ANNEX B

Aircraft Operations

This Annex provides further guidance on, and illustrative examples of, key elements of sub-volume 2A, Specific Aircraft Type Procedures and should be read in conjunction with the relevant headings and explanations within the body of CAAP 215-1(3).

Introduction

The purpose of this sub-volume of the Operations Manual is:

- to provide information regarding operational procedures, performance and limitations for specific aircraft
- to standardise terminology and behavioural patterns
- to provide rapid access to procedures, typically in the form of a Quick Reference Handbook (QRH).

In writing this part of the manual, the experience of the flight crew should be taken into account, so basic system principals should be omitted. The text should not be intended to teach the crew how to fly an aircraft, but to enable crew to operate the aircraft safely and proficiently.

For clarity and simplicity, the aircraft Operations Manual should be written in the imperative (a direction or order), so that the information and operating instructions be presented in a positive sense and require no interpretation by the user.

Specific items requiring emphasis should be expanded upon and ranked in increasing order of importance. For example:

NOTE

Expands on information which is considered essential to emphasize. Information contained in notes may also be safety related.

CAUTION

Provides information that may result in damage to equipment if not followed.

****WARNING****

Emphasises information that may result in personal injury or loss of life if not followed.

APPENDIX B1

Normal operating procedures

This section should contain detailed procedures for conducting a normal flight with all aircraft systems operational. Procedures are listed sequentially by phase of flight, starting with exterior safety inspection and extending through post-flight duties at destination.

Line items defining the steps to be accomplished during each phase of flight should be expanded to define the action required to perform the steps.

These procedures should be compiled from various sources and consist of normal checklists, standard profiles and standard callouts. The reference sources should include the Aircraft Flight Manual (AFM), manufacturer's operating manuals and experience gained in operating the aircraft.

Since safety is paramount, compliance with the procedures contained in this part of the manual should be compulsory unless the situation requires modification for specified operational reasons or in an emergency.

Normal flight refers to an aircraft in smooth air, without malfunction and clear of icing.

APPENDIX B2

Checklists

Checklists are to contain the procedures to be followed by the pilot-in-command and other flight crew members before take-off, before landing, in emergency situations and for other procedures necessary for the efficient handling of the aircraft.

The following standard abbreviations and symbols are commonly used on checklists to identify which crew member is responsible for the procedure:

- C – Captain
- F – First Officer
- CR – Captain and First Officer
- PF – Pilot Flying
- PNF – Pilot Not Flying
- PLT – Either Pilot.

Items marked CR are responded to as follows:

- On the ground – by the Captain followed by the First Officer
- In-flight – by the pilot flying, followed by the pilot not flying.

All checklists performed on the ground are initiated at the command of the Captain.

All checklists performed in flight are initiated at the command of the pilot flying (PF). The Captain, however, still retains final authority for all actions directed or performed.

Where any check is partially completed, call "Check to (insert item)".

When a checklist is completed, the pilot reading the checklist will state the name of the check and the word "complete"; for example, "Before Take-off Check Complete".

First Flight of the Day (FFD)

Some aircraft systems require operational verification prior to the first flight of the day. An asterisk (*) in the checklist may be used to identify these items. For subsequent flights on the same day, these items can be omitted.

Types of Checklists

There are two types of checklists.

Read and Do Checklist

The Read and Do checklist is a silent checklist. The designated crewmember will read the checklist item and carry out the appropriate action. A Read and Do checklist is indicated by a dotted line between the item and the action.

Challenge and Response Checklist

The applicable pilot shall respond to the challenge after having verified the existing configuration. Both pilots shall cross-check, whenever feasible, the validity of the response. If the actual configuration is not in accordance with the checklist requirement, corrective action shall be initiated. A solid line between the item and the action indicates a challenge and response checklist.

STRICT ADHERENCE TO THE CHECKLIST MUST BE OBSERVED AT ALL TIMES, and the pilot not flying must not call the next item until the item called is checked and the appropriate response is given. If any item is not ready for a response it must be recorded. The checklist may be continued provided the recorded item is called and responded to at a later time.

In some instances the Challenge and Response checklist is first done as a flow. The applicable items are completed from memory (recall) using a flow pattern. Upon completion of the pattern the checklist is read aloud.

Checklist responses must be committed to memory. If a pilot incorrectly responds to a challenge, the pilot reading the checklist will state the proper response and then wait for the corrected response before proceeding.

Example: (Challenge and Response)

F Parking Brake

C Set (Proper response is “On”)

F On

C On

APPENDIX B3

Callouts

This section contains information pertaining to flight crews' responsibility during various phases of flight.

Examples of standard callouts during phases of operation:[1]

Example: CALLOUTS DURING TAKEOFF ((1) is the challenger, (2) the responder)

CONDITION	PILOT FLYING CALLS	PILOT NOT FLYING CALLS
Transfer of controls	"Taking Over" (1) or (2)	"Handing Over" (2) or (1)
When Captain starts to advance thrust levers to take-off power	"Set Thrust"	
When take-off thrust is set		"Thrust Set"
When PFD shows: (say) 100 knots At V1 At VR	 "Check"	 "100 knots" "V1" "Rotate"
When take-off is to be rejected (for any reason)	"Stop" (Captain must call & initiate the RTO)	
When positive rate of climb is attained	"Positive rate – Gear up"	"Selected"
Landing gear lever up and EICAS indicates 3 white UP lights on		"Gear is up"
At (say) 600 feet AGL, minimum	"Autopilot-On" "Autopilot Engaged (Active FMC Indications)"	"Selected"

[1] The example is drawn from the Airbus Industrie publication *Airlines Operations Policy Manual* published on the www.airbus.com website (for subscribers only) and used with persmission and courtesy of the copyright holder.

CONDITION	PILOT FLYING CALLS	PILOT NOT FLYING CALLS
Transfer of controls	“Taking Over” (1) or (2)	“Handing Over” (2) or (1)
Conditions for flap retraction are fulfilled	“Flaps …#….”	“Selected”
When EICAS indicates flaps at zero degrees		“Flaps at zero”
Conditions for reduction to climb thrust are fulfilled	“Climb thrust”.	
When climb thrust is set		“Climb thrust – set”

Example: CALLOUTS DURING CLIMB AND DESCENT

CONDITION	PILOT FYLING CALLS	PILOT NOT FLYING CALLS
1000 feet before reaching clearance altitude or flight level	“Checked (FL/ALT........)” (2)	“1000 to go” (1)

Example: CALLOUTS DURING APPROACH

CONDITION	PILOT FLYING CALLS	PILOT NOT FLYING CALLS
Conditions for flaps extension are fulfilled	“Flaps…#….”	“Selected”
When EICAS indicates flaps position		“Flaps at …#….”
When localiser course bar starts to move from full scale deflection		“Course Bar Active”
When glideslope pointer starts to move downward		“Glideslope active”

CONDITION	PILOT FLYING CALLS	PILOT NOT FLYING CALLS
When at the appropriate segment of the approach	“Gear down” (1)	“Selected” (2)
When landing gear is down and EICAS indicates 3 green DN lights on		“Gear down- 3 greens”
If maximum localiser deviation is exceeded	“Checked”	“Localiser” (1)
If maximum glideslope deviation is exceeded	“Checked”	“Glide Slope (1)
If maximum speed deviation is exceeded	“Checked”	“Speed” (1)
If maximum descent rate is exceeded	“Checked”	“Sink rate” (1)
If maximum altitude deviation is exceeded	“Checked”	“Altitude” (1)
At 100 feet above decision height (DH) or decision altitude (DA) or MDA	“Checked”	“100 to minimum” (1)
At decision height (DH) or decision altitude (DA) or MDA. (If no Auto callout)		“Minimum” (1)
At the MAP or DH/DA or MDA, when visual reference is established	“Visual” “Landing”	
When on final and the VASIS indicates the aircraft is at or more than two lights above or below normal on slope profile or more than one light high or low indication on PAPI	“Checked”	“Low on slope” (1) or “High on slope” (1)
At minimum height for autopilot use, if still engaged		“Autopilot- disengage”

Example: CALLOUTS DURING MISSED APPROACH

CONDITION	PILOT FLYING CALLS	PILOT NOT FLYING CALLS
At the MAP or DH/DA/MDA and the runway is not in sight or at any instance when a go-around is called for.	“Nil sighting” “Going-Around, Flaps #”	“Selected”
When positive rate of climb is attained	“Positive Rate – Gear Up”	“Selected”
Go-Around thrust is set	“Set thrust”	
Check Go-Around thrust is set		“Thrust-Set”
When EICAS indicates flaps are set		“Flaps at #”
EICAS indicates 3 white UP lights on		“Gear is up”

APPENDIX B4

Abnormal operating procedures

This section details the procedures to be used by flight crew to handle abnormal situations. They are concerned with foreseeable situations, usually involving a failure condition, in which their use can be expected to maintain an acceptable level of safety.

The procedures are presented in expanded form, describing in detail how and why the abnormal procedures are used.

The presentation of these abnormal procedures assumes a standard flight deck composition with regard to flight deck resource management. It is essential that the pilot-in-command assesses the situation and clearly determines the task distribution for the various phases of flight. Abnormal operation is non-routine, and all actions in abnormal procedures are announced before being performed. Under no circumstances should control of the aircraft be compromised.

Whenever an abnormal condition arises, the nature of the problem must first be recognised and assessed, then action taken to remedy the condition, extinguishing any warning/caution lights and silencing any aural warnings.

When carrying out any procedures detailed within this section, as is the case during all stages of flight, one crew member must be assigned the prime role of “flying the aircraft”. This does not mean he/she must fly the aircraft physically but that they must constantly monitor the flight path of the aircraft. It is expected that, when available, maximum use of the autopilot will be made.

It is expected that the flight crew possess sufficient knowledge to select the correct checklist. The flight crew is further expected to have a thorough understanding of what is accomplished by performing a certain item in the checklist.

It is not possible to cover all combinations of malfunctions in checklists which, with some exceptions, only cover single, discrete failures. If multiple unrelated failures should occur, the flight crew may have to combine parts or whole different checklists and to exercise good judgement to determine the safest course of action.

WHEN A MALFUNCTION SITUATION IS EXPERIENCED, IT SHALL BE POSITIVELY IDENTIFIED BEFORE ANY ACTION IS TAKEN AND UNDER NO CIRCUMSTANCES SHALL CONTROL OF THE AIRCRAFT BE COMPROMISED.

PRIOR TO SHUTTING DOWN OR SWITCHING OFF VITAL ITEMS LIKE ENGINE, FUEL, GENERATORS ETC. BOTH PILOTS SHALL VERIFY THE APPROPRIATE LEVER, HANDLE, OR PUSHBUTTON.

APPENDIX B5

Emergency operating procedures

Detail procedures which can be related to foreseeable emergency situations. The procedures should explain how and why the emergency procedures are used.

This section details the procedures to be used by flight crew to handle emergency situations. They are concerned with foreseeable but unusual situations in which immediate and precise crew action will substantially reduce the risk of disaster. The procedures should be grouped into systems in the form of a Quick Reference Handbook.

The presentation of these emergency procedures assumes a standard crew composition. It is essential that the pilot-in-command assesses the situation and clearly determines the task distribution for the various phases of flight. Emergency operation is non-routine, and all actions in emergency procedures are announced before being performed. As with abnormal operations, under no circumstances should control of the aircraft be compromised.

When carrying out any procedures as is the case during all stages of flight, one crew member must be assigned the prime role of “flying the aircraft”. This does not mean he/she must fly the aircraft physically but that they must constantly monitor the flight path of the aircraft. It is expected that, when available, maximum use of the autopilot will be made.

For some emergency procedures, specific actions can be designed to be performed as soon as the situation permits. The delay involved in referring to the applicable checklist is potentially dangerous; therefore, the flight crew must be able to carry out the applicable procedure by memory. Such actions should be printed with the “memory items” clearly marked. When the checklist is subsequently read it should be read from the beginning of the checklist and confirmation made that the memory items have been carried out.

As with abnormal situations, it is expected that the flight crew possess sufficient knowledge to select the correct checklist in an emergency. The flight crew is further expected to have a thorough understanding of what is accomplished by performing a certain item in the checklist.

It is not possible to cover all possible emergencies in checklists and with some exceptions it only covers single failures. If multiple unrelated failures should occur, the flight crew may have to combine parts or whole different checklists and to exercise good judgement to determine the safest course of action.

NOTE

WHEN AN EMERGENCY SITUATION IS EXPERIENCED, IT SHALL BE POSITIVELY IDENTIFIED BEFORE ANY ACTION IS TAKEN AND UNDER NO CIRCUMSTANCES SHALL CONTROL OF THE AIRCRAFT BE COMPROMISED.

PRIOR TO SHUTTING DOWN OR SWITCHING OFF VITAL ITEMS LIKE ENGINE, FUEL, GENERATORS ETC. BOTH PILOTS SHALL VERIFY THE APPROPRIATE LEVER, HANDLE, OR PUSHBUTTON.

Prior to actioning any procedures, pilots must ensure the malfunction is POSITIVELY IDENTIFIED to ensure that the correct procedure/drill is performed. The PF will call for IDENTIFICATION to be made by the PNF; the PF will then CONFIRM the identification. The identification and confirmation of a warning or caution alert must be by reference to prime indications, for example visually or flight management system pages/engine indications/warning and fault lights.

The aircraft's flight path control is paramount, and must be assured by confirming who is flying the aircraft prior to commencing any emergency procedures. Normally the PF will assume control; this will be done by the PF calling for the drill or memory action, followed by the statement that "I have control and the radios." This confirms to the PNF that the PF is responsible for the aircraft flight path and radio communications. The PNF will then carry out the required memory items, and once the memory actions have been completed reference the written check list to confirm all memory items have been completed and announce to the PF that he/she is: "Standing by with the .... checklist". This indicates to the PF that all memory items have been completed and confirmed. The PF would then command completion of the checklist items when he/she is ready.

> ***Note**: The PNF is still required to support the PF with system selections and to give normal instrument flying support.*

Example: Engine Fire in flight

PF "Identify the Failure".

PNF "Left Engine Fire".

PF "Confirm/Negative" (As applicable).

PF "Engine Fire Memory Items. I have control and the radios".

PNF Places his/her hand on Left thrust lever and announces "Left Thrust lever IDLE".

PF "Confirmed IDLE/Negative" (As applicable).

PNF Then selects the thrust lever to idle. With his/her hand still on the thrust lever he/she announces "Left Thrust lever SHUT OFF".

PF "Confirmed SHUT OFF/Negative" (As applicable).

PNF Then places his/her finger on the ENGINE FIRE PUSH switch/light and announces: "Left ENG FIRE switch PUSH".

PF "Confirmed PUSH/Negative" (As applicable)

PNF Will then lift the guard and PUSH the ENGINE FIRE PUSH switch/light.

PNF Then places his/her finger on the fuel boost pump and announces "Left BOOST PUMP OFF"

PF "Confirmed OFF/Negative" (As applicable).

PNF Starts timing and discharges the fire bottles as required; he/she then references the checklist to confirm all recall actions complete and announces to the PF that he/she is "Standing by with the Engine Fire in Flight Checklist".

PNF Complete the checklist when directed by PF.

Upon completion of all checklist items:

PNF States "Engine Fire in Flight Checklist Complete"

Incapacitation of Crew Members

Overview

Incapacitation of a crew member is defined as any condition which affects the health of a crew member during the performance of duties which renders him incapable of performing the assigned duties.

Incapacitation is a real air safety hazard which occurs more frequently than many of the other emergencies which are the subject of routing training. Incapacitation can occur in many forms varying from obvious sudden death to subtle, partial loss of function. It occurs in all age groups and during all phases of flight and may not be preceded by any warning.

Recognition

The critical operational problem is early recognition of the incapacitation. The keys to early recognition of incapacitation are:

- routine monitoring and cross-checking of flight instruments, particularly during critical phases of flight, such as take-off, climb out, descent, approach landing and go-around
- flight crew members should have a very high index of suspicion of a "subtle incapacitation":
  - if a crew member does not respond appropriately to two verbal communications
  - if a crew member does not respond to a verbal communication associated with a significant deviation from a standard flight profile
- if you don’t feel well, say so and let the other pilot fly.

Other symptoms of the beginning of an incapacitation are:

- incoherent speech
- strange behaviour
- irregular breathing
- pale fixed facial expression
- jerky motions that are either delayed or too rapid.

Action

The recovery from a detected incapacitation of the handling pilot shall follow the sequence below:

- The fit pilot must assume control and return the aircraft to a safe flight path, announce “I have control” and engage the autopilot if not already engaged.
- The fit pilot must take whatever steps are possible to ensure that the incapacitated pilot cannot interfere with the handling of the aircraft. This may include involving cabin crew to restrain the incapacitated pilot.
- If the cockpit door is locked, the assisting cabin crew will apply the relevant procedure to unlock the door.
- The fit pilot must land as soon as practicable after considering all pertinent factors.
- Arrange medical assistance after landing giving as many details about the condition of the affected crew member as possible.

APPENDIX B6

Flight planning and preparation

Operational flight planning requirements

Prior to each flight, an operational flight plan must be prepared by dispatchers or by the flight crew. In larger operations, it is normally obtained through a computerised process from the dispatcher.

The operational flight plan must contain the following items (where applicable to the operation):

- Aircraft registration
- Aircraft type and variant
- Date of flight
- Flight identification
- Names of flight crew members
- Duty assignment of flight crew members
- Place of departure
- Time of departure (actual off-block time, take-off time)
- Place of arrival (planned and actual)
- Time of arrival (actual landing and on-block time)
- Type of operation (ETOPS, VFR, Ferry flight, etc.)
- Route and route segments with checkpoints/waypoints, distances, time and tracks
- Planned cruising speed and flying times between check-points/waypoints. Estimated and actual times overhead
- Safe altitudes and minimum levels
- Planned altitudes and flight levels
- Fuel calculations (records of in-flight fuel checks)
- Fuel on board when starting engines
- Alternate(s) for destination and, where applicable, take-off and en-route, including the information required in items (12), (13), (14), and (15) above
- Initial ATC Flight Plan clearance and subsequent re-clearance
- In-flight re-planning calculations
- Relevant meteorological information.

Items which are readily available in other documentation or from another acceptable source or are irrelevant to the type of operation may be omitted from the operational flight plan.

The operational flight plan must be checked by the flight crew and approved by the pilot-in-command before the departure.

Amendments due to flight crew requirements, ATC clearance or limitations such as aircraft MEL or CDL items may require the operational flight plan to be updated by the flight crew.

The operational flight plan may be calculated with updated performance of the aircraft, ATC cleared route, the weather forecast on the route and the actual aircraft weights. Aircraft limitations must be taken into account and recorded.

APPENDIX B7

Aircraft loading, weight and balance

Aircraft loading

Judgement must always be used when determining the load of an aircraft, and any of the methods adopted by an operator are not dispensation from the requirement to ensure that loading limitations and centre of gravity limits are met. Loading of an aeroplane is to be in accordance with the aeroplane's weight and balance limits. The Operations Manual should include guidance and instructions on the calculation of aeroplane weight and balance, on the use of standard figures for passengers mass and balance and on any special loading instructions, particularly in relation to the carriage of dangerous goods. This is to ensure that all phases of operation, the loading, weight and centre of gravity of the aeroplane comply with the limitations specified in the Operations Manual.

The operator is responsible for providing acceptable guidance to the aircraft operating crew, or any other staff, such as load planners or load supervisors, on the operator's system for loading the aircraft. An operator should specify in the Operations Manual the principles and methods involved, including the responsibilities of any delegated staff, for the determination of the load that enables the requirements of current regulations to be satisfied. The system should cover all types of intended operation.

Where an approved load system is used that is different from the AFM, procedures describing the use of the load system must be included in the Operations Manual.

Definitions

The following definitions relate to the practices and procedures for establishing the aircraft load.

Basic empty weight means the weight of the aeroplane including all fixed equipment, system fluids, unusable fuel and configuration equipment, including galley structure.

Dry operating weight of an aeroplane means the sum of the following:

- the aeroplane's basic empty weight
- the weight of any potable water and lavatory chemicals
- the weight of the removable equipment used to conduct the flight, including any catering and passenger service equipment
- the weight of crew members and crew baggage.

Loading system for an aeroplane means an approved loading system that ensures that the aeroplane is loaded within the certified weight and centre of gravity limits during all operations including loading and unloading.

Load planner in relation to an aeroplane, means the person (who may be the pilot-in-command of the aeroplane) who:

- assembles load information for the aeroplane
- prepares a plan of the load distribution and calculates the aeroplane's weight and centre of gravity in accordance with its loading system
- prepares and distributes the loading documentation
- certifies that, if the plan is followed, the aeroplane will be loaded within weight and centre of gravity limits during all phases of flight.

Load controller, in relation to an aeroplane, means the person, who may be the pilot-in-command of the aeroplane, who supervises the loading of the aeroplane to ensure that it is loaded in accordance with the loading system and the information provided to him or her by a load planner.

Maximum landing weight (MLW) of an aeroplane is its maximum permissible total weight, under normal circumstances, upon landing.

Maximum take-off weight (MTOW) of an aeroplane is its maximum permissible total weight at the start of the take-off run.

Maximum zero fuel weight of an aeroplane means the weight limit beyond which any increase in load must consist entirely of usable fuel.

Payload of an aeroplane means the total weight of passengers, baggage and cargo and goods but excludes usable fuel.

Carry-on baggage means anything carried onto the aircraft and taken into the passenger cabin.

Weight and balance documentation for an aeroplane means any document prepared by the operator for the purpose of enabling the pilot-in-command to determine that the load and its distribution do not exceed the weight and balance limits for the aircraft concerned.

Crew, passenger and baggage weights

Weight values for crew

When determining the dry operating weight of an aeroplane, an operator shall take into account the weight of the aeroplane crew. Crew weights may be calculated in the following ways:

- by determining their actual weights (including the weight of any crew baggage)
- by using the following standard weights for each crew member:
  - for each male crew member, a value of 85 kilograms
  - for each female crew member, a value of 65 kilograms
  - other standard weights that are acceptable to CASA and described in the Operations Manual.

Note: *Where standard weights are used, an allowance acceptable to CASA must be made for the weight of each crew member's baggage.*

Weight values for passengers and baggage

The operator may adopt one of the following methods to determine the weight of the passengers when loading an aeroplane:

- if the aeroplane has a maximum approved passenger seat configuration of less than six:
  - weighing each passenger (adult, child and infant) including the weighing of all personal items and carry-on baggage. Weighing, where practicable, should be carried out prior to and near the place of boarding
- if the aeroplane has a maximum approved passenger seat configuration of more than five:
  - weighing each passenger (adult, child and infant) including the weighing of all personal items and carry-on baggage. Weighing, where practicable, should be carried out prior to and near the place of boarding
  - the standard passenger weight values specified in CAAP 235-1.

Weighing survey plan

An operator of an aeroplane may determine their own standard passenger weights by adopting a weighing survey plan, and applying the statistical analysis by the method detailed below.

The revised standard passenger weight values may only be used in circumstances consistent with those under which the survey was conducted and for no more than five years. (It is an operator's responsibility to monitor the standard passenger weight values at regular intervals. This would be in line with the Safety Management System (SMS) concept of continual monitoring and improvement). The values determined are only applicable to the operator who conducted the survey.

Example of a Weighing survey plan acceptable to CASA

Weight sampling method: the average weight of passengers and their hand baggage must be determined by weighing and taking random samples. The selection of random samples must, by nature and extent, be representative of the passenger volume, considering the type of operation, the frequency of flights on various routes, inbound and outbound flights, applicable season and seat capacity of the aeroplane.

Sample size: the survey plan must cover the weighing of at least the greater of the following:

- a number of passengers calculated from a pilot sample, using normal statistical procedures and based on a relative confidence range (accuracy) of 1% for all adult and 2% for separate male and female average weights
- a total number of 50 multiplied by the maximum approved passenger seat configuration.

Passenger weights: Passenger weights must include the weight of the passengers' belongings that are carried when entering the aeroplane. When taking random samples of passenger weights, infants must be weighed together with the accompanying adult.

Weighing location: the location for the weighing of passengers must be as close as possible to the aeroplane, at a point where a change in the passenger weight by disposing of or acquiring more personal belongings is unlikely to occur before the passengers board the aeroplane.

Weighing machine: the weighing machine to be used for passenger weighing must have a capacity of at least 150 kg. The weight must be displayed at minimum graduations of 500 g. The weighing machine must be accurate to within 0.5% or 200 g whichever is the greater.

Recording of weight values: for each flight included in the survey, the weight of the passengers, the corresponding passenger category (i.e., male, female and children) and the flight number must be recorded.

Determination of revised standard weight values for passengers

To ensure that the use of revised standard passenger weight values does not adversely affect operational safety, a statistical analysis must be carried out.

On aeroplanes with a maximum approved passenger seat configuration of 6 to 9 (inclusive), an increment of 8 kg must be added to the average passenger weight to obtain the revised standard passenger weight values.

All adult revised standard weight values must be based on a male/female ratio of 80/20 in respect of all flights. If an operator wishes to obtain approval for use of a different ratio on specific routes or flights, data must be submitted to CASA showing that the alternative male/female ratio is conservative and covers at least 84% of the actual male/female ratios on a sample of at least 100 representative flights.

The average weight values found are to be rounded to the nearest whole number in kilograms or pounds.

Weight and balance documentation

It is the responsibility of the operator to develop documentation to accurately record the load status of the aircraft prior to each flight. All of the following items should be considered as applicable to the operation:

Weight and balance documentation contents:

- the aeroplane registration and type
- the flight identification number and date
- the name of the pilot-in-command
- the aerodromes of departure and destination
- the name of the person who prepared the document
- the dry operating weight and corresponding centre of gravity of the aeroplane
- the weight of the fuel at take-off and the weight of fuel to be used before the next landing
- the weight of consumables other than fuel
- the weights of the components of the load including passengers, baggage, cargo and ballast
- the take-off weight, landing weight and zero fuel weight
- the load distribution
- evidence that the centre of gravity of the aeroplane remains within the limits set out in the flight manual
- the limiting weight and centre of gravity values.

Last-minute changes

For last-minute changes after the completion of the weight and balance documentation, a procedure should be developed to ensure any change is brought to the attention of the aeroplane's pilot-in-command and entered on the weight and balance documentation.

The maximum allowed change in the number of passengers or load acceptable as a last-minute change should also be specified in the Operations Manual and the values should be mentioned in the weight and balance documentation prepared for the flight.

Computerised systems

If weight and balance documentation is generated by a computerised weight and balance system, the operator should develop a system to verify the integrity of the output data at regular intervals not exceeding six months.

The operator should establish a system to check that:

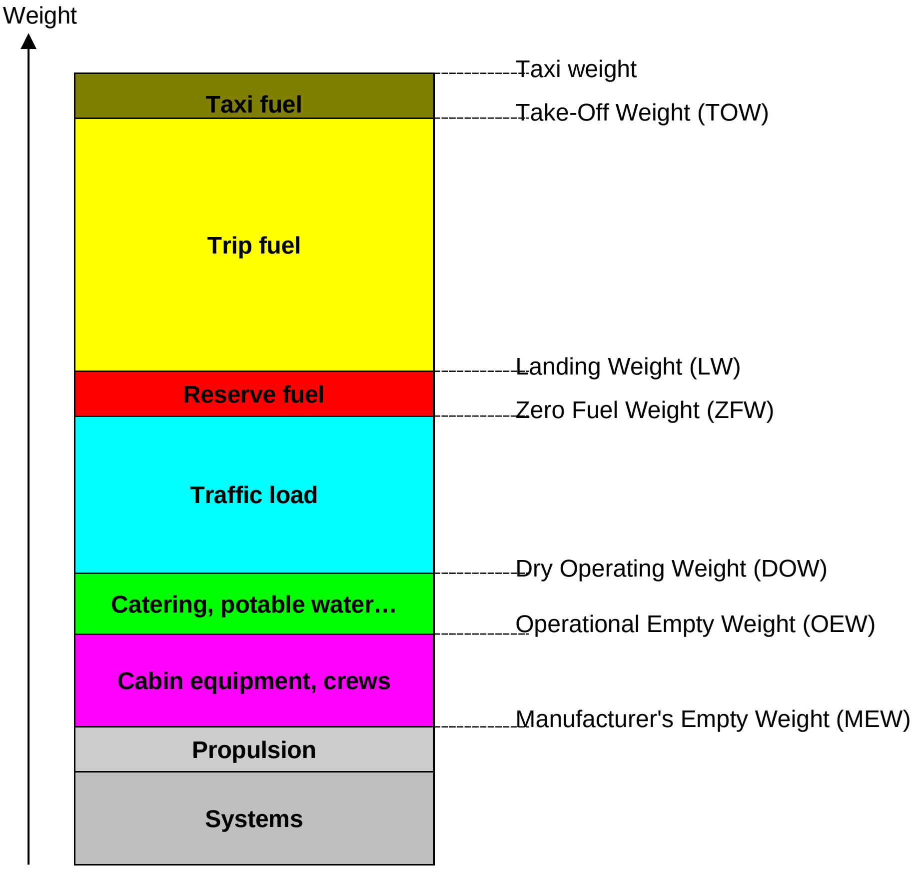
- amendments of the input data are incorporated properly in the system
- the system is operating correctly on a continuous basis.

The operator should retain evidence of each verification for a period of six (6) months.

Datalink

If weight and balance documentation is sent to an aeroplane by datalink, a copy of the final weight and balance documentation, as accepted by the aeroplane's pilot-in-command, should remain available on the ground.

Definition of Aircraft Weights – Diagram



Methods, Procedures and Responsibilities for Preparation and Acceptance of Weight and Centre of Gravity Calculations

The correct loading of the aircraft is the responsibility of the pilot-in-command. The pilot-in-command must be satisfied that the load is distributed in a correct and safe manner and that it is properly stowed and secured. The pilot-in-command shall ensure that before each flight a weight and balance/load and trim sheet is prepared on the correct form and complies with the aircraft weights and CG certified limitations.

For many operators, standard weights are given for the equipment and catering that will be carried. The pilot-in-command should check the relevant loading section of the Aircraft Flight Manual to determine the weight balance limits for the type of operation being conducted.

The pilot-in-command considers the following assumptions:

- The weighing report showing the weight and the basic index of the empty aircraft has been correctly compiled.
- The freight has been correctly weighed and loaded in accordance with the Load and Trim sheet.

The pilot-in-command is personally responsible for:

- Checking that sufficient fuel and oil of the correct grade are on board and correctly loaded and distributed

- Checking the weight and balance/load and trim sheet calculation
- Accepting and signing the sheet.

If deemed necessary, the pilot-in-command has full authority to modify the aircraft loading such as number of passengers, usable cabin seats and cargo compartments loading and distribution.

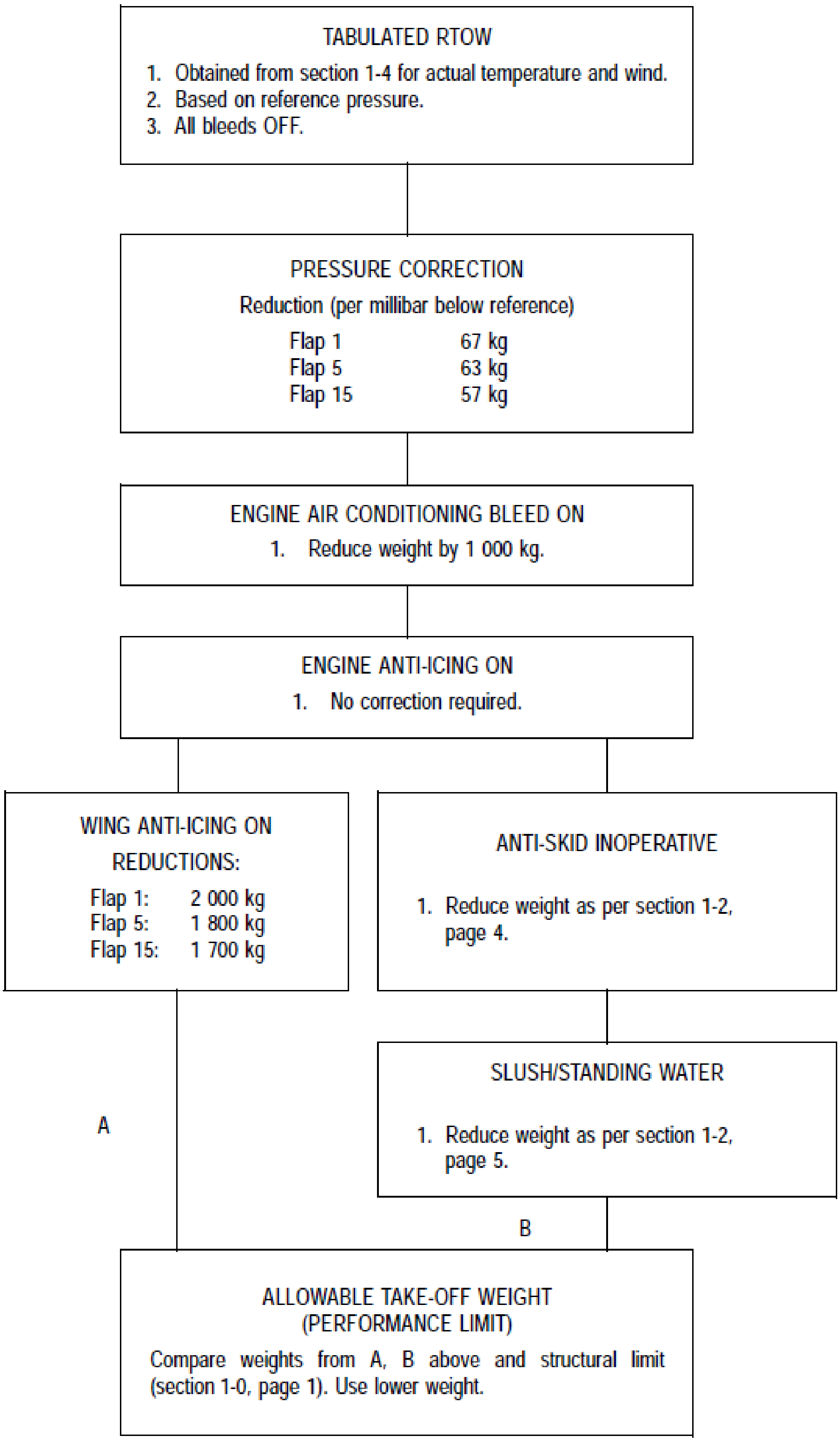
The CG limits given in the weight and balance/load and trim sheet include tolerances to cope with the combination of the following independent errors:

- error on initial conditions (dry operating weight and index)
- error on cargo loading (weight and distribution)
- error on passenger boarding (weight and distribution)
- error on fuel (quantity and distribution)
- error due to graphical method.

And the following configurations/movements:

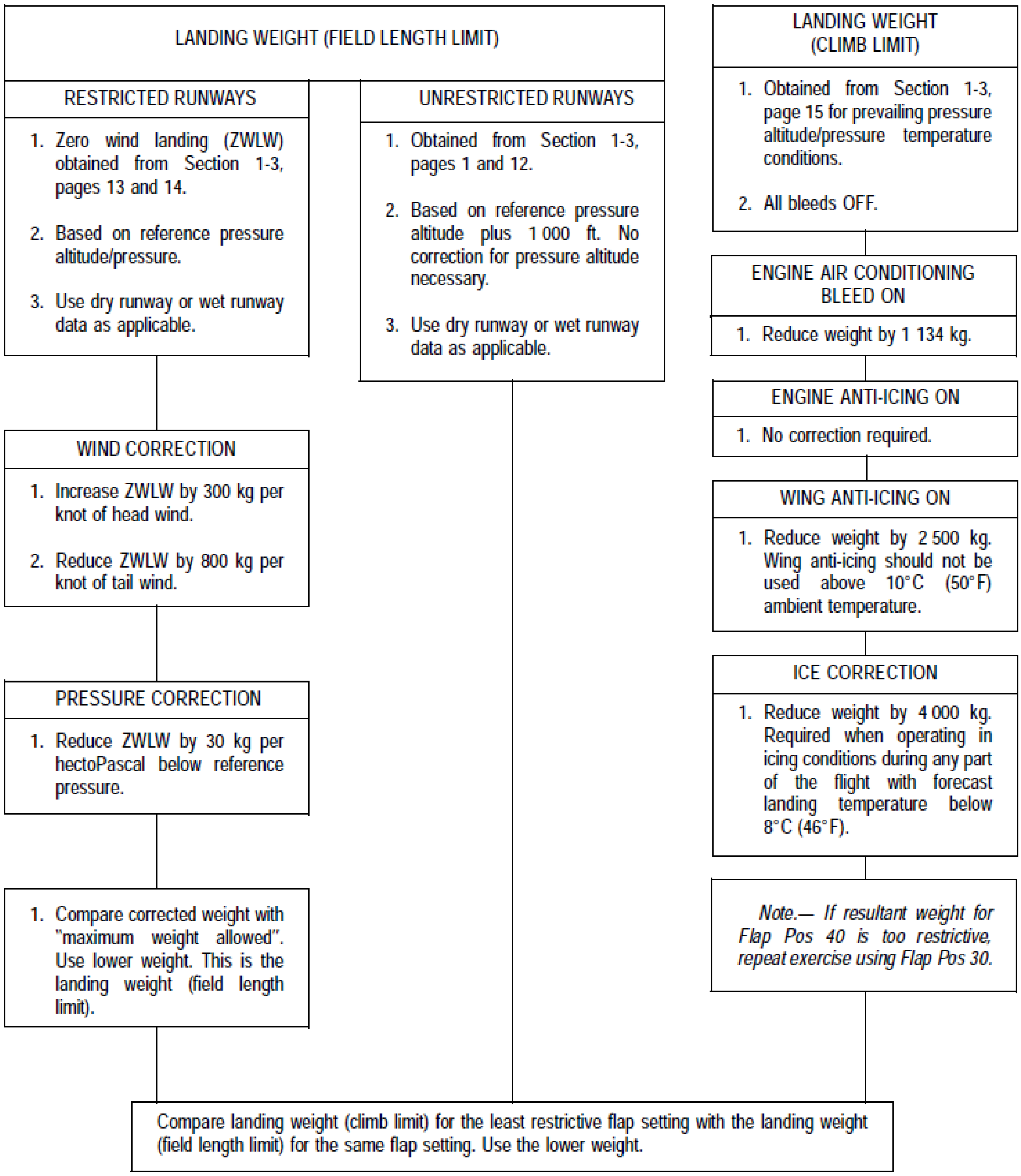
- landing gear, flaps and slats movements
- movements in the cabin.

AN EXAMPLE OF AN OPERATOR'S FLOWCHART FOR CALCULATION OF ALLOWABLE TAKE-OFF WEIGHT [2]



[2] Reprinted with permission from ICAO Document 9376 – Preparation of an Operations Manual 1997.

CALCULATION OF ALLOWABLE LANDING WEIGHT[3]



[3] Reprinted with permission from ICAO Document 9376 – Preparation of an Operations Manual 1997.

APPENDIX B8

Performance

The person responsible for operational control shall ensure that the performance data in the Approved Flight Manual (AFM) is supplemented as necessary with other data acceptable to the Authority if the approved performance data in the AFM is insufficient in respect of items such as:

- accounting for reasonably expected adverse operating conditions such as take-off and landing on contaminated runways
- consideration of engine failure in all flight phases.

Take-off

An operator and the pilot-in-command shall ensure that the take-off weight does not exceed the maximum take-off weight specified in the AFM for the pressure altitude and the ambient temperature at the aerodrome at which the take-off is to be made4.

An operator and the pilot-in-command must meet the following requirements when determining the maximum permitted take-off weight:

- The accelerate-stop distance must not exceed the accelerate-stop distance available
- The take-off distance must not exceed the take-off distance available, with a clearway distance not exceeding half of the take-off run available
- The take-off run must not exceed the take-off run available
- On a wet or contaminated runway, the take-off weight must not exceed that permitted for a take-off on a dry runway under the same conditions.

When showing compliance with the points above, an operator must take account of the following:

- The pressure altitude at the aerodrome
- The ambient temperature at the aerodrome
- The runway surface condition and the type of runway surface
- The runway slope in the direction of take-off
- Not more than 50% of the reported head-wind component or not less than 150% of the reported tailwind component
- The loss, if any, of runway length due to alignment of the aircraft prior to take-off.

Landing - Destination and alternate aerodromes

An operator and the pilot-in-command shall ensure that the landing weight of the aircraft does not exceed the maximum landing weight specified for the altitude and the ambient temperature expected for the estimated time of landing at the destination and alternate aerodrome.

For instrument approaches with a missed approach gradient greater than 2.5% an operator and pilot-in-command shall verify that the expected landing weight of the aeroplane allows a missed approach with a climb gradient equal to or greater than the applicable missed approach gradient in the one-engine inoperative missed approach configuration and speed. The use of an alternative method must be approved by CASA.

For instrument approaches with decision heights below 200 ft, an operator and the pilot-in-command must verify that the approach weight of the aeroplane, taking into account the take-off

[4] The operator's responsibility is achieved through publishing and distributing procedures in the Operations Manual and ongoing processes to ensure that operational staff adhere to the procedures.

weight and the fuel expected to be consumed in flight, allows a missed approach gradient of climb, with the critical engine failed and with the speed and configuration used for go-around of at least 2.5%, or the published gradient, whichever is the greater. The use of an alternative method must be approved by CASA.

The required missed approach gradient may not be achieved when operating at a high landing weight and in engine-out conditions. Weight, altitude and temperature limitations and wind for the missed approach should be considered.

An alternative method is to increase the decision altitude/height or minimum descent altitude/height, and/or a contingency procedure providing a safe route to avoid obstacles may be approved.

More detailed guidance will be included in guidance material attached to the new Air Transport CASRs.

APPENDIX B9 - Fuel Policy and Associated Fuel Elements

Introduction

This appendix 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 as relate to fuel policy, fuel management and fuel related procedures.

This appendix will address:

- prescriptive rules – legislative requirements, for inclusion in fuel policy and operational execution of the company fuel policy
- 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. It is not a requirement however, 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.

Difficulty arises when the operator cannot, due to differences in terminology, assure that the terms used in the operations manual are substantially equivalent, allocate fuel in a similar fashion, and, when combined, result in an equivalent or greater amount of fuel, than is required by legislation.

To avoid any confusion in relation to compliance with the contents of the operations manual, the operations manual should contain a clear statement that the variously described; information, techniques, practices, procedures and instructions, are to read as instructions as meets the intent of Subregulation 215 (9) of the *Civil Aviation Regulations 1988* (CAR). An example being:

> *The information, techniques, practices, procedures and instructions contained in this operations manual shall be taken by each member of the operations personnel to be instructions to be complied with in so far as they relate to their duties or activities.*

Fuel Requirements Legislation

Regulation 234 of the *Civil Aviation Regulations 1988* (CAR) permits CASA to prescribe in the Instrument number CASA 29/18 Civil Aviation (Fuel Requirements) Instrument 2018:

a) matters that must be considered when determining whether an aircraft has sufficient fuel to complete a flight safely, and
b) the amounts of fuel that must be carried on board an aircraft for a flight, and
c) procedures for monitoring amounts of fuel during a flight and,
d) procedures to be followed if fuel reaches specified amounts during a flight

The provisions contained in the Fuel Requirements Instrument 2018, with guidelines contained in Civil Aviation Advisory Publication 234-1(2) – Guidelines for Aircraft Fuel Requirements should form the minimum prescriptive basis for the development of an operator's basic fuel policy to be contained in the operations manual.

The Fuel Requirements Instrument 2018 also allows CASA to approve AOC holders to vary certain prescribed elements of those provisions under certain circumstances.

Basic Fuel Policy Requirements

The operator's fuel policy described within the 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 the potential for 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 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, and
- fuel consumption monitoring and conservation practices

Determining Fuel Quantities for Flight

The overarching premise reflected in the provisions contained in the Fuel Requirements Instrument 2018, is that, taking the aircraft fuel consumption data and operating conditions for the planned flight into account and allowing for possible deviations from the planned operation, sufficient fuel must be carried to safely complete the planned flight.

The 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 operations manual with respect to 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

CAAP 234-1(2) reflects the provisions from the Fuel Requirements Instrument 2018 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 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:

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

b) 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 requirements of the Fuel Requirements Instrument 2018, 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, and
- 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 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 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 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 Instrument 2018 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 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 operations manual, for use in planning and operationally.

The use of alternatives to the prescriptive taxi fuel calculation requirements of the Fuel Requirements Instrument 2018 are discussed in the operational variations section of this appendix.

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 Instrument 2018 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 (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 or descent from the initial cruising level/altitude mentioned in a); 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 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 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 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: 1,5000lbs 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 Instrument 2018 are discussed in the operational variations section of this appendix.

Holding Fuel

Holding fuel is defined in Fuel Requirements Instrument 2018 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 operations manual should contain clear instructions in relation to the conditions and fuel consumption basis to be applied to the calculation of holding fuel.

Variable Fuel Reserve

From a safety risk management perspective, variable fuel reserve 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 variable fuel reserve is that of creating a diversion or low fuel state that could subsequently impact on air traffic management and other airspace users.

Variable fuel reserve is defined in Fuel Requirements Instrument 2018 as the amount of fuel that is the highest:

a) the percentage of trip fuel as specified and as applicable to the operation; and

b) in the event of in-flight re-planning, the percentage of trip fuel as specified and as 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 destination aerodrome; and

c) for an RPT or charter flight in an aeroplane an amount of fuel to fly for 5 minutes at holding speed at 1 500 feet above the destination aerodrome in ISA conditions.

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

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

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

The operations manual should contain a direction to ensure that variable fuel reserve is protected in-flight when it is required for a particular purpose. The consumption of any of the variable fuel reserve 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 variable fuel reserve calculation requirements of the Fuel Requirements Instrument 2018 are discussed in the operational variations section of this appendix.

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

Alternate Fuel

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 alternates should be contained in the operations manual, although not necessarily required to be associated with the alternate fuel requirements.

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

Note: Where 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 towards that needed for an approach and landing at the destination alternate aerodrome.

If the operator specifies a particular alternate 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 operations manual. Accordingly, the 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 alternate fuel calculation requirements of the Fuel Requirements Instrument 2018 are discussed in the operational variations section of this appendix.

Fixed Fuel Reserve

The Fuel Requirements Instrument 2018 defines fixed fuel reserve, as the amount of fuel, expressed as a period of time, required to enable an aircraft to fly under specified conditions, required to be useable fuel remaining in the fuel tanks until completion of the final landing.

The specified conditions are:

a) for a helicopter conducting an IFR flight or an aeroplane or an airship:

   at holding speed at 1,500 feet above aerodrome elevation at ISA conditions, or

b) for a helicopter conducting a VFR flight:

   at best-range speed at 1,500 feet above aerodrome elevation at ISA conditions,

c) calculated with the estimated weight on arrival at the destination alternate aerodrome, or the destination aerodrome when no destination alternate aerodrome is required.

The time values of fixed fuel reserve to be applied by type and category of operation are contained in column 3 of Table 1 of the Fuel Requirements Instrument 2018.

The 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) fixed fuel reserve 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 fixed fuel reserve 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 operations manual.

The use of alternatives to the prescriptive fixed fuel reserve calculation requirements of the Fuel Requirements Instrument 2018 are discussed in the operational variations section of this appendix.

Additional Fuel

Additional fuel is defined in the Fuel Requirements Instrument 2018 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:

a) to proceed to an alternate aerodrome; and

b) to fly for 15 minutes at holding speed at 1 500 feet above aerodrome elevation in ISA conditions; and

c) to 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 variable fuel reserve may be used on the ground. This would not be the case if some or all variable fuel reserve is a component of the required additional fuel. In other words, if some or all variable fuel reserve is part of the additional fuel, it may not be used on the ground and must be available at the critical point.

The 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 variable fuel reserve 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 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 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.

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.

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 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 operations manual include:

- Operators may set an absolute minimum fuel value to commence a flight irrespective of the length of the anticipated flight.
  - *e.g. 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.
  - *e.g. 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, or*
  - *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.
  - *e.g. 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.

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

Variable Fuel Reserve Variations

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

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

Alternate Fuel Variations

An operator's fuel policy may contain variations in excess of regulatory prescribed minimums for 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.
  - *e.g. 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.
  - *e.g. Alternate leg planning is to include allowance for the most conservative (longest) destination missed approach and alternate aerodrome arrival routing.*

Fixed Fuel Reserve Variations

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

- Setting higher values of fixed fuel reserve for specified operations with inexperienced or trainees (such as in flying training organisations).
- Setting higher values of fixed fuel reserve for cross-country training than in use for local area training.
- Setting higher values of fixed fuel reserve 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.
  - *e.g. Additional fuel calculations are to apply fixed fuel reserve value in lieu of the 15 minutes required under legislation.*
- Specifying that 'where possible' variable fuel reserve be applied to the additional fuel scenario calculations.
- Continuing to apply the CAAP 234-1(1) 8.1(a) contingency fuel to accommodate a loss of pressurisation by requiring; not less than depressurised flight fuel, fixed fuel reserve

and fuel for an approach and landing.
Note: Operations Manual fuel policies for depressurised fuel that conform with the CAAP 234-1(1) November 2006, guidance, will result in fuel quantities greater than that required under the amended legislation. (This is not the case in all instances for OEI fuel).

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 operations manuals.

Fuel Policy Elements - Operational Variations

The Fuel Requirements Instrument 2018 allows CASA to accept operational variations to fuel requirements relating to the calculation of:

a) taxi fuel,
b) trip fuel,
c) variable fuel reserve,
d) alternate fuel,
e) additional fuel, and
f) fixed fuel reserve (only in instances where the operation is an aerial work operation, during which the only occupants of the aircraft are flight crew members. (as defined in *Civil Aviation Safety Regulations 1998 (CASR)* Dictionary – Part 1)

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

The 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 Instrument 2018 can ensure an acceptable level of safety performance commensurate with that of the prescriptive requirements.

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

Where the operations manual includes the prescriptive requirements and operational variations, the 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 Instrument 2018 are not operational variations under the definition contained in that instrument and are not subject to the operational variation requirements.

Basis for operational variations

In order for an operational variation, contained in the 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 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 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 operations manuals.

Variable Fuel Reserve Operational Variations

Operational variations to variable fuel reserve calculations are an alternative calculation means that can be applied in order to calculate a value of variable fuel reserve 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 variable fuel reserve merely replace the method for calculating the amount of variable fuel reserve with a more scientific method.

Operational variations to variable fuel reserve that operators may specify in the operations manual may include:

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

Note: The ICAO terminology for variable fuel reserve is contingency fuel.

Alternate Fuel Operational Variations

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

- Reduction of the 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 alternate fuel quantity values.
- Alternate fuel calculations based on statistical criteria, such as statistical aircraft weights, statistical winds, statistical routing (level and tracking), etc.

Although not specifically an alternate fuel operational variation, the use of advanced 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 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 operations manual procedures should contain the minimum requirements:

a) for each flight into an isolated aerodrome a point of no return (PNR) shall be determined; and
b) 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 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 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.

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 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 operations manual may include:

- Additional fuel calculations and values based on statistical criteria, such as statistical aircraft weights, statistical winds, statistical routing (level and tracking), etc.

Fixed Fuel Reserve Operational Variations

The use of operational variations to fixed fuel reserve is limited to instances where the operation is an aerial work operation, during which the only occupants of the aircraft are flight crew members (as defined in CASR Dictionary - Part 1). 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 FFR. The variation would specify the amount of FFR and any additional mitigation measures to be applied. These measures would include, but not be limited to:

- specifying the minimum value of FFR 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 FFR 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 fuel reserve values less than the prescriptive values contained legislation. That operational variation does not override the Subregulation 138 (1) of CAR requirement 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 Instrument 2018 requires 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:

a) flight fuel calculations;
b) the capabilities of the certificate holder, including:
    - a data driven method that includes a fuel consumption monitoring program; and
    - the advanced use of alternate aerodromes; and
    - 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 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 Instrument 2018 should be complied with by operational personnel by following the procedures detailed in the 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

Regulation 244 of CAR allows CASA to give directions that are deemed necessary in the interests of safety in respect to the duties and responsibilities of the pilot-in-command and other persons for tests, checks and other precautions before the commencement of a flight. Civil Aviation Order (CAO) 20.2 (6) requires that the operations manual of an operator of an aircraft having a maximum take-off weight of more than 5 700 kg and engaged in commercial operations must contains instructions and procedures for the pilot-in-command of the aircraft to verify the quantity of fuel on board the aircraft before flight.

The Fuel Requirements Instrument 2018 requires that the pilot-in-command must ensure that a pre-flight determination of fuel quantity is conducted, and that the operations manual must contain procedures ensuring the results of the pre-flight fuel quantity determination are recorded.

The operations manual should therefor 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 should 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 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 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 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.

An operator conducting air transport operations (charter and RPT) is required to provide policy and procedures in the operations manual for the pilot-in-command to off-load passengers or cargo when any performance limitation would otherwise be exceeded.

The operations manual must contain detailed descriptions of the procedures to be applied by the pilot-in-command for the off-loading of fuel should it be required. 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 Instrument 2018 requires that during a flight the pilot-in-command 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:

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

The 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 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 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 Instrument 2018 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 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 Instrument 2018 as being a distinct time period. It is intended that the operator specify in the operations manual the acceptable period between in-flight fuel quantity checks that ensures the pilot-in-command 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 operations manual:

- The intention of an in-flight fuel quantity check is to ensure that the fixed fuel reserve remains intact, throughout the flight (*the principal importance of this must not be overlooked in developing 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 fixed fuel reserve will be intact at completion of the flight
- The 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 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 operations manual should therefore describe the appropriate methods for recording the results of the in-flight fuel quantity checks, when conducted.
  - *Note: 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.*
  - *Note: 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.

Some industry feedback has indicated that the understanding of the requirements for in-flight fuel checks and recording needed further clarification.

> 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 operations manual should specify the circumstances under which the checks and/or recording would not be required. If the 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, the subsections 6(2) and 6(3)(b) of Fuel Requirements Instrument 2018, shall be taken by CASA as 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

Regulation 220 of CAR requires that an operator maintains a record of the fuel remaining at the end of the flight. It also requires 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 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 Appendix, operations manuals are not required to use specific terminology consistent with legislation nor with this CAAP. 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 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; or
- 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

The Fuel Requirements Instrument 2018 defines a decision point as a point en-route at which an aircraft can:

- if the flight arrives 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 Decision Point (DP) in CAAP 234-1(2) 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 decision points. Prior to crossing each decision point 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 requirements of Fuel Requirements Instrument 2018, section 5 (*The amount of fuel that must be carried for a flight*), subsection 3, in lieu of subsection 2, without the need for an operational variation to the method of calculation of variable fuel reserve. This provision is intended to ensure that a flight planned via a DP does not commence without planning and uploading the variable fuel reserve required to meet the legislated requirement from the DP to the destination or last ERA, without the need to uplift variable fuel reserve to meet the legislated percentage (%) value of trip fuel from take-off.

Prior to the final DP 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 DP, however, the aircraft may not have the operational capability to divert to an alternate aerodrome. As such, prior to crossing the final DP, 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. DP planning can mitigate the effects of forecasting inaccuracies as the flight crew seek updated meteorological information prior to crossing each DP. 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.

DP planning can be consistent with the nomination of a destination alternate aerodrome; however, over long sectors, or in areas of limited infrastructure, DP 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, DP 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 DP 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 decision point 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 decision point 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 DP planning, those provisions and the detailed descriptions of the procedures and practices should be contained in the 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 requirements of Fuel Requirements Instrument 2018.

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 DP planning where the decision point 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 fuel reserve, alternate fuel and variable fuel reserve may also be subject to elements of operational approval as they differ from the methodology used in DP planning.

PDP planning is intended to be used where the distance between the destination aerodrome and the destination alternate aerodrome is so great that carrying alternate fuel as required by the prescriptive elements of Fuel Requirements Instrument 2018 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 operations manual in sufficient detail to allow effective implementation by planning staff and flight crew.

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

3% ERA is a performance-based variable fuel reserve 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 variable fuel reserve is used before reaching the planned destination, there would be sufficient fuel on board to land at the ERA with fixed fuel reserve 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 variable fuel reserve planning and operations.

Equi-time Point (ETP) Selection and Calculation

Equi-time Point (ETP) is defined in CAAP 234-1(2) 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.

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

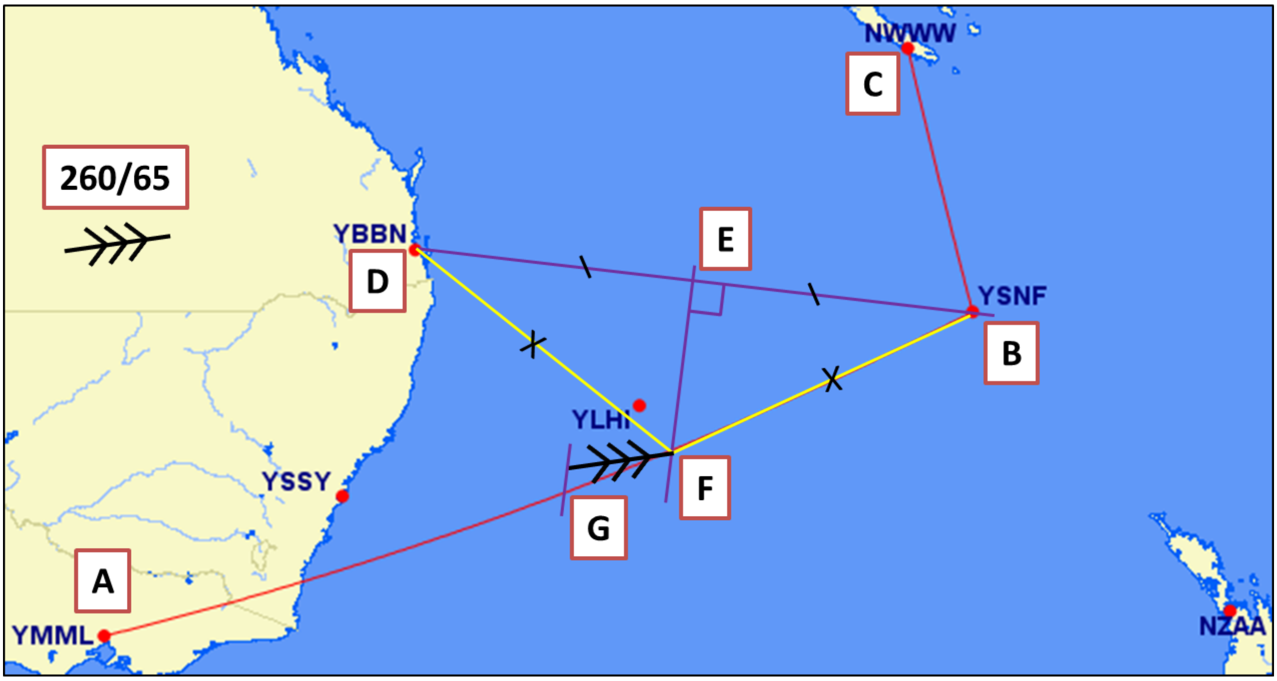
The calculation of off-track ETPs is more complex than for on-track ETPs. Aside from computer-based flight planning applications or Flight Management Computers (FMCs) that can calculate and return the off-track ETP values, the most commonly used method available to flight crew is the graphical plotting 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 operations manual contains a requirement to calculate ETPs, the descriptions of procedures and practices contained in the 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 operations manual is provided in the following section. (Note: 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.*



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 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 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 in the following section. (Note: 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, 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:

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

APPENDIX B10

Adverse weather operations (example text)[5]

Thunderstorms

There is no useful correlation between the external visual appearance of thunderstorms and their severity. Knowledge and weather radar have modified attitudes toward thunderstorms, but one rule continues to be true: 'Any thunderstorm should be considered hazardous'

Weather information

Meteorological observations/forecasts, messages and charts contain thunderstorm and associated hazards information. When thunderstorms are, or are expected to be, sufficiently widespread to make their avoidance by aircraft difficult (e.g. a line of thunderstorms associated with a front or squall line or extensive high level thunderstorms) the meteorological office issues warnings, in the form of SIGMET messages, noting 'thunderstorms in the area' . In addition, pilots are required to send a short air report (AIREP) when conditions are encountered which are likely to affect the safety of aircraft. Such a report would be the basis of a SIGMET warning.

The meteorological office does not issue SIGMET messages in relation to isolated thunderstorm activity and the absence of SIGMET warnings does not therefore necessarily indicate the absence of thunderstorms.

Thunderstorm hazards

Thunderstorms concentrate a number of weather hazards to aviation into one dangerous package. The most important hazards are:

Turbulence

Potentially hazardous turbulence is present in all thunderstorms. The strongest turbulence within the cloud occurs with shear between updrafts and downdrafts. Outside the cloud, shear turbulence has been encountered several thousand feet above and 20 NM laterally from a severe storm. A low-level turbulent area is the shear zone associated with the gust front. Often, a 'roll cloud' on the leading edge of a storm marks the top of eddies in this shear and it signifies an extremely turbulent zone. Gust fronts often move far ahead (up to 15 NM) of associated precipitation. The gust front causes a rapid and sometimes drastic change in surface wind ahead of an approaching storm.

It is almost impossible to hold a constant altitude in a thunderstorm, and manoeuvring in an attempt to do so produces greatly increased stress on the aircraft. It is understandable that the speed of the aircraft determines the rate of turbulence encounters. Stresses are least if the aircraft is held in a constant attitude and allowed to 'ride the waves'. Information on this and other thunderstorm hazards should be in included in procedures and referenced as in sub-section 2C.5 of this CAAP.

---

[5] Sourced from Airbus Industrie's publication *Airlines Operations Policy Manual* published on the www.airbus.com website (for subscribers only) and used with persmission and courtesy of the copyright holder.

Icing

Supercooled water freezes on impact with an aircraft. Clear icing can occur at any altitude above the freezing level; but at high levels, icing from smaller droplets may be rime or mixed rime and clear. The abundance of supercooled water droplets makes clear icing very rapid between 0°C and -15°C.

Hail

Hail competes with turbulence as the greatest thunderstorm hazard to aircraft. Supercooled drops above the freezing level begin to freeze, and once a drop has frozen, other drops latch on and freeze to it, so the hailstone grows. Large hail occurs in severe thunderstorms with strong updrafts that have built to great heights. Eventually, the hailstones fall, possibly some distance from the storm core. Hail may be encountered in clear air several miles from dark thunderstorm clouds.

Low ceiling and visibility

Generally, visibility is near zero within a thunderstorm cloud. The hazards and restrictions created by low ceiling and visibility are increased manyfold when associated with the other thunderstorm hazards.

Effect on altimeters

Pressure usually falls rapidly with the approach of a thunderstorm, and then rises sharply with the onset of the first gust and arrival of the cold downdraft and heavy rain showers, falling back to normal as the storm moves on. This cycle of pressure change may occur in 15 minutes. If the pilot does not receive a corrected altimeter setting, the aircraft’s altimeter may be more than 1,000 feet in error.

Lightning

A lightning strike can puncture the skin of an aircraft. Lightning has been suspected of igniting fuel vapours causing explosion; however, serious accidents due to lightning strikes are extremely rare. Nearby lightning can blind the pilot rendering him momentarily unable to navigate either by instrument or by visual reference. Lightning can also induce permanent errors in the magnetic compass and lightning discharges, even distant ones, can disrupt radio communications on low and medium frequencies.

In the event of lightning strike conduct the following procedure:

- In flight - check:
  - check all radio communication and navigational equipment and the weather radar
  - Record the lighting strike in the technical logbook.
- On ground - check:
  - compensation of the (standby) compass
  - signs of damage on fuselage, wings, radome, empennage
  - antennas, pitot heads
  - all control trailing edges and static dischargers
  - radio and navigation equipment.

Lightning intensity and frequency have no simple relationship to other storm parameters. But, as a rule, severe storms have a high frequency of lightning.

Engine water ingestion

Jet engines have a limit on the amount of water they can ingest. Updrafts are present in many thunderstorms, particularly those in the development stages. If the updraft velocity in the thunderstorms approaches or exceeds the terminal velocity of the falling raindrops, very high concentrations of water may occur. It is possible that these concentrations can be excess of the quantity of water engines are designed to ingest. Therefore, severe thunderstorms may contain areas of high water concentration which could result in flameout and/or structural failure of one or more engines.

Avoiding thunderstorms

Never regard a thunderstorm lightly; avoiding thunderstorms is the best policy.

Don't land or take-off in the face of an approaching thunderstorm. Turbulence wind reversal or windshear could cause loss of control.

Don't attempt to fly under a thunderstorm even if you can see through to the other side. Turbulence and wind shear under the storm could be disastrous.

Don't fly without airborne radar into a cloud mass containing scattered embedded thunderstorms. Scattered thunderstorms not embedded usually can be visually circumnavigated.

Don't trust the visual appearance to be a reliable indicator of the turbulence inside a thunderstorm.

Do avoid by at least 20 NM any thunderstorm identified as severe or giving an intense radar echo. This is especially true under the anvil of large cumulonimbus.

Do circumnavigate the entire area if the area has 6/10ths thunderstorm coverage.

Do remember that vivid and frequent lightning indicates the probability of a severe thunderstorm.

Do regard as extremely hazardous any thunderstorm with tops 35,000 feet or higher whether the top is visually sighted or determined by radar.

Departure and arrival

When significant thunderstorm activity is approaching within 15 NM of the airport, the pilot- in-command (PIC) should consider conducting the departure or arrival from different direction or delaying the take-off or landing. Use all available information for this judgement, including PIREPs, ground radar, aircraft radar, tower-reported winds, and visual observations. In the terminal area thunderstorms should be avoided by no less than 3 NM. Many ATC radars are specifically designed to reduce or exclude returns from ‘weather’ and in these cases little or no assistance can be given by ATC.

It is recommended that any guidance given by ATC should be used in conjunction with the aircraft own weather radar, in order to guard against possible inaccuracies in the ground radar’s interpretation of the relative severity of different parts of a storm area. Any discrepancies should be reported to ATC.

Gust fronts in advance of a thunderstorm frequently contain high winds and strong vertical and horizontal wind shears, capable of causing an upset near the ground. A gust front can affect an approach corridor or runway without affecting other areas of the airport. Under such conditions, tower-reported winds and the altimeter setting could be misleading.

Microbursts may also accompany thunderstorms. Two nautical miles or less in diameter, microbursts are violent short-lived descending columns of air capable of producing horizontal winds sometimes exceeding 60 kt within 150 ft of the ground. Microbursts commonly last one to five minutes and may emanate from high-based cumulus clouds accompanied by little or no precipitation, or may be associated with large cumulonimbus build-ups and be accompanied by heavy rainfall.

Because of their relatively small diameter, airport anemometers and low level windshear alert systems may not sense this phenomenon in time to provide an adequate warning of nearby microburst activity.

En-route

Refer to use of weather radar for thunderstorm avoidance under reference 2B.5 in Part B of this CAAP for procedures to include in the operations manual.

Overflight

Avoid overflying thunderstorms unless a minimum of 5000 ft clearance above the storm top is ensured. When possible, detour between the storm cells of a squall line rather than directly above them. Keep the radar antenna tilted down during overflight to properly assess the most severe cells, which may be masked by clouds formations.

Lateral avoidance

At altitudes above the freezing level, supercooled rain and hail may display as only weak radar echoes, which can mask extreme thunderstorm intensity. Avoid weak radar echoes associated with thunderstorms by the following minimum distances:

Altitude	**Lateral Distance**
20 000 ft	10 NM
25 000 ft	15 NM
30 000 ft	20 NM

Flight near thunderstorms

If flight closer than the minimum recommended distances is unavoidable, observe the following precaution:

- When it is necessary to fly parallel to a line of cells, the safest path is on the upwind side (the side away from the direction of storm travel). Although severe turbulence and hail can be encountered in any direction outside a thunderstorm, strong drafts and hail are more often encountered outside the body of the cell on the downwind side.
- Avoid flight under the anvil. The greatest possibility of encountering hail is downwind of the cell, where hail falls from the anvil or is tossed out from the side of the storm. Hail has been encountered as much as 20 NM downwind from large thunderstorms.
- Avoid Cirrus and Cirrostratus layers downwind from the storm tops. Such layer may be formed by cumulonimbus tops and may contain hail, even though the radar scope shows little or no return echoes.
- If ATC requirements make flight into unsafe conditions imminent, the crew should request a change of routing and if necessary use their emergency authority to avoid the severe weather conditions.
- Any flight in the vicinity of thunderstorms carries the risk of a sudden onset of moderate or severe turbulence.

Thunderstorm penetration

If thunderstorm penetration is unavoidable, the following guidelines will reduce the possibility of entering the worst areas of turbulence and hail:

- Use the radar to determine the areas of least precipitation. Select a course affording a relatively straight path through the storm. Echoes appearing hooked, finger-like, or scalloped indicate areas of extreme turbulence, hail and possibly tornadoes, and must be avoided.
- Penetrate perpendicular to the thunderstorm line; if not possible maintain the original heading. Once inside the cell, continue on a straight course through the storm that most likely will get the aircraft out of the hazards most quickly. The likelihood of an upset is greatly increased when a turn is attempted in severe turbulence and turning manoeuvres increase the stress on the aircraft.
- Pressure changes may be encountered in strong drafts and may lead to an altitude error of 1,000 ft.
- Gyro-stabilised instruments supply the only accurate flight instrument indications.
- Avoid level flight near the 0°C isotherm. The greatest probability of severe turbulence and lightning strikes exist near the freezing level.
- Generally the altitudes between 10 000 ft and 20 000 ft encompass the more severe turbulence, hail, and icing conditions, although violent weather may be encountered at all level inside and outside an active thunderstorm.
- Due to very high concentration of water, massive water ingestion can occur which could result in engine flameout and/or structural failure of one or more engines. Changes in thrust should be minimised.

Operational procedures

If is not possible to avoid flying through or near to a thunderstorm, the following procedures and techniques are recommended:

- Approaching the thunderstorm area ensures that crewmembers' safety belts are firmly fastened and secure any loose articles.
- Switch on the Seat Belt signs, or advise passengers verbally, and make sure that all passengers are securely strapped in and that loose equipment (e.g. cabin trolleys and crew baggage) is firmly secured. Pilots (particularly of long- bodied aircraft) should remember that the effect of turbulence is normally worse in the rear of the aircraft than on the flight deck.
- One pilot should fly the aircraft and control aircraft attitude regardless of all else and the other monitor the flight instruments continuously.
- Height for penetration must be selected bearing in mind the importance of ensuring adequate terrain clearance. Due to turbulence, wind shear, local pressure variations the maintenance of a safe flight path can be difficult.
- The recommended speed for flight in turbulence must be observed and the position of the adjusted trim must be noted.
- If fitted the autopilot should be engaged. The autopilot is likely to produce lower structural loads and smaller oscillations than would result from manual flight. Also, any auto-thrust system should be disconnected to avoid unnecessary and frequent thrust variations.
- Check the operation of all anti-icing equipment if applicable and operate all these systems in accordance with operations manual instructions as icing can be very rapid at any altitude. Refer to section 2C.5.2 in the CAAP.
- Turn the cockpit lighting fully on to minimise the blinding effect of lightning.

- Continue monitoring the weather radar in order to pick out the safest path. Tilt the antenna up and down occasionally to detect thunderstorm activity at altitudes other than that being flown. Use of weather radar procedures should be set-out in 2B.5 of Part B of the operations manual.

Icing

Icing conditions occur when low temperatures are accompanied by precipitation. Icing of the aircraft is one of the most dangerous flight hazards. Procedures for operating in icing conditions should be included under 2C.5 in Part C of the operations manual. Regulation 238 of CAR 1988 prohibits flight into known icing conditions unless the aircraft is suitably equipped and the crew familiar with anti- or de-icing procedures.

Turbulence

Turbulence is defined as a disturbed, irregular flow of air with embedded irregular whirls or eddies and waves. An aircraft in turbulent flow is subjected to irregular and random motions while, more or less, maintaining the intended flight path.

If the weather conditions and route forecast indicate that turbulence is likely, the cabin crew should be pre-warned, and passenger advised to return to, and/or remain seated and to ensure that their seat belts are securely fastened. Catering and other loose equipment should be stowed and secured until it is evident that the risk of further turbulence has passed.

If turbulence is encountered, pilots should report such conditions to ATC as soon as practicable.

Classification of turbulence intensity may be defined as follows:

Intensity	**Aircraft reaction**
LIGHT	Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude. Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.
MODERATE	Similar to light turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.
SEVERE	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variation in indicated airspeed. Aircraft may be momentarily out of control. Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking is impossible.
EXTREME	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage.

Windshear

Windshear is a rapid variation in wind velocity and/or direction along the flight path of the aircraft. As with turbulence generally, on encountering windshear conditions, pilots are should report such conditions to ATC as soon as practicable stating the loss or gain of speed and the altitude at which it was encountered.

Jetstream

Jetstreams are narrow bands with extreme high wind speeds up to 300 kt. They can extend up to several thousand miles longitudinally; their width can be several miles. Avoid flying along the edge of jetstreams due to possible associated turbulence. Pilots should also be aware of the effect of increased fuel consumption due to unexpected significant head wind components that can be encountered.

Other hazards

Volcanic ash clouds

The pilot should use all means possible to avoid flying through an ash cloud due to the extreme hazard it presents. Volcanic ash can cause dangerous abrasion to all forward facing parts of the aircraft, to the extent that visibility through the windshields may be totally impaired. Aerofoil and control surface leading edges may be severely damaged, airspeed indications become unreliable, through blocking of the pitot heads/static ports, and engines may even shut-down, rapidly or gradually, often only being detected when catastrophic performance loss has occurred.

Notification

The presence of volcanic ash/gas clouds is advised through regularly updated NOTAMs, based upon information provided by the Bureau of Meteorology's (BoM) Volcanic Ash Advisory Centre.

Air Traffic Services will provide timely operational information to aircraft and will accommodate requests by pilots to avoid hazardous airspace.

> ***Note:*** *Only two active volcanoes exist within Australian territory, on Heard and McDonald islands, both in the Antarctic.*

Hazard identification, risk assessment and risk management

Pilots **should not conduct** operations into areas of airspace with a visible volcanic ash cloud as it is highly probable that, within a short period of time, the ash will damage the aircraft and reduce the airworthiness of the aircraft below a safe level.

If operating into, or near, airspace or aerodromes with known or forecast volcanic ash contamination, it is essential that the company:

- maintain the airworthiness of the aircraft at all times to ensure the continuation of safe operations
- assess the risk of operations, and determine and implement appropriate mitigation measures.

Operations into areas of airspace with known or forecast volcanic ash cloud should only occur where:

- contamination levels have been measured
- the concentration and extent of ash is known
- the location of the volcanic ash cloud and level of contamination can be communicated to the crew at every stage of the operation.

It is essential also that the company conducts a Safety Risk Analysis (SRA), in accordance with their Safety Management System (SMS) or as recommended by ICAO, with due consideration of the following points:

- Before carrying out an SRA, the company should use the Safety Risk assessment worksheet in Appendix 4 of ICAO Doc 9974, or the hazard identification/risk management template in the company SMS.

- The SRA should address, but not be limited to, the following list of risks:
  - higher concentrations of volcanic ash than reported
  - failure to obtain update-to-date volcanic ash information, both pre-flight and en route
  - inadvertent entry into an area of volcanic ash, with potential loss of thrust on one or more engines
  - undetected damage or degradation of performance of airframe, engines and/or aircraft
  - long-term cumulative effects (both detected and undetected) that degrade the aircraft's airworthiness and require maintenance rectification/actions before further flight
  - catastrophic loss of aircraft performance
  - reduced visibility
  - incorrect forecast of an ash cloud's location or density
  - regulatory requirements concerning operations in volcanic regions not currently incorporated into the flight planning process.

- The residual risks resulting from the SRA should be at acceptable levels. Acceptable levels are operations that remain within the accepted safety boundaries, as established within the operator's SMS.

- The residual risks, or risk register, should be reviewed daily or when operational changes occur. If the review identifies that the changes will affect the scope of risks, or assigned risk ratings, then the risk register should be amended to reflect the new operational environment.

Every effort should be made to liaise with organisations such as meteorological and air navigation services providers (including Aeronautical Information Services; Volcanic Ash Advisory Centres (VAAC); Volcano Observatories and the manufacturers of company aircraft and engines) to identify and use relevant information in the SRA process.

Hazard identification, risk assessment and risk management – Non-RPT operations

An SMS-based formal hazard identification and risk assessment is not a legislative requirement for non-RPT operations. In many cases there is also no requirement to have a formal SMS in place. However, the absence of these requirements does not negate the need for effective identification and management of the hazards and risks associated with flight near or within volcanic-ash contaminated airspace.

Smaller operators should take advantage of existing resources available to aviators to help determine the potential impact on their operations, such as:

- NOTAMS, SIGMETS and other advisory information issued by ATS and meteorological services, including VAACs
- pilot reports of volcanic ash contamination or aircraft performance degradation, particularly for similar aircraft types and equipment
- manufacturers' guidance and recommendations

- the ICAO volcanic ash guidance material referenced in this CAAP, particularly ICAO Document 9974 (see reference below), as it relates to risk management of flight operations with known or forecast volcanic ash contamination.

Airworthiness considerations – hazards and risk mitigation

Unless specific pre- and post-flight inspections have been defined by the aircraft and engine Type Certificate (TC) holders, it is essential that daily inspections are carried out, preferably by the company's maintenance organisation, to detect any:

- erosion
- ash accumulation
- airframe, engine or system damage or degradation, including to the following:
  - wing leading edges
  - navigation and landing lights or radomes
  - landing gear
  - horizontal stabilisers
  - any extruding structure
  - pitot tubes and static ports
  - windows or windshields
  - engine inlets or nacelles
  - engine air inlet filters (for piston engines)
  - engine air intake filters (for turbine engines equipped with air intake filters)
  - engine compressors and turbines
  - engine oil systems
  - engine fuel systems
  - rotor blades
  - air conditioning and equipment cooling systems
  - electrical and avionics units.

Based on the results of the inspections, more detailed inspections may be necessary.

Inspections should also be carried out after any encounter with volcanic ash, and whenever the following phenomena are observed, detected or experienced during flight:

- acrid odours similar to electrical smoke
- rapid onset of engine problems
- St Elmo's fire
- bright white/orange glow appearing at the engine inlets
- dust in the cockpit or cabin
- unexpected outside darkness
- airspeed fluctuations
- landing lights casting sharp, distinctly visible beams.

It is essential that**,** the aircraft is inspected after each flight in line with the guidance in the previous section.

Where possible, aircraft parked in areas that may be contaminated by the fall-out or settling of volcanic ash should be protected and covered in accordance with the aircraft and engine TC holder's advice. Any volcanic ash residue should be removed from the aircraft prior to operations, following TC holders' recommendations where available.

Reporting of ash events

Operators should report, through the normal Service Difficulty Reporting system, encounters with volcanic ash that cause damage to aircraft. Encounters that cause an operational incident or accident should be reported through the Air Safety Incident Reporting System via the Australian Air Transport Safety Bureau and to CASA. Near encounters or observations of volcanic ash cloud should be reported, to airways authorities and/or meteorological service providers via the usual means, so other airspace users can be apprised of the presence of volcanic ash in the atmosphere.

The following publications provide additional information for operations into, or near, areas of airspace with known or forecast volcanic ash cloud contamination or at aerodromes with runway volcanic ash contamination:

- Procedures for Air Navigation Services – *Air Traffic Management* (PANS-ATM. (ICAO Doc 4444))
- ICAO Annex 2 – *Rules of The Air*
- ICAO Annex 11 – *Air Traffic Services*
- ICAO Doc 9974 – *Flight Safety and Volcanic Ash – Risk management of flight operations with known or forecast volcanic ash contamination*
- ICAO Doc 9691 – Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds
- ICAO Doc 9766 – *Handbook on the International Airways Volcano Watch* (IAVW)
- ICAO Doc 9859 – *Safety Management Manual*
- ICAO Regional ATM contingency plans such as the *Volcanic Ash Contingency Plan – EUR and NAT regions*
- EASA SIB No. 2010-17.

Heavy precipitation

Heavy precipitation may occur as rain showers, snow showers and hail. The greatest impairment to flight is the reduced visibility and the risk of in combination with low temperature. Heavy precipitation can be associated with significant downdrafts and windshear.

Under given weather conditions, the water/air ratio absorbed by jet engines is directly related to its performance and aircraft speed. This ratio is considerably increased at a high aircraft speed and engines at flight idle (typical descent conditions). This means that during descent, under heavy rainfall conditions, or hail, significant ingestion of water may cause surging or uncommanded shutdown of jet engines.

Heavy precipitation can quickly lead to high levels of runway contamination so runway clearance/drainage rate must be closely monitored in order to assess if a diversion is necessary.

Sandstorms

Avoid flying in active sandstorms whenever possible. When on the ground, aircraft should ideally be kept under cover if dust storms are forecast or in progress. Alternatively, all engine blanks and cockpit covers should be fitted, as well as the blanks for the various system and instrument intakes and probes. They should be carefully removed before flight to prevent an accumulation of dust in the orifices which the covers are designed to protect.

Mountain waves

Mountain waves are caused by a significant airflow crossing a mountain range. At some airports, relief or obstacles may cause special wind conditions with severe turbulence and windshear on approach or during take-off.

Special procedures or recommendations are indicated on airport charts when appropriate. They must be taken into account by the flight crews in their choice of the landing or take-off runway.

Significant temperature inversion

In meteorology, air temperature at the earth's surface is normally measured at a height of about 1.20 m above the ground. Take-off performance will be defined based on the indicated temperature as reported by ATC.

All along the take-off flight path, aircraft performance is computed using the altitude and the speed increase, implicitly considering a standard gradient of temperature – a decrease of 2°C for each 1,000 ft.

Although most of the time, temperature will decrease with altitude in quite a standard manner, specific meteorological conditions may lead the temperature gradient to deviate from this standard rule. With altitude increasing, marked variations of the air temperature from the standard figure may be encountered. In these situations, air temperature may decrease in a lower way than the standard rule or may be constant or may even increase with altitude. The phenomenon is called a temperature inversion, and they particularly affect the very lower layer of the atmosphere near the earth's surface.

There are many parameters, which influence air temperature leading to temperature inversions. Close to the ground, air temperature variations mainly result from the effects of:

- seasonal variations
- diurnal/nocturnal temperature variations
- weather conditions (effect of clouds and wind)
- humidity of the air
- geographical environment such as:
  - mountainous environment
  - water surface (sea)
  - nature of the ground (arid, wet)
  - latitude
  - local specificity.

As a general rule, low wind conditions and clear skies at night, will lead to rapid cooling of the earth and a morning temperature inversion at ground level.

Morning temperature inversion

In the absence of wind, or if the wind is very light, the air in contact with a 'cold' earth surface will ***c***ool down by heat transfer from the 'warm' air to the 'cold' ground surface. This transfer of heat occurs by conduction and consequently leads to a temperature inversion which is limited in altitude. This process needs stable weather conditions to develop.

During the day, there is very little heating through solar radiation of the atmosphere, but the earth is heated much more. The lower layer of the atmosphere is also heated by contact with the ground, which is more reactive to solar radiation than the air, and by conduction between earth and atmosphere.

At night, in the absence of disturbing influences, ground surface cools down due to the absence of solar radiation and will cool the air near the ground surface. In quiet conditions, air cooling is confined to the lowest levels. Typically, this effect is largest in the early hours of the day and sunshine subsequently destroys the inversion during the morning. Similarly, wind will mix the air and destroy the inversion.

Magnitude of temperature inversion

This kind of inversion usually affects the very lowest levels of the atmosphere. The surface inversion may exceed 500 ft but should not exceed 1000 to 2000 ft. The magnitude of the temperature inversion cannot be precisely quantified. However, a temperature inversion of about +10°C is considered significant. Usually, within a temperature inversion, temperature regularly increases with altitude until it reaches a point where the conduction has no longer any effect.

Where can they be encountered?

This kind of inversion may be encountered world-wide. However, some areas are more exposed to this phenomenon, such as arid and desert regions. It may be also encountered in temperate climate particularly during winter (presence of fog). Tropical regions are less sensitive due to less stable weather conditions.

In polar continental areas (e.g., Canada, Antarctica) during winter in anti-cyclonic conditions, the low duration of sunshine during the day could prevent the inversion from destruction. Thus, the temperature of the ground may considerably reduce and amplify the inversion phenomenon. To a lesser extent, this may also occur in temperate regions during winter, if associated with cold anti-cyclonic conditions.

Another important aspect of an inversion is wind change. The air mass in the inversion layer is so stable that winds below and above tend to diverge rapidly. Therefore, the wind change, in force and direction, at the upper inversion surface may be quite high. This may add to the difficulty of flying through the inversion surface. In some conditions, the wind change may be so high as to generate a small layer of very marked turbulence.

Other types of temperature inversion

The morning temperature inversion is encountered most frequently and is the most sensitive. However, as also mentioned above, other meteorological conditions, of a less frequent occurrence and magnitude, may lead to temperature inversions.

For instance, the displacement of a cold air mass over a cold ground surface may lead to turbulence resulting in a transfer of heat to the lower levels of this mass, thus, also creating a temperature inversion in the lower levels of the atmosphere below this air mass. Usually, this kind of inversion has a lower magnitude than the previous case described above. In any case, pilot experience, weather reports or pilot reports are the best way to identify such weather conditions.

Effect on aircraft performance

A temperature inversion will result in a reduction of thrust only when performing a maximum take-off thrust during hot days, i.e., the actual ambient temperature is above TREF (Flat rating temperature). In the event of an inversion, the climb performance will be affected in the cases where the thrust is affected. However, to affect the aircraft performance, a temperature inversion must be combined with other factors.

During a normal take-off with all engines operative, the inversion will have no effect since the actual aircraft performance is usually far beyond the minimum required performance.

In these cases the actual aircraft performance could be affected only in the event of an engine failure at take-off. However, a margin of error is included in aircraft certified performance to take account of variations in the data that are used for performance calculations. Although not specifically mentioned, temperature inversions can be considered as part of this inaccuracy. Therefore, a temperature inversion could become a concern during the take-off. The following conditions represent the worst case if met together:

- The engine failure occurs at V1
- Take-off is performed at maximum take-off thrust

- OAT is close to or above $T._{REF}$
- The take-off weight is limited by obstacles
- The temperature inversion is such that it results in the regulatory net flight path margin cancellation and leads to fly below the regulatory net flight path.

In most other cases, even if the performance is affected (inversion above T.REF), the only detrimental effect will be a reduction in expected climb.

Operations on slippery surfaces

Runway friction characteristics

The stopping performance of aircraft is dependent on the available friction between the aircraft tyres and the runway surface, the landing or take-off speed. In some conditions the runway length required for landing or take-off could be critical in relation to the runway length available.

Adequate runway friction characteristics/braking action are mainly needed for three distinct purposes:

- deceleration of the aircraft after landing or a rejected take-off
- directional control during the ground roll on take-off or landing, in particular in the presence of cross-wind, asymmetric engine power or technical malfunctions
- wheel spin-up at touchdown.

To compensate for the reduced stopping and directional control capability for adverse runway conditions (such as wet or slippery conditions) performance corrections are applied in the form of:

- runway length increment
- reduction in allowable take-off or landing weight
- reduction of allowable cross-wind component.

Measuring and expressing friction characteristics

The friction coefficient is defined as the ratio of the maximum available tyre friction force and the vertical load acting on the tyre, and various systems are used to measure the runway friction coefficient/conditions:

- Skiddometer High pressure tyre (SKH)
- Skiddometer Low pressure tyre (SKL)
- Surface Friction Tester (SFT)
- Mu-meter (MUM)
- Diagonal braked vehicle (DBV)
- Tapley meter (TAP)
- James Brake Decelerometer (JBD).

The results of the friction measuring equipment do not generally correlate with each other for all surface conditions and no correlation has been established between these results and the stopping performance of an aircraft. The only truly accurate way of measuring the friction coefficient for a specific aircraft is by using that specific aircraft braking system on the surface concerned.

When friction measurement is not available but can be only estimated, the pilot is informed only of the estimated braking action reported as ‘good’ ,’medium’, ‘poor’, ‘unreliable (nil)’ or a combination of these terms. Pilots should treat reported braking action measurements with caution and interpret them conservatively.

Practically the following correlation may be used as a guideline:

Estimated braking action	**Friction Coefficient (Mu)**
Good	0.40 and above
medium/good	0.36 to 0.39
Medium	0.30 to 0.35
medium/poor	0.26 to 0.29
Poor	0.25 and below
unreliable	n/a

Braking action reporting

Friction measurements or braking action estimation may be reported:

- in plain language by the tower
- in routine weather broadcasts
- by SNOWTAM.

When necessary, ATC issues the latest braking action report for the runway in use to each arriving and departing aircraft. Pilots should also be prepared to provide a descriptive runway condition report to ATC after landing.

Meteorological observations

Meteorological observations in connection with knowledge of previous runway conditions will, in many cases, permit a fair estimate to be made of braking action.

On un treated snow- or ice-covered runways, the coefficient of friction varies from as low as 0.05 to 0.30. It is very difficult to state exactly how and why the runway conditions vary. The braking action is very much dependent upon the temperature especially near the freezing point. However, when it is freezing, the braking action could be fairly good, and it will remain so if the temperature decreases. If the temperature rises to the freezing point or above, braking performance will decrease rapidly. Sometimes very low friction coefficient values occur when humid air is drifting in over an icy runway, even though the temperature may be well below the freezing point.

Some of the various conditions which are expected to influence the braking action are given below:

- Friction coefficient between 0.10 and 0.30 (poor-medium/poor)
  - slush or rain on a snow- or ice-covered runway
  - runway covered with wet snow or standing water
  - a change from frost to temperature above freezing point
  - change mild to frost (not always)
  - the type of ice which is formed after long periods of cold; and
  - a thin layer of ice formed:
    - by frozen ground having been exposed to humidity or rain at 0°C or above
    - when due to radiation (e.g. when the sky clears) the runway surface temperature drops below freezing point and below the dew point (this ice formation can take place very suddenly and occur while the reported air temperature may still be quite a few degrees above the freezing point.).

- Friction coefficient between 0.25 and 0.35 (medium/poor-medium):
  – snow conditions at temperature just below freezing point
  – snow-covered runways at temperatures below freezing point, exposed to sun
  – slush-covered runway.
- Friction coefficient between 0.35 and 0.45 (medium/good-good):
  – snow-covered runways which have not been exposed to temperatures higher than about -2°C to -4°C
  – damp or wet runway without risk of hydroplaning (less than 3 mm water depth).
- Aircraft performance on wet or contaminated runways:
  – As no accurate correlation can be made between the aircraft friction coefficient on a given runway and the reported friction coefficient or braking action, performance information in company operations manuals should be established for given depths of water or contaminant (slush, snow), preferably in association with the aircraft manufacturer
  – The only way to determine the applicable take-off and landing performance is to obtain the depth and type of contaminant. It is not recommended to land or take-off on a runway for which the braking action is reported as 'POOR' or the friction coefficient is 0.25 or less. A take-off runway covered with more than 5 cm (2 inches) of dry snow or 2.5 cm (1 inch) of wet snow is not recommended.

Guidelines for operations on slippery surfaces

General

The two most important variables confronting the pilot when runway coefficient of friction is low and/or conditions for hydroplaning exist are length of runway and crosswind magnitude. The use of thrust reversers is mandatory on contaminated runways.

The total friction force of the tyres is available for two functions – braking and cornering. If there is a crosswind, some friction force (cornering) is necessary to keep the aircraft on the centreline. Tyre cornering capability is reduced during braking or when wheels are not fully spun up. Locked wheels eliminate cornering. Therefore in crosswind conditions, a longer distance will be required to stop the aircraft.

According to the runway conditions the following cross wind values indicated in section 2C.4 of the operations manual guidance in this CAAP.

Reported braking action	Reported friction co	Maximum crosswind (kt)
Good	0.40 and above	Maximum (*)
medium/good	0.36 to 0.39	30
medium	0.30 to 0.35	25
medium/poor	0.26 to 0.29	20
poor	0.25 and below	15
unreliable	-	5

*maximum cross wind value indicated in the relevant section of the operations manual.

Taxiing

Aircraft may be taxied at the PIC's discretion on ramps and taxiways not cleared of snow and slush. More power than normal may be required to commence and continue taxi so care should be taken to avoid jet blast damage to buildings, equipment and other aircraft. Be aware of the possibility of ridges or ruts of frozen snow that might cause difficulties. The boundaries/edges of manoeuvring areas and taxiway should be clearly discernible. If in doubt, request 'Follow me' guidance.

When executing sharp turns while taxiing or parking at the ramp, remember that braking and steering capabilities are greatly reduced with icy airport conditions; reduce taxi speed accordingly. Slat/flap selection should be delayed until immediately before line up to minimise contamination.

Take-off

Severe retardation may occur in slush or wet snow. In most cases, lack of acceleration will be evident early on the take-off run. Maximum permissible power must be used from the start.

Large quantities of snow or slush, usually containing sand or other anti-skid substances may be thrown into the engines, static ports and onto the airframe. Pod and engine clearance must be watched when the runway is cleared and snow is banked at the sides of runways or taxiway.

Landing

Pilots should be aware that where rain, hail, sleet or snow showers are encountered on the approach or have been reported as having recently crossed the airfield, there is a high probability of the runway being contaminated. The runway state should be checked with ATC before commencing or continuing the approach. Very often a short delay is sufficient to allow the runway to drain or the contaminant to melt.

Use of reverse thrust on landing on dry snow in very low temperatures will blow the dry snow forward especially at low speed. The increase in temperature may melt this snow and form clear ice on re-freezing on static ports.

The required landing field length for dry runways is defined as 1.67 times the demonstrated dry landing distance. For wet runways, this landing distance requirement is increased by 15%. The required landing field length for contaminated runways is defined as 1.15 times the demonstrated contaminated landing distance.

The shortest stopping distances on wet runways occur when the brakes are fully applied as soon as possible after main wheel spin up with maximum and immediate use of reverse thrust. Landing on contaminated runways without antiskid should be avoided. It is strongly recommended to use auto-braking (if available) provided that the contaminant is evenly distributed.

The factors and considerations involved in landing on a slippery surface are quite complex and depending on the circumstances, the pilot may have to make critical decisions almost instinctively. The following list of items summarises the key points to be borne in mind. Several may have to be acted upon simultaneously:

- Do not land where appreciable areas of the runway are flooded or covered with 1/2 inch or more of water or slush.
- Limit crosswind components when runway conditions are poor and runway length short.
- Establish and maintain a stabilised approach.
- Consider the many variables involved before landing on a slippery runway:
  - Landing weather forecast
  - Aircraft weight and approach speed
  - Landing distance required

  - Hydroplaning (aquaplaning) speed
  - Condition of tyres
  - Brake characteristics (anti-skid, auto-braking)
  - Wind effects on the directional control of the aircraft on the runway; Runway length and slope
  - Glidepath angle.
- Do not exceed VAPP at the threshold. An extended flare is more likely to occur if excess approach speed is present.
- Be prepared to go-around.
- Flare the aircraft firmly at the 1000 ft aiming point. Avoid build-up of drift in the flare and runway consuming float. A firm landing, by facilitating a prompt wheel spin up, also ensures efficient antiskid braking.
- Select reverse thrust as soon as possible.
- Get the nose of the aircraft down quickly. Do not attempt to hold the nose off. Aim to have the nose wheel on the ground by the time reverse thrust reaches the target level.
- If auto-braking is not available, and if remaining runway length permits, allow the aircraft to decelerate to less than dynamic hydroplaning speed before applying wheel brakes. If however maximum braking is required apply and hold full brake pedal deflection. Continue to apply rudder and aileron inputs while braking. The brakes are the primary means for stopping the aircraft but if necessary the full reverse thrust may be maintained until the aircraft is fully stopped.
- Excessive braking in crosswinds will lead to the aircraft drifting away from the centreline. Do not decrab completely as the aircraft will yaw on the slippery runway due to its weathercock stability.
- Keep the aircraft aligned with the runway centreline. Use rudder and aileron inputs. As rudder effectiveness decreases, reduce aileron deflection proportionately.

CAUTION

Do not allow large deviations from the runway heading to develop as recovery can become very difficult. Use of nose wheel steering is not recommended. Under slippery conditions; nose wheels must be closely aligned with the aircraft track or they will scrub.

If directional or lateral control difficulties are experienced, disconnect auto-braking, if necessary, reduce reverse thrust levels symmetrically, and regain directional control with rudder, aileron and differential braking. Once under control, reapply manual braking and increase symmetrical reverse levels as required while easing the aircraft back towards the runway centreline.

After landing in heavy slush do not retract the slats and flaps. Allow ground personnel to clear ice and slush from slats and flaps before full retraction. Taxi with caution to parking area if flaps are extended due to much reduced ground clearance.

APPENDIX B11

Crew Composition[6]

The method for determining crew composition must take into account the following parameters:

- Type of aircraft being used
- The area and type of operation being undertaken (e.g. long range, EDTO, Polar revenue, non-revenue flight etc.)
- The phase of the flight
- The minimum crew requirement and flight duty period
- Flight crew qualification/experience
- The designation of the pilot-in-command and of the senior cabin crew member, and, if necessitated by the duration of the flight, the procedures for their relief.

Flight crew

The minimum flight crew is given in the Aircraft Flight Manual:

- Flight crew is composed of two pilots (including at least one captain) when the cockpit is arranged and certified for a two-member crew operation.
- Flight crew is composed of two pilots (including at least one captain) and one flight engineer when the cockpit is arranged and certified for a three-member crew operation.

An instructor, an engineer, an inspector or an interpreter may complete flight crew. They will use cockpit accommodation provided for observers.

This minimum flight crew may be augmented depending of the operation and/or the flight duration.

Each flight crewmember must have valid licence, rating, qualifications and medical check needed for the type of aircraft and the type of flight.

Relief of flight crew member

A flight crew member may be relieved in flight of his duties at the controls by another suitably qualified flight crewmember.

The pilot-in-command may delegate conduct of the flight to:

- Another qualified pilot-in-command.
- For operations only above FL200, a pilot qualified as detailed below.

Minimum requirements for a pilot relieving the pilot-in-command:

- Valid Airline Transport Pilot Licence (ATPL).
- Conversion training and checking (including Type Rating training).
- All recurrent training and checking.
- Route competence qualification.

[6] As with other examples in this annex, all quantities and figures are for demonstration purposes only and do not necessarily reflect current rules.

The co-pilot may be relieved by:

- Another suitably qualified pilot
- A cruise relief co-pilot qualified as detailed below.

Minimum requirements for cruise relief co-pilot

- Valid Commercial Pilot Licence with Instrument Rating.
- Conversion training and checking, including Type Rating training except the requirement for take-off and landing training.
- All recurrent training and checking, except the requirement for take-off and landing training.
- Knowledge, skills and experience to operate in the role of co-pilot in the cruise only and not below FL 200.
- Recent experience is not required. The pilot shall, however, carry out flight simulator recency and refresher flying skill training at intervals not exceeding 90 days. This refresher training may be combined with the training prescribed for recurrent training and checking.

A system panel operator may be relieved in flight by a crew member who holds a Flight Engineer's licence or by a flight crew member with a qualification acceptable to CASA.

Inexperienced flight crew member

A flight crewmember is inexperienced, following completion of type rating or command course, and the associated line flying under supervision, until he has achieved on the type either:

- 100 flying hours and flown 10 sectors within a consolidation period of 120 consecutive days
- 150 flying hours and flown 20 sectors (no time limit).

> ***Note**:* *Crewing together of inexperienced flight crew is not authorised, although the Head of Flying Operations may approve flights under certain conditions.*

Cabin crew

For aeroplanes with a maximum approved passenger seating configuration of more than 19, when carrying one or more passengers, the minimum number of cabin crew members is the greater of:

- One cabin crewmember for every 50, or fraction of 50, passengers seats installed on the same deck of the aircraft
- The number of cabin crew who actively participated in the aircraft cabin during the relevant emergency evacuation demonstration, or who were assumed to have taken part in the relevant analysis, except that, if the maximum approved passenger seating configuration is less than the number evacuated during the demonstration by at least 50 seats, the number of cabin crew may be reduced by one for every whole multiple of 50 seats by which the maximum approved passenger seating configuration falls below the certificated maximum capacity.

> ***Note:*** *The maximum passenger seating capacity is stated in the aircraft flight manual and data sheet.*

A senior cabin crewmember (purser) is nominated by the Chief of Cabin crew for each flight whenever more than one cabin crew member is assigned.

Supernumerary crewmembers

Crewmembers in addition to the minimum crew must also have been trained in, and are proficient to perform, their assigned duties.

Designation of the pilot-in-command

For each flight, the operator or chief pilot will designate the pilot-in-command.

No pilot may accept a designation as pilot-in-command unless, in addition to his/her qualifications and training, he/she has the recent experience and knowledge required (refer to Part A of the Operations Manual) and considers himself to be in all respects competent and fit for the task.

The pilot-in-command:

- must be a captain and one of the pilots of the flight
- may delegate the conduct of the flight to a relief pilot (pilot-in-command), but remains the pilot-in-command of the flight
- may delegate the handling of the aircraft to the co-pilot (pilot flying)
- may in exceptional circumstances (e.g. unfit) designate another captain as pilot-in-command for the remainder of the flight. Any such change in command shall be reported as soon as possible to the dispatch office and to ATC.

Flight crew incapacitation

Detail the succession of command in case of incapacitation of the pilot-in-command:

- Flight crew composed of two pilots:
  - The second pilot takes the authority over all persons on board the aircraft until the normal chain of command can be re-established.
- Flight crew composed of more than two pilots:
  - The second pilot takes the authority over all persons on board the aircraft until a more qualified pilot (if any) takes the authority after having been informed by the second pilot and having acknowledged the overall situation, until the normal chain of command can be re-established.
  - If the original pilot-in-command cannot continue his/her command of the flight, the flight will not depart from the aerodrome where it has landed or, if occurring in flight, from the next aerodrome at which it lands, unless another captain on that particular type of aircraft is assigned to the flight.

APPENDIX B12

Aircraft Administration References

Listed below are references (if any) found in CASR Parts 42 & 145, the MOSs for Parts 42 & 145, CAR, CAO and CAAPs relating to each heading for Part E – Aircraft Administration, generally for AOC holders operating under CAR 206 (1) (c). As such, not all references will be applicable to all Air Transport (under CASR), charter or aerial work operations. These provide a comprehensive reference for operators, but only a small part should appear in the Operations Manual.

2E1.1 System of maintenance references

- CAR Part 4A, Division 3 – CAR 42L; CAR 39; and CAR 2 Interpretation.
- CASR Part 42.040 (1) – Aircraft authorised to operate under AOCs and large aircraft must have continuing airworthiness management organisations.
- CASR transitional regulation 202.180 (1) – Application of Part 42 from 27 June 2011 until the end of 26 June 2013.
- CASR Part 42.140 – Approved maintenance program required – aircraft authorised to operate under AOCs and large aircraft.
- CASR Part 42.145 – Compliance with maintenance program required – all aircraft.
- CASR transitional regulation 202.185 – Approved maintenance programs taken to include approved systems of maintenance.
- CASR 42.015 – Definitions for Part.
- CAAP 42M-1 (0) – Approved system of maintenance for Class A aircraft.
- 2E1.2 Maintenance Release and flight log procedures.
- Maintenance Release:
  - CAR Part 4A, Division 9 – Maintenance releases
  - CASR transitional regulation 202.182 – Certificates of release to service taken to include maintenance releases (paragraph 42.030 (2) (b))
  - CAO 100.5 – General requirements in respect of maintenance of Australian aircraft
  - (Sections 5 and 6)
  - CAAP 43-1 (1) – Maintenance release.
- Aircraft Log Book:
  - CAR Part 4A, Division 10 – Aircraft log books
  - CASR Part 1 Dictionary – definitions
  - CASR Subdivision 42.C.3.4 Flight technical log
  - CAO 100.5 – General requirements in respect of maintenance of Australian aircraft (Sections 3 and 5).
  - 2E1.3 & 2E1.4 – Recording defects & Corrective action procedures
- CAR 50; CAR Part 4B – Defect reporting CARs 51; 51A; 51B; and 52; and Draft CAAP 51-1(2)
- CASR Division 42.C.4 – Major defects – reporting and investigating
- CASR Division 42.D.6 – Requirements for dealing with defects
- CASR transitional regulation 202.187 – References to deferral of rectification of defects and recording of defects
- CASR 42.285 – Action by certificate holder or approval holder following report of a major defect
- CASR Part 145 Manual of Standards (MOS) 145.A.50 (c) (1); MOS 145.A.60 – Occurrence and major defect reporting.

2E1.5 – post-maintenance check flights references

Nil references found.

2E1.6 – Pilot maintenance references

- CAR 42ZC (4) (3) (c)
- CASR Subpart 42.D – Maintenance, specifically Item 4 of Table 42.300 of CASR Part 42.300
- CASR Subpart 42.G, Division 42.G.4 – Authorisation of pilot licence holders and flight engineers to provide maintenance services
- CASR 42.715 (b) (iii)
- CASR 42.760 91) (d)
- CASR Part 145 Manual of Standards (MOS) 145.A.37 (f) Training and assessment.

2E1.7 – Lightning strike references

- CAR 42L (b)
- CAAP 42L-1 (0) Section 4
- CAAP 39-1 (1) Systems of maintenance.

2E1.8 – Bird and animal strike references

Nil references found.

2E1.9 – Procedures in the event of unserviceability away from home references

Nil references found.

2E1.10 – Test flights references

CAR 222
CAR 262AS

2E1.11 – EDTO/RNP references

- EDTO:
  - CAAP 82-1 (0) - Extended Diversion Time Operations (EDTO)
  - CAO 82.0
  - CASR Part 42.015 – Definitions for Part
  - CASR Part 42.155 (2) (b)
  - Chapter 2 – *Requirements for a maintenance program for large aircraft and aircraft operated under an AOC* of Part 42 MOS, specifically:
- 2.6.2 (c)
- 2.8.1 (c) (i)
- RNP:
  - Nil references found.

2E1.12 – ASETPA (Approved Single Engine Turbine Powered Aeroplane) references

Nil references found.

2E1.13 – Autoland references

Nil references found.

2E1.14 – Permissible unserviceabilities – MMEL/CDL references

- Permissable Unserviceabilities:
  - CAR Part 4, Division 4 – CAR 37 *Permissible unserviceabilities*
  - CAR Part 4, Division 9 – CAR 49 *Permissible unserviceabilities* to be endorsed on maintenance releases
  - CAR 42L (f)
  - CAR 43 (10) (b)
  - CAAP 37-1 (4).
- MMEL/MEL:
  - CAAP 37-1 (4)
  - CASR Part 42, Division 42.B.2 – Continuing airworthiness requirements – all aircraft
  - 42.030 (2) (e) (i) (A)
  - CASR Part 42, Division 42.C.2 – Continuing airworthiness management tasks
  - CASR Part 42.115 (1) (b) (i)
  - CASR Part 42, Division 42.D.6 – Requirements for dealing with defects
  - CASR Part 42.360 (3) (b) (ii)
  - CASR Part 42, Division 42.E.2 – Requirements for fitting parts and using materials
  - CASR Part 42.420 (3) (a) and (4) (c)
  - Chapter 1 – *Requirements of CAMO* of the Part 42 MOS, specifically:
    - 1.5.7 (c)
    - Appendix II of the Part 145 MOS – Category A licence tasks.
  - 2E1.15 – CASA Authorisations (authorised persons, airworthiness authorities)
- CAR 6 and CAR 6A
- CAR 29A
- CAR 30
- CAR 33 and CAR 33B
- CAR 42ZC
- CAR 42ZE
- CAR 42G
- CAR 42M
- CAR 42WA
- CASR Part 42.015 – Definitions for Part
- CASR Part 42, Division 42.B.3 – Record keeping requirements in relation to authorisations under regulation 42.630, specifically:
  - 42.090
- CASR Part 42, Division 42.G.4 – Authorisation of pilot licence holders and flight engineers to provide maintenance services; specifically:
  - 42.635
  - 42.640
  - 42.645.
- CASR Part 42, Division 42.G.5 – Requirements and offences for continuing airworthiness management organisations, specifically:
  - 42.660
- CASR Part 42, Division 42.L.3 subpart 42.O – Copying or disclosing cockpit voice recording Information; specifically:
  - 42.1105
- CASR Part 145 MOS 145.A.35 – Issuing certification authorisations
- CASR Part 145 MOS 145.A.30 – Personnel requirements

- CASR Part 145 MOS 145.A.37 – Training and assessment
- Appendix II of the Part 145 MOS.

2E1.6 – Maintenance Control Manual (equivalent to a CAMO Exposition under CASR Part 42) references

- Part 4A, Division 8 of the CAR, specifically:
  - CAR 42ZY
  - CAR 42 ZZ
  - CAR 42 ZZA
  - CAR 2
  - CAAP 42ZV-1 (0)
  - CASR Part 42.015 – Definitions for Part.
- Subpart 42.F Approved Maintenance Organisations (AMO), specifically:
  - 42.500 Definition for Subpart
  - 42.510 (3) (a)
  - 42.515 (1) (a) and (3)
  - 42.530 (a) (i)
  - 42.540 (2)
  - 42.545 (1) and (2)
  - 42.550 (1) and (2)
  - 42.555 (1) (a)
  - 42.560 (1).
- Subpart 42.G Continuing airworthiness management organisations (CAMO), specifically:
  - 42.575 Definition for Subpart
  - 42.580 (c)
- Division 42.G.2 Approval of continuing airworthiness management organisations, specifically:
  - 42. 585 (3) (a)
  - 42.590 (1) (a) and (3)
  - 42.605 (a) (ii)
  - 42.610 (2) (c)
  - 42.615 (2)
  - 42.620
  - 42.625 (1) and (2).
- Division 42.G.5 “Requirements and offences for continuing airworthiness management organisations”, specifically:
  - 42.650 (1) (a)
  - 42.655 (1).
- Chapter 1 – *Requirements of CAMO* of the Part 42 MOS, specifically:
  - 1.2 *Continuing airworthiness management exposition.*