Australian Government
Civil Aviation Safety Authority

ANNEX D TO AC 1-02 V4.0

Exposition and operations manual fuel policy guidance

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Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Artwork: James Baban.

D.1 Introduction

This information is intended to provide sufficient guidance to enable operators to develop, based on legislation and other published guidance, all necessary information, procedures and instructions to ensure the safe conduct of operations with regard to fuel policy, fuel management and fuel related procedures.

This content will address:

- generic requirements relating to the formulation of an operator's fuel policy
- operational variations – evidence or performance-based variations allowed under legislation
- advanced use of fuel planning techniques to support operational variations
- considerations of fuel policy elements in addition to prescriptive requirements
- recommendations and description of fuel management procedures and techniques available for use pre-flight and in-flight

Note: The fuel policy in an operations manual must be compliant with the requirements contained in legislation. However, it is not a requirement to use the specific terminology used in legislation. It is recommended that terminology consistent with the underpinning legislative provisions be used where possible, in order to reduce or eliminate confusion in applying an operator's fuel policy. Where an operator decides to use different terms it is recommended that they be prepared to explain to CASA how their exposition or operations manual content still achieves the requisite outcomes required by the legislation. Operators that use terminology different to legislation must ensure that it is interpreted in such a way as to ensure the fuel allocation would result in an equivalent or greater amount of fuel than is required by legislation.

D.1.1 Basic Fuel Policy Requirements

The operator's fuel policy described within the exposition or operations manual should include a generic statement in relation to the intent of the fuel policy. An example being:

> An aircraft conducting operations approved under the AOC must carry a sufficient amount of usable fuel to complete the planned flight safely and to allow for potential deviations from the planned operation.

The fuel policy intent statement may include reference to the underlying systems, processes and procedures the operator relies upon to ensure that all flights will be operated with sufficient total usable fuel on-board to complete each planned flight safely.

The exposition or operations manual should contain at least the broad topics of:

- determination of the quantities of fuel to be carried and the methods used to make such determinations
- in-flight fuel monitoring and management
- in-flight re-planning procedures
- fuel consumption monitoring and conservation practices.

Determining Fuel Quantities for Flight

The overarching premise reflected in the fuel requirements legislative provisions is that sufficient fuel must be carried to safely complete the planned flight using the aircraft fuel consumption data, taking into account the operating conditions for the planned flight and possible deviations from that planned operation.

The exposition or operations manual should contain descriptions of how the required total usable fuel figure for flight is determined. Information and instructions are to be provided on how pre-flight calculation of useable fuel values is to be performed.

The level of detail contained in the exposition or operations manual for determining fuel quantity should in all instances be provided in as much detail as is necessary to ensure effective implementation in planning and operational use.

The effectiveness of the calculations of useable fuel quantities relies on the accuracy of the data used in those calculations and the operating conditions for the planned flight.

Basis for calculation of required usable fuel - aircraft specific fuel consumption data

AC 91-15 reflects the fuel requirements legislative provisions that require the most accurate fuel consumption data source to be used. In effect, a hierarchy of acceptable fuel consumption data sources is specified. Operators are required to use the most accurate available data for the calculation of fuel consumption and the exposition or operations manual should describe the source of the data being used.

The following should serve as a hierarchy of fuel consumption data sources for fuel calculation to be used:

- current aircraft specific fuel consumption data derived from a fuel consumption monitoring (FCM) system

  or
- fuel consumption data provided by the aircraft manufacturer.

Some aircraft do not have fuel consumption data available from the aircraft manufacturer. In order to comply with the fuel requirements legislative provisions, operators should establish a FCM system appropriate to the scale and complexity of the operation.

The exact specifications required in a FCM system are outside the scope of this document, they can range greatly in complexity and sophistication. Put simply, a FCM system refers to the processes of comparing the achieved in-flight fuel consumption performance to that of the predicted performance. Essentially, the minimum elements to result in useable fuel consumption data values are:

- data collection processes and recording requirements
- analysis procedures and requirements for collected data
- findings or results determination
- reporting and incorporating results into operational documentation and flight planning systems
- review, quality assurance and process refinement procedures and requirements.

Detailed guidance material in relation to FCM systems is contained in ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Appendix 5 to Chapter 5.

Basis for calculation of required usable fuel - operating conditions

The exposition or operations manual should describe the variables pertaining to operational conditions that influence the determination of useable fuel for a flight. The minimum required variables to be referenced in determining the useable fuel quantity for a flight and for which procedures should be contained in the exposition or operations manual are:

- anticipated aircraft weight or range of weights
- NOTAMS
- meteorological reports and forecasts
- ATC services, procedures, restrictions and anticipated delays
- the effects of deferred maintenance items and/or configuration deviations.

Pre-flight planning quantities

The exposition or operations manual should contain a description of the components of usable fuel including instructions and guidance for their computation and use, to include:

Taxi fuel

Taxi fuel is defined in fuel requirements legislative provisions as the amount of fuel expected to be consumed before take-off taking into account local conditions at the departure aerodrome and auxiliary power unit (APU) fuel consumption (if applicable).

Taxi fuel includes the fuel required for engine start and to move an aircraft under its own power considering the route to the departure runway based on known taxi times (when available) for specific airports and runway configurations.

For the purpose of taxi fuel calculations local conditions or occurrences that would contribute to increased fuel consumption prior to take-off including but not limited to foreseeable occurrences such as:

- ground holding
- ATC surface movement metering programmes
- remotely located de-icing or anti-icing
- aircraft engine and wing anti-ice use
- single runway operations, and
- any other occurrence with the potential to increase taxi time or taxi fuel consumption.

It is important for the exposition or operations manual to contain information which represents an accurate and, where possible, predictive computation basis of taxi fuel in order to ensure foreseeable occurrences are appropriately taken into account at the planning stage.

Taxi fuel calculation should be based on a detailed pre-flight analysis of the aforementioned criteria as well as the aircraft type, time of day and historical seasonal performance data. In the absence of a more detailed analysis, however, certain predefined taxi fuel values may be established which cover normal operations for a specific operating environment.

The procedures and values determined should be clearly presented within the exposition or operations manual, for use in planning and operationally.

The use of alternatives to the prescriptive taxi fuel calculation requirements of the fuel requirements legislative provisions are discussed in the operational variations section later in this Annex.

Operators seeking to take advantage of advanced procedures or techniques such as statistical taxi fuel programme can refer to the guidance contained in ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Appendix 6 to Chapter 5.

Trip fuel

The calculation of trip fuel is typically a complex process that is dependent on numerous interdependent activities. The intent of trip fuel calculation is to ensure, to the greatest practical extent, that the planned fuel consumption is equal to or greater than the actual fuel consumption.

Trip fuel is defined in fuel requirements legislative provisions as the amount of fuel required to enable the aircraft to fly until landing at the destination aerodrome taking into account the operating conditions, including all of the following (as applicable):

- fuel for take-off and climb from departure aerodrome elevation to initial cruising level/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 from the initial cruising level/altitude mentioned in the first bullet point

- 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 destination aerodrome.

Dependent upon the complexity of the anticipated operation, it may be appropriate to include in the exposition or operations manual, specific guidance for the determination of specific sub-elements of the items contained above.

There are many factors that contribute to the computation of trip fuel as well as the confidence operators and flight crews have in its accuracy. It is this confidence that further ensures any decisions made subsequent to the initial planning stage will yield the intended outcomes.

Where operators conduct localised or ‘area-work’ operations, the anticipated area-work aircraft performance parameters must be understood and described in the operational documentation, sufficient to enable adequate calculation of realistic trip fuel values.

Assumptions made during the calculation of trip fuel also directly impact the determination of other fuels such as variable fuel reserve and discretionary fuel. It is therefore important that flight crew are aware of any such assumptions with the potential to validate or invalidate decisions made subsequent to the pre-flight calculation of trip fuel.

From a safety risk management perspective, it may be beneficial for the exposition or operations manual to contain values for fuel calculations applicable to the anticipated operations to allow flight crews to quickly and effectively conduct gross-error checking of calculated trip fuel values. Traditionally these values have proven to be overly conservative for actual calculations but are an effective error-trapping methodology.

An example for a Medium Business jet could be:

For Normal Cruise at FL380-410 with climb from Sea Level aerodrome at MTOW, use:

- First hour: 1,900lbs
- Last hour: 1,000lbs
- Mid hours: 1,500lbs per hour.

Average 1,500lbs per hour for trips up to 3.5 hours, 1,400lbs for >3.5 hours.

An example for a light turbine helicopter may be:

For local scenic flights with 3 passengers, use:

- 250lbs per hour, irrespective of reduced on-ground consumption rate.

The use of alternatives to the prescriptive trip fuel calculation requirements of the fuel requirements legislative provisions are discussed in the operational variations section later in this Annex.

Holding fuel

Holding fuel is defined in the fuel requirements legislative provisions as the amount of fuel required to enable the aircraft to fly for the period of time anticipated to be required for holding (taking into account the operating conditions) calculated at the holding fuel consumption rate established for the aircraft for the anticipated meteorological conditions or ISA as applicable.

The exposition or operations manual should contain clear instructions in relation to the conditions and fuel consumption basis to be applied to the calculation of holding fuel.

Contingency fuel (previously variable fuel reserve)

From a safety risk management perspective, contingency fuel is used to mitigate the risks associated with operational factors or hazards that cannot be planned, anticipated or controlled. Such factors include, but are not necessarily limited to, deviations from flight plan that could influence the total fuel consumed en route to the destination such as:

- deviation of an individual aircraft from the expected 'normal' fuel consumption data
- deviation from forecast meteorological conditions
- extended delays and deviations from planned routings, cruising levels or speeds.

The risk associated with the improper calculation or complete consumption of contingency fuel is that of creating a diversion or low fuel state that could subsequently impact on air traffic management and other airspace users.

Contingency fuel is defined in the fuel requirements legislative provisions as the amount of fuel that is the highest of the following:

- the percentage of trip fuel as specified in the legislative requirements applicable to the operation
- in the event of in-flight re-planning, the percentage of trip fuel as specified in the legislative requirements applicable to the operation, based on the consumption rate used to plan the in-flight re-planning trip fuel, from the point of in-flight re-planning to the planned destination aerodrome
- an amount of fuel to fly for 5 minutes at holding speed at 1 500 feet above the planned destination aerodrome in ISA conditions.

The exposition or operations manual should clearly specify which of the values of contingency fuel apply to the operations to be undertaken. Additionally, the exposition or operations manual should clearly identify which fuel calculations are required to have contingency fuel applied.

Note: As an example - under legislation contingency fuel is not required to be applied to the calculation of destination alternate fuel.

The exposition or operations manual should contain a clear description of the situations or scenarios where contingency fuel is required to be retained or protected, such as when it forms part of the additional fuel calculation for critical fuel scenarios. Contingency fuel can also be unprotected, which assumes that not all of the contingency fuel is planned to be carried to the destination airport.

The exposition or operations manual should contain a direction to ensure that contingency fuel is protected in-flight when it is required for a particular purpose. The consumption of any of the contingency fuel prior to the critical point should necessitate recalculation or if necessary a diversion to an en-route alternate.

The use of alternatives to the prescriptive contingency fuel calculation requirements of the fuel requirements legislative provisions are discussed in the operational variations section later in this Annex.

The hazards, safety risks and mitigation strategies associated with contingency fuel planning are described in detail in ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 5.

Destination alternate fuel

Destination alternate fuel is intended to mitigate the safety risks associated with the unavailability of the planned destination aerodrome. The criteria for determining the requirement for, or the suitability of alternate aerodromes should be contained in the exposition or operations manual, although not necessarily required to be associated with the destination alternate fuel requirements.

The exposition or operations manual specified procedures and requirements for calculating destination alternate fuel should be commensurate with the complexity and scope of the operations. In determining destination alternate fuel, the underpinning requirements of aircraft specific fuel consumption data and operating conditions as they apply to trip fuel calculations are also be considered.

> **Note:** Where destination alternate fuel is carried, the amount of trip fuel carried to allow for landing from the Missed Approach Point at the destination aerodrome may be counted, provided distances are appropriately similar, towards that needed for an approach and landing at the destination alternate aerodrome.

If the operator specifies a particular alternate aerodrome diversion strategy, such as constraining the altitude used, or use of a specified cruise performance setting for the flight to the alternate, those constraints should be clearly described in the exposition or operations manual. Accordingly, the destination alternate fuel calculation techniques and procedures should be described in sufficient detail for effective use in planning and operations.

The use of alternatives to the prescriptive destination alternate fuel calculation requirements of the fuel requirements legislative provisions are discussed in the operational variations section later in this Annex.

Final reserve fuel (previously called fixed fuel reserve)

The fuel requirements legislative provisions define final reserve fuel as the amount of fuel, expressed as a period of time, required to enable an aircraft to fly under specified conditions, and required to be useable fuel remaining in the fuel tanks until completion of the final landing.

The exposition or operations manual should contain a clear statement of the required fuel quantity and time values for each aircraft type/s and variant being operated. The values should also include a description by type of operation and where possible the specified conditions that apply to the calculated values.

The quantity values should be ‘rounded up’ where possible to an easily recalled figure. The use of a conservative (rounded up) final reserve fuel figure is intended to provide:

- a reference value to compare to pre-flight fuel planning computations and for the purposes of a ‘gross error’ check
- flight crews with easily referenced and recallable final reserve fuel figures to assist in in-flight fuel monitoring and decision-making activities.

Where variations to the prescribed calculation conditions are applied, such as defaulting to using maximum landing weight as the estimated arrival weight, or using sea level aerodromes for all calculations, or cold weather adjustments, those conditions should be described in the exposition or operations manual.

The use of alternatives to the prescriptive final reserve fuel calculation requirements of the fuel requirements legislative provisions are discussed in the operational variations section later in this Annex.

Additional Fuel

Additional fuel is defined in the fuel legislative provisions as the supplementary amount of fuel (if any) required to allow the aircraft, if engine failure or loss of pressurisation (if applicable), whichever results in the greater subsequent fuel consumption, occurs at the most critical point, to do all of the following:

- proceed to an alternate aerodrome
- fly for 15 minutes at holding speed at 1 500 feet above aerodrome elevation in ISA conditions
- make an approach and landing.

Additional fuel may be required to protect against the very unlikely event of an engine failure or depressurisation at the most critical point in the flight and presumes that the majority of the fuel used in basic fuel planning will be available for use in proceeding to the en-route alternate aerodrome.

Additional fuel is effectively the difference between the basic fuel calculation requirements and the fuel required to meet the most fuel critical of the depressurised or one-engine inoperative scenarios described above.

The basic fuel calculation takes into account only foreseen and unforeseen factors (excluding system failures) that could influence fuel consumption to the planned destination or destination alternate aerodrome.

In determining the amount of additional fuel required (if any) a comparison between the fuel required for the basic calculation and the fuel required to meet the critical fuel scenario must be conducted. The purpose of this comparison is therefore to ensure that additional fuel is uplifted when the basic flight plan fuel is insufficient, considering the most critical failure at the most critical point, to proceed to an en-route alternate aerodrome, hold at 1,500 ft for 15 minutes, conduct an approach and land.

It is important to note that in some cases contingency fuel may be used on the ground. This would not be the case if some or all contingency fuel is a component of the required additional fuel. In other words, if some or all contingency fuel is part of the additional fuel, it may not be used on the ground and must be available at the critical point.

The exposition or operations manual should contain detailed descriptions of the required considerations, processes and techniques to be applied in implementing the requirements for determining and calculating additional fuel. These descriptions should include instructions as to the ‘protection’ of contingency fuel as it relates to additional fuel.

Where operator activities include aeroplanes engaged in Extended Diversion Time Operations (EDTO), the fuel requirements necessary to comply with the EDTO critical fuel scenario should also be described.

Finally, in relation to additional fuel, it is important to state in the exposition or operations manual that in the event of the limiting scenario event occurring precisely at the most critical point of the route the aircraft may be in an emergency situation since the planned fuel available to be on board at that point of the route may not guarantee that the planned final reserve fuel would be available upon landing.

Discretionary Fuel

Discretionary fuel is not defined in legislation and as such is not part of the prescriptive fuel requirements for a flight. It can; however, be an important element of an operator’s fuel policy, as an optional element, which is discussed in a following section.

Many operators optionally elect to carry extra fuel into more remote destinations which is most commonly named 'tankering fuel'. Depending on how the operator prepares their operational flight plans, tankering fuel might sometimes also encompass additional and holding fuel requirements. As outlined at the beginning of this Annex, where operators elect to merge different legislative fuel requirements under different names in their exposition, operations manual or operational flight plan, they should ensure that these differences from the legislation are explainable to CASA so that it can fulfil its entry control and oversight responsibilities.

Ballast Fuel

Ballast fuel is not defined in legislation and as such is not part of the prescriptive fuel quantity requirements for a flight. Ballast fuel can be required 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 wings through all phases of flight to prevent excessive wing bending. In both cases, this fuel is considered ballast and, under anything other than emergency circumstances, is not to be burned during the flight.

Expositions or operations manuals should contain information in relation to the procedures and practices applicable to planning, loading and operating with ballast fuel in sufficient detail to allow effective implementation.

Operator Fuel Policy Elements Exceeding Prescriptive Minimums

It is entirely the prerogative of the operator to set fuel policy elements at values greater than the prescriptive minimums contained in legislation. Operators may set more conservative values, as appropriate to the operations being conducted and the associated risk appetite of the organisation.

If an operator's fuel policy includes provisions intended to address specific company policy requirements in excess of regulatory minimums, they should be captured in the exposition or operations manual in sufficient detail to allow effective implementation.

It is beyond the scope of this advisory publication to describe every conceivable variation of operator fuel policy in excess of the prescriptive requirements. The following section contains some of the more commonplace industry applied variations with respect to elements of operator fuel policy that may be set at levels above legislative minimums.

Note: Fuel policy elements that are in excess of the prescriptive minimums set by the Fuel Requirements Instrument 2018 are not operational variations under the definition contained in that instrument and are not subject to the operational variation requirements.

Trip Fuel Variations

Variations to trip fuel in excess of regulatory prescribed minimums, that operators may specify in their exposition or operations manual include:

- Operators may set an absolute minimum fuel value to commence a flight irrespective of the length of the anticipated flight.

Example

Notwithstanding the calculation of useable fuel, for a B200, no flight may be commenced with less than 800lbs of useable fuel on board.

- Operators of aeroplanes that are not Reduced Vertical Separation Minima (RVSM) approved, but can be flight planned at RVSM levels, may set a policy that requires flights to have fuel planning values calculated for non-RVSM levels or may set some other parameter for proportion of flight at non-RVSM levels.

Example 1

For flights operationally planned at RVSM levels, the fuel plan must be based on not more than 50% of cruise at levels above the highest non-RVSM level

Example 2

Flights planned at RVSM levels must have include supplementary fuel the sufficient for one hour at the highest available non-RVSM level.

- Trip fuel calculations for 'area work' operations such as surveillance or SAR, may specify a planning fuel consumption value set at a conservative value which would be greater than for the anticipated conditions.

Example

For surveillance operations conducted at levels below 10,000ft, the fuel consumption rate for normal surveillance airspeed at 1,000ft is to be used for calculating available endurance (time) on-station.

Holding Fuel Variations

The legislative requirement for the calculation of holding fuel allows for a precise calculation to be conducted based on the anticipated conditions. Operators may prefer to specify conservative criteria to be used in calculating holding fuel consumption rates. A commonly applied methodology is to round up the holding fuel consumption rate to a readily recallable fuel consumption rate value that is valid in all but the most unlikely holding scenarios.

Example

For all company B200 operations a holding fuel consumption rate of 600lbs/hour is to be used.

Contingency Fuel Variations

An operator's fuel policy may contain variations in excess of regulatory prescribed minimums for contingency fuel, should the operator so specify, including but not limited to:

- applying a contingency fuel value when one is not required under legislation
- setting a higher, more conservative, percentage value of contingency fuel than is required by legislation
- setting a higher, minimum quantity value of contingency fuel than is required by legislation
- applying contingency fuel to the calculation of destination alternate fuel, although not required by legislation
- requiring protection of contingency fuel, subject to specific requirements, for example for on-ground operations, or until a specified point such as the last ETP pairing.

Destination Alternate Fuel Variations

An operator's fuel policy may contain variations in excess of regulatory prescribed minimums for destination alternate fuel, should the operator so specify, including but not limited to:

- Constraining the maximum alternate leg planning cruise height to lower than the optimal alternate cruise level.

Example

Alternate leg flight planning should be conducted at 10,000ft for alternates within 100nm and no higher than FL200 for alternates at greater ranges.

- Constraining the 'expected' conditions such as missed approach routing and alternate aerodrome arrival routing for the destination alternate aerodrome.

Example

Alternate leg planning is to include allowance for the most conservative (longest) destination missed approach and alternate aerodrome arrival routing.

Final Reserve Fuel Variations

An operator's fuel policy may contain variations in excess of regulatory prescribed minimums for final reserve fuel, should the operator so specify, including but not limited to:

- setting higher values of final reserve fuel for specified operations with inexperienced or trainees (such as in flying training organisations).
- setting higher values of final reserve fuel for cross-country training than in use for local area training.
- setting higher values of final reserve fuel to be applied when conducting maintenance check flights or other non-routine operations.

Additional Fuel Variations

An operator's fuel policy may contain variations in excess of regulatory prescribed minimums for additional fuel, including:

- Requiring a greater value of fuel reserve be applied than the 15 minutes specified for the critical fuel scenario.

> **Example**
>
> Additional fuel calculations are to apply final reserve fuel value in lieu of the 15 minutes required under legislation.

- Specifying that 'where possible' contingency fuel be applied to the additional fuel scenario calculations.
- Specifying a requirement, in addition to the preceding point, to uplift contingency fuel to accommodate a loss of pressurisation by requiring; not less than depressurised flight fuel, final reserve fuel and fuel for an approach and landing.

Discretionary Fuel Variations

Discretionary fuel, by its very nature is in excess of regulatory minimums. Although routinely the prerogative of the PIC to determine the amount of discretionary fuel to be carried, operators may assist in setting 'standard' discretionary loads.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 4 (4.25.4) contains enhanced guidance in relation to example discretionary fuels such as lateral deviation fuel and altitude deviation fuel, which may be included in expositions and operations manuals.

Fuel Policy Elements - Operational Variations

The fuel requirements legislative provisions allow CASA to accept operational variations to fuel requirements relating to the calculation of:

- taxi fuel
- trip fuel
- contingency fuel
- destination alternate fuel
- additional fuel
- final reserve fuel (only in instances where the operation is an aerial work operation, during which the only occupants of the aircraft are flight crew members.

These operational variations are performance-based alleviations to prescriptive (compliance based) requirements contained in the legislation.

The exposition or operations manual should contain the procedures and practices required by the operator to ensure that the operational variations to fuel policy elements allowed by the fuel requirements legislative provisions can ensure an acceptable level of safety performance commensurate with that of the prescriptive requirements.

The procedures and practices should be described in the exposition or operations manual in sufficient detail as is necessary to ensure effective implementation in planning and operational use.

Where the exposition or operations manual includes the prescriptive requirements and operational variations, the exposition or operations manual should ensure that the conditions under which the operational variation may be applied or dis-applied are clearly described. Operational personnel should have a clear understanding and instructions as to the circumstances and conditions for which an operational variation can be applied, and the conditions under which the prescriptive rules must be followed.

> **Note:** Fuel policy elements that are in excess of the prescriptive minimums set by the fuel requirements legislative provisions are not operational variations under the legislation and are not subject to the operational variation requirements.

Basis for operational variations

In order for an operational variation, contained in the exposition or operations manual, to be acceptable to CASA, the operator must be able to demonstrate that the operational variation will maintain or improve safety. This is usually accomplished through a specific safety risk assessment by the operator that describes how the capabilities of the operator's data driven fuel consumption monitoring system and specific risk mitigation measures are applied to maintain or improve safety.

The ongoing use of a performance-based operational variation requires that the operator collects operational performance data and monitors the actual performance against the anticipated performance measures. The elements required in developing an operational variation and the system capabilities to ensure ongoing effectiveness of the performance-based variation are described in detail in a later section.

Examples of operational variations are contained in the following sections.

Taxi Fuel Operational Variations

Operational variations to taxi fuel that operators may specify in an exposition or operations manual may include:

- Statistical taxi fuel values, based on a data-driven methodology that collects aircraft taxi time data at the specific aerodromes where the operational variation is applied, and monitors the actual taxi fuel usage to determine the suitability of the statistical fuel values.
- Predictive Modelling of taxi routes at specified aerodromes and runways that result in a lower value of taxi fuel than a purely 'time-based' methodology. (Considering taxi distance, slope, number of turns, accelerations, stops, etc.) This methodology can also be used to supplement a statistical taxi fuel program.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Appendix 6 to Chapter 5 (5-A6-1) contains enhanced guidance and requirements in relation to statistical taxi fuel program requirements to support the use of operational variations, which may be included in expositions or operations manuals.

Trip Fuel Operational Variations

Operational variations to trip fuel are usually in the form of advanced use of alternates and/or decision points. Strictly speaking, trip fuel is required to include fuel quantities calculated to address variables that can be foreseen or expected. In order to reduce unnecessary fuel uplift (as part of trip fuel) to mitigate the foreseeable, but low likelihood occurrences, alternative strategies may be employed as operational variations.

These strategies may include the variation to the use of decision point (DP) planning and the advanced use of alternates, for example.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Appendix 1, 2 & 3 to Chapter 5 contain additional criteria requirements, processes, mitigation measures, safety risk controls and/or other demonstrable abilities specific to the application of an operational variation associated with the specific flight planning methods as apply to trip fuel calculation, which may be included in expositions or operations manuals.

Contingency Fuel Operational Variations

Operational variations to contingency fuel calculations are a means of alternative calculation that can be applied in order to calculate a value of contingency fuel that is sufficient to compensate for unforeseen factors. Compliance with the prescriptive rules is achieved by applying (when applicable) a percentage value of trip fuel and not less than the prescribed minimum value of time.

The operational variations to contingency fuel merely replace the method for calculating the amount of contingency fuel with a more scientific method.

Operational variations to contingency fuel that operators may specify in the exposition or operations manual may include:

- Statistical variable fuel reserve values.
- Specific values, not relative to flight duration.
- 3% En-route alternate (ERA) contingency fuel planning.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Appendix 4 to Chapter 5 (5-A4-1) contains enhanced guidance and requirements in relation to contingency fuel calculations.

Destination Alternate Fuel Operational Variations

Operational variations to destination alternate fuel that operators may specify in the exposition or operations manual may include:

- Reduction of the destination alternate fuel quantity (by the value of the fuel allocated in trip fuel from the missed approach point to landing at the destination [not alternate] aerodrome).
- Statistical destination alternate fuel quantity values.
- Destination alternate fuel calculations based on statistical criteria, such as statistical aircraft weights, statistical winds, statistical routing (level and tracking), etc.

For Part 133, 135 and 138 operators, although not specifically a destination alternate fuel operational variation, the use of advanced destination alternate aerodrome selection criteria such as the ICAO Isolated aerodrome policy coupled with the isolated aerodrome fuel provisions, may be acceptable as a means of compliance, subject to CASA approval or acceptance.

In constructing a fuel and alternates policy that seeks to use the elements of the ICAO Isolated aerodrome provisions, the exposition or operations manual should contain specific destinations for which the policy is intended to apply, along with any specific mitigation measures required for those locations. Additionally, the exposition or operations manual procedures should contain the minimum requirements:

- for each flight into an isolated aerodrome a point of no return (PNR) shall be determined pre-flight
- flight to an isolated aerodrome shall not be continued past the PNR unless a current assessment of meteorological conditions, traffic and other operational conditions indicate that a safe landing can be made at the estimated time of use.

Circumstances may arise during a flight where the conditions at, or suitability of, the destination aerodrome, destination alternate, or en-route alternate/s may change. Where a flight is planned and commenced with a quantity of fuel that is sufficient to complete the planned flight in safety, but due to unforeseen circumstances, a change to conditions occurs which imposes a fuel requirement, where none existed during planning, the PIC must still comply with the legislative requirements in relation to fuel quantity required to continue the flight from that time.

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.

The exposition or operations manual should contain clear instructions that dispel any misunderstanding among operational personnel, who may incorrectly consider that once the flight has commenced, any in-flight imposed fuel requirements need not necessarily be applied.

Whilst outside of the scope of the destination alternate fuel operational variation, it may be of benefit for operators with advanced dispatch and operational control capabilities to consider alternate and destination policy variations that allow a 'commitment to destination' when within a prescribed time/distance of the destination, for specified meteorological values or conditions. This may not be available as an approval for non-Part 121 operations. Such non-Part 121 operators would need to carefully consider their fuel rules to determine whether using such techniques would instead require an exemption.

For example, an operator may seek approval for an operational policy that allows commitment to destination; when in-flight and within 1 hour of the destination, the destination weather conditions (cloud or visibility) drop below alternate minima, but not below landing minima required. In which case the PIC may not be required to comply with the 'below alternate minima' requirement that would normally necessitate a diversion to another aerodrome (if fuel on-board was sufficient).

The exposition or operations manual should contain sufficiently detailed descriptions of the procedures and practices identified in the preceding section, as is necessary to ensure effective implementation in operational use by flight crew.

Detailed guidance material in relation to isolated aerodrome planning and PNR calculation is contained in ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 4, 4.10 reflecting the provisions contained in ICAO Annex 6 Part I Operation of Aircraft – International Commercial Air Transport - Aeroplanes, Chapter 4, 4.3.4.3.1.

Additional Fuel Operational Variations

Operational variations to additional fuel that operators may specify in the exposition or operations manual may include calculations and values based on statistical criteria, such as:

- statistical aircraft weights
- statistical winds
- statistical routing (level and tracking).

Final Reserve Fuel Operational Variations

The use of operational variations to final reserve fuel reserve is limited to instances where the operation is an aerial application operation or aerial work operation, conducted by an aerial application operator or an aerial work operator during which the only occupants of the aircraft are flight crew members. This is primarily intended to enable very short-duration flights, generally in the immediate vicinity of an aerodrome (safe landing site), with additional controls that ensure the unimpeded use of that landing site.

As an example, in order to achieve the required helicopter performance, a helicopter external load operation to lift or lower heavy plant/equipment onto or from a high-rise building, may need to operate with a reduced final reserve fuel. The variation would specify the amount of final reserve fuel and any additional mitigation measures to be applied. These measures would include, but not be limited to:

- specifying the minimum value of final reserve fuel for the flight
- specifying the additional steps to be applied in the pre-flight determination of actual fuel on-board, to ensure the precision required with such small fuel margins
- access controls for ensuring exclusive or unimpeded use of the safe landing site
- alert levels and fuel remaining monitoring methodologies to ensure that the reduced final reserve fuel is not compromised.

This type of operational variation may also be used by aerial application operations in the immediate vicinity of a landing/refuelling site. The operations manual should contain detailed descriptions of the limitations and risk mitigation measures to be applied in support of the variation.

Note: An operational variation may permit operations with final reserve fuel values less than the prescriptive values contained legislation. That operational variation does not override the

Part 91 and 138 requirements to comply with a flight manual instruction, procedure or limitation concerning the operation of the aircraft that is set out in the manual, in this instance if it contains a fuel value. For example, if the flight manual requires the PIC to 'Land ASAP' when the fuel quantity remaining reaches a specific value, irrespective of a potentially lower operational variation fuel quantity, the PIC must comply with the flight manual requirement.

Operational Variations - Risk Assessment Elements

The fuel requirements legislative provisions require that an operational variation be based upon documented in-service experience and/or a specific safety risk assessment. The specific safety risk assessment must contain at least:

- flight fuel calculations;
- the capabilities of the certificate holder, including all of the following:
  - a data driven method that includes a fuel consumption monitoring program
  - the advanced use of alternate aerodromes
  - specific risk mitigating measures

The methodology used to construct the safety risk assessment should contain at least the following elements:

- specifying the prescriptive requirement to which the operational variation is sought
- description of the existing or baseline safety performance in relation to the prescriptive requirement applicable
- identification of the safety performance indicators used (quantitative and/or qualitative)
- organisational capabilities of the operator (technology, systems, processes, policies, procedures)
- hazards or risks identified
- mitigation measures (safety risk controls) to the hazards or risks identified
- monitoring procedures that compare actual safety performance against safety performance indicators, to ensure acceptable safety levels are maintained.

ICAO Doc 9859 – Safety Management Manual (SMM) Chapter 2, 2.16 contains descriptive guidance in relation to the design and application of the safety risk management principles intrinsic in performance-based system design. The SMM is a valuable source of reference information that can be used by operators during the development and implementation of performance-based variations to the prescriptive fuel rules contained in legislation.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 5 contains descriptive guidance as to the generalities of performance-based compliance. Table 5-10 provides a limited example of possible safety indicators in relation to fuel variations.

Finally, it is up to the operator to consider whether the benefits brought about by a performance-based variation are justified when compared to the costs of maintaining the system elements required to support an effective ongoing performance-based variation.

Ultra-long-haul Aeroplane Operations

Long-haul and ultra-long-haul aeroplane operations are specialised operations undertaken by relatively few AOC holders. Strict adherence to prescriptive requirements, particularly regarding the provision of destination alternate aerodromes, may be particularly problematic in these operations due to the inability of an aeroplane to physically carry the fuel required.

The performance-based variations from prescriptive regulations may be appropriate where an operator is able to continually demonstrate a level of operational sophistication and experience that ensures potential hazards have been properly considered and safety risks mitigated. The AOC holder must possess the operational capability to ensure acceptable levels of safety performance can be maintained before relief from the prescriptive requirements for alternate aerodrome selection and fuel planning regulations can be accepted, through an operational variation, described in previous sections.

Fuel Related Procedures

Procedures to ensure the safety of operations

Operators should ensure that the procedures contained in their expositions and operations manuals take into account the specific roles and environments in which their operations are likely to be conducted.

The procedures necessitated by the fuel requirements legislative provisions should be complied with by operational personnel by following the procedures detailed in the exposition or operations manual. It is very important that those procedures are developed recognising the environments in which they are intended to be conducted.

Determining and recording fuel quantity - Pre-flight

Certain fuel requirements legislative provisions require that the operator have instructions and procedures for the PIC to verify the quantity of fuel on board the aircraft before flight.

The fuel requirements legislative provisions require that the PIC and operator must ensure that a pre-flight determination of fuel quantity is conducted, and that the exposition or operations manual must contain procedures ensuring the results of the pre-flight fuel quantity determination are recorded.

The exposition or operations manual must therefore contain detailed descriptions of the procedures for fuel quantity determination, cross-checking and recording in as sufficient detail as is necessary to ensure effective implementation by flight crew. This must also include the acceptable limits for discrepancies between independent means of quantity determination.

For example, the operator may specify for a given aircraft type, that any fuel quantity discrepancy up to an identified value or percentage (such as a commonly accepted 3% variation) may be acceptable and that the most conservative value must be used as the basis for subsequent fuel quantity assessment. The exposition or operations manual should also contain a description of the procedure/s to be used should the determination result in values which differ by more than the prescribed limits.

Where an operation uses aircraft from another operator (cross-hires), the exposition or operations manual should contain instructions and procedures that describe how the fuel records or other information, as relate to the verification of the actual fuel on-board, are to be obtained. The exposition or operations manual should also contain instructions pertaining to the required accuracy and validity of those fuel records and describe the procedures to be followed should those fuel records not meet the accuracy or validly requirements described.

The exposition or operations manual must contain detailed descriptions of the procedures to be applied by the PIC for the off-loading of fuel should it be required[1]. The descriptions should be in sufficient detail as to ensure effective implementation by the operator’s personnel.

Determining and recording fuel quantity - In-flight

The fuel requirements legislative provisions require that during a flight the PIC must ensure that fuel quantity checks are carried out at regular intervals. The methods for determining the usable fuel remaining at each in-flight fuel quantity check should be in accordance with the aircraft manufacturers procedures, where provided. Dependent upon the aircraft systems capability, this may be a simple as through direct reading fuel quantity indicating systems (FQIS), or with less capable systems, through a calculation process.

Having conducted a determination of useable fuel remaining, that fuel quantity value must be evaluated to do all of the following:

[1] Based on paragraph 119.205(1)(h) and 138.155(1)(h) of CASR.

- compare planned fuel consumption with actual fuel consumption
- determine whether the usable fuel remaining is sufficient to complete the planned
- determine the expected usable fuel remaining on arrival at the destination aerodrome.

The exposition or operations manual must contain procedures for recording the fuel quantity data evaluated after each fuel quantity check conducted during a flight.

Additionally, the fuel remaining should be evaluated to update, if applicable, any of the in-flight decision points based on fuel quantity, such as PNR, DP or PDP.

To comply with the regular interval requirements for fuel checks, operators may wish to specify in the exposition or operations manual, the desired regularity of fuel checks and limits of acceptable time between fuel checks, noting that under certain circumstances the flight time or operational environment may preclude the check being required. Whilst not a specified value, it would be normal industry practice for this interval to rarely exceed 30 minutes. One variation to this may be where the time interval between flight plan waypoints exceeds 30 minutes; to which the exposition or operations manual may allow the normal period to be extended. Specific requirements for fuel quantity checks should also be described for instances such as being conducted prior to critical points so that informed decisions can be made.

The in-flight fuel quantity check required by the fuel requirements legislative provisions includes the evaluation steps described above. It is not intended to be taken that every time the fuel gauges are referred to during a flight that an an-flight fuel quantity check has been conducted nor is it required for the quantity to be recorded after each instance.

Notwithstanding the above, it is recognised that the breadth of roles and diverse environments in which operations can be conducted necessitates the fuel procedures in expositions and operations manuals having several areas of flexibility. In that respect, factors including the relationship between duration of the flight and fuel margin is of critical importance.

The interval between in-flight fuel quantity checks is deliberately not specified in the fuel requirements legislative provisions as being a distinct time period. It is intended that the operator specify in the exposition or operations manual the acceptable period between in-flight fuel quantity checks that ensures the PIC retains awareness of the fuel state throughout the flight, without imposing an undue or unsafe burden on the operational personnel to conduct.

In regard to requirements to conduct an in-flight fuel check and recording, the following points are to be considered in developing those operational procedures for inclusion in the exposition or operations manual:

- the intention of an in-flight fuel quantity check is to ensure that the final reserve fuel remains intact, throughout the flight (the principal importance of this must not be overlooked in developing exposition or operations manual procedures)
- the normal period between in-flight fuel checks is to be determined by the operator to achieve the appropriate protections of ensuring final reserve fuel will be intact at completion of the flight
- the exposition or operations manual should describe the circumstances where the characteristics of the flight would render the in-flight fuel quantity check unnecessary

> **Note:** That may include where the period between checks specified in the exposition or operations manual exceeds flight duration or where the nature of the flight precludes safely conducting the checks (and also therefore the recording).

- The requirements for recording of the in-flight fuel check are triggered by the conduct of the check. The exposition or operations manual should therefore describe the appropriate methods for recording the results of the in-flight fuel quantity checks, when conducted.

Notes:

1. The requirement to record is not in all instances intended to be interpreted as a requirement to write down or physically transcribe the fuel quantity values. The operator should determine the most appropriate means of recording the results of the in-flight fuel quantity check for the operation being conducted.
2. As the rationale for recording of an in-flight fuel check is to allow earlier results from that flight to be reviewed to assess whether there are fuel trends that may be detrimental to the safe completion of the flight, recording those values after the flight provides no value.

It is essentially the operator's responsibility to determine the reasonableness of the requirements to conduct and/or record the in-flight fuel quantity checks based on the specific circumstances of their operations and to specify the procedures to be followed to ensure continuous fuel state awareness is maintained.

Note: Some operational environments such as certain single-pilot low-level aerial work activities may be such that the priority of maintaining flight path control through manipulative control of the aircraft prevents more than a visual scan of the fuel quantity gauges to maintain fuel state awareness.

If an operator identifies instances where the conducting of an in-flight fuel quantity check and/or the subsequent recording of the check would be unreasonable or unsafe on the basis of the flight duration or the flight environment (such as low-level single-pilot), the exposition or operations manual should specify the circumstances under which the checks and/or recording would not be required. If the exposition or operations manual describes those circumstances and the operator is satisfied that the operational flight crew are able to maintain continual fuel state awareness by other means, then the relevant fuel legislative provisions are being complied with.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 6, Section 6.6 contains extensive descriptive guidance in relation to policies and procedures to ensure that in-flight fuel checks and fuel management are performed by flight crew to ensure successful fuel management occurs in-flight.

Determining and monitoring fuel quantity - Post-flight

Multiple fuel legislative provisions require that an operator maintains a record of the fuel remaining at the end of the flight, as well as requiring that the operator continually review, based upon the fuel remaining, the adequacy of the instructions regarding fuel quantity to be carried.

The post-flight assessment of the fuel usage from the flight or series of flights forms an important element of the fuel consumption monitoring process. The exposition or operations manual should contain detailed descriptions of the procedures for the post-flight recording and assessment procedures used to determine and monitor the adequacy of the fuel instructions of the operator.

Supplementary Procedures - General

General Procedures

Effective compliance with operators' fuel policy in-flight by flight crews is dependent upon many assumptions made during pre-flight planning. These assumptions can be quickly invalidated, however, by inconsistent flight crew actions or unforeseen circumstances. Given this potential, it is essential for all relevant personnel to understand their roles and responsibilities related to the operator's fuel policy. This is especially important in scenarios where fuel carriage is optimised for the route and continual re-analysis/adjustment is crucial to ensuring the completion of the flight as planned. With all of this in mind, operator in-flight fuel checks and fuel management policies and procedures should address:

- the variables used in the calculation of the usable fuel required prior to take off or to continue beyond a decision point or point of in-flight re-planning
- the alternate aerodrome selection and fuel planning methods used in flight planning
- flight crew responsibilities and actions related to pre-flight fuel planning and fuel load determination
- flight crew responsibilities and actions related to flight planning methods that require specific in-flight re-analysis, re-planning or re-dispatch procedures
- generation of the operational flight plan (OFP) and instructions for its use
- deviations from the OFP or other actions that could invalidate flight planning assumptions (e.g. acceptance of direct routings, altitude changes, speed changes)
- actions related to the acquisition of timely and accurate information that may affect in-flight fuel management (e.g. meteorology, NOTAM, aerodrome condition)
- the practical means for the in-flight validation or invalidation of assumptions made during alternate aerodrome selection or fuel planning including instructions for recording and evaluating remaining usable fuel at regular intervals
- the factors to be considered and actions to be taken by the PIC if flight planning assumptions are invalidated (re-analysis and adjustment) including guidance on the addition of discretionary fuel at the flight planning stage if necessary to ensure adequate safety margins are maintained throughout the flight
- actions to be taken by the PIC to protect final reserve fuel including instructions for requesting delay information from ATC
- instructions for the declaration of MINIMUM FUEL
- instructions for the declaration of a fuel emergency (MAYDAY FUEL).

Much of the information that can be used as the basis for operational policy and procedures required, was discussed in the preceding sections.

Note: As described in the introduction to this block of fuel related information in this Annex, expositions and operations manuals are not required to use specific terminology consistent with legislation nor with this AC. Several of the terms described in the following sections are used interchangeably in industry, with specific terminology having differing uses in industry segments. Operators are again reminded that although terminology may vary, the use of terms in expositions or operations manuals should be sufficiently clear and understood to ensure that compliance with the underpinning legislation requirements is achieved and maintained. Consistent use of terminology is one means by which ambiguity can be eliminated or reduced.

Considerations at the point of in-flight re-planning and/or decision point

Flights that are planned with an in-flight re-planning or decision point share common considerations regardless of the flight re-planning method used. In each case, a combination of conditions must be satisfied to proceed beyond the re-planning or decision point and continue to the destination. The flight crew therefore spends the time during the en-route phase judiciously monitoring and evaluating many factors to determine whether a flight may continue beyond a decision point to the destination or must divert to an en-route alternate. All such considerations are typically explained in detail within an operator's fuel policy.

One scenario that may not necessarily be considered in operator procedures is the notion of an 'un-planned' decision point. In the case of simple A-to-B flights, for example, there is no planned decision point although many of the considerations for in-flight re-planning are applicable. It is important to note, however, that regardless of the flight planning method used, flight crews must always be able to recognise when the conditions under which a flight was originally planned have changed. To accomplish this aim, flight crews must become attuned to the conditions of their flight plan as well as have access to the most current information available related to its execution.

Information that would be useful in determining whether a landing can be made at the destination or any available en-route alternate is typically related to:

- meteorological conditions, both en route and at the destination, to include hazardous phenomena such as thunderstorms, turbulence, icing and restrictions to visibility;
- field conditions, such as runway condition and availability and status of navigation aids
- en-route navigation systems and facilities status, where possible failures could affect the safe continuation or completion of the flight
- en-route fuel supply, including actual en-route consumption compared to planned consumption, as well as the impact of any changes of alternate airport or additional en-route delays
- airborne equipment that becomes inoperative, which results in an increased fuel consumption or a performance or operational decrement that could affect the flight crew's ability to make a safe landing at an approved airport
- air traffic management concerns, such as re-routes, altitude or speed restrictions and facilities or system failures or delays
- security concerns that could affect the routing of the flight or its airport of intended landing.

Access to such information is crucial to ensuring flights do not proceed beyond the last possible point of diversion to an en-route alternate and continue to the destination when in the opinion of the pilot-in-command, it is unsafe to do so.

Supplementary Procedures - Specific

Specific Procedures

Specific procedures described in the following section include:

- Decision Point (DP) Procedure.
- Pre-determined Point (PDP) Procedure.
- 3% En-route Alternate (3%ERA) Variable Fuel Reserve Planning Procedure.
- Equi-time Point (ETP) Selection and Calculation.
- Critical Point (CP) Calculation.
- Point of No Return (PNR) Calculation.

Decision Point (DP) Procedure (related to point of in-flight replanning)

The legislative provisions define a point of in-flight replanning as a point en-route at which an aircraft can:

- arrive at the point with adequate fuel to complete the flight to the destination aerodrome while maintaining the required amount of fuel, continue to the destination aerodrome

  or
- divert to an en-route alternate with adequate fuel to complete the flight to the en-route alternate while maintaining the required amount of fuel.

The expanded definition and explanation of point of in-flight replanning in AC 91-15 contains the following note:

> **Note:** For the purpose fuel requirement calculations and decision making, the terms, 'point of in-flight replanning', 're-release point', 're-dispatch point' and 'decision point' are interchangeable.

DP planning is used by operators whereby an aircraft is planned and filed to a destination via one or more points of in-flight replanning. Prior to crossing each point of in-flight replanning the pilot-in-command assesses the aircraft serviceability, the meteorological conditions, and any other known factors that may affect the flight before deciding whether to continue to the aerodrome of intended landing or divert to the nominated en-route alternate aerodrome.

The use of DP planning allows an operator to meet the fuel legislative provision requirements without the need for an operational variation to the method of calculation of contingency fuel. This provision is intended to ensure that a flight planned via a DP does not commence without planning and uploading the contingency fuel required to meet the legislated requirement from the DP to the destination or last ERA, without the need to uplift contingency fuel to meet the legislated percentage (%) value of trip fuel from take-off.

Prior to the final point of in-flight replanning the aircraft is required to be able to divert to at least one aerodrome that is suitable for use by the operator. Once past the final point of in-flight replanning, however, the aircraft may not have the operational capability to divert to an alternate aerodrome. As such, prior to crossing the final point of in-flight replanning, the aircraft serviceability, meteorological and aerodrome conditions should be assessed to determine whether a reasonable certainty exists that a successful landing can be completed at the destination or nominated destination alternate aerodrome.

With routine operations over long-range sectors, the accuracy of the destination meteorological forecast at the time of departure is a significant factor in the planning process. Point of in-flight replanning planning can mitigate the effects of forecasting inaccuracies as the flight crew seek updated meteorological information prior to crossing each point of in-flight replanning. The flight will then continue to the destination based on this updated information, which will have a higher degree of accuracy than the reports originally received during flight planning.

Point of in-flight replanning planning can be consistent with the nomination of a destination alternate aerodrome; however, over long sectors, or in areas of limited infrastructure, this planning may also be used as a mitigation strategy to manage the risks associated with the planned operation. Where a destination alternate cannot be planned, this planning ensures that the decision to proceed past the last point of diversion is based on the latest available information.

It is important to note that this planning requires that at all times in-flight the aircraft will have sufficient fuel on board to either continue to its planned destination or divert to an alternate aerodrome while conforming to the operator's in-flight fuel policy.

The point of in-flight replanning used by the flight crew is a calculated position. That is, it considers the planned fuel load on the aircraft as well as the operational requirements (meteorology and holding) at both the destination and alternate aerodromes. In flight, the crew has the ability to move the point of in-flight replanning based on changes to the planned fuel load and changes in the operational conditions present.

If an operator's fuel policy includes provisions which allow the use of this planning, those provisions and the detailed descriptions of the procedures and practices should be contained in the exposition or operations manual in sufficient detail to allow effective implementation by planning staff and flight crew.

Pre-determined point (PDP) procedure

The Pre-Determined Point (PDP) is another method of flight planning that ensures an aircraft carries sufficient fuel to complete a planned flight safely. This differs from the DP procedure described in the preceding section, in so far as the PDP procedure requires an operational variation in accordance with the fuel requirements legislative provisions.

PDP planning does not allow the recalculation in-flight of the pre-determined point location and may in fact not necessarily aim to optimise the fuel use of the flight. PDP planning is typically used to provide a control gate whereby the operator or crew make a decision to continue or divert prior to passing the nominated point. Unlike the previous DP procedure where the point of in-flight replanning is a calculated position that will vary with each flight, PDP planning utilizes a fixed point nominated by the operator. PDP planning is, therefore, a more prescriptive version of DP planning wherein only one scenario allows continuation towards the intended destination when reaching the pre-determined point. The method for the calculation of final reserve fuel, destination alternate fuel and contingency fuel may also be subject to elements of operational approval as they differ from the methodology outlined in the DP procedure in the earlier section.

PDP planning is intended to be used where the distance between the destination aerodrome and the destination alternate aerodrome is so great that carrying destination alternate fuel as required by the prescriptive elements of fuel requirements legislative provisions would not be possible. It may also be used where operational requirements dictate that it is desirable to make a final go/no go decision at a point in time after the aircraft has departed.

If an operator's fuel policy includes provisions which intend to the use PDP planning, those provisions and the detailed descriptions of the procedures and practices should be contained in the exposition or operations manual in sufficient detail to allow effective implementation by planning staff and flight crew.

3% En-route Alternate (3%ERA) Contingency Fuel Planning procedure

3% ERA is a performance-based contingency fuel planning methodology that may be used by operators subject to an operational variation.

3% ERA has some similarities with the in-flight re-planning methodologies. It however differs in that it requires mandatory selections in the operational flight plan (OFP) of an ERA located along the second half of the planned route and before the destination aerodrome. This designation of the ERA is predicated on the qualitative and quantitative assumption that, even if the 3% ERA contingency fuel is used before reaching the planned destination, there would be sufficient fuel on board to land at the ERA with final reserve fuel remaining.

ICAO Doc 9976 – Flight Planning and Fuel Management Manual (FPFMM) Chapter 5, Appendix 3, Section 11 contains descriptive guidance in relation to criteria, operator capabilities and processes required to support 3% ERA contingency fuel planning and operations.

Equi-time Point (ETP) Selection and Calculation

Equi-time Point (ETP) is defined in AC 91-15 as being a point along the planned route that is located at the same flight time from two points. Whilst not specifically a dedicated fuel related procedure, the calculation of an ETP is often required in order to determine fuel requirements for certain points of a planned flight or in-flight, as applicable.

> **Note:** Equi-time point may also be referred to as the Equal time point.

ETP is commonly understood to be the point along track from which it will take equal flight time to proceed to either of two (diversion) aerodromes (ERAs). The ETP is not necessarily the midpoint by distance between the two selected points, as the distance will be influenced by the wind component in each direction. ETPs provide pilots with decision making aids in the event the aircraft needs to proceed to a landing aerodrome as soon as possible.

Equi-time Point (ETP) Selection

In common practice the selection of aerodromes to which an ETP calculation would be applied is based upon the characteristics of the route being flown. Routes where long distances between suitable ERAs prevail, such as in oceanic or remote areas, the planned route of flight should be examined to identify suitable ERAs based on aircraft requirements, aerodrome capability, and weather.

There are three broad ETP strategies that may be considered for each ERA pairing to cover particular contingency or emergency scenario types:

- One Engine Inoperative (OEI) ETP strategy

  - *May be referred to variously as: 1E INOP ETP, ETP-OEI, ETP1.*
- Depressurised ETP strategy
  - *May be referred to variously as: DEPRESS ETP, ETP-DP, ETPD.*
- Generic (Maintain Level) ETP strategy
  - *May be referred to variously as: ETP, ETP-ALL, ETP-A, ETP-MED.*

One Engine Inoperative (OEI) ETP strategy: in the event of an engine loss, drift-down procedures are applied as required and the pilot-in-command would make the diversion decision to the nearest suitable ERA based the present position relative to the OEI ETP.

Depressurised ETP strategy: in the event of the loss of pressurisation or any other requirement for a rapid descent without an engine failure, the pilot-in-command would make the diversion decision to the nearest suitable ERA based the present position relative to the Depressurised ETP.

Generic (maintain level) ETP strategy: in the event of a need to land as soon as possible without the need to descend, such as a medical emergency, the pilot-in-command would make the diversion decision to the nearest suitable ERA based the present position relative to the generic (maintain level) ETP.

In calculating the position of the ETP for each strategy, the values of planned TAS and anticipated wind velocity (direction and speed) for the level to be flown are required. Based on the possible differences in wind and TAS at each of the possible ETP strategy levels, it may be the case that at some points in-flight that the closest aerodrome for one strategy may be different from another.

Equi-time Point (ETP) Calculation

There are many methods that can be used to calculate an on-track ETP. The commonly used equation or ETP formula returns the distance along track to the ETP from the departure point with input values of total distance, groundspeed back and groundspeed forward.

$$\text{Ground Distance to ETP} = \frac{\text{Total Distance} \times \text{Ground Speed Back}}{\text{Ground Speed Back} + \text{Ground Speed Forward}} = \text{NM}$$

The calculation of off-track ETPs is more complex than for on-track ETPs. Aside from computer-based flight planning applications or Flight Management Computers (FMCs) that can calculate and return the off-track ETP values, the most commonly used method available to flight crew is the graphical plotting method.

In simplistic terms, the graphical off-track ETP method identifies a point on-track that is equi-distant from two selected points (often the last ERA and the destination aerodrome), to which a wind correction value based on flight time, is applied.

Where an exposition or operations manual contains a requirement to calculate ETPs, the descriptions of procedures and practices contained in the exposition or operations manual should be sufficiently detailed so as to ensure effective implementation by flight crews.

An example of a generic off-track ETP calculation methodology that may be used in an exposition or operations manual is provided in the following section (note this is not a complete example).

1. Select and plot route of flight: Departure (A), Route of flight, Destination (B), Destination Alternate (C), En-route Alternate (D).

2. Select ETP aerodromes for calculation: A, B & D.

3. Find mid-point (E) between aerodromes B & D.

4. Plot perpendicular bisector of line between aerodromes B & D, from E until it crosses planned track at point F. F is the nil-wind ETP between B & D.

5. Determine distance (X) from nil-wind ETP (E) and B or D. (same for either)

e.g. distance (X), from F to (B or D) is 465nm.

6. Determine ETP strategy (diversion at cruise level and TAS)

e.g. maintain level, F410, TAS 435

7. Determine wind velocity (direction and speed) at ETP strategy level.

e.g. 260/65

8. Determine the wind vector plot length by dividing the distance (X) by the TAS and multiplying by the wind strength.

e.g. wind plot = $\frac{Distance\ (X)}{TAS} \times Wind\ Strength = \frac{465}{435} \times 65 = 70nm$

9. Plot the wind vector from nil-wind ETP (E) back into wind by plot length (70nm)

10. Plot a line parallel to the line (E to F), from the tail of the wind vector plot to cross planned track. This results in position G which is the resultant wind adjusted ETP.

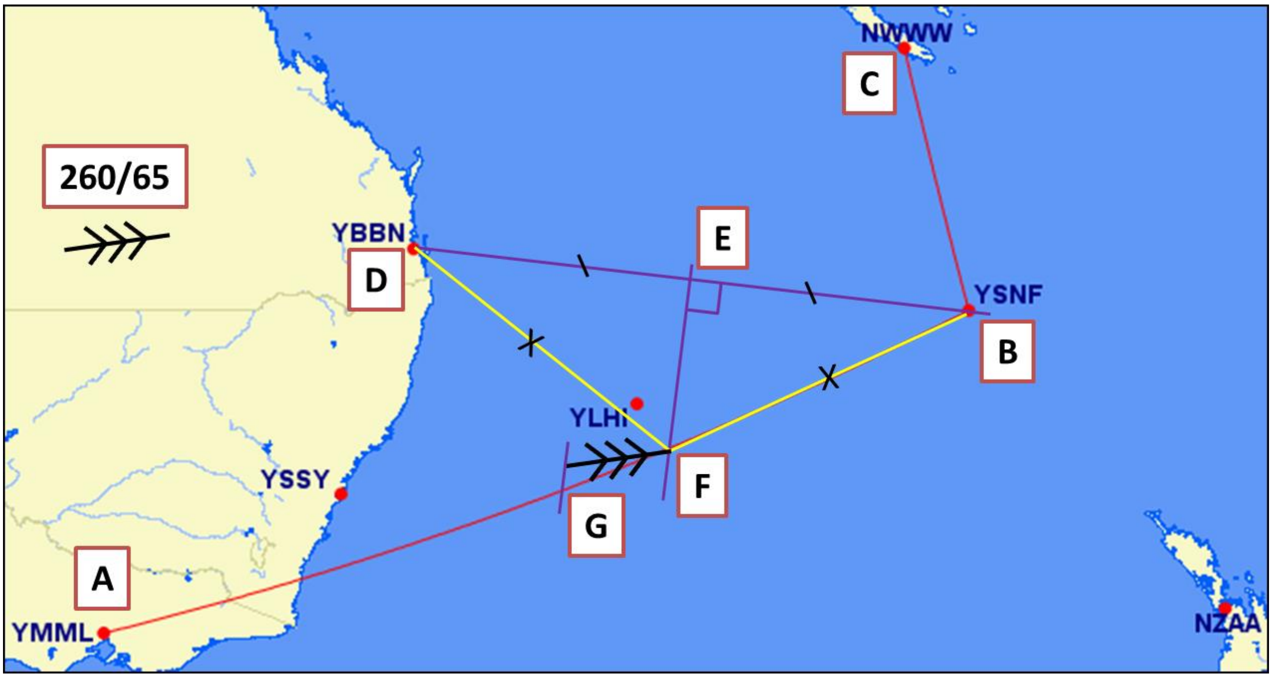

Figure 1. Example off-track ETP plot

Critical Point (CP) Calculation

The Critical Point (CP) is the point along a route which is most critical from a fuel requirement point of view. The CP is usually, but not always, the last ETP between the final ERA and the destination aerodrome along the planned route.

> **Note:** The critical point may, dependent upon the circumstances, coincide with a decision point.

The calculation of the CP is an important step in determining whether additional fuel is required to be uplifted and the degree to which variable fuel reserve (if applicable) must be protected.

To calculate which is the most fuel critical point for a planned operation, three scenarios are required be considered:

- Critical Point - All Engines Operating (CPA).

- Critical Point - One Engine Inoperative (CP1).
- Critical Point - Depressurised (CPD).

The three scenarios will each have differing characteristics in relation to TAS and fuel consumption.

Operators may elect to specify in the exposition or operations manual, conservative values (such as requiring the critical point be determined for a ‘multiple emergency’ case, i.e. engine failure and depressurisation) rather than the minimum prescriptive requirements contained in legislation.

The practical means of determining the critical point follows the same methodology as the applicable on-track or off-track ETP, with additional steps of calculating the fuel usage and consideration of fuel reserve requirements.

The exposition or operations manual should contain sufficiently detailed descriptions of how the critical point is to be determined and the considerations in relation to the fuel scenario to be applied in as much detail as is necessary to ensure effective implementation in planning and operational use.

An example of a generic CP calculation methodology that may be used in an operations manual is provided immediately below (note this is not a complete example).

1. Identify the position of the final ETP, based on the final ERA and the destination aerodrome.
2. Select the most limiting CP scenario. (in this example depressurised = CPD).
3. Adjust ETP position for wind at CPD level (in this case 10,000ft) to find CPD position.
4. Determine distance from CPD to destination/ERA.
5. Calculate ‘basic’ fuel requirements from CPD to destination/ERA.

(Trip fuel (at planned cruise level from CPD to destination) + alternate fuel (if required) + fixed fuel reserve).

6. Calculate CPD fuel requirement from CPD to destination/ERA.

(Trip fuel (at CPD level, TAS and fuel consumption rate; from CPD to destination/ERA) + 15 minutes holding fuel + approach & landing fuel).

7. Identify the most limiting case between the results of steps 6 and 7 based on conditions.

Point of No Return (PNR) Calculation

The Point of No Return (PNR) last possible geographic point at which an aircraft can proceed to an available en-route alternate aerodrome for a given flight. It is the point beyond which diversion to the en-route alternate aerodrome is no longer possible and the aircraft is committed to proceeding to the destination aerodrome.

The definition of PNR may in some instances be considered or intended to apply solely to a return to the departure aerodrome. Other similar terminology may include the Last Point of Diversion (LPD). Irrespective of the terminology selected, expositions and operations manuals should contain clearly defined terms that ensure operational personnel understand the intended use.

In practical terms the PNR is the greatest distance that an aircraft can proceed along track and return or divert to aerodrome (that is not the destination aerodrome) with the required reserve fuel still intact upon landing, before being committed to landing at the destination aerodrome.

While the PNR can be calculated and specified in the operational flight plan (OFP), such a calculation does not typically take into account any discretionary fuel, or the real-time changes in fuel consumption that may occur after departure. The actual PNR will often be reached later in the flight than the point originally calculated in the OFP.

Operators should provide practical instructions so that the flight crew can calculate the actual position of the PNR. These instructions may take the form of the mathematical calculation equations, a fuel plotting chart or practical instruction in the use of the calculating capabilities other systems such as an FMS (if fitted).

The PNR can be determined by either time or distance from the return aerodrome.

The equation for calculating time to a PNR is:

$$\text{Time to PNR} = \frac{Safe\ Endurance \times Ground\ Speed\ Back}{Ground\ Speed\ Back + Ground\ Speed\ Forward}$$

Where safe endurance is:

$$\frac{Total\ Fuel\ Quantity - Required\ Fuel\ Reserves}{Average\ Fuel\ Consumption\ Rate}$$

> **Note:** When calculating time to PNR, the units (hours or minutes) for endurance and groundspeed must be consistent.

The equation for calculating ground distance to a PNR is:

$$\text{Ground Distance to PNR} = \frac{Safe\ Endurance \times Ground\ Speed\ Back \times Ground\ Speed\ Forward}{Ground\ Speed\ Back + Ground\ Speed\ Forward}$$