairns, with no available en-route alternates and no requirement for a destination alternate.

B.5.3 The basic fuel calculation is shown below:

Start and Taxi: 0 mins/40 lbs

Trip Fuel: 240 mins/2223 lbs

Take-off (0 mins/50 lbs), Climb (20 mins/242 lbs),

Cruise (197 mins/1711 lbs), Descent (18 mins/170 lbs), and

Approach (5 mins/50 lbs)

Fixed Fuel Reserve: 45 mins/450 lbs

Item	Fuel calculation	Min	lbs, L or kg
a	**Taxi fuel**	0	40
b	**Trip fuel**	240	2223
c	**Variable fuel reserve** (% of b)	0	0
d	**Alternate fuel**	0	0
e	**Fixed fuel reserve**	45	450
f	**Additional fuel**	0	0
g	**Holding fuel**	0	0
h	**Fuel required** (a+b+c+d+e+f+g)	285	2713
i	**Discretionary fuel**	0	0
j	**Margin fuel**	93	932
k	**Endurance** (h+i+j)	378	3645

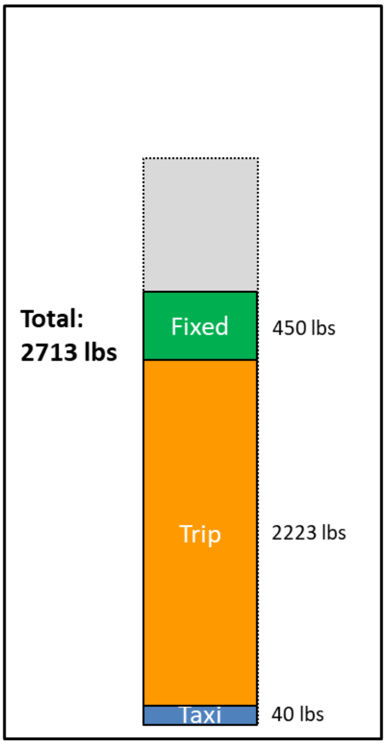

Figure 7 - Basic fuel analysis table and graphical depiction

B.5.4 The scenario describes a situation where there are no available ERAs. In that case, the basic fuel calculation shown in Figure 7 may not address the critical fuel scenario requirements. The amount of additional fuel required, must be calculated.

B.5.5 The first step is to determine the critical point, in this scenario, between Darwin and Cairns. The wind adjusted CP occurs (for the depressurised case - being most limiting for the aeroplane type chosen) at a position 487 Nm from Darwin and 419 Nm onwards to Cairns.

B.5.6 The fuel required to fly depressurised from the CPD on/or back, conduct an approach and landing with 15 minutes of holding fuel remaining, is 1594 lbs.

B.5.7 The planned fuel required (taxi + trip fuel) to fly as planned to the CPD is calculated to be 1317 lbs. The fuel required to meet critical fuel scenario is therefore the sum of the fuel required to the CPD and the fuel from the CPD, which is 2911 lbs.

B.5.8 The basic fuel required is 2713 lbs, however the fuel to meet the critical fuel scenario is 2911 lbs, the difference value of 198 lbs must be uplifted as additional fuel, as part of the fuel for the flight.

Item	Fuel calculation	Min	lbs, L or kg
a	**Taxi fuel**	0	40
b	**Trip fuel**	240	2223
c	**Variable fuel reserve** (% of b)	0	0
d	**Alternate fuel**	0	0
e	**Fixed fuel reserve**	45	450
f	**Additional fuel**	14	198
g	**Holding fuel**	0	0
h	**Fuel required** (a+b+c+d+e+f+g)	299	2911
i	**Discretionary fuel**	0	0
j	**Margin fuel**	73	734
k	**Endurance** (h+i+j)	372	3645

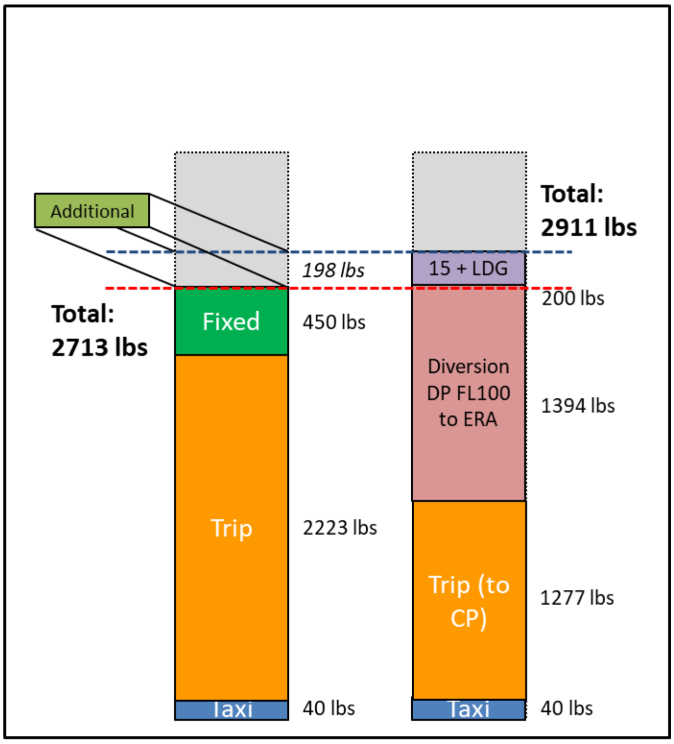

Figure 8 - Basic fuel with additional fuel and graphical depiction

B.5.9 Additional information pertaining to this sample calculation is contained in Annex B to this CAAP.

B.6 Sample 2b: Charter IFR flight - Darwin to Cairns with destination alternate and ERA

B.6.1 In order to illustrate a scenario where the additional fuel calculation is required the following IFR flight is provided:

B.6.2 The flight is a Charter IFR flight conducted in a small turbine multi-engine aeroplane from Darwin to Cairns, with an en-route alternate at Mt Isa and a requirement for a destination alternate, Townsville.

B.6.3 The basic fuel calculation is shown below:

Start and Taxi: 0 mins/40 lbs

Trip Fuel: 240 min/2223 lbs

Take-off (0 mins/50 lbs), Climb (20 mins/242 lbs)

Cruise (197 mins/1711 lbs), Descent (18 mins/170 lbs)

Approach (5 mins/50 lbs)

Fixed Fuel Reserve: 30 mins/300 lbs - *Note: Changed from Private IFR values*.

Variable Fuel Reserve: 12 mins/111 lbs

Item	Fuel calculation	Min	lbs, L or kg
a	**Taxi fuel**	0	40
b	**Trip fuel**	240	2223
c	**Variable fuel reserve** (% of b)	12	111
d	**Alternate fuel**	43	388
e	**Fixed fuel reserve**	30	300
f	**Additional fuel**	0	0
g	**Holding fuel**	0	0
h	**Fuel required** (a+b+c+d+e+f+g)	325	3062
i	**Discretionary fuel**	0	0
j	**Margin fuel**	58	583
k	**Endurance** (h+i+j)	383	3645

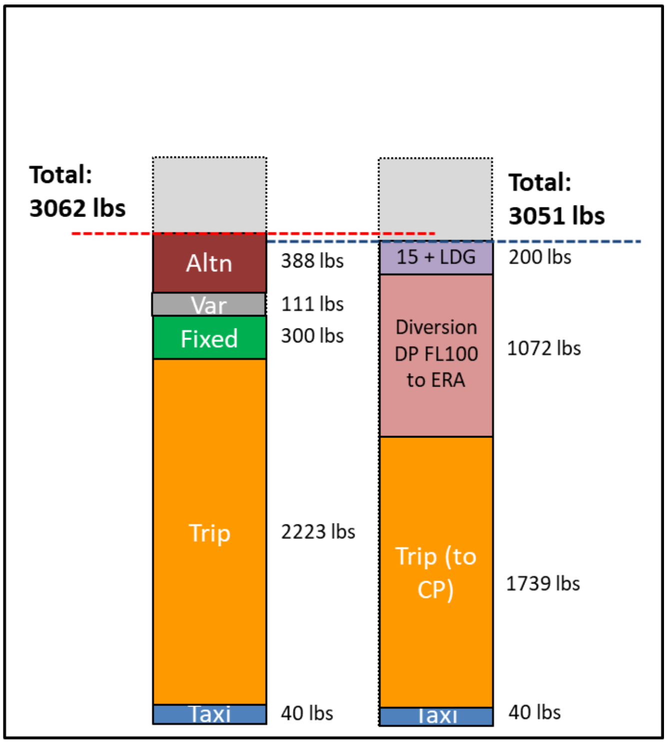

Figure 9 - Basic fuel with additional fuel and graphical depiction

B.6.4 The scenario change introduces the requirement for variable fuel reserve and also a reduction in the fixed fuel reserve values. This is shown in the fuel analysis and graphical depiction in Figure 9.

B.6.5 The calculated fuel from the revised CPD, between the ERA and the destination alternate, returns a diversion fuel value of 1072 lbs, coupled with the 200 lbs for the approach and landing and 15 mins reserve, when added to the taxi fuel and trip fuel to the CDP, returns a minimum fuel to meet the critical fuel scenario of 3051 lbs.

B.6.6 The basic fuel calculation, including the destination alternate fuel and the variable fuel reserve returns a minimum value of 3062 lbs.

B.6.7 As the basic fuel calculation value is greater than the critical fuel scenario value, no additional fuel must be uplifted. Of the 111 lbs of variable fuel reserve, 100 lbs, being the quantity of variable fuel reserve required to meet the critical fuel scenario value, must be protected prior to the CPD, so as to be available at the CPD, should the critical scenario arise.

B.6.8 Additional information pertaining to this sample calculation is contained in Annex B to this CAAP.